NASA TECHNICAL MEMORANDUM

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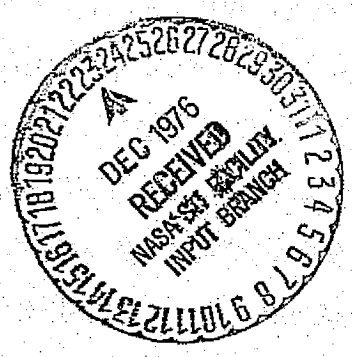
SPACELAB EXPERIMENT COMPUTER STUDY
VOL 1: Executive Summary (Presentation)

By James L. Lewis, Bobby C. Hodges, and James O. Christy
Data Systems Laboratory

April 1976



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George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

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This is Volume I of five volumes.

16. ABSTRACT

The purpose of this study was to provide a quantitative cost for various Spacelab flight hardware configurations, along with varied software development options. The three major conclusions reached as a result of this study are as follows:

1. Spacelab program cost for software development and maintenance is independent of experimental hardware and software options.

2. Distributed standard computer concept simplifies software integration without a significant increase in cost.

3. Decision on flight computer hardware configuration should not be made until payload selection for a given mission and a detailed analysis of the mission requirements are completed.

This report is published in five volumes: Volume I contains the Executive Summary (Presentation); Volume II, Study Elements and Approach; Volume III, Spacelab Cost Data; Volume IV, Spacelab User Cost Data (Central Experiment Computer); and Volume V, Spacelab User Cost Data (Distributed Computer).

This is Volume I: Executive Summary (Presentation).

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SPACELAB EXPERIMENT COMPUTER STUDY

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DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

PRESENTATION OUTLINE

STUDY DEFINITION

- OBJECTIVE
- APPROACH
- METHOD

SOFTWARE REQUIREMENTS DEVELOPMENT

COSTING

SUMMARY

EF207

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
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		DATE: APRIL 1976

OBJECTIVE OF STUDY

- TO DEFINE, VIA ANALYSIS AND TRADE STUDIES, THE MOST COST EFFECTIVE CONFIGURATION OF FLIGHT COMPUTATIONAL RESOURCES THAT WILL SATISFY SPACELAB USER REQUIREMENTS

APPROACH

- PROJECT COSTS ASSOCIATED WITH VARIOUS OPTIONS (CENTRALIZED VS. DISTRIBUTED) THAT CAN POTENTIALLY BE ADOPTED TO SATISFY THESE REQUIREMENTS

- PROJECT TOTAL COSTS ASSOCIATED WITH SOFTWARE DEVELOPMENT INCLUDING:
  - EXPERIMENT COMPUTER(S) SOFTWARE
  - SUBSYSTEM COMPUTER SOFTWARE
  - EGSE COMPUTER SOFTWARE
  - SUPPORT SOFTWARE
  - SIMULATION SOFTWARE
  - ASSOCIATED HARDWARE

FILE NO. _____

EF205

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

STUDY METHOD

- DERIVE COMPUTATION REQUIREMENTS FOR SPACELAB PAYLOAD ELEMENTS (EXPERIMENTS) BY DETAILED ANALYSIS OF THREE MISSIONS - EXTRAPOLATION TO 226 MISSIONS IN MISSION MODEL
  - SPEED
  - MEMORY - MAIN AND BULK
  - STATEMENTS TO BE CODED
- ESTIMATE SIZE OF EUROPEAN DELIVERED SOFTWARE AND THE EXPECTED CHANGE RATE
- DEFINE OPTIONS TO BE EVALUATED
- DEVELOP COMPREHENSIVE SET OF ASSUMPTIONS AND GROUND RULES
- DEFINE METHOD OF COSTING FOR EACH ELEMENT
- COMBINE COSTS TO DETERMINE YEARLY AND TOTAL COSTS
- MAINTAIN SEPARATION OF COSTS - SPACELAB AND USER
- EXAMINE MAJOR COST ELEMENTS FOR SENSITIVITY TO ASSUMPTIONS AND GROUND RULES
- MAINTAIN TRACEABILITY FOR ALL COST ELEMENTS

STUDY APPROACH

THE OVERALL APPROACH FOR SIZING EXPERIMENT APPLICATION SOFTWARE WAS TO REVIEW ALL PAYLOAD ELEMENTS CONTAINED IN THE SPACELAB MISSION MODEL (PM01, 75-253, DATED 11/75) WHICH CONSISTS OF 226 FLIGHT OF FORTY-FIVE (45) DIFFERENT MISSIONS. OF THIS TOTAL NUMBER OF MISSIONS THREE (3) WERE SELECTED FOR DETAILED ANALYSIS. THE THREE (3) SELECTED WERE MISSIONS EIGHT (8), FOURTEEN (14), and TWENTY ONE (21). FOR THESE THREE (3) THE DETAILED SOFTWARE REQUIREMENTS WERE DERIVED AT THE PAYLOAD ELEMENT FUNCTIONAL LEVEL. THE DERIVED REQUIREMENTS WERE STATED IN TERMS OF MAIN MEMORY, BULK MEMORY, AND EQUIVALENT ADDS PER SECOND, TEMPERED BY REALISTIC GROUNDRULES APPLIED TO MINIMIZE THE TOTAL SOFTWARE JOB WHILE MAXIMIZING PAYLOAD RETURN. FOR DATA LISTED IN SPDA AS TBD, ENGINEERING ESTIMATES WERE USED. MISSION TIME LINES WERE APPLIED AND REQUIREMENTS WERE SUMMED, IF APPROPRIATE. FINALLY, THE DATA GENERATED WAS EXTRAPOLATED OVER THE MISSION MODEL AND YEARLY TOTALS GENERATED FOR SOFTWARE DEVELOPMENT, MAINTENANCE, AND DISTRIBUTION.

NOTE THAT THE THREE (3) MISSIONS ANALYZED IN DETAIL WERE MADE UP OF 20 PAYLOAD ELEMENTS, NEARLY HALF OF THE TOTAL (47). THE FINAL SOFTWARE REQUIREMENTS DATA IS REFLECTED IN GENERAL DYNAMICS (CONVAIR DIVISION) REPORT "SPACELAB PAYLOADS ACCOMMODATION STUDY," DATED MARCH 5, 1976, REPORT NO. CASD-NAS76-010, CONTRACT NAS8-29462.

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PRESENTATION OUTLINE

STUDY DEFINITION

OBJECTIVE

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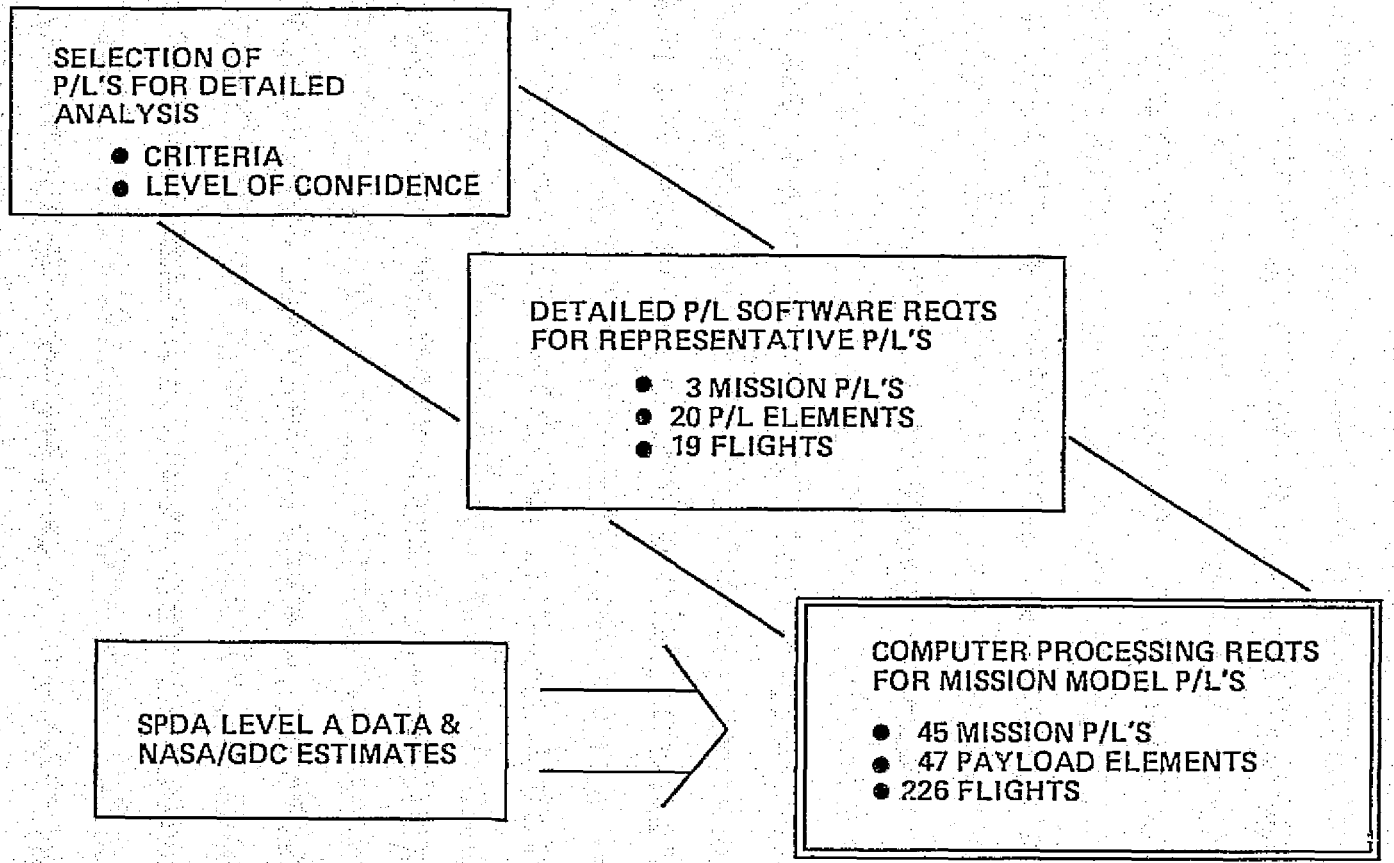
ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENTS COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

SOFTWARE REQUIREMENTS OVERALL APPROACH



SPDA: SPACE SHUTTLE PAYLOAD DATA ANALYSIS

FILE NO._____

EF203

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		DATE: APRIL 1976

SOFTWARE REQUIREMENTS STUDY GROUNDRULES

- DATA BASE USED
  - JULY 1975 SPDA LEVEL A PAYLOAD DATA
  - FOR MISSION 8, THE LEVEL 1 CONSTRAINTS FOR FIRST SPACELAB FLIGHT AND SPACELAB FIRST FLIGHT GUIDELINES - LEVEL II (BOTH DATED NOV. 1975)
  - SPACELAB MISSION MODEL (PM01) 75-253, DATED 11/75
- USE DETAILED ANALYSIS DATA (MISSIONS 8, 14, 21) TO REPLACE LEVEL A DATA FOR APPROPRIATE PAYLOAD ELEMENTS
- TALL POLES IDENTIFIED WILL BE FURTHER EVALUATED BY MSFC/GDC
- FUNCTIONS THAT CANNOT BE EFFICIENTLY HANDLED BY THE CREW MANUALLY SHALL BE CONSIDERED FOR AUTOMATION
- THE CREW SHOULD BE PROVIDED A LEVEL OF PAYLOAD CONTROL AND MONITORING THAT WILL YIELD HIGH CONFIDENCE OF PROPER EXPERIMENT OPERATION AND EXPERIMENT DATA QUALITY
- THROUGH MODEST INCREASES IN ON-BOARD PROCESSING, REAL-TIME TRANSMISSION REQUIREMENTS WILL BE MINIMIZED WHERE POSSIBLE
- PAYLOAD ELEMENT REQUIREMENTS WERE SUMMED FOR EACH MISSION IF POINTING REQUIREMENTS WERE COMPATIBLE

PAYLOADS USED FOR DETAILED ANALYSIS

MISSION 8 WAS SELECTED AT THE SPECIFIC REQUEST OF THE SPACELAB PROGRAM MANAGER. IT IS ATYPICAL SINCE IT IS THE FIRST SPACELAB FLIGHT, AND INCLUDES THE LARGEST NUMBER OF PAYLOAD ELEMENTS.

MISSIONS 14 AND 21 WERE SELECTED BECAUSE THEY REPRESENT A REASONABLE SPREAD OF REQUIREMENTS (LOW TO HIGH) AND BECAUSE GOOD DETAIL WAS AVAILABLE FROM PRIOR ANALYSES. THESE MISSIONS WERE ALSO COVERED IN THE CRAS STUDIES.

MISSIONS EXCEEDING CDMS CAPACITY

THE FIRST 3 MISSIONS, SHOWN OPPOSITE, SLIGHTLY EXCEED THE AVAILABLE OPERATIONS PER SECOND CAPACITY OF THE CENTRAL EXPERIMENT COMPUTER, WHEN THE OPERATING SYSTEM AND CONTINGENCY ARE CONSIDERED. IT WAS CONCLUDED THAT THESE 3 MISSIONS COULD BE ACCOMMODATED BY MINOR REVISION OF THE REQUIREMENT OR BY USING THE CONTINGENCY RESERVED.

THE LAST 4 MISSIONS LISTED EXCEED THE CURRENT AND ANTICIPATED STATE OF THE ART, IN TERMS OF OPERATIONS PER SECOND. IT WAS ASSUMED THAT THE FUNCTION COULD BE ACCOMPLISHED BY SPECIAL PURPOSE HARDWARE, YET TO BE DEFINED, AND THE SOFTWARE REQUIREMENTS WERE TREATED AS VALID. NO COSTS WERE INCLUDED FOR THE SPECIAL PURPOSE HARDWARE.

THE ATM/SPACELAB MISSION IS NO LONGER BEING CONSIDERED.

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SPACELAB MISSION PAYLOAD MODEL

NO. OF FLIGHTS CALENDAR YEAR

		79	80	81	82	83	84	85	86	87	88	89	90	91	
AST-10A	200 MISSION 21			1	1										2
AST-10B	200 STELLAR ASTRONOMY					1									1
AST-10C	200 STELLAR ASTRONOMY							1							1
AST-10D07X*	200 STELLAR ASTRONOMY (28.5 DEG ORBIT)						1								1
AST-10D07Y	200 STELLAR ASTRONOMY (90 DEG ORBIT)							1							1
AST-10D30X	200 STELLAR ASTRONOMY (28.5 DEG ORBIT)									1					1
AST-10D30Y	200 STELLAR ASTRONOMY (90 DEG ORBIT)											1	1		2
AST-10F	200 STELLAR ASTRONOMY								1						1
AST-10I	200 STELLAR ASTRONOMY								1						1
AST-10J	200 STELLAR ASTRONOMY									1					1
AST-10K07	200 STELLAR ASTRONOMY									1					1
AST-10K30	200 STELLAR ASTRONOMY												1	1	2
AST-10L	200 STELLAR ASTRONOMY													1	1
AST-10M	200 STELLAR ASTRONOMY											1			1
AST-11B	200 SOLAR PHYSICS				1	2	2		1						6
AST-11C07	200 SOLAR PHYSICS							1							1
AST-11C30	200 SOLAR PHYSICS								1						1
AST-11D30	200 SOLAR PHYSICS									1					1
AST-11E07	200 SOLAR PHYSICS										1		1		2
AST-11E30	200 SOLAR PHYSICS										1	1	1	1	4
LS-2A07	100 LIFE SCIENCES SHUTTLE LABORATORY (MOD 1)			2	2										4
LS-2A30	100 LIFE SCIENCES SHUTTLE LABORATORY (MOD 1)					2	2	2	2	2	2	2	2	2	18
MU-1 (A)	300 FIRST SPACELAB MISSION (MISSION 8)		1	1				1		1		1	1	1	7
MU-2 (10)	200 MULTI-USER (MISSION 10)				1	2	1	1	2	2	3	2	2	2	18
NN/D 15	200 SPACE MANUFACTURING						1	1	1	1	1			1	7
NN/D 16A X	300 EARTH OBSERVATIONS (ESA 28.5 DEG ORBIT)				1		1		1		1		1	1	6
NN/D 16A Y	300 EARTH OBSERVATIONS (ESA 90 DEG ORBIT)					1	1	1	1	1	1	1	1	1	9
NN/D 16B	200 ASTRONOMY ESA							1		1		1		1	4
OA-1A (14) X	300 MULTIDISCIPLINE APPLICATIONS (MISSN 14-55 DEG)				1					1		1	1	1	5
OA-1A (14) Y	300 MULTIDISCIPLINE APPLICATIONS (MISSN 14-90 DEG)						1		1		1	1		1	5
OA-1B X	300 GPL 1 (55 DEG ORBIT)					1					1		1	1	4
OA-1B Y	300 GPL 1 (90 DEG ORBIT)							1		1		1	1	1	5
PHY-6A + 6B	200 HIGH ENERGY (X-RAY/GAMMA RAY & COSMIC RAY SURVEY)				1	1	1	1							4
PHY-6B	200 HIGH INCLINATION COSMIC RAY SURVEY		1												1
PHY-6C + 6D	200 HIGH ENERGY (X-RAY ANGULAR STRUCT. & GAMMA RAY SURV.)					1		1		1	1		1	1	6
PHY-6E30	200 GAMMA-RAY PHOTOMETRIC STUDIES								1	1	1	1	1	1	6
PHY-7A	300 AMPS (28.5 DEG ORBIT)			1	1	1		1			1	1		1	7
PHY-7B	300 AMPS (55 DEG ORBIT)						1		1	1			1		4
PHY-7C	300 AMPS (90 DEG ORBIT)					1	1	1	1	1	1	1	1	1	9
SP-1A	300 SPACE PROCESSING LAB-MANNED & AUTOMATED (S + G + C + FP + LP + S)				1	1	1	1	1	1	1	1	1	1	10
SP-1B	200 SPACE PROCESSING PIGGYBACK 1 (AUTO. FURNACE/LFV.)				1	1	2	2	2	2	2	2	3	3	20
ST-2A	300 ADVANCED TECHNOLOGY LAB 2			1	1	1	1	1	1	1	1	1	1	1	11
ST-2B	300 ADVANCED TECHNOLOGY LAB 2					1	1	1	1	1	1	1	1	1	9
ST-2C	300 ADVANCED TECHNOLOGY LAB 3							1	1	1	1	1	1	1	8
ST-2D	300 ADVANCED TECHNOLOGY LAB 3									1	1	1	2	2	7
	TOTAL NO. OF FLIGHTS														225

