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Information Management Functional Economic Analysis for Finance Workstations to the Defense Information Technology Services Organization

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The document describes the current DoD Finance functional area technical workstations baseline, alternatives, and cost analyses that support a recommendation that DoD invest in DOS-based personal computers (PCs) or UNIX-based PCs to provide a new technical infrastructure to support the Finance business area. The preferred alternatives involve investing in information technology to create an end-user computing environment. The investment will improve the productivity of DoD Finance users and provide substantial benefits to DoD. The three alternatives considered in this FEA were drawn from the Finance Workstation Guidelines to the Defense Information Technology Services Organization.

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EXECUTIVE SUMMARY

This executive summary provides a synopsis of the Information Management Functional Economic Analysis (FEA) for Finance Workstations. It is presented in an abbreviated FEA format to provide executive management at all levels with a comprehensive document that contains the essential information required to support the review, approval, and decisionmaking for Finance workstations.

This document describes the current Department of Defense (DoD) Finance functional area technical workstations baseline, alternatives, and cost analyses that support a recommendation that DoD invest in DOS-based personal computers (PCs) or UNIX-based PCs to provide a new technical infrastructure to support the Finance business area. The preferred alternatives involve investing in information technology (IT) to create an end-user computing environment. The investment will improve the productivity of DoD Finance users and provide substantial benefits to DoD.

The current DoD technical workstation baseline primarily consists of 3270-type terminals and PCs emulating 3270-type terminals connected to host mainframes. With the current baseline, many Finance users are unable to use office automation software to improve their productivity. The existing workstations baseline functional activity cost is $86,981 per workstation over the 7-year life cycle considered in this FEA. This includes personnel costs, hardware and software costs, and operation and maintenance costs.

The three alternatives considered in this FEA were drawn from the Finance Workstation Guidelines to the Defense Information Technology Services Organization. They are X-terminals, DOS-based PCs, and UNIX-based PCs. The X-terminal alternative provides a graphical user interface (GUI) and terminal emulation, but lacks local processing capabilities. An X-terminal requires an investment of $2,795 per workstation and provides a total benefit of $2,951 per workstation. The DOS-based PC alternative provides the ability to locally execute commercial-off-the-shelf (COTS) software and to emulate both X-terminals and 3270-type terminals. A DOS-based PC requires an investment of $4,443 per workstation and provides a total benefit of $11,912 per workstation. The UNIX-based PC alternative provides Portable Operating Systems Interface Standard (POSIX) compliance and the ability to emulate DOS-based PCs and 3270-type terminals. UNIX is well suited for X Window applications. A UNIX-based PC requires an investment of $5,792 per workstation and provides a total benefit of $10,350 per workstation.

The DOS-based PC alternative provides the greatest cost-benefit ratio; however, the UNIX-based PC is nearly as cost effective and is based on open systems. Thus, either UNIX-based PCs or DOS-based PCs can be implemented. Because the DOS-only environment has a limited technological future, the use of DOS with windowing software is recommended for end users in the near term.

Chapter 1

OVERVIEW

1.1 Introduction

This Information Management Functional Economic Analysis (FEA) for Workstations directly supports the policies and guidance presented in the Finance Workstation Guidelines to the Defense Information Technology Services Organization document dated 30 November 1992. Originally termed a Technical Economic Analysis (TEA) with a macro-level-focused analysis of the technical alternatives, the economic analysis was expanded and termed a technical FEA (with an abbreviated FEA format) and renamed as stated above.

This document parallels three other FEAs that support the following guideline documents:

- Finance Communications Guidelines to the Defense Information Technology Services Organization
- Client/Server Guidelines to the Defense Information Technology Services Organization
- Finance User Interface Style Guide (3270) to the Defense Information Technology Services Organization

This particular FEA addresses workstations and assists in determining the cost-effectiveness of various Finance workstation configurations.

1.2 Purpose

This FEA compares the costs to the Finance functional area for each of three types of workstations with a baseline environment consisting of 3270-type terminals and Intel 80286- and 80386-class personal computers. Based on guidance provided in the Finance Workstation Guidelines to the Defense Information Technology Services Organization, the following workstation alternatives are examined:

- X-terminals
- DOS-based PCs
- UNIX-based PCs

1.3 Scope

The scope of this analysis is limited to the economic analysis of information technology (IT) alternatives to the Finance workstation technical infrastructure. While it is recognized that the functions, systems, and organizations are all affected by changes in technology, for the purposes of this analysis they remain constant. However, functional improvements such as increased productivity that result directly from technological enhancements will be considered in the analysis. Secondary effects (such as hiring or termination costs) are excluded from the scope of this analysis.

Cross-functionality of the equipment and capabilities addressed in this FEA must be considered in developing a true picture of the total package of recommended options. Functional managers must determine the full range of performance requirements and the capabilities various equipment must possess. This should be done in coordination with other functional areas where users may eventually employ the same equipment or share the equipment on a fee-for-service basis. An equitable method of spreading these costs across the other functional areas may be required in cases where, for example, another functional area uses a Finance workstation to perform an activity related to their business function.

1.4 Methodology

A technical FEA examines current and proposed technical architectures and expected financial results prior to the decision to invest in any new technologies. It quantifies technical costs, benefits, and risks, and adjusts the dollar amounts to account for the time value of money.

A FEA allows the current and forecasted costs of baseline operations over a stated economic life to be compared with alternatives associated with management initiatives. "Sunk costs" are not included in a FEA. The technical FEA applies to decisions involving proposed and existing technology. It provides support for and input to the decisionmaking process by comparing investment in various alternatives with a baseline, where each alternative is defined as a technology change leading to potential cost savings.

The Draft Department of Defense (DoD) 8020.1-M, Functional Process Improvement Manual, establishes eight sections that must be completed for a FEA:

- Section 1: Functional Area Strategic Plan
- Section 2: Functional Activity Strategic Plan
- Section 3: Functional Activity Performance Measures and Targets
- Section 4: Proposed Functional Activity Improvement Program
- Section 5: Economic Analysis of the Proposed Process Improvement Program

- Section 6: Data Management and Information Systems Strategy for the Functional Activity
- Section 7: Data and Systems Changes to Support the Functional Activity Improvement Programs
- Section 8: Data Management and System Cost Analysis

This technical FEA concentrates on section 5, the economic analysis of the proposed process improvements. Although a full FEA would require an analysis of all the process improvements, the technical FEA deals with process improvements that are directly linked to new technology. Since the main objective for this task was the analysis of section 5, the remaining seven FEA sections were not completed.

A technical FEA is developed and iteratively refined in the sequence of steps listed below:

- Determine scope of technical area
- Identify existing baseline technology
- Gather baseline costs
- Determine technical alternatives
- Perform financial simulations
- Analyze and make recommendations

To present the quantitative data necessary to support the decision to invest in new technology, the baseline costs of Finance technical workstations were gathered. Life cycle costs of continuing Finance operations were forecasted in budget-year dollars over a 7-year economic period. These costs were gathered and modeled in five technical FEA cost categories:

- Personnel
- IT hardware
- IT software
- IT operation and maintenance (O&M)
- Other (including facilities, materiel, training, etc.)

In order to perform this FEA responsively, a model and set of spreadsheet tools were developed for compiling cost-benefit data for the baseline and selected alternatives. As noted above, costs are depicted in budget-year dollars. However, the completed analysis requires a calculation of Return on Investment (ROI), which is calculated from discounted or present-value cash flows rather than from budget-year values themselves. The tools perform risk-adjusted present-value comparisons and compute the ROI using discount factors.

The assessment of risk in a proposed project or alternative is perhaps the most difficult and yet most critical task that faces managers charged with decisionmaking. Risk analysis attempts to account for underlying forecast error. In financial terms, risk analysis allows senior managers to compare the potential advantages of a proposed alternative balanced against the probability

that the predicted outcomes may not occur. The analytical methodology used to quantify and describe risk in this FEA uses a lognormal probability density function to model the risks, as directed by the most current FEA guidelines.

The analysis is performed at a macro level and includes several assumptions about the rest of the migration technical environment in order to separate the focus and scope of the FEAs. If the Finance community wishes to pursue the alternatives described in this FEA, it should first confirm the assumptions.

Specific information about the actual functions performed by particular Finance users was not available for this FEA. Aggregate user activity profiles generated by the Gartner Group were used for analysis purposes. While the aggregate user activity profile will not be accurate when compared to a particular Finance user, it may be applied to the Finance community as a whole. A precise functional activity profile could be determined through a full FEA of the Finance community.

1.5 Document Organization

The remainder of this document is organized as follows. Chapter 2 discusses the existing technical baseline and the associated costs. Chapter 3 presents the assumptions used in this analysis and discusses the technical alternatives. Chapter 4 presents the investment costs and benefits associated with each of the alternatives presented in chapter 3. Chapter 5 analyzes the risks associated with each of the alternatives, and presents the recommendations.

Appendix A provides acronym definitions. Appendix B provides a list of references. Appendix C details the recurring costs for the baseline and the three alternatives. Appendix D details the investment costs for each of the three alternatives. Appendix E includes exhibits detailing per-user and total baseline workstation costs; the per-user and total costs for X-terminal, DOS-based PC, and UNIX-based PC workstations; and the risk profiles for the baseline and alternatives.

Chapter 2

BASELINE

This chapter discusses the technology used in the Finance functional area baseline. It then discusses costs associated with that technology. Costs are given for the base year, FY 1994, unless otherwise stated. Costs are not equal to the average cost per year across the life cycle, due to inflation.

2.1 Baseline Technology

The technical baseline, or current environment, is composed primarily of roughly equal quantities of either 3270-type terminals or Intel 80286- and 80386-based PCs. Most PCs are connected to mainframe hosts through IRMA cards to provide 3270-type terminal services. Although many DOS-based PCs are used within the Finance functional area, the 3270-type processing is characteristic of the Finance technical baseline.

There are some Apple Macintosh computers in use. Few, if any UNIX-based workstations are in use. The number of small local area networks (LANs) existing is limited relative to what can exist in a truly networked end-user computing environment for the DoD.

2.2 Baseline Costs

Baseline costs total $11,030 per workstation for the base year ($86,981 for the entire life cycle). Because the baseline hardware has already been installed, no hardware costs are involved outside those required for maintenance. No software costs are associated with the current technical baseline, because the existing software has already been installed. The technical baseline has maintenance costs of about $70 per workstation ($547 for the entire life cycle), primarily related to the maintenance of hardware. Baseline personnel costs are $9,270 for the base year ($73,106 for the entire life cycle). The remaining $1,690 per workstation for the base year ($13,328 over the entire life cycle) is the baseline training cost. For detailed cost breakdowns, refer to appendix C.

Chapter 3

ALTERNATIVES

This chapter discusses the underlying assumptions and alternatives, based on the Finance Workstation Guidelines, which were used in formulating alternatives to the baseline. The following workstations are considered as alternatives to the baseline 3270-type terminals:

- X-terminals
- DOS-based PCs
- UNIX-based PCs

3.1 Assumptions

A wide range of assumptions is required in order to estimate the costs associated with the baseline and alternatives. These assumptions led to the alternatives chosen and the information included in the spreadsheets.

Finance users must be able to perform their current tasks on the 3270-type terminals. The workstation alternatives presented here are compatible with the existing technical baseline:

- Communications - Point-to-point or dial-in mainframe access is retained.
- Client/server - Existing 3270-type terminal functionality in a host-based environment is retained.
- User interface - Application-specific character-based user interfaces are supported.

Assumptions were not made with respect to the rest of the technical environment. Generally, each of the workstation alternatives is compatible with any communications, client/server model, or user interface alternative. However, X-terminals are compatible only with LAN-based communications and cannot support many client/server approaches that require workstation processing. The following services are provided to the user and workstation:

- Communications - Printer and modem services will be provided to the user, either through a LAN or as direct peripherals.
- Client/server - Finance data and applications will be available on centralized mainframes or servers.
- User interface - All alternatives provide support for graphical user interface (GUI) services and are available through MS Windows or Motif.

The alternatives presented were drawn from the guidance document, Finance Workstation Guidelines to the Defense Information Technology Services Organization. Specific workstation configurations listed within the guidelines include the following:

- LAN-attached DOS-based PCs
- Stand-alone DOS-based PCs
- Imaging DOS-based PCs
- LAN-attached UNIX-based PCs
- X-terminals

LAN-specific hardware and software are considered within this FEA, so the workstation alternatives concentrate on the following:

- X-terminals
- DOS-based PCs
- UNIX-based PCs

The targeted workstation alternatives presented in this analysis should be considered as a near-term solution. Workstations such as the ones considered in this analysis become technically obsolete after 4 to 6 years. Nonetheless, these workstation alternatives provide a new technical infrastructure to support long-term DoD and Federal objectives. In addition, the workstation alternatives provide functional capabilities that are not present in the baseline or that would be prohibitively expensive to perform using existing baseline technology.

The assumptions and constraints underlying the overall analysis and modeling of the economic activity of the Finance enterprise are as follows:

- All costs and benefits are presented for the five technical FEA cost categories:
  - Personnel
  - IT hardware
  - IT software
  - IT O&M
  - Other (including facilities, materiel, training, etc.)
- Benefits are reductions from baseline costs. All costs affected by Finance operations have been included as baseline costs in this FEA. Benefits are phased in over a 2-year period, which represents the learning curve of new technology.
- FEA costs are generally gathered and modeled for the base year and then appropriate growth rates are applied to forecast the costs for the remainder of the life cycle.
- This technical FEA uses FY 1994 as the base year. The length of the analysis is 7 years, which includes both a planning phase and a residual period. The planning phase for this FEA is 4 years, with the residual accounting for the remaining 3 years.

