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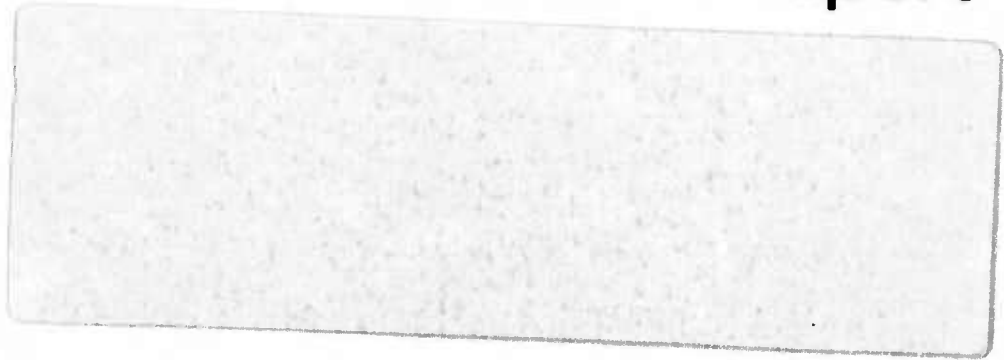
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**B-1 SYSTEMS APPROACH TO TRAINING
TECHNICAL MEMORANDUM SAT-1
FINAL REPORT
VOLUME 2 ✓**

Calspan Report No. FE-5558-N-1 ✓

**APPENDIX A: COST DETAILS
JULY 1975**

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The purpose of this report is to document the details of the cost analysis for the B-1 Aircrew Training System. Included are the cost data base, which is the raw material from which cost estimates are made, the actual values used to evaluate the recommended, baseline system, and results from the other analyses which were conducted on selected parameters.		

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PREFACE

This document is one of several technical memoranda which have been delivered to the B-1 Systems Project Office (B-1 SPO) in performance of the Systems Approach to Training (SAT) Task under Contract Number F33657-75-C-0021. Each of the separate SAT documents is listed below. Additional copies may be requested from: B-1 Systems Project Office, Data Configuration Division, Wright-Patterson Air Force Base, Ohio.

<u>Technical Memoranda</u>	<u>Number</u>	<u>Author(s)</u>	<u>Date</u>
B-1 Systems Approach to Training, Final Report.	SAT- 1 Vol. 1	R. Sugarman S. Johnson W. Ring	July 1975
B-1 Systems Approach to Training, Final Report. Appendix A: Cost Details.	SAT- 1 Vol. 2	H. Reif W. Ring	July 1975
B-1 Systems Approach to Training, Final Report. Appendix B: Bibliography and Data Collection Trips.	SAT- 1 Vol. 3	A. Blair	July 1975
Behavioral Objectives for the Pilot, Copilot, and Offensive Systems Operator.	SAT- 2 Vol. 1 & 2	J. Mitchell W. Hinton S. Johnson	July 1975
Simulation Technology Assessment Report (STAR).	SAT- 3	S. Johnson J. Knight R. Sugarman	July 1975
Sorting Model for B-1 Aircrew Training Data. User's and Programmer's Guide.	SAT- 4	J. Menig T. Ranney	July 1975
Training Resources Analytic Model (TRAM). User's Manual.	SAT- 5	W. Ring G. Gaidasz J. Menig W. Stortz	July 1975
Training Resources Analytic Model (TRAM). Programmer's Manual.	SAT- 6	W. Ring G. Gaidasz J. Menig W. Stortz	July 1975
Task Analysis Listings.	SAT- 7	J. Mitchell T. Ranney	July 1975
Control/Display Catalog and Action Verb Thesaurus.	SAT- 8	T. Ranney A. Blair	July 1975

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SAT-1
VOL. 2

APPENDIX A: COST DETAILS

Hans G. Reif
William F.H. Ring

SUMMARY

The purpose of this report is to document the details of the cost analysis for the B-1 Aircrew Training System. Included are the cost data base, which is raw material from which cost estimates are made, the actual values used to evaluate the recommended baseline system, and results from the other analyses which were conducted on selected paramters.*

*The data reported in this document reflect the latest calculations and may therefore deviate somewhat from data released prior to 1 October 1975.

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SECTION 1
INTRODUCTION

In the course of the B-1 SAT study, a list of equipment, activities and facilities has been compiled from which the components of the B-1 aircrew training system have been selected. Costs for these items are presented in this appendix. The component costs are in FY 1974 dollars. The results are presented in FY 1974 dollars and inflated then - year dollars.

Contacts with Air Force agencies and private firms revealed a general lack of relevant background information in the main areas of interest. For example, in the field of large simulators, reporting requirements and record keeping necessary to develop a meaningful data base have been implemented only very recently. The elapsed time since the reporting program has been initiated has been too short to generate useful information for this study.

