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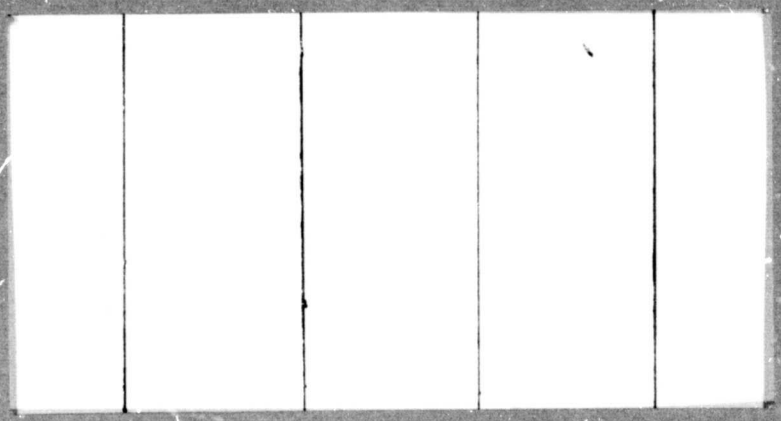

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SEASAT PROGRAMS
OPTION ANALYSIS

Prepared for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SPECIAL PROGRAMS DIVISION
OFFICE OF APPLICATIONS

Under

Contract No. NASW-2558

August 31, 1976

NOTE OF TRANSMITTAL

This analysis of the costs of alternative operational SEASAT options was performed for the Special Programs Division, Office of Applications, National Aeronautics and Space Administration, under Contract NASW-2558.

The cost data used in this analysis was provided by the Jet Propulsion Laboratory (JPL). While these costs reflect the best estimates of the alternative programs, they should be considered preliminary, and are subject to several conditions as follows:

1. TDRS operational costs are not included.

2. The space segment costs are based upon SEASAT-A experience. The data processing costs do not contain a similar experience factor.

3. All costs are in $1976, and inflation has not been considered.

4. The costs estimates were prepared for this analysis and are not programatic.

The cost data was prepared by Mr. Alan Bowman of JPL. Ms. Larrain Luckl of ECON performed the analysis described in this report.

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1. INTRODUCTION

The following is a preliminary analysis of the costs of SEASAT follow-on options. All the options assume the existence of SEASAT-A as currently defined in the SEASAT Economic Assessment, Vol. 1 (ECON, August 1975). All cost estimates included have been supplied by Jet Propulsion Laboratory (June 18, 1976, Mr. Al Bowman).

It is assumed that each option will continue through the year 2000 and approach operational system status in the 1983-1986 period, depending upon the sensor package selected. The launch vehicle assumed through 1983 is the Atlas-Agena. After 1983, it is assumed SEASAT-A will switch to the use of the Space Shuttle.

All cost estimates are 1976 dollars for fiscal year cost accounting, with no inflation rate included.

2. SEASAT PROGRAM OPTION

2.1 Option I

Option I is a back-up launch for SEASAT-A, with the launch data dependent upon the type of failure. A 1979 launch would be a no-change repeat to replace a random failure. A 1981 launch would be to replace a design related failure.

The costs for a 1979 launch, which is assumed to take place in the last quarter of fiscal year 1979, (based on SEASAT-A launch in third quarter fiscal year 1978) will be:

1. Hardware Costs of $9.2M and $21.5M during 1978, 1979 respectively
2. Launch vehicle costs of $7M will be incurred in 1979
3. Tracking costs will be $1.0M and $3.0M in 1979, 1980 respectively
4. Operating Costs will be $2.3M and $5.6M in 1979, 1980 respectively.
5. This total 1979 launch project will cost:

1978	$ 9.2M
1979	31.8
1980	8.6
Total	$49.6M

Costs for a 1981 launch will begin in 1979:

1. Hardware Costs will be $13.4M, $33.6M, $20.0M for 1979, 1980 and 1981 respectively.
2. Launch vehicle costs for 1981 will be the same as for a 1979 launch - $7.0M.
3. Tracking costs will be $1.0M, $3.0M for 1981 and 1982 respectively.
4. Operating Costs incurred in 1981 and 1982 will be $5.7M and $13.2M respectively.

