

Statement of  
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before the  
Subcommittee on **Science**, Technology and Space  
Committee on Commerce, Science and Transportation  
United States Senate

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Mr. Chairman, I am pleased to appear before this Subcommittee to discuss space shuttle pricing policy for foreign and commercial users. The Congressional Budget Office (CBO) has analyzed the cost of the shuttle, developed a set of pricing options, and explored the implications of these options for space policy objectives.

The shuttle price is a key factor in determining the resources the nation devotes to space and whether these are provided by the public or private sector. For instance, a high shuttle price could encourage private U.S. companies to enter the commercial launch market, but would leave the shuttle underused and possibly strengthen the position of the shuttle's major current competitor, Arianespace. On the other hand, a very low price would encourage use of the shuttle, but limit private competition, subsidize foreign and commercial users, and possibly encourage unprofitable expansion of the shuttle system.

The shuttle launch price is not of equal importance in achieving all of the nation's space objectives. Regardless of the price charged commercial and foreign customers, the shuttle system will fly at least 12 to 15 flights annually from 1989 through 1991, a sufficient number to maintain U.S. national prestige in space technology and to contribute substantially toward

meeting the nation's objectives in space science research. A significant portion of the shuttle's national security mission also could probably be met with a flight rate lower than the 24 annual flights projected by NASA.

## BACKGROUND

The President soon will submit to the Congress a new pricing policy for shuttle launch services provided to non-U.S. government users from 1989 through 1991. These users are foreign governments and mature commercial enterprises requiring launch services for payloads such as communication satellites and remote-sensing satellites. <sup>1/</sup>

The current price for a shuttle launch, \$38 million plus fees for capital facilities and insurance, was set by NASA in 1977 to recover all operating and production costs, including orbiters and related equipment. <sup>2/</sup> But by the early 1980s, the shuttle program was behind its technical schedule, and the market for launch services proved substantially smaller than expected, forcing NASA to spread its costs over a smaller number of flights.

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1. In contrast, so-called "infant industries" (such as materials processing and pharmaceutical manufacture) receive free or very low-cost transportation from NASA, until they approach financial self-sufficiency.
  2. All figures in 1982 dollars.

Accordingly in 1982, when NASA set the second pricing policy for launches in the years 1986 through 1988, the price was significantly higher. But at \$71 million, it still will not recover all the costs of the shuttle system. The Administration is now reviewing a new policy proposed by NASA for 1989 through 1991. This price--\$87 million per flight--calls for the recovery of average operational costs only. It remains substantially less than the price implied by the original pricing policy to cover all operating and production costs.

In determining a price for space shuttle services, two sets of factors are considered. The first is the cost of providing shuttle services and how closely the shuttle price should be linked to the resources consumed by the use of the shuttle. The second is space policy objectives, because the shuttle price, in effect, sets priorities among conflicting space goals. But even with agreement on priorities, two major complications remain in pricing the shuttle. First, uncertainty exists about the level of demand for shuttle services four to six years in the future. Second, there is disagreement about how NASA cost estimates should be used to develop an appropriate price. As a result, the CBO analysis of cost bases for shuttle pricing includes both a base case and ranges around that base for each potential pricing option.

## SHUTTLE COSTS

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In the absence of a competitive market for shuttle services, either average or marginal costs can provide a basis for determining prices. Average cost is simply the total cost of providing a service divided by the number of units of service provided. For the shuttle, flights are usually thought of as the relevant unit. Marginal cost is the cost of providing an additional unit of service, or one more flight. While an additional shuttle flight entails increased costs for fuel and other expendable supplies, many other expenditures on facilities, equipment, and people are unaffected and do not enter into the calculation of marginal costs.

Three elements are key in the calculation of shuttle costs, and uncertainties about these lead us to consider ranges of cost estimates:

- o The shuttle flight rate. The base case assumes 24 flights for 1989.
- o The depreciation rate and discount rate used to calculate the annual capital charge for the shuttle's assets. The base case uses a 4 percent real interest rate and a 25-year system life.
- o The accuracy of NASA's operational cost estimates and the division of operational costs between fixed and variable components. The base case uses the NASA total operational cost estimate and divides it equally between fixed and variable costs.