100 = MODULE
200 = PALLET
300 = MODULE + PALLET

*X, Y DISTINGUISH DIFFERENT ORBITS OR MISSION DURATION FOR SAME MISSION PAYLOAD

FILE NO. _____

EF220

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

PAYLOADS USED FOR DETAILED ANALYSIS

MISSION 8 (JOINT NASA/ESA)

APE-01	LIDAR/LASER SOUNDER
AP-09-S	ELECTRON ACCELERO-METER
AP-13-S	LOW LIGHT LEVEL TV
APE-07	PASSIVE ATMOSPHERE SOUNDER
SPE-01	FREE-FLOW ELECTROPH-ORESIS FACILITY
SPE-80/85	ISOTHERMAL MULTI-HEATING FACILITY
EO-01-S	ZERO G CLOUD PHYSICS
ST-31-S	DROP DYNAMICS FACILITY
STE-10	ADVANCED HEAT PIPE
LS-13-S	LIFE SCIENCE PAYLOAD
ASE-01	WIDE-FIELD CAMERA
EOE-01	METRIC CAMERA
EO-19-S	MK II INTERFEROMETER
CN-08-S	OPEN TWT EXPERIMENTS
———	VERIFICATION FLIGHT INSTRUMENTATION

MISSION 14 (MULTIDISCIPLINE APPLICATIONS)

CN-04-S	ELECTROMAGNETIC ENVIRONMENT
CN-08-S	TWT OPEN ENVELOPE
EO-20-S	IMAGING RADAR
OP-03-S	MICROWAVE RADIO-METRY
SP-31-S	BIOLOGICAL/FURNACE SUBELEMENTS AND CORE

MISSION 21 (COMBINED STELLAR ASTRONOMY)

AS-01-S	1.5 M IR TELESCOPE
AS-04-S	1.0 M UV/OPTICAL TELESCOPE

FILE NO. _____

EF209

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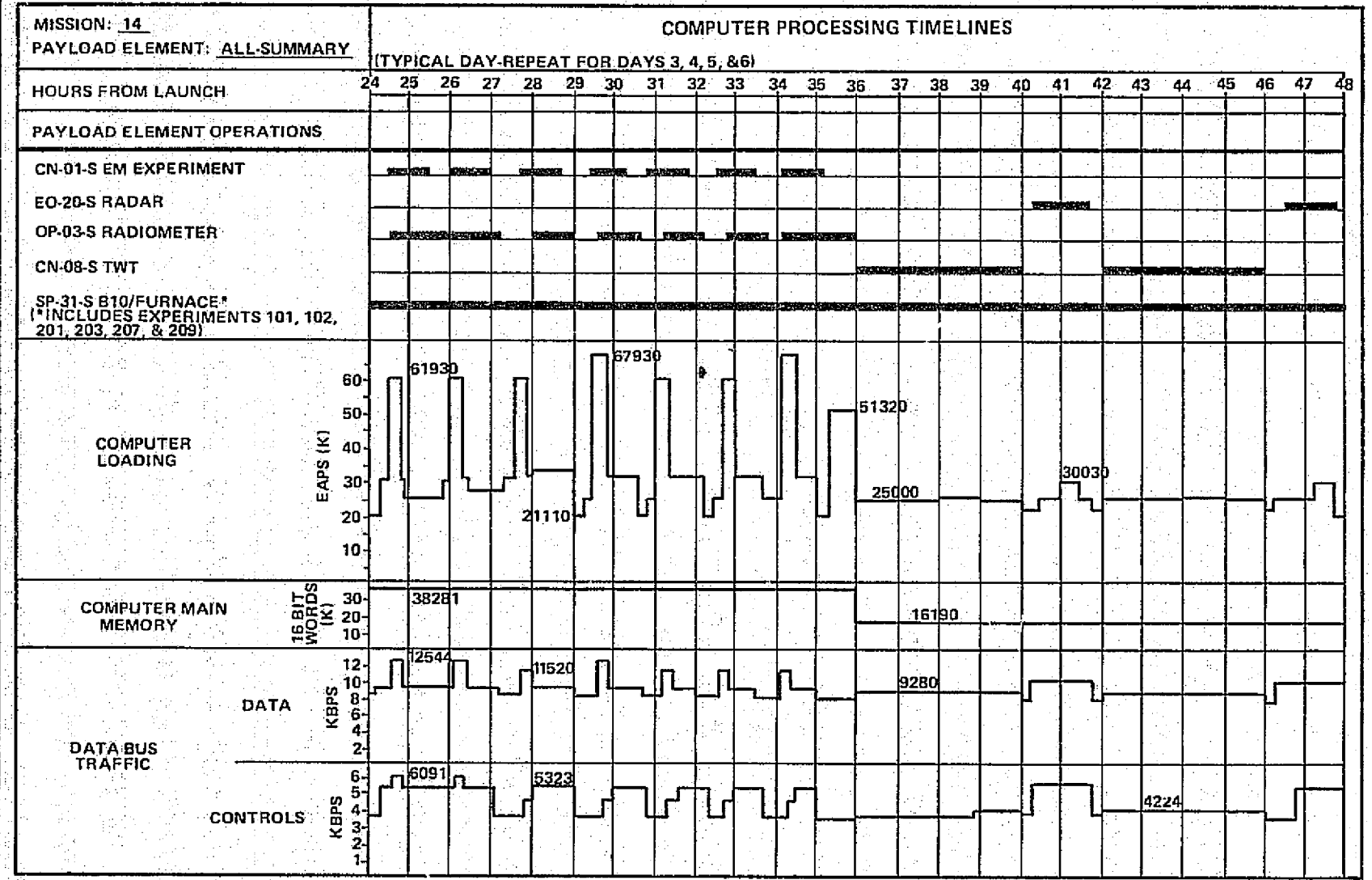
		DATE: APRIL 1976

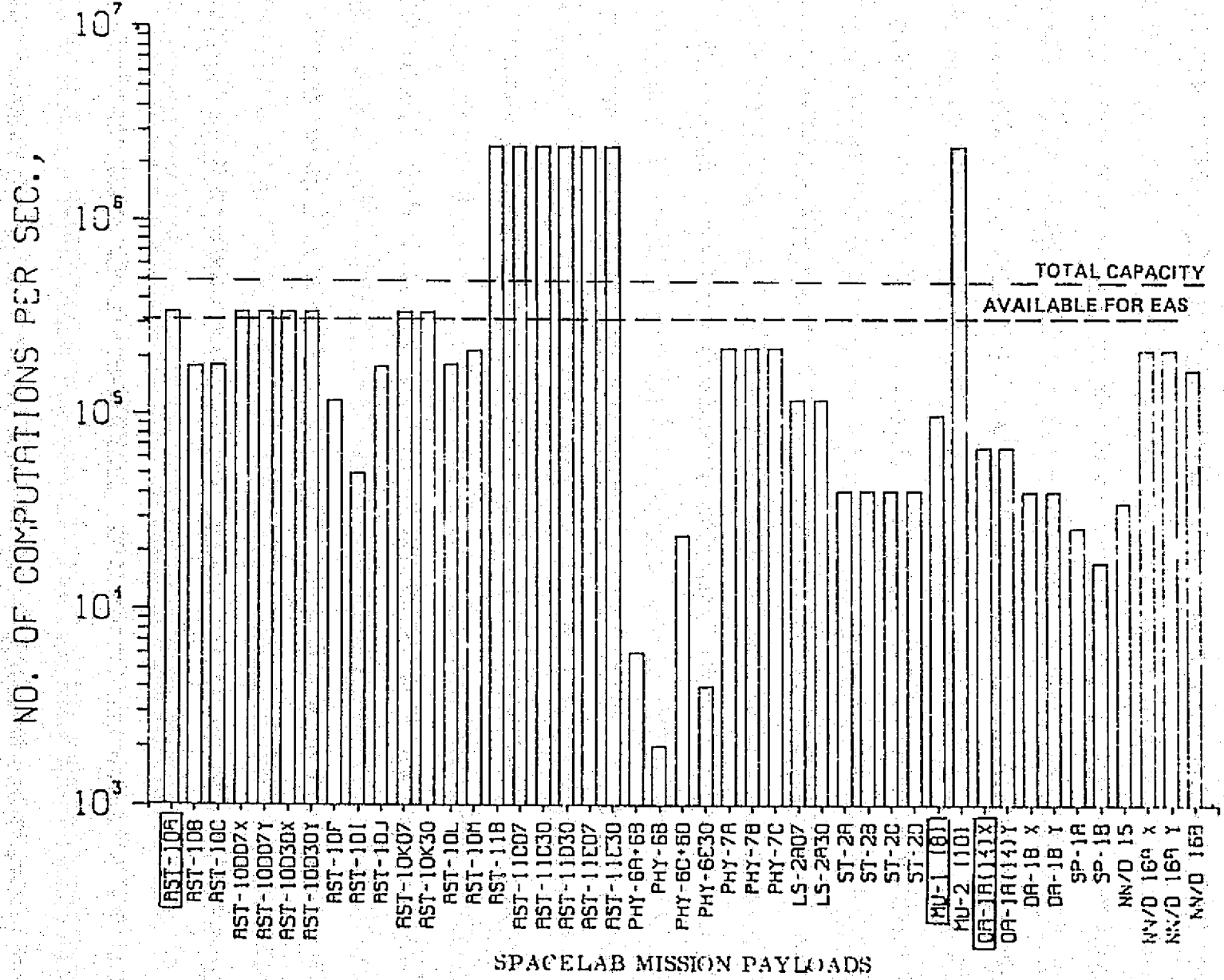
EXAMPLE INTEGRATED PAYLOAD COMPUTER PROCESSING TIMELINE



FILE NO._____

SPACELAB EXPERIMENT COMPUTER STUDY

NO. OF COMPUTATIONS PER SEC.



RAPID ACCESS MEMORY

THE AVAILABLE TOTAL RAPID ACCESS MEMORY CAPACITY, SHOWN OPPOSITE, IS THAT OF THE BASELINE SYSTEM. THE CAPACITY AVAILABLE FOR EXPERIMENT APPLICATION SOFTWARE IS LESS BECAUSE OF REQUIREMENTS FOR OPERATING SYSTEM, COMMON CENTRAL SERVICES, AND CONTINGENCY. ADDITIONAL MEMORY MODULES CAN BE ADDED WITH NO DESIGN CHANGE TO ACCOMMODATE THE INDICATED REQUIREMENTS. ESTIMATED COSTS FOR THIS WERE INCLUDED IN THE OVERALL COST ANALYSIS.

BULK MEMORY

THE BULK MEMORY CAPACITY WAS EXCEEDED BY THE SAME 7 MISSIONS WHICH EXCEEDED THE COMPUTATIONS PER SECOND CAPACITY. NO COSTS WERE INCLUDED FOR MODIFICATION ON THE BASIS THAT THESE MISSIONS WOULD EITHER BE ELIMINATED, OR THE REQUIREMENT SOLVED BY THE SPECIAL-PURPOSE HARDWARE POSTULATED EARLIER.

EF226

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MISSIONS EXCEEDING CDMS CAPACITY

	MISSION P/L	P/L ELEMENTS	P/L ELEMENT COMPS/SEC	MISSION COMPS/SEC
1.	AST 10a	1M UV TELESCOPE 1M IR TELESCOPE	167,600 178,700	346,300
2.	AST 10d	1M UV TELESCOPE 3M AMBIENT TEMP. IR TELESCOPE	167,600 180,000	347,600
3.	AST 10k	1M UV TELESCOPE 2.5M IR TELESCOPE	167,600 180,000	347,600
4.	AST 11b/c	ATM SPACELAB	2,500,000*	2,500,000
5.	AST 11d	SOLAR ACTIVITY	2,500,000*	2,500,000
6.	AST 11e	SOLAR FINE POINTING	2,500,000*	2,500,000
7.	MU–2	X–RAY ANGULAR STRUCTURE SOLAR ACTIVITY GROWTH MK. II INTERFEROMETER	20,000 2,500,000* 7,600	2,527,600

*BASED ON PROCESSING (1024 X 1024) IMAGE EVERY 10 SECONDS.

