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BY THE COMPTROLLER GENERAL

# Report To The Congress

OF THE UNITED STATES

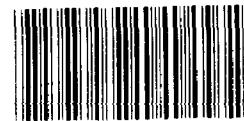
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## NASA Must Reconsider Operations Pricing Policy To Compensate For Cost Growth On The Space Transportation System

NASA's Shuttle pricing policy, established 5 years ago and based on average pricing over 12 years of operations, combined with increasing Shuttle operations costs, has created a situation where NASA must absorb the higher costs of operations for all users in the early years. At the same time, because of budget cutbacks, NASA must seek additional appropriations or delay or cancel its own research programs.

The projected average Shuttle launch cost has increased 73 percent from \$16.1 million in June 1976 to \$27.9 million in September 1980 (1975 dollars). Fixed user prices based on the June 1976 cost data will result in a \$1.2 billion NASA subsidy to other users through 1985 (1975 dollars).

GAO recommends that NASA's Administrator reassess the Space Transportation System pricing policy to establish a more equitable price to all users.



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COMPTROLLER GENERAL OF THE UNITED STATES  
WASHINGTON D.C. 20548

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To the President of the Senate and the  
Speaker of the House of Representatives

This report presents our views on how the National Aeronautics and Space Administration's pricing policy for the Space Transportation System, coupled with continuing Shuttle operations cost increases and constrained budgets, could affect future research and development programs of the National Aeronautics and Space Administration. This is our first report on the Space Transportation System's operational phase and is being furnished to the Congress for its use in reviewing fiscal year 1983 requests for funds.

Throughout this review, NASA officials have been slow to provide us the data and information we have needed to perform the review. A number of meetings between NASA and our officials failed to adequately resolve our access to records problems. On April 15, 1981, the Acting Comptroller General, in accordance with section 313 (b) of the Budget and Accounting Act, as amended, sent a demand letter to NASA's Administrator requesting access to certain specific data within 20 days. NASA responded on the 20th day. However, subsequent efforts to obtain additional data were met with continued delaying tactics.

Copies of this report are being sent to the Director, Office of Management and Budget; the Administrator, National Aeronautics and Space Administration; and the Secretaries of Defense, Air Force, and Commerce.

A handwritten signature in cursive script that reads "Charles A. Bowsher".

Comptroller General  
of the United States



D I G E S T

The first 3 years of operating the Space Shuttle will significantly affect the National Aeronautics and Space Administration's (NASA's) budgets because NASA has committed itself to charging a flat price over this period--even though operations costs, which are continuing to increase, would not, and do not, support the current price. This will require substantially higher prices than originally anticipated starting in fiscal year 1986 if NASA adheres to its present pricing policy of eventual recovery of total operations costs. Also, increasing upper stages and spacelab costs and understated use fee charges will affect NASA's budgets.

GAO made this review to determine the overall effect that the increases in the Space Transportation System's operations costs, and the Space Transportation System's pricing policy in general, would have on NASA's future budget requests and its other research and development programs.

NASA SUBSIDIZES OTHER USERS

Based on estimated future costs, NASA established a 3-year \$18 million 1/ fixed price in 1977 for commercial, foreign, and other U.S. civil agencies launches and a 6-year \$12.2 million fixed price for the Department of Defense (DOD) launches. The price was to be adjusted annually thereafter as necessary to recover total operations costs. (See p. 32.)

The projected average cost to fly a standard Space Shuttle mission has increased 73 percent from \$16.1 million in June 1976 to \$27.9 million as of September 1980. (See p. 7.)

NASA must fund the full cost of its flights and the difference between the actual cost per flight and the reimbursements received

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1/All costs are in 1975 dollars unless stated otherwise.

from other users until the price charged to users becomes more than actual costs and provides recoupment to the U.S. Government. (See pp. 32 to 34.)

It is currently estimated that NASA would pay 80 percent, or about \$2.1 billion of the \$2.5 billion, of the Shuttle operations costs through 1985 while flying 36 percent of the Shuttle flights. The \$2.1 billion includes about a \$1.2 billion subsidy to other users. (See p. 14.)

#### OPTIONAL SERVICES WILL AFFECT NASA BUDGETS

A minimum of 62 percent, or 103 of the 166 NASA flights included in NASA's 487 flight traffic model, will require more than the standard launch services. These services, such as upper stages and spacelab, can significantly increase the price of a Shuttle launch and affect future budgets. When costs increased, NASA tended to decrease the number of its missions to be flown. These decreases in turn have meant cutbacks in NASA's space science programs. (See pp. 23 to 28.)

#### USE FEE IS UNDERSTATED AND NOT CHARGED TO ALL USERS

NASA established a use fee of \$4.3 million (1977 dollars) to recover a fair share of the Government's capital investment in the orbiter fleet and in equipment and facilities. This fee is added to the standard launch price of \$18 million.

The use fee is understated by about \$6 million (1977 dollars) and is only charged to commercial and foreign users that did not participate in the Space Transportation System's development. As a result, NASA's budget must bear a major portion of these costs. (See p. 29.)

#### CONCLUSIONS

NASA is committed to a Space Transportation System pricing philosophy/policy under which it must subsidize other users' launches on the Space Shuttle in the early years of operations. At a time when NASA's programs are suffering due to budget constraints, they are locked into a pricing policy that encourages Space Transportation System use at NASA's expense and at

the expense of the space science, applications, and aeronautics programs. (See p. 19.)

GAO believes DOD and other Government agencies should bear a greater share of the Shuttle's early years operations costs. GAO also believes that optional services can increase the launch price significantly. (See pp. 20 and 28.)

#### RECOMMENDATIONS

GAO recommends that NASA's Administrator reevaluate the Space Transportation System's pricing and use fee policies with the objective of establishing a more equitable price to all users. Some alternatives include:

- Void the current pricing policy as it pertains to DOD and other Government agencies and establish a price more in line with NASA's Shuttle launch costs. (See p. 20.)
- Void the pricing policy as it pertains to all users and establish a price more in line with the cost to NASA to launch a Shuttle flight except for those launches that have legally binding agreements. (See p. 20.)
- Ensure that the prices established for the period after the first 3 years of operations adequately recoup the previous losses and fully recognize the potential cost increases during the early years of operations. (See pp. 20 and 21.)
- Charge DOD and other Government users the current use fee charged to commercial and foreign users. (See p. 30.)
- Update the current use fee to reflect all appropriate facilities and equipment costs and to reflect a more realistic orbiter flight rate. Charge the updated fee to commercial and foreign users where legally binding agreements have not been signed. (See p. 30.)
- Update the use fee as above and charge it to all users, including DOD and other Government users. (See p. 30.)

GAO also recommends that NASA's Administrator direct that the Agency's annual budget presentations to the Congress clearly show NASA's subsidies by user class, that is, DOD, civil

U.S. Government agencies, and non-Government users. (See p. 21.)

AGENCY COMMENTS AND  
GAO'S EVALUATION

GAO requested NASA, the Departments of Defense, Agriculture, Commerce, and the Interior to comment on our draft report. DOD declined comment on GAO's recommendations except to state that it believes any revision to DOD/NASA agreements should be a matter of interagency negotiation subject to the mandates of the Congress. Also, the Departments of Agriculture and the Interior declined comment on the report. NASA's and the Department of Commerce comments, and GAO's evaluations, are discussed below:

--NASA states that it is currently renegotiating a new launch price. (See p. 21.)

Details on NASA's proposed pricing policy revisions and revised DOD agreement were not available to GAO for analysis and inclusion in this report. (See p. 21.)

--NASA says a revised Space Transportation System's pricing policy and use fee are being reviewed and will be the basis for missions booked after 1985. NASA's position is that a pricing policy change now, including a change in the use fee, would undermine user's and potential user's confidence in the Shuttle program and the agency. (See pp. 21 and 31.)

GAO believes that price adjustments now would help alleviate NASA's budget problems. Canceling or delaying space science programs because of Shuttle cost increases and budget constraints also undermines the scientific community's confidence in NASA. (See pp. 21 and 31.)

--NASA states that GAO's recommendation that NASA charge the use fee to all users would be an exception to the practice of Government agencies providing services to one another without charge.

NASA further states that its practice of not charging the use fee to all users is consistent with the Office of Management and Budget Circular A-25. (See p. 31.)



Although the Office of Management and Budget Circular A-25 does provide exceptions to recovering full cost, it is an option, not a requirement. Under current economic conditions and NASA's present critical budgetary environment, GAO believes that NASA should charge the full use fee to DOD, civil U.S. Government agencies, and foreign governments. Otherwise, NASA appropriations are indirectly funding other U.S. Government agency and/or foreign government missions. (See p. 31.)

--NASA did not specifically comment on GAO's recommendation that the Agency revise its budget presentations to the Congress to identify NASA's subsidies to Shuttle users.

NASA is currently considering revisions to its Space Transportation System's pricing policy. The revised policy could conceivably reduce the amount of NASA's subsidies to Shuttle users. However, an underlying principle of the Space Transportation System's pricing policy is to encourage users to change over to the Shuttle by offering a launch price that is less than the cost to NASA to launch the Shuttle. Consequently, GAO believes it is reasonable to assume that even after NASA revises its current pricing policy, the Agency will be subsidizing users in the early program years. GAO continues to believe that NASA's Space Transportation System budget presentations to the Congress should provide greater visibility by clearly showing NASA's subsidies by user class. (See p. 22.)

The Department of Commerce objected to a revised pricing policy that would shift additional funding responsibilities to the users. (See p. 22.)

GAO believes the user agencies should be responsible for justifying any additional program costs to the Congress. If a user cannot justify a program's cost, then it raises a question as to the program's overall worth. (See p. 22.)

The full text of each agency's comments on a draft of this report and GAO's response to those comments are included in appendixes II through V.



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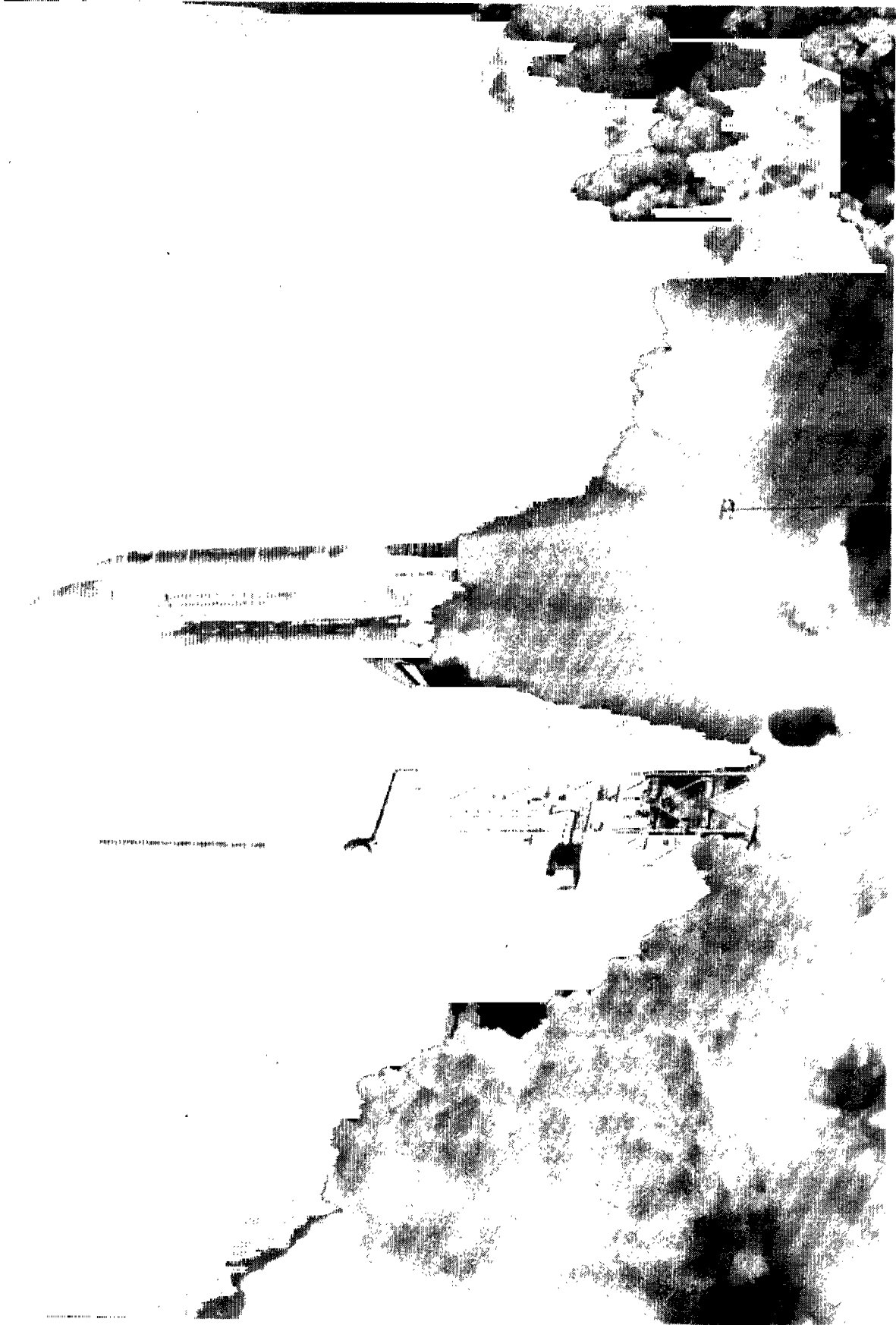
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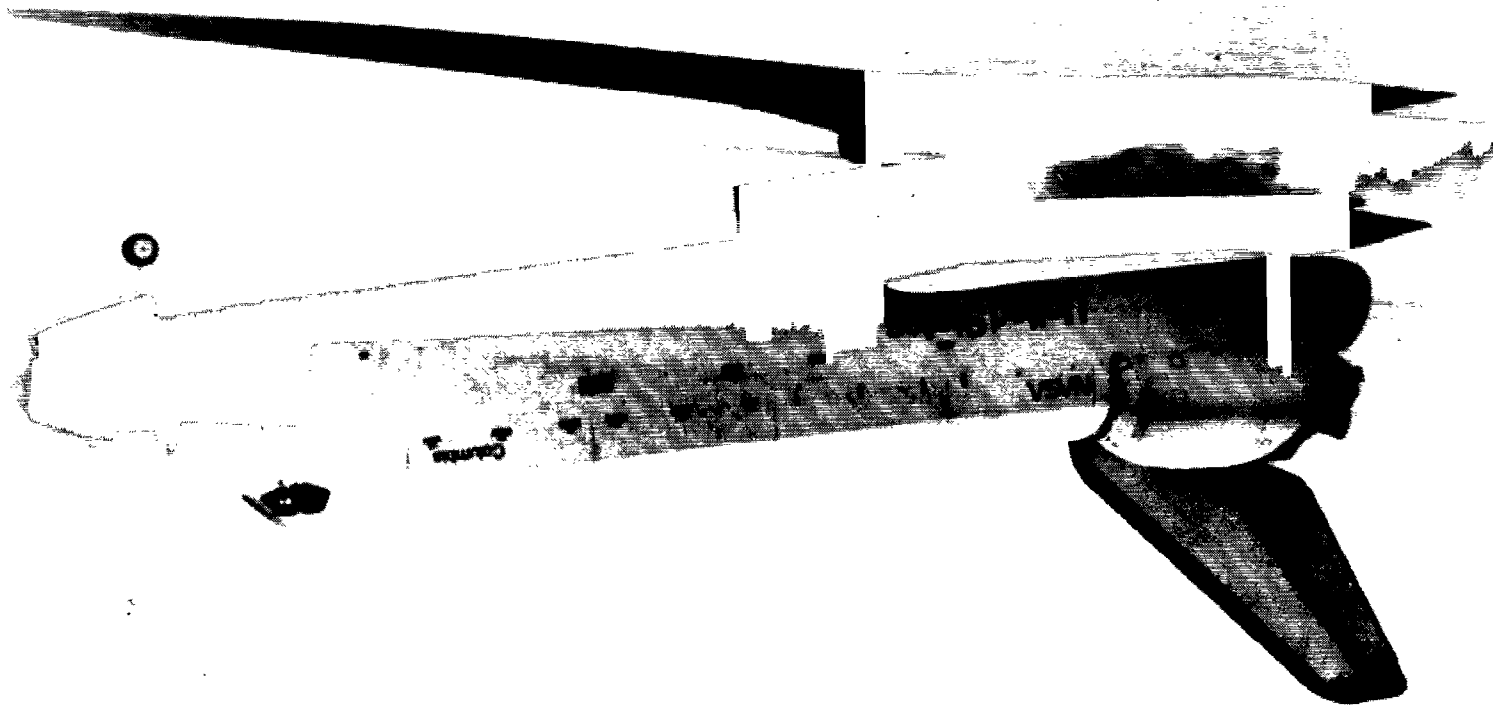
#### ABBREVIATIONS

