Analysis of NASA Lease and Purchase Alternatives for the Commercial Middeck Augmentation Module

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PRICE WATERHOUSE STUDY 1991 (FOR NASA)

SPACEHAB

This lease-versus-buy analysis conducted by Price Waterhouse quantifies the costs of two alternative approaches to obtaining Commercial Mid-deck Augmentation Service.

The model used by Marshall Space Flight Center to estimate procurement costs is the standard cost model used to estimate space hardware candidate programs. Marshall has 20 years of experience in estimating costs of government procurement of space hardware. They use a database that includes extensive project records and histories as the basis for their estimation. The model used is supported by top cost assessment consultant teams, in addition to NASA experts in cost assessment of hardware projects.

It is assumed that NASA will use the equivalent number of Middeck Locker Volume Equivalents (MLVE's) as specified in its lease agreement with Spacehab if it elects to purchase the module. NASA's lease contract with Spacehab calls for the use of 200 MLVE's for a total of $184,236,000.

Total net present value for the purchase of hardware and services, as calculated by Marshall, ≈ $1,016,000,000, or ≈ $5,081,000 per MLVE[1]. The total net present value for the lease ≈ $159,000,000, or ≈ $795,000 per MLVE[2]. Thus, the lease cost is 16% of the purchase cost.[3]

NASA can decrease the unit cost per MLVE to the upper limit of the lease alternative by increasing the use of the module and spreading the costs of the purchase over a greater number of units. NASA must fly the module approximately 16-40 (under different purchase cost scenarios) to approach the lease alternative ranges.

[1] Under alternative purchase cost scenarios, the upper limit for the unit cost for the full cost purchase alternative ≈ $5,200,000 per MLVE. The lower limit unit cost (≈ $3,125,700 per MLVE) assumes users pay 33% full fixed costs plus 33% variable costs and shuttle costs.

[2] OMB Circular No. A-104, 5(c), "Lease-versus-buy analysis should compare the discounted (present value) life-cycle costs of leasing with the cost of buying an identical asset."

[3] Even under an unrealistically pessimistic scenario, where NASA purchases all of the remaining Spacehab locker space at its commercial price (100 MLVEs at $1.5 million each) and still only flies 200 MLVEs, the cost per MLVE would be very roughly $1.4 million, 28% of the purchase cost.

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I. Purpose of Analysis

The purpose of this analysis is to quantify the costs of two alternative approaches to obtaining Commercial Mid-deck Augmentation Module Service (CMAM). The alternatives studied include:

(1) direct government purchase through traditional contracting and procurement management; and,

(2) leasing the service through a commercial venture, Spacehab.

Case buy analysis

This analysis will be used to better understand the financial effects of leasing space hardware as an alternative to using traditional NASA procurement mechanisms, leading to full NASA ownership of the hardware. The data used in the analysis will thus come from (1) an estimate of the costs to NASA of contracting a design-build procurement; and (2) the details of the lease agreement currently in place for the CMAM service.

The document which follows details the methodology and data used in the analysis in Section II. Section III describes the results of the analysis. In order to test the robustness of the results of the analysis, we prepared several different lease-buy scenarios, and these are detailed in Section IV. Our conclusions are presented in Section V. Appendices are attached which provided supporting information for our selection of methodology and data for analysis.

II. Methodology and Data Inputs

This section of the report describes the methodology used in the study and the data used. The service to NASA to be costed is the provision of 200 mid-deck locker volume equivalents (MLVE's). NASA has leased this amount of service from SPACEHAB, Inc., over a six shuttle flight duration. The lease cost analysis is thus based upon the actual contract price for the lease. The purchase cost scenario by necessity must be a purchase of the entire module. In our base comparison, we allocated the entire cost of the module (and attendant flight costs for services provided in the lease) over 200 MLVE's. In Section IV of this report, we study alternative use scenarios, and the effect they have on the per unit MLVE price.

It is important to note that the study team relied on data supplied by NASA's hardware purchase cost estimators for the procurement data. This team of cost estimators uses a database representing twenty years of experience in costing NASA hardware projects, and uses a state of the art model for estimation developed with the assistance of Booz, Allen & Hamilton and PRC, Inc.

A. The Methodology

The goal of the analysis is to project the cost to NASA of procuring 200 MLVE's of service under both the purchase and lease options. To do this, the team defined the cost as the present value of net cash flows over the projected life of the program. This net present value method is a discounted cash flow technique which recognizes the time value of money

and is consistent with OMB Circular A-104, Evaluating Leases of Capital Assets (see Appendix A).

OMB Circular A-104 defines the cost of each of the two alternatives as follows:

(1) The cost of **leasing** is the present value of the lease payments to be made by the Federal Government over the entire lifetime of the lease, plus the cost to the Treasury of any tax benefits provided to the lessor. It is given by the formula:

$$\sum_{t=0}^{n} \frac{L_t}{(1+d)^t} + B$$

Where L_t is the lease payment in year t,

d is the discount rate,

n is the term of the lease, and

B is the cost of tax benefits.

(2) The cost of **purchasing** is the price that the Federal Government would have to pay to purchase an identical asset, minus the (discounted) price that the Federal Government could realize by selling the asset at the end of the lease term, plus the cost of any services that would be provided by a lessor, but are not included in the purchase price. It is given by the formula:

$$P = \frac{R}{(1+d)^n} + \sum_{t=0}^{n} \frac{S_t}{(1+d)^t}$$

Where **P** is the purchase price,

R is the resale price,

S_t is the cost in year **t** of services that would be provided by a lessor,

d is the discount rate, and

n is the term of the lease.

B. The Data

The data set for the purchase and lease options are very different, and come from very different sources. The data and the sources are described below. The key features of the data and its treatment are summarized in Appendix F, Slide 1.

The Data for Estimating the Purchase Alternative

The data used to construct the cost estimate for the purchase alternative came from the NASA hardware cost estimation model in Huntsville, Alabama. We also needed to estimate the cost of services, as the lease agreement with SPACEHAB, Inc. includes service provision.

The government procures hardware and services by purchasing hardware and contracting for support services. The hardware acquisition portion of this alternative is analyzed independently of the support services portion. A present value for the stream of purchase payments is calculated based on the cost estimated to design and build CMAM that was obtained from a hardware costing model at the Marshall Space Flight Center in Huntsville, Alabama (see Appendix B).

The estimate from Marshall is based upon subsystem specifications and commonalities with previously developed subsystems as set forth in the CDR data package. From this estimate, the discounted value of the purchase payments is calculated based on the time to complete, likely payment scenario, and the time value of money. The services provided for in the lease contract is treated as a separate contract the cost of which is estimated independently of the hardware. The cost of additional hardware related costs such as storage, repair, and maintenance along with other imputed financial costs is estimated and added to the hardware purchase and support services costs to arrive at a discounted estimate of cash flow required from NASA over the useful life of the module.

Details of the NASA Spacehab Cost Estimate

The following estimate, expressed in 1989 and 1990 dollars, is based upon work that was preformed by the Engineering Cost Group at the Marshall Space Flight Center and is documented by the letter provided in Appendix B to this report.

This estimate is used within the purchase alternative model to estimate the total procurement cost of two modules and a spare. The $1990 amounts are not intended to imply greater precision of the estimate. They are merely the result of applying the appropriate inflation rate to the $1989 estimates. It is assumed that funds for the second and spare units will be disbursed in 1992 while all other funds are disbursed in 1990.

Cost Element	$ 1989	$ 1990
Design, Development, Test and Evaluation	$350,700,000	$364,728,000
Construction of 1st Unit	$101,947,369	$106,025,264
Construction of 2nd Unit	$100,752,631	$113,333,007
Construction of Spare (Ground) Unit	$50,376,316	$56,666,504
Software Development	$10,000,000	$10,400,000
Subtotal	$613,776,316	$651,152,775
Fee	$67,600,000	$70,304,000
Reserve	$112,700,000	$117,208,000
Program Support	$111,500,000	$115,960,000
Total	$905,576,316	$954,624,775

Major Assumptions and Parameters in Estimate

The cost estimate generated by this analysis is a parametric estimate based on similarities between Spacehab subsystems and other previously developed hardware subsystems. For each subsystem, the weights, degree of modification, and complexity are estimated to adjust the cost data to this specific project.

To allow for the lack of detailed subsystem weight information, two approaches were utilized in estimating the cost of Spacehab: using the total system weight as an analog to Spacelab; and estimating the subsystem weights using ratios generated from Spacelab subsystems.

In addition to estimating the subsystem weights, estimates were made for the complexity factor and new design factor for each of the subsystems along with selecting a direct subsystem analog.

A complexity factor of 1.0 rates the system equally complex as its analog. A new design factor of 1.0 represents a completely new design with no benefit from existing technology. A new design factor of 0.5 represents the basic integration of existing technology. The Command and Data System (CDS) subsystem was judged to be significantly less complex than its analog and requires little new design.

The Electrical Power System (EPS) subsystem was judged to be equally complex as its Spacelab analog but significantly smaller with a lower capacity. The Environmental Control System (ECS) subsystem was judged to be equally complex as its analog and require simple integration. The pressurized structure represents some new design, but is based on Spacelab to some extent and was rated 0.7 for new design and 1.0 for complexity.

"Change traffic", i.e., the changing requirements often found in NASA procurements, result in higher costs under traditional procurement actions. In a previous unrelated analysis, NASA estimated these costs at 25% of total cost.

The second unit costs are estimated to be 90% of the first unit flight hardware costs. A spare unit estimated to cost approximately $50,000,000 was added to the NASA MSFC estimate to better represent the total units NASA would request under this program.

The cost estimate generated by the NASA model is intended to capture costs up to day of delivery, with 30 to 60 days of contract support. No operations costs are included. NASA estimates that a crude approximation for these costs would be 5% of prime contract and project office costs per year of operations.