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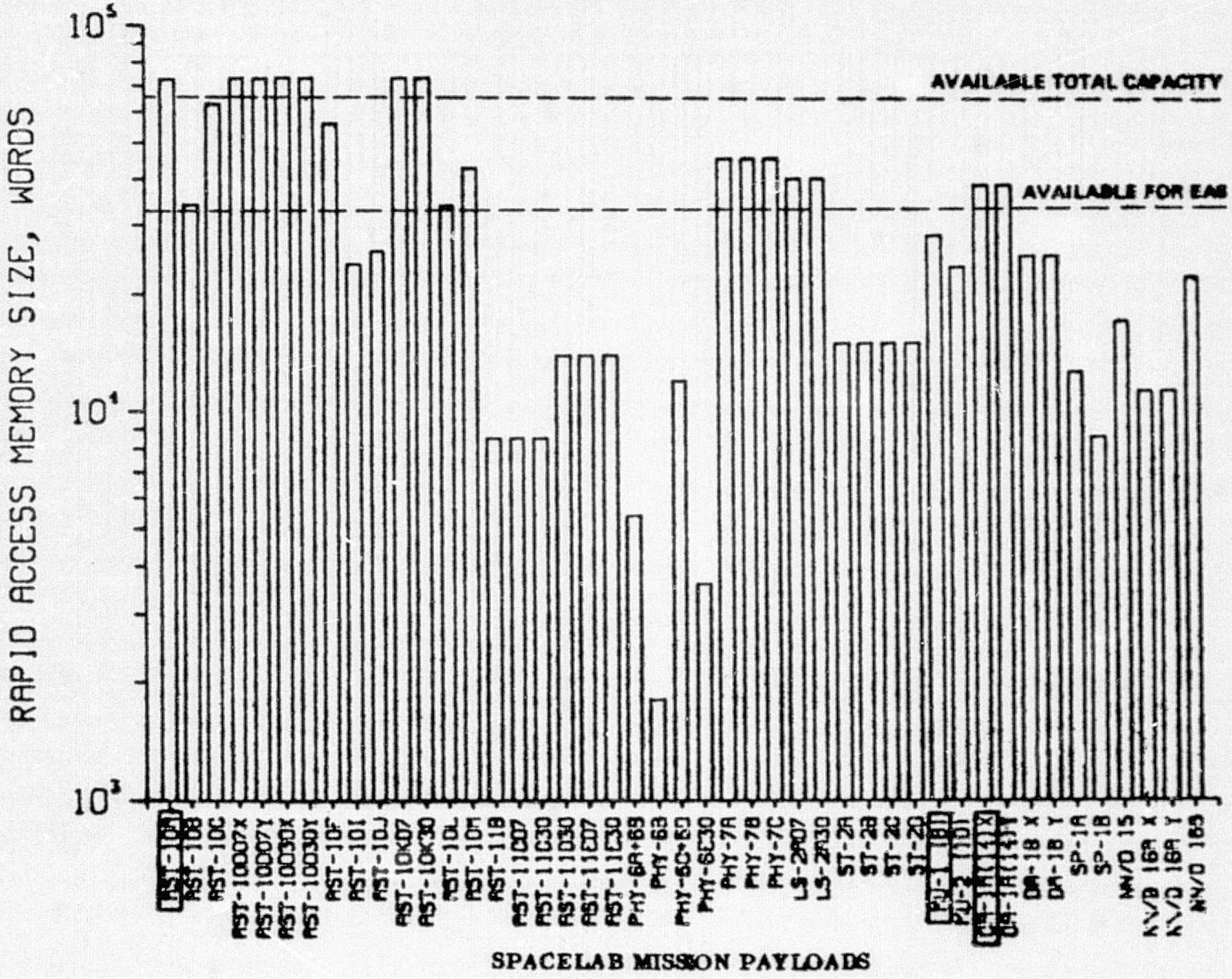
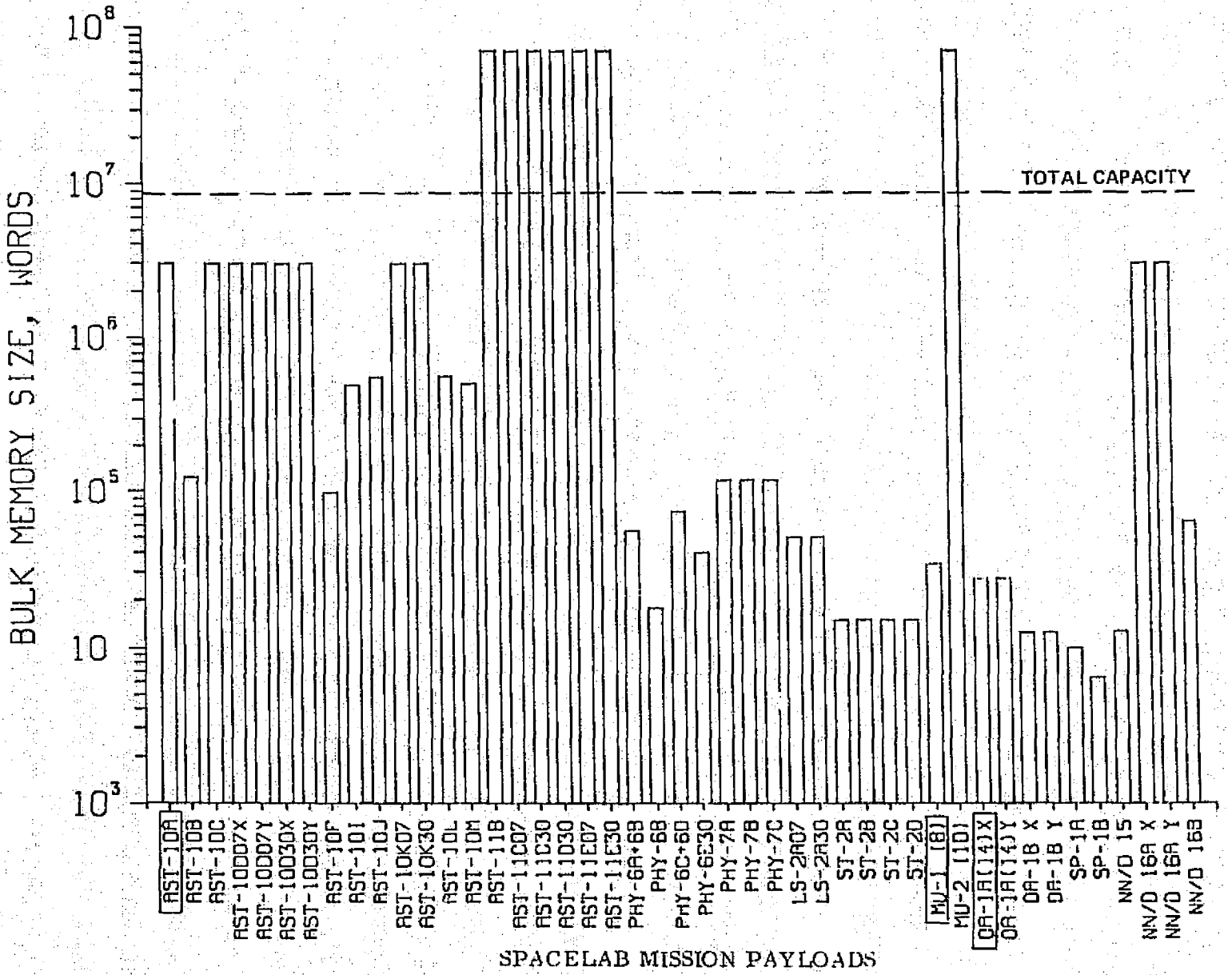
SPACELAB EXPERIMENT COMPUTER STUDY

RAPID ACCESS MEMORY



SPACELAB EXPERIMENT COMPUTER STUDY

BULK MEMORY



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ACCOMMODATION OF PAYLOAD REQUIREMENTS

- SPEED - CENTRAL EXPERIMENT COMPUTER CAN ACCOMMODATE ALL MISSIONS EXCEPT 7
  - THESE 7 HAVE STATED REQUIREMENTS THAT EXCEED STATE OF THE ART
  - MADE UP OF 4 PAYLOADS
- RAPID ACCESS MEMORY - MUST BE EXPANDED FOR SOME PAYLOADS
  - CAPABILITY INHERENT IN MACHINE - NO REDESIGN
- BULK MEMORY - CENTRAL MASS STORAGE CAN ACCOMMODATE ALL MISSIONS EXCEPT 7 (SAME 7 AS ABOVE)

COSTING APPROACH

THE COSTING APPROACH CONSISTED OF ESTABLISHING A COSTING METHOD FOR EACH COST FACTOR THAT WAS IDENTIFIED AS APPLICABLE TO THE COST ELEMENT WITHIN A GIVEN OPTION. THE COSTING METHOD EQUATION FOR EACH COST FACTOR WAS THEN APPLIED, YIELDING A RESULT IN TERMS OF: ONE TIME COST, COST PER FLIGHT, COST PER YEAR, USER COST, OR SPACELAB COST AS APPLICABLE. THIS DERIVED COST BY FACTORS WAS THEN SUMMED BY YEAR, ESCALATED, AND A TOTAL COST PER OPTION ESTABLISHED. THE TOTAL COST FOR EACH OPTION WAS THEN ANALYZED FOR SENSITIVITY TO THE COSTING RULES SUCH AS RATE OF CHANGE, COST PER STATEMENT, AND MISSION MODEL. DELTA TOTALS FOR EACH OPTION WERE DERIVED THUS GIVING VISIBILITY AS TO SENSITIVITY EFFECTS.

EF227

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
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SOFTWARE REQUIREMENTS DEVELOPMENT

COSTING

SUMMARY

OPTIONS CONSIDERED

THE TWO BASIC OPTIONS CONSIDERED FOR THIS STUDY ARE: EMPHASIS ON USE OF CENTRAL ONBOARD COMPUTING RESOURCES WITH OVERFLOW TO MINI'S, AS REQUIRED, AND EMPHASIS ON USE OF DISTRIBUTED MINI'S WITH CENTRAL RESOURCES PROVIDING STANDARD SERVICES. SUB-OPTIONS WITHIN EACH OPTION CONSIDERED SUCH ITEMS AS STANDARD MINI'S, AND VARIOUS EXPERIMENT APPLICATION SOFTWARE DEVELOPMENT OPTIONS. IN ALL, THIRTY (30) OPTIONS WERE IDENTIFIED AND A PRELIMINARY ANALYSIS MADE OF EACH. NINE (9) OF THE THIRTY (30) WERE ELIMINATED FROM FURTHER DETAIL ANALYSIS DUE TO EXCESSIVE COSTS, OR DUE TO THEIR BEING TOTALLY IMPRACTICAL TO IMPLEMENT AS WELL AS CONTAINING EXCESSIVE COST ELEMENTS. THE REMAINING TWENTY-ONE (21) WERE ANALYZED IN DETAIL AND THE RESULTS ARE INCLUDED IN VOLUME 2, BOOK 2, APPENDIX B1 THRU B30.

EF221

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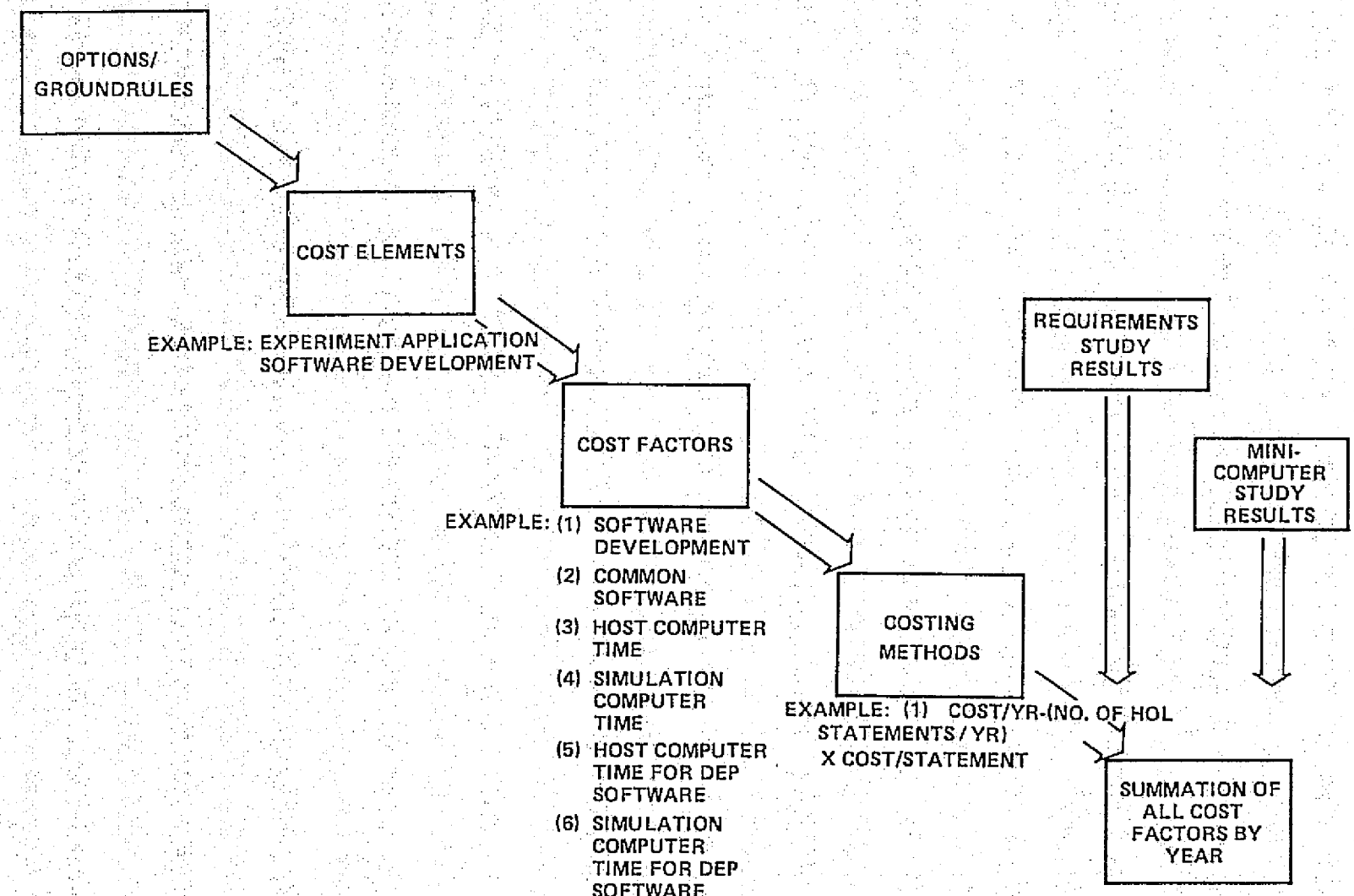
COSTING APPROACH



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EF202

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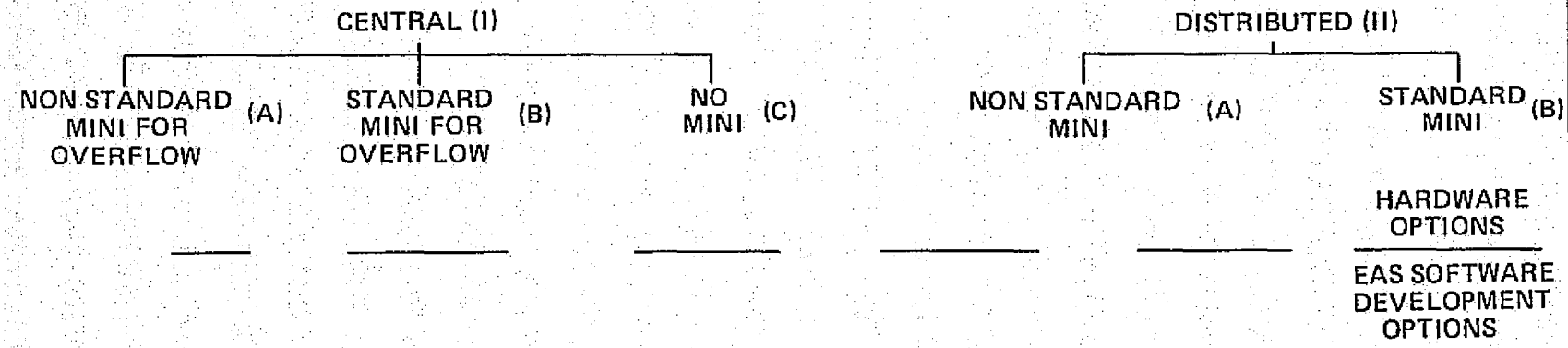
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

OPTIONS CONSIDERED



1. CENTRAL GROUP DEVELOPS EXPERIMENT APPLICATION SOFTWARE (EAS) AT CENTRAL SITE
2. PRINCIPAL INVESTIGATOR (PI) EXPERIMENT APPLICATION SOFTWARE (EAS) AT CENTRAL SITE
   - A. LOCAL TO CENTRAL SITE
   - B. UTILIZING REMOTE TERMINALS
3. PRINCIPAL INVESTIGATOR (PI) DEVELOPS EXPERIMENT APPLICATION SOFTWARE (EAS) ON HIS HOST THAT IS COMPATIBLE WITH CENTRAL SITE
   - A. ALL REALTIME SIMULATION AT CENTRAL SITE
   - B. REALTIME SIMULATION FOR DEDICATED EXPERIMENT PROCESSOR (DEP) EXPERIMENT APPLICATION SOFTWARE (EAS) ON REALTIME SIMULATION TEST SET (RTSTS) AT PRINCIPAL INVESTIGATOR (PI) FACILITY
4. PRINCIPAL INVESTIGATOR (PI) DEVELOPS EXPERIMENT APPLICATION SOFTWARE (EAS) ON HIS HOST THAT IS NOT COMPATIBLE WITH CENTRAL SITE.