The CBO base case estimates, which are described in more detail in our recent report, include five alternative measures of costs (see Table 1): <sup>3/</sup>

- o Short-run marginal cost, \$42 million per flight--operational cost of an additional shuttle flight.
- o Long-run marginal cost, \$76 million per flight--operational cost of an additional shuttle flight, plus the capital costs associated with providing services for foreign and commercial users.
- o Average full operational cost, \$84 million per flight--the average total operational cost of a shuttle flight. Unlike marginal cost, it includes fixed operational costs.
- o Average full cost less development, \$106 million per flight. This cost averages all shuttle costs, except research and development, over the number of shuttle flights.
- o Average full cost, \$150 million per flight. This measure averages all shuttle costs, both past and future, over all shuttle flights.

The estimated marginal costs are less than the average costs because the former exclude fixed costs that do not change as additional flights are flown. Uncertainty in these estimates is worth highlighting, as shown in the ranges in Table 2. The base case estimate of short-run marginal costs--\$42 million per flight--lies in a range between \$28 million per flight (roughly NASA's estimate) and \$71 million per flight. The actual cost in 1989 will depend on the flight rate between now and then and on how well NASA has

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3. Congressional Budget Office, *Pricing Options for the Space Shuttle* (March 1985).

**TABLE 1. PRICING OPTIONS**

Pricing Policy	Definition of Cost	Price Per Flight in 1989 (millions of 1982 dollars)		Policy Implications
		With 24 Flights	With 18 Flights	
<b>Marginal Cost Prices</b>				
Short - Run Marginal Cost	Variable operational costs.	42	42	Maximum use of shuttle. Likely end to domestic expendable launch vehicles (ELVs). Direct competition with Arianespace. If NASA's costs are underestimated, revenues will not cover cost. High flight rate encourages future expansion.
Long-Run Marginal Cost	Variable operational costs, plus a capital charge for an orbiter dedicated to foreign and commercial flights.	76	76	Shuttle should maintain current market share and generate net federal revenues. Domestic ELV firms have little chance of success.
<b>Full -Cost Prices</b>				
Full Operational Cost	All operational costs. Approximation of proposed NASA policy for 1989 through 1991.	84	98	Largely the same as for long-run marginal price.
Full Cost Less Development	All operational costs, orbiters at replacement cost (\$1.7 billion each), plus other investment but excluding research and development.	106	128	Shuttle will lose part of its market share unless Arianespace increases its price as well. Prospects for domestic ELVs improved but still uncertain. Less than full use of shuttle.
Full Cost	All operational costs, plus all investment valued at historic costs.	150	186	Shuttle loses all but specialized foreign and commercial payloads - flight rate will be below efficient level. * Reduced net federal revenues. Domestic ELVs will do well, particularly if Arianespace increases price. Investors in new space processing may reduce planned spending. Little immediate need to expand shuttle system.

SOURCE: Congressional Budget Office.

NOTE: Estimates reflect base-case assumptions about interest rate and depreciation. Alternative assumptions would generally result in higher costs for options with capital costs. Operational costs based on estimates by NASA.

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TABLE 2. MARGINAL COST: RANGE OF ESTIMATES  
(In millions of 1982 dollars)

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Cost Bases	Cost per Flight
<b>Short-Run Marginal Cost</b>	
Low	28
Base case	42
High	71
<b>Long-Run Marginal Cost</b>	
Low	62
Base case	76
High	105

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SOURCE: Congressional Budget Office.

estimated future operating costs and has distinguished fixed from variable costs. The base case estimate for the long-run marginal cost is \$76 million per flight--in a range between \$62 million and \$105 million. It adds to short-run marginal cost an annual capital cost that reflects a \$1.7 billion replacement orbiter, which might be needed to service the foreign and commercial market.

Estimated full costs rise significantly as the estimated number of flights decreases, because fixed costs, either operational or capital, must be spread over a smaller base, as Table 3 shows. For example, if 18 rather than



TABLE 3. FULL-COST PRICES UNDER VARIOUS SHUTTLE FLIGHT RATES (In millions of 1982 dollars)

Full-Cost Prices	Number of Flights		
	12	18	24
Average Total Cost, Including All Capital Costs	258	186	150
Average Total Cost, Less Research and Development	170	128	106
Average Operational Cost (The NASA Base)	126	98	84

SOURCE: Congressional Budget Office.