The general and administrative estimates inherent in the Spacelab analog may be too high for the Spacehab case because it was based on European firms and their G&A levels.

Using the data described above, the purchase model as prescribed by OMB Circular A-104 was applied as follows:

- **P**, the present value of the purchase price in 1990 dollars, was set at $954,624,775. The rationale for this estimate is provided in the next section "NASA Spacehab Cost Estimate."
- **R**, the resale price, was given a $0 value which expresses that NASA is unlikely to seek to sell the module at the completion of the program.
- S_t, the estimated cost of services under a service contract in year t, is estimated to be approximately $1,633,461 in 1990 dollars. The detail supporting this assumption is provided in Appendix D. In addition, imputed insurance cost of approximately $12,600,000 per flight in 1990 dollars are included in this variable when appropriate. The detail supporting the assumption of insurance cost is provided in Appendix C.

- Additionally, when it is assumed that commercial users will reimburse NASA for flight service payments and variable costs, they will be used to offset this cost on a per flight basis.

The Data for Estimating the Lease Alternative

The government plans to lease the 200 MLVE's, hardware and services as set forth by the terms of NASA contract number NAS9-18371. The amounts and timing of payments to NASA to be used in the analysis are set forth in Section B of the contract Supplies or services and prices/costs.

For this application, the lease model as prescribed by OMB Circular A-104 was applied as follows:

- L_t is the lease payment in month t with t=0 set at 6/30/91 as set forth in the lease contract.
- **d** is the discount rate net of inflation which is defined as the 90 day Treasury rate of 8% less an inflation rate of 4%. This 4% discount rate expresses the discounted value of lease payments in terms of 1990 dollars.
- **n** is the term of the lease expressed in months and is set at 51 consistent with the terms of the contract.
- **B** which represents the cost of tax benefits accruing to the lessor as a result of the lease contract is assigned a value of zero. This treatment is consistent with the guidance provided by OMB Circular A-104 which states that unless a proposed lessor provides information to the contrary, Federal agencies

generally may assume that there are not tax benefits associated with leasing.

Description of the Base Case for Cost Comparison

The primary focus of this analysis is the comparison of alternative approaches to the acquisition of access to locker space in the Commercial Middeck Augmentation Module. The fundamental approach in comparing the cost of the two alternatives is to equate the number of Middeck Locker Volume Equivalents (MLVEs) and the level of support services under each alternative. The lease contract specifies the use of 200 MLVEs and related services. Therefore, it is assumed that NASA will use the equivalent number of MLVEs should it elect to purchase the module.

To determine an upper bound of the lease cost alternative to NASA, it is assumed that NASA will not receive any service payments from commercial users of MLVEs for shuttle services. In addition, NASA will adhere to its planned flight schedule and fly the module six times to utilize 200 MLVEs. This equates to a total present value cost of approximately $1,046,994,244, or a cost per MLVE of approximately $5,230,000. However, a more rational NASA schedule will seek to minimize shuttle costs by utilizing the full capacity of the module of each launch since there will be no commercial users. Since the module capacity is 50 MLVEs per flight, NASA will be able to utilize 200 MLVEs in four flights. (Note: Rounding is done to most estimates. In some cases, we provide the complete estimate from the model to allow easy cross reference to the model output. The significant figures for any number in this report are three.)

BUT IT MAY NOT BE POSSIBLE TO SCHEDULE PAYLOADS IN BUNCHES THIS WAY.

III. Results

The net present value of the lease alternative is significantly less than that of the purchase alternative. If NASA uses only 200 MLVEs under the purchase alternative, the total net present value for the purchase of hardware and services will be approximately $1,016,000,000 versus the net present value of lease of approximately $159,000,000. Comparing the two alternatives on an MLVE, or per unit, basis indicates that the unit cost of the purchase option would be approximately $5,081,000 compared with a unit cost of approximately $795,000 under the lease alternative. See Appendix F for comparison results.

1016 x 10^6 / 200 = 5.081 x 10^6

159 x 10^6 / 200 = .795 x 10^6

This cost differential is primarily due to NASA having to spread the large fixed procurement cost of approximately $954,624,775 over 200 MLVEs. If NASA planned to utilize the module over its entire designed life, it would have to fly approximately 40 times over a five year period to achieve a unit cost of approximately $797,000 which would be just less than that provided under the terms of the lease alternative.

Since the lease makes available additional capacity to NASA at a price not to exceed that paid by commercial providers, NASA has considerable flexibility to increase module use without absorbing all of the fixed costs required under the purchase alternative.

50 MLVE'S / FLT
X 40 FLTS
2000 MLVES THROUGHOUT
BREAKEVEN LEVEL
OF UTILITY

IV. Scenario Analysis

There are many assumptions used to develop the purchase cost base case. These actual use profile of the module, NASA's ability to lease off or charge for the use of a portion of the module if it owned the hardware, reduction in the cost of insurance (or assuming no cost under a self-insurance policy) all contribute to potential reductions in the cost per unit of the purchase option over the life of the purchased modules.

THERE ALWAYS EXISTS AN IMPUTED COST OF SELF INSURANCE

In order to fully understand the effects of changes to the way NASA manages its purchased resource, we have developed five different sets of use assumptions. These indicate the financial effects of the changes in the use profile on the validity of the decision to lease the service. In summary, the lease option is still financially preferable to the purchase option, even accounting for the use profile changes. The cost estimate of the lease alternative does not vary as it is stated firmly in the contract.

It has already been shown that an upper limit in the lease alternative is calculated by determining the present value of lease payments made by NASA as prescribed by the provisions of the lease contract with no flight service reimbursements on behalf of commercial users. This upper limit was calculated to be approximately $795,000 per MLVE. It has also been shown that an upper limit of the cost per MLVE under a full cost purchase alternative was estimated to be approximately $5,200,000 per MLVE.

In order to investigate the relationship between purchase alternative assumptions, level of module usage, and unit cost per MLVE, five

scenarios have been analyzed. In these scenarios the unit cost per MLVE assuming NASA utilizes only 200 MLVEs ranges from the upper limit of approximately $5,200,000.

NASA can decrease the unit cost per MLVE to the upper limit of the lease alternative by increasing its usage of the module. This is due to the fixed cost of the purchase of the module being spread over a greater number of units as usage is increased. The number of times NASA must fly the module to have the unit cost approach that of the upper limit to the lease alternative ranges from approximately 40 times to 16 times under the assumptions of the various scenarios. These scenarios, and the data in the assumptions of each scenario, are described below.

Scenario 1: **Full NASA Use, No Insurance**

This scenario is a modification of the full cost purchase scenario in which there is no imputable insurance. Since insurance cost is an estimate that approximates the cost to NASA of repairing or replacing the module should it be damaged or destroyed, not including it in this scenario is equivalent to an assumption that NASA would discontinue this program in the event of a serious mishap. The implication is that the cost of the risk of termination is not accounted for in this scenario.

The table of detailed assumptions and results indicates that NASA would be required to fly the module 26 times to have the cost per MLVE of this purchase scenario less than the lease alternative. However, the lease alternative is less risky for the program since the commercial lessor will insure the module to assure that funds are available for repair or

replacement. A detailed listing of discounted cash flows for this scenario is provided in Appendix E.

SCENARIO 1

Full NASA use, no insurance

Discounted Value of Purchase Payments	
Years from Contract to First Flight	2
Number of Units Procured	2.5
Total Procurement Cost (Fixed Cost)	$954,624,775
Service Cost per Flight	$1,633,461
Imputable Insurance Cost	$0
Total Variable Cost per Flight	$1,633,461
Proportional Flight Service Payment	$0
Cost for Equivalent Scenario (Flight Basis)	$965,691,781
Cost for Equivalent Scenario (MLVE Basis)	$961,691,781
Cost per MLVE (Flight Basis)	$4,828,459
Cost per MLVE (MLVE Basis)	$4,808,459

Approximate number of flights for purchase alternative to be less costly per MLVE than the lease alternative: 26

Scenario 2: Users Pay 33% of Variable Flight Costs

The lease contract provides for six flights of the module over its term. At 50 MLVEs per flight, this is the equivalent of 300 MLVEs flown. Since NASA has leased 200 or two thirds of the MLVEs, 100 or one third are available to

commercial users. This scenario assumes that such commercial users will pay NASA for one third or 33% of the variable flight costs associated with each flight. The variable flight costs are the sum of the service cost per flight and the imputable insurance cost.

The table of detailed assumptions and results indicates that NASA would be required to fly the module 33 times to have the cost per MLVE of this purchase scenario less than the lease alternative. A detailed listing of discounted cash flows for this scenario is provided in Appendix E.

SCENARIO 2

Users pay 33% of variable flight costs

Discounted Value of Purchase Payments	
Years from Contract to First Flight	2
Number of Units Procured	2.5
Total Procurement Cost (Fixed Cost)	$954,624,775
Service Cost per Flight	$1,094,419
Imputable Insurance Cost	$8,442,000
Total Variable Cost per Flight	$9,536,419
Proportional Flight Service Payment	$0
Cost for Equivalent Scenario (Flight Basis)	$1,016,512,319
Cost per MLVE (Flight Basis)	$5,082,561
Approximate number of flights for purchase alternative to be less costly per MLVE than lease alternative:	33

Note: Costs expressed on an MLVE basis do not apply to scenarios providing for commercial participation since 100% of module capacity is not available to NASA.

Scenario 3: Users Pay 33% of Flight Service and Variable Flight Costs

This scenario modifies Scenario 2 by making the assumption that commercial users will pay NASA for one third or 33% of flight service costs in addition to 33% of variable flight costs. This scenario is intended to illustrate the effect of commercial reimbursement for shuttle services in addition to variable costs associated with the module.

