Telesat

Telesat Canada

# STUDY OF L-BAND UTILIZATION BY MSAT

## SUB-TASK 4. MARKET STUDIES AND ECONOMIC ANALYSIS

Prepared For

Communications Research Centre
Department of Communications

Submitted by:
TELESAT CANADA

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| | | DATE |
|---|---|---|
| Prepared by: | Ignace R. Mvungi<br>Sr. Service Development Engineer | October 31, 1985 |
| Approved by: | <br>Supervisor, Commercial Viability Studies | Nov. 4, 1985 |
| | <br>Manager, Business & Network Planning | Nov 5, 1985 |
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## 1.0 INTRODUCTION

The purpose of the Economic Analysis is to evaluate the economic viability of alternative plans for MSAT. These plans are as follows:

Plan 1: L-Band only (1645.5 to 1660.5 MHz and 1544 to 1559 MHz) satellite.

This plan involves the change of existing design of UHF frequency to L-Band frequency.

Plan 2: Dual Band (L-Band and UHF) satellite.

This plan involves the change of existing design of UHF frequency to a concept that integrates UHF and L-Band frequencies in one satellite.

Plan 3: Separate L-Band and UHF satellites.

This plan employs separate L-Band and UHF satellites.

The economic analysis results of each alternative plan are compared to those of the Reference System which is a UHF system as described in reference (1). In order to have valid comparisons, the market forecasts, the financial and economic assumptions used in the Reference System are retained for this study.

## 2.0 DEFINITION OF REFERENCE AND ALTERNATIVE PLANS

### 2.1 Reference Plan

The reference plan is the baseline system option as described in the Business Proposal of February, 1985. It can be described as follows:

| | |
|---|---|
| No. of Beams | 2 |
| No. of Spacecraft | 2 |
| Class of Spacecraft | PAM D |
| Operating Frequency | UHF |
| Feeder Link Frequency | SHF |
| Payload Configuration | UHF |
| System Availability | 98.4% |
| System Capacity | 35,000 |
| Net Present Value (1984) $MCD | -16 |

### 2.2 Alternative Plans

As described in Section 1, there are three alternative plans of using L-Band for MSAT services. All plans assume a Canada/US cooperative system. Within these three plans, there are various options of implementation. They are summarized in Table 2.1.

#### Plan 1

Plan 1 consists of three alternatives as shown in Table 2.1. The first alternative, utilizing a PAM D satellite with 2 beams, has a system capacity of 6,000 users. The second, which is a PAM DII 2 beam satellite, has a system capacity of 13,000 users and the third alternative employs a PAM DII 4 beam satellite with a system capacity of 21,000 users.

TABLE 2.1
SUMMARY OF ALTERNATIVE PLANS

| | ALTERNATIVE PLANS | | | | | |
|---|---|---|---|---|---|---|
| | PLAN 1 | | | PLAN 2 | | PLAN 3 |
| NO. OF BEAMS | 2 | 2 | 4 | 2 UHF/4 L-BAND | | 2 UHF/2 L-BAND |
| NO. OF SPACECRAFT | 2 | 2 | 2 | 2 | | 2 UHF/2 L-BAND |
| CLASS OF SPACECRAFT | PAM D | PAM DII | PAM DII | PAM DII | HS 393 | PAM D |
| OPERATING FREQUENCY | L-BAND | L-BAND | L-BAND | UHF/L-BAND | UHF/L-BAND | UHF/L-BAND |
| FEEDER LINK FREQUENCY | SHF | SHF | SHF | SHF | SHF | SHF |
| PAYLOAD CONFIGURATION | L-BAND | L-BAND | L-BAND | UHF/L-BAND | UHF/L-BAND | UHF/L-BAND |
| SYSTEM AVAILABILITY | 97% | 97% | 97% | 97% | 97% | 97% |
| SYSTEM CAPACITY | 6,000 | 13,000 | 21,000 | 36,000 | 47,000 | UHF 35,000<br>L-BAND 6,000 |

Plan 2

Two alternatives were considered in Plan 2. The first alternative consists of a PAM DII spacecraft employing 2 UHF and 4 L-Band beams. The UHF system capacity is 35,000 users and the L-Band capacity is 1,000 users for a total system capacity of 36,000 users as shown in Table 2.1. The second alternative utilizes an HS 393 spacecraft with the same beam configuration. The UHF capacity for this alternative is also 35,000 users but the L-Band capacity is 12,000 users for a total system capacity of 47,000 users.

Plan 3

In the joint agreement for a cooperative system, Canada and U.S. satellite operators would share the procurement costs of a four spacecraft system: two satellites for Canada and two satellites for the U.S. Therefore, from Canada's viewpoint, Plan 3 consists of two satellites (1 UHF and 1 L-Band).

Two scenarios are envisaged:

Scenario 1: launch both UHF and L-Band satellites in 1991;

Scenario 2: launch UHF satellite in 1991. Launch L-Band satellite when UHF capacity runs out.

Each of the separate satellites used in Plan 3 is a PAM D class with 2 beams. The UHF satellite has a system capacity of 35,000 users and the L-Band satellite has a system capacity of 6,000 users as shown in Table 2.1.

## 3.0 STUDY ASSUMPTIONS & ECONOMIC METHODOLOGY

### 3.1 General

The study assumptions and Economic Methodology delineated in the MSAT Business Proposal Appendix F, reference (1), strictly applies to this study. These assumptions are listed in the following subsections. Only the first generation, though, is considered in this study. The proposed first generation scenarios, like in reference (1), consist of a satellite used by Canada in a joint venture with a U.S. partner. In the joint agreement, Canada and U.S. satellite operators would share the procurement costs of a two spacecraft system. The U.S. operator would launch the first spacecraft in April 1990, as shown in Figure 3.1. Canada would lease transponders on this satellite for service introduction until the second spacecraft is launched one year later. This allows one full year for building the Canadian market.

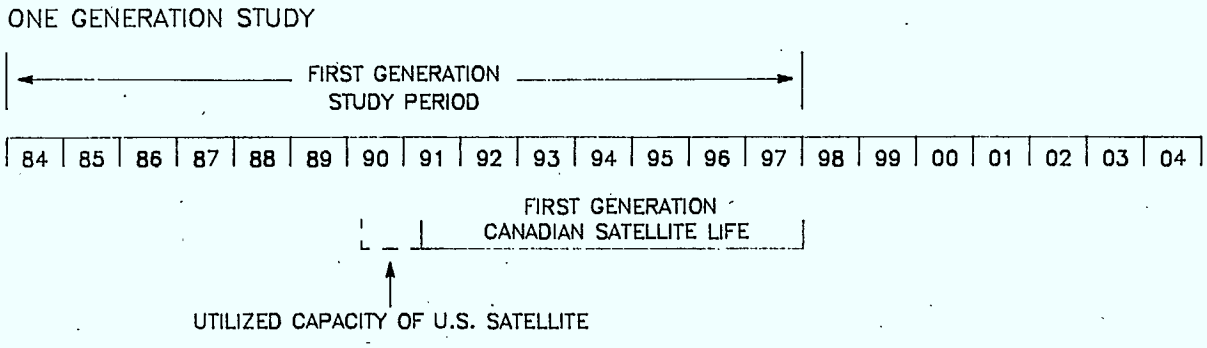


Figure 3.1 Study Period Assumptions



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For the analysis, the lease charges associated with using the American satellite and the revenues accrued from it have not been incorporated into the cost and revenue profiles. It is expected that the lease charges and associated revenues would be equivalent and would have no economic impact on the net result. However, all other costs, revenues and expenses have been projected using this assumption as a basis. The income tax calculations are derived with the assumption that no losses could be written off against any other profitable project. The financial parameters are projected for the period under study for cash flow analysis.

## 3.2 Study Period

The study period for all alternative plans is 14 years, commencing 1984. Other assumptions are as follows:

| | |
|---|---|
| Life estimate of satellite: | 7 years |
| Life estimate of ground segment equipment: | 15 years |
| First Generation study period with launch in 1991: | 14 years |
| In-service date: | 1990 second quarter |
| Base year: | 1984 |

## 3.3 Financial Paramenter

The financial parameters used in the economic analysis are as follows:

| | RATE |
|---|---|
| Cost of long term debt | 13% |
| Cost of equity | 15% |
| Debt ratio | 50% |
| Composite cost of capital | 14% |
| Income tax | 50% |
| Capital Cost Allowance (CCA) rate: | |
| - Space Segment | 40% |
| - Ground Segment | 20% |

## 3.4 Cost and Revenue Increase Factors

### 3.4.1 Expense Increase Factors

A ten year profile of Cost Increase Factors was projected by Telesat's Finance Department in November 1984. The factors required beyond the ten year projection period are assumed to be the same as the last projected year. The factors represent economy-wide inflation rates. Figure 3.2 shows the projection of inflation rates for the study period.

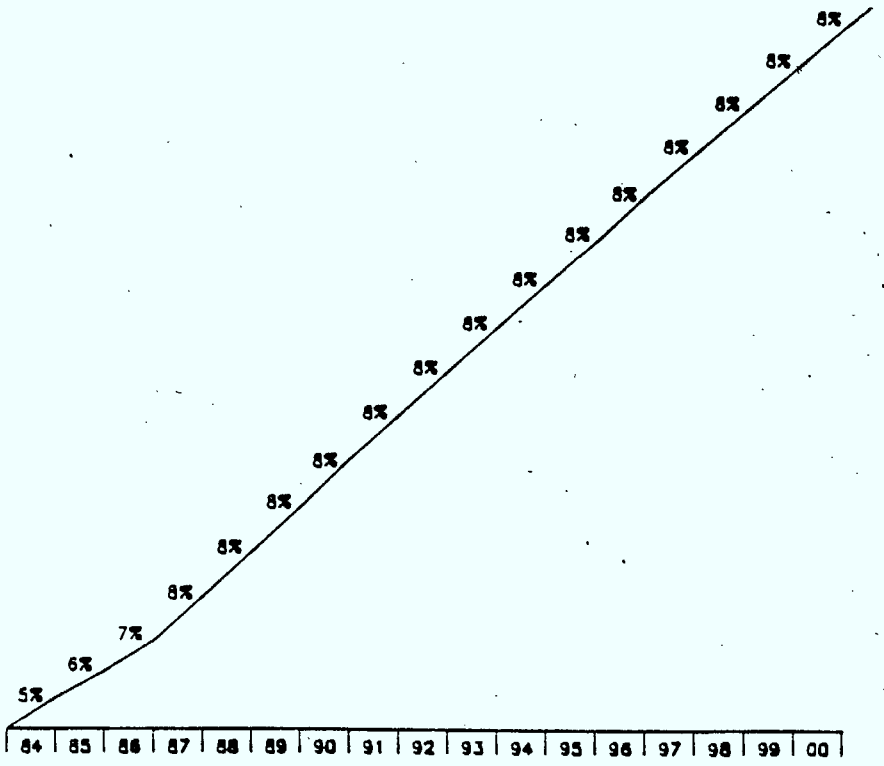


Figure 3.2 Expense Increase Factors

### 3.4.2 Revenue Increase Factors

Revenues are inflated with rate increase factors which are consistent with the existing regulatory environment. It has been Telesat's experience that price increases are not normally compensatory for the effects of inflation. However,

we have devised a reasonable strategy of rate increases. These Rate Increase Factors have been applied to both the airtime and access charges. Figure 3.3 graphically demonstrates the Rate Increase Factors.