FILE NO. _____

EF200

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

SPACELAB COST ELEMENTS

CDMS

- HARDWARE MODIFICATIONS
- SUBSYSTEM COMPUTER SOFTWARE DEVELOPMENT AND ACCEPTANCE
- SUBSYSTEM COMPUTER SOFTWARE MAINTENANCE
- SUBSYSTEM COMPUTER SOFTWARE CONFIGURATION MANAGEMENT, RELEASE, AND DISTRIBUTION
- EXPERIMENT COMPUTER SOFTWARE DEVELOPMENT AND ACCEPTANCE
- EXPERIMENT COMPUTER SOFTWARE MAINTENANCE
- EXPERIMENT COMPUTER SOFTWARE CONFIGURATION MANAGEMENT, RELEASE, AND DISTRIBUTIONS

EGSE

- HARDWARE MODIFICATIONS
- GROUND CHECKOUT SOFTWARE DEVELOPMENT AND ACCEPTANCE
- GROUND CHECKOUT SOFTWARE MAINTENANCE
- GROUND CHECKOUT SOFTWARE CONFIGURATION MANAGEMENT RELEASE, AND DISTRIBUTION
- EGSE COMPUTER SOFTWARE PRODUCTION SET DEVELOPMENT AND ACCEPTANCE
- EGSE COMPUTER SOFTWARE PRODUCTION SET MAINTENANCE
- EGSE COMPUTER SOFTWARE PRODUCTION SET CONFIGURATION MANAGEMENT, RELEASE, AND DISTRIBUTION

CENTRAL SITE

- FACILITY ACQUISITION
- FACILITY OPERATION AND AND MAINTENANCE
- HOST AND SIMULATION COMPUTER SUPPORT SOFTWARE DEVELOPMENT AND ACCEPTANCE
- HOST AND SIMULATION COMPUTER SUPPORT SOFTWARE MAINTENANCE

EF199

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

USER COST ELEMENTS

PI HOST COMPUTER

- HOST AND SIMULATION COMPUTER SUPPORT SOFTWARE MAINTENANCE

EXPERIMENT

- EAS DEVELOPMENT
- EAS MAINTENANCE
- EAS INTEGRATION
- EXPERIMENT PREFLIGHT CHECKOUT SOFTWARE DEVELOPMENT
- EXPERIMENT PREFLIGHT CHECKOUT SOFTWARE MAINTENANCE
- EAS DEPENDENT CENTRAL SITE HARDWARE SUPPLEMENT
- EAS DEPENDENT CENTRAL SITE SOFTWARE SUPPLEMENT
- EXPERIMENT REAL-TIME SIMULATION SOFTWARE DEVELOPMENT
- EXPERIMENT REAL-TIME SIMULATION SOFTWARE MAINTENANCE

DEP*

- EXPERIMENT PROCESSOR ACQUISITION
- EXPERIMENT PROCESSOR MAINTENANCE AND DISTRIBUTION
- DEP SOFTWARE DEVELOPMENT AND PROCUREMENT
- DEP SOFTWARE MAINTENANCE AND DISTRIBUTION

RTSTS*

- RTSTS ACQUISITION
- RTSTS MAINTENANCE, OPERATION, AND DISTRIBUTION
- RTSTS SUPPORT SOFTWARE DEVELOPMENT AND PROCUREMENT
- RTSTS SUPPORT SOFTWARE MAINTENANCE AND DISTRIBUTION

*DEP - DISTRIBUTED EXPERIMENT PROCESSOR
RTSTS - REAL-TIME SIMULATION TEST SET

FILE NO:

EF211

ORGANIZATION:

DATA SYSTEMS LABORATORY

MARSHALL SPACE FLIGHT CENTER

SPACELAB EXPERIMENT COMPUTER STUDY

NAME: J. T. POWELL

DATE: APRIL 1976

OPTION/COST ELEMENT CORRELATION MATRIX

SPACELAB COST ELEMENTS

OPTIONS			1. CDMS							2. EGSE							3. STIL			
			1.1 HARDWARE MODIFICATIONS	1.2 SUBSYSTEM COMPUTER SOFTWARE DEVELOPMENT AND ACCEPTANCE	1.3 SUBSYSTEM COMPUTER SOFTWARE MAINTENANCE	1.4 SUBSYSTEM COMPUTER SOFTWARE CONFIGURATION MANAGEMENT, RELEASE, AND DISTRIBUTION	1.5 EXPERIMENT COMPUTER SOFTWARE DEVELOPMENT AND ACCEPTANCE	1.6 EXPERIMENT COMPUTER SOFTWARE MAINTENANCE	1.7 EXPERIMENT COMPUTER SOFTWARE CONFIGURATION MANAGEMENT, RELEASE, AND DISTRIBUTION	2.1 HARDWARE MODIFICATIONS	2.2 GROUND CHECKOUT SOFTWARE DEVELOPMENT AND ACCEPTANCE	2.3 GROUND CHECKOUT SOFTWARE MAINTENANCE	2.4 GROUND CHECKOUT SOFTWARE CONFIGURATION MANAGEMENT, RELEASE, AND DISTRIBUTION	2.5 EGSE COMPUTER SOFTWARE PRODUCTION SET DEVELOPMENT AND ACCEPTANCE	2.6 EGSE COMPUTER SOFTWARE PRODUCTION SET MAINTENANCE	2.7 EGSE COMPUTER SOFTWARE PID SOFTWARE CONFIGURATION MANAGEMENT RELEASE AND DISTRIBUTION	3.1 FACILITY ACQUISITION	3.2 FACILITY OPERATION AND MAINTENANCE	3.3 HOST AND SIMULATION COMPUTER SUPPORT SOFTWARE DEVELOPMENT AND ACCEPTANCE	3.4 HOST AND SIMULATION COMPUTER SUPPORT SOFTWARE MAINTENANCE
I CENTRALIZED ONBOARD COMPUTING CONFIGURATION	A NON-STANDARD MINICOMPUTER	1 CENTRAL GROUP DEVELOPS EAS AT CENTRAL FACILITY (STIL) 2 PI DEVELOPS EAS AT CENTRAL FACILITY A LOCAL B REMOTE 3 PI DEVELOPS EAS AT HIS FACILITY WHICH IS COMPATIBLE WITH STIL A REALTIME SIMULATION @ STIL B PI USES AN RTSTS 4 PI DEVELOPS EAS AT HIS FACILITY WHICH IS NOT COMPATIBLE WITH STIL																		
	B STANDARD MINICOMPUTER	1 CENTRAL GROUP DEVELOPS EAS AT CENTRAL FACILITY (STIL) 2 PI DEVELOPS EAS AT CENTRAL FACILITY A LOCAL B REMOTE 3 PI DEVELOPS EAS AT HIS FACILITY WHICH IS COMPATIBLE WITH STIL A REALTIME SIMULATION @ STIL B PI USES AN RTSTS 4 PI DEVELOPS EAS AT HIS FACILITY WHICH IS NOT COMPATIBLE WITH STIL																		
	C NO MINICOMPUTER	1 CENTRAL GROUP DEVELOPS EAS AT CENTRAL FACILITY (STIL) 2 PI DEVELOPS EAS AT CENTRAL FACILITY A LOCAL B REMOTE 3 PI DEVELOPS EAS AT HIS FACILITY WHICH IS COMPATIBLE WITH STIL A REALTIME SIMULATION @ STIL B PI USES AN RTSTS 4 PI DEVELOPS EAS AT HIS FACILITY WHICH IS NOT COMPATIBLE WITH STIL																		
II DISTRIBUTED ONBOARD COMPUTING CONFIGURATION	A NON STANDARD MINICOMPUTER	1 CENTRAL GROUP DEVELOPS EAS AT CENTRAL FACILITY (STIL) 2 PI DEVELOPS EAS AT CENTRAL FACILITY A LOCAL B REMOTE 3 PI DEVELOPS EAS AT HIS FACILITY WHICH IS COMPATIBLE WITH STIL A REALTIME SIMULATION @ STIL B PI USES AN RTSTS 4 PI DEVELOPS EAS AT HIS FACILITY WHICH IS NOT COMPATIBLE WITH STIL																		
	B STANDARD MINICOMPUTER	1 CENTRAL GROUP DEVELOPS EAS AT CENTRAL FACILITY (STIL) 2 PI DEVELOPS EAS AT CENTRAL FACILITY A LOCAL B REMOTE 3 PI DEVELOPS EAS AT HIS FACILITY WHICH IS COMPATIBLE WITH STIL A REALTIME SIMULATION @ STIL B PI USES AN RTSTS 4 PI DEVELOPS EAS AT HIS FACILITY WHICH IS NOT COMPATIBLE WITH STIL																		

FILE NO.

EF210

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

OPTION/COST ELEMENT CORRELATION MATRIX

SPACELAB USER COST ELEMENTS

4. EXPERIMENT | 5. DEP | 6. RTSTS

OPTIONS			4.1 EXPERIMENT APPLICATION SOFTWARE DEVELOPMENT	4.2 EXPERIMENT APPLICATION SOFTWARE MAINTENANCE	4.3 EXPERIMENT APPLICATION SOFTWARE VERIFICATION INTEGRATED	4.4 EXPERIMENT PRELIGHT CHECKOUT SOFTWARE DEVELOPMENT	4.5 EXPERIMENT PRELIGHT CHECKOUT SOFTWARE MAINTENANCE	4.6 EAS DEPENDENT STIL SOFTWARE SUPPLEMENT	4.7 EAS DEPENDENT STIL SOFTWARE SUPPLEMENT	4.8 EXPERIMENT REAL TIME SIMULATION SOFTWARE DEVELOPMENT	4.9 EXPERIMENT REAL TIME SIMULATION SOFTWARE MAINTENANCE	5.1 EXPERIMENT PROCESSOR ACQUISITION	5.2 EXPERIMENT PROCESSOR MAINTENANCE & DISTRIBUTION	5.3 DEP SOFTWARE DEVELOPMENT & PROCUREMENT	5.4 DEP SOFTWARE MAINTENANCE & DISTRIBUTION	6.1 RTSTS ACQUISITION	6.2 RTSTS MAINTENANCE, OPERATION & DISTRIBU TION	6.3 RTSTS SUPPORT SOFTWARE DEVELOPMENT & PROCUREMENT	6.4 RTSTS SUPPORT SOFTWARE MAINTENANCE & DISTRIBUTION	PI HOST COMPUTER SOFTWARE
I CENTRALIZED ONBOARD COMPUTING CONFIGURATION	A NON STANDARD MINICOMPUTER	1. CENTRAL GROUP DEVELOPS EAS AT CENTRAL FACILITY (STIL). 2. PI DEVELOPS EAS AT CENTRAL FACILITY. A. LOCAL. B. REMOTE. 3. PI DEVELOPS EAS AT HIS FACILITY WHICH IS COMPATIBLE WITH STIL. A. REAL TIME SIMULATION @ STIL. B. PI USES AN RTSTS. 4. PI DEVELOPS EAS AT HIS FACILITY WHICH IS NOT COMPATIBLE WITH STIL.																		
	B STANDARD MINICOMPUTER	1. CENTRAL GROUP DEVELOPS EAS AT CENTRAL FACILITY (STIL). 2. PI DEVELOPS EAS AT CENTRAL FACILITY. A. LOCAL. B. REMOTE. 3. PI DEVELOPS EAS AT HIS FACILITY WHICH IS COMPATIBLE WITH STIL. A. REAL TIME SIMULATION @ STIL. B. PI USES AN RTSTS. 4. PI DEVELOPS EAS AT HIS FACILITY WHICH IS NOT COMPATIBLE WITH STIL.																		
	C NO MINICOMPUTER	1. CENTRAL GROUP DEVELOPS EAS AT CENTRAL FACILITY (STIL). 2. PI DEVELOPS EAS AT CENTRAL FACILITY. A. LOCAL. B. REMOTE. 3. PI DEVELOPS EAS AT HIS FACILITY WHICH IS COMPATIBLE WITH STIL. A. REAL TIME SIMULATION @ STIL. B. PI USES AN RTSTS. 4. PI DEVELOPS EAS AT HIS FACILITY WHICH IS NOT COMPATIBLE WITH STIL.																		
II DISTRIBUTED ONBOARD COMPUTING CONFIGURATION	A NON STANDARD MINICOMPUTER	1. CENTRAL GROUP DEVELOPS EAS AT CENTRAL FACILITY (STIL). 2. PI DEVELOPS EAS AT CENTRAL FACILITY. A. LOCAL. B. REMOTE. 3. PI DEVELOPS EAS AT HIS FACILITY WHICH IS COMPATIBLE WITH STIL. A. REAL TIME SIMULATION @ STIL. B. PI USES AN RTSTS. 4. PI DEVELOPS EAS AT HIS FACILITY WHICH IS NOT COMPATIBLE WITH STIL.																		
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FILE NO. _____

EF201

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

MAJOR COSTING RULES

- EXPERIMENT APPLICATION SOFTWARE CHANGE RATE:

40%	FIRST REFLY
30%	SECOND REFLY
20%	THIRD REFLY
10%	EACH SUCCEEDING REFLY

- EGSE SOFTWARE CHANGE RATE:

5%	EACH NEW FLIGHT
1%	EACH REFLIGHT

- SUBSYSTEM COMPUTER SOFTWARE CHANGE RATE:

5%	PER FLIGHT FOR 1ST THREE YEARS
10%	PER YEAR THEREAFTER

- ALL COSTS ESCALATED - 7% PER YEAR, COMPOUNDED ANNUALLY
- COST PER HIGHER ORDER LANGUAGE STATEMENT FOR EAS:

REQUIREMENTS ANALYSIS	$ 15.00
DESIGN, CODE. VERIFICATION	$ 30.00
	$ 45.00

- COST PER STATEMENT FOR INTEGRATION AND VERIFICATION IF IN CENTRAL COMPUTER (NOT APPLICABLE TO EAS IN DISTRIBUTED COMPUTER OPTIONS) $ 15.00
- COST PER CHECKOUT STATEMENT $ 30.00
- COST PER ASSEMBLY LANGUAGE INSTRUCTION $100.00
- ONE HIGHER ORDER LANGUAGE STATEMENT, WHEN COMPILED, RESULTS IN FIVE COMPUTER INSTRUCTIONS
- ONE MAN-YEAR OF EFFORT IS EQUIVALENT TO $50,000 IN 1976

FILE NO. _____

SPACELAB AND USER COST

THE TOTAL SPACELAB AND USER COSTS ARE SHOWN TO INDICATE DELTA COSTS BETWEEN OPTIONS. OPTION IIA4 IS SHOWN FOR COMPARISON AND IS AN INDICATOR OF THE HIGH COSTS ASSOCIATED WITH OPTIONS IA4, IB4, IC3B, IC4, IIA1, IIA2A, IIA2B, IIA3A, AND IIA3B WHICH ARE NOT INCLUDED.