The planning phase represents the economic life of the new technology. All graphs have been shown over a 4-year timeframe beginning in FY 1994 and ending in FY 1997.

- All costs and benefits are in budget-year dollars, which include nominal growth (inflation and real growth). The source for the inflators is the Office of the Secretary of Defense (Comptroller) (OSD (C)). The inflation rates for each FEA cost category are as follows:

Cost Category	Type	Rate (Percent)
Personnel	Outlays - Military Personnel	3.95
IT Hardware	DoD Information Rate	12.00
IT Software	DoD Information Rate	12.00
IT O&M	Outlays - O&M	3.70
Other (Training)	Outlays - Military Personnel	3.95

According to the Bureau of Labor Statistics, there are no real growth rates in the cost categories in this FEA. Since the nominal growth rates are found by multiplying the real growth rate by the appropriate inflator, the nominal rates are the same as the inflation rates.

- To compute the ROI and present value, the model uses a 7 percent mid-year discount factor as provided in the Office of Management and Budget Guidance, Circular A94 (Revised).

- All costs are defined on a per-workstation basis, and both costs and benefits are scalable unless noted otherwise.

- All alternatives are deployed in FY 1994, but the maximum benefits are not realized until FY 1996. Only 20 percent of the maximum benefit is realized in FY 1994, while 80 percent of the maximum benefit is realized in FY 1995.

3.2 X-Terminals

An X-terminal comprises a 14- to 17-inch monitor, video processor, Ethernet connector, keyboard, and mouse. An X-terminal is bundled with appropriate software to connect to mainframe hosts and perform display management functions. An X-terminal is interoperable with any system sharing X and underlying network protocols.

X-terminals support Massachusetts Institute of Technology's (MIT's) developed X Window system, the de facto industry standard window system in the UNIX environment. An X-terminal's use is limited to display. It has no processing power and performance depends on the servers. X-terminals require annual maintenance or repairs.

3.3 DOS-Based PCs

A DOS-based PC is a 486-class machine, with 8 megabytes (MB) of random access memory (RAM), floppy diskette drives, a hard drive, video card, monitor, keyboard, and mouse. For the purposes of this analysis, MS DOS and MS Windows software, PC/TCP, and Network File System (NFS) software are required. However, in the Guidance document it is understood that the preferred configuration is TCP/IP, NFS, and X Window so that X applications can be run on the DOS-based PC. Both support most current commercial-off-the-shelf (COTS) software. Both are emerging as a common end-user environment for PC users, supporting multi-tasking and GUI. The DOS-only environment is a technological dead end. A DOS-based PC requires annual maintenance or repairs.

3.4 UNIX-Based PCs

A UNIX-based PC is a 486-class machine, with 8 MB of RAM, floppy diskette drives, a hard drive, video card, monitor, keyboard, and mouse. Software includes POSIX-compliant UNIX, TCP/IP, NFS, X Window, and Motif. DOS emulation is performed through Interactive VP/ix software. UNIX is closely aligned with the Technical Reference Model (TRM), is technically superior to DOS/Windows, and is a steadily growing market for applications. UNIX systems are particularly well suited to take advantage of client/server architectures, because internally the UNIX operating system works on the client/server principle. UNIX systems are inherently networked, multi-user, and multi-tasking. Although the clear long-term choice, UNIX/POSIX is still relatively inferior in terms of COTS software availability and price. A UNIX-based PC requires annual maintenance or repairs.

Chapter 4

BENEFITS

This section discusses the benefits the alternative workstations would provide over the current baseline.

4.1 X-Terminals

An X-terminal provides greater functionality than the 3270-type terminal. X-terminals can perform screen formatting and presentation functions that 3270-type dumb terminals cannot. Unlike PCs and workstations, X-terminals cannot perform local data processing. The host or X-server must perform the actual calculation and data processing. An X-terminal uses a bit-mapped display rather than a character display, allowing the use of a GUI. An X-terminal can provide 3270-type terminal-emulation services through server-based virtual-terminal software or by direct display of X output from an X Window-capable mainframe.

The greater functionality of the X-terminal provides benefits in user productivity over the 3270-type terminal. These benefits are derived primarily from the ability to display simultaneous output from multiple applications and to permit the user to exchange information among them. In addition, the X-terminal can connect to an X-server for access to UNIX-based COTS application software. Because the X-terminal is dependent upon a server to execute COTS software, the X-terminal provides fewer benefits than do DOS-based PCs and UNIX-based PCs, which can execute COTS application software directly.

The X-terminal alternative requires an investment of $2,795 per workstation in budget-year dollars over the full life cycle. This investment includes $1,400 in hardware costs, $300 in software costs, and $1,095 in maintenance costs. Additional details on the investment costs are included in appendix D.

The Finance community would realize benefits from this investment. (Benefits are defined as the difference between the selected alternative and the baseline.) A total of $2,951 in net benefits (including investment costs) per workstation is expected as a result of implementing X-terminals over the full life cycle. Benefits are realized in every cost category except IT software. Total benefits of $5,365 over the life cycle are expected in the personnel area, realized from the increased productivity provided by the X-terminals. The baseline hardware is sold, so both the hardware salvage value ($350) and the O&M costs associated with the baseline 3270-type terminal ($547) are classified as benefits for this alternative. The remaining $517 is a negative benefit representing the increased training costs that are necessary for the implementation of this alternative. The following table summarizes these costs and benefits. Additional discussion of the benefits is included in appendix C.

X-Terminal Benefits

Personnel	$5,364.0
IT Hardware	350.0
IT Software	0.0
IT O&M	547.3
Other	(516.7)
Gross Benefits	$5,745.5
IT Hardware Investment	(1,400.0)
IT Software Investment	(300.0)
IT O&M Investment	(1,094.5)
Net Benefits	$2,951.0

4.2 DOS-Based PCs

A DOS-based PC provides the ability to emulate both 3270-type terminals and X-terminals. In addition, DOS-based PCs can execute COTS software and remain attached to a mainframe host. DOS-based PCs provide the capability to exchange information with other hosts and process the data locally.

The DOS-based PC alternative provides benefits in user productivity. The DOS-based PC provides its user with the ability to execute office automation software to enhance user productivity. Word processing, spreadsheet, and other office automation software improve user productivity. Data can be processed locally by multiple applications, eliminating the need to rekey data while improving accuracy. Because the user can remain attached to a host while executing COTS software, less time is lost while switching between applications or host sessions.

The DOS-based PC alternative requires an investment of $4,443 per workstation in budget-year dollars over the full life cycle. This investment is composed of $2,060 in hardware costs, $780 in software costs, and $1,603 in maintenance costs. Additional details on the investment costs are included in appendix D.

The Finance community would realize benefits from this investment. A total of $11,912 in net benefits (including investment costs) per workstation is expected as a result of implementation of DOS-based PCs over the full life cycle. Benefits are realized in every cost category except IT software. Total benefits of $16,095 over the life cycle are expected in the personnel area,

realized from the increased productivity provided by the DOS-based PC. The baseline hardware is sold, so both the hardware salvage value ($350) and the O&M costs associated with the baseline 3270-type terminal ($547) are classified as benefits for this alternative. The remaining $638 is a negative benefit representing the increased training costs that are necessary for the implementation of this alternative. The following table summarizes these costs and benefits. Additional discussion of the benefits is included in appendix C.

DOS-Based PC Benefits

Personnel	$16,095.4
IT Hardware	350.0
IT Software	0.0
IT O&M	547.3
Other	(638.3)
Gross Benefits	$16,354.4
IT Hardware Investment	(2,060.0)
IT Software Investment	(780.0)
IT O&M Investment	(1,602.7)
Net Benefits	$11,911.7

4.3 UNIX-Based PCs

A UNIX-based PC also provides the ability to emulate 3270-type terminals and X-terminals. A UNIX-based PC can execute COTS software and remain attached to a mainframe host; data exchange capabilities are supported. UNIX-based PCs require DOS emulation software or hardware to execute DOS-based COTS software. In addition, UNIX-based PCs can interact with mainframe hosts as peers while transferring data or performing other functions. While providing may of the same benefits as a DOS-based PC, UNIX-based PCs are a step in the direction of interoperability and portability. UNIX also allows users to take advantage of its multi-tasking, multi-user capabilities so more users can perform more tasks.

The UNIX-based PC alternative provides benefits in user productivity. Like the DOS-based PC, the UNIX-based PC also provides its user with the ability to execute office automation software to enhance user productivity. Word processing, spreadsheet, and other office automation software can be used to simplify and speed up routine office tasks. Because the user can remain attached to a host while executing COTS software, less time is lost while switching between

applications or mainframe connections. While providing many of the same benefits as a DOS-based PC, UNIX-based PCs are a step in the direction of interoperability and portability. UNIX also allows users to take advantage of its multi-tasking, multi-user capabilities so more users can perform more tasks.

The UNIX-based PC alternative requires an investment of $5,792 per workstation in budget-year dollars over the full life cycle. This investment is composed of $2,075 in hardware costs, $2,075 in software costs, and $1,642 in maintenance costs. Additional details on the investment costs are included in appendix D.

The Finance community would realize benefits from this investment. A total of $10,350 in net benefits (including investment costs) per workstation is expected as a result of the implementation of UNIX-based PCs over the full life cycle. Benefits are realized in every cost category except IT software. Total benefits of $16,095 over the life cycle are expected in the personnel area, realized from the increased productivity provided by the UNIX PC. The baseline hardware is sold, so both the hardware salvage value ($350) and the O&M costs associated with the baseline 3270-type terminal ($547) are classified as benefits for this alternative. The remaining $851 is a negative benefit representing the increased training costs that are necessary for the implementation of this alternative. The following table summarizes these costs and benefits. Additional discussion of the benefits is included in appendix C.

UNIX-Based PC Benefits

Personnel	$16,095.4
IT Hardware	350.0
IT Software	0.0
IT O&M	547.3
Other	(851.0)
Gross Benefits	$16,141.7
IT Hardware Investment	(2,075.0)
IT Software Investment	(2,075.0)
IT O&M Investment	(1,641.8)
Net Benefits	$10,349.9

Chapter 5

ANALYSIS AND RECOMMENDATIONS

This chapter presents overall conclusions and recommendations based on the analysis performed for this FEA. It discusses the risk analysis that was performed, the analysis results, and the final comments.

5.1 Risk Analysis

The following sections describe the risk profiles that were applied to the baseline and various alternatives. According to *The Business Value of Computers*, by Paul Strassmann, risk identifies both the potential advantages of information technology investments and the chances that predicted outcomes may not materialize. The risk profiles classify the level of risk for each of the various alternatives. The profiles provide endpoints that define the best possible cost outcome, as well as the worst, for each technology investment. The risk profiles are included in appendix E.

5.1.1 BASELINE

The baseline is considered to have low risk since it is well established within the Finance functional area. However, if the Finance user community is expected to operate its business more efficiently, it will need to incorporate new technologies. If it does not, then the Finance functional area runs the risk of increasing its current operating costs in order to remain competitive.

The baseline risk is represented by a lognormal distribution with a low-end equivalent of 0.9 of the expected cost, and a high end capped at 1.22 of the expected cost. In probability terms, the distribution is identified to be within 25 percent of a standard deviation on the low end and within 50 percent of a standard deviation on the high end. Baseline costs are expected to be as forecasted in the analysis, but costs could be 10 percent lower than expected or up to 22 percent higher than expected.

5.1.2 X-TERMINALS

The X-terminal has somewhat greater risk than the 3270-type terminal that it replaces, because it is a new technology that has not been implemented within the Finance community. The risk is represented by a lognormal distribution with a low-end equivalent of 0.9 of the expected cost, and a high end capped at 1.43 of the expected cost. In probability terms, the distribution is identified to be within 25 percent of a standard deviation on the low end and within 1 standard

deviation on the high end. This means that the X-terminal costs may range from 10 percent below to 43 percent above the analysis results.

5.1.3 DOS-BASED PCs

The risk for the DOS-based PC is somewhat higher than for the 3270-type terminal, since it is more complicated. The risk is represented by a lognormal distribution with a low-end equivalent of 0.9 of the expected cost, and a high end capped at 1.65 of the expected cost. In probability terms, the distribution is identified to be within 25 percent of a standard deviation on the low end and within 1.5 standard deviations on the high end. This means that the DOS-based PC costs may range from 10 percent below to 65 percent above the analysis results.

5.1.4 UNIX-BASED PCs

The risk for the UNIX-based PC is somewhat higher than for the other alternatives because it is more expensive and less common than the other alternatives. The risk is represented by a lognormal distribution with a low-end equivalent of 0.9 of the expected cost, and a high end capped at 1.86 of the expected cost. In probability terms, the distribution is identified to be within 25 percent of a standard deviation on the low end and within 2 standard deviations on the high end. This means that the UNIX-based PC costs may range from 10 percent below to 86 percent above the analysis results.

5.2 Analysis Summary

This section summarizes the cost analysis of the baseline and alternatives presented in the FEA. The costs of the alternatives are compared with the baseline and with each other. Expected benefits are summarized. The ROI for each alternative is presented. Finally, the distribution of investment return is presented and analyzed as it relates to the risk analysis associated with each alternative.

5.2.1 COST COMPARISON FOR BASELINE AND THREE ALTERNATIVES

Exhibit 5-1 shows the total expected costs for the baseline and three alternatives at a summary level. The low, expected, and high costs over the entire life cycle are shown in exhibit 5-2.