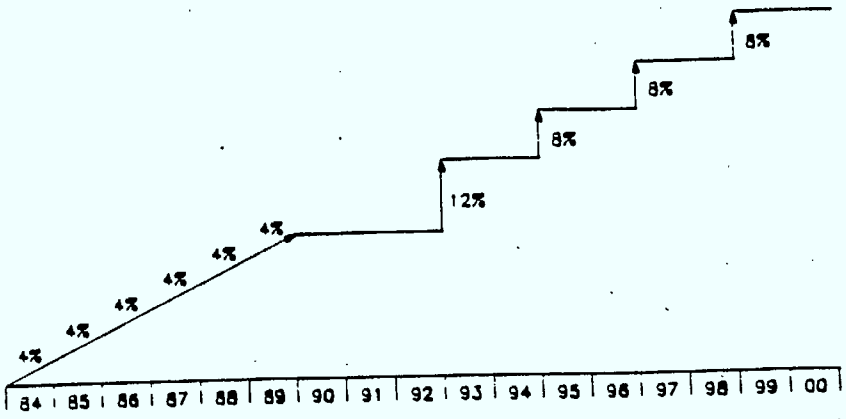


Figure 3.3 Revenue Increase Factors



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## 4.0 CASH FLOWS

The cash flows consist of capital expenditures, operating expenses, and revenues.

### 4.1 Capital Expenditures

#### 4.1.1 Space Segment

The space segment capital expenditures include the total investment required for the design, procurement and launch of the required satellite system. Annex A contains the detailed analysis of space segment costs for the various spacecraft classes. The Canadian investment portion required for a joint venture has been calculated and inflated for the first generation systems. The data in Annex A is used to calculate annual space segment capital expenditure cash flows. The cash flows are shown in Annex B.

For proper treatment of capital cost allowance and income tax calculations purposes, the Economic Analysis System (EES) requires a one-time capital injection in the in-service-date. Therefore, it is necessary to calculate the future value to 1991 of the space segment capital expenditure cash flows. These one-time capital injections for the various spacecraft used in the alternative plans are shown in Tables 4.1, 4.2, and 4.3.

TABLE 4.1

MSAT SPACE SEGMENT COSTS: PLAN 1 (L-BAND)

| SPACECRAFT CLASS | FUTURE VALUE FOR IN-SERVICE DATE 1991 DOLLAR $ MCD* | L-BAND SYSTEM CAPACITY # OF USERS |
|---|---|---|
| PAM D, 2 Beams | 235.937 | 6,000 |
| PAM D II, 2 Beams | 273.408 | 13,000 |
| PAM D II, 4 Beams | 305.187 | 21,000 |

* MCD: Million Canadian Dollars

TABLE 4.2

MSAT SPACE SEGMENT COSTS: PLAN 2 (DUAL BAND)

| SPACECRAFT CLASS | FUTURE VALUE FOR IN-SERVICE DATE 1991 DOLLAR $ MCD | UHF SYSTEM CAPACITY # OF USERS | L-BAND SYSTEM CAPACITY # OF USERS | TOTAL SYSTEM CAPACITY # OF USERS |
|---|---|---|---|---|
| PAM DII<br>2 Beams UHF<br>4 Beams L-Band | 332.097 | 35,000 | 1,000 | 36,000 |
| HS393<br>2 Beams UHF<br>2 Beams L-Band | 325.668 | 35,000 | 12,000 | 47,000 |



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TABLE 4.3

MSAT SPACE SEGMENT COSTS:

PLAN 3 (SEPARATE UHF AND L-BAND SATELLITES)

| SPACECRAFT CLASS | FUTURE VALUE FOR IN-SERVICE DATE 1991 DOLLAR $ MCD | L-BAND SYSTEM CAPACITY # OF USERS |
|---|---|---|
| PAM D, 2 Beams UHF | 265.391** | 35,000 |
| PAM D, 2 Beams L-Band | 235.937 | 6,000 |

** Obtained from reference (1)

4.1.2 Ground Segment

The ground segment costs incurred by Telesat include the Central Control Station (CCS), Network Management Control System (NMCS) and Demand Assigned Multiple Access (DAMA) System. The costing methodology for the ground segment portion is given in reference (2). A one-time capital injection is calculated for the in-service-date in the same manner as explained in subsection 4.1.1. The cost summary of the ground segment is shown in Table 4.4.



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TABLE 4.4

MSAT GROUND SEGMENT COSTS

| | PLAN 1 L-BAND | PLAN 2 DUAL BAND | PLAN 3 SEPARATE UHF & L-BAND SATELLITES |
|---|---|---|---|
| Estimated Cost 1984 $ | $25.5 MCD | $28.4 MCD | $25.5 MCD |
| Inflated Current Year 1987 $ | $30.957 MCD | $33.822 MCD | $30.957 MCD |
| Annual (Current Year) Construction Charges | | | |
| 1987 | $10.319 MCD | $11.274 MCD | $10.319 MCD |
| 1988 | $10.319 MCD | $11.274 MCD | $10.319 MCD |
| 1989 | $10.319 MCD | $11.274 MCD | $10.319 MCD |
| Future Value For In-Service Date 1990 $ | $40.462 MCD | $47.762 MCD | $40.462 MCD |

4.3.1 Ground and Space Capitalized Development Costs

The capitalized developmental costs are assumed to be incurred prior to service introduction. These costs include expenses relating to marketing, business development, advertising and promotion. For two years prior to service introduction, marketing, advertising and promotion expenses have been allocated. Business development costs have been allocated for two full earlier years, 1986 and 1987.

The costs have been estimated in 1984 dollars, as shown in Table 4.5. A detailed calculation of these figures is outlined in Annex E of reference (1). The projected cost increase factors are used to inflate the 1984 figures to current year dollars.

TABLE 4.5

DEVELOPMENT COSTS

($1984 $ MCD)

| COST ITEM | AMOUNT |
|---|---|
| Marketing | 1.2 |
| Advertising & Promotion | 2.16 |
| Business Development | 1.2 |

These items have been affiliated with either the space or ground capital equipment. It is necessary to allocate an equitable amount to each capital group. Such amounts were computed in proportion to the space and earth expenditures in a given year. Table 4.6 illustrates the annual allocations associated with the space and ground segment capital. They are listed in inflated current year dollars.

## 4.2 Operating Expenses

Operating expenses consist of Operations and Maintenance Expense, General and Administrative Expense, and Marketing, Advertising, and Promotion Expense.

### 4.2.1 Operations and Maintenance (O&M) Expense

(1) Space Segment

As per Annex D of reference (1), the O&M for the space segment is estimated to be $1.5 MCD per year in 1984 dollars. This cost is inflated using the cost increase factors.

TABLE 4.6

CAPITALIZED COST BREAKDOWN

(Current Year $ MCD)

| | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|
| Marketing | | | 1.158 | 1.667 | .450 |
| Advertising & Promotion | | | 2.084 | 3.000 | .810 |
| Business Development | 1.336 | 1.429 | | | |
| TOTAL | 1.336 | 1.429 | 3.242 | 4.667 | 1.260 |
| Portion Charged to Space Segment | 1.336 | 1.159 | 2.153 | 3.141 | 1.260 |
| Portion Charged to Ground Segment | | .270 | 1.089 | 1.526 | |



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(2) Ground Segment Equipment

Operations and maintenance expense associated with the ground segment is estimated as 7.12% of the existing plant in service for each year. Detailed description of methodology used in the calculation is contained in Annex D of reference (1).

4.2.2 General and Administrative (G&A) Expense

As per Annex D of reference (1), the following percentages were used:

| | % of Plant in Service |
|---|---|
| Space Segment | 3.31% |
| Earth Segment | 3.85% |

4.2.3 Marketing, Advertising and Promotion Expense

As per Annex E of reference (1), marketing expense is estimated as $1.2 MCD per year, and advertising and promotion expense is estimated as $1.3 MCD, both in 1984 dollars. These cost estimates are inflated to current year dollars using the study's cost increase factors.

## 4.3 Revenue Projections

### 4.3.1 L-Band Market Forecast

It has been determined in Sub-Task 3, that there is an incremental cost of $700 in the mobile terminal cost because of changing the design from UHF to L-Band. The cost breakdown is shown in Table 4.7.