EF198

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

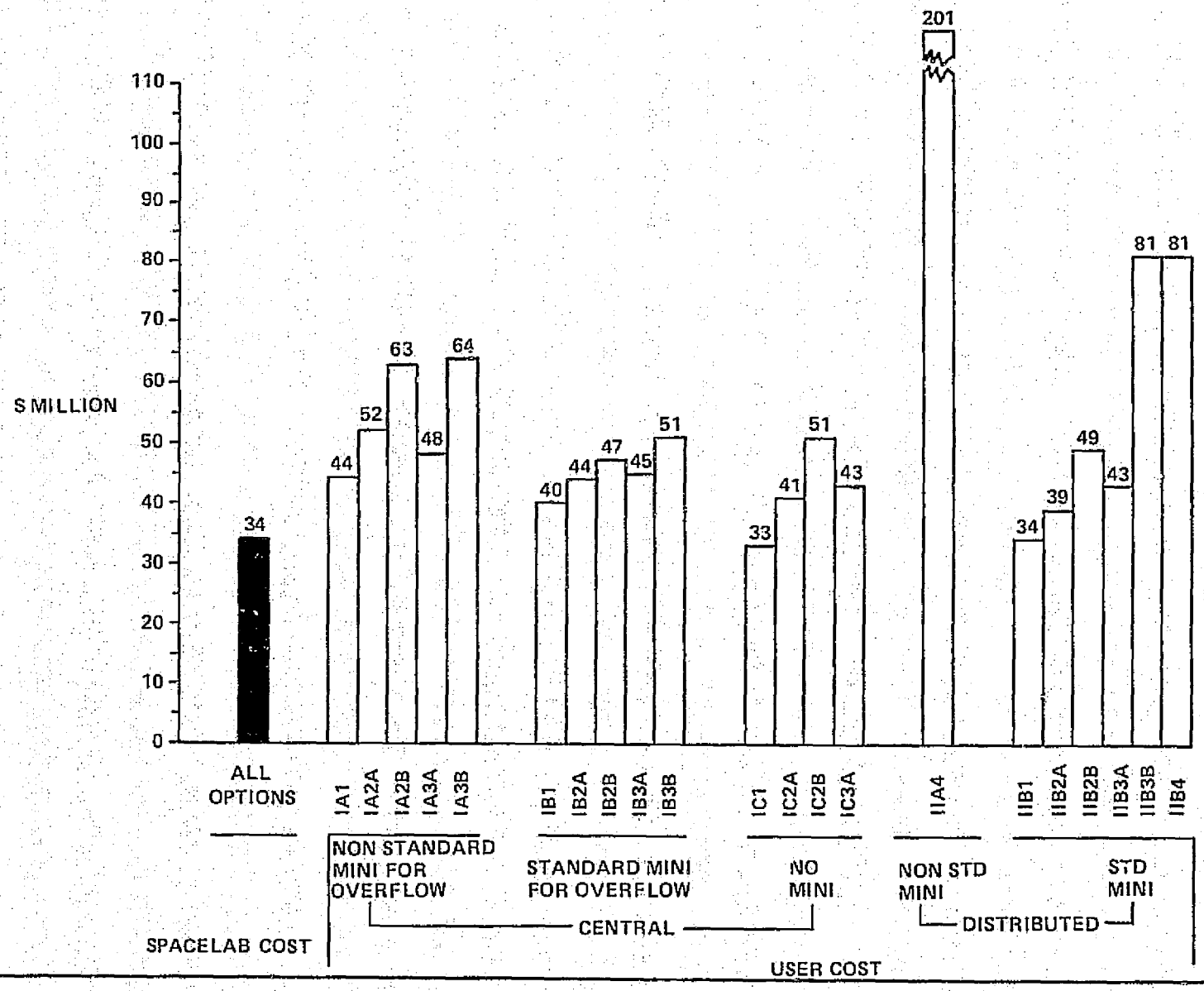
STATEMENTS TO BE CODED OPTION 11B2A

COST ELEMENT	FY77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
EAS DEVELOPMENT	-	-	-	4940	14596	8282	1240	3937	0	5183	4526	868	1550	-	-
EAS MAINTENANCE	-	-	-	-	3371	4443	7956	5344	7793	3969	5750	5618	5892	7877	7229
PREFLIGHT CHECKOUT S/W DEV	-	-	-	13020	4650	13950	3720	1860	0	2790	2790	930	930	-	
PREFLIGHT CHECKOUT S/W MAINT		-	-	-	1302	558	2232	3511	4092	2790	4650	3627	4929	5022	5952
EXP. REAL-TIME SIMULATION S/W DEV	-	-	-	19600	7000	21000	5600	2800	0	4200	4200	1400	1400	-	-
EXP. REAL TIME SIMULATION S/W MAINT	-	-		-	1960	840	3360	3780	6160	4200	7000	5460	7420	7560	8960
DEP. OP. SYS. DEV	-	-	-	800	-	-	-	-	-	-	-	-		-	-
DEP. OP. SYS. MAINT	-	-	-	-	40	40	40	40	40	40	40	40	40	40	40
STATEMENTS TOTAL	—	-	—	38360	32919	49113	24148	20272	18085	23172	28956	17945	22161	20499	22181

FILE NO. _____

EF194

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976



MSFC - Form 3304 (Rev October 1972)

FILE NO. ___ ___

SENSITIVITY TO COST PER STATEMENT

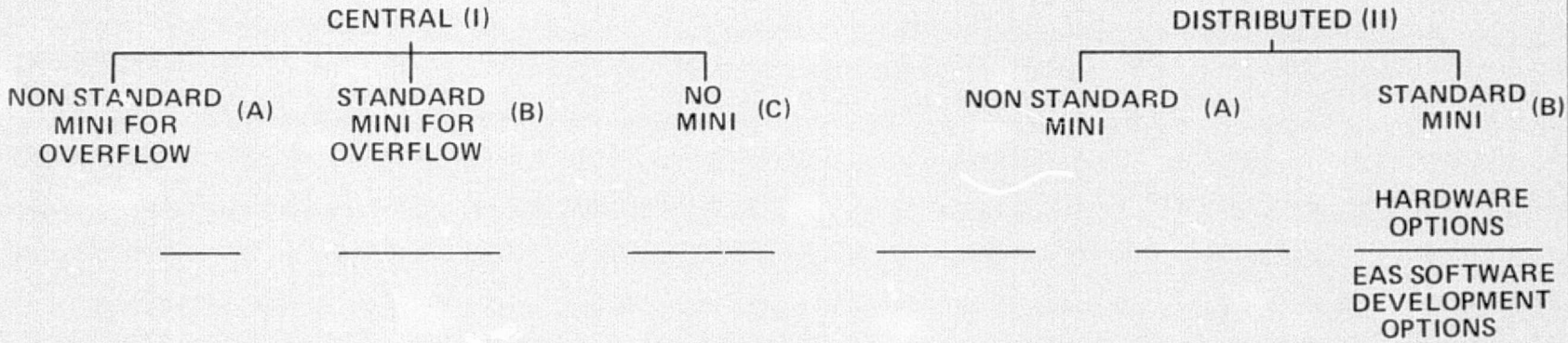
AN ANALYSIS OF SENSITIVITY TO COST PER STATEMENT WAS EXERCISED FOR EACH OPTION USING, AS A BASE, 50% OF THE ORIGINAL ESTIMATED COST PER INSTRUCTION OR LANGUAGE STATEMENT AS APPLICABLE. THE RESULTING DELTA COSTS FOR COMPARABLE USER OPTIONS AS WELL AS SPACELAB DELTA COSTS ARE SHOWN. DELTA COSTS FOR ALL OPTIONS DUE TO COST PER STATEMENT SENSITIVITY ARE INCLUDED IN VOLUME 1, EXECUTIVE SUMMARY.

ALSO SHOWN, ON OPTION IIA4, IS THE EFFECT OF PARTIAL STANDARDIZATION OF MINICOMPUTERS; i.e., EACH OF 12 DISCIPLINES WOULD USE THE SAME TYPE OF COMPUTER.

EF202

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

OPTIONS CONSIDERED



1. CENTRAL GROUP DEVELOPS EXPERIMENT APPLICATION SOFTWARE (EAS) AT CENTRAL SITE
2. PRINCIPAL INVESTIGATOR (PI) EXPERIMENT APPLICATION SOFTWARE (EAS) AT CENTRAL SITE
   - A. LOCAL TO CENTRAL SITE
   - B. UTILIZING REMOTE TERMINALS
3. PRINCIPAL INVESTIGATOR (PI) DEVELOPS EXPERIMENT APPLICATION SOFTWARE (EAS) ON HIS HOST THAT IS COMPATIBLE WITH CENTRAL SITE
   - A. ALL REALTIME SIMULATION AT CENTRAL SITE
   - B. REALTIME SIMULATION FOR DEDICATED EXPERIMENT PROCESSOR (DEP) EXPERIMENT APPLICATION SOFTWARE (EAS) ON REALTIME SIMULATION TEST SET (RTSTS) AT PRINCIPAL INVESTIGATOR (PI) FACILITY
4. PRINCIPAL INVESTIGATOR (PI) DEVELOPS EXPERIMENT APPLICATION SOFTWARE (EAS) ON HIS HOST THAT IS NOT COMPATIBLE WITH CENTRAL SITE.

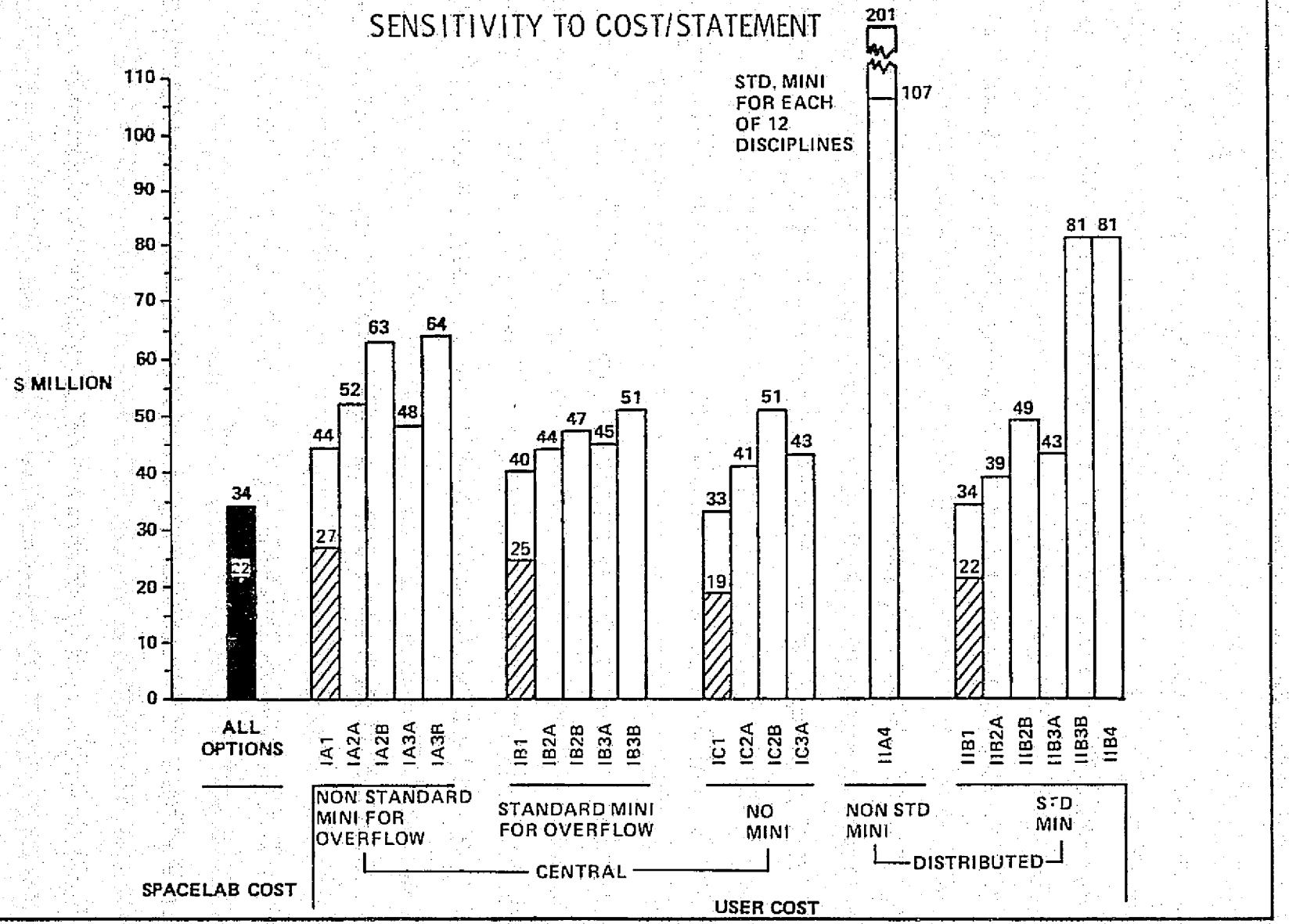
SENSITIVITY TO MISSION RATE

IN ORDER TO INDICATE THE SENSITIVITY TO MISSION RATE AN EXERCISE WAS CONDUCTED USING A TWELVE (12) YEAR MISSION MODEL CONSISTING OF SEVENTY-SEVEN (77) TOTAL FLIGHTS. DELTA COSTS FOR THIS REDUCED MISSION MODEL ARE SHOWN FOR SPACELAB COST AND USER COSTS FOR SIX (6) COMPARABLE OPTIONS.

EF 215

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME / DATE
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL APRIL 1976

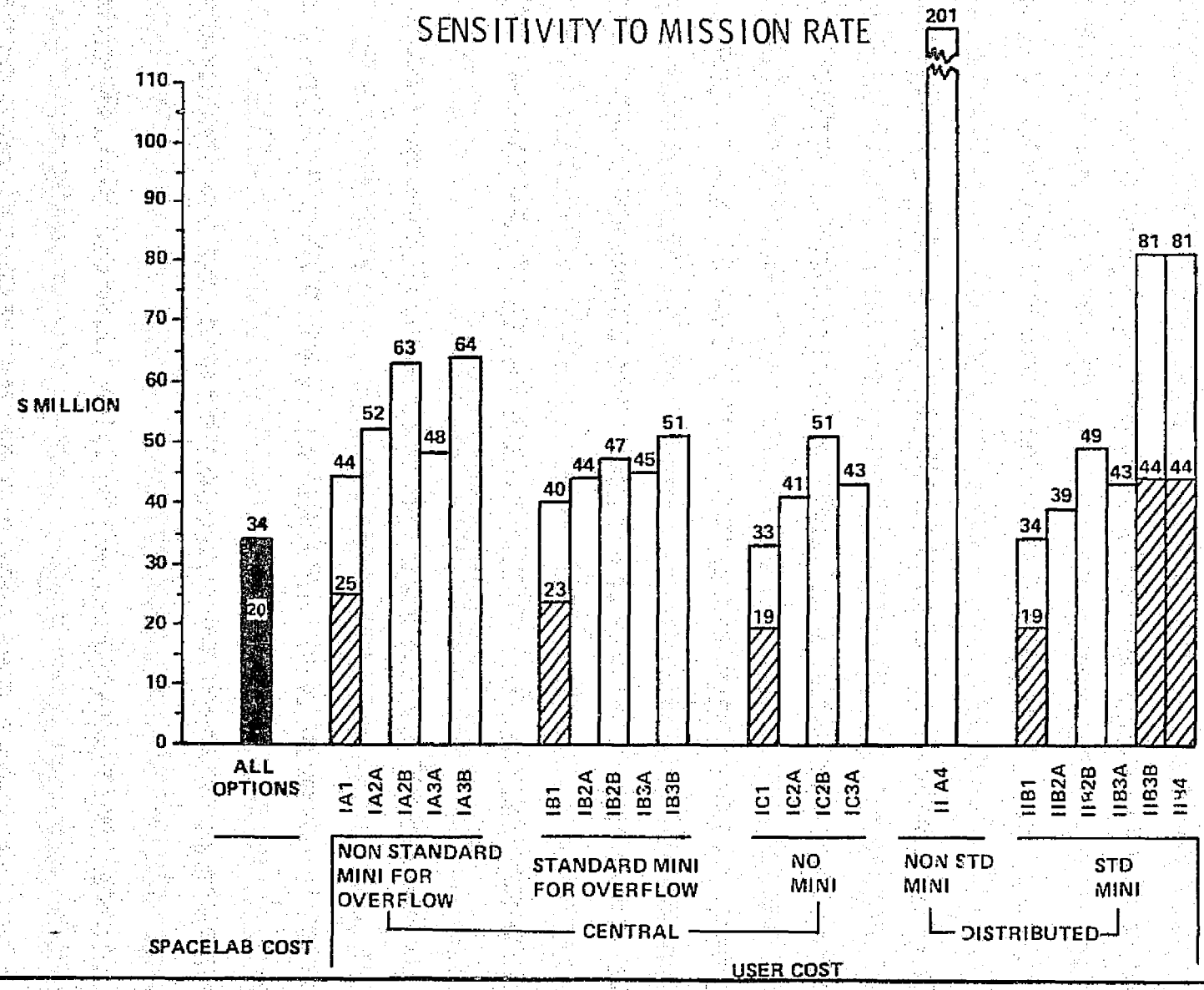
SENSITIVITY TO COST/STATEMENT



FF-216

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

SENSITIVITY TO MISSION RATE



ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

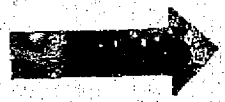
PRESENTATION OUTLINE

STUDY DEFINITION

- OBJECTIVE
- APPROACH
- METHOD

SOFTWARE REQUIREMENTS DEVELOPMENT

COSTING



SUMMARY

EF229

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

SUMMARY

- SPACELAB SOFTWARE DEVELOPMENT AND MAINTENANCE COST IS INDEPENDENT OF OPTIONS
- COST IS NOT A SIGNIFICANT DRIVER BETWEEN CENTRAL AND DISTRIBUTED COMPUTER CONFIGURATIONS
- DISTRIBUTED COMPUTER CONCEPT SIMPLIFIES INTEGRATION WITHOUT SIGNIFICANT COST INCREASE
- STANDARD MINI HAS COST ADVANTAGES WHEN DEDICATED EXPERIMENT PROCESSOR IS SELECTED
- CENTRALIZED EXPERIMENT APPLICATION SOFTWARE DEVELOPMENT IS LEAST COST FOR ALL HARDWARE CONFIGURATIONS
- DECISION ON CENTRAL OR DEDICATED EXPERIMENT PROCESSOR SHOULD BE BASED ON ANALYSIS OF EACH MISSION REQUIREMENTS AFTER FINAL PAYLOAD SELECTION