The costs reported herein should be treated as planning estimates. They should be continually updated as the system components are more precisely defined.

Calculated costs to support analyses of the recommended training system and alternative concepts are based on TRAM (TrainResources Alytic Model) and the quick-look version TROLIE (TrainResources Organized for Logical Integration of Expenses) model runs and subsequent data reduction.

SECTION 2
COSTS AND COSTING METHODOLOGY FOR B-1 SAT

The equipment considered corresponds to the four crew stations:

Pilot/Copilot
OSO
DSO

Costs are developed for three general types of special trainers for each crew station. These special trainers are:

- 1) The familiarization trainer which is a combined carrel and mockup of the flight station and contains a limited amount of interactive hardware.
- 2) Procedures trainers which incorporate mini-computers capable of generating normal in-flight data as well as a range of malfunctions. The instrumentation and hardware are interactive. There is a pilot-copilot version, an OSO station version, and a DSO station version.
- 3) Part-Mission Trainers in Pilot/Copilot, OSO, and DSO versions, which provide the means for the practice of maneuvers and other procedures that require a high fidelity of control/display interaction. The pilot/copilot version is equipped with a visual scene presentation and a motion platform. These Part-Mission Trainers may be combined via software to form the Full-Mission Trainer in which the full crew can achieve coordinated practice of the EWO (Emergency War Order) mission.

The following paragraphs describe the methodology and basic data used for arriving at costs. The following section describes the application of this methodology and data for evaluation of training system alternatives. Finally, Section 4 gives detailed cost breakdowns for each of the cases investigated as a part of the study.

2.1 INITIAL ACQUISITION COSTS

2.1.1 Cost Factors

RDT&E and Other Preproduction Costs

The design concepts for the equipment of choice have not been completely specified at this time. It appears, however, that with some notable exceptions such as FLIR, most of the devices can be developed from existing technology. In other instances only relatively minor modifications of extant equipment will be required. Research, Development, Test and

Evaluation (RDT&E) includes the cost of the RDT&E along with the cost of the first unit. This first unit cost is the first unit production cost plus an allowance for installation, checkout, and profit.

Other Acquisition Costs

The categories included and the bases on which their costs are computed are listed below:

Age, Data and Other	20% of hardware acquisition cost (excluding familiarization trainer)
Initial Training	1.5% of hardware acquisition cost (excluding familiarization trainer)
Initial Spares	15% of hardware acquisition cost (excluding familiarization trainer)
Integration & Interface	20% of hardware acquisition costs of hardware which is interconnected
Installation & Checkout	% of hardware acquisition costs Familiarization Trainer - 3% Procedure Trainer - 5% Part-Mission Trainer - 10%
Profit	10% of hardware acquisition cost
Learning Rate* (cum. avg.)	95%

2.1.2 First Unit Production Costs for Trainers

Pilot-Copilot Station

	Range (\$x10 ⁶)	Estimate (\$x10 ⁶)
Familiarization	\$0.01 - \$0.04	\$0.02
Procedures	0.10 - 0.25	0.20
Part-Mission	2.0 - 3.5	2.5

* The learning rate is defined as the average cost of 2N units given the cost of N units. Mathematically, $C_N = C_1 N (L_R)^{\log_2 N}$

where: C_N = Cost of N units

C_1 = Cost of first unit

L_R = Learning rate (typically $0.5 < L_R \leq 1.0$)

The familiarization trainer is basically a mockup. Its costs will vary according to the type of interactive hardware (if any) mounted on the device. The procedures trainer corresponds to systems currently in use by several commercial airlines. The part-mission trainer cost is derived from cost estimates of comparable equipment for the KC-135, B-52 and C-130.

OSO Station

	Range (\$x10 ⁶)	Estimate (\$x10 ⁶)
Procedures	\$0.15 - \$0.25	\$0.20
Part-Mission	3.6 - 6.0	5.0

The procedures trainer combines mockup and interactive hardware. Filmed visual presentations rather than digitally-produced land simulations are employed. In contrast, the part-mission trainer uses a digital land-mass simulator as a basis for the attack radar simulation. The digital landmass simulation cost accounts for a significant part of its cost.

DSO Station

	Range (\$x10 ⁶)	Estimate (\$x10 ⁶)
Procedures	\$0.10 - 0.20	\$0.15
Part-Mission	0.80 - 1.6	1.0

DSO trainer requirements have not been defined at this time. The costs are estimated from an analysis of the complexities of these trainers relative to other crew station trainers.