TABLE 4.7

MOBILE TERMINAL COST COMPARISON

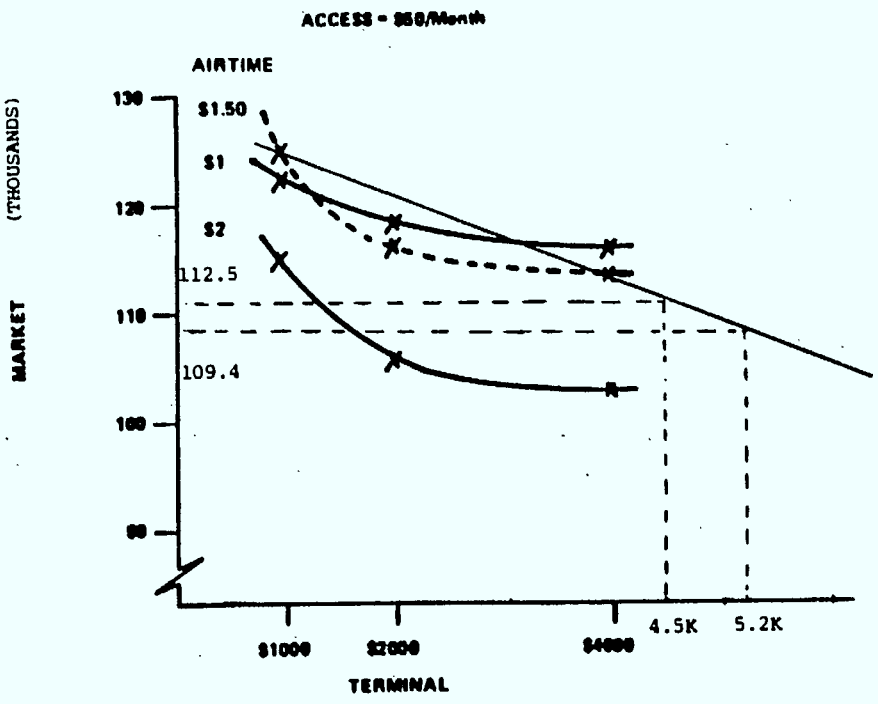
| | UHF MOBILE TERMINAL COST | L-BAND MOBILE TERMINAL COST |
|---|---|---|
| TERMINAL | $3,500 | $3,700 |
| ANTENNA | $1,000 | $1,500 |
| TOTAL | $4,500 | $5,200 |

The effect of the cost increase on the market forecast derived in reference (3) is a decrease of 2.8% in the number of terminals. This decrease is based on the Wood's Gordon demand/price elasticity curve shown in Figure 4.1. The curve of interest is the dotted one corresponding to an airtime charge of $1.50 per minute. A straight line, as shown, is assumed to be an approximation to this curve. From the straight line, it is seen that when the terminal cost increases from $4,500 to $5,200, the number of terminals decreases from 112,500 to 109,400, a drop of 3,100 or 2.8%. Figure 4.2 is a graphical representation of the resultant L-Band market forecast. The two market forecasts are offset by 2.8%. Table 4.8 gives the market forecasts in tabular form.

FIGURE 4.1

MSAT POTENTIAL MARKET

SENSITIVITY TO VARIATIONS IN PRICE OF USER TERMINALS




2 DATA POINTS APPROXIMATION

| TERMINAL COST $ | NO. OF TERMINALS K |
|---|---|
| 4,500 | 112.5 |
| 5,200 | 109.4 |
| Decrease in # of Terminals | 3.1 |
| Percent Decrease | 2.8% |



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FIGURE 4.2

MSAT BUSINESS PROPOSAL AND
L-BAND MARKET FORECASTS

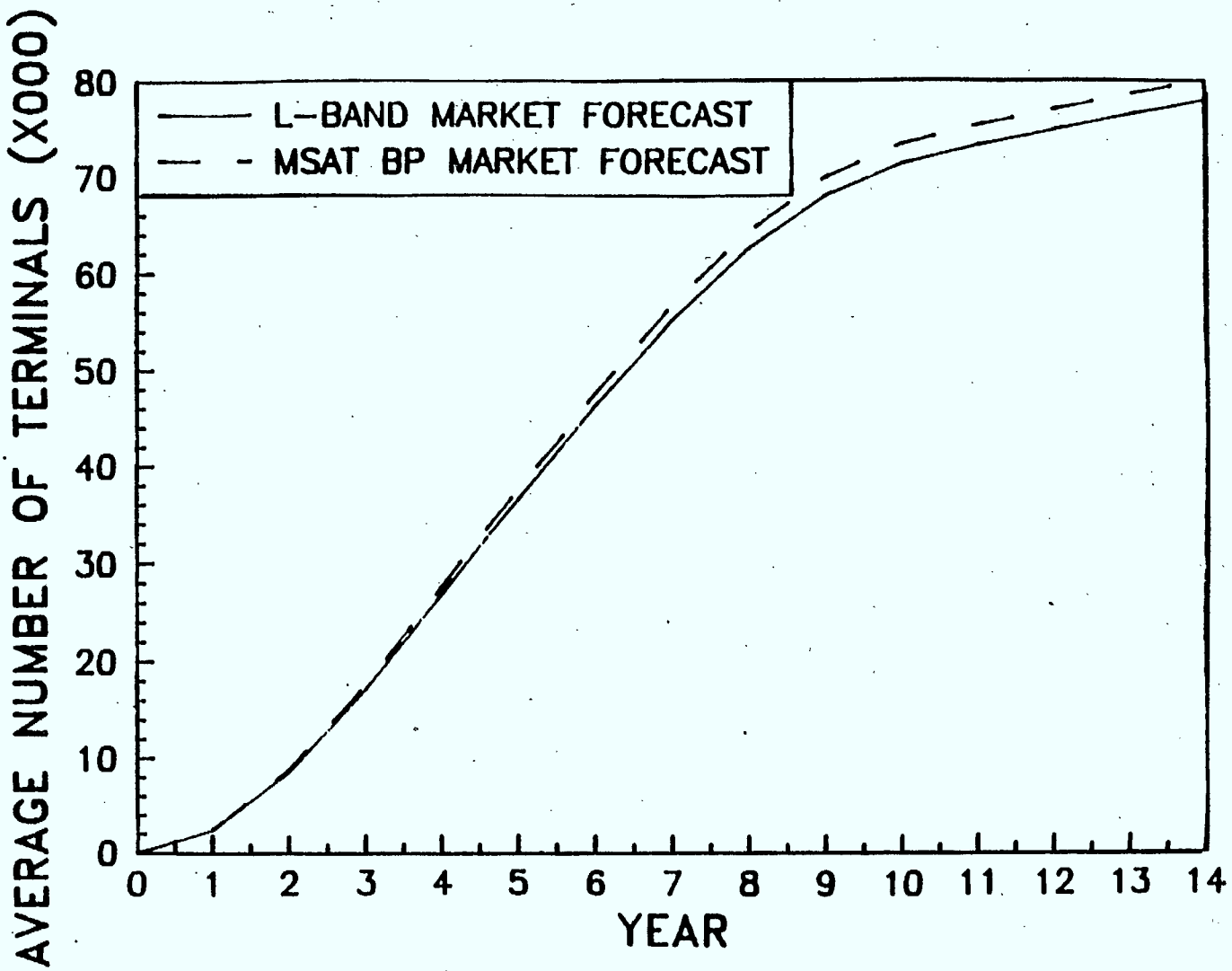




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TABLE 4.8

| YEAR | PROJECTED MSAT BUSINESS PROPOSAL | PROJECTED L-BAND (2.8% REDUCTION) |
|---|---|---|
| | Average Users (Users/Year) | |
| 1 | 2,501 | 2,431 |
| 2 | 8,751 | 8,509 |
| 3 | 17,501 | 17,018 |
| 4 | 27,500 | 26,742 |
| 5 | 37,499 | 36,467 |
| 6 | 47,500 | 46,191 |
| 7 | 56,719 | 55,156 |
| 8 | 64,325 | 62,553 |
| 9 | 69,924 | 68,000 |
| 10 | 73,315 | 71,296 |
| 11 | 75,346 | 73,271 |
| 12 | 77,017 | 74,896 |
| 13 | 78,623 | 76,458 |
| 14 | 80,181 | 77,972 |



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### 4.3.2 Revenue

The methodology used to calculate revenue is described in reference (1). The L-Band market forecast, shown in Table 4.8 together with the price scenarios defined in Table 4.9, are used to project revenue. The revenue increase factors are applied to bring the revenue projections to current year dollars.

TABLE 4.9

1984 PRICE STRATEGY

| | User Payment | Telesat's Income | Service Provider's Income |
|---|---|---|---|
| Access Charge Per Month | $50.00 | $25.00 | $25.00 |
| Airtime Charge Per Minute | $ 1.50 | $ 1.25 | $ 0.25 |

1990 PRICE STRATEGY

| | User Payment | Telesat's Income | Service Provider's Income |
|---|---|---|---|
| Access Charge Per Month | $63.26 | $31.63 | $31.63 |
| Airtime Charge Per Minute | $ 1.90 | $ 1.60 | $ 0.30 |

The market forecasts have been defined by the number of Mobile Radio Service (MRS) and Mobile Telephone Service (MTS) subscribers projected by the end of each year and the corresponding monthly airtime. In order to calculate the revenue projections, the year-end data is modified to represent the average number of subscribers throughout each year. This number of subscribers, shown in Table 4.4, is then used to calculate the average monthly airtime based on a monthly usage of 150 minutes per month per terminal. This data is then used as input to a computer model which calculates the projected revenue of the various MSAT system scenarios.

The revenue computer model calculates the year by year revenue potential of a particular satellite system given the average number of users and average monthly airtime. Given the maximum user capacity of the first generation satellite systems, the model restricts the total number of users to that capacity. By limiting the total number of users, the amount of airtime is also restricted and the resulting maximum revenue potential is calculated. The spacecraft capacities are identified to the model in thousands of users. When the total capacity of the first generation satellite is saturated by the market penetration, the model assumes that, when the second generation is put into service, the market growth will resume to the expected market penetration from the point of the initial truncation.

The revenue projections, in current year dollars, for the various satellite systems are shown in the Cash Flow Summary, Annex B.

## 5.0 RESULTS OF THE ECONOMIC ANALYSIS

The preceeding data is fed into the Economic Evaluation System (EES) model. The results are expressed in terms of the Net Present Value (NPV). For comparison, the results of the MSAT Business proposal baseline scenario have been included. All the NPV values are negative, indicating that all plans considered are not economically viable in the first generation.

### 5.1 Plan 1: L-Band Only Option

Plan 1 consists of three alternatives as shown in Table 5.1. In this table, 97% availability corresponds to a satellite L-Band EIRP of 32.3 dBW per carrier. This availability is comparable to that in the UHF scenario. Therefore the service quality of the L-Band alternatives is comparable to that of the UHF MSAT Business Proposal scenario.

The results in Table 5.1 show that between the three options, only the 4-beam system using a PAM DII class spacecraft can achieve a maximum capacity of 21,000 users. It has the best NPV value. However, when compared to the UHF scenario, its NPV is still less than that of the UHF option. This reduction in the NPV value is largely due to the much lower revenues arising from diminished spacecraft capacity of the L-Band alternatives as compared to the UHF case. Table 5.2 shows the components making up the NPV.

Table 5.1 further indicates that, if we are restricted to the same spacecraft class as that used in the UHF system, and the availability of 97%, the capacity for the 2-beam system using a PAM D spacecraft is 6,000 users, a reduction of 29,000 users as compared to the UHF 2-beam system. The penalty of maintaining a comparable availability and the same spacecraft as in the UHF system is a drastic reduction in capacity and therefore revenue. In terms of the NPV, it is a reduction of about $69 MCD as compared to the UHF 2-beam system.