5. The total 1981 launch project will cost:

1979	$13.4M
1980	33.6
1981	33.7
1982	16.2
Total	$96.9M

In both of the above cases, it is assumed that user ground data handling costs will be borne by the users in the same manner as SEASAT-A.

Table 2.1 Costs for Option I

Option 1: 1979 Launch:	1978	1979	1980	1981	1982	Total
Hardware	9.2	21.5				30.7
L/V		7.0				7.0
Tracking		1.0	3.0			4.0
Ops		2.3	5.6			7.9
Total	9.2	31.8	8.6			49.6
1981 Launch:						
Hardware		13.4	33.6	20.0		67.0
L/V				7.0		7.0
Tracking				1.0	3.0	4.0
Ops				5.7	13.2	18.9
Total		13.4	33.6	33.7	16.2	96.9

2.2 Option II

Option II would provide an improved SEASAT-A type bus with the incorporation of a Global Positioning Satellite receiver and necessary on-board computing for trajectory determination. All formatting, footprinting and processing of all data will be done on board.

There will be a development cycle every six years to upgrade the instrument and space craft technology. The first launch will occur in 1981 at a total cost of $119M. In 1984, six units plus spare parts will be purchased and three units launched. The total cost of the 1984 purchases and launches is $247.9M.

In 1987, the remaining three units purchased in 1984 will be launched incurring costs of $93.6M.

In 1990, six upgraded units, plus spare parts, will be purchased and three launched. Total costs for 1990 will be $279.2M. The remaining three units will be launched in 1993 costing the same as the 1974 launch of $93.6M.

In 1996, the same upgrade cycle as 1990 will occur in the six units being purchased, three launched in 1996. The remaining three will be launched in 1999.

The ground data system will process and distribute data (all non-SAR data in real time) to the users in a standard form with no special processing or correlations provided. Combining of data from two or more instruments in the spacecraft or other data sources will not be provided.

There will be near real-time SAR data reduction for areas in the 200-mile continental United States limit and Arctic region covered by four STDN net stations in the United States. A TDRS compatibility/capability for SAR data will be provided and used for ice or storm target areas worldwide. Data

is taken on a 10 percent duty cycle. A SAR processor is also assumed at STDN and TDRS stations.

The average cost per year for this project is $50M from 1981-1999. The total cost for 19 launches is $1206.1M.

Table 2.2 Costs for Option II

	FY 1981			FY 1984			FY 1987	FY 1990			FY 1993	FY 1996	FY 1999
	NR	R	Total	NR	R	Total		NR	R	Total			
Bus	1.7	13.3	15.0	1.7	47.6	49.3		4.1	47.6	51.7			
Sensor Module	9.8	10.7	20.5	1.5	55.6	57.1	1.3	9.8	55.6	65.4			
Subtotal	11.5	24.0	35.5	3.2	103.2	106.4	1.3	13.9	103.2	117.1			
Sensor Instruments	8.0	5.8	13.8	1.8	37.1	38.9	-	14.4	37.1	51.5	Same as 1987	Same as 1990	Same as 1987
Mission Operations and Data Handling			37.9			53.4	53.4			58.7			
Project Management			3.7			6.9	4.0			8.1			
Contingency			9.1			10.3	2.9			11.8			
Launch			7.0			15.0	15.0			15.0			
Tracking (OTDA)			12.0			17.0	17.0			17.0			
Total			119.0			247.9	93.6			279.2	93.6	279.2	93.6
													1206.1

NR = Non-recurring
R = Recurring

19 Launches
24 Years

Avg. Cost/Year: $50 M

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2.3 Option III

Option III is an improved SEASAT-A type bus, similar to Option II with additional features:

1. Power increased to 5kW
2. 00.1 A/C knowledge and control
3. 200 mb/sec data system
4. Automatic picture taking processor and transmitter
5. Advanced active and passive microwave devices in sensors.