Ancillary Equipment

	Range (\$x10 ⁶)	Estimate (\$x10 ⁶)
Motion Base		
3 DOF	\$0.06 - \$0.10	\$0.08
6 DOF	0.20 - 0.35	0.25
G Seat	0.10 - 0.15	0.10
Visual Displays		
3-channel, wide FOV, full daylight	\$2.2 - \$2.5	\$2.3

	Range (\$x10 ⁶)	Estimate (\$x10 ⁶)
Narrow FOV, take-off and landing, visual refueling	\$0.70 - \$1.0	\$0.8
Night visual (Point Lights)	\$0.15 - \$0.60	\$0.3
FLIR	\$1.5 - \$2.5	\$2.0

Motion base and G-seat costs are derived from extant equipment costs. The visual displays noted provide for a range of capabilities and are in various stages of development. The FLIR cost range is based on the GE FLIR, the B-57 transparency type, and a film plate system.

Other equipment whose cost was estimated are:

	Range (\$x10 ⁶)	Estimate (\$x10 ⁶)
Subsystem trainer	\$0.04 - \$0.05	\$0.05
Computer Aided Instruction Central facility	0.20 - 0.30	0.25
Terminals (each)		0.0015

The basic elements of the subsystem trainer consist of a minicomputer, panels, and one or more random access projectors with display. It has been used as a part-task and procedures trainer for maintenance training.

The computer aided instruction system is assumed to consist of a central facility and 30-50 console terminals. The central facility consists of two minicomputers with peripheral equipment.

2.1.3 General Purpose Carrels and Briefing Rooms

General Purpose Carrels

Carrel costs are largely a function of the installed multimedia A/V equipment. They generally range from \$750 to \$2,500. A cost of \$2,000 is used. A carrel occupies about 50 sq. ft. of space.

Briefing Rooms/Classrooms

Costs are developed for classrooms (also to be used as briefing rooms) with capacities for 16, 32 and 48 students. The estimated classroom sizes are 350, 550 and 750 sq. ft., respectively. Each classroom is equipped with simple audio-still visual equipment costing \$400. One audio-motion film projector is shared by two classrooms.

New classroom construction, including basic furnishings, is estimated at \$40/sq. ft. Conversion costs are estimated as 25 percent of new construction. Resultant costs are:

<u>Room Size</u>	<u>New Construction</u>	<u>Conversion</u>
16 seat classroom	\$16,400	\$ 5,900
32 seat classroom	20,000	6,800
48 seat classroom	38,400	11,400

Briefing rooms in the CCTS are supplied in several sizes. Included is a large, subdividable squadron room. An additional cost of \$2,400 is estimated for the furnishings of a briefing room, which would include a table, chairs, maps and charts, and mission planning aids.

2.1.4 Facility Requirements and Costs

Because of the lack of final subsystem and system designs, only preliminary estimates of facility requirements and costs can be made at this time.

Facility costs can range from \$40 to \$125 per sq. ft. Costs are sensitive to requirements such as high bay areas. The estimated costs are:

General carrels and briefing rooms	\$40/ft. ²
Procedures and familiarization	\$75/ft. ²
Part-Mission and Full-Mission	\$125/ft. ²

The size of the facilities required for each device are indicated in Table 2. These values were obtained from the sample CCTS facility discussed in Volume 1 of this report. The areas quoted are the area required for the facility itself plus an allowance for access and support areas.

2.1.5 Instructional Material

Representative costs of instructional material preparation and production are:

Lectures 10 Hrs per contact hour at \$10/Hr.	\$100/contact hour
Visual Stills	
Viewgraphs	\$ 8 each
35mm B/W slide	\$ 5 each
35mm color slide	\$10 each
Films	
Single concept (7-8 min.)	\$300/min.
30 minute film	\$400/min.
Film with animations	\$1,000/min.

Audio Tape	\$ 30/min.
Audio-Visual Presentations	
Narrated slide	\$150/min.
Multi-media	\$200/min.
Video tape	\$200/min.
Kinescope	\$200/min.
Technical Data Manual	\$125/page
Programmed Courses	
Self-paced linear single track	\$600/instruction hour
Linear track with branching	\$900/instruction hour
Linear track with question & branching	\$1500/instruction hour
Linear track with instruction diagnosis	\$3000/instruction hour
Individualized multi-tracking with diagnostics, question and answering with branching capability	\$4500/instruction hour

2.2 ANNUAL OPERATIONS AND MAINTENANCE COSTS

2.2.1 Instructor Personnel

The average instructor is assumed to be equivalent to an 0-3 or 0-4 (GS-11 or -12) with an annual salary of \$18,000-\$22,000. An average cost of \$20,000 is used. Hourly costs where applicable are shown as \$10/hour.

2.2.2 Trainee TDY

This cost is estimated as \$10.75/day/trainee plus transportation. An average transportation cost is estimated as \$150/trainee.

2.2.3 B-1 Aircraft

The estimated cost/flying hour is \$3,170. This cost includes only the direct costs, i.e. petroleum, oil, and lubricants (POL), base and depot level maintenance, and replenishment spares.