DOD	Department of Defense
GAO	General Accounting Office
JSC	Johnson Space Center
KSC	Kennedy Space Center
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
STS	Space Transportation System



FIRST LAUNCH OF SPACE SHUTTLE COLUMBIA FROM KENNEDY SPACE CENTER

ORBITER COLUMBIA LANDING AT NASA'S DRYDEN FLIGHT RESEARCH CENTER



## CHAPTER 1

### INTRODUCTION

On April 12, 1981, a new space era was born. The spaceship Columbia roared to life and literally leaped from its launch pad at Kennedy Space Center (KSC) as it began its near perfect 54-1/2 hour journey into space--a scene that is to be often repeated in the decades ahead.

Columbia is the first of several orbiters that will become the workhorses of the Space Transportation System (STS). Designed to fly a minimum of 100 times, this reusable vehicle is the key to providing routine access to space for a wide range of scientific, defense, and commercial users.

The STS, approved for development in 1972, is composed of the Space Shuttle, expendable upper stages, spacelab, and related launch and landing facilities.

### SPACE SHUTTLE

The Space Shuttle consists of a reusable piloted orbiter, such as Columbia, with three main engines, two reusable solid rocket boosters, and an expendable liquid propellant tank referred to as the external tank. It is being designed to place payloads weighing up to 65,000 pounds into a 150-nautical mile due-east orbit from KSC and up to 32,000 pounds into a specified 100-nautical mile near-polar (north-south) orbit from Vandenberg Air Force Base.

The spacecraft Columbia was designated Orbiter 102. It is currently scheduled to make four test flights before the time the system will be considered operational in late 1982. By March 1985, three additional orbiters are planned to be in operation. Orbiter 099 (Challenger) is being converted from a structural test article to flight configuration and is scheduled to be used for the second operational mission. Procurement of long-lead items for Orbiter 103 (Discovery) and Orbiter 104 (Atlantis) has started and their initial operational flights are scheduled for January 1984 and March 1985, respectively. The fiscal year 1982 Shuttle production request also provides the necessary funding for long-lead materials to maintain an option for a fifth orbiter.

### EXPENDABLE UPPER STAGES

The STS upper stages are required to deploy Shuttle-launched payloads to orbits not attainable by the Shuttle alone. These upper stages are the spinning solid upper stages, the inertial upper stage, and the centaur. Each upper stage has its own unique capabilities. The spinning solid upper stage, for example, was developed commercially by the McDonnell Douglas Astronautics

Company and includes two models. The D and A models will be used to deploy payloads of up to 2,750 pounds and 4,400 pounds, respectively, from the Shuttle's low Earth orbit of about 100- to 600-nautical miles into a geosynchronous transfer orbit for eventual placement into the geosynchronous orbit 1/ which is about 22,000-nautical miles above the Earth.

The Department of Defense (DOD) is developing a solid-fueled "two stage" inertial upper stage for use by DOD and the National Aeronautics and Space Administration (NASA). The inertial upper stage is designed to place a 5,000 pound payload into geosynchronous orbit. NASA canceled a "three stage" inertial upper stage initially intended to provide for NASA's planetary mission needs because of cost overruns and performance deficiencies. The Administration's revised fiscal year 1982 budget for NASA supported the decision to replace the three-stage inertial upper stage with a modified General Dynamics Corporation centaur upper stage for integration into the Shuttle.

### SPACELAB

The spacelab is a cooperative venture between NASA and the European Space Agency. The major program objective is to provide versatile, low-cost laboratory and observatory facilities. This self-contained laboratory will be carried into orbit in the Shuttle's cargo bay and will remain in the orbiter throughout its mission. Early spacelab flights will last up to 7 days with future missions projected for as long as 30 days. The orbiter will provide all of spacelab's support requirements. Using the spacelab, scientists can conduct space research in a shirt-sleeve environment.

The spacelab consists of module and pallet sections used in various configurations to suit the needs of a particular mission. The pressurized module is accessible from the orbiter's cabin through a transfer tunnel. Pallets accommodate experiment equipment for direct exposure to space. NASA considers research for inspace manufacturing to be one of spacelab's most promising uses. The spacelab will also have advantages for life sciences' research because such research on previous spacecraft had to be fully automated and self-contained and did not allow interaction with the investigator after the experiment had started as the spacelab will do.

### LAUNCH AND LANDING FACILITIES

NASA and DOD agreed that the program, to be fully operational, would require two launch and landing sites--KSC in Florida and Vandenberg Air Force Base in California. Missions from KSC

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1/A geosynchronous orbit is one with the same period as the Earth's rotation.



are launched eastward out over the Atlantic Ocean and include all satellites for geosynchronous orbit. Missions requiring north-south orbits, including many weather and Earth-survey satellites, are launched southward over the Pacific Ocean from Vandenberg.

#### A MISSION PROFILE

A Shuttle mission begins with the installation of the payload into the orbiter cargo bay either on the launch pad or in special payload installation facilities. On launch, the Shuttle's three main engines and the two solid rocket boosters fire in parallel. The two solid rocket boosters are jettisoned at burnout which is approximately 2 minutes into the mission at an altitude of about 35-nautical miles. Using a parachute system for deceleration, the boosters fall back through the atmosphere into the ocean, are recovered by ship, and towed to land for refurbishment for future missions.

The main engines continue to burn for a total of about 8 minutes. Just before entering orbit, the main engines shutdown and the empty external tank, which contained the fuel for the main engines, is jettisoned. It is largely destroyed as it re-enters the Earth's atmosphere and falls into remote ocean areas.

The Shuttle's orbital maneuvering system is then fired to attain the correct orbit. The orbital maneuvering system plus the reaction control system is used to accomplish the orbital maneuvers required for the mission.

The normal stay in orbit is 7 days, but NASA hopes to eventually extend this to 30 days with Shuttle electrical power augmentation such as the 25-kilowatt power module. While in orbit, the payload bay doors can be opened to expose the payload to space. The crewmembers can conduct extravehicular activity related to the payload and mission requirements or safety considerations. Experiments can be conducted and satellites can be placed in orbit, launched to higher orbits or to a trajectory for deep space missions using upper stages, retrieved, and serviced. These orbital operations can be conducted at altitudes of 100- to 600-nautical miles.

When the orbital mission is completed, deorbiting is initiated by the orbital maneuvering system. The orbiter reenters the Earth's atmosphere at an altitude of about 76-nautical miles. When it gets about 5- to 6-nautical miles from the runway, the orbiter goes into a horizontal flight glide for an aircraft type approach and landing. Once the orbiter has landed, the payload is removed and the orbiter is serviced and reloaded for the next mission. The goal is to achieve ground turnaround in 2 weeks.

TRANSITION FROM DEVELOPMENT  
TO OPERATIONS

NASA originally planned six orbital test flights for the design, development, test, and evaluation phase of the Shuttle program. Only four test flights are now planned with the final flight set for July 1982. The same orbiter, Columbia, will be used for the four test flights.

The test flights are to verify the design and operational capability of the Shuttle flight system and all of the ground-based monitoring, communications, and support systems. The first flight conducted in April 1981 was structured to minimize risk and complexity and was about 2 days in duration. The second flight, conducted in November 1981, was scheduled for 5 days but was cut to about 2 days due to a fuel cell problem. The latter two flights increase up to 7 days and will expand the mission and payload capabilities and become progressively more complex.

Following completion of the four orbital test flights in July 1982, NASA plans to move into the STS operations. The first operational flight is scheduled for November 1982 and will also use the Columbia.

NASA/DOD OPERATIONS  
MANAGEMENT RESPONSIBILITY

NASA and DOD have been jointly involved from the beginning in planning for the Space Shuttle. As the Shuttle design evolved in the early 1970s, DOD requirements were a driving factor, and DOD is now anticipated to be the single largest user and a major investor in the Shuttle.

In January 1977, DOD and NASA executed a Memorandum of Understanding to formulate their responsibilities. This memorandum was revised in March 1980 to better define DOD/NASA management interfaces.

DOD is responsible for the conduct of all national security missions. Also, DOD will develop and acquire specified elements of the STS and ensure that other aspects of the STS program are consistent with national security requirements. On behalf of DOD, the Air Force will provide and operate the facilities for all Shuttle operations at Vandenberg.

NASA's responsibility under the revised Memorandum of Understanding is to develop, manage, provide systems engineering, and operate the Shuttle to serve all authorized space users. NASA will also provide and operate the facilities and equipment for Shuttle mission planning, simulation, training, and flight operations at the Johnson Space Center (JSC) and for Shuttle launch, landing, and turnaround activities at KSC.

## BACKGROUND

Developing the Space Shuttle and producing a fleet of operational vehicles has dominated NASA's overall program and its funding requests in recent years. NASA estimates that the Shuttle development will cost \$9.9 billion (1982 dollars) and the orbiter procurement \$4.6 billion (1981 dollars). During the February 1980 hearings on NASA's authorization for fiscal year 1981, the chairman of the Senate Committee on Commerce, Science and Transportation said that technical difficulties, schedule delays, program management problems, and the need for additional funds for the Shuttle program during the past year had been a source of increasing concern to the committee. He further stated:

"While the Shuttle program is an immediate concern, the committee desires to assess carefully the space science and applications activities contemplated by this budget, because these activities, in fact, represent the substantive means for exploring and utilizing the space environment. The NASA space program must have balance. We cannot at this time neglect the planning and other preparatory work essential to effectively utilizing the shuttle's capabilities in the future."

NASA has already canceled or delayed a number of new programs because of STS' development costs and budget constraints. For example, funding constraints precluded major new initiatives in NASA's fiscal year 1980 program and limited the number of new initiatives in all the years of its fiscal years 1980-84 5-year plan. It now appears that increases in the cost to operate STS and NASA's policy for determining the price to users of STS could further strain NASA's budgets.

## OBJECTIVE, SCOPE, AND METHODOLOGY

The objective of our review was to determine the overall effect that the increases in STS' operations costs, and STS' pricing policy in general, would have on NASA's future budget requests and its other research and development programs. Our review was directed to the fiscal years 1983-94 time frame, which is the projected operational life of the STS program as currently designed. This review was performed in accordance with our current "Standards for Audit of Governmental Organizations, Programs, Activities, and Functions."

Our audit was conducted primarily at the Marshall Space Flight Center (MSFC), Alabama; KSC, Florida; and NASA Headquarters, Washington, D.C.

We selected MSFC because they manage the solid rocket boosters and external tank--two items that make up the bulk of the consumable operations costs. KSC was selected because the majority of the flights will be launched from this site. NASA Headquarters

manages the overall program and is the source for official NASA positions. Additional information was obtained at DOD Headquarters and from JSC, Texas, and the Air Force Systems Command's Space Division, California.

The fluidity of the STS' operations data and time constraints compelled us to limit our report to data supporting NASA's fiscal year 1982 budget request that was submitted to the Congress in January 1981. We did not attempt to determine the effect that subsequent reductions in NASA's fiscal year 1982 budget will have on the STS program.

We obtained our data on STS' operations costs and costs per flight from NASA Centers' inputs to the STS program operating plans and from NASA Headquarter's presentation of this data. The program operating plan is NASA's internal management system used in preparing NASA's annual budget.

Our review of NASA's pricing policy was directed to the price of a dedicated flight which is one flown for a single user. We did not review prices per payload on multimission launches or on small, relatively inexpensive research and development "get-away specials" that require no Shuttle services and are flown on a space available basis.

We reviewed NASA's budget presentations to the Congress, including related congressional testimony and NASA's 5-year planning documents. We also reviewed various NASA studies and assessments on Shuttle operations costs, documents prepared by NASA's user charge working group, NASA's user charge pricing and reimbursement policy and supporting data and conducted interviews with responsible NASA and DOD officials concerning the rationale and justification for decisions made and actions taken.