Data processing for Option III would be expanded to cover additional satellite data and conduct theme processing to satisfy the requirements of various technologies (i.e., oceanography, fisheries, etc.). SAR processing would be expanded to cover the additional satellites. High rate data would be relayed by TDRS or communications satellites. TDRS would be used on a 20 percent duty cycle for targets of opportunity for SAR.

Launches will occur in:

One	1981
One	1984
Six	1987
Six	every third year thereafter

The 1981 launch will be approximately at the SEASAT-A level of capability for system continuity. This launch will cost $119.0M (as the 1981 launch for Option II).

In 1984, a major upgraded unit will be launched at a cost of $186.8M. In 1987, twelve buses and sensor modules will be purchased. Six of these units will be launched in 1987, the remaining six in 1990. Then, in 1993, twelve upgraded units will be purchased, six of which will be launched that

same year, and the remaining six launched in 1996. In 1999, six final upgraded units will be launched.

The total 32 launches over the 24 years average $76M/launch or $101.2M/year. The total project will cost $2492.3M.

Table 2.3 Costs for Option III

	1981			1984			1987/88			1990	1993/94			1996	1999			Total All Years
	NR	R	Total	NR	R	Total	NR	R	Total		NR	R	Total	Same as 1990	NR	R	Total	
Bus	1.7	13.3	15.0	1.7	10.3	12.0	1.7	80.9	82.6	-	4.1	80.9	85.0	-	4.1	47.6	51.7	
Sensor Module	9.8	10.7	20.5	15.9	13.5	29.4	2.0	103.6	105.6	1.8	15.9	103.6	119.5	1.8	15.9	94.5	80.4	
Subtotal	11.5	24.0	35.5	17.6	23.8	41.4	3.7	184.5	188.2	1.8	20.0	184.5	204.5	1.8	20.0	112.1	132.1	
Sensor Instruments	8.0	5.8	13.8	21.3	9.8	31.1	2.4	112.2	114.6	-	21.3	112.2	133.5	-	21.3	62.8	84.1	
Mission Operations and Data Handling			37.9		75.5				172.5	168.8		174.1	168.8					
Project Management			3.7		6.4				20.4	7.3		22.0	7.3					
Contingency			9.1		15.4				24.8	8.9		26.7	8.9					
Launch			7.0		5.0				30.0	30.0		30.0	30.0					
Tracking			12.0		12.0				19.4	19.4		19.4	19.4					
Total			119.0		186.8				569.9	236.2		610.2	236.2				168.8	2429.3

1981 cost assumed to be the same as for Option II. Cost breakdown among elements of cost might vary.

NR = Non-recurring

R = Recurring

32 Launches
24 Years

Avg. Cost/Year: $100M

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3. BENEFITS

Benefits have been calculated for an operational SEASAT program based upon a satellite capability similar to SEASAT-A, including a vertical temperature profile measurement sensor, and improved data dissemination and processing.* While a direct comparison of costs and benefits is not possible from the work performed to date, for the purpose of preliminary analysis, Option II is reasonably similar to the operational system configuration used as the basis for benefits computation, while Option III represents a capability greater than that used as the basis for benefit computations. Benefits and cost for Options II and III (at 0 percent discount) are shown in Figure 3.1.

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*SEASAT Economic Assessment, Vol. I, ECON, 1975.