TABLE 5.1

ECONOMIC ANALYSIS OF L-BAND ALTERNATIVES
($MCD 1984)

PLAN 1

| CASE | SPACECRAFT CLASS | NO. OF BEAMS | EIRP/ CARRIER | L-BAND SYSTEM CAPACITY | NPV $MCD (1984) |
|---|---|---|---|---|---|
| 1. | PAM D | 2 | 32.3 | 6,000 | -83.988 |
| 2. | PAM DII | 2 | 32.3 | 13,000 | -74.613 |
| 3. | PAM DII | 4 | 32.3 | 21,000 | -59.647 |
| PAM D (MSAT BUSINESS PROPOSAL BASELINE) | | 2 | 26.5 | 35,000 | -15.601 |

TABLE 5.2

NPV COMPONENTS ($MCD 1984) L-BAND

| PRESENT WORTH | BASELINE | CASE 1 | CASE 2 | CASE 3 |
|---|---|---|---|---|
| REVENUE | 161.097 | 36.786 | 69.990 | 111.369 |
| CAPITAL | 121.129 | 109.358 | 124.333 | 137.908 |
| EXPENSES | 35.915 | 34.925 | 36.977 | 39.038 |
| INCOME TAX | 19.654 | -23.509 | -16.707 | -5.930 |
| NPV | -15.601 | -83.988 | -74.613 | -59.647 |



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This reduction in the NPV can be compensated by increasing the service price. The new price option required to achieve the same NPV value as that for the UHF system is a subject for further study. On the other hand, in order to provide a capacity of 35,000 users and an availability of 97%, a spacecraft larger than PAM DII would have to be considered. Again, the cost impact of such an option is a subject for further study.

## 5.2 Plan 2: Dual Band Option

Two alternatives were considered in Plan 2. The first alternative consists of a PAM DII spacecraft employing 2 UHF and 4 L-Band beams and the second alternative an HS 393 spacecraft with the same beam configuration. Tables 5.3 and 5.4 present the results of the two alternatives in comparison with the UHF system.

Table 5.3 indicates that the alternative using the HS 393 spacecraft with a capacity of 47,000 users is economically better than that employing the PAM DII spacecraft with a capacity of 36,000 users. Despite the larger number of users as compared to the 35,000 users for the UHF system, the NPV values of both alternatives are lower than that of the UHF system. A study of Table 5.4 shows that the contributing factor for the poorer performance in NPV is the capital cost of the alternatives. The present worth of the capital costs for the PAM DII spacecraft and the HS 393 spacecraft are about $28 MCD and $25 MCD higher than that of the UHF system respectively.

The NPV of the alternative utilizing an HS 393 spacecraft is only $5 MCD lower than the NPV of the UHF system. This is due to the higher capacity of 47,000 users as compared to 35,000 users for the UHF system. The NPV performance of alternatives in Plan 2 are much better than alternatives in Plan 1 due to the larger spacecraft capacities in Plan 2.

TABLE 5.3

ECONOMIC ANALYSIS OF DUAL BAND ALTERNATIVES

| CASE | SPACECRAFT CLASS | NO. OF BEAMS | EIRP/CARRIER dBW | | SYSTEM CAPACITY NO. OF USERS | | | NPV $MCD (1984) |
|---|---|---|---|---|---|---|---|---|
| | | | UHF | L-BAND | UHF | L-BAND | TOTAL | |
| 1 | PAM DII | 2 UHF/4 L-BAND | 26.5 | 32.3 | 35,000 | 1,000 | 36,000 | -34.468 |
| 2 | HS 393 | 2 UHF/4 L-BAND | 26.5 | 32.3 | 35,000 | 12,000 | 47,000 | -20.605 |
| UHF REFER-ENCE | PAM D | 2 UHF | 26.5 | - | 35,000 | - | 35,000 | -15.601 |

TABLE 5.4

NPV COMPONENTS ($MCD 1984) DUAL-BAND

| PRESENT WORTH | BASELINE PAM D 2 BEAM UHF | PAM DII 2 UHF/4 L-BAND BEAMS | HS 393 2 UHF/4 L-BAND BEAMS |
|---|---|---|---|
| REVENUE | 161.097 | 162.606 | 185.754 |
| CAPITAL | 121.129 | 149.153 | 146.584 |
| EXPENSES | 35.915 | 34.925 | 34.925 |
| INCOME TAX | 19.654 | 12.996 | 24.850 |
| NPV | -15.601 | -34.468 | -20.605 |



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## 5.3 Plan 3: Separate L-Band and UHF Satellites

### 5.3.1 Description of the Scenarios

Plan 3 consists of two satellites (1 UHF and 1 L-Band) used by Canada in a joint venture with a U.S. partner. The capital costs for the UHF satellite, (a PAM D 2 beam) are the same as those used in the UHF reference scenario. The one time capital injection in 1991 for the UHF satellite is $265.391 MCD [from reference (1)] and that for the L-Band satellite is $235.937 MCD (PAM D 2 beams shown in Table 4.1).

Two scenarios are envisaged:

Scenario 1: Launch both UHF and L-Band satellites in 1991

In this scenario, the one time capital injection for the space segment in 1991 is the sum of the capital injections for the two satellites, i.e.,

$265.391 + 235.937 MCD = $501.328 MCD. The one time capital injection for the ground segment is $40.462 MCD as shown in Table 4.4. The operating expenses and revenues are given in the Cash Flow Summary, Annex B.

Scenario 2: Launch UHF satellite in 1991. Launch L-Band satellite when UHF capacity runs out.

It is assumed in this scenario that all the UHF capacity is utilized first, and the L-Band satellite is launched when the UHF capacity runs out. Figure 5.1 illustrates the market build up for this scenario. MSAT service is introduced in year 1 and the market builds up along the L-Band market forecast curve until

the UHF capacity of 35,000 users exhausts in year 5. In year 5, therefore, the L-Band satellite is launched and the market build up continues. Since the capacity of the L-Band satellite is only 6,000 users, there is a truncation at 41,000 users which is the sum of the total number of users for the UHF and the L-Band satellites. As shown in Figure 5.1, there will be two satellites in service from year 5 to year 8. Year 8 is the end of the first generation. When the second generation is put in service in year 8, it is assumed that the market growth will resume to the expected market penetration from the point of initial truncation. The one time capital injection for the UHF satellite, $265.391 MCD, occurs in 1991 and for the L-Band satellite, $235.937, in 1995. The one time capital injection for the ground segment is $40.462, as shown in Table 4.4. The operating expenses and revenues are given in the Cash Flow Summary, Annex B.

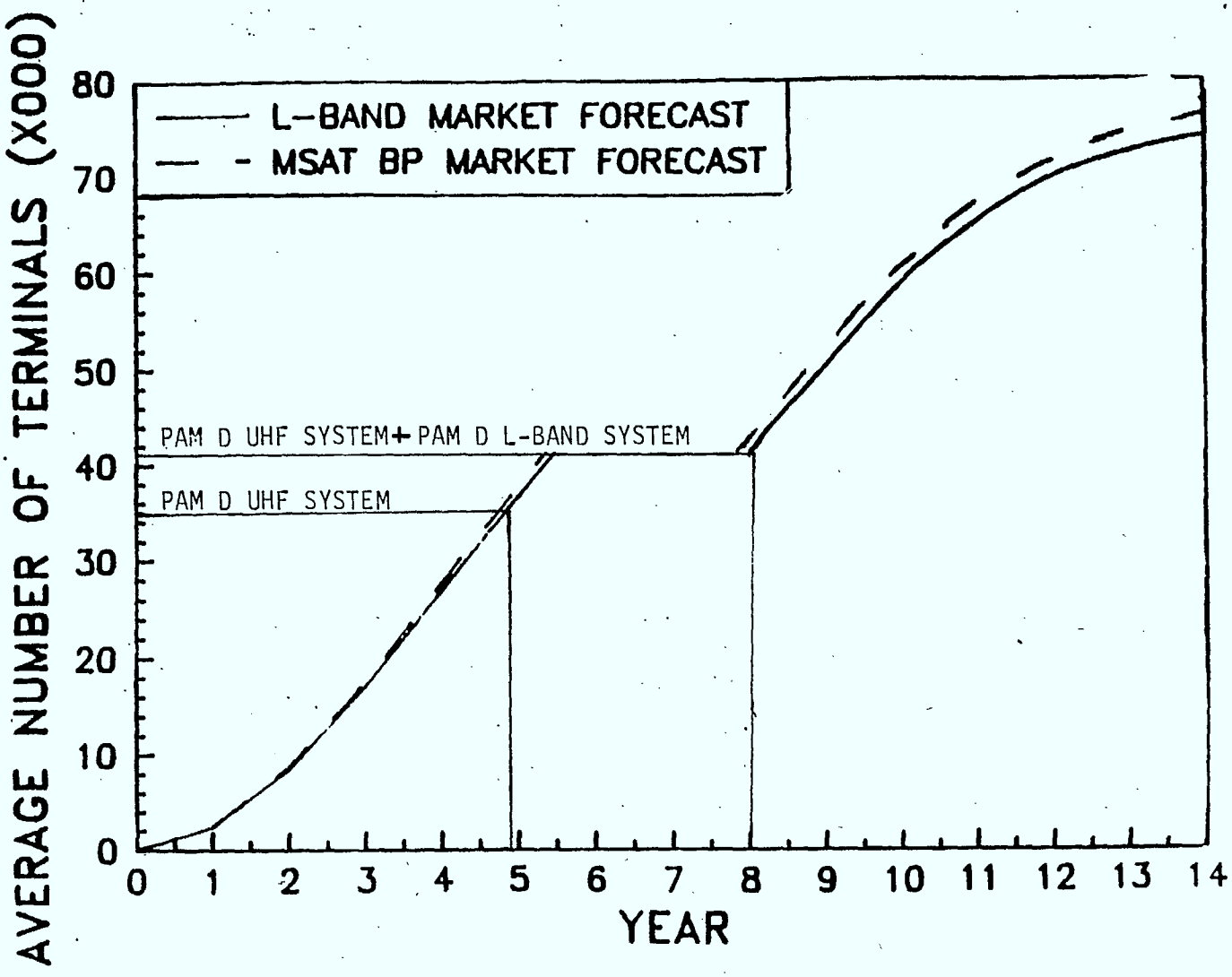


Figure 5.1

Market Buildup for Separate

UHF & L-Band Satellites in the First Generation



8340z/

Table 5.5 gives the description of the UHF and L-Band satellites used in Plan 3.