As can be seen from these exhibits, the DOS-based PC and UNIX-based PC alternatives have the lowest costs. However, the UNIX-based PCs would require a greater investment cost in FY 1994. Both of these alternatives offer substantial benefits over the present baseline.

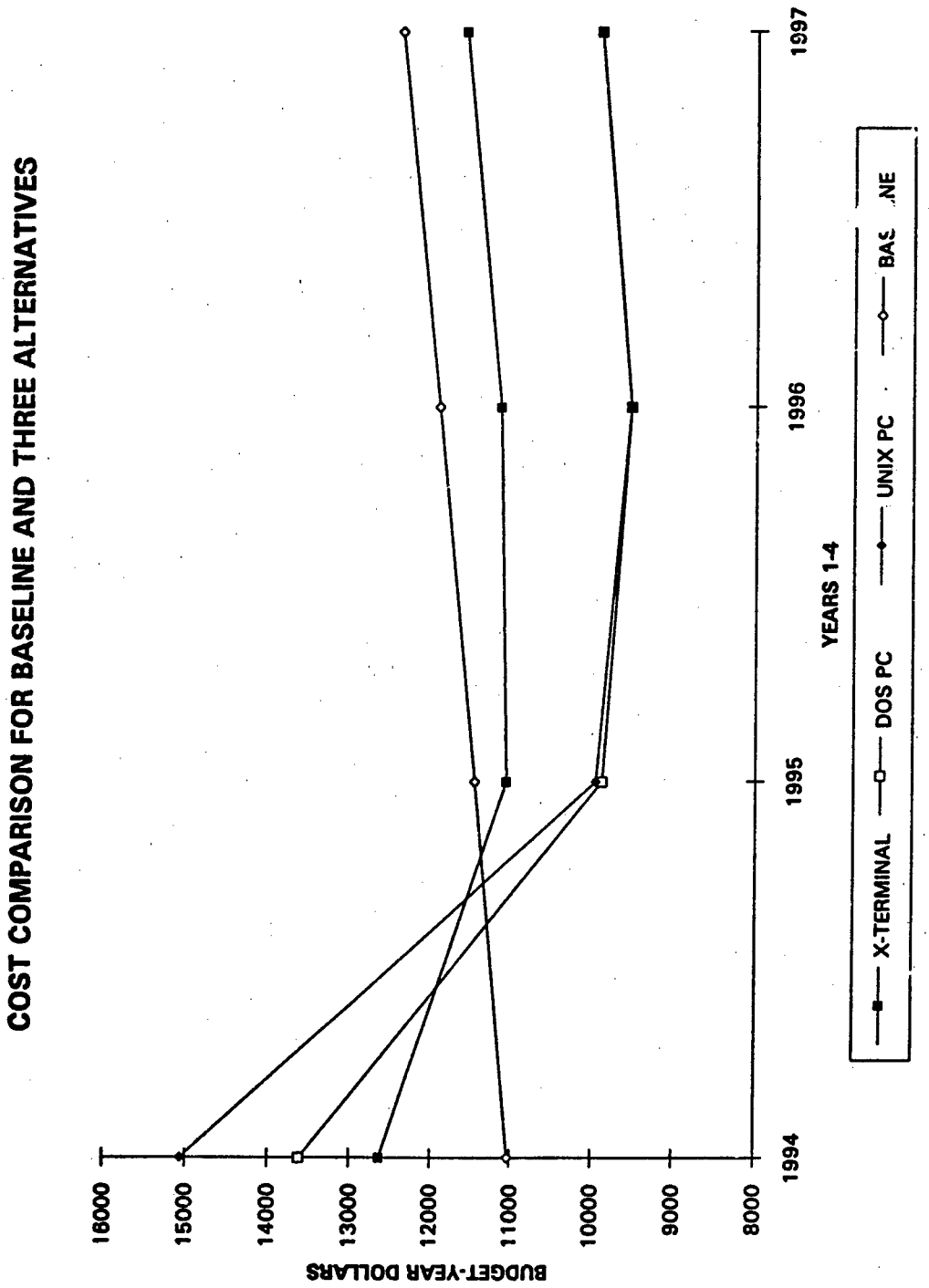
COST COMPARISON FOR BASELINE AND THREE ALTERNATIVES
BUDGET-YEAR DOLLARS
16000
15000
14000
13000
12000
11000
10000
9000
8000
1994
1995
1996
1997
YEARS 1-4
X-TERMINAL
DOS PC
UNIX PC
BAS NE

Exhibit 5-1

FINANCE WORKSTATION COSTS
BUDGET-YEAR DOLLARS

		1994	1995	1996	1997	RESIDUAL	TOTAL
BASELINE:	LOW	9,527.0	10,318.9	10,726.4	11,149.9	36,161.1	78,283.3
	EXPECTED	11,030.0	11,465.5	11,918.2	12,388.7	40,179.0	86,981.4
	HIGH	13,401.5	13,930.6	14,480.6	15,052.3	48,817.5	105,682.5
X-TERMINAL:	LOW	11,367.0	9,963.3	10,035.5	10,431.5	33,830.1	75,627.4
	EXPECTED	12,630.0	11,070.3	11,150.6	11,590.6	37,589.0	84,030.4
	HIGH	18,060.9	15,830.5	15,945.3	16,574.5	53,752.2	120,183.5
DOS-BASED PC:	LOW	12,244.5	8,891.9	8,581.3	8,919.7	28,925.5	67,562.8
	EXPECTED	13,605.0	9,879.9	9,534.7	9,910.7	32,139.4	75,069.7
	HIGH	22,380.2	16,252.4	15,684.6	16,303.2	52,869.3	123,489.7
UNIX-BASED PC:	LOW	13,554.0	8,962.0	8,586.1	8,924.7	28,941.6	68,968.4
	EXPECTED	15,060.0	9,957.8	9,540.1	9,916.3	32,157.4	76,631.6
	HIGH	28,011.6	18,521.5	17,744.6	18,444.3	59,812.7	142,534.8

Exhibit 5-2

5.2.2 BENEFIT COMPARISON OF THREE ALTERNATIVES

Exhibit 5-3 shows the total expected benefits for the three alternatives at a summary level. Exhibit 5-4 shows these values (low, expected, and high) by year over the entire life cycle. The DOS-based PC and UNIX-based PC alternatives offer the greatest expected benefit, $11,912 and $10,350 respectively, compared with the baseline.

Exhibit 5-5 shows the total expected cumulative benefits for the three alternatives at the summary level. Exhibit 5-6 shows these expected values by year over the entire life cycle. As illustrated by this exhibit, the DOS-based PC offers the greatest cumulative benefits and the earliest payback period. The UNIX-based PC offers a slightly lower cumulative benefit due to the increased investment cost that is necessary to implement this alternative. X-terminals offer cumulative benefits of $2,951, but the investment cost is not paid back until the fourth year, FY 1997.

5.2.3 RETURN ON INVESTMENT

Exhibit 5-7 provides a summary of expected costs, benefits, and ROI for each of these alternatives. The top portion of the exhibit presents total costs, investment, and expected benefits in budget-year dollars over the full life cycle, The lower portion of the exhibit, entitled Return on Investment, presents the ROI calculation. The calculation of the ROI requires conversion of dollar values to a discounted, or present value, form.

The ROI is defined as the baseline cost minus the alternative cost divided by the investment cost. The alternative cost includes the investment for that alternative. Thus, the resulting benefit is a net value.

The expected ROI for all of the alternatives is positive. The DOS-based PCs yield the greatest ROI, with an expected ROI value that is 60 percent greater than for the UNIX-based PCs and almost 300 percent greater than for the X-terminals.

5.2.4 DISTRIBUTION OF INVESTMENT RETURN

Determining the distribution of expected investment return is the final process in the analysis methodology that links baseline, alternative, benefits, and ROI. The underlying risk assessment that was constructed for each alternative now interacts with the expected ROI to provide a probability distribution of the investment return. Exhibits 5-8, 5-9, and 5-10 show the distribution of investment return for each of the alternatives.

As explained in section 5.2.3, the model calculates ROI as the quotient of the baseline discounted cost minus the alternative discounted cost (including investment) divided by the alternative discounted investment. Each risk profile provides 20 cost multipliers that, when multiplied by the total baseline or alternative cost, define a range of possible costs. The ROI

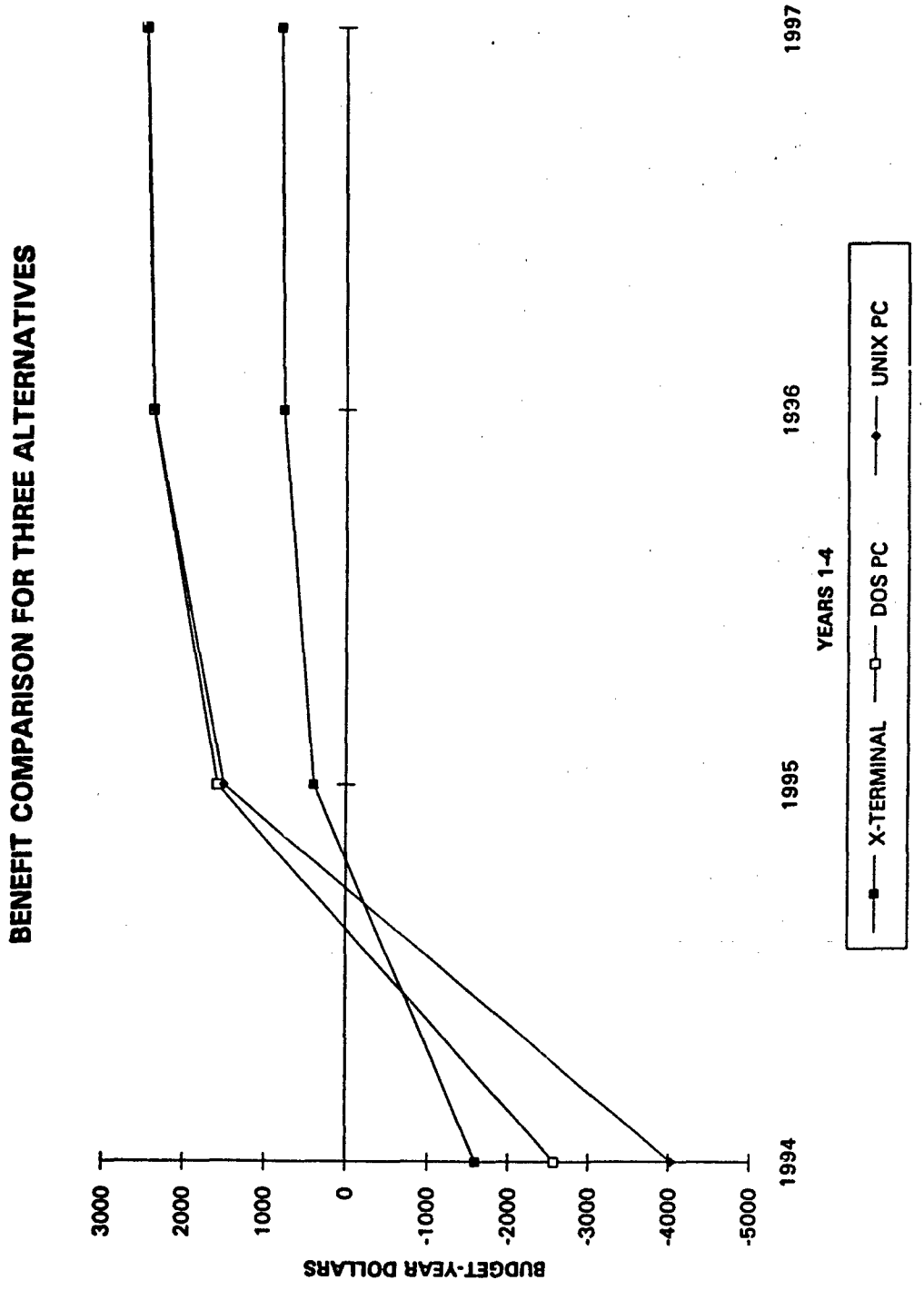
BENEFIT COMPARISON FOR THREE ALTERNATIVES
BUDGET-YEAR DOLLARS
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
1994
1995
1996
1997
YEARS 1-4
X-TERMINAL
DOS PC
UNIX PC

Exhibit 5-3

FINANCE WORKSTATION BENEFITS
BUDGET-YEAR DOLLARS

		1994	1995	1996	1997	RESIDUAL	TOTAL
X-TERMINAL:	LOW	-1,440.0	355.7	690.9	718.3	2,331.1	2,655.9
	EXPECTED	-1,600.0	395.2	767.6	798.2	2,590.1	2,951.0
	HIGH	-2,288.0	565.2	1,097.7	1,141.4	3,703.8	4,220.0
DOS PC:	LOW	-2,317.5	1,427.1	2,145.1	2,230.2	7,235.7	10,720.5
	EXPECTED	-2,575.0	1,585.6	2,383.4	2,478.0	8,039.6	11,911.7
	HIGH	-4,235.9	2,608.4	3,920.8	4,076.3	13,225.2	19,594.8
UNIX PC:	LOW	-3,627.0	1,356.9	2,140.3	2,225.2	7,219.5	9,314.9
	EXPECTED	-4,030.0	1,507.7	2,378.1	2,472.4	8,021.7	10,349.9
	HIGH	-7,495.8	2,804.3	4,423.2	4,598.7	14,920.3	19,250.7