The detail of assumptions and results indicates that NASA would have to fly the module 23 times for the unit cost under the purchase scenario to be less than the lease scenario. A detailed listing of discounted cash flows under this scenario is provided in Appendix E.

SCENARIO 3

Users pay 33% of Flight Service and variable flight costs

Discounted Value of Purchase Payments	
Years from Contract to First Flight	2
Number of Units Procured	2.5
Total Procurement Cost (Fixed Cost)	$954,624,775
Service Cost per Flight	$1,094,419
Imputable Insurance Cost	$8,442,000
Total Variable Cost per Flight	$9,536,419
Proportional Flight Service Payment	$<11,764,202>

Cost for Equivalent Scenario (Flight Basis)	$940,167,354
Cost per MLVE (Flight Basis)	$4,700,837

Approximate number of flights for purchase alternative to be less costly per MLVE than lease alternative: 23

Scenario 4: Users Pay 33% of Module and Variable Flight Costs

This scenario is intended to model the impact on unit cost to NASA if commercial users are required to pay one third or 33% of fixed module procurement cost as well as 33% of the variable costs of using the module which does not include shuttle costs.

The detail of assumptions and results indicates that NASA would have to fly the module 23 times for the unit cost under this purchase scenario to be less than the lease scenario. A detailed listing of discounted cash flows under this scenario is provided in Appendix E.

SCENARIO 4

Users pay 33% of module and variable flight costs

Discounted Value of Purchase Payments	
Years from Contract to First Flight	2
Number of Units Procured	2.5
Total Procurement Cost (Fixed Cost)	$639,598,599
Service Cost per Flight	$1,094,419
Imputable Insurance Cost	$8,442,000
Total Variable Cost per Flight	$9,536,419
Proportional Flight Service Payment	$0

Cost for Equivalent Scenario (Flight Basis) $701,468,143

Cost per MLVE (Flight Basis) $3,507,341

Approximate number of flights for purchase alternative to be less costly per MLVE than lease alternative: 23

INCLUDES INSURANCE

Scenario 5: Users Pay 33% of Module, Variable Costs, and Flight Service Costs

REIMBURSABLE IN FULL IF 100% COMMERCIAL UTILIZATION OF MODULE

This scenario is intended to model the impact on unit cost to NASA if commercial users are required to pay one third of the full fixed cost of the module as well as one third of variable module costs and shuttle costs. This scenario most closely represents NASA attempting to recover all costs associated with using the module on a per unit basis and effectively represents a lower limit for unit cost to NASA.

The detail of assumptions and results indicates that NASA would have to fly the module 16 times for the unit cost under this purchase scenario to be less than the lease scenario. A detailed listing of discounted cash flows under this scenario is provided in Appendix E.

SCENARIO 5

Users pay 33% of module, variable flight costs, and flight service costs

Discounted Value of Purchase Payments	
Years from Contract to First Flight	2
Number of Units Procured	2.5
Total Procurement Cost (Fixed Cost)	$639,598,599

Service Cost per Flight	$1,094,419
Imputable Insurance Cost	$8,442,000
Total Variable Cost per Flight	$9,536,419
Proportional Flight Service Payment	$<11,764,202>
Cost for Equivalent Scenario (Flight Basis)	$625,141,178
Cost per MLVE (Flight Basis)	$3,125,706

Approximate number of flights for purchase alternative to be less costly per MLVE than lease alternative: 16

V. Conclusions

The results of the preceding analysis support the conclusion that the lease alternative is the least costly means for NASA to obtain use of 200 Middeck Locker Volume Equivalents (MLVEs) and related services. The most conservative estimate of lease costs excluding flight service payments is significantly below any of the reasonable scenarios considered under the purchase alternative. Even in the event NASA is able to fully recover 33% of all fixed, variable and flight service costs the module would have to be flown at least 16 times to have the unit cost per MLVE be comparable to the unit cost under the lease alternative. Given the current demands on the use of the space shuttle this level of usage over a reasonable period of time is unlikely.

The primary reason that the unit cost per MLVE is higher than the lease alternative under any likely purchase scenario is that the module's procurement cost is a fixed cost that must be spread over the number of MLVEs that NASA is able to fly. This cost is so large relative to variable costs that a substantial decrease in unit costs results as the number of flights increases. However, the level of flights for which the unit cost decreases enough to approach the unit cost as calculated given the terms of the lease contract will likely exceed the number of available shuttle flight opportunities for the CMAM lease period (51 months).

There are additional considerations in the lease vs. buy decision which fall outside the scope of the quantitative analysis provided in this report. Of prime concern is the risk that the commercial lessor will be unable to perform under the contract either for technical or financial reasons. In the event of non-performance, NASA's options would be to terminate the contract and either discontinue the

program or pursue a purchase alternative that incorporates the conditions that are extant at the time of termination.

In addition to non-performance on the part of the lessor, NASA faces certain government related risks such as schedule delays related to flying the module on the space shuttle and the uncertainty of maintaining appropriations to fund the contract for the entire term of the lease. Naturally, these concerns could result in the termination of a NASA program which utilizes the module, however, they are also present in the purchase scenario and therefore do not provide a basis for selecting one alternative over the other.

APPENDIX A

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

June 1, 1986

CIRCULAR NO. A-104
Revised

TO THE HEADS OF EXECUTIVE DEPARTMENTS AND ESTABLISHMENTS

SUBJECT: Evaluating Leases of Capital Assets

1. Purpose. This Circular prescribes a method for the economic analysis that should be conducted when considering whether to use leasing in place of direct government purchase and ownership as a means of acquiring the use of assets.

2. Rescission. This Circular replaces and rescinds Office of Management and Budget (OMB) Circular No. A-104, dated June 14, 1972.

3. Authority. This Circular is issued under the authority of the Budget and Accounting Act of 1921, as amended.

4. Scope and Applicability.

   a. This Circular applies to all agencies in the Executive Branch of the Federal Government. It does not apply to the United States Postal Service, to the Government of the District of Columbia, or to non-Federal recipients of loans, contracts, or grants.

   b. The guidelines in this Circular are suggested for use in the internal planning documents of the executive agencies in the Executive Branch and required for use in all prospectuses, proposed legislation, budget justifications or other proposals submitted to the Office of Management and Budget and to the Congress.

   c. This Circular applies to leases of capital assets.

      (1) A capital asset, for the purposes of this Circular, is any tangible property, including durable goods, equipment, buildings, facilities, installations, or land, which:

         (a) is leased to the Federal Government for a term of five or more years; or

         (b) in the case of a new asset with an economic life of less than five years, is leased to the Federal Government for a term of 75 percent or more of the economic life of the asset; or

         (c) is built for the express purpose of being leased to the Federal Government; or

         (d) clearly has no alternative commercial use (e.g., a special-purpose government installation).

(2) For purposes of lease-versus-buy analysis, the economic life of an asset is the physical or productive lifetime of the asset. It begins when the asset is new and ends when it is retired from service. The economic life is frequently not the same as the useful life for tax purposes.

(3) In determining the term of a lease, all renewal options shall be added to the initial lease period. In addition, successive leases with respect to the same or substantially similar property shall be added to the intitial lease term unless the succeeding lease is entered into after fully considering alternative lease contracts offered in competition. Lease-purchase or purchase-contract agreements are subject to the same requirements under this Circular.

d. This Circular does not apply to:

(1) Any lease of one or more assets that together have a total fair market value of less than $1 million at the time the lease would be signed. Agencies may apply the provisions of this Circular to leases of assets valued at less than $1 million, but are not required to do so.

(2) Service contracts that involve the use of capital assets by the contractor incidental to the provision of services to the Federal Government. Economic analyses of service contracts are governed by OMB Circular No. A-76, "Performing Commercial Activities," dated August 4, 1983.

e. Notwithstanding paragraphs (a) through (d), the Office of Management and Budget may require that any particular lease or service contract be subjected to the provisions of this Circular.

5. Lease-Versus-Buy Analyses

a. Whenever the mission of a Federal agency requires that it acquire the use of a capital asset, it should use that method of acquisition which is least expensive to the government as a whole.

(1) For purposes of lease-versus-buy analysis, the cost of leasing should include both the cost of lease payments made by the Agency entering into the lease, and the cost to the Treasury of any special tax benefits associated with leasing such as the investment tax credit or the tax deferral provided by accelerated depreciation allowances.

(2) The normal payment of taxes on income and profits by the lessor (or by other parties to the transaction) should not be included in the lease-versus-buy analysis. Normal income

taxes are already taken into account when the cost of obtaining assets is measured by their market prices; including them explicitly in the analysis would represent double counting. Only those special tax preferences that are provided to lessors above and beyond their normal tax liabilities represent an additional cost to the Federal Government that should be included in the lease-versus-buy analysis. Additional guidance on evaluating the cost of tax benefits is provided in Appendix A.

b. The lease-versus-buy analysis required by this Circular is intended to determine whether it would be cheaper to lease or to buy a given asset. It should not be used to determine what kind of asset should be acquired, in what quantity, or on what acquisition schedule. When an agency is confronted by a decision that combines both aspects--a choice between leasing an asset this year and purchasing it next year, for example--the agency should first conduct a cost-benefit analysis to determine when to acquire the asset, and then conduct the lease-versus-buy analysis required by this Circular to determine whether to lease or buy.

c. Lease-versus-buy analyses should compare the discounted (present value) life-cycle cost of leasing with the cost of buying an identical asset.

(1) Other methods, such as those based on savings-investment ratios, payback periods, and internal rates of return, should not be used.