We asked NASA, DOD, and the Departments of Agriculture, Commerce, and the Interior to comment on our draft report. The Department of the Interior did not provide comments. The comments of the other agencies are included in their entirety as appendixes II through V. Their responses to our recommendations are discussed on pages 21 and 30 of this report.

NASA's STS pricing philosophy is discussed in appendix I and a listing of our 11 previous reports on the STS is included in appendix VII.

## CHAPTER 2

### SHUTTLE LAUNCH AND OPERATIONS COSTS HAVE EXCEEDED

#### ESTIMATES AND WILL PROBABLY CONTINUE TO GROW

The basic criterion of NASA's user charge policy is to recover total Shuttle operations costs, not for each flight or for each year but, rather, over a 12-year projected operating life of the program. In June 1976, NASA officials estimated that the cost of the Space Shuttle operations for 572 flights between 1980 and 1991 would cost about \$9.2 billion <sup>1/</sup>, or an average of \$16.1 million a flight. However, NASA established a price range of \$16.1 million to \$18 million to cover possible cost increases before reimbursement agreements were negotiated.

The projected average cost of a standard flight has increased from \$16.1 million in June 1976 to \$27.9 million as of September 1980, or about 73 percent. The external tank, the solid rocket boosters, and other items whose costs are common to either an East or West Coast launch account for \$9.2 million of the recognized \$11.8 million cost-per-flight increase. The remaining \$2.6 million is the average cost-per-flight increase for KSC and Vandenberg launch operations, propellants, and ground-support equipment spares. These costs vary depending on the launch location.

Additional cost-per-flight increases are likely to be recognized by NASA in its fiscal year 1983 budget submission to the Congress. These increases could add as much as \$2.6 million to the \$27.9 million cost per flight.

#### REASONS FOR COST GROWTH ALREADY EXPERIENCED

NASA data show that at least half of the cost growth is due to design changes, added requirements, and inaccurate estimates. Other increases can be attributed to inaccurate inflation rates and a reduction in the mission model from the 1976 baseline projection of 572 flights to 487 flights projected as of September 30, 1980. With the exception of the reduction in the mission model, which is unique to the Shuttle, the causes of the cost growth in the STS are not new or unlike the causes of cost growth experienced by other Government agencies. Unfortunately, significant cost growth, and the factors contributing thereto, have historically occurred with some consistency in major research and development programs. In fact, in our reports as

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<sup>1/</sup>All costs are in 1975 dollars unless stated otherwise.

far back as 1975, we discussed these factors as the major contributing factors to cost growth in NASA programs. 1/

The following schedule shows the cost-per-flight increases since 1976 by cost element.

Cost-Per-Flight Increases

	June 1976 <u>estimate</u>	September 1980 <u>estimate</u>	<u>Increase</u>
—(millions in 1975 dollars)—			
Common cost elements:			
Solid rocket boosters	\$ 3.55	\$ 6.98	\$3.43
External tank	3.04	6.22	3.18
Flight operations support	2.82	5.01	2.19
Orbiter spares	.63	.87	.24
Main engine	.31	.48	.17
Contract administration	.14	.18	.04
Crew equipment	<u>.26</u>	<u>.18</u>	(.08)
Total	\$10.75	\$19.92	\$9.17
KSC only:			
Launch operations	\$ 4.29	\$ 5.11	\$ .82
Ground support equipment spares	.45	.31	(.14)
Propellants	<u>.76</u>	<u>.66</u>	(.10)
Total	\$ 5.50	\$ 6.08	\$ .58
Vandenberg only:			
Launch operations	\$ 4.10	\$12.45	\$8.35
Ground support equipment spares	.12	.24	.12
Propellants	<u>.69</u>	<u>.77</u>	<u>.08</u>
Total	\$ 4.91	\$13.46	\$8.55
Totals:			
KSC launch	<u>\$16.25</u>	<u>\$26.00</u>	a/ <u>\$9.75</u>
Vandenberg launch	<u>\$15.66</u>	<u>\$33.38</u>	a/ <u>\$17.72</u>
Combined Averages	<u>\$16.07</u>	<u>\$27.90</u>	a/ <u>\$11.83</u>

a/The 1976 projection was based on a 572 flight model, 399 flights from KSC and 173 flights from Vandenberg. The current estimate is based on the September 1980 presentation to the Office of Management and Budget for 487 flights; 362 flights from KSC, and 125 flights from Vandenberg.

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1/"Need for Improved Reporting and Cost Estimating on Major Unmanned Satellite Projects" (PSAD-75-90, July 25, 1975).

The following paragraphs provide some of the reasons for the cost-per-flight increases.

#### Solid rocket booster

Each Shuttle launch requires two solid rocket boosters. They are recovered, refurbished, and reused on future flights. The solid rocket boosters along with the external tank make up the bulk of the consumable costs. Since 1976, the solid rocket booster cost-per-flight estimate has just about doubled. A November 1980 NASA assessment showed a number of reasons for the cost growth. For example, there were a number of design and configuration changes to the solid rocket motor and booster systems to perfect the hardware. In some instances this required additional hardware and/or equipment handling, processing and inspection, and production labor.

A reduction in the mission model has decreased usage of reusable hardware in the solid rocket motor and the booster systems. This has reduced the expendable hardware and labor learning benefits. Production gaps and restartup have primarily affected the booster systems.

The 1976 and current cost-per-flight estimates are stated in 1975 dollars. Actual inflation has outpaced the Bureau of Labor Statistics inflation index. For example, the solid rocket motor expendable material costs were 64 percent greater than reflected in the inflation rates. Similar results were noted for the booster systems' structural material and labor rates at 20 percent and 30 percent, respectively. Thus, according to NASA, although the cost-per-flight estimates are stated in 1975 dollars, certain inflation factors have crept in.

In addition to the above items, the cost-per-flight estimate for the solid rocket boosters was understated. For example, recurring refurbishment kits and other items not initially considered in the estimate have been included.

#### External tank

The external tank is actually two tanks in one, one for liquid oxygen and one for liquid hydrogen. It is mated to the bottom of the orbiter and supplies propellant to the main engines through an umbilical connection. Shortly before reaching orbit the external tank is jettisoned and destroyed. The external tank's cost has doubled since 1976 to over \$6 million.

The external tank has required a more complicated thermal protection system than originally anticipated. There have been additional structural requirements. Requirements were also added for a range safety system, ice protection, weight reduction, and interface hardware.

NASA has also adjusted its estimate to reflect the cost of certain Government and contractor furnished hardware that was excluded from the original estimate. NASA has also been able to better identify requirements for spares; Michoud Assembly Facility support; propellants and pressurants; barge operations; transportation; and sustaining engineering at MSFC.

Finally, the STS' flights 5 and 6 have been dropped from the development test phase and are now scheduled as operational flights. The cost of external tanks 5 and 6 formerly included in the design, development, test, and evaluation programs are now included in the operations costs.

#### Flight operations support

JSC has responsibility for providing users preflight and real-time support. Standard real-time payload support services include one of two flight controllers to assist the user. One controller functions as the user's primary interface with the STS operations while the other works closely with the user to resolve payload data routing problems, and so forth. Additionally, JSC will provide flight control support of the Shuttle during launch and entry and support of on-orbit Shuttle operations.

Flight operations support costs have increased about 77 percent since 1976. This has been due in part to increases in civil service and contractor human resources requirements at JSC from 3,523 to 5,071. The reasons for the human resources increase include flight planning complexities, increased mission control center support from a 7-day/2-shift operation to a 7-day/3-shift operation, increased simulator modifications between flights, increased flight-to-flight software reconfiguration requirements, inclusion of orbiter postflight data reduction analysis, and program office management integration support.

#### Orbiter spares

The orbiter spares cost-per-flight estimate has increased from \$0.63 million in 1976 to \$0.87 million as of September 1980. There are several factors contributing to the increased costs, including reduced flight hardware operating life. The fuel cell has an estimated 600- to 800-hour operating life compared to the 2,000-hour design goal. The orbiter has 3 power units each with an estimated operating life of 10 missions instead of the 50-mission design goal. Also, the nose cap and wing panels on the leading edge support structure has an estimated life of from 20 to 50 missions compared to a 100-mission design goal.

There has also been a better identification of consumables and spares requirements that have increased costs. The orbiter's wheels will be changed every flight instead of every 36 flights as originally planned. The addition of pyrotechnics in the consumables estimate has also increased unit costs.



NASA has also included thermal protection system tile spares in the orbiter cost per flight. These spares were not previously included. Also, NASA has identified the spares shelf life which has also increased spares requirements and thus the costs. The better identification of requirements further increased costs due to the need for increased sustaining engineering tasks.

#### Main engine

The orbiter has three main engines, which combined with the solid rocket boosters provide the power for launch. The design goal was to have each engine fly 55 flights before major overhaul. Since 1976 the Space Shuttle main engines cost per flight has increased by \$0.17 million.

One reason for the cost increase is that the current estimate is based on main engine overhaul once every 40 flights instead of the design goal of 55 flights. This has also increased requirements for replacement spares. NASA also increased the sustaining engineering for resolution of anomalies.

#### Crew equipment, ground support equipment spares, and propellants

Each of these three elements has shown cost-per-flight decreases since 1976. There was an \$0.08 million decrease for crew equipment attributed to a decrease in the outyears contractor price. Ground support equipment spares cost per flight has decreased by \$0.14 million. The original replacement factor of 5.9 percent was based on aircraft experience and was too high. Based on the ground support equipment replacement factor for the Shuttle, the estimate has been reduced. Finally, the \$0.10 million cost-per-flight reduction for propellants is the result of a 19-percent reduction in the acquisition cost of liquid hydrogen.

#### KSC launch operations

The primary reason cited for the KSC launch operations increase was a 26-percent increase in civil service and contractor human resources requirements, that is, from 5,423 to 6,837. About 64 percent of the increase was for additional tasks to prepare the orbiter, main engines, solid rocket booster, and external tank for launch, and to refurbish this equipment, except for the external tank, for reflight. The tasks include tile installation and require a limited third shift.

#### Other cost elements

A November 1980 assessment was conducted at the NASA Center level using its cost estimate inputs. Contract administration is a NASA Headquarters' function and the cost variance for this item was not addressed. Also, the study did not address the reasons for increased Vandenberg operational cost increases. One

obvious factor, however, is a reduced flight rate from the Vandenberg launch site.

#### OTHER COST-PER-FLIGHT INCREASES LIKELY

On March 10, 1981, NASA submitted a revised fiscal year 1982 budget to the Congress which showed a decrease of \$604 million from the request accompanying the budget submitted in January 1981. This provides for NASA to prepare for early Space Shuttle operational missions at a flight rate reduced from 44 flights to 30 flights for the operational period through fiscal year 1985. A part of the problem is the external tank production rate which is less than anticipated to fly the early missions. These problems are being studied but the total cost effect has not yet been determined.

We identified a number of potential KSC launch cost increases which could further increase the cost per flight a total of \$2.64 million. This includes a \$1.44 million consumables cost increase for the external tank, solid rocket boosters, and main engines and \$1.2 million for KSC launch operation. These are discussed below:

#### External tank, solid rocket booster, and main engine

The external tank's cost per flight could increase as much as \$1.2 million due to (1) additional thermal protection system changes, (2) a possible requirement for range safety and ice protection systems beyond the 54th flight, (3) nonrealization of projected produceability savings, (4) potential production labor cost increase, and (5) other potential increases for which funds are being reserved. Also, the external tank's cost per flight may be over or understated due to possible inaccuracies in the projected spare parts cost.

The projected solid rocket booster's cost per flight may be understated by about \$0.03 million because it excludes the cost of spare parts to be used on the first 20-operational Shuttle flights and excludes funds reserved for potential increases due to hardware modifications and underestimated human resources requirements for selected contracts.

The main engine's cost per flight may increase as much as \$0.21 million due to revised failure rates and recalculations of hardware cost and requirements, additional overhaul costs, and potential increases in hardware requirements.

#### KSC launch operations

The KSC launch operation cost per flight of \$5.36 million may increase by more than \$1.2 million for additional cost to

- operate and maintain equipment to test the compatibility of electrically powered payloads with the Shuttle's electrical system;
- assemble, checkout, and refurbish solid rocket boosters;
- launch the first operational Shuttle flight (STS-5);
- process the Shuttle for launch;
- operate and maintain mobile launcher platform number 3 and the software development facility; and
- obtain DOD support for Shuttle launches.

In the STS program, the cost growth discussed in the preceding sections takes on a new dimension. That is, although the Shuttle is considered to be a national asset to be used by others in addition to NASA, the cost growth in the program will have to be absorbed by NASA's budget, at least during the first 3 years of operation (fiscal years 1983-85). That is, under NASA's pricing policy, a firm-fixed price was established for flights in these first 3 years. In 1977, with the exception of DOD, NASA set \$18 million as the charge to a single user for a standard Shuttle launch. The fixed price charged DOD is \$12.2 million.

#### CONCLUSIONS

The cost per flight to launch and operate the Space Shuttle has already significantly exceeded the original estimates and will probably continue to grow. Under NASA's current pricing policy, the agency cannot pass on these cost increases to the Shuttle users during the first 3 years of Shuttle operations. As a result, these increases are affecting NASA's budget.

### CHAPTER 3

#### NASA'S PRICING POLICY AND SHUTTLE OPERATIONS

##### COST GROWTH PUTS GREATER DEMANDS ON ITS BUDGETS

NASA will pay 80 percent or about \$2.1 billion of the \$2.5 billion phase I (fiscal years 1983-85) Shuttle operations costs, while flying only 36 percent or 16 of the 44 Shuttle flights. The \$2.1 billion includes \$920 million to fund NASA's flights at the actual costs and a \$1.2 billion subsidy to fund the difference between actual costs and reimbursements for civil, foreign government, commercial users, and for DOD. NASA's success in recouping these costs in the future will depend on NASA's phase II (fiscal years 1986-94) price, not yet established, and their success in renegotiating DOD's agreement that is discussed on pages 18 and 21 of the report.