Exhibit 5-4

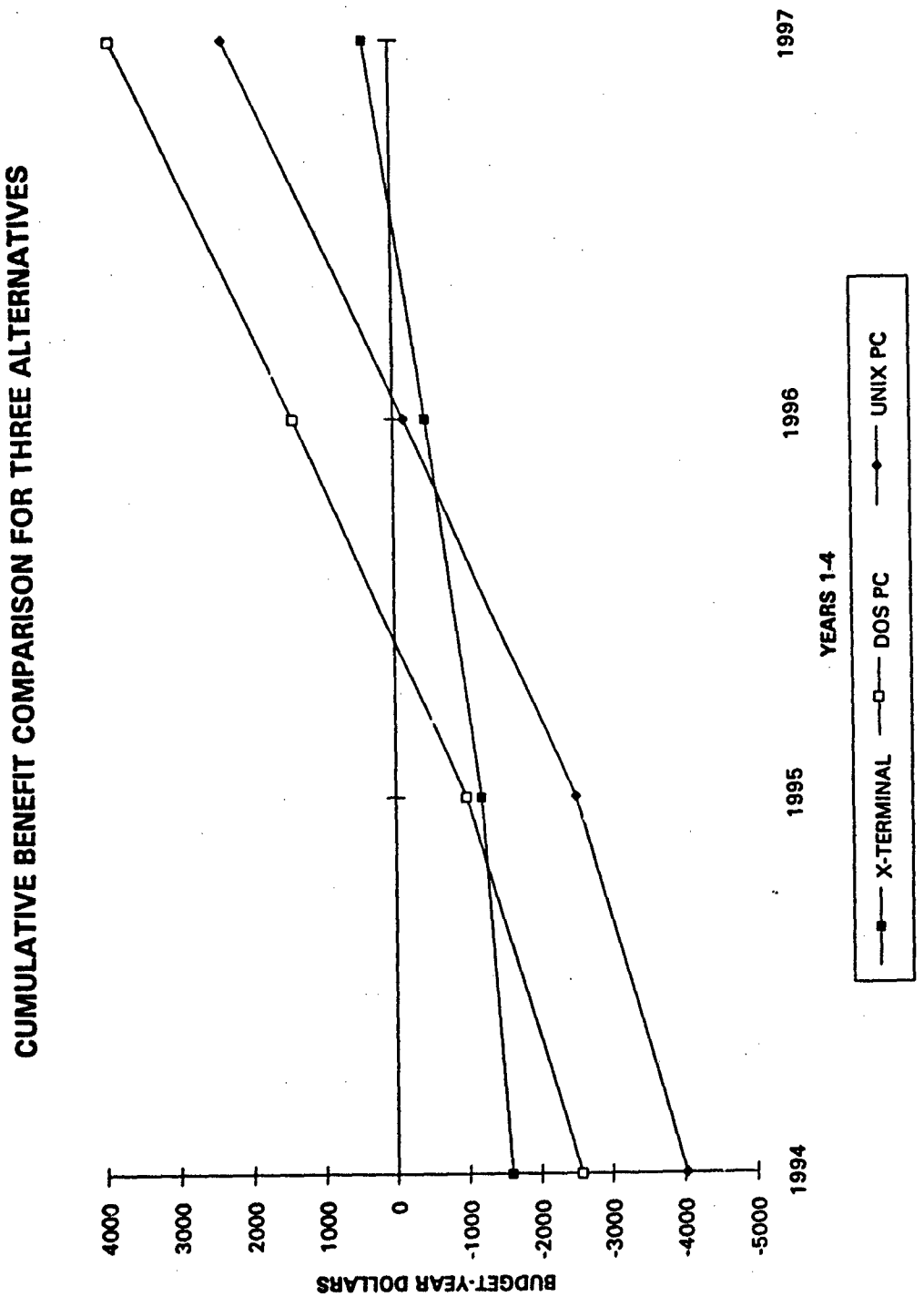
CUMULATIVE BENEFIT COMPARISON FOR THREE ALTERNATIVES
BUDGET-YEAR DOLLARS
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
1994
1995
1996
1997
YEARS 1-4
X-TERMINAL
DOS PC
UNIX PC

Exhibit 5-5

FINANCE WORKSTATION CUMULATIVE BENEFITS
BUDGET-YEAR DOLLARS

		1994	1995	1996	1997	RESIDUAL
X-TERMINAL:	EXPECTED	-1,600.0	-1,204.8	-437.2	361.0	2,951.0
DOS PC:	EXPECTED	-2,575.0	-989.4	1,394.1	3,872.1	11,911.7
UNIX PC:	EXPECTED	-4,030.0	-2,522.3	-144.3	2,328.2	10,349.9

Exhibit 5-6

SUMMARY OF EXPECTED COSTS AND BENEFITS
FY 1994 - FY 2000

BUDGET-YEAR DOLLARS			
ALTERNATIVES	EXPECTED INVESTMENT	EXPECTED COSTS	EXPECTED NET BENEFITS
BASELINE	N/A	86,981.4	N/A
X-TERMINAL	2,794.5	84,030.4	2,951.0
DOS PC	4,442.7	75,069.7	11,911.7
UNIX PC	5,791.8	76,631.6	10,349.9

RETURN ON INVESTMENT CALCULATION
FY 1994 - FY 2000

DISCOUNTED DOLLARS				
ALTERNATIVES	EXPECTED INVESTMENT	EXPECTED COSTS	EXPECTED NET BENEFITS	EXPECTED ROI %
BASELINE	N/A	67,719.8	N/A	N/A
X-TERMINAL	2,497.2	65,901.6	1,970.9	72.8%
DOS PC	3,995.9	59,437.4	7,955.4	207.3%
UNIX PC	5,293.5	60,936.2	6,912.3	128.2%

Exhibit 5-7

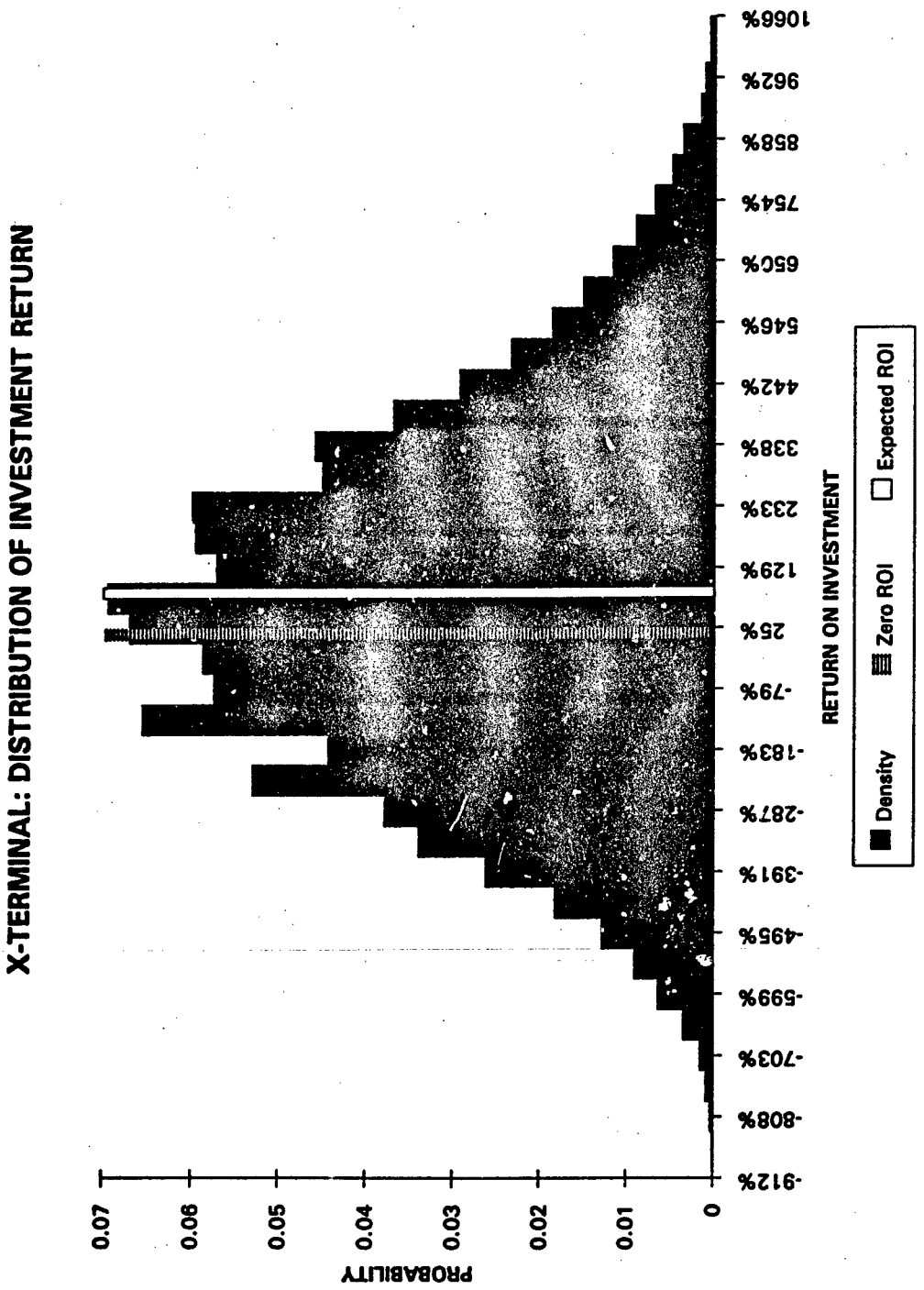
X-TERMINAL: DISTRIBUTION OF INVESTMENT RETURN
PROBABILITY
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
RETURN ON INVESTMENT
-912%
-808%
-703%
-599%
-495%
-391%
-287%
-183%
-79%
25%
129%
233%
338%
442%
546%
650%
754%
858%
962%
1066%
Density
Zero ROI
Expected ROI

Exhibit 5-8

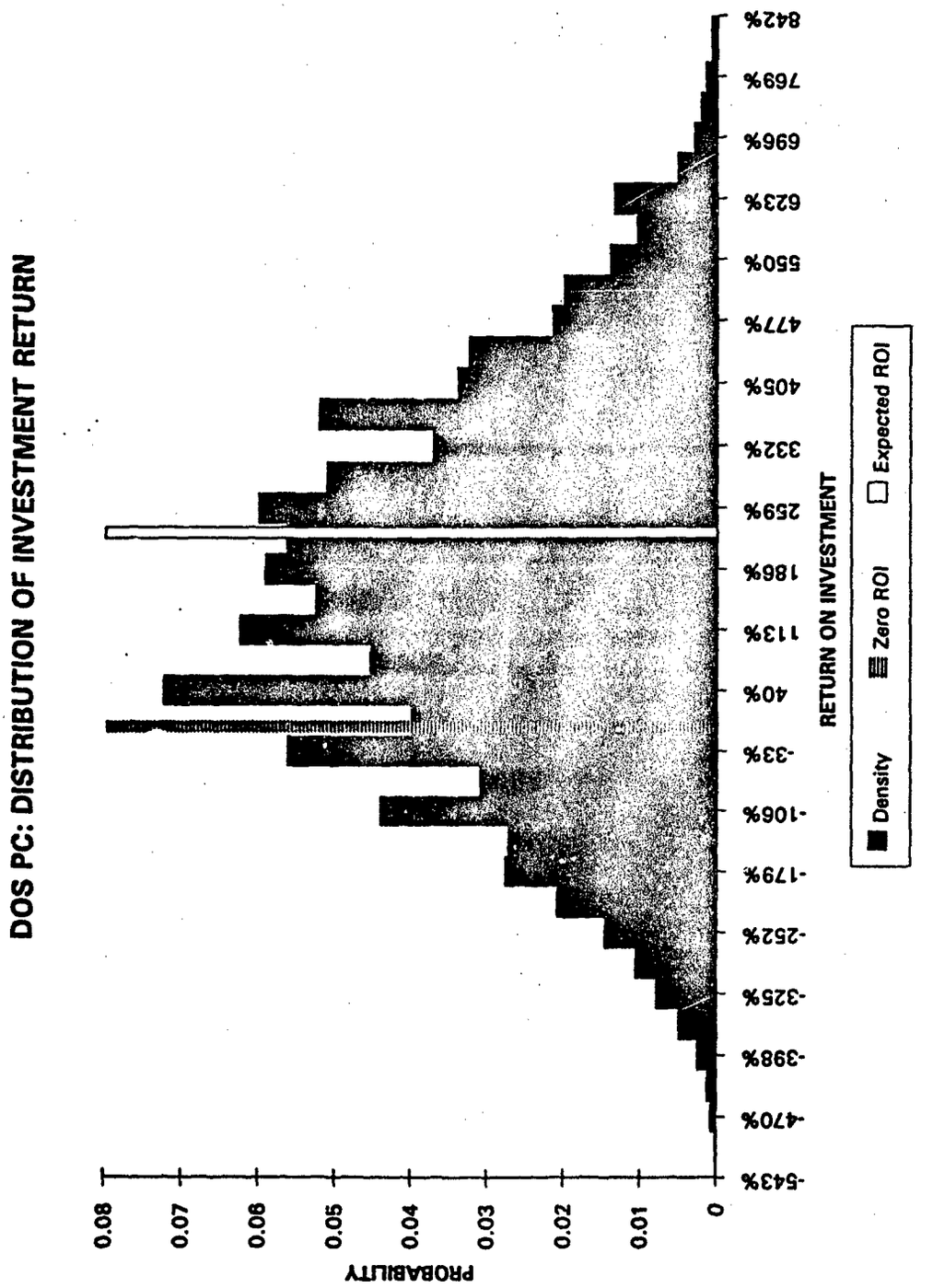
DOS PC: DISTRIBUTION OF INVESTMENT RETURN
PROBABILITY
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
RETURN ON INVESTMENT
-543%
-470%
-398%
-325%
-252%
-179%
-106%
-33%
40%
113%
186%
259%
332%
405%
477%
550%
623%
696%
769%
842%
Density
Zero ROI
Expected ROI