(2) This Circular does not preclude consideration of undiscounted cash flows, or of noneconomic programmatic factors, for budgetary or other purposes, but they should not be used in lease-versus-buy analyses.

d. Calculation of present values should be performed in accordance with established discounting procedures, using either continuous or end-of-year discount factors.

e. All costs should be expressed in current (i.e., "then-year") dollars (taking account of any price escalation clauses that may apply), and discounted back to a common year, usually the year in which the lease would begin.

f. If the terms of the lease include ancillary services provided by the lessor, such as operation and maintenance, the cost of obtaining these services separately should be added to the purchase price. Such costs may be ignored if they are estimated to be too small to affect the outcome of the lease-versus-buy analysis. (Appendix B provides additional guidance on costs to be included in analyses of leases of general purpose real property, which frequently involve such ancillary services.)

g. Certain costs associated with the Federal Government's purchase of an asset do not involve any direct Federal payment. Such costs include the imputed market value of public land, imputed insurance premiums on government-owned assets, and imputed State and local property taxes on Federally owned facilities. Any such cost that, in the case of a lease, would be incurred by the lessor (and subsequently charged to the Federal Government as part of the rental rate) should be included in the lease-versus-buy analysis. This is accomplished by estimating the imputed cost associated with government ownership and adding it to the purchase price. Additional guidance on imputed costs is provided in Appendix B.

h. The discount rate for lease-versus-buy analysis is the current interest rate on new issues of U.S. Treasury securities with maturities most nearly equal to the term of the lease. This rate includes expected inflation, and, therefore, is consistent with current-dollar cost estimates, which also include inflation. It applies only when all of the alternatives have the same benefits and all costs are paid for in the same way, as is the case with lease-versus-buy analysis of the same asset(s). This rate is not generally applicable to cost-benefit analyses because they usually do not meet these criteria. Additional guidance on determining the correct discount rate is provided in Appendix A, paragraph 2(g).

i. Agencies should avoid entering into leases that defer payment past the time that services are rendered by the asset. Further, leases should be structured with equal annual payments, or payments that decline in size over time; larger payments in later years should be avoided.

6. Analytic Requirements for Leases of Capital Assets

All leases of capital assets must be justified as preferable to direct government purchase and ownership. In general, this can be done in one of three ways:

a. By conducting a separate lease-versus-buy analysis of each lease of one or more capital assets that the agency proposes to enter into. This is the only acceptable method for major acquisitions.

(1) A lease of one or more capital assets is major acquisition if:

(a) the acquisition represents a separate line-item in the agency's annual budget;

(b) The agency determines that the significance of the acquisition to the agency merits designating it as major;

(c) The Office of Management and Budget designates it as a major acquisition; or

(d) The total value of the acquisition, as measured by the purchase price of the assets to be leased, exceeds $500 million.

(2) Lease-versus-buy analyses of major acquisitions should be reviewed by the agency head, or by the official designated by the agency head as responsible for acquisition policy.

b. In the case of recurrent decisions to lease similar assets for the same general purpose, by periodically conducting a lease-versus-buy analysis for the entire class of assets in question, using the same analytic methods used to evaluate individual leases. Any decision that a given lease is covered by a generic analysis is to be pursuant to a written statement of the scope of the generic analysis which has been approved by OMB.

c. By adopting a formal policy that would generally be expected to result in the same lease-versus-buy decisions as a requirement for lease-versus-buy cost analyses, and submitting that policy to the Office of Management and Budget for approval. Such a policy, which should normally apply only to smaller leases, might require:

(1) A demonstration that the leases in question would result in substantial savings to the government that could not be realized on a purchase, and that are great enough to ensure that leasing is less expensive than purchase.

(2) A demonstration that the leases in question are so small in dollar amount, or for such a short lease term, as to make it inefficient to conduct lease-versus-buy analyses.

(3) Full funding of leases, whereby the agency obligates funds, in the year the lease is signed, equal to the entire undiscounted sum of the lease payments over the entire term of the lease, including all renewal options.

7. Applicability of Other Guidance

a. OMB Circular No. A-11 ("Preparation and Submission of Budget Estimates") provides guidance to agencies on the proper presentation in the Federal budget of the amount of budgetary resources required for leases.

b. OMB Circular No. A-70 ("Policies and Guidelines for Federal Credit Programs") provides guidance on the use of leases as financial contracts that are the equivalent of indirect loan guarantees. (OMB Circular A-70 directs that leases signed by Federal agencies shall not be used to support, directly or indirectly, Federally tax-exempt debt obligations.)

c. OMB Circular No. A-76 ("Performance of Commercial Activities") provides guidance on conducting economic analyses comparing service contracts with government performance of the requirements.

d. Federal Information Resources Management Regulations (41 CFR 201-24.208(b) and 24.305) provide additional guidance on conducting economic analyses of ADP and telecommunications acquisitions.

e. "Joint OMB and Treasury Guidelines to the Department of Defense Covering Lease or Charter Arrangements for Aircraft and Naval Vessels," dated October 31, 1984, provides guidelines for satisfying the requirements of Chapter 141 of Title 10 of the United States Code.

8. Effective Date. This Circular is effective immediately.

9. Inquiries. For information concerning this Circular, contact the Office of Management and Budget, Office of Economic Policy, Room 9002, New Executive Office Building, 726 Jackson Place, N.W., Washington, D.C. 20503.

James [illegible], III
Director

Attachments

APPENDIX A

1. Summary of Lease-Versus-Buy Analysis

a. The lease-versus-buy analysis compares the cost of leasing with the cost of purchase.

b. The cost of leasing is the present value of the lease payments to be made by the Federal Government over the entire lifetime of the lease, plus the cost to the Treasury of any tax benefits provided to the lessor. It is given by the formula:

$$\sum_{t=0}^{n} \frac{L_t}{(1+d)^t} + B$$

Where L_t is the lease payment in year t,
d is the discount rate,
n is the term of the lease, and
B is the cost of tax benefits

Public Law 98-369 (The Deficit Reduction Act of 1984) withdrew tax benefits on most assets leased to tax-exempt entities. Leases of capital assets to the Federal Government would normally be expected to fall within the scope of the Deficit Reduction Act. Therefore, unless a proposed lessor provides information to the contrary in its bid, or there are special circumstances that indicate that the lessor will receive tax benefits, Federal agencies generally may assume that there are no tax benefits associated with leasing. Hence the cost of a lease to the government as a whole can be evaluated simply by discounting the stream of lease payments.

Although capital assets leased to the Federal Government do not as a rule qualify for tax benefits under current law, exceptions to that rule may arise, including many energy facilities and some classes of real property. If there is reason to believe that a lease to a Federal agency will be eligible for tax credits or accelerated depreciation allowances, then the lease-versus-buy analysis must include the cost of those tax benefits as part of the cost of leasing. The method for calculating the cost of tax benefits is outlined in section 2 of this attachment.

c. The cost of purchase is the price that the Federal Government would have to pay to purchase an identical asset, minus the (discounted) price that the Federal Government could realize by selling the asset at the end of the lease term, plus the cost of any services that would be provided by a lessor, but are not included in the purchase price. It is given by the formula:

$$P = \frac{R}{(1+d)^n} + \sum_{t=0}^{n} \frac{S_t}{(1+d)^t}$$

Where P is the purchase price,
R is the resale price,
S_t is the cost in year t of services that would be provided by a lessor,
d is the discount rate, and
n is the term of the lease.

2. Cost of Tax Benefits

a. In order to evaluate the cost of any tax benefits associated with leasing, the following additional data are required:

(1) The economic lifetime of the asset;

(2) The rate of tax on income generated by the lease;

(3) The dollar amount of any tax credits that ownership of the asset confers on the lessor; and

(4) The dollar amount of depreciation allowances that the lessor may deduct from its taxable income in each year that it owns the asset.

b. The process of evaluating the cost of tax benefits associated with leasing involves two steps:

(1) Determining the total cost of tax benefits conferred on the lessor over the entire life of the asset, and

(2) Determining how much of the total cost of the tax benefits is properly attributable to the period during which the asset is leased to the Federal Government.

c. Tax benefits fall into two categories: tax credits and depreciation allowances.

(1) A tax credit is an amount that is subtracted directly from the taxes owed by the lessor, and can therefore be viewed as the equivalent of a cash grant from the Treasury. Since this cash grant is not itself subject to tax, it is worth more to the lessor (and it costs the government more) than would a direct, taxable outlay of the same dollar magnitude. In order to measure the cost of a tax credit in the same way that is used to measure outlays (such as lease payments), the tax credit must be converted to its outlay equivalent: the taxable payment that would have the same value to both the government and the recipient. This is accomplished by dividing the amount of the tax credit by one minus the tax rate. Thus the cost of a tax credit is given by the formula:

$$\frac{\frac{C}{1-T}}{(1+d)^t}$$

Where C is the amount of the tax credit.
T is the tax rate,
d is the discount rate, and
t is the year in which the tax credit is given.

(2) A depreciation allowance is an amount that is subtracted from the lessor's taxable income, rather than from its taxes. Note, however, that a deduction in the amount of "economic depreciation" is a feature of normal income taxes and does not represent a tax benefit. It is only the amount by which actual depreciation allowances exceed (or fall short of) economic depreciation that represents a tax benefit (or penalty). Accelerated depreciation schedules, for example, typically allow deductions greater than economic depreciation in the first few years of ownership of an asset, and less than economic depreciation in subsequent years. The resulting deferral of taxes represents a tax benefit. The amount of the deferral in any given year t is $T(A_t-D_t)$, where A_t is the amount that the lessor is actually allowed to deduct from taxable income, D_t is economic depreciation, and T is the rate of taxation. As was the case with a tax credit, this amount is equivalent to a tax-exempt cash grant. Its cost to the government (in outlay terms) is:

$$\frac{T(A_t-D_t)}{1-T}$$

(3) The total cost of accelerated depreciation over the life of the asset is given by the formula:

$$\sum_{t=0}^{u} \frac{T(A_t - D_t)}{(1+d)^t}$$

(4) The total cost of tax benefits associated with leasing (tax credits plus deductions) is given by the formula:

$$\sum_{t=0}^{u} \frac{C_t + T(A_t - D_t)}{(1+d)^t}$$

Where C_t is the amount of any tax credits in year t,
A_t is the depreciation deduction allowed in year t,
D_t is "economic depreciation" in year t,
T is the tax rate,
d is the discount rate, and
u is the economic life of the asset.