##### AVERAGE COST CONCEPT RESULTS IN EARLY YEAR NASA SUBSIDIES TO NON- NASA SHUTTLE USERS

Through fiscal year 1985, NASA's total estimated budget for 44 flights <sup>1/</sup>(16 NASA flights, 15 other civil, commercial and foreign users, and 13 DOD flights) was \$2.53 billion or an average of about \$57.5 million per flight. The cost per flight for the first eight Shuttle operational flights scheduled through fiscal year 1983 is even more staggering, that is, \$116 million per flight. To charge a price equal to the cost of a launch in the early years of the program would have defeated NASA's goal of encouraging the early transition of users from expendable launch vehicles to the Shuttle. That is why NASA decided to base the price on a 12-year average rather than trying to recoup actual costs on a year-to-year basis.

As a result, NASA must fund the difference between actual cost of a launch and the price charged the Space Shuttle users in phase I. It has been understood since the Congress approved the Shuttle pricing policy in 1977 that NASA would pay a large percentage of the early year costs. At the time approval was given to the pricing policy, NASA was paying 82 percent of the costs during the first 3 years of operations while flying 55 percent of the flights. It is currently estimated that NASA will pay 80 percent, while flying 36 percent of the Shuttle flights. As shown in the following table, the current estimate of NASA subsidies to non-NASA Shuttle users are very substantial.

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<sup>1/</sup>Based on the May 15, 1980, traffic model. Two of the 44 flights were listed as reflight opportunities. We included these as commercial flights.

Phase I Subsidies

<u>User class</u>	<u>Number of flights</u>	<u>Reimbursements to NASA</u>	<u>Cost at \$57.5M per flight</u>	<u>Subsidy</u>
		----- (millions in 1975 dollars) -----		
NASA	16	\$ -	\$ 920.0	\$ -
Civil, commercial, and foreign	15	a/270.0	862.5	592.5
DOD	<u>13</u>	<u>b/158.6</u>	<u>747.5</u>	<u>588.9</u>
Total	<u>44</u>	<u>\$428.6</u>	<u>\$2,530.0</u>	<u>\$1,181.4</u>

a/Based on a price of \$18 million per flight.

b/Based on a price of \$12.2 million per flight.

The table shows that a significant portion of NASA's estimated budget for STS operations in phase I of the program will be used to subsidize non-NASA users of the Shuttle. These funds are being siphoned from NASA's science and applications programs. The March 1981 revised budget submission deferred or eliminated 1981 and 1982 new programs and reduced selected ongoing programs. For example, NASA deleted the U.S. spacecraft for the International Solar Polar Mission and postponed the Gamma Ray Observatory launch about 2 years from the first half of 1986 to either late 1987 or early 1988.

A more recent example of the Shuttle's effect on NASA's budget is the merger of NASA's Office of Space Science and Space and Terrestrial Applications into the Office of Space Science and Applications which took effect on November 9, 1981. The Administrator said one of the reasons for the consolidation is the program reductions that have occurred over the last several years.

At a time when all of NASA's programs are competing for limited funds, NASA is in effect, supplementing other agencies' budgets with its own funds. Since DOD is expected to be the single largest user of the Shuttle, the effect of DOD's pricing agreement on NASA's budget is discussed in detail in the following section.

DOD "special customer" status adversely affects NASA's budget

NASA estimates show Shuttle launch costs for DOD missions will exceed DOD reimbursements by \$745.5 million over the 12-year period of Shuttle operations. This includes the \$588.9 million subsidy by NASA through fiscal year 1985.

The 1977 NASA/DOD pricing agreement sets a fixed price for DOD flights of \$12.2 million for the initial 6 years of Shuttle

operations. Subsequent prices to DOD cannot reflect any under or over charges from this period. The pricing agreement is based on the assumption that NASA launch operations support for DOD missions from KSC plus flight operations support for all DOD flights will about equal DOD launch support for non-DOD missions from Vandenberg. As a result NASA and DOD will not exchange funds for these services.

The \$12.2 million price represents the 6-year average of consumable costs only--such as the external tank, solid rocket booster, and main engine refurbishments. A recent NASA estimate shows the consumable cost per flight to be \$21 million rather than the \$12.2 million provided for in the NASA/DOD agreement. The following table shows a comparison of the two NASA estimates.

6-Year Average  
Consumable Cost Per Flight

<u>Cost element</u>	<u>Basis for NASA/DOD March 1977 agreement</u>	<u>Estimate dated November 5, 1980</u>	<u>Cost variance</u>
------(millions in 1975 dollars)-----			
External tank	\$ 3.9	\$ 8.2	\$ 4.3
Solid rocket booster	4.1	8.6	4.5
Main engine	0.3	0.8	0.5
Crew equipment	0.2	0.4	0.2
Orbiter spares	0.5	1.1	0.6
Contract administration	<u>0.2</u>	<u>0.4</u>	<u>0.2</u>
Total	\$ 9.2	\$19.5	\$10.3
Contingency	<u>3.0</u>	<u>1.5</u>	<u>(1.5)</u>
Total	<u>\$12.2</u>	<u>\$21.0</u>	<u>\$ 8.8</u>

As can be seen in the above table, the estimated cost of consumables over the first 6 years of Shuttle operations has more than doubled. At an \$8.8 million per flight undercharge, the 29 DOD flights in the first 6 years will run up a \$255.2 million tab which NASA must fund from its appropriations, but which they cannot recoup from DOD in later years.

In addition to the increases in the consumable cost per flight, the assumption that NASA's launch operations support for DOD missions from KSC plus flight operations support for all DOD flights will about equal DOD launch support costs for non-DOD flights from Vandenberg has proven to be invalid. Initial calculations upon which the NASA/DOD pricing agreement was based showed that the value of the services were relatively close and actually favored NASA by about \$12 million. However, there has been a significant shift in the number of DOD missions and a

reduction in the number of non-DOD launches from Vandenberg projected over the 12-year period. As a result, NASA's support costs for DOD missions launched from KSC plus flight operations support for all DOD missions exceed DOD's launch support for non-DOD missions from Vandenberg by \$490.3 million. A table comparing the two estimates follows:

DOD vs. NASA Support Costs  
12-Year Operations Base

	<u>Basis for NASA/DOD</u> <u>March 1977 agreement</u>			<u>NASA estimate based on</u> <u>September 26, 1980, FY 82</u> <u>Office of Management</u> <u>and Budget presentation</u>		
	<u>Flights</u>	<u>Cost</u> <u>per</u> <u>flight</u>	<u>Value</u>	<u>Flights</u>	<u>Cost</u> <u>per</u> <u>flight</u>	<u>Value</u>
		(millions in 1975 dollars)			(millions in 1975 dollars)	
DOD support to non-DOD users at Vandenberg:						
Launch operations	84	\$7.5	\$630	62	\$12.45	\$ 771.90
Propellants and ground support equipment spares	84	<u>\$1.1</u>	<u>92</u>	62	<u>1.01</u>	<u>62.62</u>
Total		<u>\$8.6</u>	<u>\$722</u>		<u>\$13.46</u>	<u>\$ 834.52</u>
NASA support to DOD at KSC and Vandenberg:						
Launch operations (KSC)	71	4.3	305	91	5.11	465.01
Flight operations (KSC and Vandenberg)	109	3.0	327	154	5.01	771.54
Propellants and ground support equipment spares (KSC)	71	<u>1.1</u>	<u>78</u>	91	<u>0.97</u>	<u>88.27</u>
Total		<u>\$8.4</u>	<u>\$710</u>		<u>\$11.09</u>	<u>\$1,324.82</u>
Difference			\$ 12 (DOD short- fall)			\$490.30 (NASA short- fall)

It is evident that the Shuttle's cost growth has far exceeded anything NASA had expected. NASA was confident that the Shuttle's consumable cost growth would not exceed the \$3 million contingency per flight through the first 6 years of operations. NASA not only agreed to give DOD a \$12.2 million 6-year fixed price but also agreed that any costs above the fixed price could not be recovered from DOD in later years. Before Shuttle operations have even begun, the estimated 6-year average for consumable costs has grown to \$21 million for a cost growth about 4 times the contingency provided, and there are 7 years to go before the price can be adjusted.

The issue of whether DOD should reimburse NASA for expected increases in Shuttle costs is being debated. DOD has indicated that the dedicated flight price of \$12.2 million per flight for the first 6 years should remain unchanged. However, by letter dated January 20, 1981, NASA's Acting Administrator advised the Secretary of the Air Force, as follows, of the need to revise the reimbursement provision of the 1977 NASA/DOD pricing agreement:

"\* \* \* under the 1977 agreement, DOD was to be charged a fixed price equivalent to \$12.2 million in FY 1975 dollars for each flight for the first 6 years of the operational period. This price, when originally established was intended to cover the 'out-of-pocket' costs for conducting the mission, i.e., consumables such as the external tanks, engine refurbishment, solid rocket propellants and refurbishment, etc. Since this price was established, the estimated costs for these consumables have increased by about fifty percent.

"As discussed with you informally last year, in recognition of these increased estimates, the NASA FY 1982 budget projections to the OMB reflected higher anticipated reimbursement consistent with the above estimates for DOD missions starting in FY 1983. In view of the potential impact of these revised estimates upon our budget planning, I think it is essential that we now renegotiate a new price for DOD launches \* \* \*."

The Office of Management and Budget has also expressed concern about the need for NASA and DOD to resolve the repricing issue. By letter dated March 19, 1981, the Director of the Office of Management and Budget advised the NASA Acting Administrator that the issue of whether DOD should reimburse NASA for expected increases in near-term Shuttle launch costs must be addressed during the 1983 spring planning review. The pricing agreement had not been revised at the time we prepared our draft report.



## NASA UNLIKELY TO RECOVER TOTAL SHUTTLE OPERATIONS COSTS AS PLANNED

NASA's stated pricing policy is to recover total Shuttle operations costs projected for the initial 12 years of operations by the end of that period. NASA estimated that they would begin to break even on commercial, foreign, and other U.S. civil flights sometime in fiscal year 1987 or not until the 2d year of phase II. At that point in time they were to begin, albeit slowly initially, recouping some of the early years losses. However, there are several factors that make this unlikely.

In August 1980, NASA projected that if the price of \$18 million is held for the initial 3-full years of Shuttle operations, the minimum price which should be charged for flights during fiscal years 1986-94 to recover all costs for the 12-year period would be \$27.6 million per flight. This would be a significant price rise for phase II users and NASA had been looking at a number of options, including the possibility of phasing in the price adjustment over several years and/or extending the operational cost base beyond 12 years. Furthermore, NASA is planning fixed-price-type contracts in phase II signed about 3 years before flight date which, if the actual costs continue to increase, will continue to push cost recovery to later years.

A second factor is a June 1981 change in the STS traffic model reducing the number of operations flights in phase I from 44 flights to 30 flights. This will further increase costs and extend the period of time before NASA can begin to recover early years losses. The full effect on cost recovery will not be known until NASA firms up its traffic model, revises its estimated cost per flight, and establishes a phase II price.

A third factor is the NASA/DOD pricing agreement. Unless this agreement is revised, NASA stands to lose at least \$745 million on DOD flights as noted earlier. A further imbalance is that NASA will be funding the launches of DOD from KSC several years before DOD begins launching non-DOD flights from Vandenberg. Also, although NASA incurs costs beginning at least 3 years before flight, DOD, unlike other users does not make payment until about 1 year before launch. In this way, NASA is using its appropriated funds to support DOD flights without any cost being reflected in the estimated \$745 million loss.

## CONCLUSIONS

NASA is committed to an STS pricing philosophy/policy under which it must subsidize other users' launches on the Space Shuttle in the early years of operations. It is ironic that at a time when NASA's programs are suffering due to budget constraints, they are locked into a pricing policy that encourages STS use at NASA's expense and at the expense of its space science, applications, and aeronautics programs.

In addition to the average cost concept, NASA further enhanced user transition to the STS by assuming certain cost risks in establishing a 3-year firm-fixed price for non-DOD users and a 6-year firm-fixed price for DOD flights. NASA was more or less gambling, particularly regarding DOD flights, that total STS operations costs would not increase to the point where the average cost per flight would exceed the fixed price. NASA can recover excess costs for non-DOD flights in phase II but this will increase the Shuttle price to phase II users. NASA, however, cannot recover excess costs for DOD flights nor recover the imbalance between launch services costs at the Vandenberg and KSC launch sites.

We believe other Government agencies and especially DOD should bear a greater share of the Shuttle's early years operations costs. Also, NASA should not be required to subsidize other user's flights at a time when NASA has to severely curtail missions such as the already agreed to International Solar Polar mission.

In our opinion, it is essential that the Congress be aware of the extent to which NASA's appropriations will be supporting non-NASA activities in the early program years. While NASA's annual budget presentation to the Congress discloses the amount of reimbursements, it does not disclose non-NASA unreimbursed costs. Also, the inclusion of this data would increase congressional visibility over NASA's purchasing power to carry out its own mission.

We also believe NASA's annual budget presentation to the Congress should clearly disclose the amount of Shuttle operations funds that will be used to subsidize each class of user in these early years.

#### RECOMMENDATIONS

We recommend that NASA's Administrator reconsider the STS pricing policy. Some alternatives that could be considered are:

- Void the current pricing policy as it pertains to DOD and other Government agencies and establish a price more in line with the cost to NASA to launch a Shuttle flight. Included would be a reevaluation of the NASA/DOD agreement for offsetting launch services charges at KSC and Vandenberg. This alternative would maintain the phase I prices for commercial and foreign users.
- Void the pricing policy as it pertains to all users and establish a price more in line with the cost to NASA to launch a Shuttle flight except for those launches that have legally binding agreements.
- Ensure that the soon to be established phase II prices adequately recoup the previous losses and fully

recognize the potential cost increases during the early years of operation.

Regardless of the alternative selected, we recommend that NASA's Administrator direct that the Agency's annual budget presentations to the Congress clearly show NASA's subsidies by user class, that is, DOD, civil U.S. Government agencies, and non-Government users.

#### AGENCY COMMENTS

In responding to a draft of this report, NASA listed a number of efforts underway which deal with the substance of our recommendations. Those efforts and our responses thereto are as follows:

--NASA and DOD are currently renegotiating a new launch price which recognizes the increase in cost for materials and services and also permits price adjustments annually beyond fiscal year 1985.

Details on a revised NASA/DOD agreement were not available for our analysis and incorporation in this report. We will follow up with the agencies on any revised agreement to determine the extent these revisions will change the effect on NASA's budget requirements.

--A pricing policy, which NASA says is consistent with cost increases and recognizes competition, is under review and will be the basis for missions booked subsequent to 1985. NASA's position is that a pricing policy change now, including a change in the use fee, would undermine user's and potential user's confidence in the Shuttle program and the agency.