Exhibit 5-9

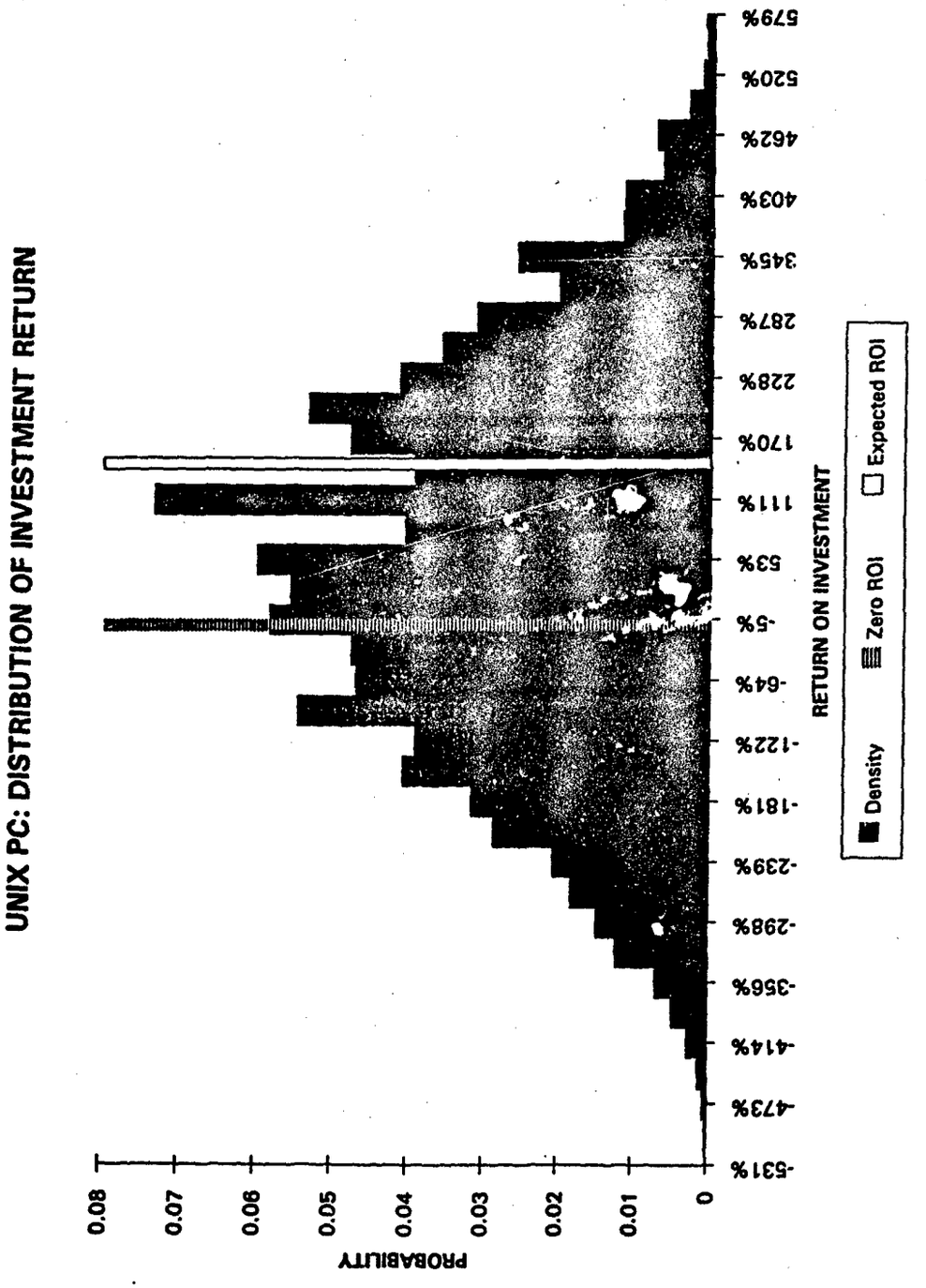
UNIX PC: DISTRIBUTION OF INVESTMENT RETURN
PROBABILITY
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
RETURN ON INVESTMENT
579%
520%
462%
403%
345%
287%
228%
170%
111%
53%
-5%
-64%
-122%
-181%
-239%
-298%
-356%
-414%
-473%
-531%
Density
Zero ROI
Expected ROI

Exhibit 5-10

calculation is performed for every possible combination of these derived cost multipliers for the baseline and alternatives (20 values for the baseline and 20 values for the alternative resulting in 400 total observations). The 400 points are then graphed in order to display the range of possible ROIs and their probabilities that can result from the alternative.

The expected ROI is identified in each exhibit. The single most important factor to consider when viewing and interpreting these probability distributions is the tendency of the distribution to skew around the expected value. Since the expected ROI is the value that was calculated from the most likely baseline and alternative costs, this ROI, or a ROI in a close range to this value, is likely to occur. If there is a large probability surrounding the expected value, then the decisionmaker can have confidence in using the calculated ROI to make an investment decision.

Each of the distributions displays a zero ROI, the point where the investment pays for itself or "breaks even." This value helps to define the possibility of a negative return from the investment. In addition to the zero reference point, the high and low endpoints provide valuable information for the decisionmaker. Even though the probability associated with the high and low endpoints is small, these points identify the worst case scenario and the best case scenario for the decisionmaker.

In all three alternatives, there is a large probability surrounding the expected ROI, so the decisionmaker should feel confident that the expected ROI can be used in making the investment decision. The DOS PC alternative has the greatest ROI as well as the greatest probability (71 percent) of a positive ROI. The UNIX PC alternative has the second-highest ROI with a 57 percent probability of returning a positive ROI. The X-terminals alternative provides the lowest ROI with a 49 percent probability of a negative ROI. The X-terminals alternative provides the best case scenario for an ROI, 1066 percent, but also provides the worst case scenario with a possibility for a -912 percent ROI.

5.3 Recommendations

This FEA performed for the DoD Finance functional area demonstrates the potential for significant benefits that can be realized through the adoption of new workstation technologies. On the basis of this cost-benefit analysis, the recommendation is to invest $4,443 per workstation in DOS-based PCs.

While the DOS-based PC alternative offers the potential for a greater ROI, the selection of either DOS-based PCs or UNIX-based PCs can achieve significant enough benefits to justify the investment costs. Both of these alternatives offer substantial benefits that pay back the investment within 3 years. The X-terminal alternative also provides potential benefits, but both the ROI and total benefit are significantly lower than with the other two alternatives.

In addition, other subjective or nonquantified factors are relevant. For example, the 3270-type terminal and X-terminal alternatives have higher security since all software must be loaded onto a server or host by a central administrator. Since the X-terminal and UNIX-based PC

alternatives are based on open systems, both are TRM-compliant and would not need to be replaced or upgraded to achieve TRM compliance.

Finally, more than one platform may be appropriate due to the variety of functions performed by the Finance community. If a Finance user cannot use the additional functionality provided by a more expensive alternative, then it is not cost effective to provide that alternative. Conversely, if an alternative lacks adequate support for a user to perform his or her functions, then it is not an effective solution.

APPENDIXES

APPENDIX A

ACRONYM DEFINITIONS

Appendix A

ACRONYM DEFINITIONS

COTS	Commercial-Off-the-Shelf
DISA	Defense Information Systems Agency
DoD	Department of Defense
EMI	Electromagnetic Interference
FEA	Functional Economic Analysis
FTP	File Transfer Protocol
FY	Fiscal Year
GUI	Graphical User Interface
HDS	Human Designed Systems, Inc.
IDE	Integrated Drive Electronics
ISA	Industry Standard Architecture
IT	Information Technology
KB	Kilobyte
LAN	Local Area Network
MB	Megabyte
MHz	Megahertz
NFS	Network File System
O&M	Operation and Maintenance
OSD(C)	Office of the Secretary of Defense (Comptroller)
PC	Personal Computer

PC/TCP	Personal Computer/Transmission Control Protocol
POSIX	Portable Operating Systems Interface Standard
RAM	Random Access Memory
RCAS	Reserve Components Automation System
RFI	Radio Frequency Interference
ROI	Return on Investment
SMC	Small Multiuser Computer
SVGA	Super Video Graphics Array
TCP/IP	Transmission Control Protocol/Internet Protocol
TRM	Technical Reference Manual

APPENDIX B

REFERENCES

Appendix B

REFERENCES

The following references were used in developing this FEA:

Corporate Information Management Functional Economic Analysis Guidebook, 15 January 1993.

Finance Workstation Guidelines to the Defense Information Technology Services Organization, 30 November 1992.

HDS Catalog. Human Designed Systems, Inc. 421 Fehley Drive, King of Prussia, Pennsylvania 19406. (215) 277-8300 voice. HDS supplies X Window terminals for the Boeing Company under the Reserve Component Automation System (RCAS) for the U.S. Army Reserve and Army National Guard.

"Productivity Management." *Personal Computing*. Gartner Group, Inc. End-user computing has high investment costs, with potential benefits of 20 to 50 percent. Management of improved productivity is important, and job functions may change.

Small Multiuser Computer (SMC) Contract. 13600 EDS Drive, Herndon, Virginia 22071. (800) 762-3371 voice. The SMC contract has Intel-based hardware and software for DOS and UNIX systems. Training and engineering services are also available.

APPENDIX C

RECURRING COSTS

Appendix C

RECURRING COSTS

This appendix details the recurring costs associated with the baseline and each of the three alternatives: X-terminals, DOS-based PCs, and UNIX-based PCs.

The recurring costs for the baseline and each of the three alternatives are categorized into personnel costs, IT hardware costs, IT software costs, IT operation and maintenance costs, and other costs. Costs are presented on a per-workstation basis. All costs are gathered and discussed for the base year, FY 1994. Costs are not equal to the average cost per year across the life cycle, due to inflation.

C.1 Baseline

The technical baseline has recurring costs in personnel, ongoing maintenance, and other training. No hardware or software costs are associated with the baseline. These costs are also plotted in appendix E.

C.1.1 PERSONNEL

Baseline personnel costs of $9,270 per workstation have been identified as follows:

- Technical-user costs of $5,480 per year per workstation
- Direct-support user costs of $3,790 per year per workstation

Technical-user costs of $5,480 per year per workstation are based on an estimate that the typical Finance user spends 13 percent of his or her time performing tasks that can be improved through office automation. The technical Finance user is a civilian whose annual salary and benefits in FY 1994 are $42,190, the DoD composite compensation rate for civilians. A Gartner Group study states that 13 percent of a typical user's time is spent on clerical tasks. Technical-user activities include connecting to mainframes, producing memoranda and notes, analyzing information, and writing reports.

The Gartner Group found that as an aggregate, users without computers spent 17 percent of their time on management tasks, 54 percent on professional tasks, 8 percent on support tasks 13 percent on clerical tasks, and 7 percent nonproductively. As an aggregate, users with computers spent 16 percent of their time on management tasks, 67 percent on professional tasks, 3 percent on support tasks, 7 percent on clerical tasks, and 7 percent nonproductively.

Direct-support user costs of $3,790 per year per workstation are based on an estimate that a typical support person spends 67 percent of his or her time supporting five technical users. The

direct-support person is an enlisted person whose annual salary and benefits in FY 1994 are $28,254, the DoD composite compensation rate for enlisted personnel. Direct-support activities include typing, copying, filing, proofing, editing, and mailing.

C.1.2 IT HARDWARE

The existing technical baseline has no associated IT hardware costs. The 3270-type terminals and their host mainframes have already been installed, so those hardware costs are sunk costs.

C.1.3 IT SOFTWARE

The current baseline has no associated IT software costs. The host-based application software already has been installed on the host mainframes, so those software costs are sunk costs.

C.1.4 IT OPERATION AND MAINTENANCE

The 3270-type terminals require $70 in annual maintenance or repairs. The $70 maintenance cost is based on industry norms of 10 percent annual maintenance for a replacement 3270-type terminal. Under the SMC contract, an equivalent 3270-type terminal costs $700.

C.1.5 OTHER

The baseline has additional training costs associated with it. Training costs of $1,690 per person per year are based on industry norms for equivalent commercial practices. A typical user should spend 2 weeks per year in training and is paid an average of $21 per hour, the DoD composite compensation rate for civilian personnel. This training may be composed of formal class-based instruction, informal training by co-workers and other users, and informal self-training as the user explores the capabilities of the workstation and its software.

C.2 X-Terminals

The X-terminal alternative affects recurring costs in personnel and other training. Ongoing maintenance costs for 3270-type terminals are eliminated. No hardware or software costs are associated with the X-terminal alternative.

C.2.1 PERSONNEL

The X-terminal alternative affects personnel costs as follows:

- Technical-user costs per workstation are reduced by 5 percent after the second year.
- Direct-support user costs per workstation are reduced by 13 percent after the second year.