24 flights are flown in 1989, the average full cost increases from \$150 million to \$186 million. With only 12 flights, it increases to \$258 million.

#### SHUTTLEPRICESANDPOLICYOBJECTIVES

Each of the alternative cost measures could be used as a basis for shuttle prices. The choice will directly affect how well the nation's competing space objectives are met. The three objectives most sensitive to the shuttle price are:

- o Cost recovery;
- o Efficient resource use; and,
- o Encouragement of commercial activities in space.

### Cost Recovery and Efficiency

Economic analysis suggests that competitive markets yield prices approximating marginal costs and that such prices provide for efficient use of resources. When price exceeds marginal cost, society forgoes benefits because consumers are willing to pay more for the additional unit of the service than the value of the resources that went into providing it. Conversely, if marginal cost exceeds price, resources used to produce the service would be better employed in providing some alternative good or service. Thus, a price equal to the marginal cost of production tends to promote the efficient use of our resources, which in turn suggests that prices set for government enterprises should be based on marginal costs.

But the shuttle system is not a conventional enterprise because many of its costs remain fixed regardless of the number of flights. These high fixed costs make the goals of cost recovery and efficiency incompatible. Specifically, because of high fixed costs, marginal cost--the cost of providing an additional shuttle launch--is significantly less than the average

cost of a launch. Simply put, recovering average costs does not lead to efficient pricing, and efficient pricing does not result in full-cost recovery.

The short-run marginal cost price, \$42 million per flight, sacrifices the goal of cost recovery to ensure that the shuttle has sufficient customers to maintain a high flight rate. This price forgives shuttle users from repaying the system's fixed costs, and implicitly holds full use of the shuttle to be a preeminent policy objective. A shuttle price set at this level would have no net budgetary implications, as long as NASA's cost estimates are correct. If costs prove to have been underestimated, however, the government could end up subsidizing foreign and commercial payloads.

A short-run marginal cost price is valid only if excess capacity remains in the shuttle system. In contrast, the long-run marginal cost price, \$76 million per flight, adopts the perspective that serving the foreign and commercial market requires capital costs to expand the system as well as operating costs. From a budgetary perspective, the concept of a price based on long-run marginal costs provides a litmus test to help determine the need for an additional orbiter. If the shuttle is fully booked at this price, then a new orbiter could be acquired with the confidence that its users would pay its costs (already reflected in the shuttle price). But, as with the short-run

marginal cost option, the advantages of a long-run marginal cost price will not be achieved if operational costs are significantly underestimated.

It is frequently presumed that, if cost recovery is emphasized, a full-cost price would best meet this goal. But this may not be the case if flight demand for the 1989 through 1991 period is misestimated. The prices of \$150 million (full cost) and \$106 million (full cost less development) are high enough to permit full-cost recovery if, and only if, 24 flights are filled and flown in 1989. In fact, revenues from the sale of shuttle services may be maximized by charging a price below the estimated average total costs.

Proponents of full-cost prices point out that if foreign and commercial users are charged less than full costs, then they will reap, but not pay for, the benefits of the past expenditures that went into the shuttle and its technology. Moreover, full-cost prices are more comparable to the cost structures faced by private operators of competitive launch services.

But it should be remembered that the demand for the shuttle could drop dramatically in the face of high, full-cost prices. Thus, paradoxically, a full-cost price could lead to the necessity of budgetary subsidies for the shuttle system. Full-cost prices would tend to reduce long-run government involvement in commercial space activities since they would discourage use

of the shuttle and thus reduce pressures to expand capacity. Such market information may, however, give a misleading signal about the government's appropriate role.

### The Long-Term Commercial Development of Space

There are two aspects to the commercialization of space: the promotion of a private, domestic launch industry using rockets--expendable launch vehicles (ELVs)--and the support of further commercial, industrial, and communication uses of space. The former objective is aided by higher shuttle prices while the latter, for which launch prices are a business expense, is strengthened by lower shuttle prices. The price that any user ultimately must pay depends importantly on the alternative suppliers in the launch market, and therefore CBO has concentrated on this element of commercialization.