Again, details on NASA's proposed pricing policy revisions were not available. We will follow up with NASA on any revised pricing policy to determine the extent these revisions will change the effect on NASA's budget requirements.

We disagree with NASA's position of not adjusting the early year's prices. We have pointed out in our report that NASA is canceling or delaying space science programs as a result of Shuttle cost increases and budget constraints. We believe this also undermines the scientific community's confidence in NASA. Price adjustments in these early years would help alleviate NASA's budget effects. Also, delaying price increases may postpone the effect on users but the end result will be a greater price increase as NASA adjusts the price to recoup the early years' losses.

--NASA did not specifically comment on our recommendation that the Agency revise its budget presentations to the Congress to identify NASA's subsidies to Shuttle users.

NASA is currently considering revisions to its STS pricing policy. The revised policy could conceivably reduce the amount of NASA's subsidies to Shuttle users. However, an underlying principle of the STS pricing policy is to encourage users to change over to the Shuttle by offering a launch price that is less than the cost to NASA to launch the Shuttle. Consequently, we believe it is reasonable to assume that even after NASA revises its current pricing policy, the agency will be subsidizing users in the early program years. We continue to believe that NASA's STS budget presentations to the Congress should provide greater visibility by clearly showing NASA's subsidies by user class.

The Department of Commerce also commented on our recommendations. The Department objected to a revised pricing policy that would shift additional funding responsibilities to the users.

We believe the user agencies should be responsible for justifying any additional program costs to the Congress. This is a purpose of the authorization and appropriation process. If a user cannot justify the cost of its program to the Congress then it seems to raise a question as to the program's overall worth. NASA has established a Shuttle pricing policy that results in a price to users which NASA has often pointed out is much less than launching on a comparable expendable launch vehicle.

The full text of each agency's comments on a draft of this report and our response to those comments is included in appendixes II through V.

## CHAPTER 4

### OPTIONAL SERVICES FOR NASA MISSIONS

#### WILL FURTHER AFFECT NASA'S BUDGETS

A standard launch on the Space Shuttle consists of 1 day of operations by a three-member crew. It includes on-orbit payload handling and deployment of a free flying spacecraft at a 160-nautical mile orbit. The objective of the definition of a standard Shuttle launch was to establish a minimum cost for a mission and allow the user to decide on and pay for whatever additional services that is desired. Therefore, other optional services are also available which include such things as: spacelab, upper stages to boost a payload beyond low Earth orbit, staying in orbit more than 1 day, requiring more than three crewmembers, adding flight kits, or performing optional payload related services such as extravehicular activities. These services will significantly increase the cost of a Shuttle launch. In turn, the increased launch costs can affect future budgets because as costs have increased, NASA has tended to decrease the number of its missions that can be flown.

A minimum of 62 percent, or 103 of the 166 NASA flights included in the 487 traffic model, will require optional services of some type. Consequently, as the cost per flight of a NASA launch increases, the potential for delays or deletions of NASA missions is heightened. Some of the optional services and their potential add-on costs to the standard launch cost are discussed below.

#### SPACELAB

Spacelab is a reusable self-contained laboratory designed to be carried into orbit and remain in the Shuttle's cargo bay throughout the mission. Spacelab requires more time on orbit than most missions--up to 7 days initially, with the plan eventually to increase the mission duration up to 30 days.

The spacelab's two principal components are the pressurized module, which provides a laboratory with a shirtsleeve working environment, and the open pallet that exposes materials and equipment directly to space.

#### Spacelab prices are increasing and projected usage is decreasing

The 1977 STS mission model included a projected 201 spacelab missions. In May 1980, this dropped to 110 flights with 88 projected for NASA. Further cutbacks or slippages are likely since the revised fiscal year 1982 space science budget includes a stretchout of the overall spacelab payload flight schedule.

A January 1981 report to the House Subcommittee on Space Science and Applications, Committee on Science and Technology

prepared by the Library of Congress Congressional Research Service captured the essence of the potential effect on NASA's space science program as a result of the increased cost and decreased usage of spacelab. The report stated:

"Plans in both the United States and in Europe for utilization of Spacelab are perceived by many to be under reconsideration. Potential users have complained about the high cost of doing research on the Spacelab versus the costs of sending up unmanned satellites to do the same work. The orbital stay-time of the Spacelab is short (seven days) and this impacts adversely on the cost. Potential users suggest that extension of mission duration to 30 days, increasing power available to experiments, and increasing the cooling capabilities, would all be of benefit to Spacelab users and would encourage utilization.

"The issue of the high cost of doing space research on the Spacelab was discussed extensively in 1978 in House Committee on Science and Technology hearings and a panel on international space activities. The panel noted that 'Rising costs appear to be inhibiting both the scope and number of experiments users can afford (Spacelab is of particular concern here). Cost reductions should be actively sought.'

"The Europeans likewise perceive that the high cost of flying a Spacelab mission may prove an inhibiting factor in space utilization. As one European official noted. 'Twenty million dollars (1975 price basis) for a standard shuttle launch and possibly the same amount for a standard Spacelab flight service are hardly suited to arouse the interest of the European user community, in particular of the European industry'."

The report further noted:

"The estimated cost of a Spacelab mission in 1978 dollars is \$22.5 million, excluding shuttle launch costs, though the SL pricing policy is still in formulation. High operating cost estimates and declining NASA budgets may put Spacelab into competition with free-flying satellites and future space programs.

"A few years ago NASA's Office of Space Science viewed Spacelab as a real opportunity for growth in the overall science program and anticipated annual Spacelab budgets of \$250 million. Now, in a stringent budget situation, and considering limitations of the Spacelab, a budget of \$100-125 million per year is more likely. That is roughly equivalent to the funding required for one major free flyer or planetary spacecraft per year."

Thus, as spacelab costs increase, projected usage decreases, further affecting the space science program.

#### UPPER STAGES

The expendable upper stage is a Shuttle launched vehicle for spacecraft missions with altitudes, inclinations, or trajectories beyond the basic Space Shuttle capability. Depending on the payload size and destination, the basic price in real-year dollars of an upper stage for a 1982 launch could range from \$3 million for the smallest upper stage to more than \$14 million for a two-stage inertial upper stage. These are charges in addition to the standard launch price.

One upper stage system, developed commercially by the McDonald Douglas Astronautics Company, offers two basic sizes to the STS user community. Called the spinning solid upper stage, one size accommodates the current Delta expendable launch vehicle class of missions and the other the Atlas centaur class of missions. STS users are encouraged to contract directly with industry for these services.

These basic prices for the spinning solid upper stage systems include the vehicle expendable hardware, ground and airborne support equipment rental, and certain launch support services. The KSC launch site support provided to the user during the upper stage processing at KSC is not a part of the basic price and is billed directly to the user by NASA as a payload related service. NASA will also bill each spinning solid upper stage (model D) user a charge to pay for certain NASA funds expended for its development.

The basic spinning solid upper stage prices were estimated to be \$3 and \$5 million in real-year dollars for a 1982 launch. In addition to the baseline system, McDonald will provide to each user the mission analysis, hardware, and services unique to each mission at an additional charge to be negotiated.

A second upper stage is the inertial upper stage being developed by the Boeing Aerospace Company for the Department of the Air Force. It is a two-stage solid-propellant vehicle designed to deliver a 5,000 pound payload to geosynchronous orbit. The two-stage inertial upper stage was estimated to cost \$14 million in real-year dollars for a 1981 launch.

A three-stage inertial upper stage was also being developed for NASA to be used on planetary missions. The cost of this upper stage was estimated at over \$50 million. Because of technical problems in development and cost overruns, this program has been canceled. NASA has just recently contracted for a remodeled liquid fueled centaur as a replacement which will be used for the Galileo mission. The cost of this upper stage is not yet known. NASA has a total of 15 flights which require one or more upper stages.

## FLIGHT KITS

The orbiter is designed to provide adequate standard interfaces that can be used by or adopted to most potential payloads. Additional support systems--flight kits--are available as an optional service to extend the basic Shuttle capability. These kits range in price from about \$16,000 to \$155,000, plus cost of installation and removal called the serial impact costs. The serial impact costs will probably cost more than the kits themselves. The following paragraphs give a brief description of these kits and prices.

### Orbital maneuvering subsystem Delta-V kit

The orbital maneuvering subsystem Delta-V kit consists of auxiliary propellant tanks that provide approximately an additional 500 feet per second velocity to the orbiter mission capability and has no direct interface with the payload. As many as three kits can be added to the integral orbital maneuvering system propellant tank. These kits cost from \$86,210 to \$155,000, including the use fee.

### Docking module

The docking module kit is installed in the orbiter cargo bay when mission requirements call for other orbiting vehicles to dock with the Shuttle. It incorporates a docking device similar to that demonstrated in the Apollo-Soyuz Test Project. Its price is \$16,100.

### Remote manipulator

This kit provides a second remote manipulator arm that can be located on the right side of the cargo bay opposite the baseline remote manipulator system. It enables multiple deployment of payloads or allows both arms to manipulate one payload together. Its price, including use fee, is \$108,100.

### Power reactant supply and distribution/ electrical power supply system tank sets

The power reactant supply and distribution/electrical power supply system kits are available to provide additional power to payloads. A kit consists of one set of liquid oxygen tanks and one set of liquid hydrogen tanks. This kit can cost as much as \$151,000.

The prices listed for each of the above kits, excluding use fee, are subject to escalation. A serial impact cost is also part of the user's cost. It is associated with the total installation time and is determined at the time the launch agreement is negotiated. These kits become a part of the Shuttle payload and consume a part of the Shuttle payload carrying capacity



ranging from 1,150 pounds for the remote manipulator arm to 43,033 pounds for an orbital maneuvering subsystem Delta-V kit with three tanks.

OPTIONAL PAYLOAD-RELATED SERVICES

While the above options were hardware items, the optional payload related services discussed in this section are specific tasks performed in the user's behalf by NASA. These tasks are outside the scope of currently defined standard STS services. As shown below, some optional services are common to all payloads while others are custom tailored to a user's specific requirement.

Common Optional Services

<u>Options</u>	<u>Price range, 1975 dollars</u>
Extravehicular activity	\$ 60,000 to \$100,000 each
Payload specialist training	75,000 to 100,000 each
Additional days of STS support	200,000 to 300,000 per day
Payload revisit	300,000 to 400,000 per flight
Launch site services:	
Spacecraft optional services package	\$330,000
Spinning solid upper stage (model D) optional services package	75,000
Spinning solid upper stage (model A) optional services package	85,000
Vertical processing facility	5,000

In addition to the common type items there are also some costly unique payload services.

### Unique Optional Services

<u>Options</u>	<u>Price range, 1975 dollars</u>
Engineering analyses:	
Thermal loads analysis:	
Initial	\$100,000 to \$150,000 each
Subsequent	50,000 to 75,000 each
Structural dynamic loads, Shuttle models, and forcing functions	40,000 to 75,000
Electromagnetic interference/compatibility analysis	20,000 to 50,000 each
Special studies	To be negotiated
Data analysis and software support:	
Nonstandard inclination (dedicated) initial	400,000 to 600,000 each
Nonstandard altitude-initial	60,000 to 100,000 each
Data software modifications	20,000 to 200,000 each
End-to-end data tests	100,000 to 500,000 each
Unique integration hardware	To be negotiated

The final price for each payload-related optional service is contingent on specific user requirements.

### CONCLUSIONS

The \$18 million quoted price for an STS launch provides for the basic services only. The optional services, discussed in this chapter, can increase the launch price significantly. To the extent that the increased price forces NASA to delay a portion of its flights, such as in the case of spacelab, there is the real possibility of having to cut space science research since spacelab figures prominently in this program.

## CHAPTER 5

### THE SHUTTLE OPERATIONS USE FEE IS

#### UNDERSTATED AND NOT CHARGED TO ALL USERS

In 1977 NASA established a use fee to recover a fair share of the Government's capital investment in the orbiter fleet and in equipment and facilities. However, NASA's use fee policy will result in NASA procuring the orbiter fleet and related equipment and facilities with only a small portion of the cost recovered from other users. The Shuttle operations use fee of \$4.3 million (1977 dollars) appears to be understated by as much as \$6 million (1977 dollars) and is only charged to commercial and foreign users that did not participate in the STS development program. DOD, civil U.S. Government agencies, the European Space Agency, and the Canadian Government are excluded. As a result, NASA's appropriations must bear a major portion of these costs.

The use fee includes \$1.5 million for the orbiter fleet, \$2.1 million for equipment, and \$0.7 million for facilities. NASA's use fee policy provides that the fee is to remain fixed for the first 3 years of Shuttle operations and is not subject to escalation.

#### ORBITER FLEET COSTS

The orbiter use fee of about \$1.5 million per flight appears to be understated by as much as \$5.8 million because NASA projected each orbiter's useful life as 500 reuses instead of the presently projected 100 reuses. Using NASA's formula to compute the use fee, but substituting 100 missions as an orbiter's useful life, the use fee would be \$7.26 million in 1977 dollars. Therefore, we believe the orbiter use fee is significantly understated. Consequently, NASA will share a greater portion of the burden of the Government's capital investment in the orbiter fleet. (See appendix VI for NASA's computation of the \$1.5 million orbiter use fee and our revised computation using 100 reuses as the orbiter's projected life.)

#### EQUIPMENT AND FACILITIES USE FEES

The equipment and facilities use fees are based on a useful life of 12 years and 40 years, respectively. The total value of the equipment and 30 percent of the facilities' value were amortized over the 12-year mission model to arrive at the respective use fees per flight.

Of the \$2.134 million equipment use fee, the bulk (about \$1.417 million) is for KSC equipment. The KSC equipment use fee may be understated by as much as \$0.142 million or 10 percent, because the equipment value did not include costs for shipping, receiving, and inspection. KSC data shows that these costs increase equipment value by about 10 percent.

KSC's facilities use fee is \$0.593 million or about 83 percent of the \$0.711 million total fee. The fee may be understated by about \$0.012 million because the value of certain facilities did not include design and development costs. KSC data shows that these costs increase the value of facilities by about 6 percent.

KSC recognizes that the equipment and facilities values used to compute the use fees may be understated due to the excluded costs described above. We were advised that the facilities and equipment values may be adjusted in subsequent use fee updates to include these costs.