Over a 2-year period, technical-user costs are reduced by 5 percent and direct-support user costs are reduced by 13 percent over 2 years. Twenty percent of the benefit occurs during the first year and the remaining 80 percent during the second year. These benefits are realized because the X-terminal provides additional capabilities over the 3270-type terminal, although an X-terminal cannot execute COTS software. An X-terminal can connect to multiple hosts simultaneously, emulating various types of terminals or managing the display for native X Window applications. The X-terminal must connect to a server or host to allow the user to run application software. The full 20 percent to 50 percent benefit for end-user computing projected by the Gartner Group cannot be realized with an X-terminal.

C.2.2 IT HARDWARE

The X-terminal alternative recovers $350 as the salvage value of the user's 3270-type terminal. The X-terminal replaces the 3270-type terminal, so the old 3270-type terminal can be sold. The salvage value of the 3270-type terminal is 50 percent of the value of an equivalent new terminal, which costs $700 under the SMC contract.

C.2.3 IT SOFTWARE

The X-terminal alternative has no associated software costs because the 3270-type terminals have no associated software.

C.2.4 IT OPERATION AND MAINTENANCE

The X-terminal alternative eliminates recurring baseline maintenance costs because the X-terminal replaces the user's 3270-type terminal.

C.2.5 OTHER

The X-terminal alternative increases other training costs. An additional 16 hours ($340) in the first year and an additional 8 hours ($170) in the second year are spent becoming familiar with the X-terminal. Training costs are increased initially because the user must learn how to use the

new capabilities of the X-terminal. After the user has become familiar with the X-terminal, the training cost returns to its original level.

C.3 DOS-Based PCs

The DOS-based PC alternative affects recurring costs in personnel. Ongoing maintenance costs for 3270-type terminals are eliminated. No hardware costs, software costs, or other costs are associated with the alternative.

C.3.1 PERSONNEL

The DOS-based PC alternative affects personnel costs as follows:

- Technical-user costs are reduced by 15 percent per workstation.
- Direct-support user costs are reduced by 40 percent per workstation.

Technical-user costs are reduced by approximately 15 percent because the additional functionality of the DOS-based PC allows the user to perform tasks in less time with the aid of COTS application software. Based on Gartner Group studies, technical personnel with PCs can be 20 percent to 50 percent more productive than personnel who do not have PCs. A 15 percent cost reduction is conservative for technical users.

Direct-support user costs are reduced by approximately 40 percent based on experience within both Government and industry. These reductions are due to greater efficiencies due to the ability to execute COTS software. With the ability to execute COTS software, 1 support person assists 10 technical people. Based on Gartner Group studies, direct-support personnel with PCs are 50 percent more productive than personnel who do not have PCs. A 40 percent cost reduction is conservative for support staff.

C.3.2 IT HARDWARE

The DOS-based PC alternative recovers $350 as the salvage value of the user's 3270-type terminal. The PC replaces the 3270-type terminal, so the old 3270-type terminal can be sold. The salvage value of the 3270-type terminal is 50 percent of the value of an equivalent new terminal, which costs $700 under the SMC contract.

C.3.3 IT SOFTWARE

The DOS-based PC alternative has no associated software costs, since the 3270-type terminals have no associated software.

C.3.4 IT OPERATION AND MAINTENANCE

The DOS-based PC alternative eliminates recurring baseline maintenance costs because the DOS-based PC replaces the user's 3270-type terminal.

C.3.5 OTHER

The DOS-based PC alternative increases other training costs. An additional 20 hours in the first year and an additional 10 hours in the second year are spent becoming familiar with the PC. Training costs are increased initially because the user must learn how to use the new capabilities of the PC. After the user has become familiar with the PC, the training cost returns to its original level. Because the DOS-based PC is more complicated than an X-terminal, a DOS-based PC has higher initial training costs.

C.4 UNIX-Based PCs

The UNIX-based PC alternative affects recurring costs in personnel. Ongoing maintenance costs for 3270-type terminals are eliminated. No hardware costs, software costs, or other costs are associated with the alternative.

C.4.1 PERSONNEL

The UNIX-based PC alternative affects personnel costs as follows:

- Technical-user costs are reduced by 15 percent per workstation.
- Direct-support user costs are reduced by 40 percent per workstation.

Technical-user costs are reduced by approximately 15 percent because the additional functionality of the UNIX-based PC allows the user to perform tasks in less time with the aid of COTS application software. Based on Gartner Group studies, technical personnel with PCs can be 20 percent to 50 percent more productive than personnel who do not have PCs. A 15 percent cost reduction is conservative for technical staff.

Direct-support user costs are reduced by approximately 40 percent based on experience within both Government and industry. These reductions are due to greater efficiencies due to the ability to execute COTS software. With the ability to execute COTS software, one support person assists 10 technical people. Based on Gartner Group studies, direct-support personnel with PCs are 50 percent more productive than personnel who do not have PCs. A 40 percent cost reduction is conservative for support staff.

C.4.2 IT HARDWARE

The UNIX-based PC alternative recovers $350 as the salvage value of the user's recurring 3270-type terminal costs.

C.4.3 IT SOFTWARE

The UNIX-based PC alternative has no associated software costs.

C.4.4 IT OPERATION AND MAINTENANCE

The UNIX-based PC alternative eliminates recurring baseline maintenance costs because the UNIX-based PC replaces the 3270-type terminal.

C.4.5 OTHER

The UNIX-based PC alternative increases other training costs. An additional 26 hours in the first year and an additional 13 hours in the second year are spent becoming familiar with the PC. Training costs are increased initially because the user must learn how to use the new capabilities of the PC. After the user has become familiar with the PC, the training cost returns to its original value. Because the UNIX-based PC is more complicated than either an X-terminal or a DOS-based PC, the UNIX-based PC has higher initial training costs than either of the alternatives.

APPENDIX D

INVESTMENT COSTS

Appendix D

INVESTMENT COSTS

This appendix details the investment costs associated with each of the three alternatives: X-terminals, DOS-based PCs, and UNIX-based PCs.

The investment costs for each of the three alternatives are categorized into IT hardware costs, IT software costs, and IT operation and maintenance costs. Costs are presented on a per-workstation basis. Costs are gathered and discussed for the base year, FY 1994. Costs are not equal to the average cost per year across the life cycle, due to inflation.

D.1 X-Terminals

The X-terminal alternative requires an investment in hardware and ongoing maintenance or repairs. Most software for the X-terminal is included with the hardware. The investment costs for the X-terminal alternative are plotted in appendix E.

D.1.1 IT HARDWARE

The X-terminal used for this analysis costs $1,400. It includes a high-resolution 14-inch color display, video processor, 4 MB RAM, network interface, mouse, keyboard, and X-terminal client software. This price is based on the *HDS Catalog* price for X-terminals that are being supplied to the U.S. Army Reserve and Army National Guard under the RCAS contract.

X-terminals can be configured with many options, such as a larger display ($900 additional for 17-inch color display), different network interfaces ($80 per additional port), or additional memory ($75 per MB RAM).

D.1.2 IT SOFTWARE

The X-terminal includes software for performing video processing, for connecting to a server, and for input/output and display management. In addition, DEC VT320 terminal emulation, OpenLook, Motif, Telnet, FTP, and TCP/IP software are included. This software is included with the purchase of the X-terminal. Software for 3270-type terminal emulation would be required, at a cost of about $100.

D.1.3 IT OPERATION AND MAINTENANCE

Based on an initial hardware cost of $1,400, the X-terminal requires $140 in annual maintenance or repairs.

D.2 DOS-Based PCs

The DOS-based PC alternative requires investment in hardware and software. In addition, the DOS-based PC requires ongoing maintenance or repairs. Operating system software is bundled with the hardware and the mouse is bundled with the GUI operating environment software. The investment costs for the DOS-based PC are plotted in appendix E.

D.2.1 IT HARDWARE

The DOS-based PC used in this analysis costs $2,060. It includes an ASL 486DX-33 Industry Standard Architecture (ISA) computer with 8 MB RAM, 80 MB Integrated Drive Electronics (IDE) hard drive, 1.44 MB and 1.2 MB floppy drives, Super Video Graphics Array (SVGA) graphics with 512 KB video RAM, 14-inch color monitor, keyboard, and MS-DOS v5.0.

Actual DOS-based PCs vary widely in their configurations. A DOS-based PC can have many options, ranging from more processing capability to additional storage. For example, RAM costs $40 per additional MB, a larger 213 MB hard drive adds $150, and a removable 88 MB hard drive costs $430.

D.2.2 IT SOFTWARE

The DOS-based PC requires $780 in software investment consisting of the following:

• MS Windows bundle	$ 80
• PC/TCP with NFS	100
• X-Vision	300
• 3270-type terminal emulator	100
• Application software	200

The MS Windows bundle includes the MS Windows v3.1 GUI and a mouse. The operating system was bundled with the hardware. Network software is provided through PC/TCP and NFS. X-terminal and 3270-type terminal capabilities are provided through emulation software. Application software provides office automation support with a word processor and spreadsheet.

D.2.3 IT OPERATION AND MAINTENANCE

The DOS-based PC will require $205 in annual maintenance or repairs. This is based on a 10 percent annual maintenance rate for $2,060 worth of hardware.

D.3 UNIX-Based PCs

The UNIX-based PC alternative requires investment in hardware and software. In addition, the UNIX-based PC requires ongoing maintenance or repairs. The investment costs for this alternative are plotted in appendix E.

D.3.1 IT HARDWARE

The $2,075 UNIX-based PC hardware investment consists of the following:

• UNIX PC bundle	$2,060
• Mouse	15

The representative UNIX-based PC is an ASL 433 PC available through the SMC contract. The UNIX-based PC bundle is an Intel 486DX 33 megahertz (MHz)-based ISA computer with 8 MB RAM, 80 MB IDE hard drive, combination 1.44 MB and 1.2 MB floppy drive, SVGA graphics with 512 KB video RAM, 14-inch color monitor, and keyboard.

Like DOS-based PCs, UNIX-based PCs can vary widely in their configurations. A UNIX-based PC has the same options as a DOS-based PC, with RAM costing $40 per additional MB, a larger 213 MB hard drive for an additional $150, and a removable 88 MB hard drive costing $430.

D.3.2 IT SOFTWARE

The $2,075 UNIX-based PC software investment consists of the following:

• Interactive POSIX UNIX SVR3 (1 to 2 users)	$132
• Interactive TCP/IP	285
• Interactive NFS	294
• Interactive VP/ix DOS emulator	289
• 3270-type terminal emulator	100
• X Window and Motif	475
• X-Vision	300
• Applications software	200

A POSIX-compliant operating system and GUI are provided through UNIX, X Window, and Motif. Network software is provided through TCP/IP and NFS. X-terminal, 3270-type terminal, and DOS capabilities are all provided through emulation software. Application software provides office automation support with a word processor and spreadsheet.

D.3.3 IT OPERATION AND MAINTENANCE

The UNIX-based PC will require $210 in annual maintenance or repairs. This is based on a 10 percent annual maintenance rate for $2,060 worth of hardware.

APPENDIX E

SUPPORTING EXHIBITS

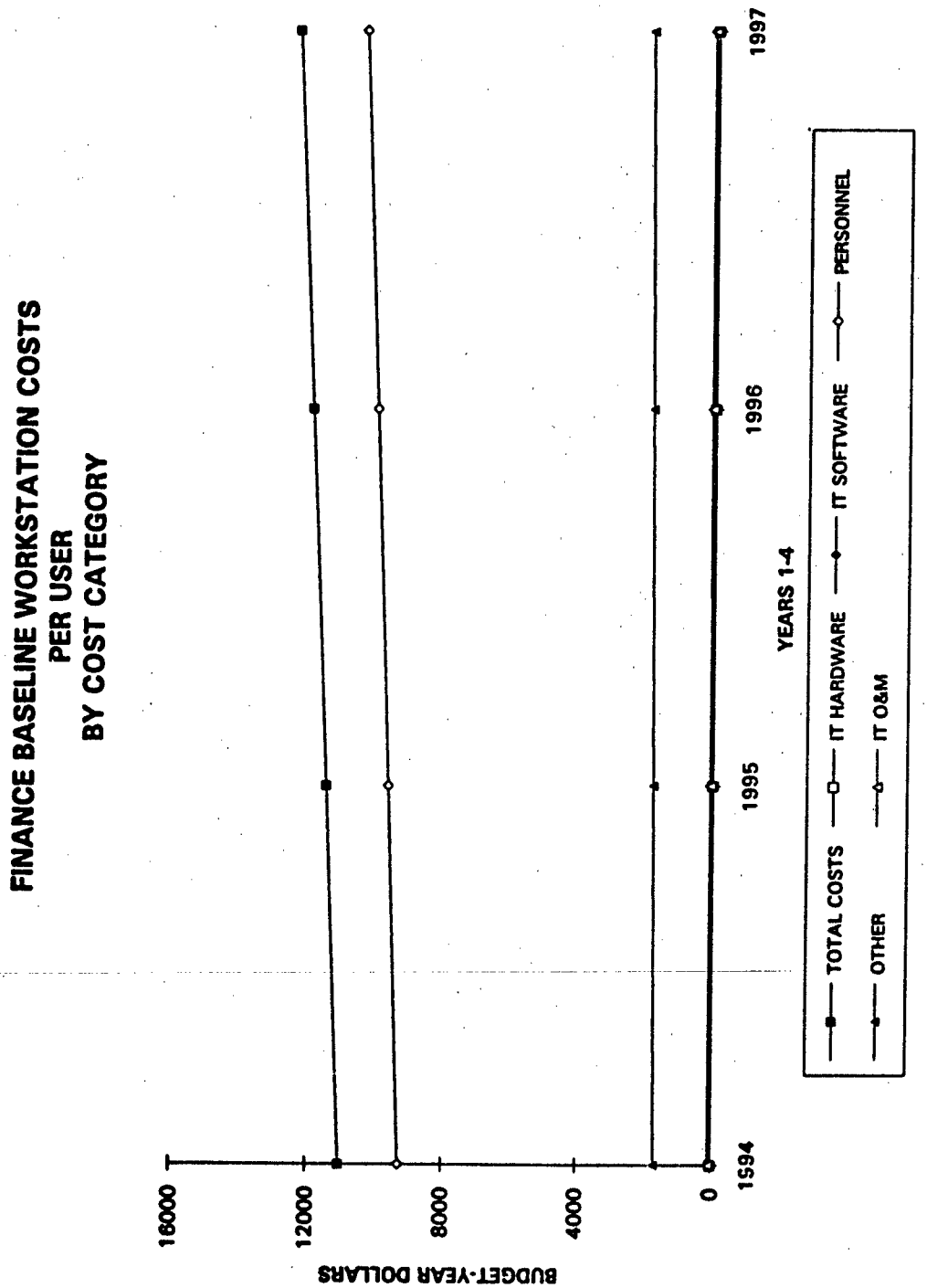
FINANCE BASELINE WORKSTATION COSTS
PER USER
BY COST CATEGORY
BUDGET-YEAR DOLLARS
16000
12000
8000
4000
0
1994
1995
1996
1997
YEARS 1-4
TOTAL COSTS
IT HARDWARE
IT SOFTWARE
PERSONNEL
OTHER
IT O&M