2.2.4 Equipment Operations and Maintenance

The annual operations and maintenance costs are included as 10 percent of the initial hardware procurement cost of trainers.

Equipment Upgrade

This cost is included as 10 percent of the initial hardware procurement cost of the trainer and carrels.

2.2.5 Instructional Materials

A cost of \$5.00/manual or text book issued to trainees is charged if required. The annual upgrade cost is estimated as 10 percent of the initial preparation cost.

2.2.6 Facilities

Facility maintenance is defined to include utilities, repairs and normal housekeeping. The cost is estimated as \$4.00/sq. ft. of occupied area.

2.3 LEAD TIMES

Representative lead times are shown for the three types of trainers.

<u>Familiarization Trainer</u>		Estimate
Development	3-9 Mos.	6 Mos.
Production contract to 1st procurement	6-18 Mos.	12 Mos.
<u>Procedure Trainers</u>		
Development	6-18 Mos.	12 Mos.
Production contract to 1st procurement	12-24 Mos.	18 Mos.
<u>Part and Full-Mission Trainers</u>		
Development	12-24 Mos.	18 Mos.
Production contract to 1st procurement	24-48 Mos.	36 Mos.

It is assumed that instructional material and facilities associated with the trainers can be developed concurrently.

2.4 DATA QUALITY ESTIMATES

Three levels of data quality are designated for use in estimating the quality of the cost inputs. They are defined as follows:

<u>Data Quality Level</u>	<u>Basis for Quality Estimate</u>
1 (Good)	Sources provide data of high quality for SAT purposes. Sources are of a form that can be referenced, and contain data related closely enough to the SAT systems to be reasonably applicable.

Data
Quality
Level

Basis for Quality Estimate

2
(Medium) Some adaptation is required in correlating source data with SAT needs, resulting in medium quality. Not all sources are of a form that can be referenced (e.g., informal contacts with manufacturers, contractors or Government agencies).

3
(Low) Data are provided by rough estimates or considerable adaptation of source data, resulting in low quality for SAT purposes even though it is the best obtainable within contract boundary conditions.

Cost ratings of the equipment and activities considered are presented in Table 1.

2.5 DATA SOURCES

2.5.1 Cost Factors

The cost factors shown are based on an estimated breakdown of simulator systems costs considered typical by the Simulation SPO budgetary planners.

2.5.2 First Unit Production Trainer Costs^{1-7*}

Cost data were part of the information sought in visits to manufacturers, government facilities, and various simulator users in the course of work leading to the Simulation Technology Assessment Report (STAR), Technical Memorandum SAT-3. Contacts with Plattsburg Air Force Base afforded particular attention to FB-111 simulator and training information.

The very limited data available has been supplemented as much as possible through contacts with the Simulator SPO. Cost data from the latter pertained mainly to simulators planned for the training of B-52 and KC-135 aircrews. Specific price data were obtained on programmable simulators applicable to subsystem trainer needs. Guidelines for CAI costing were furnished by a recent Calspan survey, supplemented by information from the October 1974 Air Force Education Symposium and a visit to TICCIT users at the Naval S-3A Training Facility. Information on mockup costs was included in data gathered for STAR and data from a visit to Chanute Air Force Base.

2.5.3 General Purpose Carrels and Classrooms^{8,9}

Standard sources of cost information on audio-visual equipment provide data for equipment costs in this category.

* References

Table 1
DATA QUALITY ESTIMATES

EQUIPMENT/ACTIVITY	RATING
INITIAL ACQUISITION COST	
<u>COST FACTORS</u>	
RDT&E AND OTHER PREPRODUCTION COST	3
AGE, DATA, OTHER	3
INITIAL TRAINING	3
INITIAL SPARES	3
INTEGRATION AND INTERFACE	3
INSTALLATION AND CHECKOUT	2
PROFIT	2
LEARNING RATE	2
<u>FLIGHT STATION TRAINERS</u>	
FAMILIARIZATION	2
PROCEDURES	2
PART-MISSION	2
<u>OSO TRAINERS</u>	
PROCEDURES	2
PART-MISSION	2
<u>DSO TRAINERS</u>	
PROCEDURES	3
PART-MISSION	3
<u>ANCILLARY EQUIPMENT</u>	
MOTION BASE	1
G-SEAT	1
VISUAL DISPLAYS	2
IR	3
<u>OTHER EQUIPMENT</u>	
PROCEDURES TRAINER	2
SUBSYSTEM TRAINER	1
COMPUTER-AIDED INSTRUCTION (CAI)	3
<u>GENERAL PURPOSE CARRELS AND CLASSROOMS</u>	
GENERAL PURPOSE CARRELS	2
CLASSROOMS	2
<u>FACILITY REQUIREMENTS AND COSTS</u>	
REQUIREMENTS (SIZE)	2
COST	2
<u>INSTRUCTIONAL MATERIAL PREPARATION AND PRODUCTION</u>	
LECTURES	3
VISUAL STILLS	1
FILMS	2
AUDIO TAPE	2
AUDIO-VISUAL PRESENTATIONS	2
TECHNICAL DATA MANUAL	3
CAI PROGRAM COURSES	3
<u>ANNUAL OPERATIONS AND MAINTENANCE COSTS</u>	
INSTRUCTOR PERSONNEL	1
TDY TRAINEES	1
B-1 AIRCRAFT	2
TRAINER EQUIPMENT	3
EQUIPMENT UPGRADE	3
INSTRUCTIONAL MATERIAL	2
MANUALS AND TEXTBOOKS	2
UPGRADE	3
FACILITY MAINTENANCE	2