According to NASA officials, the STS is a national system, and they have been given the task of developing this system. NASA's position is that asking DOD or any other U.S. Government agency to fund the purchase of orbiters or other equipment would not change the cost to the U.S. Government nor would recouping these cost through use fees.

#### CONCLUSIONS

We believe that NASA should adjust the use fee based on all appropriate costs and correct orbiter reuse data. While we agree that the total cost to the Government may not change, NASA appropriations are indirectly funding other agency and/or Government missions. If users were to fly on an expendable launch vehicle, they would have to pay the cost of this hardware. Although the Shuttle is reusable, the hardware is also more expensive and still has a limited life. We believe all users should pay their fair share of the cost.

#### RECOMMENDATIONS

NASA's Administrator should reconsider NASA's use fee policy. Some alternatives that could be considered are:

- Charge DOD and other Government users the current use fee charged to commercial and foreign users.
- Update the current use fee to reflect all appropriate facilities and equipment costs and to reflect a more realistic orbiter flight rate. Charge the updated fee to commercial and foreign users where legally binding agreements have not been signed.
- Update the use fee as above and charge it to all users, including DOD and other Government users.

#### AGENCY COMMENTS

NASA strongly objects to our recommended alternatives that NASA update the current use fee and charge this fee to all users

including DOD, other civil users, and foreign governments. NASA states:

- The use fee will be updated when the fiscal year 1986 price is set. To change the pricing policy at this point in time would undermine user's and potential user's confidence in the Shuttle program and the Agency.
- A charge to DOD and other Government users for use of Government facilities and equipment would be an exception to the current practice of Government agencies providing services to one another.
- The Office of Management and Budget Circular A-25 provides "The furnishing of the service without charge is an appropriate courtesy to a foreign country or international organization, or comparable fees are set on a reciprocal basis with a foreign country."

As pointed out on page 21, we believe that canceling or delaying space science programs as a result of Shuttle cost increases and budget constraints also undermines the scientific community's confidence in NASA. Additionally, under current economic conditions and NASA's present critical budgetary environment, we believe that NASA should charge the full use fee to DOD, civil U.S. Government agencies, and foreign governments. In our opinion, the availability of the STS even with full use fee charges is an extremely valuable and attractive asset to all users. If the full use fee is not charged, NASA appropriations are indirectly funding other U.S. Government agencies and/or foreign government missions.

Regarding the Office of Management and Budget Circular A-25, it does provide exceptions to recovering full cost; but, it is an option, not a requirement. For the foregoing reasons, we do not believe that NASA should exercise this option.

The full text of each agency's comments on a draft of this report and our response to those comments are included in appendixes II through V.

### NASA'S STS PRICING PHILOSOPHY

Based on estimated outyear costs, NASA established a 3-year \$18 million (1975 dollars) fixed price in 1977 for commercial, foreign, and other U.S. civil agencies launches and a 6-year \$12.2 million (1975 dollars) fixed price for DOD launches. The price was to be adjusted annually thereafter as necessary to recover total operations costs. The objective of the 3-year fixed price was to encourage users to change over to the Shuttle by offering a launch price competitive with expendable launch vehicles. However, NASA must fund the full cost of NASA flights and the difference between the actual cost per flight and the reimbursements received from other users until the price charged to users becomes more than actual costs and provides recoupment to the U.S. Government.

NASA's pricing policy provides that Space Shuttle users be charged on an average, rather than on an actual, cost-per-flight basis. That is, the cost per flight that users must pay is arrived at by dividing the total estimated operations costs during the 12-year projected life of the program (initially 1980-91) by the total number of projected flights during that period. The resultant price does not provide for any recovery of the Shuttle's development cost (\$9.9 billion in 1982 dollars). This technique enables NASA to lower the cost per flight during the early program years by averaging the higher initial operating costs with the expected lower operating costs during the later program years. This will result in NASA accumulating a deficit in the early years. However, in the later years the actual cost per flight is expected to be less than the price based on the average yearly cost per flight. This reserve in the later years was expected to zero out the early years deficits by the end of the 12-year period. The various provisions of the policy are discussed below.

#### PRICING POLICY PROVISIONS

NASA's pricing policy recognizes three basic groups of users (1) non-U.S. Government, (2) civil U.S. Government users and foreign users who have made substantial investment in the STS program, and (3) DOD. The reimbursement policies for each of these groups were published in the January and February 1977 Federal Register. The principal features follow.

#### Non-U.S. Government users, civil U.S. Government users, and foreign users having made substantial program investments

--The policy established two distinct phases of Shuttle operations. The first phase is through the 3d full fiscal year of Shuttle operations and phase II consists of 9 full fiscal years after phase I. Due to program slippages, phase I is fiscal years 1983 through 1985, and phase II is fiscal years 1986 through 1994.

- A firm-fixed price was established for flights in the first 3 years (phase I) of STS operations. In 1977 NASA set \$18 million as the charge to a single user for a standard Shuttle launch.
- After the first 3 years the price will be adjusted annually to ensure that aggregate costs are recovered over a 12-year period. This will reflect any under/over estimates of phase I costs and/or anticipated cost increases over the remaining years of the program (phase II).
- Shuttle services for both phases will be contracted on a fixed-price basis. The payments in the contract will be escalated to the time of the payment using the Bureau of Labor Statistics Index for compensation per hour.
- There will be no postflight charges, except for prespecified optional services.
- A use charge, in lieu of depreciation, for use of facilities, support equipment, and the Shuttle fleet will be charged. A fee of \$4.298 million was set in 1977 and only applies to commercial and foreign users. DOD, civil U.S. Government agencies, the European Space Agency, and the Canadian Government will not be charged this fee.

The \$18 million price is for a standard KSC launch. It will buy 1-day's operations by a three-member crew with on-orbit payload handling and deployment of a spacecraft at a 160-nautical mile orbit inclined at 28.5 or 56 degrees, that is, the angle between the orbital plane and the equator. Also included are Shuttle orbit flight planning services, support of payload design reviews, safety assessment, prelaunch payload installation, verification, and orbiter compatibility testing.

NASA will charge extra for such options as upper stages, additional time on orbit, payload revisit and retrieval, payload data processing, extravehicular activity services, use of spacelab, mission kits to extend basic orbiter capabilities, and short-term callup missions for such purposes as replacement of a failed spacecraft. These options and prices are discussed in chapter 4.

Users are expected to contract for launches 3 years in advance and pay 20 percent of the cost the 1st year, 35 percent the 2d year, and the remaining 45 percent during the year before launch. Payments are required every 6 months with the last one due 3 months before launch.

The price increases if a contract is signed less than 3 years in advance of the launch. That is, the price increases to about 103, 113, and 121 percent of the base price (\$18 million) if contracting is 24, 12, or 3 months in advance of the launch date, respectively.

For phase II, or the last 9 years of Shuttle operations (fiscal years 1986-94), NASA proposes to charge a fixed price that can be adjusted, as necessary, on a yearly basis to ensure recovery of all costs over the 12-year period. A final pricing policy and charges to non-DOD users for phase II have not been set. NASA plans to have that policy and charges available by September 1982, or 3 years before phase II launches beginning in October 1985.

#### DOD users

DOD is considered a special class of customer because of its investment and active involvement in flights from Vandenberg and operates under a special agreement with NASA. That agreement states:

- The DOD reimbursement to NASA will be based on the cost of materials and services. The mutually agreed upon price is \$12.2 million. (That is \$9.2 million for materials and services and a \$3 million contingency.)
- The DOD price will be fixed for the first 6 years of operations.
- For launches after the first 6 years of STS operations, the price to DOD will be adjusted annually based on actual costs projected each year for materials and services.
- There will be no recoupment of prior years costs over or under the mutually agreed upon projected costs of the first 6 years.
- DOD will provide the Vandenberg Space Shuttle launch support for all non-DOD users in return for provision by NASA of all Shuttle launch operations support from KSC and Shuttle flight operations support for all DOD flights. These services were projected to be of approximately equal value to each agency.
- DOD agrees to reimburse NASA for STS launches in the fiscal year before the fiscal year of the launch and at least 12 months before the planned launch date.
- The reimbursement will be made in dollars escalated to the fiscal year of payment.

A Vandenberg launch will be provided to non-DOD Shuttle users for an additional charge over and above the basic \$18 million with orbit inclinations of 90 and 104 degrees. NASA has not set a price for Vandenberg launches but hopes to have it available by early 1982. The first launch from Vandenberg is scheduled for October 1985.





National Aeronautics and  
Space Administration

Washington, D C  
20546

Office of the Administrator

REC 15 198:

Honorable Charles A. Bowsher  
Comptroller General of the United States  
U. S. General Accounting Office  
Washington, DC 20548

Dear Mr. Bowsher:

The GAO Draft Report entitled, "Cost Growth on the Space Transportation System Demands NASA Reconsider Its Pricing Policy for Operations," Code 952264, has been carefully reviewed by members of our staff. I have also read the report. The draft is based on the program status at the time of the review some months ago, including FY 1982 budget data, and covers adequately the general history of quantity, cost increases, etc., up to that time. I am concerned, however, that inferences derived from the presentation may be prejudiced and not totally correct. The specific issues of concern are as follows:

1. While it is true that NASA is delaying or cancelling a number of its own research programs because of constrained budgets, this should not be attributed to increased Shuttle costs. With this Administration's stated policy of cutting back Government spending, the space science budgets would be constrained regardless of Shuttle requirements. Therefore, the statement "NASA has already cancelled or delayed a number of new programs because of increased STS development costs and budget constraints" is misleading and not appropriate.

[GAO comment: We believe the quoted statement is correct. However, to avoid the possible implication that delays or cancellations of other NASA programs are totally attributable to increased STS development costs, we have modified the quoted statement which appears on page 5 of the report. Additionally, the following excerpts from congressional reports and NASA budget documents are provided to attest to the validity of our statement.

--A December 1978 report "United States Civilian Space programs: An Overview" prepared by the Science Policy Research Division, Congressional Research Service, Library of Congress for the House Subcommittee on Space Science and Applications says:

"NASA has maintained an active space science program since its inception, although heavy funding requirements for manned programs, such as Apollo and the Space Shuttle, led to reduced funding in the space science area."

--A June 1981 Staff Report of the House Committee on Science and Technology "Survey of Science and Technology Issues Present and Future" included the following statement:

"The past decade has seen a decline in the level of activity in the space science area, partially because of the large funding requirements for another NASA program, the space shuttle. Criticism of this decline has become more vocal in the past few years, as the lack of support for space science in the early 1970s is emphasized by few space science launches now."

This trend is continuing as evidenced in the Acting NASA Administrator's presentation of NASA's revised budget request for fiscal year 1982 before the Senate Appropriations Subcommittee on HUD-Independent Agencies. He said in part "The revised budget for fiscal year 1982

--preserves the Space Shuttle research, development, and production schedules leading to a first flight in April and to an operational fleet of four orbiters supporting civil and military need from launch sites on both coasts in 1984;

--maintain an option for a fifth Shuttle orbiter;

\* \* \* \*

--eliminates or defers all fiscal year 1981 and 1982 new program initiatives in Space Science, Aeronautics and applications."

STS' fiscal year 1982 Research and Development request was \$3,304.2 million or about 61 percent of the total Research and Development request as compared to \$756.7 million or about 14 percent for space science. However, in coming up with a revised fiscal year 1982 Research and Development budget, STS was reduced \$168.1 million or only 5 percent while space science was reduced \$172.5 million or about 23 percent.]

2. The report correctly states that the costs for Shuttle have increased. However, the report fails to note that costs for other modes of space transportation have also significantly increased over the same period. The cost of a Delta launch will increase approximately 30%; the cost of an Atlas/Centaur 40%. The cost of a Titan 34D launch is estimated to exceed \$100 million. Any careful review of the cost and pricing of the Shuttle should recognize contemporaneous increases in other launch systems.

[GAO comment: We agree that the cost of expendable launch vehicles has increased. However, it is not the intent of this report to compare the cost to launch the Space Shuttle to that of launching an expendable launch vehicle. Our report deals with the pricing policy for STS and its effect, combined with STS operations cost growth, on NASA's budgets.]

3. NASA's pricing policy, which was established in 1977, calls for a fixed price per flight through the first three years of operations following the OFT series. In order to provide the Shuttle user the assurance of a known price, even though he signs up three years in advance, the policy also calls for a new price to be set annually after the flat price period, always three years in advance of when the payload is launched.

When the pricing policy was established, NASA agreed that all Shuttle operations costs would be recovered over a fixed operations time horizon, which is currently 12 years. In order to give incentive to users by keeping Shuttle prices low, while at the same time recovering total operations costs over the fixed operations time horizon, prices are related to the average price per flight over the entire period. Due to the low launch rate associated with the early years of Shuttle operations, prices geared to average flight costs will result in the accumulation of a substantial early deficit. The GAO report terms this deficit a "subsidy." However, what is not made clear is that eventually, if the current pricing policy remained in place and anticipated demand was realized, yearly revenues would exceed yearly costs. As this trend continued, the deficit would be zeroed out at the end of the fixed operations time horizon.

There are precedents for this type of pricing in almost every major industry. For example, if the automotive industry charged actual costs for the first vehicles off its assembly lines, it would be hard-pressed to find any customers. The same type of "subsidy" applies to the sale of commercial aircraft to airlines. Airlines can afford to buy airplanes only because aircraft are "flat priced" over a large anticipated sales volume by the manufacturers.

[GAO comment: We have clarified this point by incorporating the language proposed by NASA. The clarifying language is on page 32.]

4. The report makes several statements concerning the use fee. Specifically, it states that the use fee is understated by \$6.2M because NASA projected each orbiter's useful life at 500 flights instead of the Shuttle Specifications which called for capability of 100 reflights. NASA did not use the 100 reflight figure as a criteria for determining use fee because we believe that the structure is good for 500 flights. Because of replacement of tiles, engines, and other replaceable units whose costs are recovered through cost per flight, the lifetime will be extended considerably beyond 100 reflights.

The report also suggests charging the use fee to DOD, civil U.S. Government agencies, the European Space Agency, and the Canadian Government. In determining who should be charged the use fee, NASA followed OMB Circular A-25. A-25 makes several exceptions to the general policy of charging use fees. Specifically, exceptions may be made when: "The furnishing of the service without charge is an appropriate courtesy to a foreign country or international organization; or comparable fees are set on a reciprocal basis with a foreign country" and "The recipient is engaged in a nonprofit activity designed for the public safety, health, or welfare." Clearly, there is sufficient reason to exclude DOD, civil U.S. Government agencies, the European Space Agency, and the Canadian Government.