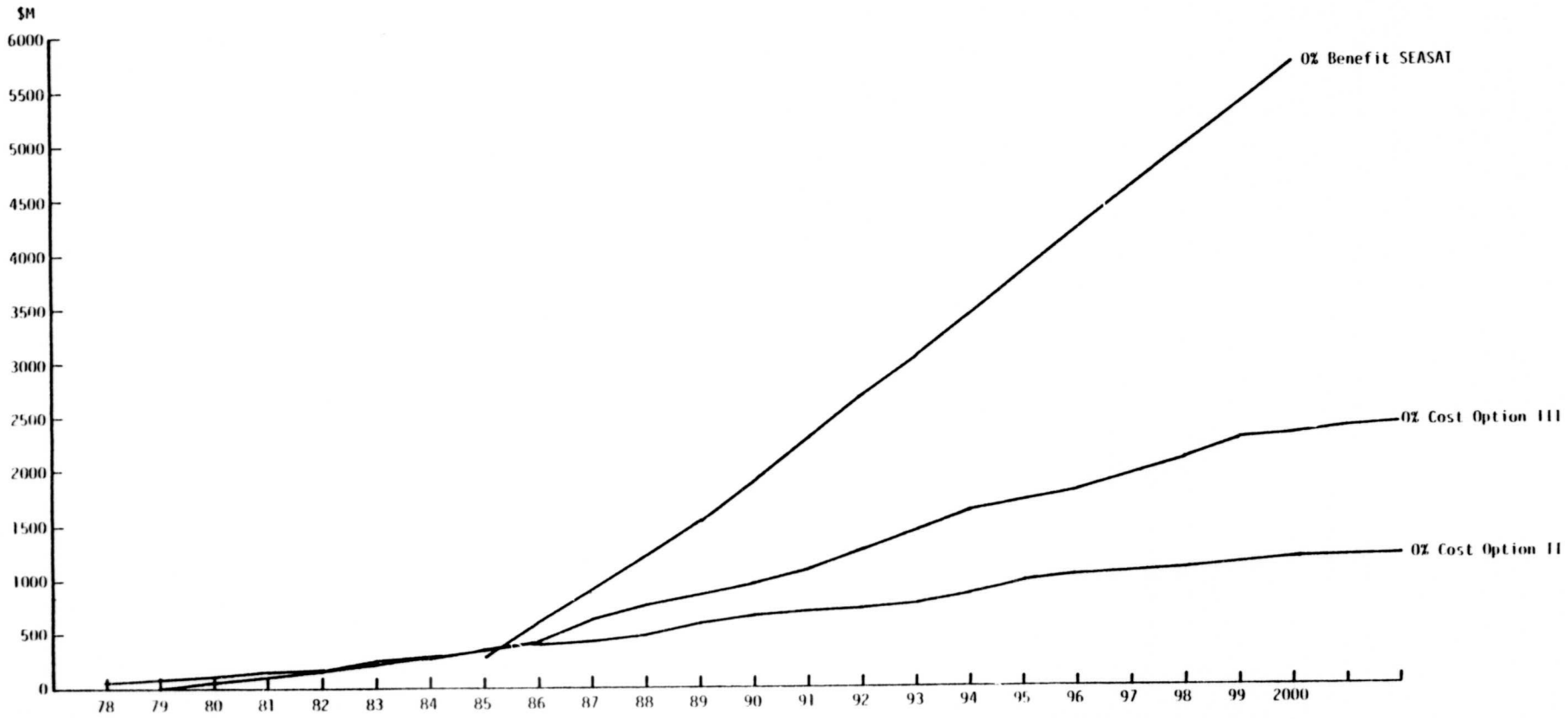

Figure 3.1 Cumulative Costs for Option II and Option III at 0 Percent Discount

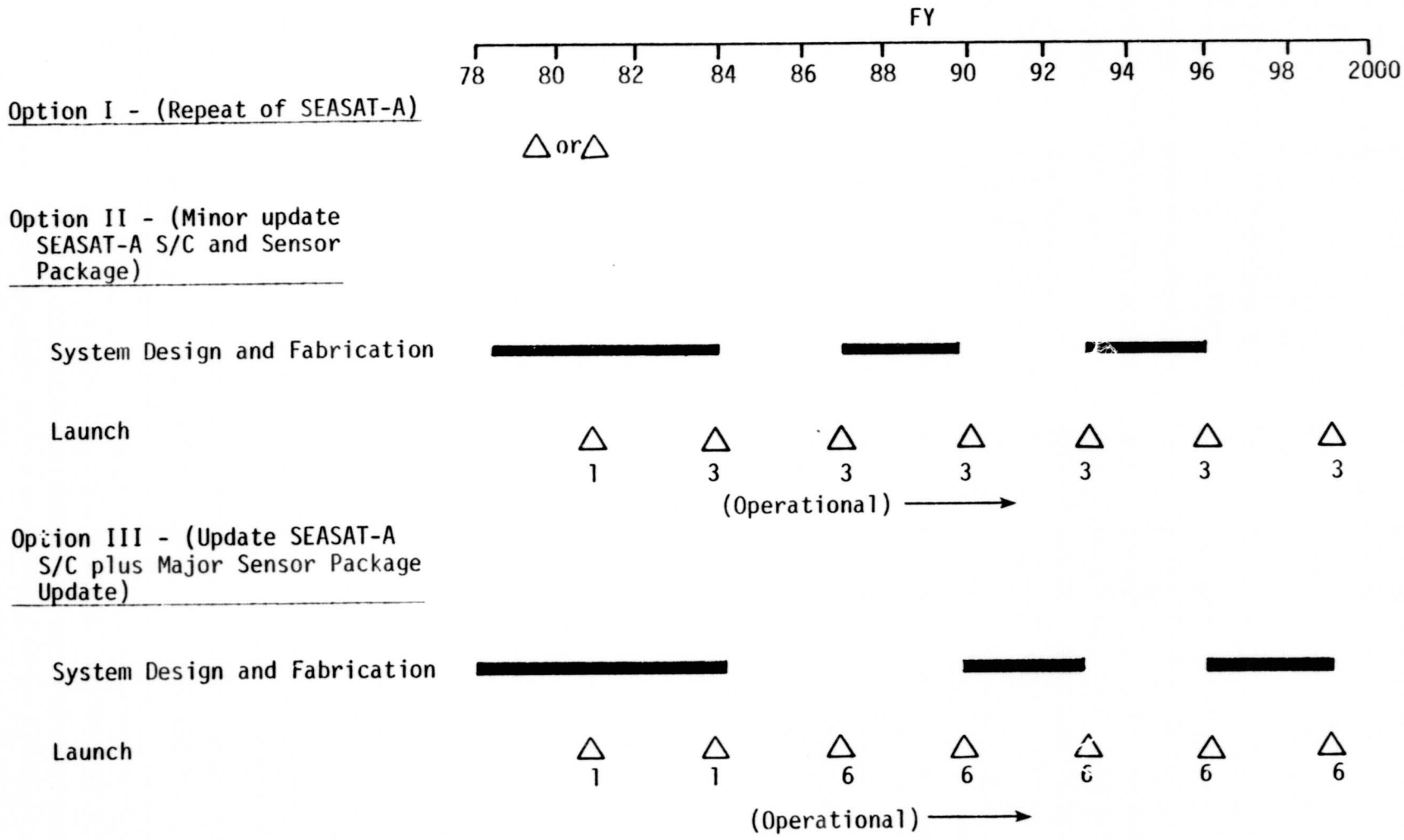

Figure 3.2 SEASAT Program Options

Table 3.1 SEASAT Program Options

	Option I		Option II		Option III	
	Launch	Buy	Launch	Buy	Launch	Buy
1978						
1979	1	1 + EU				
1980						
1981	1	1 + EU	1*	1 + EU	1	1 + EU
1982						
1983						
1984			3	6 + EU	1*	1 + EU
1985						
1986						
1987			3	-	6	12 + EU
1988						
1989						
1990			3*	6 + EU	6*	
1991						
1992						
1993			3*		6*	12 + EU
1994						
1995						
1996			3*	6 + EU	6*	
1997						
1998						
1999			3*		6*	6 + EU
2000						

EU = spare engineering units
* = upgrade