TABLE 5.5

PLAN 3

| SPACECRAFT CLASS | NO. OF BEAMS | EIRP/CARRIER dBW | SYSTEM CAPACITY # OF USERS |
|---|---|---|---|
| PAM D* | 2 UHF | 26.5 | 35,000 |
| PAM D | 2 L-BAND | 32.3 | 6,000 |

* Same as MSAT Business Proposal baseline scenario.

5.3.2 Results of the Economic Analysis of Plan 3

The results of the Economic Analysis are given in Table 5.6. The NPV of Plan 3, scenario 1, is about $62 MCD lower than that of the baseline UHF reference. However, it is marginally better than the NPV of Plan 1, case 1 (L-Band, PAM D 2 Beam). The poor performance in NPV of Plan 3, scenario 1, is due to the higher capital outlays in procuring two satellites. Table 5.6 shows that the present worth of capital for this plan is $215.419 MCD as compared to $121.129 MCD for that of the UHF baseline reference.

The results of scenario 2 indicate that there is an improvement of about $44 MCD in NPV as compared to scenario 1. Indeed, scenario 2 has a better NPV than any of the L-Band alternatives, and it is even marginally better than the Dual Band case 1 alternative (PAM DII spacecraft). The improvement in the NPV is due to two factors:

1. Delay in the launch of the L-Band satellite.

2. End of study adjustment. The life estimate of the L-Band satellite is 7 years. Therefore, at the end of the first generation, there are four years of service potential left. To reflect this potential the alternative is credited with the present worth of a pseudo-salvage value, the end of study adjustment, which is subtracted from the present worth of capital.

TABLE 5.6

PLAN 3

NPV COMPONENTS ($ MCD 1984)

| PRESENT WORTH | PLAN 3 SCENARIO 1 | PLAN 3 SCENARIO 2 | BASELINE UHF REFERENCE |
|---|---|---|---|
| REVENUE | 173.666 | 173.666 | 161.097 |
| CAPITAL | 215.419 | 162.249 | 121.129 |
| EXPENSES | 34.925 | 34.925 | 35.915 |
| TAX | .903 | 9.733 | 19.654 |
| NPV | -77.581 | -33.241 | -15.601 |



8340z/

## 6.0 CONCLUSION

The results of the economic analyses show that the utilization of L-Band for MSAT will not achieve the same economic viability as the UHF-system. All the NPV values in the plans considered were negative, and none of them were better than the NPV of the UHF reference system.

Since this was strictly a comparative study, assumptions made about the spacecraft life, and economic and financial parameters in the UHF reference scenario, had to be carried over to the L-Band Study. Comparison was also made on the basis of equivalent quality of service. If these assumptions were altered, the results could change. For example, we could consider providing lower quality of service at L-Band relative to UHF. For instance in a 2-beam L-Band system using a PAM D spacecraft, reducing the EIRP per carrier from 32.3 dBW to about 28.2 dBW would increase the capacity from 6,000 users to about 22,000 users. To achieve a system capacity of 35,000 users or more, the EIRP per carrier, and therefore quality of service, would have to be reduced even further. The carrier level and corresponding availability for such a system would have to be determined.

The results also indicate that the Dual-Band Plan is economically better than the L-Band Only Plan. By dropping the availability figure to 94%, and increasing the spacecraft life estimate from 7 years to 10 years, preliminary analysis, using current economic and financial parameters, show that the Dual-Band system can achieve a positive NPV.

There is on-going work at Telesat to study the impact of Dual-Band satellites on MSAT. For example, results show that a .27 STS occupancy Dual-Band spacecraft is capable of a capacity of 35,000 UHF users and 25,000 L-Band users for a total capacity of 60,000 users. For a 10 year spacecraft life, the NPV is about +37 MCD (1985$) in the first generation. The detailed results of this study will be reported in Telesat's Business Proposal Revision at a later date.

## 7.0 ANNEXES

## 7.1 ANNEX A

SPACE SEGMENT INFLATED COST PROFILES

| | | |
|---|---|---|
| - | TABLE 1.1 | PAM D, 2 BEAM L-BAND |
| - | TABLE 1.2 | PAM-D2, 2 BEAM L-BAND |
| - | TABLE 2.1 | PAM-D2, 4 BEAM L-BAND |
| - | TABLE 3.1 | PAM-D2, 2 BEAM UHF<br>4 BEAM L-BAND |
| | TABLE 3.2 | HS 393, 2 BEAM UHF<br>4 BEAM L-BAND |

## ASSUMPTIONS

1. Joint procurement, equal cost sharing.

2. Separate ownership and operation.

3. Contract Signature (Kick-off) 3Q, 1986.

4. First Delivery 1Q, 1990.

5. Canadian spacecraft launched 2Q, 1991.

6. Payment time base; quarterly.

7. Incentive Payments: 12% at commissioning.

8. Insurance: 10% of insurable capital costs.

9. Satellite operations: pre-launch capital only.

TABLE 1.1

2-BEAM L-BAND PAM-D
SPACE SEGMENT PROGRAM COSTS

<VERSION 31/05/85 D.SHOWALTER>

CAPITAL COSTS

CURRENCY $MCD 3Q 1986
EXCHANGE RATE 1.30

| COMPONENT | TYPE | COST | DESCRIPTION |
|---|---|---|---|
| Spacecraft | MSAT2 | 73.0 | Launched:1 Procured:2 |
| Incentives | | 8.8 | 12.0% Of Spacecraft |
| Upper Stage | PAMD | 9.4 | GTO Mass: 1270.0kg |
| Launch Vehicle | STS | 26.5 | Cargo Mass:4619.8kg |
| Launch Site Supp. | | 2.9 | $2MUS Per Launch (STS) |
| Cap. Engineering | | 5.0 | Procurement: JOINT |
| Insurance | | 12.6 | 10.0% Of Above Costs |
| Mission Control | | 2.6 | Operation: SEPARATE |
| Sat. Operations | | 3.7 | Lifetime: 7.0yr |
| Contingency | | 7.2 | 5% Of Total |
| Total | | 151.6 | |

SCHEDULE

BASE DATE 4Q 1984
KICK-OFF DATE 3Q 1986

| SPACECRAFT | DELIVERY | LAUNCH | EOL | STAGE COST |
|---|---|---|---|---|
| 1 | 1Q 1990 | 2Q 1991 | 2Q 1998 | 14.5 |
| 2 | 2Q 1990 | 3Q 1991 | 3Q 1998 | 12.4 |

TABLE 1.1 (CONTD) 2-BEAM L-BAND PAM-D

Program Cost Disbursements PAGE 1

| Dates (QUART) | 3/1986 | 4/1986 | 1/1987 | 2/1987 | 3/1987 | 4/1987 | 1/1988 | 2/1988 | 3/1988 | 4/1988 |
|---|---|---|---|---|---|---|---|---|---|---|
| Events | KICK | | | | | | | | | |
| Spacecraft | 10.3 | 12.9 | 12.1 | 10.1 | 7.9 | 5.9 | 4.3 | 3.1 | 2.2 | 1.5 |
| Incentives | | | | | | | | | | |
| Upper Stage | | | | | | | | | | 1.7 |
| Launch Vehicle | | | | | | | | | 3.1 | |
| Launch Site Supp | | | | | | | | | | |
| Cap. Engineering | .2 | .2 | .2 | .2 | .2 | .7 | .2 | .2 | .2 | .2 |
| Insurance | | | | | | | | | | |
| Mission Control | | | | | | | | | .2 | .2 |
| Sat. Operations | | | | | | | | | | |
| Annual Totals | 10.5 | 13.1 | 12.3 | 10.3 | 8.1 | 6.6 | 4.5 | 3.3 | 5.7 | 3.7 |

TABLE 1.1 (CONTD) 2-BEAM L-BAND PAM-D

Program Cost Disbursements PAGE 2

| Dates (QUART) | 1/1989 | 2/1989 | 3/1989 | 4/1989 | 1/1990 | 2/1990 | 3/1990 | 4/1990 | 1/1991 | 2/1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| Events | | | | | DELIVR | | | | | LAUNCH |
| Spacecraft | 1.0 | .7 | .5 | .3 | .2 | | | | | |
| Incentives | | | | | | | | | | |
| Upper Stage | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 2.5 | 2.5 | .9 | .9 |
| Launch Vehicle | 3.2 | | 5.6 | | 5.8 | | 8.2 | | 8.5 | |
| Launch Site Supp | | | | | | | | | | 3.2 |
| Cap. Engineering | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | 1.0 |
| Insurance | | | | | | | | | | 14.0 |
| Mission Control | .2 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 |
| Sat. Operations | | | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 |
| Annual Totals | 5.7 | 2.2 | 8.2 | 2.4 | 8.2 | 2.1 | 11.8 | 3.6 | 10.6 | 20.0 |

TABLE 1.1 (CONTD) 2-BEAM L-BAND PAM-D

Program Cost Disbursements PAGE 3

| Dates (QUART) | 3/1991 | 4/1991 | 4/1991 |
|---|---|---|---|
| Events | | COMMIS | TOTALS |
| Spacecraft | | | 73.0 |
| Incentives | | 8.8 | 8.8 |
| Upper Stage | | | 14.5 |
| Launch Vehicle | | | 34.4 |
| Launch Site Supp | | | 3.2 |
| Cap. Engineering | | | 6.2 |
| Insurance | | | 14.0 |
| Mission Control | | | 3.1 |
| Sat. Operations | | | 4.7 |
| Annual Totals | | 8.8 | 162.0 |
| Contingency (5%) | | | 8.1 |
| TOTAL | | | 170.1 |

TABLE 1.2 :