(5) If the term of the lease coincides with the economic life of the asset, then this entire amount should be added to the cost of lease payments in order to determine the cost of leasing to the government as a whole.

d. In some instances, the term of the Federal Government's lease will be less than the full economic life of the asset. For example, an agency may lease an asset for the first several years of its life, for the last few years, or for some period in between. In such cases, a portion of the tax benefits generated over the entire life of the asset should be allocated to the period during which the asset is leased to the Federal Government. This is accomplished by annualizing the total cost of the tax benefits over the life of the asset. The procedure is the same whether the Federal Government's lease occurs at the beginning, the middle, or the end of the asset's economic life.

(1) The total cost of tax benefits over the life of the asset is divided by a standard amortization factor to convert it to a stream of equal annual amounts.

$$\text{Annual Benefits} = \frac{\text{Total Benefits}}{\frac{1 - \left(\frac{1}{1+d}\right)^{u}}{d}}$$

Where d is the discount rate, and
u is the economic life of the asset.

(2) The annualized tax benefits that accrue while the asset is leased to the Federal Government are converted back to their present value.

$$\text{Cost Allocated to Federal Government} = \sum_{t=1}^{n} \frac{\text{Annual Benefits}}{(1+d)^{t}}$$

Where d is the discount rate, and
n is the term of the agency component's lease.

This amount should be added to the cost of lease payments in order to determine the cost of leasing to the government as a whole.

e. Determining the Amount of Economic Depreciation

True economic depreciation in any given year is the decline in the value of the asset over the course of the year. The value of the asset at any given time is the present value of the stream of revenues (including the outlay equivalent of tax benefits) generated by the asset over its remaining economic life. Thus the exact amount of economic depreciation in a given year can be computed by subtracting the present value of the remaining stream of revenues at the end of the year from the present value of the remaining stream of revenues at the beginning of the year.

The lease-versus-buy analysis can be considerably simplified, however, with relatively little loss of precision, by using straight-line depreciation over the economic life of the asset as an approximation to true economic depreciation. Economic depreciation is then estimated by dividing the price at which the lessor buys the asset by the economic life of the asset.

f. Determining the Rate of Tax

The tax rate used in lease-versus-buy analyses should be the maximum rate of tax on corporate profits -- currently 46 percent. This represents an estimate of the marginal rate of tax on the income generated by the lease. In fact, the income generated by the lease ultimately flows to a wide variety of entities, including corporations, some of which may have losses that offset their income from the lease; tax-exempt institutions; and individuals. Some of these entities may face marginal tax rates that differ from the maximum rate on corporate profits. It is generally impossible, however, to trace the income generated by the lease to each ultimate recipient, and to determine the exact marginal tax rate faced by each one. Lease-versus-buy analyses should therefore assume that all of the income generated by the lease is taxed at the maximum rate for corporate profits -- currently 46 percent. (Corporate tax returns should not be used as a source of tax rates, because they reflect average rather than marginal rates.)

g. Determining the Discount Rate

Current interest rates on Treasury securities may be obtained by consulting Statistical Release H-15, a weekly publication of the Federal Reserve Board, which quotes current interest rates for new issues of 1, 2, 3, 5, 7, 10, 20, and 30 year Treasury securities (referred to in H-15 as "Treasury constant maturities"). The correct discount rate is determined by selecting the category of Treasury security whose maturity is most nearly equal to the term of the lease; finding the current interest rate on new issues in the most recent Statistical Release H-15; and adding one eighth of a percentage point (which represents the Treasury charge for agency borrowings financed through the Federal Financing Bank).

APPENDIX B

Additional Guidance for Lease-Versus-Buy Analysis of General Purpose Real Property

1. Lease-versus-buy analyses of general purpose real property, such as office buildings and warehouses, generally should include the following costs, adjusted as necessary to ensure valid comparisons:

   a. Lease alternative:

      (1) Lease payments.

   b. Purchase alternative:

      (1) Purchase costs, including any construction, installation, site, design, management, and other costs associated with acquiring the property and preparing it for use;

      (2) Repair and improvement (if included in lease payments);

      (3) Operation and maintenance (if included in lease payments);

      (4) Imputed property taxes (excluding foreign taxes on overseas acquisitions unless actually paid);

      (5) Imputed insurance premiums; and

      (6) Cost offset: residual value at the end of the period (subtract from purchase cost).

2. Some costs may be excluded from the lease-versus-buy analysis if they are estimated to be the same for all alternatives under consideration, or too small to affect the economic choice between lease and purchase. This may be the case for:

   a. Repair and improvement costs;

   b. Operation and maintenance costs;

   c. Property taxes; and

   d. Insurance premiums.

3. Potential problems in estimating certain costs should be resolved as follows:

   a. The purchase price used in the analysis should be the fair market value of the property; the price a buyer could reasonably expect to pay to acquire the property. In the case of property that is already owned by the Federal Government, or that has been donated

or acquired by condemnation, an imputed purchase price should be estimated from the fair market value of similar properties that have been traded on commercial markets in the same or similar localities.

b. Imputed property taxes on government-owned property.

(1) Determine the property tax rate and assessed (taxable) value for comparable property in the intended locality. If there is no basis by which to estimate future changes in tax rates and assessed value, the first-year rate and assessed value (inflation adjusted for each year) can be applied to all years.

(2) Multiply the assessed value by the tax rate to determine the annual imputation for property taxes.

(3) As an alternative to steps (1) and (2) above, obtain an estimate of the local effective property tax rate from the Building Owners and Managers Association's Regional Exchange Reports. Multiply the fair market value of the government-owned property (inflation adjusted for each year) by the effective tax rate.

c. Imputed insurance premiums: determine local estimates of standard commercial coverage for similar property from the Building Owners and Managers Association's Regional Exchange Reports.

d. The residual value is the price that the property could be sold for at the end of the period covered by the lease-versus-buy analysis. One measure of residual value is the price that similar, comparably aged property is currently selling for in commercial markets adjusted for inflation to the year in question. Book estimates of the resale value of used property may also be available from industry or government sources. When neither of these sources is available, the residual value can be estimated from the following factors:

(1) The value of buildings and other structures is assumed to decline, due to decay and obsolescence, at a rate of 1.7 percent annually after inflation.

(2) The value of land is assumed to appreciate at a rate of 1.5 percent annually after inflation.

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

March 2, 1987

M-87-22

MEMORANDUM FOR THE HEADS OF DEPARTMENTS AND AGENCIES

FROM: James C. Miller III
Director

SUBJECT: Update of Circular A-104 to Conform to the Tax Reform Act of 1986

OMB Circular A-104 prescribes the method of economic analysis that should be used in evaluating leases of capital assets. Appendix A (page 6) of the revised circular, released in June 1986, provides that the tax rate used in lease-versus-buy analysis should be the maximum rate of tax on corporate profits -- at the time equal to 46 percent. Since then, the Tax Reform Act of 1986 has set the maximum corporate tax rate for 1987 equal to 40 percent, and for all subsequent years equal to 34 percent.

A revised page 6 of Appendix A to OMB Circular A-104, incorporating these tax rate changes, is attached.

Attachment

APPENDIX B

National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812
AC(205)544-2121

NASA

y to Attn of:

PP03

June 6, 1991

TO: NASA Headquarters
Attn: Mr. John R. Yadvish
Code/CP
Washington, D.C. 20546

FROM: PP03/Joseph W. Hamaker

SUBJECT: Spacehab Cost Estimates

Ms. Julie Wheeler of Price Waterhouse, Richard D. Golden and Ross Murphy of CSAT visited the Engineering Cost Group on June 6, 1991. The purpose of their visit was to provide technical information on Spacehab so that PP03 could estimate the cost of Spacehab as if it were a NASA funded project. The available information on Spacehab was not sufficiently detailed to perform a thorough cost estimate on Spacehab.

An attempt was made to break the available top level weights into the required component/subsystem level weights. However, this task was quickly envisioned to be very labor intensive and thus was scraped. A request was made by PP03 to acquire a detailed mass properties statement on Spacehab. PP03 has agreed to re-estimate the cost of Spacehab, once such a detailed weight statement is made available.

Despite the lack of detailed data, two top level estimates were derived using two different approaches. As detailed in the attachments, the first approach was to use total system level cost estimating relationships based on Spacelab as the analogy. The resulting cost for development plus 2 flight units was $829 million (89$). The second approach again used Spacelab data but at the major subsystem level. This approach necessitated some guesswork on the Spacehab subsystem weights. The resulting cost for this approach was $855 million (89$).

Joseph W. Hamaker
Chief, Engineering Cost Group

Attachment

SPACEHAB COST ESTIMATES
GROUND RULES AND ASSUMPTIONS

- ALL COSTS ARE IN FISCAL YEAR 1989 DOLLARS.
- THE COSTS WERE ESTIMATED FOR SPACEHAB BASED ON THE ASSUMPTION THAT IT WAS A NASA FUNDED PROJECT.
  - FOR THE RECORD, THE MARCH 1989 MSFC CDSF COST STUDY PROJECTED A 25% SAVINGS FOR A COMMERCIALLY MANAGED PROJECT WITH MINIMAL GOVERNMENT INVOLVEMENT
- THE TOTAL COST OF SPACEHAB REPRESENTS THE DESIGN, DEVELOPMENT, TEST AND EVALUATION, AND THE PRODUCTION COSTS OF THE FIRST AND SECOND FLIGHT UNITS.
- A 10% FEE, 20% COST RESERVE AND 15% PROGRAM SUPPORT COST ARE INCLUDED.
- EXCLUDED ARE THE LAUNCH AND MISSION OPERATIONS COST, LAUNCH SITE PROCESSING FACILITIES AND ALL OTHER POST PRODUCTION COSTS.
- COST DO NOT INCLUDE ANY EXPERIMENTS.
- SPACELAB WAS USED AS AN ANALOG TO SPACEHAB FOR COST ESTIMATION PURPOSES.