Exhibit E-1

TOTAL BASELINE WORKSTATION COSTS
BUDGET-YEAR DOLLARS

COST CATEGORY		Year 1 1994	Year 2 1995	Year 3 1996	Year 4 1997	RESIDUAL 1998-2000	TOTAL 1994-2000
Recurring							
	Low	8,343.0	8,672.6	9,015.1	9,371.2	30,393.7	65,795.6
Personnel	Expected	9,270.0	9,636.2	10,016.8	10,412.5	33,770.8	73,106.3
	High	11,263.1	11,707.9	12,170.4	12,651.2	41,031.6	88,824.1
	Low	0.0	0.0	0.0	0.0	0.0	0.0
IT Hardware	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	0.0	0.0	0.0	0.0	0.0	0.0
IT Software	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	63.0	65.3	67.7	70.2	226.3	492.5
IT O&M	Expected	70.0	72.6	75.2	78.0	251.5	547.3
	High	85.1	88.2	91.4	94.7	305.6	664.9
	Low	1,521.0	1,581.1	1,643.5	1,708.5	5,541.0	11,995.1
Other	Expected	1,690.0	1,756.8	1,826.1	1,898.3	6,156.7	13,327.9
	High	2,053.4	2,134.5	2,218.8	2,306.4	7,480.4	16,193.4
	Low	9,927.0	10,318.9	10,726.4	11,149.9	36,161.1	78,283.3
Total Recurring Costs	Expected	11,030.0	11,465.5	11,918.2	12,388.7	40,179.0	86,981.4
	High	13,401.5	13,930.6	14,480.6	15,052.3	48,817.5	105,682.5
Investment							
	Low	0.0	0.0	0.0	0.0	0.0	0.0
IT Hardware	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	0.0	0.0	0.0	0.0	0.0	0.0
IT Software	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	0.0	0.0	0.0	0.0	0.0	0.0
IT O&M	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	0.0	0.0	0.0	0.0	0.0	0.0
Total Investment Costs	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	9,927.0	10,318.9	10,726.4	11,149.9	36,161.1	78,283.3
TOTAL COST	Expected	11,030.0	11,465.5	11,918.2	12,388.7	40,179.0	86,981.4
	High	13,401.5	13,930.6	14,480.6	15,052.3	48,817.5	105,682.5
	Low	9,927.0	10,318.9	10,726.4	11,149.9	36,161.1	78,283.3
BASELINE COST	Expected	11,030.0	11,465.5	11,918.2	12,388.7	40,179.0	86,981.4
	High	13,401.5	13,930.6	14,480.6	15,052.3	48,817.5	105,682.5

(Totals may not be exact due to rounding)

Exhibit E-2

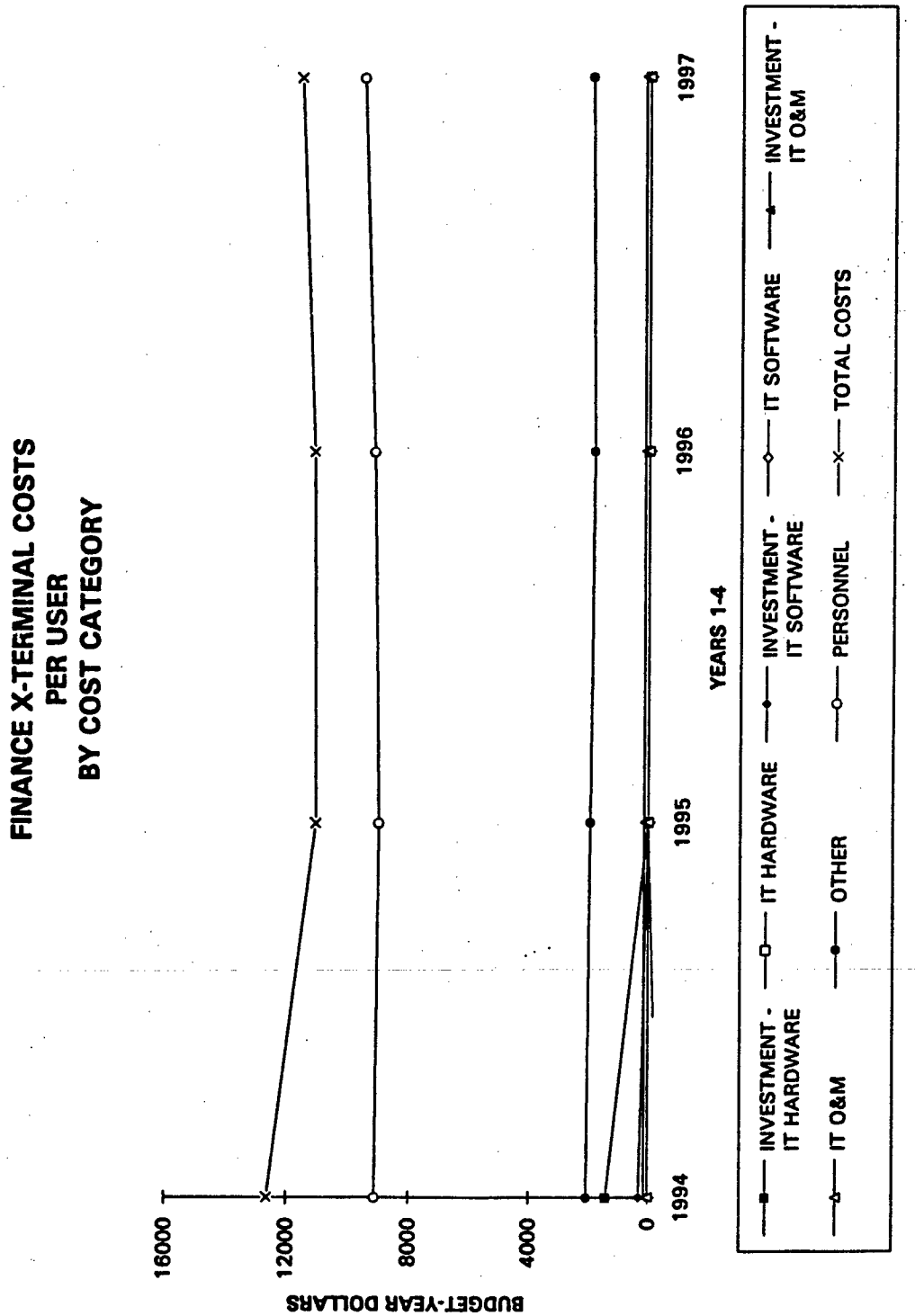
FINANCE X-TERMINAL COSTS
PER USER
BY COST CATEGORY
BUDGET-YEAR DOLLARS
16000
12000
8000
4000
0
1994
1995
1996
1997
YEARS 1-4
INVESTMENT - IT HARDWARE
IT HARDWARE
INVESTMENT - IT SOFTWARE
IT SOFTWARE
INVESTMENT - IT O&M
IT O&M
OTHER
PERSONNEL
TOTAL COSTS

Exhibit E-3

TOTAL COSTS
ALTERNATIVE ONE: X-TERMINAL
BUDGET-YEAR DOLLARS

COST CATEGORY		Year 1 1994	Year 2 1995	Year 3 1996	Year 4 1997	RESIDUAL 1998-2000	TOTAL 1994-2000
Recurring							
	Low	8,199.0	8,092.5	8,256.6	8,582.7	27,836.3	60,967.1
Personnel	Expected	9,110.0	8,991.7	9,174.0	9,536.3	30,929.3	67,741.3
	High	13,027.3	12,858.1	13,118.8	13,637.0	44,228.9	96,870.0
	Low	-315.0	0.0	0.0	0.0	0.0	-315.0
IT Hardware	Expected	-350.0	0.0	0.0	0.0	0.0	-350.0
	High	-500.5	0.0	0.0	0.0	0.0	-500.5
	Low	0.0	0.0	0.0	0.0	0.0	0.0
IT Software	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	0.0	0.0	0.0	0.0	0.0	0.0
IT O&M	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	1,827.0	1,740.1	1,643.5	1,708.5	5,541.0	12,460.2
Other	Expected	2,030.0	1,933.5	1,826.1	1,898.3	6,156.7	13,844.6
	High	2,902.9	2,764.9	2,611.4	2,714.5	8,804.1	19,797.8
Total	Low	9,711.0	9,832.6	9,900.1	10,291.2	33,377.4	73,112.3
Recurring Costs	Expected	10,790.0	10,925.2	11,000.1	11,434.6	37,086.0	81,235.9
	High	15,429.7	15,623.0	15,730.2	16,351.5	53,033.0	116,167.3
Investment							
	Low	1,260.0	0.0	0.0	0.0	0.0	1260.0
IT Hardware	Expected	1,400.0	0.0	0.0	0.0	0.0	1400.0
	High	2,002.0	0.0	0.0	0.0	0.0	2002.0
	Low	270.0	0.0	0.0	0.0	0.0	270.0
IT Software	Expected	300.0	0.0	0.0	0.0	0.0	300.0
	High	429.0	0.0	0.0	0.0	0.0	429.0
	Low	126.0	130.6	135.4	140.4	452.7	985.1
IT O&M	Expected	140.0	145.1	150.4	156.0	503.0	1094.5
	High	200.2	207.5	215.1	223.0	719.3	1565.2
Total	Low	1656.0	130.6	135.4	140.4	452.7	2515.1
Investment Costs	Expected	1840.0	145.1	150.4	156.0	503.0	2794.5
	High	2631.2	207.5	215.1	223.0	719.3	3996.2
	Low	11,367.0	9,963.3	10,035.5	10,431.5	33,830.1	75,627.4
TOTAL COST	Expected	12,630.0	11,070.3	11,150.6	11,590.6	37,589.0	84,030.4
	High	18,060.9	15,830.5	15,945.3	16,574.5	53,752.2	120,163.5
	Low	9,927.0	10,318.9	10,726.4	11,149.9	36,161.1	78,283.3
BASELINE COST	Expected	11,030.0	11,465.5	11,918.2	12,388.7	40,179.0	86,981.4
	High	13,401.5	13,930.6	14,480.6	15,052.3	48,817.5	105,682.5
BENEFITS	Expected	-1600.0	395.2	767.6	798.2	2590.1	2951.0
CUMULATIVE BENEFITS	Expected	-1,600.0	-1,204.8	-437.2	361.0	2,951.0	

(Totals may not be exact due to rounding)