EF195

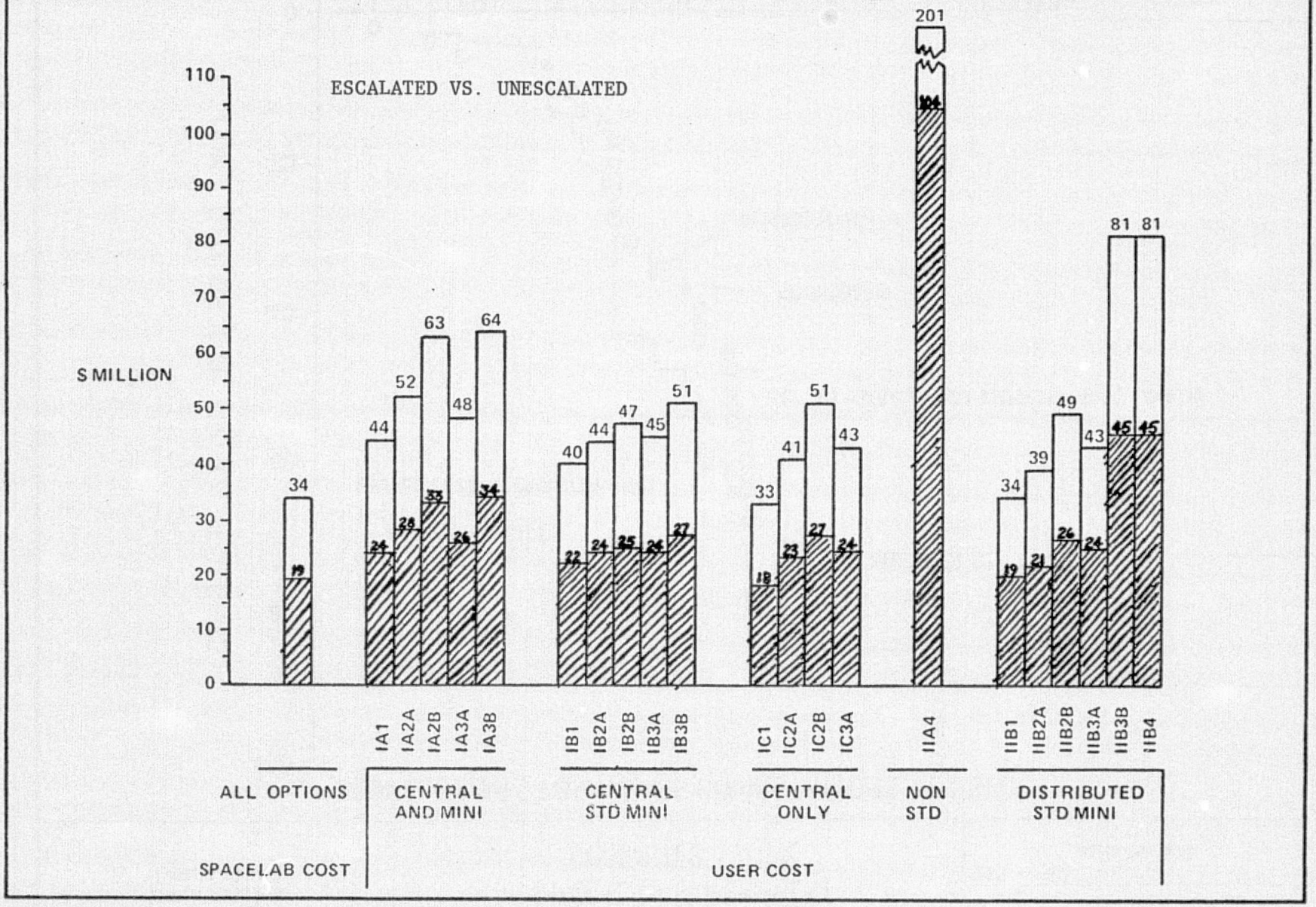
ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: MARCH 1976

ASSUMED CDMS FUNCTIONAL CAPABILITIES

- CRT HAS REFRESH CAPABILITY
- SYSTEM SOFTWARE ACCEPTS & ACCUMULATES CONTROL DATA VIA KEYBOARD ENTRY
- SPACELAB PROVIDES CAPABILITY TO INITIATE AND SCHEDULE P/L APPLICATION SOFTWARE AT DISCRETE MISSION ELAPSED TIMES
- SPACELAB PROVIDES TRANSFER OF TIME AND STATE VECTORS FROM ORBITER TO EXPERIMENT COMPUTER
- P/L APPLICATION SOFTWARE NOT REQUIRED TO SCHEDULE AND CONTROL SPACELAB MAGNETIC RECORDERS
- SPACELAB PROVIDES TRANSFER OF UPLINK COMMANDS FROM ORBITER TO EXPERIMENT COMPUTER
- SPACELAB PROVIDES FOR INPUT OF HIGH RATE P/L DATA TO EXPERIMENT COMPUTER
- SPACELAB TRANSFERS IPS STATE VECTORS FROM SPACELAB SUBSYSTEM COMPUTER TO EXPERIMENT COMPUTER
- ALL APPLICATION PROGRAMS, DATA CONSTANTS AND DISPLAY FORMATS STORED IN BULK MEMORY
- ALL APPLICATION PROGRAMS DATA CONSTANTS, DISPLAY FORMATS AND BUFFER DATA MEMORY FOR ACTIVE PROGRAMS ARE INCLUDED IN THE ESTIMATE OF RAPID ACCESS MEMORY

EF194

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: MARCH 1976

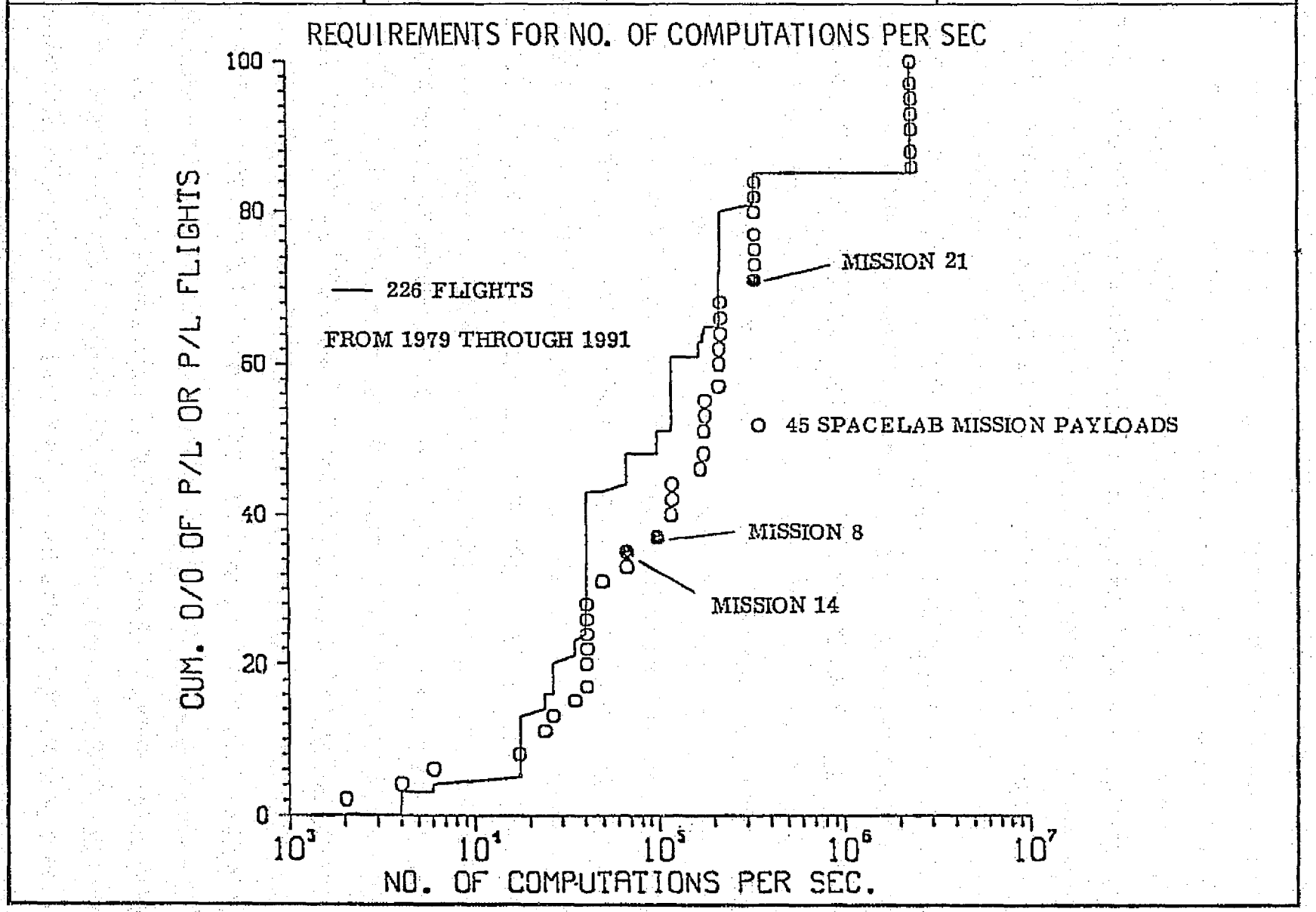


MSFC Form 3304 (Rev October 1972)

FILE NO

EF212

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: MARCH 1976

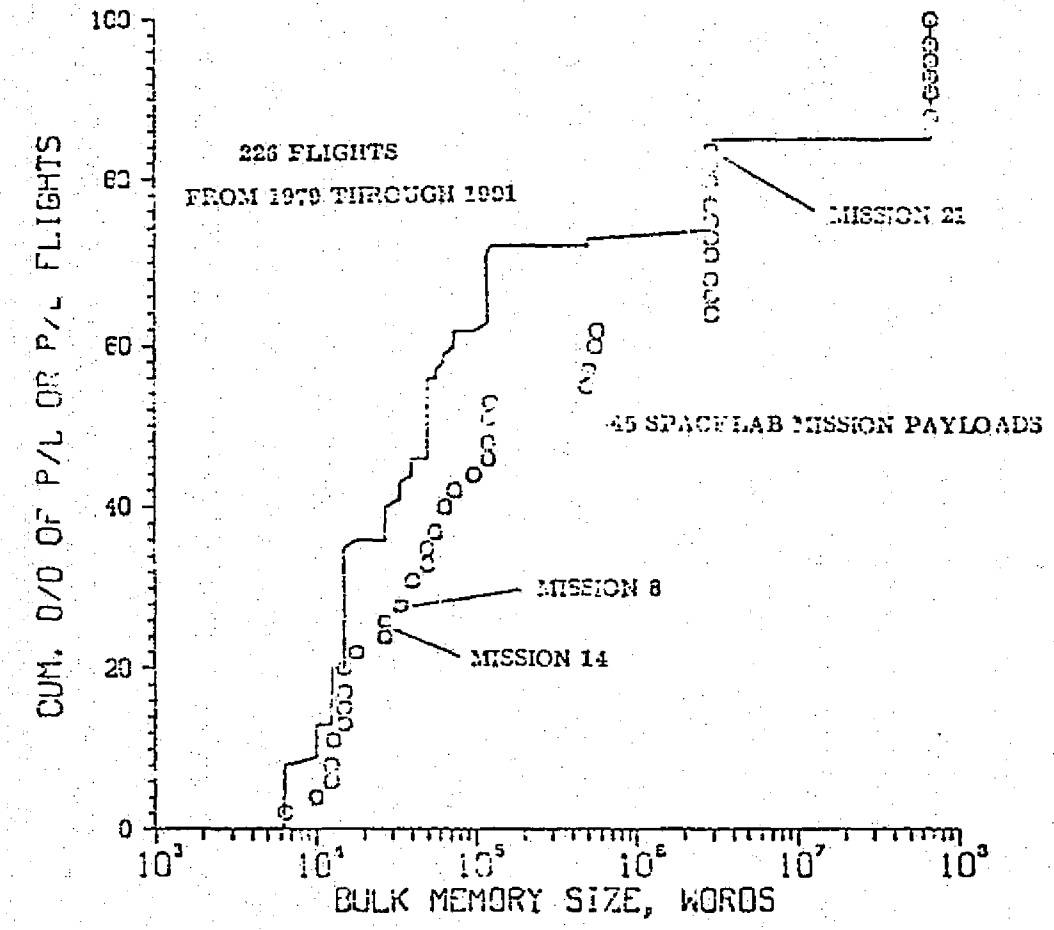


FILE NO.

EF213

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: MARCH 1976

BULK MEMORY

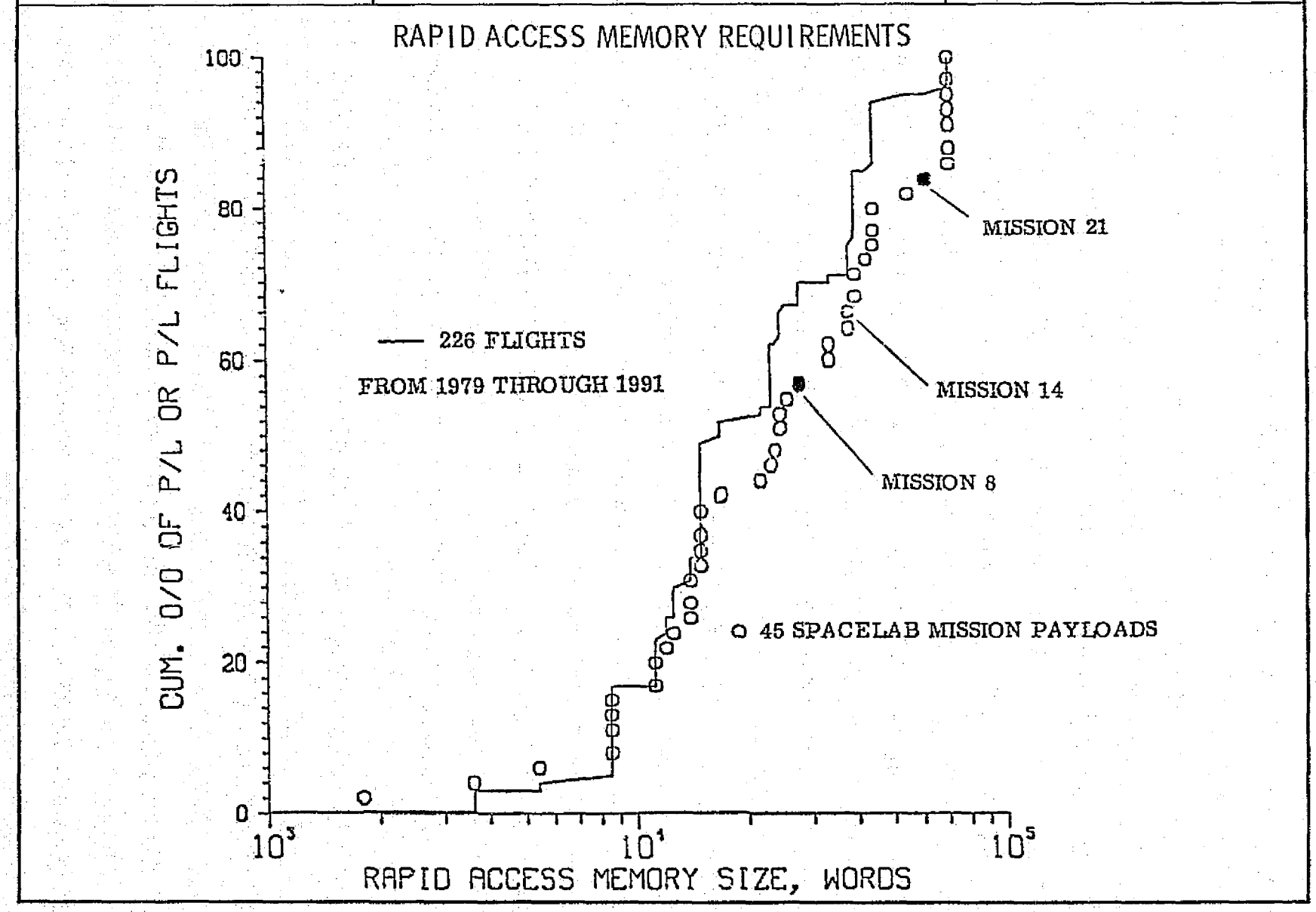


MSFC - Form 3304 (Rev October 1972)