2-BEAM L-BAND PAM-D2
SPACE SEGMENT PROGRAM COSTS

<VERSION 31/05/85 D.SHOWALTER>

CAPITAL COSTS

CURRENCY $MCD 3Q 1986
EXCHANGE RATE 1.30

| COMPONENT | TYPE | COST | DESCRIPTION |
|---|---|---|---|
| Spacecraft | MSAT2 | 84.0 | Launched:1 Procured:2 |
| Incentives | | 10.1 | 12.0% Of Spacecraft |
| Upper Stage | PAMD2 | 11.3 | GTO Mass: 1500.0kg |
| Launch Vehicle | STS | 33.9 | Cargo Mass:6073.0kg |
| Launch Site Supp. | | 2.9 | $2MUS Per Launch (STS) |
| Cap. Engineering | | 5.0 | Procurement: JOINT |
| Insurance | | 14.7 | 10.0% Of Above Costs |
| Mission Control | | 2.6 | Operation: SEPARATE |
| Sat. Operations | | 3.7 | Lifetime: 10.0yr |
| Contingency | | 8.4 | 5% Of Total |
| Total | | 176.6 | |

SCHEDULE

BASE DATE 4Q 1984
KICK-OFF DATE 3Q 1986

| SPACECRAFT | DELIVERY | LAUNCH | EOL | STAGE COST |
|---|---|---|---|---|
| 1 | 1Q 1990 | 2Q 1991 | 2Q 2001 | 17.5 |
| 2 | 2Q 1990 | 2Q 1991 | 2Q 2001 | 14.7 |

TABLE 1.2 (CONTD) 2-BEAM L-BAND PAM-D2

Program Cost Disbursements PAGE 1

| Dates (QUART) | 3/1986 | 4/1986 | 1/1987 | 2/1987 | 3/1987 | 4/1987 | 1/1988 | 2/1988 | 3/1988 | 4/1988 |
|---|---|---|---|---|---|---|---|---|---|---|
| Events | KICK | | | | | | | | | |
| Spacecraft | 11.9 | 14.9 | 13.9 | 11.6 | 9.1 | 6.8 | 5.0 | 3.5 | 2.5 | 1.7 |
| Incentives | | | | | | | | | | |
| Upper Stage | | | | | | | | | .4 | 1.8 |
| Launch Vehicle | | | | | | | | | 3.9 | |
| Launch Site Supp | | | | | | | | | | |
| Cap. Engineering | .2 | .2 | .2 | .2 | .2 | .7 | .2 | .2 | .2 | .2 |
| Insurance | | | | | | | | | | |
| Mission Control | | | | | | | | | .2 | .2 |
| Sat. Operations | | | | | | | | | | |
| Annual Totals | 12.1 | 15.1 | 14.1 | 11.8 | 9.3 | 7.5 | 5.2 | 3.8 | 7.2 | 4.0 |

TABLE 1.2 (CONTD) 2-BEAM L-BAND PAM-D2

Program Cost Disbursements PAGE 2

| Dates (QUART) | 1/1989 | 2/1989 | 3/1989 | 4/1989 | 1/1990 | 2/1990 | 3/1990 | 4/1990 | 1/1991 | 2/1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| Events | | | | | DELIVR | | | | | LAUNCH |
| Spacecraft | 1.2 | .8 | .5 | .4 | .2 | | | | | |
| Incentives | | | | | | | | | | |
| Upper Stage | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 3.0 | 3.0 | 1.1 | 1.1 |
| Launch Vehicle | 4.1 | | 7.2 | | 7.5 | | 10.5 | | 10.9 | |
| Launch Site Supp | | | | | | | | | | 3.2 |
| Cap. Engineering | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | 1.0 |
| Insurance | | | | | | | | | | 16.5 |
| Mission Control | .2 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 |
| Sat. Operations | | | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 |
| Annual Totals | 7.0 | 2.5 | 10.0 | 2.7 | 10.0 | 2.3 | 14.6 | 4.1 | 13.1 | 22.7 |

TABLE 1.2 (CONTD) 2-BEAM L-BAND PAM-D2

Program Cost Disbursements PAGE 3

| Dates (QUART) | 3/1991 | 4/1991 | 4/1991 |
|---|---|---|---|
| Events | | COMMIS | TOTALS |
| Spacecraft | | | 84.0 |
| Incentives | | 10.1 | 10.1 |
| Upper Stage | | | 17.5 |
| Launch Vehicle | | | 44.1 |
| Launch Site Supp | | | 3.2 |
| Cap. Engineering | | | 6.2 |
| Insurance | | | 16.5 |
| Mission Control | | | 3.1 |
| Sat. Operations | | | 4.7 |
| Annual Totals | | 10.1 | 189.4 |
| Contingency (5%) | | | 9.5 |
| TOTAL | | | 198.9 |

TABLE 2.1:

4-BEAM L-BAND PAM-D2
SPACE SEGMENT PROGRAM COSTS

<VERSION 31/05/85 D.SHOWALTER>

CAPITAL COSTS

CURRENCY $MCD 3Q 1986
EXCHANGE RATE 1.30

| COMPONENT | TYPE | COST | DESCRIPTION |
|---|---|---|---|
| Spacecraft | MSAT4 | 98.0 | Launched:1 Procured:2 |
| Incentives | | 11.8 | 12.0% Of Spacecraft |
| Upper Stage | PAMD2 | 11.4 | GTO Mass: 1700.0kg |
| Launch Vehicle | STS | 36.7 | Cargo Mass:6620.3kg |
| Launch Site Supp. | | 2.9 | $2MUS Per Launch (STS) |
| Cap. Engineering | | 5.0 | Procurement: JOINT |
| Insurance | | 16.6 | 10.0% Of Above Costs |
| Mission Control | | 2.6 | Operation: SEPARATE |
| Sat. Operations | | 3.7 | Lifetime: 10.0yr |
| Contingency | | 9.4 | 5% Of Total |
| Total | | 198.1 | |

SCHEDULE

BASE DATE 4Q 1984
KICK-OFF DATE 3Q 1986

| SPACECRAFT | DELIVERY | LAUNCH | EOL | STAGE COST |
|---|---|---|---|---|
| 1 | 1Q 1990 | 2Q 1991 | 2Q 2001 | 17.7 |
| 2 | 2Q 1990 | 2Q 1991 | 2Q 2001 | 14.9 |

TABLE 2.1 (CONTD) 4-BEAM L-BAND PAM-D2

Program Cost Disbursements PAGE 1

| Dates (QUART) | 3/1986 | 4/1986 | 1/1987 | 2/1987 | 3/1987 | 4/1987 | 1/1988 | 2/1988 | 3/1988 | 4/1988 |
|---|---|---|---|---|---|---|---|---|---|---|
| Events | KICK | | | | | | | | | |
| Spacecraft | 13.9 | 17.3 | 16.2 | 13.5 | 10.6 | 7.9 | 5.8 | 4.1 | 2.9 | 2.0 |
| Incentives | | | | | | | | | | |
| Upper Stage | | | | | | | | | .4 | 1.8 |
| Launch Vehicle | | | | | | | | | 4.2 | |
| Launch Site Supp | | | | | | | | | | |
| Cap. Engineering | .2 | .2 | .2 | .2 | .2 | .7 | .2 | .2 | .2 | .2 |
| Insurance | | | | | | | | | | |
| Mission Control | | | | | | | | | .2 | .2 |
| Sat. Operations | | | | | | | | | | |
| Annual Totals | 14.1 | 17.5 | 16.5 | 13.8 | 10.8 | 8.6 | 6.0 | 4.4 | 8.0 | 4.3 |

TABLE 2.1 (CONTD) 4-BEAM L-BAND PAM-D2

Program Cost Disbursements PAGE 2

| Dates (QUART) | 1/1989 | 2/1989 | 3/1989 | 4/1989 | 1/1990 | 2/1990 | 3/1990 | 4/1990 | 1/1991 | 2/1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| Events | | | | | DELIVR | | | | | LAUNCH |
| Spacecraft | 1.4 | .9 | .6 | .4 | .3 | | | | | |
| Incentives | | | | | | | | | | |
| Upper Stage | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 3.0 | 3.0 | 1.1 | 1.1 |
| Launch Vehicle | 4.4 | | 7.8 | | 8.1 | | 11.4 | | 11.8 | |
| Launch Site Supp | | | | | | | | | | 3.2 |
| Lap. Engineering | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | 1.0 |
| Insurance | | | | | | | | | | 18.5 |
| Mission Control | .2 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 |
| Sat. Operations | | | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 |
| Annual Totals | 7.5 | 2.7 | 10.7 | 2.8 | 10.7 | 2.4 | 15.5 | 4.2 | 14.0 | 24.6 |

TABLE 2.1 (CONTD) 4-BEAM L-BAND PAM-D2

Program Cost Disbursements PAGE 3

| Dates (QUART) | 3/1991 | 4/1991 | 4/1991 |
|---|---|---|---|
| Events | | COMMIS | TOTALS |
| Spacecraft | | | 98.0 |
| Incentives | | 11.8 | 11.8 |
| Upper Stage | | | 17.7 |
| Launch Vehicle | | | 47.7 |
| Launch Site Supp | | | 3.2 |
| Cap. Engineering | | | 6.2 |
| Insurance | | | 18.5 |
| Mission Control | | | 3.1 |
| Sat. Operations | | | 4.7 |
| Annual Totals | | 11.8 | 210.9 |
| Contingency (5%) | | | 10.5 |
| TOTAL | | | 221.4 |

TABLE 3.1

2UHF/4L-BAND PAM-D2
SPACE SEGMENT PROGRAM COSTS

<VERSION 31/05/85 D.SHOWALTER>

CAPITAL COSTS

CURRENCY $MCD 3Q 1986
EXCHANGE RATE 1.30

| COMPONENT | TYPE | COST | DESCRIPTION |
|---|---|---|---|
| Spacecraft | MSAT4 | 109.5 | Launched:1 Procured:2 |
| Incentives | | 13.1 | 12.0% Of Spacecraft |
| Upper Stage | PAMD2 | 11.4 | GTO Mass: 1900.0kg |
| Launch Vehicle | STS | 39.5 | Cargo Mass:7167.6kg |
| Launch Site Supp. | | 2.9 | $2MUS Per Launch (STS) |
| Cap. Engineering | | 5.0 | Procurement: JOINT |
| Insurance | | 18.2 | 10.0% Of Above Costs |
| Mission Control | | 2.6 | Operation: SEPARATE |
| Sat. Operations | | 3.7 | Lifetime: 10.0yr |
| Contingency | | 10.3 | 5% Of Total |
| Total | | 216.2 | |

SCHEDULE

BASE DATE 4Q 1984
KICK-OFF DATE 3Q 1986

| SPACECRAFT | DELIVERY | LAUNCH | EOL | STAGE COST |
|---|---|---|---|---|
| 1 | 1Q 1990 | 2Q 1991 | 2Q 2001 | 17.7 |
| 2 | 2Q 1990 | 2Q 1991 | 2Q 2001 | 14.9 |