2.5.4 Facility Requirements and Costs^{10,11}

All facility size requirements are estimated in terms of square foot allocations for correlation with standard construction cost estimates expressed in dollars per square foot.

2.5.5 Instructional Material Preparation and Production^{1-2, 4-7, 12-14}

The above references provide appropriate bases for estimating costs for preparation of audio-visual instructional materials. Data in these references on instructional materials and preparation hours per hour of instruction cover a range of instructional categories suitable for the purposes of this Project in estimating costs from the simplest lecture to complex preparations for CAI, including computer programming.

2.5.6 Annual Costs

Personnel costs are provided by Reference 15. CCTS trainee TDY costs are estimated from TDY costs obtained from discussions with Air Force personnel.

The non-labor portion of cost per flying hour for the B-1 is based on data from Reference 15.

Estimates of other annual costs are based on data from the same sources listed above for initial costs in the designated categories. Data contributing to the estimating of annual costs for simulator maintenance and upgrade were included in operational information from SAC on experience with downtimes for simulator maintenance and upgrading.

SECTION 3 RESULTS

The previous section provided the methodology and basic data for the derivation of costs for the B-1 training system. This section presents values of costs used to evaluate training systems.

The training year consists of 50 five-day weeks with 6 hours of scheduled instruction per day. Variation in student abilities, incoming knowledge, etc. could allow a departure of individual progress from the given schedules. The times associated with individual instructional blocks and the number of calendar units in a week are chosen so that the average trainee will easily be able to follow the nominal pace. Less capable trainees should find ample time for makeup work. More capable trainees should find the pace adequate to maintain their interest. The accuracy of these statements depends in part on the assumed small variance of incoming trainee skills and knowledges within each track.

3.1 NON-RECURRING COSTS

The data for non-recurring costs, provided in Table 2, is divided into RDT&E, Acquisition, Facilities, and Instructional Material.

3.1.1 RDT&E

The RDT&E costs include two components. The first includes normal Research, Development and Test activities. This cost is estimated to be equal to the first unit equipment cost. The second component consists of the cost of the first equipment employed for test and evaluation. Its cost is computed as the first unit equipment cost plus installation, checkout, and profit.

RDT&E costs are distributed with a 60/40 ogive (i.e., proportioning). That is 60% of the cost is incurred in the first half of the time period with the remainder in the second half. For a 2-year procurement period 60% occurs in the first year and 40% occurs in the second year. Table 3 shows the resultant RDT&E expense distribution.

3.1.2 Acquisition

Acquisition refers to the procurement of devices after the initial RDT&E item. Acquisition of multiple items can involve a reduction in the average cost using the learning rate technique described above. In addition to the unit production cost, acquisition involves installation, checkout, AGE, spares, data, and profit. The total acquisition cost is divided by the number of units purchased (less the RDT&E item) to arrive at the average acquisition cost.