FILE NO.___

EF214

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: MARCH 1976



MSFC - Form 3304 (Rev October 1972)

FILE NO.___

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: MARCH 1976

REAL TIME SIMULATION TEST SET (RTSTS)

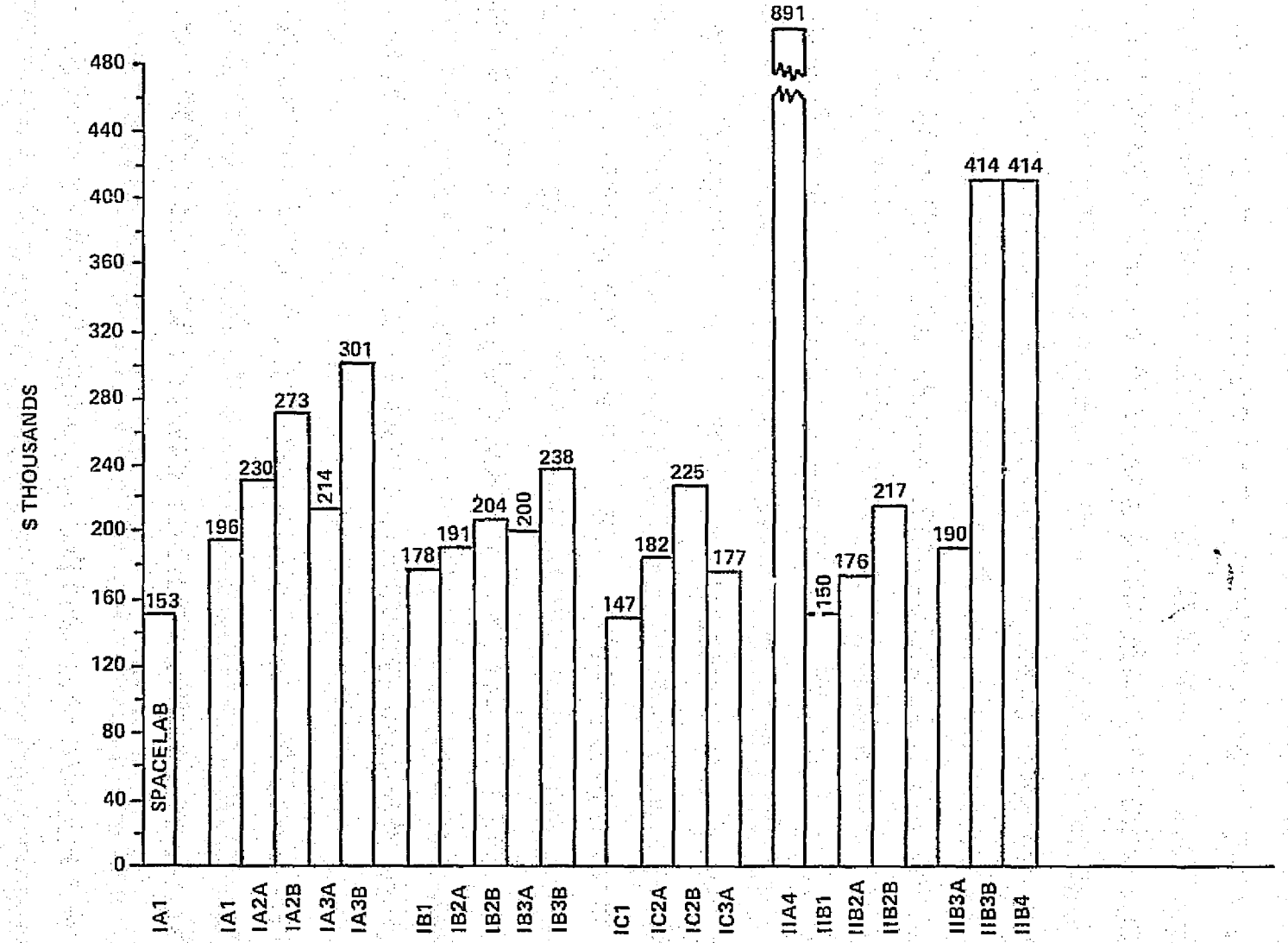
REQUIRED FOR USE BY PIs DEVELOPING DEP SOFTWARE

- PERFORMS REAL TIME EXPERIMENT SIMULATIONS
- PERFORMS REAL TIME CDMS SIMULATIONS
  - CENTRAL STANDARD SERVICES
  - DISPLAY
  - MASS STORAGE
- SERVES AS HOST COMPUTER FOR:
  - ASSEMBLY
  - COMPILATION
  - LINK EDIT
  - POST PROCESSING OF REAL TIME SIMULATIONS

EF197

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: MARCH 1976

AVERAGE COST PER FLIGHT



MSFC - Form 3304 (Rev October 1972)

FILE NO.

EF222

SPACELAB EXPERIMENT COMPUTER STUDY

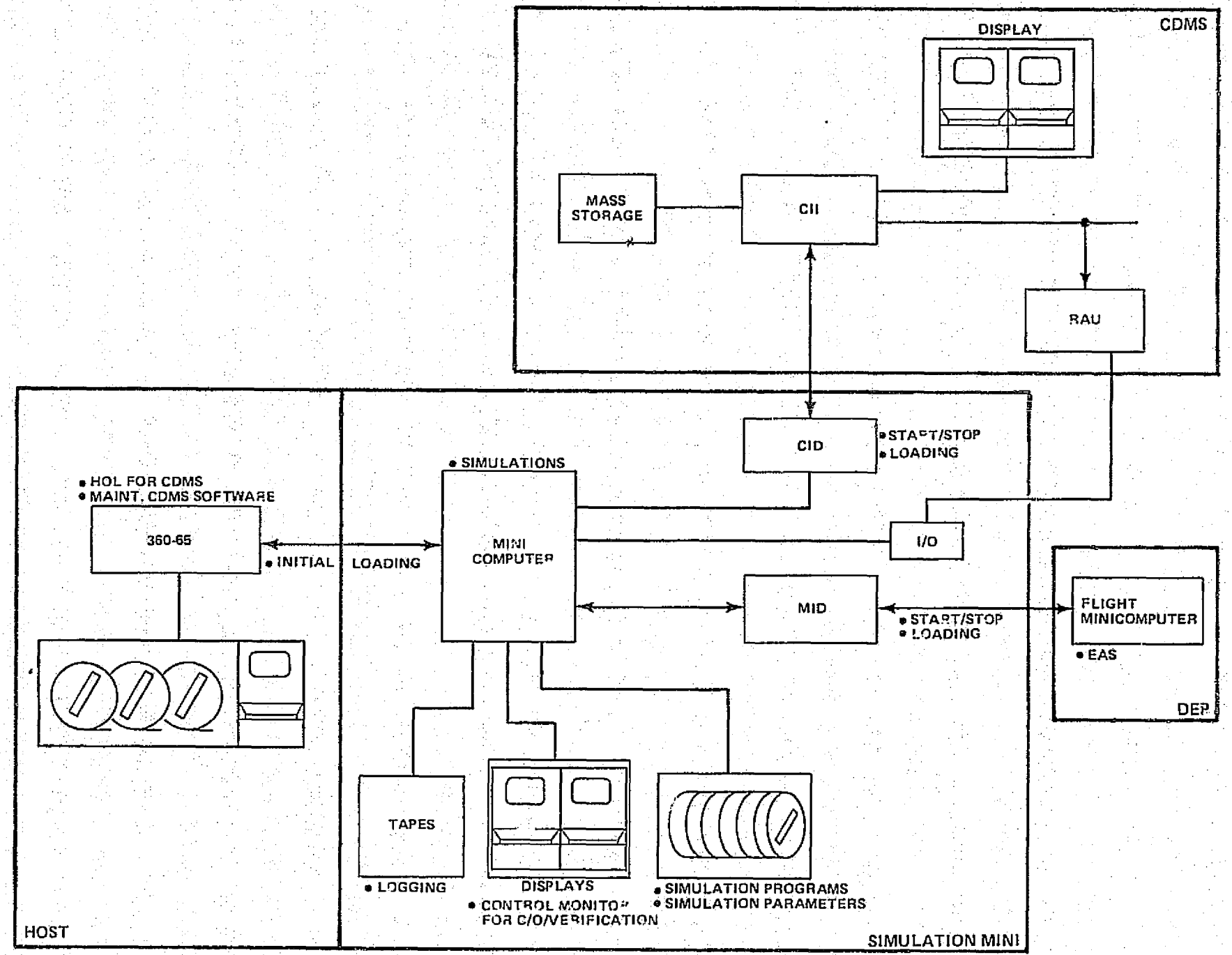
SELECTION OF MISSIONS FOR DETAILED ANALYSIS EARLY SHUTTLE MISSION CANDIDATES

MISSION NO. / NAME / CRITERIA FOR SELECTION	8 JOINT NASA/ESA	10 MULTI-DISCIPLINE	12 LIFE SCIENCES	14 MULTI-DISCIPLINE APPLIC.	19 AMPS	21 COMBINED ASTRONOMY	26 LIFE SCIENCES
Preliminary Mission Feasibility Established	MSFC Study	IMAP	IMAP DRM (PH A)	IMAP DRM	IMAP DRM	(DRM) ERNO Accom Analysis	(IMAP) (DRM) (PH A)
Anticipated Level of Computer Processing Requirements	Medium	Medium	Low	Low	High	High	Low
Availability of Existing or Near Term Supporting Data	Available - GDC Data Mgt. Study	Near Term - GDC Data Mgt. Study	Derivable from GDC Ph. A Study	Near Term -GDC Data Mgt. Study	–	Near Term -GDC Data Mgt. Study	Derivable from GDC Ph. A Study
Other Computer Processing Studies	–	CRASS	CRASS	CRASS	CRASS	CRASS	CRASS
Other Considerations	Close MSFC I/F	Payload Complement Expected to Change Soon	–	GDC Wrote DRM, Reviewed IMAP	Extremely Complex, Current Ph. B for Redefinition	Payload Discipline Specialist at GDC	–

☐ Selected for detailed analysis

( ) Study has close relation to mission

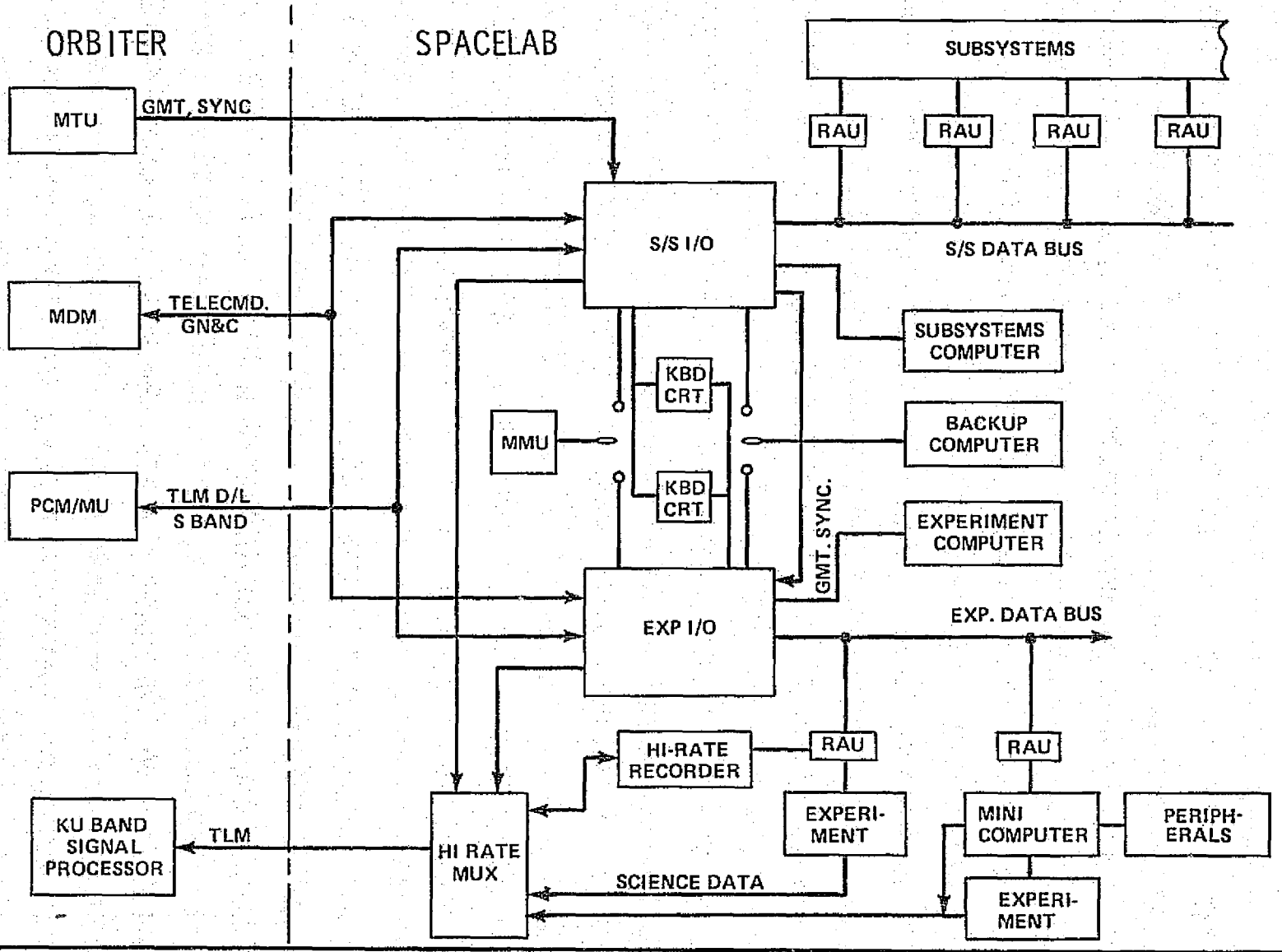
CENTRAL SITE



EF 96

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: MARCH 1976

COMMAND DATA MANAGEMENT SYSTEM



FILE NO.

EF231

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

CENTRAL EXPERIMENT COMPUTER FUNCTIONS

- NEEDED EVEN IF DISTRIBUTED COMPUTER CONFIGURATION IS ADOPTED
- EXECUTES STANDARD TASKS THAT ARE REQUIRED BY ALL PAYLOADS
- EXAMPLES ARE
  - DISPLAY
  - KEYBOARD
  - ORBITER COMMUNICATION
  - DISTRIBUTION OF UPLINK COMMANDS
  - PCM FORMATTING

OPTIONS NOT COSTED

1A4 1B4 1C4	IMPRACTICAL TO DEVELOP SUPPORT SOFTWARE FOR CENTRAL COMPUTER TO RUN ON EACH NON STANDARD HOST
1C3B	NO DEDICATED EXPERIMENT PROCESSOR (DEP) IN THIS OPTION - THEREFORE NO DEP SOFTWARE SIMULATION REQUIRED
IIA1 IIA2A IIA2B	IMPRACTICAL FOR CENTRAL SITE TO MAINTAIN SUPPORT FACILITIES FOR EVERY NON STANDARD DEP
IIA3A	IMPRACTICAL FOR CENTRAL SITE TO FURNISH SIMULATION FACILITIES FOR EVERY NON STANDARD DEP
IIA3B	COST IS THE SAME AS OPTION IIA4