TABLE 3.1 (CONTD) 2UHF/4L-BAND PAM-D2

Program Cost Disbursements PAGE 1

| Dates (QUART) | 3/1986 | 4/1986 | 1/1987 | 2/1987 | 3/1987 | 4/1987 | 1/1988 | 2/1988 | 3/1988 | 4/1988 |
|---|---|---|---|---|---|---|---|---|---|---|
| Events | KICK | | | | | | | | | |
| Spacecraft | 15.5 | 19.4 | 18.1 | 15.1 | 11.8 | 8.9 | 6.5 | 4.6 | 3.2 | 2.3 |
| Incentives | | | | | | | | | | |
| Upper Stage | | | | | | | | | .4 | 1.8 |
| Launch Vehicle | | | | | | | | | 4.6 | |
| Launch Site Supp | | | | | | | | | | |
| Cap. Engineering | .2 | .2 | .2 | .2 | .2 | .7 | .2 | .2 | .2 | .2 |
| Insurance | | | | | | | | | | |
| Mission Control | | | | | | | | | .2 | .2 |
| Sat. Operations | | | | | | | | | | |
| Annual Totals | 15.7 | 19.6 | 18.4 | 15.4 | 12.0 | 9.6 | 6.7 | 4.9 | 8.7 | 4.5 |

TABLE 3.1 (CONTD) 2UHF/4L-BAND PAM-D2

Program Cost Disbursements PAGE 2

| Dates (QUART) | 1/1989 | 2/1989 | 3/1989 | 4/1989 | 1/1990 | 2/1990 | 3/1990 | 4/1990 | 1/1991 | 2/1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| Events | | | | | DELIVR | | | | | LAUNCH |
| Spacecraft | 1.5 | 1.1 | .7 | .5 | .3 | | | | | |
| Incentives | | | | | | | | | | |
| Upper Stage | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 3.0 | 3.0 | 1.1 | 1.1 |
| Launch Vehicle | 4.7 | | 8.4 | | 8.7 | | 12.2 | | 12.7 | |
| Launch Site Supp | | | | | | | | | | 5.2 |
| Cap. Engineering | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | 1.1 |
| Insurance | | | | | | | | | | 20.1 |
| Mission Control | .2 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 |
| Sat. Operations | | | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 |
| Annual Totals | 8.0 | 2.8 | 11.4 | 2.8 | 11.4 | 2.4 | 16.4 | 4.2 | 14.9 | 28.3 |

TABLE 3.1 (CONTD) 2UHF/4L-BAND PAM-D2

Program Cost Disbursements PAGE 3

| Dates (QUART) | 3/1991 | 4/1991 | 4/1991 |
|---|---|---|---|
| Events | | COMMIS | TOTALS |
| Spacecraft | | | 109.5 |
| Incentives | | 13.1 | 13.1 |
| Upper Stage | | | 17.7 |
| Launch Vehicle | | | 51.3 |
| Launch Site Supp | | | 3.2 |
| Cap. Engineering | | | 6.2 |
| Insurance | | | 20.1 |
| Mission Control | | | 3.1 |
| Sat. Operations | | | 4.7 |
| Annual Totals | | 13.1 | 229.0 |
| Contingency (5%) | | | 11.5 |
| TOTAL | | | 240.5 |

TABLE 3.2 :

2UHF/4L-BAND HS393
SPACE SEGMENT PROGRAM COSTS

<VERSION 31/05/85 D.SHOWALTER>

CAPITAL COSTS

CURRENCY $MCD 3Q 1986
EXCHANGE RATE 1.30

| COMPONENT | TYPE | COST | DESCRIPTION |
|---|---|---|---|
| Spacecraft | MSAT4 | 117.0 | Launched:1 Procured:2 |
| Incentives | | 14.0 | 12.0% Of Spacecraft |
| Upper Stage | MM3 | 2.9 | GTO Mass: 2000.0kg |
| Launch Vehicle | STS | 37.9 | Cargo Mass:6845.6kg |
| Launch Site Supp. | | 2.9 | $2MUS Per Launch (STS) |
| Cap. Engineering | | 5.0 | Procurement: JOINT |
| Insurance | | 18.0 | 10.0% Of Above Costs |
| Mission Control | | 2.6 | Operation: SEPARATE |
| Sat. Operations | | 3.7 | Lifetime: 10.0yr |
| Contingency | | 10.2 | 5% Of Total |
| Total | | 214.2 | |

SCHEDULE

BASE DATE 4Q 1984
KICK-OFF DATE 3Q 1986

| SPACECRAFT | DELIVERY | LAUNCH | EOL | STAGE COST |
|---|---|---|---|---|
| 1 | 1Q 1990 | 2Q 1991 | 2Q 2001 | 4.1 |
| 2 | 2Q 1990 | 2Q 1991 | 2Q 2001 | 4.1 |

TABLE 3.2 (CONTD) 2UHF/4L-BAND HS393

Program Cost Disbursements PAGE 1

| Dates (QUART) | 3/1986 | 4/1986 | 1/1987 | 2/1987 | 3/1987 | 4/1987 | 1/1988 | 2/1988 | 3/1988 | 4/1988 |
|---|---|---|---|---|---|---|---|---|---|---|
| Events | KICK | | | | | | | | | |
| Spacecraft | 16.5 | 20.7 | 19.4 | 16.2 | 12.6 | 9.5 | 6.9 | 4.9 | 3.5 | 2.4 |
| Incentives | | | | | | | | | | |
| Upper Stage | | | | | | | | | | .5 |
| Launch Vehicle | | | | | | | | | 4.4 | |
| Launch Site Supp | | | | | | | | | | |
| Cap. Engineering | .2 | .2 | .2 | .2 | .2 | .7 | .2 | .2 | .2 | .2 |
| Insurance | | | | | | | | | | |
| Mission Control | | | | | | | | | .2 | .2 |
| Sat. Operations | | | | | | | | | | |
| Annual Totals | 16.8 | 20.9 | 19.6 | 16.4 | 12.9 | 10.2 | 7.1 | 5.2 | 8.3 | 3.4 |

TABLE 3.2 (CONTD) 2UHF/4L-BAND HS393

Program Cost Disbursements PAGE 2

| Dates (QUART) | 1/1989 | 2/1989 | 3/1989 | 4/1989 | 1/1990 | 2/1990 | 3/1990 | 4/1990 | 1/1991 | 2/1991 |
|---|---|---|---|---|---|---|---|---|---|---|
| Events | | | | | DELIVR | | | | | LAUNCH |
| Spacecraft | 1.7 | 1.1 | .8 | .5 | .3 | | | | | |
| Incentives | | | | | | | | | | |
| Upper Stage | .3 | .3 | .3 | .3 | .3 | .3 | .7 | .7 | .2 | .2 |
| Launch Vehicle | 4.5 | | 8.0 | | 8.3 | | 11.7 | | 12.2 | |
| Launch Site Supp | | | | | | | | | | 3.2 |
| Cap. Engineering | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | 1.1 |
| Insurance | | | | | | | | | | 19.4 |
| Mission Control | .2 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 | .3 |
| Sat. Operations | | | .6 | .6 | .6 | .6 | .6 | .6 | .6 | .6 |
| Annual Totals | 7.0 | 1.9 | 10.1 | 1.9 | 10.1 | 1.4 | 13.6 | 1.9 | 13.6 | 24.7 |

TABLE 3.2 (CONTD) 2UHF/4L-BAND HS393

Program Cost Disbursements PAGE 3

| Dates (QUART) | 3/1991 | 4/1991 | 4/1991 |
|---|---|---|---|
| Events | | COMMIS | TOTALS |
| Spacecraft | | | 117.0 |
| Incentives | | 14.0 | 14.0 |
| Upper Stage | | | 4.1 |
| Launch Vehicle | | | 49.2 |
| Launch Site Supp | | | 3.2 |
| Cap. Engineering | | | 6.2 |
| Insurance | | | 19.4 |
| Mission Control | | | 3.1 |
| Sat. Operations | | | 4.7 |
| Annual Totals | | 14.0 | 221.0 |
| Contingency (5%) | | | 11.0 |
| TOTAL | | | 232.0 |

7.2 ANNEX B

## CASH FLOW SUMMARY

## 7.2.1 CAPITAL EXPENDITURES

CAPITAL EXPENDITURES

- PAM D, 2 BEAM L-BAND
- PAM DII, 2 BEAM L-BAND
- PAM DII, 4 BEAM L-BAND
- PAM DII, 2 BEAM UHF
  4 BEAM L-BAND
- HS 393, 2 BEAM UHF
  4 BEAM L-BAND
- Plan 3 Scenario 1
- Plan 3 Scenario 2

CAPITAL EXPENDITURES
(Current Year Dollars $MCD)

Plan 1 L-Band: Case 1: PAM D 2 Beam

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * Space Segment | | 25.0 | 38.7 | 18.6 | 19.9 | 27.1 | 40.8 | | | | | | | 170.1 |
| * Earth Segment | | | 10.319 | 10.319 | 10.319 | | | | | Based on $30.957 MCD in 1987 April | | | | 30.957 |
| Marketing | | | | 1.158 | 1.667 | .450 | | | | Based on $1.2 MCD 1984/Year | | | | 3.275 |
| Advertising and Promotion | | | | 2.084 | 3.000 | .810 | | | | Based on $2.16 MCD 1984/Year | | | | 5.894 |
| Business Development | | 1.336 | 1.429 | | | | | | | Based on $1.2 MCD 1984/Year | | | | 2.765 |
| TOTAL | | 26.336 | 50.448 | 32.161 | 34.886 | 28.36 | 40.800 | | | | | | | 212.991 |

* Includes Capitalized Engineering

CAPITAL EXPENDITURES
(Current Year Dollars $MCD)

Plan 1 L-Band: Case 2: PAM D11 2 Beam

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * Space Segment | | 28.8 | 44.3 | 21.9 | 23.8 | 32.6 | 47.5 | | | | | | | 198.8 |
| * Earth Segment | | | 10.319 | 10.319 | 10.319 | | | | | Based on $30.957 MCD in 1987 April | | | | 30.957 |
| Marketing | | | | 1.158 | 1.667 | .450 | | | | Based on $1.2 MCD 1984/Year | | | | 3.275 |
| Advertising and Promotion | | | | 2.084 | 3.000 | .810 | | | | Based on $2.16 MCD 1984/Year | | | | 5.894 |
| Business Development | | 1.336 | 1.429 | | | | | | | Based on $1.2 MCD 1984/Year | | | | 2.765 |
| TOTAL | | 30.136 | 50.448 | 32.161 | 34.786 | 33.860 | 47.500 | | | | | | | 241.691 |