Table 2 NON-RECURRING COSTS

	BRIEFING ROOM	GENERAL PURPOSE CARREL	FAMILIARIZATION TRAINER	PROCEDURES TRAINERS			PART AND FULL MISSION TRAINER				INSTRUCTOR OFFICES	SUB. TOTALS	GRAND TOTALS
				P/CP	OSO	DSO	P/CP	OSO	OSO	INTERFACE			
RDT&E													
(1) FIRST UNIT PRODUCTION COST \$K		2.0	20	200	100	3,080	5,000	1,000	1,816		11,418		
(2) RDT&E [(1)] \$K		2.0	20	200	100	3,080	5,000	1,000	1,816		11,418		
(3) PROFIT - INSTALLATION + CHECKOUT %		10.0	13	15	15	20	20	20	20				
(4) PROFIT - INSTALLATION + CHECKOUT [(1)] x (3) \$K		0.2	2.6	30	15	616	1,000	200	363		2,257		
(5) COST OF RDT&E UNIT [(1) + (4)] \$K		2.2	22.6	230	115	3,696	6,000	1,200	2,179		13,675		
(6) TOTAL RDT&E [(2) + (5)] \$K		4.2	42.6	430	215	6,776	11,000	2,200	3,995		25,093		
ACQUISITION													
(7) NUMBER OF DEVICES PROCURED	12	61	4	8	9	16	16	16	8				
(8) LEARNING RATE %	100	100	95	95	95	95	95	95	95				
(9) LEARNING RATE MULTIPLIER [(8) / 95]	1.0	1.0	0.9025	0.8574	0.8573	0.8145	0.8145	0.8145	0.8574				
(10) FIRST UNIT PRODUCTION COST \$K	2.4	2.0	200	200	100	3,080	5,000	1,000	1,816		11,420		
(11) AGE, SPARES, ORAL INSTALLATION, CHECKOUT, AND PROFIT %	0	10	13	51.5	51.5	56.5	56.5	56.5	56.5				
(12) AGE, SPARES, ORAL INSTALLATION, CHECKOUT AND PROFIT ON 1 UNIT [(10) x (11)] \$K	0	0.2	2.6	103	103	1,740	2,825	565	1,026		6,416		
(13) FIRST UNIT SYSTEM COST [(10) + (12)] \$K	2.4	2.2	22.6	303	303	4,820	7,825	1,565	2,842		17,837		
(14) TOTAL ACQUISITION [(7) x (9) x (13)] \$K	288	134.2	81.6	2,078	2,316	62,814	101,975	20,395	19,494		210,357		
(15) ACQUISITION OF N-1 UNITS [(14) - (5)] \$K	288	132.0	99.0	1,848	2,088	59,118	99,975	19,195	17,315		196,683		
(16) AVERAGE ACQUISITION COST [(15) / (17-1)] \$K	2.4	2.2	19.7	264	261	3,941	6,398	1,280	2,474				
FACILITIES													
(17) CONSTRUCTION COST TYPE	LOW	LOW	LOW	MED	MED	HIGH	HIGH	HIGH	HIGH	LOW			
(18) COST PER SQUARE FOOT (Sq. Ft.)	40	40	75	75	75	125	125	125	125	40			
(19) SQUARE FEET FOR 1 UNIT	185	112	175	350	350	2,830	870	870	84	84			
(20) NUMBER OF DEVICES PROCURED [= (7)]	12	61	4	8	9	16	16	16	8	111			
(21) TOTAL AREA [(19) x (20)] Sq. Ft.	2,220	6,832	700	3,480	3,150	45,280	13,920	13,920	8	9,324			
(22) TOTAL COST [(18) x (21)] \$K	89	273	28	261	236	5,660	2,400	1,740	106,906	373	11,270		
INSTRUCTIONAL MATERIAL													
(23) CONTACT HOURS (UNIQUE)	N/A	236	48	38	88	N/A	N/A	N/A	N/A				
(24) COST/CONTACT HOUR \$K	0	7.5	0.6	4.5	4.5	0	0	0	0				
(25) TOTAL COST [(23) x (24)] \$K	0	1,785	29	171	396	0	0	0	0		2,606		
TOTALS (\$K)	118	2,194	159	2,710	3,150	71,954	109,375	23,135	21,310	373	235,652		

Table 3
RDT&E ANALYSIS
(COSTS IN THOUSANDS)

DEVICE	YEAR			TOTAL	TOTAL WITH INFLATION
	'77	'78	'79		
FULL-MISSION TRAINER	\$9,588	\$ 7,910	\$6,472	\$23,971	\$32,854
PROCEDURES TRAINER	-	645	430	1,075	1,504
FAMILIARIZATION TRAINER	-	-	42.6	42.6	61
GENERAL PURPOSE CARREL	-	-	4.2	4.2	6
TOTALS	\$9,588	\$ 8,555	\$6,948	\$25,093	
TOTAL WITH INFLATION	\$12,694	\$11,780	\$9,949		\$34,424

Some equipment can be "returned to store." In particular, the number of instructors can vary with the demand. A one-year planning horizon is used for instructors.

The yield of an equipment is the number of units of use per year that a unit of equipment will provide. The unit of use which has been chosen for most of the data is trainee contact hours. A low loading rate for the larger training devices is allowed to represent down time, makeup time and instructor training.

The short-term planning horizon of a trainee for a given device is the "bucket size." Bucket size is chosen to be the maximum length of time the trainee can wait for the device without delaying his training. In general, the delay is one day, which is 6 calendar units (CUs). The general-purpose carrel has a 1/2-day bucket size (3 CUs). The aircraft has a larger bucket size of 21 CUs (3-1/2 days).

3.1.3 Facilities

For the purposes of the study, briefing rooms, general-purpose carrels and the familiarization trainer are assumed to be located in low-cost new buildings. The procedures trainers should be located close to the part-mission trainers so that trainees will be able to move rapidly between these devices. New construction is most likely required for the full- and part-mission trainers.