At the shuttle's conception, its low projected costs led planners to believe that it ultimately would replace ELVs. But these low costs did not materialize, and ELVs continue to be a viable option for many space payloads. Currently, the shuttle's ELV competitors include Arianespace (an enterprise backed by the 11 nations of the European Space Agency) and,

potentially, several private U.S. firms. The ELV industry offers launch services with rockets directly or indirectly developed by U.S. government efforts--Delta, Atlas Centaur, Titan and their European relative, Ariane. Arianespace has priced its services to be competitive with the shuttle and plans to win a third of the launch market over the next decade. Potential private U.S. ELV firms claim that both the shuttle and Arianespace charge below-cost prices and that, if the full cost of service were reflected in their prices, American ELVs would prove competitive.

The implications for space commercialization of a very low shuttle price, such as a short-run marginal cost price, are mixed. The U.S. commercial ELV industry simply could not survive and the potential entry of other nations (Japan, for example) might be discouraged. Although the response of Arianespace is hard to predict, continued subsidies by its European supporters appear likely. As a result, the commercial market would probably continue to be shared between Ariane and the shuttle, with the shuttle gaining some relative advantage.

Firms investing in shuttle-related launch technology would benefit most from a very low price. These include companies that are designing upperstage rockets to lift into higher orbits payloads which the shuttle has placed in low orbit. Investors interested in new space processing techniques

would also be encouraged, perhaps overly so since the price would make no allowance for recapturing capital costs.

Without a more extensive analysis of demand and the costs of shuttle competitors, it is difficult to evaluate the relative prospects of domestic ELVs, Arianespace, and the shuttle, should the shuttle system charge a mid-range price based on long-run marginal costs or full operating costs. While a shuttle price based on long-run marginal costs might be low enough to allow NASA to compete effectively with Arianespace, it could be too low to permit domestic ELVs to survive. Alternatively, under a higher price based on full costs (and perhaps a full cost less development price), the U.S. ELV industry could compete directly with Ariane and the shuttle. Although existing ELVs firms (those using the Delta and Atlas-Centaur rockets) would have a difficult time matching Arianespace's price, they would have real incentives to invest additional funds in improving these rockets or in developing new ones. From this perspective, a competitive domestic launch industry would be best promoted by launch prices that reflect full costs, unsubsidized by governments.

Proponents of charging a higher shuttle price to encourage a private domestic launch industry contend that the benefits of a strong private industry are not limited to launch privatization. According to this view, a

private launch industry would enhance national security and would provide lower launch costs in the long run, thus encouraging all types of space commercialization. Lower launch costs presumably would be realized by superior private-sector cost control and technical innovation stemming from competition in the marketplace.

These benefits could be jeopardized, however, if Arianespace undercut a full-cost shuttle price with a subsidized predatory price. If investors perceived that Arianespace would use its government subsidies to prohibit the entry of U.S. ELVs, then the development of the U.S. ELV industry could be thwarted. Thus, in addition to a higher shuttle price, an aggressive trade policy that sought to eliminate Ariane subsidies might be a necessary precondition to investment in U.S. ELVs.

#### OTHERFACTORS

A significant aspect of pricing policy concerns the time for which the price remains in effect. NASA has proposed a three-year policy, covering 1989 through 1991. The rationale is that price stability is desirable from a marketing standpoint and that the detailed engineering and construction work on communication satellites must start at least three years before launch. A very long lead time, such as the six years from now until 1991,



however, greatly increases the likelihood of errors in forecasting costs and demand. One alternative to the proposed policy would be to establish a pricing principle, use it to set a price for 1989, and then to update the price each year using NASA's most recent information on costs and flight rates. This policy would implicitly have foreign and commercial users share a portion of the risks with the U.S. government.

#### SUMMARY

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In summary, Mr. Chairman, the choice of a future shuttle price will implicitly set priorities among national space policy goals. No single price for shuttle services can meet all the nation's space objectives. Some objectives--such as the efficient short-term use of the shuttle's capacity and the encouragement of commercial activities in space--are best met by a relatively low price, while others--such as encouragement of a private, domestic launch industry and perhaps full-cost recovery--suggest a higher price. The new price proposed by NASA, and now under review by the Administration, represents an attempt to trade off these competing policy objectives.