SPACEHAB: WEIGHTS, NEW DESIGN FACTORS AND COMPLEXITIES

	WEIGHT (LBS)	NEW DESIGN FACTOR	COMPLEXITY	ANALOG
PRESSURIZED STRUCTURES	4196	0.7	1.0	SPACELAB
SECONDARY STRUCTURES	1974	0.2	1.0	SPACELAB
ENVIRONMENTAL CONTROL SYSTEM		0.5	1.0	SPACELAB
ELECTRICAL POWER SYSTEM		0.4	1.0	SPACELAB
COMMAND AND DATA HANDLING SYSTEM		0.5	0.1 (TOO LOW)	SPACELAB
TRANSITION STRUCTURES	86	1.0	0.8	SPACELAB TUNNEL

SPACEHAB - TOP LEVEL COST ESTIMATES

CERS: DESIGN, DEVELOPMENT, TEST AND EVALUATION — $COST = 10.588(WEIGHT)^{0.5*}$
FLIGHT HARDWARE (UNIT) — $COST = 0.2912(WEIGHT)^{0.7}$

SPACEHAB COST	FY89 M $	BASIS	NEW DESIGN	COMPLEXITY
DDT&E	335	$10.588(6256)^{0.5}$	0.5*	0.8*
1ST UNIT	106	$0.2912(6256)^{0.7}$		0.8*
2ND UNIT	95			
SOFTWARE	10	PLACE HOLDER		
SUBTOTAL	546			
FEE	55	10%		
RESERVE	120	20%		
PROGRAM SUPPORT	108	15%		
TOTAL	829			

*CERS WERE DEVELOPED USING SPACELAB AS A HISTORICAL DATA ANALOG. BOTH CERS RUN THROUGH SPACELAB DATA POINT.

SPACEHAB

VEHICLE CONFIGURATION :PROTOTYPE/MANNED
FILE NAME :SPACEHAB.WR1
DATE :07-Jun-91 08:37 AM
YEAR DOLLARS :FY89$ IN MILLIONS

	DDT&E		FHA		TOTAL	
STRUCTURES	$42.4		$42.4		$84.8	
-PRIMARY		$40.5		$38.9		$79.4
-SECONDARY		$1.9		$3.5		$5.4
-MECHANISM		$0.0		$0.0		$0.0
THERMAL CONTROL	$0.0		$0.0		$0.0	
-ACTIVE		$0.0		$0.0		$0.0
-PASSIVE		$0.0		$0.0		$0.0
AEROBRAKE	$0.0		$0.0		$0.0	
-STRUCTURE		$0.0		$0.0		$0.0
-THERMAL		$0.0		$0.0		$0.0
CDS	$2.3		$27.3		$29.6	
-C&DH(ANTENNA INCLUDED)		$2.3		$27.3		$29.6
-CONTROLS & DISPLAYS		$0.0		$0.0		$0.0
-GN&C		$0.0		$0.0		$0.0
ELECTRICAL POWER	$21.5		$28.9		$50.4	
-SOLAR ARRAYS(IN KW)		$0.0		$0.0		$0.0
-FUEL CELLS + REACTANT		$0.0		$0.0		$0.0
-BATTERIES		$0.0		$0.0		$0.0
-DISTRIBUTION		$21.5		$28.9		$50.4
PROPULSION	$0.0		$0.0		$0.0	
-ENGINES		$0.0		$0.0		$0.0
-TANKS		$0.0		$0.0		$0.0
-LINES/VALVES		$0.0		$0.0		$0.0
-RCS		$0.0		$0.0		$0.0
ECLSS	$24.1	$24.1	$57.1	$57.1	$81.2	$81.2
CREW ACCOMMODATIONS	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
RECOVERY SYSTEM	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
SUBTOTAL	$98.4		$155.6		$246.0	
SYSTEM TEST HARDWARE	$106.5				$106.5	
INTEGR,ASSEMBLY,& CO	$18.1		$23.3		$41.4	
SYSTEM TEST OPERATION	$26.2				$26.2	
SOFTWARE	$18.0				$18.0	
SSE	$55.5				$55.5	
SE&I	$38.7		$16.1		$46.8	
PROG. MGT	$13.5		$17.6		$31.0	
SUBTOTAL	$358.7		$212.7		$563.4	
CONTINGENCY	$70.1		$42.5		$112.7	
FEE	$42.1		$25.5		$67.6	
PROGRAM SUPPORT	$69.4		$42.1		$111.5	
TOTAL	$532.4		$322.8		$855.2	

APPENDIX C

. Schick, CPCU, ARM
ent

Marsh & McLennan Aviation
1166 Avenue of the Americas
New York, NY 10036-2774
Telephone 212 345 3352
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Telex WCM 423876

MARSH & MCLENNAN

June 21, 1991

Ms. Julie Wheeler
Price Waterhouse
Office of Government Services
1801 K Street N.W.
Washington, D.C. 20006

Spacehab Contracts with NASA
Insurance Cost Considerations
Lease vs. Buy Analysis

Dear Julie:

We have reviewed the Space Systems Development Agreement (SSDA) and the Commercial Middeck Augmentation Module (CMAM) Contract. The purpose of the review was to analyze, to the extent possible with the information available, the insurance and risk assumption cost savings (or increases) which are likely to occur if NASA were to procure and own the middeck augmentation module(s) as opposed to leasing space on the modules from Spacehab.

As a preface to our analysis, it must be made clear that Marsh & McLennan is not Spacehab's insurance broker and, with the exception of Spacehab's delay insurance costs which have been publicized, we do not know the specifics of Spacehab's insurance program coverages or costs. Our comments will therefore to some extent be limited to generalities concerning our assumptions for the types of insurance coverages a company such as Spacehab would need to purchase and maintain in order to be in this type of business. We are also working under the assumption that Spacehab would continue in business as a contractor to NASA providing training and other mission support services even if NASA became the owner of the module(s).

Insurance required by almost any business entity would include the following types of coverages:

a) Worker's Compensation Insurance
b) Comprehensive General Liability Insurance
c) Automobile Liability Insurance
d) Property Insurance for real and personal property
e) Directors and Officers Liability Insurance
f) Fidelity Insurance and Surety Bonds

While the costs to Spacehab of some of the above coverages might be slightly reduced if NASA owned the module(s) due to a reduction of Spacehab's payroll or revenues (which is the rating basis for some of these coverages), the cost savings to NASA would probably not be significant since Spacehab would probably not reduce their service fees significantly due to their slight reduction in overhead costs for these insurances.

Insurance coverages particular to Spacehab would include the following:

a) Pre-Launch Physical Damage - covers damage to the module during transit to the launch facility and while at the launch facility prior to launch.

b) Space Flight Physical Damage - covers loss or damage to the module during shuttle flight.

c) Launch Liability Insurance - covers property damage and bodily injury to third parties caused by the module during launch and subsequent space flight.

d) **Flight Delay and Termination Insurance** - covers Spacehab for losses associated with launch delays or termination of the program by the government.

The Pre-Launch Physical Damage coverage can be relatively expensive since underwriters consider the possibility of loss to be fairly high during transit, pre-launch testing and loading into the shuttle. An additional concern is the high value concentrated in a comparatively small unit. For the purposes of this example, we will assume the insured value of the module to be $50,000,000. The flat premium rate per pre-launch event could be up to $0.20 per $100 value, which is a total of $100,000 premium for a $50,000,000 value. We assume that Spacehab includes the cost of this insurance in their overall pricing structure for Spacehab customers. Since NASA does not insure government property, this insurance would not be necessary and NASA would potentially save a proportionate cost equal to the amount of leased module space NASA would have used as a customer of Spacehab. Since NASA was committed to 2/3 of the space on the first 6 flights, with a pre-launch insurance cost of $100,000 per flight, the savings is 2/3 x 6 x $100,000 = $400,000.

The Space Flight Physical Damage Coverage is another cost which Spacehab would presumably pass along to its customers in its overall pricing scheme. This coverage would also not be necessary if NASA owned the module due to the government's policy of not insuring government-owned property. The cost of this coverage is a rate of about 6% of the total value insured per launch. Again assuming a module value of $50,000,000, this works out to a cost of $3,000,000 per flight. Therefore, the theoretical savings to NASA over the six flight commitment for 2/3 space is 2/3 x 6 x $3,000,000 = $12,000,000.

It could be argued that some of the physical damage insurance cost savings to NASA are theoretically offset to some degree by the fact that NASA ownership of the modules results in a "risk factor cost" to NASA. This "risk factor cost" is the potential of a shuttle failure resulting in the loss of or damage to the module per flight times the value of the module. The value of the module could include not only the replacement cost of the module but also the value of earnings lost by the inability of NASA to lease module space while the module was being replaced or repaired. It is difficult to accurately assess the statistical likelihood of a shuttle failure which could damage or destroy a module, since one must not only look at the historical failure rates for launches (1 in 36) but also consider the landing success rate (35 in 35 successful launches). Is the past an accurate predictor for the future? It is our contention that a detailed statistical analysis of the risk factor cost to NASA of owning the modules is unnecessary since the value of a lost module is insignificant compared to the overall loss to NASA if there is a catastrophic incident which results in loss of an entire shuttle orbiter. When viewed in this context, the risk factor cost assumed by NASA in owning the modules is inconsequential.