* Includes Capitalized Engineering

CAPITAL EXPENDITURES
(Current Year Dollars $MCD)

Plan 1 L-Band: Case 3: PAM D11 4 Beam

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * Space Segment | | 33.4 | 51.5 | 24.5 | 25.5 | 34.6 | 52.2 | | | | | | | 221.7 |
| * Earth Segment | | | 10.319 | 10.319 | 10.319 | | | | | Based on $30.957 MCD in 1987 April | | | | 30.957 |
| Marketing | | | | 1.158 | 1.667 | .450 | | | | Based on $1.2 MCD 1984/Year | | | | 3.275 |
| Advertising and Promotion | | | | 2.084 | 3.000 | .810 | | | | Based on $2.16 MCD 1984/Year | | | | 5.894 |
| Business Development | | 1.336 | 1.429 | | | | | | | Based on $1.2 MCD 1984/Year | | | | 2.765 |
| TOTAL | | 34.736 | 63.248 | 38.061 | 40.486 | 35.860 | 52.200 | | | | | | | 264.591 |

* Includes Capitalized Engineering

CAPITAL EXPENDITURES
(Current Year Dollars $MCD)

Plan 2 Dual Band: Case 1: PAM D11 2 Beam UHF, 4 Beam L-Band

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * Space Segment | | 37.2 | 57.3 | 26.7 | 26.9 | 36.3 | 56.2 | | | | | | | 240.6 |
| * Earth Segment | | | 11.274 | 11.274 | 11.274 | | | | | Based on $33.822 MCD in 1987 April | | | | 33.822 |
| Marketing | | | | 1.158 | 1.667 | .450 | | | | Based on $1.2 MCD 1984/Year | | | | 3.275 |
| Advertising and Promotion | | | | 2.084 | 3.000 | .810 | | | | Based on $2.16 MCD 1984/Year | | | | 5.894 |
| Business Development | | 1.336 | 1.429 | | | | | | | Based on $1.2 MCD 1984/Year | | | | 2.765 |
| TOTAL | | 38.536 | 70.003 | 41.216 | 42.841 | 37.560 | 56.200 | | | | | | | 286.356 |

* Includes Capitalized Engineering

CAPITAL EXPENDITURES
(Current Year Dollars $MCD)

Plan 2 Dual Band: Case 2: HS 393 2 Beam UHF, 4 Beam L-Band

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * Space Segment | | 39.5 | 60.9 | 25.8 | 22.7 | 28.8 | 54.1 | | | | | | | 231.8 |
| * Earth Segment | | | 11.274 | 11.274 | 11.274 | | | | | Based on $33.822 MCD in 1987 April | | | | 33.822 |
| Marketing | | | | 1.158 | 1.667 | .450 | | | | Based on $1.2 MCD 1984/Year | | | | 3.275 |
| Advertising and Promotion | | | | 2.084 | 3.000 | .810 | | | | Based on $2.16 MCD 1984/Year | | | | 5.894 |
| Business Development | | 1.336 | 1.429 | | | | | | | Based on $1.2 MCD 1984/Year | | | | 2.765 |
| TOTAL | | 40.836 | 73.603 | 40.316 | 38.641 | 30.06 | 54.1 | | | | | | | 277.556 |

* Includes Capitalized Engineering

CAPITAL EXPENDITURES
(Current Year Dollars $MCD)

Plan 3 Scenario I: PAM D 2 Beam UHF Satellite and PAM D 2 Beam L-Band Satellite

Both Launched in 1991

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * Space Segment | | 53.6 | 83.0 | 39.0 | 41.2 | 56.8 | 88.7 | | | | | | | 362.3 |
| * Earth Segment | | | 10.319 | 10.319 | 10.319 | | | | | Based on $30.957 MCD in 1987 April | | | | 30.957 |
| Marketing | | | | 1.158 | 1.667 | .450 | | | | Based on $1.2M 1984/YR. | | | | 3.275 |
| Advertising and Promotion | | | | 2.084 | 3.000 | .810 | | | | Based on $2.16M 1984/YR. | | | | 5.894 |
| Business Development | | 1.336 | 1.429 | | | | | | | Based on $1.2M 1984/YR. | | | | 2.765 |
| TOTAL | | 54.936 | 94.748 | 52.561 | 56.186 | 58.060 | 88.700 | | | | | | | 405.191 |

* Includes Capitalized Engineering

CAPITAL EXPENDITURES
(Current Year Dollars $MCD)

Plan 3 Scenario 2: PAM D 2 Beam UHF Satellite Launched in 1991
PAM D 2 Beam L-Band Satellite Launched in 1995

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * Space Segment (UHF Satellite) | | 28.6 | 44.3 | 20.4 | 21.3 | 29.7 | 47.9 | | | | | | | 192.2 |
| * Space Segment (L-Band Satellite) | | | | | | 33.7 | 52.7 | 25.3 | 27.1 | 36.9 | 55.5 | | | 231.2 |
| * Earth Segment | | | 10.319 | 10.319 | 10.319 | | | | | based on $30.957 in 1987 April | | | | 30.957 |
| Marketing | | | | 1.158 | 1.667 | .450 | | | | Based on $1.2M 1984/YR. | | | | 3.275 |
| Advertising and Promotion | | | | 2.084 | 3.000 | .810 | | | | Based on $2.16M 1984/YR. | | | | 5.894 |
| Business Development | | 1.336 | 1.429 | | | | | | | Based on $1.2M 1984/YR. | | | | 2.765 |
| TOTAL | | 29.936 | 56.048 | 33.961 | 36.286 | 64.660 | 100.600 | 25.300 | 27.100 | 36.900 | 55.500 | | | 466.291 |

* Includes Capitalized Engineering

## 7.2.2 OPERATING EXPENSES (ALL ALTERNATIVES)

OPERATING EXPENSES
(Current Year Dollars $MCD)
All Plans

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Space Segment O & M | | | | | | | 1.823 | 2.625 | 2.835 | 3.062 | 3.306 | 3.571 | 3.857 | 21.079 |
| Earth Segment O & M | | | | | | 1.653 | 2.204 | 2.204 | 2.204 | 2.204 | 2.204 | 2.204 | 2.204 | 17.081 |
| Space Segment G & A | | | | | | 4.223 | 5.630 | 5.630 | 5.630 | 5.630 | 5.630 | 5.630 | 5.630 | 43.633 |
| Earth Segment G & A | | | | | | 0.894 | 1.192 | 1.192 | 1.192 | 1.192 | 1.192 | 1.192 | 1.192 | 9.238 |
| Marketing | | | | | | 1.350 | 1.944 | 2.100 | 2.268 | 2.449 | 2.645 | 2.857 | 3.085 | 18.698 |
| Advertising and Promotion | | | | | | 1.463 | 2.106 | 2.275 | 2.457 | 2.653 | 2.866 | 3.095 | 3.342 | 20.257 |
| TOTAL | | | | | | 9.583 | 14.899 | 16.026 | 16.586 | 17.190 | 17.843 | 18.549 | 19.310 | 129.986 |

O & M: Operations & Maintenance

G & A: General & Administrative

7.2.3 REVENUES

- PLAN 1 L-BAND:
  - CASE 1: PAM D 2 BEAM
  - CASE 2: PAM DII 2 BEAM
  - CASE 3: PAM DII 4 BEAM

- PLAN 2 DUAL BAND:
  - CASE 1: PAM DII 2 BEAM UHF
    4 BEAM L-BAND
  - CASE 2: HS 393 2 BEAM UHF
    4 BEAM L-BAND

- PLAN 3: SEPERATE UHF & L-BAND SATELLITES, BOTH PAM D
  2 BEAMS

REVENUE
(Current Year Dollars $MCD)

Plan 1 L-Band: Case 1: PAM D 2 Beam

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baseline | | | | | | | 12.361 | 19.359 | 21.682 | 21.682 | 23.417 | 23.417 | 25.290 | 147.208 |
| Average Number of Users | | | | | | 2431 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 | 6000 |

REVENUE
(Current Year Dollars $MCD)

Plan 1 L-Band: Case 2: PAM DII 2 Beam

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baseline | | | | | | | 16.913 | 38.323 | 42.921 | 42.921 | 46.355 | 46.355 | 50.063 | 283.851 |
| Average Number of Users | | | | | | 2431 | 8509 | 13000 | 13000 | 13000 | 13000 | 13000 | 13000 | 13000 |

REVENUE
(Current Year Dollars $MCD)

Plan 1 L-Band: Case 3: PAM DII 4 Beam

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baseline | | | | | | | 16.913 | 48.047 | 72.290 | 75.889 | 81.960 | 81.960 | 88.516 | 465.575 |
| Average Number of Users | | | | | | 2431 | 8509 | 17018 | 21000 | 21000 | 21000 | 21000 | 21000 | 21000 |

REVENUE
(Current Year Dollars $MCD)

Plan 2 Dual Band: Case 1: PAM DII 2 Beam UHF, 4 Beam L-Band

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baseline | | | | | | | 16.913 | 48.047 | 87.855 | 121.731 | 140.502 | 140.502 | 151.742 | 707.292 |
| Average Number of Users | | | | | | 2431 | 8509 | 17018 | 26742 | 36000 | 36000 | 36000 | 36000 | 36000 |

REVENUE
(Current Year Dollars $MCD)

Plan 2 Dual Band: Case 2: HS 393 2 Beam UHF, 4 Beam L-Band

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baseline | | | | | | | 16.913 | 48.047 | 87.855 | 122.996 | 170.790 | 182.645 | 198.110 | 827.356 |
| Average Number of Users | | | | | | 2431 | 8509 | 17018 | 26742 | 36467 | 46191 | 47000 | 47000 | 47000 |

REVENUE

(Current Year Dollars $MCD)

Plan 3: Separate L-Band and UHF Satellites. PAM D, 2 Beam Satellites

| | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Baseline | | | | | | | 16.913 | 28.047 | 87.855 | 122.996 | 155.593 | 160.016 | 172.818 | 764.238 |
| Average Number of Users | | | | | | 2431 | 8509 | 17018 | 26742 | 36467 | 41000 | 41000 | 41000 | 41000 |

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