Recurrent and proficiency maintenance training is assumed to require new construction for the large trainers. Space for carrels and briefing rooms can be obtained from existing facilities.

3.1.4 Instructional Material

The total contact hours were obtained by counting the time in each instructional block for each training device or facility. If there were two parallel blocks with the same allocation of time, this time was only counted once. If one or more parallel blocks contained a larger number of contact hours, the largest block was used with the assumption that the shorter blocks contained a subset of the larger block.

The development cost for instructional material was based on estimates of the costs of instructional material for similar devices normally used in modern instructional technology. Good data is impossible to obtain because of the great variation in effort required to produce a unit of contact time. Upgrade and modification costs are estimated at 10% of the initial cost. Subject matter expert time is not included since it is provided by instructor overhead.

3.2 TIME PHASED SYSTEM COSTS

The system costs aggregated by category and attributed to the year of commitment are indicated in Table 4. Table 4 provides the data in current (1974) and then-year (inflated) dollars.

Table 4
TIME PHASED SYSTEM COSTS FOR BASELINE SYSTEM
(IN MILLIONS)

	YEAR												TOTAL	TOTAL WITH INFLATION				
	'76	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87			'88	'89		
RD&E		9.6	8.5	6.9														
ACQUISITION				26	38	53	28	51										
FACILITIES			2.2	2.2	1.2	2.0	1.7	1.2	0.5									
INSTRUCTIONAL MATERIAL	0.3	0.4	0.5	0.6	0.8													
RECURRING SUPPORT				3	6	6	9	11	13	14	14	14	14	14	14	14	14	196
O&M				6	6	33	57	81	105	103	103	103	103	103	103	103	103	797
TOTAL	\$0.3	\$10	\$11.2	\$35.7	\$49	\$ 94	\$ 96	\$144	\$119	\$117	\$117	\$117	\$117	\$117	\$117	\$117	\$117	\$ 25
TOTAL WITH INFLATION	\$0.4	\$13.2	\$15.4	\$51	\$73	\$145	\$154	\$241	\$208	\$138	\$220	\$229	\$238	\$248	\$248	\$248	\$248	\$ 34.3

Inflation is included in the computation of then-year dollars using inflation factors supplied by the B-1 SPO. The model is based on January 1, 1975 = 1.0 with an 8% cumulative rate of 8% until 1978, with 4% cumulative thereafter. Inflated dollars are used only where specified.

The time phased acquisition costs are shown in Table 5 for the devices in the procurement schedule for the baseline system. The procurement of the facilities at CCTS are assumed to be totally in 1979 and 1980 while the PMT facilities are procured as the MOBs are activated. The acquisition dates in the table are listed as occurring in the year before the equipment is required. Note also that the procurement of the first units are considered RDT&E. One RDT&E model of the Full-Mission trainer is procured as RDT&E to provide both Full- and Part-Mission RDT&E trainers.

3.3 LIFE-CYCLE COSTS PER DEVICE

The life-cycle costs per device are calculated by adding the cost of equipment RDT&E, acquisition, O&M, recurring support, and associated facilities construction and O&M. The average cost for each equipment is obtained by dividing the total costs per device by the number of devices. These results are presented in Table 6.

B-1 time is costed on the basis of missions at the rate of \$3170/hour. A normal training mission is assumed to be slightly more than 5 hours long yielding the per-mission cost \$17K. The mature B-1 is estimated to yield 10 five-hour missions per month. For the first 6 months, the B-1 is assumed to yield 5 missions per month. For the next 18 months, a B-1 will yield 8 missions per month. After a total of two years, the full 10 missions per month are achieved. These values are based on data supplied to us informally by SAC by the following process. The original data from SAC indicated a yield rate of 10/month, 14/month and 17.3/month (XPH letter to DPX dated 4 June 1974). The missions per month for the mature system were subsequently reduced to 10 per month. The values cited are roughly proportional to the original numbers where the ratio is 10/17.3.

3.4 PMT CONCEPTS

Three alternative PMT concepts were studied:

- Replacement of both the full-mission trainer and part-mission trainers with aircraft time
- Partial centralization of the part-mission and full-mission trainers
- Increased aircraft time over the recommended to conform to the current concept of operations.

The emphasis is on the decreased use of the larger trainers and the corresponding increased use of the aircraft itself. The latter are the dominant costs in the system. Table 7 compares these concepts. This table corresponds to Table 16 in Volume 1.