Under the terms of the SSDA (Article V-2), NASA requires the customer to obtain third party liability (i.e. - Launch Liability) insurance at no cost to NASA protecting both the customer and NASA during the "Risk Period". While we do not know the specific cost of this insurance, it is likely to be fairly low because the risk of loss to third parties is remote since the interparty waiver of liability between NASA, its customers and associated

ould suffer a loss due to the module(s). Since ASA would most likely require this insurance of odule customers regardless of whether NASA or pacehab owned the modules, and since the cost annot be charged to NASA anyway, this insurance is non-factor in the lease vs. buy analysis.

he Flight Delay and Termination Insurance purchased y Spacehab is a large insurance cost factor in this nalysis. This coverage is required by Spacehab's ankers as a loan guarantee and costs $16,000,000 or a 36 month policy period with a total of 80,000,000 in policy limits ($30,000,000 primary olicy and $50,000,000 excess). The cost of this nsurance is certainly passed on to Spacehab's ustomers in their pricing scheme. The insurance ould be unnecessary if NASA purchased the modules ince Spacehab would then no longer need the bank inancing to help start the company. Using the same logic as with the property insurance, NASA's share of the savings would be 2/3 x $16,000,000 = 10,666,667. This figure is only good as an order of magnitude since the 36 month policy would expire before all 6 of the flights for which NASA has a 2/3 total space commitment would take place, so there could be a requirement by the banks to renew the coverage for an unknown policy limit at pricing which can not be determined at this time.

Additional policy renewals would result in additional costs passed on to NASA.

Summary:

A rough estimate of potential insurance cost savings to NASA resulting from module ownership over the 6 flights for which NASA has made leasing space commitments is as follows (assuming

Insurance Type	Savings
Pre-Launch Physical Damage:	$ 400,000
Space Flight Physical Damage:	12,000,000
Flight Delay & Termination:	10,666,667
TOTAL SAVINGS:	$23,066,667

We look forward to discussing this analysis during our meeting in your office on Tuesday, June 25th.

Very truly yours,

Gordon Schick

GES/mpm

cc: R. Nausch

APPENDIX D

Detailed Estimate of Service Cost Per Flight

The purchase alternative model as prescribed by OMB Circular A-104 requires an estimate of the cost of services provided under the lease contract to be included in the estimated cost of the purchase alternative. An estimate based upon the descriptions of services provided in the lease contract is provided below. The estimate is on a per flight basis and is primarily focused on estimated staffing requirements which are then quantified by making certain rate assumptions.

Contract Section	Description	Estimated Level of Effort per Flight (man year equivalent)
4.1	Space Shuttle Integration Support	1.50
4.2	Flight Design Support	1.00
4.3	CMAM Systems Training Support	.25
4.4	CMAM Experiment Training	1.00
4.5	Training Aids/Mock-ups	.25
4.6	CMAM Systems and Configuration Data	1.00
4.7	Design Review and Program Statusing	.50
4.8	Experiment Documentation	1.50
4.9	Space Shuttle Program Flight Documentation	2.00
4.10	Integration Documentation	2.00
4.11	Mission Support Data Base	1.00
4.12	Experiment Integration	4.00
4.14	Integrated Safety Package	1.50
4.15	CMAM Flight Support Team	.25
5.2.1	Interfaces	2.00
5.2.2	Experiment Requirements	2.00
6.2	Flight Operations Support	1.00
6.3.2	Contractor/Kennedy Space Center (KSC) Support	.35
6.3.3	KSC Delivery	.10
6.3.4	KSC Facility Compatibility	.25
6.3.5	Late Access	.10
6.3.6	Fit Checks	.10
6.3.7	Scrub Turnaround	.10
6.3.8	End-of-Mission Access	.10
7.3	Safety and Review Requirements	1.00

Total Estimated Man Year Equivalents (MYE) per Flight	24.85
Estimated Average Cost per MYE	$36,500
Estimated Overhead Rate	45%
Estimated General and Administrative Rate	15%
Estimated Fee	8%
Estimated Service Cost per Flight ($ 1990)	$1,633,461

APPENDIX F

NASA Business Advisory Services

Spacehab Lease-Vs.-Buy Analysis

Spacehab Lease-vs.-Buy Analysis

Framework of Analysis

To compare in net present value terms the cost to NASA and the government of leasing capacity on the Spacehab module to the cost of procuring the module through standard NASA procurement channels.

Results

Leasing 200 MLVE's is cheaper than procuring and owning the Spacehab module. Under the most conservative set of assumptions, owning the module does not become cheaper for NASA until it has been flown approximately twenty times. Under the base set of assumptions, it becomes cheaper to buy only if NASA flies the module more than 40 times.

Spacehab Lease-vs.-Buy Analysis

Capacity Analysis

Under the lease scenario, NASA has procured 200 mid-deck locker volume equivalents (MLVE's), with the option to procure additional space as necessary.

Under the purchase scenario, NASA procures all the available Spacehab MLVE's, with the total capacity determined by the number of flights of the module.

Results

Under the lease scenario, the discounted per-unit cost to NASA is approximately $795,000.

Under the purchase scenario, if NASA procured the same number of MLVE's, the discounted per-unit cost would be approximately $5,081,000. If NASA flew the module more than 40 times, this per-unit cost would decline to the lease-scenario level.

Spacehab Lease-vs.-Buy Analysis

Cost Comparison Basis

Lease Scenario

Net Present Value of Lease Payments

includes:

- support services
- design and build costs
- cost of private financing
- insurance costs

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Purchase Scenario

Net Present Value of Purchase Payments

Valuation includes addition of:

- equivalent cost of support services services
- imputed financing costs
- imputed insurance costs
- risk adjustments

Valuation includes subtraction of:

- capacity-procured adjustments

No value given the following:

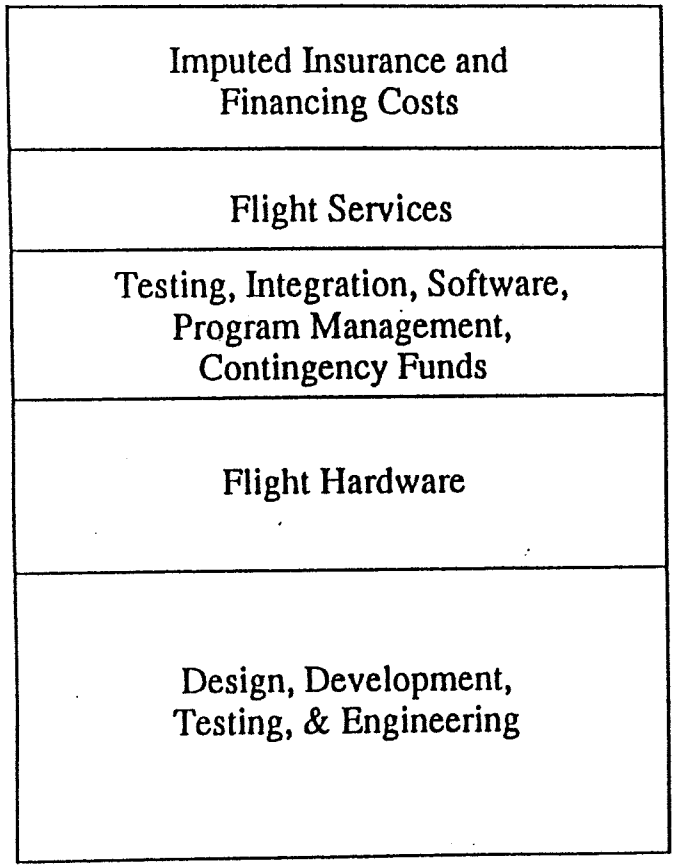
- NASA management of additional procurement of service contracts
- depreciation
- tax effects

Spacehab Lease-vs.-Buy Analysis

Cost Comparison Results

Net Present Value of Purchase Scenario

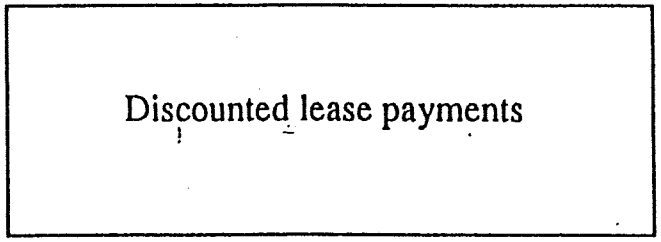
$1,016,000,000



assuming 200 MLVE's

Net Present Value of Lease Scenario

$159,000,000



200 MLVE's provided

Spacehab Lease-vs.-Buy Analysis

Assumptions

- Purchase scenario is based on NASA generated estimate of the procurement of the module which include design costs, hardware costs, contingency funds, and NASA program costs
- Purchase scenario assumes construction of two flight-ready modules
- Purchase estimate assumes same contract-to-flight time
- Lease scenario analysis is based on actual lease costs
- Project team did not have access to Spacehab corporate information
- Project team did not analyze the financial viability of the lease scenario for Spacehab

SpaceHab Lease-vs.-Buy Analysis

Marshall Cost Estimation Service

- Twenty years of experience and expertise in estimating the cost of a government procurement for space hardware
- Data base includes extensive project records and histories as basis for estimation, and is updated continuously
- The model used to estimate SpaceHab procurement costs is the standard cost model used to estimate space hardware candidate programs
- Model used by NASA is supported by top cost assessment consultant teams, in addition to NASA experts in cost assessment for hardware projects

Spacehab Lease-vs.-Buy Analysis

Scenario Analysis

For this analysis, several different scenarios were considered to test the sensitivity of these results to the key assumptions and data. These tests included:

- changing assumptions about the number of flights, modules built, and potential delays
- determining the effect of NASA's leasing additional space to the private sector under the purchase scenario
- testing the results of potential private sector savings under a modified public purchase scenario

Results

Under all the scenarios tested, the cost to NASA to procure the same capacity was lower under the lease scenario.