The European Space Agency and the Canadian Government have contributed substantially to the development of Shuttle. For example, ESA developed and delivered to NASA, without charge, a Spacelab (module plus pallets, IPS plus ATE) and NASA upon procuring additional Spacelabs will not be charged the costs associated with the development of this item. The European Space Agency's investment in this effort is estimated at \$800 million. The Canadian Government developed and delivered to NASA, without charge, one flight unit of the Remote Manipulator System (RMS). The Canadian Government investment in the RMS contribution to the Shuttle is estimated at \$100 million.

[GAO comment: Current indications are that NASA will fly less than 400 missions in the first 12 years of operations. Assuming the orbiter would last through 500 flights and assuming NASA flies an orbiter an average of 10 flights per year (that is, 40 to 50 flights total per year depending on whether NASA has a 4 or 5 orbiter fleet), it would mean the orbiter would have a 50-year life to fly 500 flights. We do not believe it is realistic to assume that the state of the art for launch vehicles will remain at a level where the current orbiter would have a useful 50-year life. In fact, NASA's program plan for fiscal years 1981 through 1985 already makes reference to the need for Shuttle improvements when it states: "Later needs will require further updating of the Shuttle to the 100,000 pound payload level."

NASA quotes the Office of Management and Budget Circular A-25 as justification for not charging DOD, civil U.S. Government agencies, the European Space Agency and the Canadian Government, the Shuttle use fee. NASA correctly states that the Office of Management and Budget Circular A-25, which was issued in September 1959, does give it the authority to make exceptions to the general policy of recovering the full cost to the Federal Government of rendering a service. However, under current economic conditions and NASA's present critical budgetary environment, we believe that NASA should charge the full use fee to DOD and civil U.S. Government agencies. Otherwise, NASA appropriations are indirectly funding other agency and/or Government missions.

NASA's basis for not charging the use fee to the European Space Agency and the Canadian Government as a courtesy to reciprocate for their contributions to the STS development program may have merit because of the benefits that accrued to the United States. However, we believe that the availability of STS even at full costs is an extremely valuable and attractive asset to non-U.S. Government users. In our opinion, for NASA to subsidize the launches of foreign governments at a time when it is delaying or canceling its own research and development programs is not an efficient and economical practice. Consequently, we continue to believe that charging the use fee to DOD, and U.S. Government agencies, the European Space Agency, and the Canadian Government is an alternative that should be considered in revising the STS pricing policy.]

5. The report implies that Shuttle standard services provide users with too few services. This statement is based on the assumption that the majority of payloads will require optional services of some type and that these additional services impact non-transportation budgets. The standard services provided equate to the total requirement for a communication satellite except for the upper stage, procured from outside NASA, and user's payload preparations for flight using NASA equipment, if so desired. In fact, there are private organizations currently considering providing these services. Standard services were defined in this manner so that users with minimum needs pay the lowest price.

[GAO comment: It is not our intent to imply that the Shuttle standard services provide users with too few services. Our only intent is to point out that many missions require services in addition to the standard services provided for the \$18 million price. To further clarify the report, however, we have incorporated NASA's suggested language on page 23 of the report body. That language states that the objective of the definition of a standard Shuttle launch was to establish a minimum cost for a mission and allow the user to decide on and pay for whatever additional services he desires.]

6. Certain detailed information presented in the report is inaccurate. For example, the SSUS-D weight should be 2,750 pounds instead of 2,320 pounds (page 2). The price for the SSUS-D should be \$3.0 million real year dollars for a 1982 launch instead of \$4.3 million for a 1981 launch (page 28). The price for the SSUS-A should be \$5.0 million real year dollars for a 1982 launch, instead of \$5.3 million for a 1981 launch (page 28). The cost of the IUS was estimated at over \$50 million, instead of over \$22 million (page 28).

[GAO comment: We have revised the appropriate figures in the report to reflect NASA's updated information. The original SSUS and IUS real-year dollars for a 1981 launch were based on data NASA supplied to the Senate Appropriations Committee in response to questions asked during the fiscal year 1981 hearings.]

7. The \$4.6 billion (1981 dollars) for orbiter procurement referenced on page 5 is misleading. The \$4.6 billion represents the total FY 1981 budget requirements included in the Shuttle Production Budget. The FY 1981 Production Budget included orbiter fleet investment of \$3.2 billion to procure the follow-on orbiters with engines and the Government-furnished equipment; \$0.3 billion for orbiter ground support equipment and facility ground support equipment at KSC to support an orbiter two-in-flow capability; \$0.5 billion for systems integration and support activities; and \$0.6 billion for initial operational spares and equipment.


[GAO comment: We have revised chapter 5 concerning the use fee and have used NASA's formula to compute the use fee but substituting 100 missions as an orbiter's useful life. This precludes the use of any misleading production costs and makes a direct comparison of the use fee for 500 reuses and 100 reuses of an orbiter.]

[PP. i-ii.] Based on the above points, Enclosure 1 contains recommended changes to the wording of the Cover Summary and pages ii - vi. Enclosure 2 responds to each of the seven recommendations which begin on page iv.

[P. iii.]

We appreciate the opportunity to comment on your well-researched report and hope our comments will assist in the publication of an accurate reflection of the situation as it stood at the time of your review.

Sincerely,

  
James M. Heggs  
Administrator

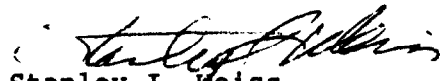
Enclosures

GAO DRAFT REPORT

COST GROWTH ON THE SPACE TRANSPORTATION  
SYSTEM DEMANDS NASA RECONSIDER ITS  
PRICING POLICY FOR OPERATIONS

(Code 952264)

This reponds to the GAO request of November 12, 1981, seeking NASA comments on draft report 952264.

  
Stanley I. Weiss  
Associate Administrator for Space  
Transportation Operations



Suggested Changes to GAO ReportCover SummaryFirst paragraph as written:

NASA's Space Transportation System pricing policy, combined with increasing shuttle operations costs, has created a paradoxical situation where NASA is subsidizing other users' launches at a time when it is delaying or cancelling its own research programs because of constrained budgets.

Suggested change to first paragraph:

NASA's Shuttle pricing policy, established five years ago and based on average pricing over 12 years of operations (underpricing in early years), combined with increasing Shuttle operations costs, has created a situation where NASA must absorb the higher costs of operations for all users in the early years. At the same time, because of the Administration's major effort to reduce budgets, NASA must seek additional appropriations or delay or cancel its own research programs.

Page i - First paragraph as written:

The Space Transportation System's early years of operations will significantly impact NASA's budgets because NASA is offering users bargain basement prices even though the Space Transportation System's operations costs are increasing. In addition, increasing upper stages and spacelab costs and understated use fee charges will also impact NASA budgets.

Page i - Suggested change to first paragraph:

The Shuttle's first three years of operations will significantly impact NASA's budgets because NASA has committed to a flat price for three years even though operations costs, which are continuing to increase, would not and do not support the current price. This will require substantially higher prices than originally anticipated starting in FY 1986 if NASA adheres to its present pricing policy of eventual recovery of total operations costs.

Page ii - First and second paragraphs as written:

NASA established a 3-year \$18 million (1975 dollars) fixed price for commercial, foreign and other U.S. civil agencies launches and a 6-year \$12.2 million (1975 dollars) fixed price for DOD launches. The objective was to encourage users to change over to the shuttle by offering a launch price competitive with expendable launch vehicles. However, NASA must fund the full cost of its

flights and the difference between the actual cost-per-flight and the reimbursements received from other users. (See pp. 36 [PP. 32-34.] to 39.)

NASA will pay 80 percent, or about \$2.1 billion of the \$2.5 billion (1975 dollars) shuttle operations cost through 1985 while flying only 36 percent or 16 of the 44 shuttle flights. The \$2.1 billion includes \$920 million to fund NASA flights at the actual cost and subsidies of \$592.2 million for civil, foreign government and commercial users and \$588.9 million for [PP. 14-15.] DOD. (See pp. 16 and 17.)

[P. 32.] Page ii - Suggested change to first paragraph:

Based on estimated outyear costs,, NASA established a 3-year \$18 million (1975 dollars) fixed price in 1977 for commercial, foreign and other U.S. civil agencies launches and a 6-year \$12.2 million (1975 dollars) fixed price for DOD launches. The price was to be adjusted annually thereafter as necessary to recover total operations costs. The objective of the 3-year fixed price was to encourage users to change over to the Shuttle by offering a launch price competitive with expendable launch vehicles. However, NASA must fund the full cost of NASA flights and the difference between the actual cost-per-flight and the reimbursements received from other users until the price charged to users becomes more than actual costs and provides recoupment to the U.S. Government.

[P. 14.] Page ii - Suggested change to second paragraph:

It has been understood since Congress approved the Shuttle pricing policy in 1977 that NASA would pay a large percentage of the early year costs. At the time approval was given to the pricing policy NASA was paying 82 percent of the costs during the first three years of operations while flying 55 percent of the flights. It is currently estimated that NASA will pay 80 percent, or about \$2.1 billion of the \$2.5 billion (1975 dollars) Shuttle operations cost through 1985 while flying 36 percent or 16 of the 44 Shuttle flights. The \$2.1 billion includes \$920 million to fund NASA flights at the actual costs and the difference between actual costs and reimbursements of \$592.2 million for civil, foreign government and commercial user and \$588.9 million for DOD.

Page ii - Third paragraph as written:

A standard space shuttle launch consists of 1-day operations by a three-member crew with on-orbit payload handling and deployment of a free flying spacecraft at a 160 nautical mile orbit. However, NASA will also provide operational services for a price in addition to the \$18 million for a standard launch. These optional services include such things as: spacelab, upper stages to boost a payload beyond low earth orbit, staying on orbit

more than one day, requiring more than three crew members, adding flight kits, or performing optional payload related services such as extravehicular activities.

[P. 23.] Page ii - Suggested change to third paragraph:

A standard Shuttle launch consists of one day of operations by a three-member crew with on-orbit payload handling and deployment of a free flying spacecraft at a 160 nautical mile orbit. The objective of the definition of a standard Shuttle launch was to establish a minimum cost for a mission and allow the user to decide on and pay for whatever additional services he desires. Therefore NASA will provide other operational services for a price in addition to the 18 million for a standard launch. These optional services include such things as: spacelab, upper stages to boost a payload beyond low earth orbit, staying on orbit more than one day, requiring more than three crew members, adding flight kits, or performing optional payload related services such as extra-vehicular activities.

Page iii - USE FEE IS UNDERSTATED AND NOT CHARGED TO ALL USERS - third bullet as written:

--\$.036 million because the facilities' value did not include design and development costs. (See pp. 32 and 33.)

[PP.

29-30.] Page iii - Suggested change to USE FEE IS UNDERSTATED AND NOT CHARGED TO ALL USERS - suggested change to third bullet:

--\$.012 million because the facilities' value was understated.

Page iii - paragraph 1:

NASA is committed to a Space Transportation System pricing philosophy/policy under which it must subsidize other users' launches on the space shuttle in the early years of operations. It is ironic that at a time when NASA's programs are suffering due to budget constraints, and there are more Space Transportation System customers than NASA can handle, they are locked into a pricing policy that encourages Space Transportation System use at NASA's expense and at the expense of the space science, applications and aeronautics programs. (See p. 23.)

[P.32.] Page iii - Suggested change to Conclusions, paragraph 1:

NASA is committed to a Space Transportation System pricing philosophy/policy under which it must subsidize other users' launches on the Shuttle in the early years of operations. This pricing policy was published in the January 1977 Federal Register, Vol. 42, and the average pricing effects discussed with GAO, as evidenced in the GAO report PSAD-77-113, dated May 27, 1977.

[GAO comment: NASA states that the average pricing effects were discussed with us as evidenced in our report PSAD-77-113, dated May 27, 1977. We did discuss NASA's pricing policy in our 1977 report but we did not endorse the policy, as might be inferred from NASA's comments. In fact, in our prior report we concluded that sufficient information was not available to establish or evaluate user charge policies for STS. We recommended that NASA's Administrator delay implementing a user charge policy until costs and policies for all elements of STS have been formulated.

Our report states that the user charge policy should be evaluated on the basis of its merit in equitably distributing all costs to users. We pointed out that at the time of our review, NASA's operating costs and the proposed user charge policy were preliminary and were applicable only to a portion of STS. Neither cost estimates nor policies had been proposed for optional Space Shuttle services or other STS elements, such as upper stages and the spacelab.

The report expressed reservations that the principles underlying NASA's policies raised serious questions as to whether total operations costs would ever be recovered. Further, we reported that NASA had not established accounting procedures for Shuttle operations cost and reimbursements.]

GAO notes: NASA's suggested language changes have been incorporated in the report where appropriate with the exception as noted in the above comment. Where page numbers in the comments on the draft report do not correspond with the final report, the correct page numbers are annotated in the left margin.

Responses to RecommendationsRecommendation No. 1

Void the current pricing policy as it pertains to DOD and other Government agencies and establish a price more in line with the cost to NASA to launch a Shuttle flight. Included would be a reevaluation of the NASA/DOD agreement for offsetting launch services charges at KSC and Vandenberg. This alternative would maintain the fixed price for commercial and foreign users during the first 3 years of operations.

Response to Recommendation No. 1

NASA and the DOD are currently renegotiating a new price which recognizes the increase in costs for materials and services and also permits adjustments of price annually beyond FY 1985.

Recommendation No. 2

Void the pricing policy as it pertains to all users and establish a price more in line with the cost to NASA to launch a shuttle except for those launches that have legally binding agreements.

Response to Recommendation No. 2

NASA currently has five legally binding agreements and is in the process of negotiating others. To change pricing policy at this point in time would undermine user's and potential user's confidence in the Shuttle program and the Agency. A pricing policy consistent with cost increases and recognizing competition is under review at NASA. This policy will be the basis for missions booked subsequent to 1985.

Recommendation No. 3

Maintain the current pricing policy recognizing that NASA's research and development programs will continue to suffer and that it may not be able to maintain a balanced research and development program without increased appropriations. In this case the Administrator should also direct that NASA's annual budget presentation to the Congress clearly show NASA subsidies by user class; i.e., DOD, civil U.S. Government Agencies, and non-Government users.