Table 5
DEVICE PROCUREMENT SCHEDULE
(BASELINE SYSTEM)

DEVICE	AVERAGE COST \$K	FISCAL YEAR PROCURED												TOTALS	
		'79		'80		'81		'82		'83		#	COST		
		#	COST	#	COST	#	COST	#	COST	#	COST				
BRIEFING ROOM	\$ 2.4	12	\$ 28.8	0	-	0	-	0	-	0	-	12	\$ 28.8		
GENERAL PURPOSE CARREL	2.2	2	6.6	18	\$ 39.6	13	\$ 28.6	14	\$ 30.8	12	\$ 26.4	60	132		
FAMILIARIZATION TRAINER	19.7	0	-	1	19.7	1	19.7	0	-	1	19.7	3	59.1		
PROCEDURES TRAINER P/CP	264	1	264	1	264	2	528	1	264	2	528	7	1,848		
OSO	261	1	261	2	522	2	522	2	522	1	261	8	2,088		
DSO	132	1	132	1	132	2	264	2	264	1	132	7	924		
FULL-MISSION TRAINER P/CP	3,941	2	7,882	3	11,823	4	15,764	2	7,882	4	15,764	15	59,115		
OSO	6,398	2	12,796	3	19,194	4	25,592	2	12,796	4	25,592	15	95,969		
DSO	1,280	2	2,560	3	3,840	4	5,120	3	3,840	3	3,840	15	19,200		
FULL-MISSION INTERFACE	2,474	1	2,474	1	2,474	2	4,948	1	2,474	2	4,948	7	17,310		
TOTALS (\$K)			\$26,404		\$38,308		\$52,786		\$28,063		\$51,111		\$196,673		
TOTALS WITH INFLATION (\$K)			\$37,807		\$57,071		\$81,781		\$45,209		\$85,647		\$307,517		

Table 6
LIFE CYCLE COSTS PER DEVICE

	LIFE CYCLE COSTS (\$M)		LIFE CYCLE COSTS WITH INFLATION (\$M)	
	TOTAL	AVERAGE	TOTAL	AVERAGE
FAMILIARIZATION TRAINER	0.26	0.066	0.46	0.115
PROCEDURES TRAINER P/CP	4.6	0.57	7.6	0.96
PROCEDURES TRAINER OSO	6.0	0.67	10.1	1.1
PROCEDURES TRAINER DSO	4.0	0.51	6.8	0.85
PART-MISSION TRAINER P/CP	131.0	16.4	226.0	28.3
PART-MISSION TRAINER OSO	208.0	26.0	360.0	45.0
PART-MISSION TRAINER DSO	43.0	5.3	73.0	9.1
FULL MISSION TRAINER	420.0	53.0	727.0	91.0

Table 7
COMPARISON OF PMT CONCEPTS*

CASE	INITIAL COSTS (millions)	LIFE-CYCLE COSTS (millions)
NO FULL- OR PART-MISSION TRAINERS	\$ 70	\$2,016
PARTIAL CENTRALIZATION	178	1,663
INCREASED PMT MISSIONS	235	1,502
BASELINE	235	1,144

* FOR ANALYSIS PURPOSES, IT IS ASSUMED THAT CREW RATIO = 2.0 AND ALERT RATE = 0.6. FOR DATA RELATING TO FEASIBILITY, SEE TABLE 16 IN VOLUME 1.

3.5 CREW RATIO

Modification of the crew ratio has a significant effect on the training program for both CCTS and PMT. Table 8 shows the effect on system costs. The corresponding non-cost data are included in Table 17 in Volume 1.

3.6 BASING CONCEPTS

Basing concepts data are indicated in Table 9. Table 9 gives the number of squadrons assumed at each base for each concept and the resulting costs of the system.

Table 8
EFFECT OF CREW RATIO VARIATION ON
TEN-YEAR LIFE-CYCLE COST

CREW RATIO	1.0	1.27	1.5	1.75	2.0 (BASELINE)
LIFE-CYCLE COST (MILLIONS)	753	878	948	1047	1144

Table 9
BASING CONCEPTS—ASSUMED NUMBER OF SQUADRONS
(15UE) AT EACH BASE

BASE	CONCEPT				
	5 MOB	7 MOB (Baseline)	9 MOB	11 MOB	13 MOB
1 (CO-LOCATED AT CCTS)	1	1	1	1	1
2	3	2	2	2	1
3	3	2	2	2	1
4	3	2	2	1	1
5	3	2	2	1	1
6		2	1	1	1
7		2	1	1	1
8			1	1	1
9			1	1	1
10				1	1
11				1	1
12					1
13					1
ACQUISITION COSTS (\$M)	\$ 212	\$ 196	\$ 212	\$ 216	\$ 221
LIFE-CYCLE COSTS (\$M)	\$1176	\$1144	\$1174	\$1185	\$1196

SECTION 4
CONCLUDING REMARKS

The cost and other details in this Appendix are provided to supplement the results and rationale contained in the main body of the Final Report (Volume 1). The assumptions and assertions which are used as inputs to the TRAM and TROLIE programs may be changed as new information warrants or as new operational doctrine is formulated. Every attempt has been made to include current operational concepts.

SECTION 5
REFERENCES

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