Under the most conservative scenario, NASA would still need to fly the module over 20 times for the per-unit cost to equal the per-unit cost under the lease scenario.

Spacehab Lease-vs.-Buy Analysis

Scenario Development Assumptions

SCENARIO: ALL COSTS PAID BY NASA
Approximate Number Of Flights To Recover Costs: 40

SCENARIO: NASA LEASES 1/3 SPACE FOR VARIABLE SERVICE COSTS
Approximate Number Of Flights To Recover Costs: 33

SCENARIO: NASA LEASES 1/3 SPACE FOR FLIGHT AND VARIABLE SERVICE COSTS
Approximate Number Of Flights To Recover Costs: 23

SCENARIO: NASA LEASES 1/3 SPACE FOR FULLY ALLOCATED COSTS OF FLIGHT, MODULE, AND SERVICE
Approximate Number Of Flights To Recover Costs: 16

Spacehab Lease-vs.-Buy Analysis

Conclusion

According to the factors examined in this analysis, NASA made a cost effective decision by leasing the Spacehab module. In so doing, NASA has also captured the benefits of private sector efficiency and retained flexibility in meeting their own needs for the module.

APPENDIX G

Estimate of Cost for the Commercial Purchase of a Spacehab Module

As a follow-on assignment to the preceding task, NASA/OCP asked that the Price Waterhouse/CSAT team provide an estimate of the cost of a commercially purchased Spacehab capacity. What we present here is our best guess at such a cost, using assumptions based upon the Marshall Center data presented previously. As the officers of Spacehab, Inc. were unable to give us complete cost data on their operation, this guess has no grounding in the facts of the company. A more complete analysis may be done at such time as Spacehab, Inc., makes this data available to us.

The purchase plan under consideration theoretically differs from the standard NASA RFP/Procurement process. NASA would buy the modules built by Spacehab, Inc. (two operational modules and a ground spare), and would not have a role in the planning, financing, design, or construction of the modules. The modules would be thus purchased as one purchases an automobile from the car lot the vehicle is inspected, and then purchased. The buyer had no role in the creation or construction of the vehicle.

very unrealistic situation since NASA would play a role in design if it were a one-shot product procurement.

Methodology

Estimating a price for such a sale is extremely difficult. The desired analysis should be done on data obtained from the private company. This data would be a detailed breakdown of all costs of operation related to the design, construction, marketing, and administration of module production. Ownership interests and repayment expectations, along with details of all debt costs and their timing, should be available for study. This information has not been provided to us, as Spacehab, Inc. cannot go public with this information at this stage.

The only data available concerning the cost of construction comes from the Marshall study contained in Appendix A. As this represents a true government

costing approach, it may not represent the true costs to a private firm such as Spacehab, Inc. In this analysis, we have tried to construct an estimate of a sales price by making some broad assumptions about the nature of the costs faced by Spacehab, Inc., the nature of the equity and debt costs, and the timing of a potential sale. We have created three scenarios under which these assumptions can be used together to estimate a sales price. The client, NASA, has approved these assumptions as a basis for analysis, and any responsibility for these assumptions and any resulting cost estimates lies with NASA.

The result of the analysis is shown in the following four slides, used as part of a presentation to NASA of our findings. We began the analysis by identifying the components of the cost of constructing the module. These came from two sources.

- **Cost of Design and Construction:** This data came from the Marshall estimate of the cost to design and build two modules and a ground spare. This base set of assumptions is presented in Appendix B.

- **Cost of Capital:** The estimates of the cost of debt and equity capital came from interviews with investment bankers dealing with high technology investments.

To create the three scenarios, we first adjusted the Marshall assumptions for design and construction costs by broadly estimated factors representing the following factors.

- Change Traffic: This is the NASA term for the costs added to a procurement by changes in the original design demanded by NASA's managing engineers. These costs are the result of slipped delivery dates and extra contractor time needed to make adjustments to original plans.

- **Design Costs:** Spacehab modules may be constructed using well understood designs from previous space mission hardware. The reduction of design costs may significantly affect the cost of modules to NASA.

- **Overhead Costs:** By managing costs better than the average NASA contractor, Spacehab may realize further savings.

- **Fees Charged:** As with overhead costs, these may be reduced or eliminated.

- **Cost of Capital Charges:** These must be added to the private firm's costs.

Scenario Development

Two steps were necessary in designing the scenarios. First, the mix of factors affecting cost were selected. Second, the magnitude of the effect was estimated. The scenarios selected are as follows:

- **Scenario A: Marshall Estimate of Overall Cost Reduction.** In this scenario, all costs in the original Marshall estimate are reduced by twenty-five percent. This assumption is based upon a recent study of standard NASA procurement prices paid versus commercial purchases for similar equipment, cost analysts at the Marshall Space Flight Center estimated that the commercial purchase price was approximately twenty-five percent less than the government procurement price.

- **Scenario B: Significant Design and Overhead Savings.** In this scenario, savings in the design phase of seventy-five percent are

added to savings in fee, reserve, and program support costs. The base assumption here is that the firm benefits from the design work done by NASA on the Spacelab module, and reduces the overhead from the charges to this project, spreading recovery of that overhead to other commercial projects or reducing the overhead below average NASA costs by working more efficiently.

- **Scenario C: Design, Overhead, and Construction Savings.** In this scenario, the design savings assumed in Scenario B are added to construction savings of twenty-five percent from Scenario A. Further, the commercial entity reduces its fee to zero, and minimizes reserve and program support charges.

The predicted costs to construct the model using each set of assumptions is as follows:

Scenario	Estimated Design and Construction Cost
MSFC Base Case	$ 879,000,000
A	$ 660,000,000
B	$ 430,000,000
C	$ 315,000,000

Details of these calculations are provided on Slide Two of the attached presentation.

Cost of Capital is then added to each scenario. Spacehab, Inc. officials stated that their goal for a mix of equity and debt financing is forty (40) percent equity and sixty (60) percent debt. This is roughly consistent with financial industry experts' estimates of the appropriate debt-equity ratio for a high technology firm. The cost of the equity is assumed to be thirty-five percent per annum, as it is venture capital. This is actually on the low side for expected venture capital return.

This is a conservative assessment due to the positive signals the company has received from its principal buyer, NASA, which reduces the expected risk in the venture investment. Debt costs are assumed to be ten percent per year, consistent with commercial bank lending rates at the time of the analysis.

Slide Three of the attachment to this Appendix shows the costs of equity and debt for each scenario. The final costs estimated for each scenario are:

Scenario	Estimated Design and Construction Cost	Estimated Cost of Capital Price	Estimated Total Price
MSFC Base Case	$ 879,000,000	$ 0	**$ 879,000,000**
A	$ 660,000,000	$ 300,000,000	**$ 960,000,000**
B	$ 430,000,000	$ 195,000,000	**$ 625,000,000**
C	$ 315,000,000	$ 144,000,000	**$ 459,000,000**

Conclusion

This analysis is a rough estimate of the cost of producing and selling a Spacehab module. The analysis is severely restricted by the lack of real commercial data available to the study team. Using government data and NASA-approved assumptions regarding potential cost savings, we conclude that the potential price of the commercially procured module may range from between four hundred million dollars ($ 400,000,000) to one billion dollars ($1,000,000,000). A complete inspection of the cost records and ownership structure of Spacehab, Inc., combined with assumptions regarding expected return to equity investors, could offer better insights into the potential cost of such a sale.

Spacehab Lease-vs.-Buy Analysis

Can We Estimate a Commercial Sale Price?

Issues

- "Change Traffic" - Reduce NASA change orders and gain efficiencies
- Design Cost - Use pre-existing Spacelab designs
- Overheads - Reduce charges for indirect support
- Fees - Create equity partnership for construction firms
- Interest - Add back expected payout to equity and debt investors

These were used to develop three scenarios for a potential commercial price.

Spacehab Lease-vs.-Buy Analysis

Estimation of Commercial Cost and Price

(FY1989$) (millions of $)

ITEM	PUBLIC PROCUREMENT COST	COMMERCIAL ESTIMATES		
		Scenario A[1] (25% saving)	Scenario B[2] (Design and OH Savings)	Scenario C[3] (Design, OH, and Build Savings)
DDT&E	335	251	84	84
1st Unit	106	80	106	80
2nd Unit	95	71	95	71
Spare	50	38	50	38
Software	10	8	10	8
Subtotal	596	448	345	281
Fee	55	41	20	0
Reserve	120	90	40	20
Program Support	108	81	25	14
Total	879	660	430	315

1. Twenty five percent off all costs, per MSFC commercial cost study.
2. Significant design savings through use of Spacelab analog, overhead savings through commercial efficiency.
3. Design and overhead savings, plus fee is forgiven in lieu of equity opportunity.

Spacehab Lease-vs.-Buy Analysis

Ultimate Cost of Modules Under Commercial Scenarios

(millions of 1989 $)

Cost	Scenarios A	B	C
Total Investment	$660	$430	$315
Equity (40%)	$264	$172	$126
Debt (60%)	396	258	189
Cost to pay out equity (35% return, two year average life)	217	141	104
Cost to pay out debt (10% return, two year average life)	83	54	40
Total Sales Price	$960	$625	$459

Spacehab Lease-vs.-Buy Analysis

Flights to Obtain Comparable Unit Costs: Commercial Scenario Prices vs. CMAM Lease Unit Price

	Cost Per Unit	Flights
Scenario A	$795,314	47 in 10 years
Scenario B	$795,396	30 over 8 years
Scenario C	$796,754	21 over 5 years
Government Procurement	$797,430	43 over 10 years
Lease Cost	$795,014	as needed

PROGR-