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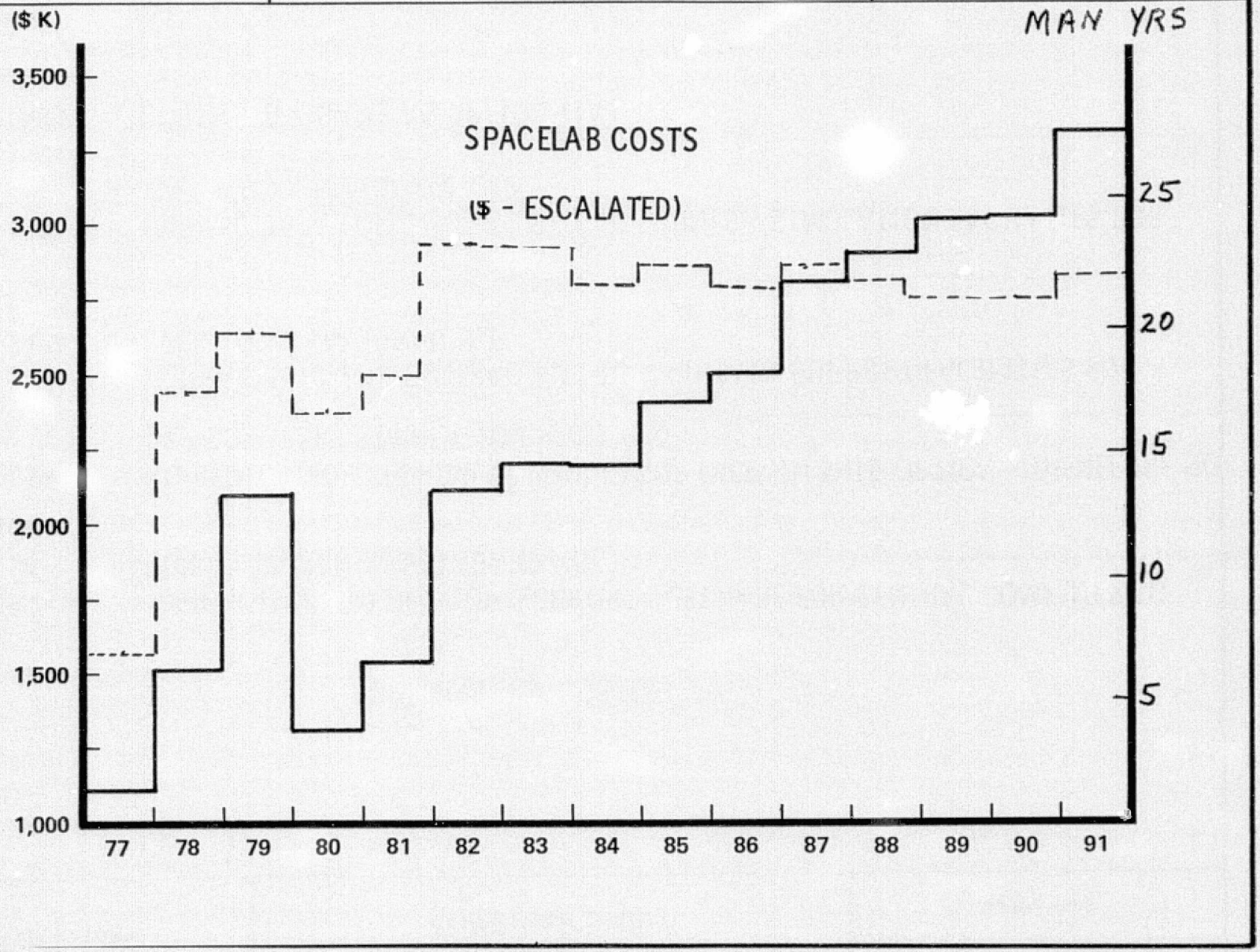
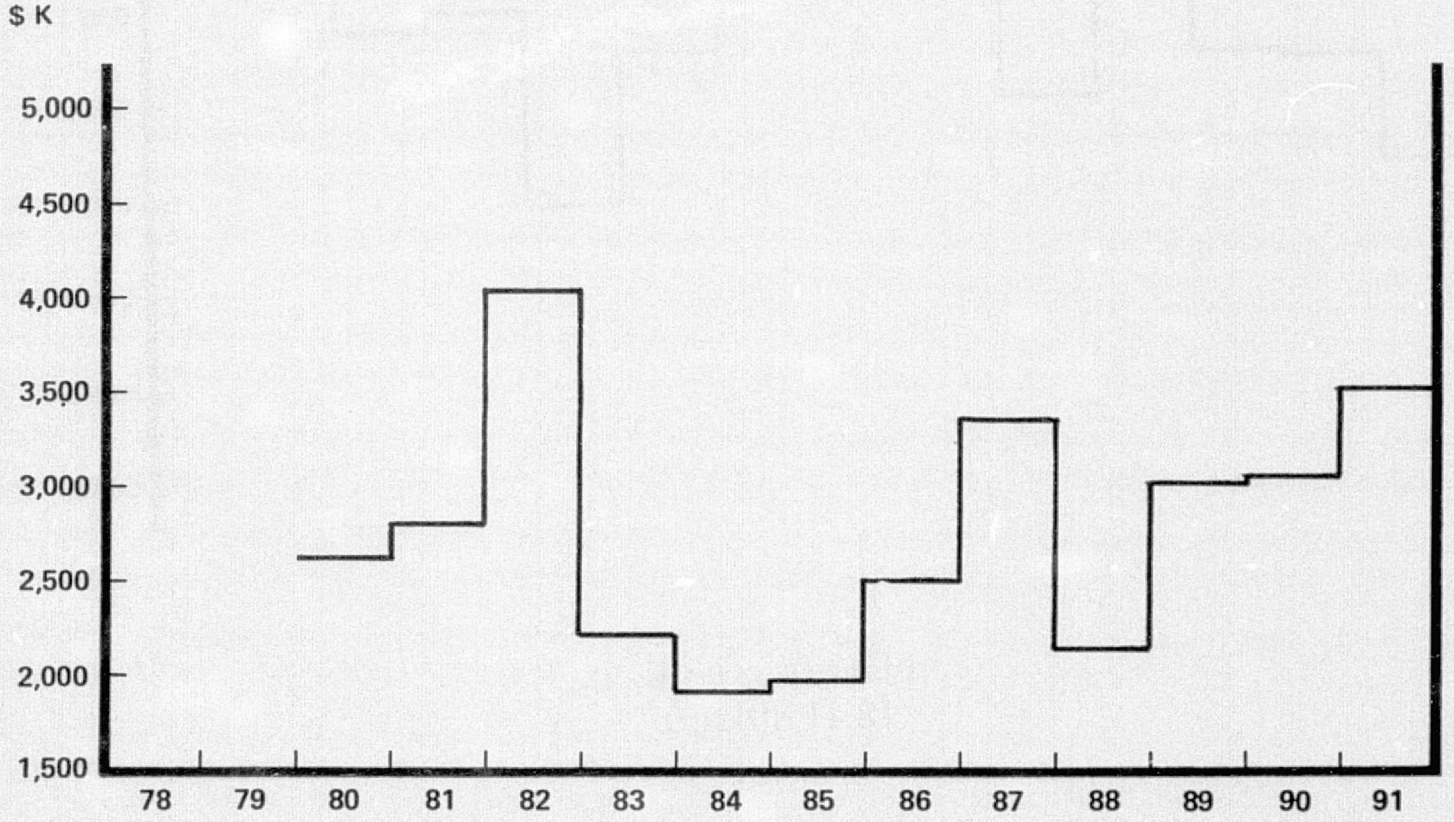


FILE NO. 1

ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T POWELL
		DATE: APRIL 1976

OPTION I CI
($ - ESCALATED)



FILE NO.___ _____

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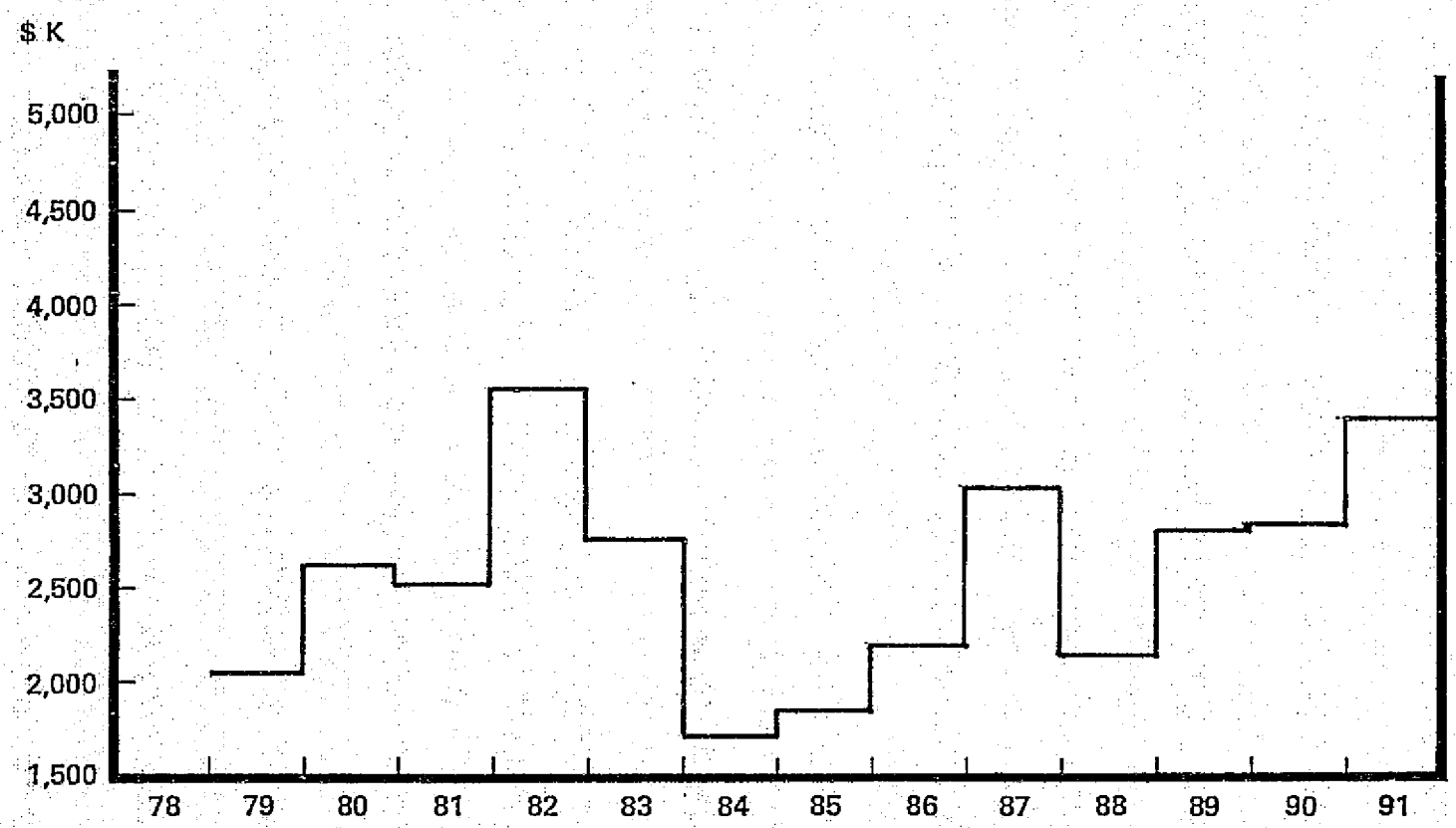
DATA SYSTEMS LABORATORY	SPACELAB EXPERIMENT COMPUTER STUDY	J. T. POWELL
		DATE: APRIL 1976

OPTION II B1
($ - ESCALATED)



FILE NO.

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		DATE: APRIL 1976

CENTRAL SITE COSTS FOR EAS DEVELOPMENT

ITEM	COST	COSTED TO	USE
Main Memory (1 Megabyte)	$393K	Spacelab	Allow 360-65 to Accommodate Throughout Requirements
Central Site Operation, Maintenance, and Consumables	$123.22/Hr.	User	
Display Terminals (Qty. 8)	$7,912 Total	User	Local Programmer Coding, Functional Simulation EAS Checkout
Display Terminals Maintenance	$528/Yr.		
OR			
Remote Job Entry Terminal	$43.45K Each		
Telecommunications Rental	$15.72K/Yr./Terminal	User	Remote Programmer Coding, Functional Simulation EAS Checkout
Terminal Maintenance	$3,180/Yr.		

FILE NO.

SPACELAB EXPERIMENT COMPUTER STUDY

CENTRAL SITE FACILITY

360/65 AND PERIPHERALS	$2,460 K
SIMULATION COMPUTER	137 K
COMPUTER INTERFACE DEVICE (CID)	186 K
COMMAND AND DATA MANAGEMENT SYSTEM (CDMS)	1,920 K
	$4,703 K
OPERATIONS AND MAINTENANCE	511 K PER YEAR
	($245 PER HOUR)

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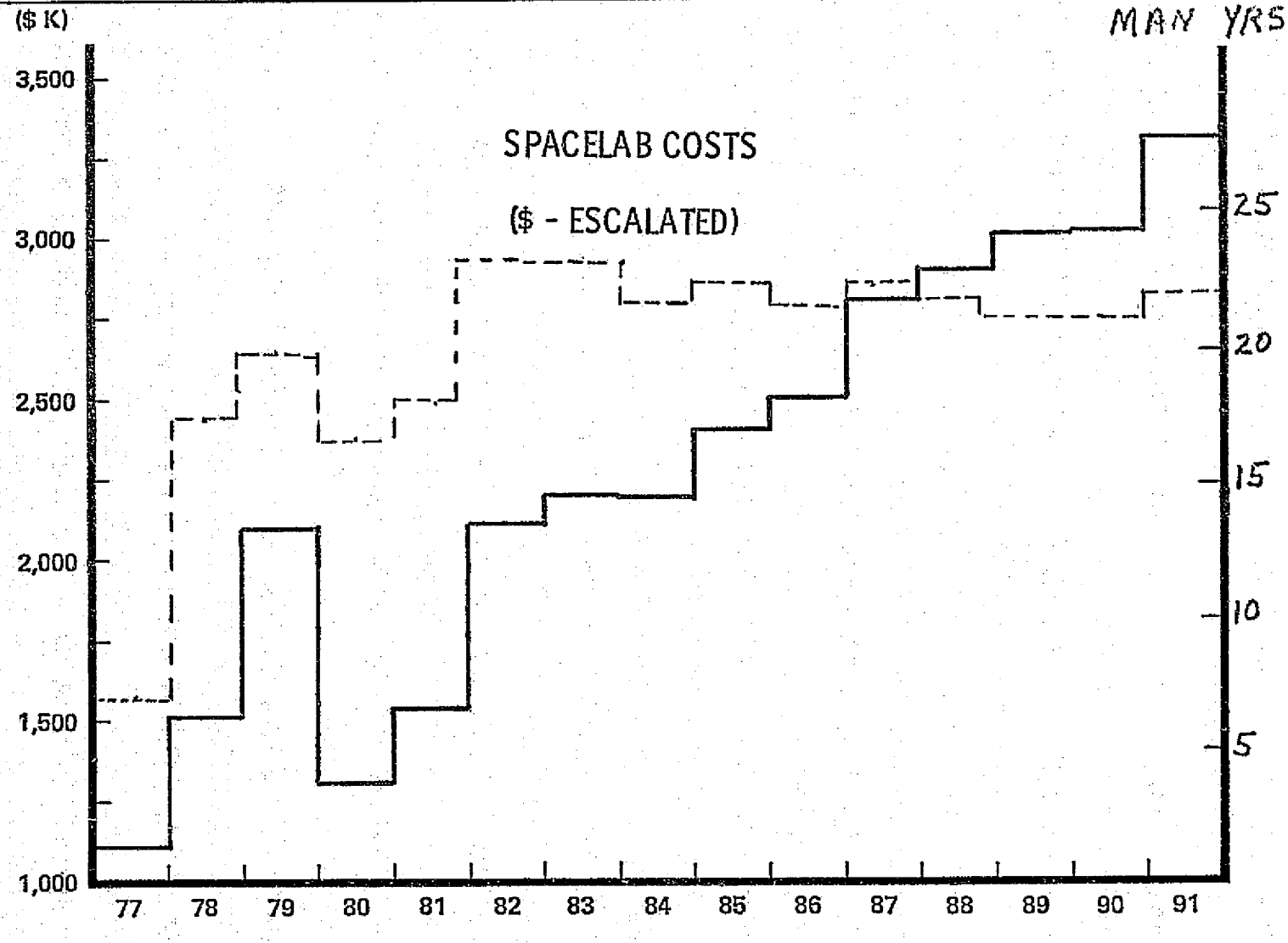

		Escalated Average Cost/Flight ($K)
SPACELAB	All Options	153
EAS	IA1	196
	IA2A	230
	IA2B	273
	IA3A	214
	IA3B	301
	IB1	178
	IB2A	191
	IB2B	204
	IB3A	200
	IB3B	238
	IC1	147
	IC2A	182
	IC2B	225
	IC3A	177
	IIA4	891
	IIB1	150
	IIB2A	176
	IIB2B	217
	IIB3A	190
	IIB3B	414
	IIB4	414

APPROVAL

SPACELAB EXPERIMENT COMPUTER STUDY
Volume I: Executive Summary

By James L. Lewis, Bobby C. Hodges, and James O. Christy

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

J. T. Powell

J. T. POWELL
Director, Data Systems Laboratory

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