Response to Recommendation No. 3

The NASA Administrator is striving to obtain sufficient appropriations from OMB to fund a balanced research and development program.

Recommendation No. 4

Assure that the prices established subsequent to the first 3 years of operations adequately recoup the early years losses and fully recognize the potential cost increases during the early years of operations.

Response to Recommendation No. 4

Repricing of the Shuttle for FY 1986 is currently underway. Appropriate changes in the current policies and principles are being considered.

Recommendation No. 5

Charge DOD and other Government users the current use fee charged to commercial and foreign users.

Response to Recommendation No. 5

This is not an appropriate exchange between U.S. Government Agencies, nor is it a practice elsewhere. To charge a fee for use of Government facilities and equipment to DOD and other Government users would be an exception to the current practice of Government Agencies providing services to one another.

Recommendation No. 6

Update the current use fee to reflect all appropriate facilities and equipment costs and to reflect a more realistic orbiter flight rate. Charge the updated fee to commercial and foreign users where legally binding agreements have not been signed.

Response to Recommendation No. 6

Both the standard flight price and the use fee will be updated when the FY 1986 price is set. To change the pricing policy at this point in time would undermine user's and potential user's confidence in the Shuttle program and the Agency.

Recommendation No. 7

Update the use fee as above and charge it to all users, including DOD and other Government users.

Response to Recommendation No. 7

See Response to Recommendation No. 5 above concerning charging fees to DOD and other Government users. Further, OMB Circular A-25 provides that the use fee not be charged when "The furnishing of the service without charge is an appropriate courtesy to a foreign country or international organization; or comparable fees are set on a reciprocal basis with a foreign country".

GAO note: We comment on NASA's responses to each of our recommendations on pages 21 and 30 of the report.)



RESEARCH AND  
ENGINEERING

THE UNDER SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

15 JAN 1982

Mr. W. H. Sheley, Jr.  
Director, Mission Analysis and  
Systems Acquisition Division  
United States General  
Accounting Office  
Washington, D.C. 20548

Dear Mr. Sheley:

This is in reply to your letter to Secretary Weinberger regarding your draft report dated November 12, 1981, "Cost Growth on the Space Transportation System Demands NASA Reconsider its Pricing Policy for Operations", Code 952264, (OSD Case #5824). The following general comments are provided which we believe enhance understanding of the report and should be included in its final version.

1. Elements of the various pricing policies have been widely known since their inception in 1977. It would appear that these policies have become an issue only when their ramifications, exacerbated by current programmatic considerations, are beginning to be understood.

[GAO comment: We agree that elements of NASA's pricing policy have been known since 1977. NASA, in its comments on our draft report, raised basically the same point and as a result we have incorporated language on page 32 of the report to indicate that the pricing policy was presented in the Federal Register in January and February 1977. The DOD comment that the pricing policy has become an issue now that its ramifications are beginning to be understood is also valid. The fact that the policy has become an issue is the basis for our report.]

2. By long-standing precedent, NASA and DoD have exchanged launch services on an additive cost basis. Recovery of capital investments by the one agency from the other has been neither practiced nor, we believe, envisioned by the appropriation process. In this regard, the DoD [P. 30.] agrees with the position ascribed to NASA on page 33 of the draft report.

[GAO comment: What we are in effect saying is that DOD is not paying its additive cost for launch services. NASA has developed STS and could probably handle its own launches with two orbiters. DOD missions make up about one-third of the STS traffic model. NASA has had to buy additional orbiters to handle the non-NASA missions. By charging DOD and other users the use fee, NASA is in effect charging other users on an additive cost basis. That is, users are charged in proportion to the use of the orbiters. Of course, another alternative would be to have DOD procure one-third of the orbiter fleet.]

3. The near-term quid pro quo exchange of services envisioned between NASA and DoD has been skewed by downward revisions of the overall Shuttle fleet flight rate capability while the DoD requirement for flights has remained essentially constant. Also, NASA's estimate of civil traffic from Vandenberg AFB has deteriorated. Additionally, in the post-1987 period, DoD plans to control its own Shuttle flights from the Consolidated Space Operations Center and, in the near-term, play a greater role in planning and conduct of DoD missions from Johnson Space Center than envisioned in the pricing agreement. While the DoD is projected to be a major Space Transportation System (STS) user, it has also been a major investor (over \$4 billion) and will be a major partner in its operation. The GAO analysis does not appear to adequately address these considerations.

[GAO comment: The quid pro quo analysis referred to by DOD was not prepared by us. The analysis was a NASA estimate based on the September 26, 1980, fiscal year 1982 Office of Management and Budget presentation. What we have presented does not take issue with NASA and DOD offsetting launch costs. Where the costs are equal and can be offset without a budgetary burden to one or the other agency involved, this would seem to be a logical approach. Basically, all we are saying is that DOD should pay NASA the additive launch services costs which, DOD has pointed out in an earlier comment, has been a longstanding precedent.

We have further acknowledged DOD as a major investor. See page 4.]



4. Although the review purports to address the 1983-1994 timeframe, the real focus is on the near-term (through 1985) and the impact on other NASA programs of STS operations in these early years. This focus is contrary to a basic premise of the policies which, as noted, were predicated on a 12-year financial planning horizon.

[GAO comment: We disagree with DOD's position that this report does not address the 12-year financial planning period. Appendix I to the report describes NASA's STS pricing philosophy and the establishment of the STS launch price based on the 12-year average cost. Chapter 2 of the report addresses the cost-per-flight increases over the 12-year operating period. In chapter 3, page 19, we address the 12-year operational life and why it is unlikely that NASA will recover total Shuttle operation costs over that period as planned and that NASA has considered the option of extending the operational cost base beyond 12 years. We did focus on the near-term effects on NASA's budget because NASA had not established a phase II price at the time of our review.]

5. DoD and NASA have recognized the problem that underlies the report and, pursuant to the NASA Acting Administrator to Secretary of the Air Force letter, dated 20 January 1981, [P.18.] (referenced on page 21) have undertaken discussions to reassess their existing pricing agreement. The issues of abrogation of basic interagency agreements or accommodation of revisions which may be directed by either Congress or the Administration have not been addressed in these discussions.

[GAO comment: As stated on pages 18 and 21 of the report, we recognize that DOD and NASA are in the process of renegotiating the pricing agreement. We plan to followup with the agencies on any revised agreement that may materialize between DOD and NASA to determine to what extent the changes will affect budget requirements.]

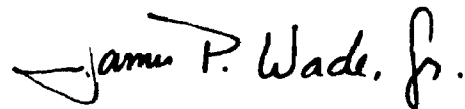
6. In restructuring the various pricing policies, the question of whether or not the Government should partially bear the near-term burden of STS operation costs through the operating agency's appropriation to achieve the goals of a national commitment must be considered as well as how to incentivize the efficient operation of the STS. Without additional appropriations, shifting the burden from operator to users will be at the expense of user programs.

[GAO comment: We believe the user agencies should be responsible for justifying any additional program costs to the Congress. That is a purpose of the authorization and appropriation process. If a user cannot justify the cost of his program to the Congress, then it seems to raise a question as to the program's overall worth. NASA's pricing policy tends to make a blanket judgment that all programs are worth launching regardless of cost increases.]

The Department of Defense declines comment on specific recommendations of the draft report except that we believe any revision to DoD-NASA agreements should be a matter of interagency negotiation subject to the mandates of Congress and the Administration and not unilaterally determined by reconsideration of the NASA Administrator. We defer to NASA the task of providing comments on the accuracy of the draft report's details and methodology.

The opportunity to comment on your draft report is appreciated.

Sincerely,

  
James P. Wade, Jr.

GAO note: Where the page numbers in the comments on the draft report do not correspond with the final report, the correct page numbers are annotated in the left margin.



**UNITED STATES DEPARTMENT OF COMMERCE**  
**The Inspector General**  
Washington, D.C. 20230

December 22, 1981

Mr. Henry Eschwege  
Director, Community and Economic  
Development Division  
U. S. General Accounting Office  
Washington, D. C. 20548

Dear Mr. Eschwege:

This is in reply to your letter of November 13, 1981, requesting comments on the draft report entitled "Cost Growth on the Space Transportation System Demands NASA Reconsider Its Pricing Policy For Operations."

We have reviewed the enclosed comments of the Acting Deputy Administrator for the Department of Commerce and believe they are responsive to the matters discussed in the report.

Sincerely,

A handwritten signature in cursive script, appearing to read "Sherman M. Funk".

Sherman M. Funk  
Inspector General

Enclosure



**UNITED STATES DEPARTMENT OF COMMERCE**  
**National Oceanic and Atmospheric Administration**  
Washington, D.C. 20230

OFFICE OF THE ADMINISTRATOR

DEC 16 1981

Mr. Henry Eschwege  
Director, Community and Economic  
Development Division  
United States General Accounting Office  
Washington, D.C. 20548

Dear Mr. Eschwege:

Thank you for the opportunity conveyed in your letter of November 13 to Secretary Baldrige to comment on your draft report on the impact of the Space Transportation System cost growth upon the NASA budget.

We have reviewed the information contained in the report and in particular have assessed the potential impact of several of your recommendations upon the operational satellite programs of the Department of Commerce.

Establishment of the space shuttle as an operational, reusable launch system is a high national priority. Its use is essential for large, heavy payloads including the Tracking and Data Relay Satellite System (TDRSS), Space Telescope, Spacelab, and many DoD missions. The increased costs for operational shuttle flights, estimated in your report, will further impact NASA's budget, under the present pricing policy, in the early years of operation and affect all users except DoD after the third year.

Changing the allocation of these cost increases from the NASA budget to the using agency budgets will not materially affect the overall level of Federal expenditures for the shuttle launches of those U.S. government payloads which require the heavy lift capability of the space shuttle. Further, unless the budgets of the using agencies are correspondingly increased, those agencies presently making cost effective use of expendable launch vehicles may be forced to delay transition to the space shuttle, contrary to current national policy. This reduction in the number of planned shuttle flights would further increase the cost per mission and generate yet another round of cost increases.



An alternative approach to the policy of full cost recovery from the users for the operational flights would entail an acknowledgement of the benefits to the nation of maintaining an operational space shuttle fleet. Some examples of national benefits derived from maintaining an operational capability are:


- o Maintenance of a high-rate launch capability that could be rapidly mobilized in an emergency.
- o Maintenance of a cadre of trained astronauts and ground support personnel for major, new space missions.
- o Technological improvements in space transportation hardware, software, and mission execution.

The recognition of the value to the nation of maintaining an operational manned space program and funding it accordingly would reduce the potential programmatic damage to NASA's science and applications programs and at the same time provide a reasonably competitive tariff for launch services to encourage expanded utilization of the space shuttle fleet.

Conversely, if the policy of full cost recovery from the actual users is pursued, then the transition policy should be modified to permit using agencies with cost effective expendable launch vehicle programs to continue with them until the space shuttle becomes truly cost competitive. In essence, vigorous pursuit of full cost recovery at this point in the space shuttle program would create a subsidy of the manned space program by those agencies requiring launch services for their operational satellite programs.

In conclusion, I suggest that the above alternative be considered in your recommendations to the NASA Administrator to permit budgetary protection for NASA's science and applications programs and to avoid distortions in the apparent costs of the civil operational satellite programs.

Sincerely yours,

  
for David S. Johnson  
Acting Deputy Administrator



United States  
Department of  
Agriculture

Foreign  
Agricultural  
Service

Washington, D.C.  
20250

DEC 2 1981

Mr. Henry Eschwege  
Director, Community and  
Economic Development Division  
United States General Accounting Office  
Washington, D.C. 20548

Dear Mr. Eschwege:

This is in response to your November 13 letter to Secretary Block concerning the draft GAO Report entitled "Cost Growth on the Space Transportation System Demands NASA Reconsider Its Pricing Policy for Operations". The Foreign Agricultural Service and other interested departmental agencies have reviewed the draft report and have no comments.

Sincerely,

A handwritten signature in black ink, appearing to read "Richard A. Smith".

Richard A. Smith  
Administrator

COMPUTATION OF THE ORBITER USE FEE CHARGE

The \$1.453 million orbiter use fee is based on production costs of \$706.1 million (1977 dollars) for orbiter vehicle 103 and a useful life of 500 missions. The \$1.453 million was computed as follows:

- a.  $\$706.1\text{M} \div 500 \text{ missions} = \$1.412\text{M}$
- b.  $\$1.412\text{M} \times 460 \text{ (total mission model)} = \$649.612\text{M}$
- c.  $\$649.612\text{M} \div 447 \text{ (460 mission model less 13 aborts)} = \$1.453\text{M}$

If the use fee charge had been based on a useful life of 100 missions, the fee would be \$7.266M computed as follows:

- a.  $\$706.1\text{M} \div 100 \text{ missions} = \$7.061\text{M}$
- b.  $\$7.061\text{M} \times 460 \text{ (total mission model)} = \$3,248.06\text{M}$
- c.  $\$3,248.06\text{M} \div 447 \text{ (460 mission model less 13 aborts)} = \$7.266\text{M}$

OUR PREVIOUS REPORTS ON STS

<u>Report title</u>	<u>Report number</u>	<u>Report date</u>
Cost Benefit Analysis Used in Support of the Space Shuttle Program	B-173677	6/2/72
Analysis of Cost Estimates for the Shuttle and Two Alternate Programs	B-173677	6/1/73
Space Transportation System Staff Study	Staff study	6/74
Space Transportation System Staff Study	Staff study	2/75
Status and Issues Relating to the Space Transportation System	PSAD-76-73	4/21/76
Space Shuttle Facility Program: More Definitive Cost Information Needed	PSAD-77-17	5/9/77
Space Transportation System: Past, Present, Future	PSAD-77-113	5/27/77
Letter report on DOD Construction Program for Facilities to Support STS at Vandenberg Air Force Base	PSAD-77-109	6/2/77
A Second Launch Site for the Shuttle? An Analysis of Needs for the Nation's Space Program	PSAD-78-57	8/4/78
Letter report on NASA's Supplemental Request of \$185 million for the Space Shuttle Program	PSAD-79-59	3/16/79
DOD Participation in STS: Status and Issues	MASAD-81-6	2/28/81

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