Exhibit E-4

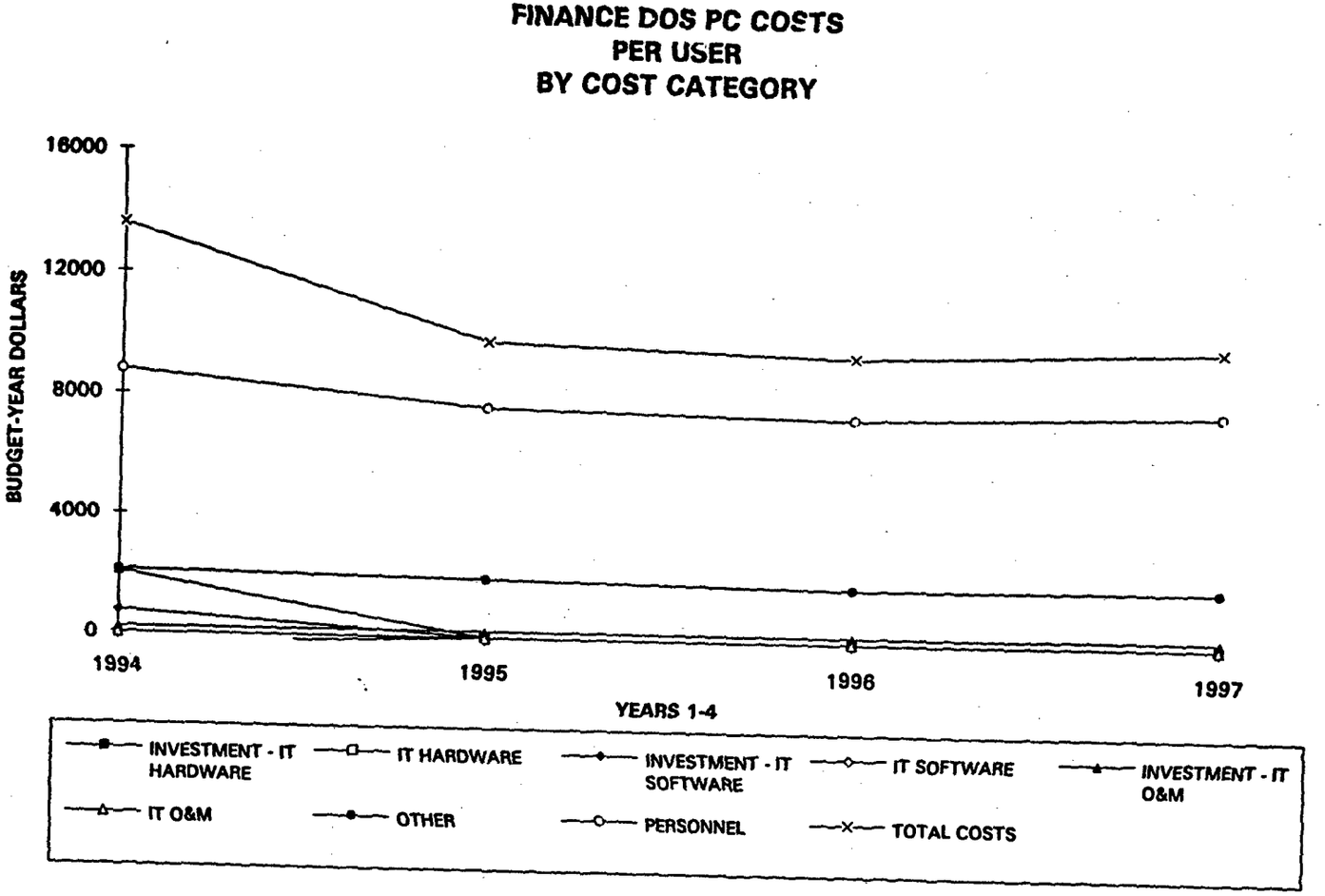
FINANCE DOS PC COSTS
PER USER
BY COST CATEGORY
BUDGET-YEAR DOLLARS
16000
12000
8000
4000
0
1994
1995
1996
1997
YEARS 1-4
INVESTMENT - IT HARDWARE
IT HARDWARE
INVESTMENT - IT SOFTWARE
IT SOFTWARE
INVESTMENT - IT O&M
IT O&M
OTHER
PERSONNEL
TOTAL COSTS

Exhibit E-5

TOTAL COSTS
ALTERNATIVE TWO: DOS PC
BUDGET-YEAR DOLLARS

COST CATEGORY		Year 1 1994	Year 2 1995	Year 3 1996	Year 4 1997	Residual 1998-2000	TOTAL 1994-2000
Recurring							
	Low	7,920.0	6,923.1	6,739.5	7,005.7	22,721.5	51,309.7
Personnel	Expected	8,900.0	7,692.3	7,488.3	7,784.1	25,246.2	57,010.8
	High	14,476.0	12,653.8	12,318.2	12,804.8	41,529.9	93,782.8
	Low	-315.0	0.0	0.0	0.0	0.0	-315.0
IT Hardware	Expected	-350.0	0.0	0.0	0.0	0.0	-350.0
	High	-575.8	0.0	0.0	0.0	0.0	-575.8
	Low	0.0	0.0	0.0	0.0	0.0	0.0
IT Software	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	0.0	0.0	0.0	0.0	0.0	0.0
IT O&M	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
	Low	1,899.0	1,777.5	1,643.5	1,708.5	5,541.0	12,569.6
Other	Expected	2,110.0	1,975.1	1,826.1	1,898.3	6,156.7	13,966.2
	High	3,471.0	3,249.0	3,004.0	3,122.7	10,127.8	22,974.4
Total	Low	9,504.0	8,700.6	8,383.0	8,714.1	28,262.6	63,564.3
Recurring Costs	Expected	10,560.0	9,667.4	9,314.4	9,682.4	31,402.9	70,627.0
	High	17,371.2	15,902.8	15,322.3	15,927.5	51,657.7	116,181.5
Investment							
	Low	1,854.0	0.0	0.0	0.0	0.0	1854.0
IT Hardware	Expected	2,060.0	0.0	0.0	0.0	0.0	2060.0
	High	3,388.7	0.0	0.0	0.0	0.0	3388.7
	Low	702.0	0.0	0.0	0.0	0.0	702.0
IT Software	Expected	780.0	0.0	0.0	0.0	0.0	780.0
	High	1,283.1	0.0	0.0	0.0	0.0	1283.1
	Low	184.5	191.3	198.3	205.5	662.9	1442.4
IT O&M	Expected	205.0	212.5	220.3	228.4	736.5	1602.7
	High	337.2	349.6	362.4	375.7	1,211.6	2636.5
Total	Low	2740.5	191.3	198.3	205.5	662.9	3998.4
Investment Costs	Expected	3045.0	212.5	220.3	228.4	736.5	4442.7
	High	5009.0	349.6	362.4	375.7	1211.6	7308.3
	Low	12,244.5	8,891.9	8,581.3	8,919.7	28,925.5	67,562.8
TOTAL COST	Expected	13,605.0	9,879.9	9,534.7	9,910.7	32,139.4	75,069.7
	High	22,380.2	16,252.4	15,684.6	16,303.2	52,869.3	123,489.7
	Low	9,927.0	10,318.9	10,726.4	11,149.9	36,161.1	78,283.3
BASELINE COST	Expected	11,030.0	11,465.5	11,918.2	12,388.7	40,179.0	86,981.4
	High	13,401.5	13,930.6	14,480.6	15,052.3	48,817.5	105,682.5
BENEFITS	Expected	-2,575.0	1,585.6	2,383.4	2,478.0	8,039.6	11,911.7
CUMULATIVE BENEFITS	Expected	-2,575.0	-989.4	1,394.1	3,872.1	11,911.7	

(Totals may not be exact due to rounding)

Exhibit E-6

FINANCE UNIX PC COSTS PER USER BY COST CATEGORY

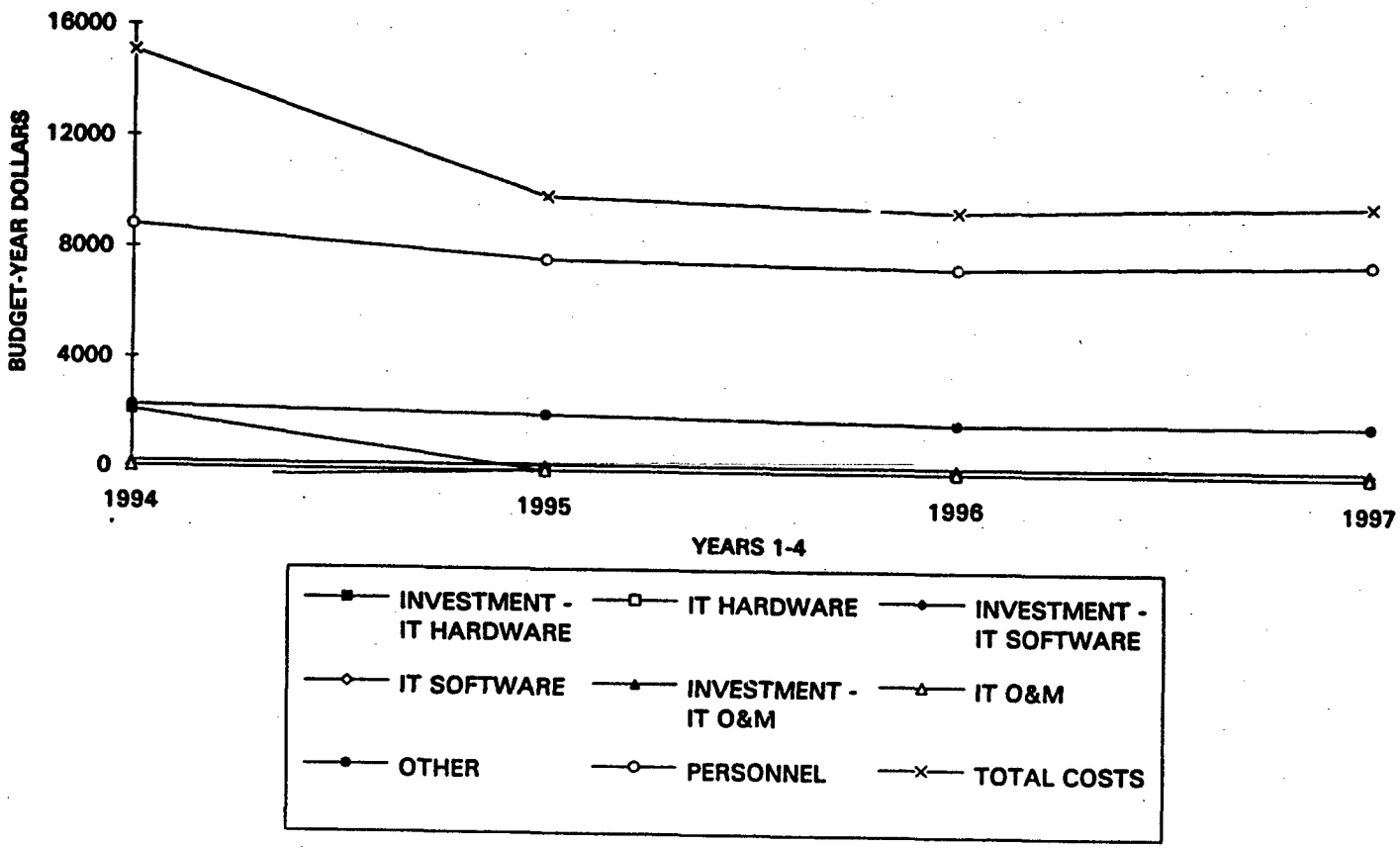

Exhibit E-7

TOTAL COSTS
ALTERNATIVE THREE: UNIX PC
BUDGET-YEAR DOLLARS

COST CATEGORY		Year 1 1994	Year 2 1995	Year 3 1996	Year 4 1997	RESIDUAL 1998-2000	TOTAL 1994-2000
Recurring							
Personnel	Low	7,920.0	6,923.1	6,739.5	7,005.7	22,721.5	51,309.7
	Expected	8,800.0	7,692.3	7,488.3	7,784.1	25,246.2	57,010.8
	High	16,368.0	14,307.7	13,928.2	14,478.4	46,957.9	106,040.1
IT Hardware	Low	-315.0	0.0	0.0	0.0	0.0	-315.0
	Expected	-350.0	0.0	0.0	0.0	0.0	-350.0
	High	-651.0	0.0	0.0	0.0	0.0	-651.0
IT Software	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
IT O&M	Low	0.0	0.0	0.0	0.0	0.0	0.0
	Expected	0.0	0.0	0.0	0.0	0.0	0.0
	High	0.0	0.0	0.0	0.0	0.0	0.0
Other	Low	2,025.0	1,843.0	1,643.5	1,708.5	5,541.0	12,761.1
	Expected	2,250.0	2,047.8	1,826.1	1,898.3	6,156.7	14,179.0
	High	4,185.0	3,808.9	3,396.6	3,530.8	11,451.5	26,372.9
Total Recurring Costs	Low	9,630.0	8,766.1	8,383.0	8,714.1	28,262.6	63,755.8
	Expected	10,700.0	9,740.1	9,314.4	9,682.4	31,402.9	70,839.8
	High	19,902.0	18,116.6	17,324.9	18,009.2	58,409.3	131,762.0
Investment							
IT Hardware	Low	1,867.5	0.0	0.0	0.0	0.0	1867.5
	Expected	2,075.0	0.0	0.0	0.0	0.0	2075.0
	High	3,859.5	0.0	0.0	0.0	0.0	3859.5
IT Software	Low	1,867.5	0.0	0.0	0.0	0.0	1867.5
	Expected	2,075.0	0.0	0.0	0.0	0.0	2075.0
	High	3,859.5	0.0	0.0	0.0	0.0	3859.5
IT O&M	Low	189.0	195.9	203.1	210.5	679.0	1477.6
	Expected	210.0	217.7	225.7	233.9	754.5	1641.8
	High	390.6	404.9	419.7	435.1	1,403.4	3053.7
Total Investment Costs	Low	3924.0	195.9	203.1	210.5	679.0	5212.6
	Expected	4360.0	217.7	225.7	233.9	754.5	5791.8
	High	8109.6	404.9	419.7	435.1	1403.4	10772.7
TOTAL COST	Low	13,554.0	8,962.0	8,586.1	8,924.7	28,941.6	68,968.4
	Expected	15,060.0	9,957.8	9,540.1	9,916.3	32,157.4	76,631.6
	High	28,011.6	18,521.5	17,744.6	18,444.3	59,812.7	142,534.8
BASELINE COST	Low	9,927.0	10,318.9	10,726.4	11,149.9	36,161.1	78,283.3
	Expected	11,030.0	11,465.5	11,918.2	12,388.7	40,179.0	86,981.4
	High	13,401.5	13,930.6	14,480.6	15,052.3	48,817.5	105,682.5
BENEFITS	Expected	-4,030.0	1,507.7	2,378.1	2,472.4	8,021.7	10,349.9
CUMULATIVE BENEFITS	Expected	-4,030.0	-2,522.3	-144.3	2,328.2	10,349.9	

(Totals may not be exact due to rounding)

Exhibit E-8

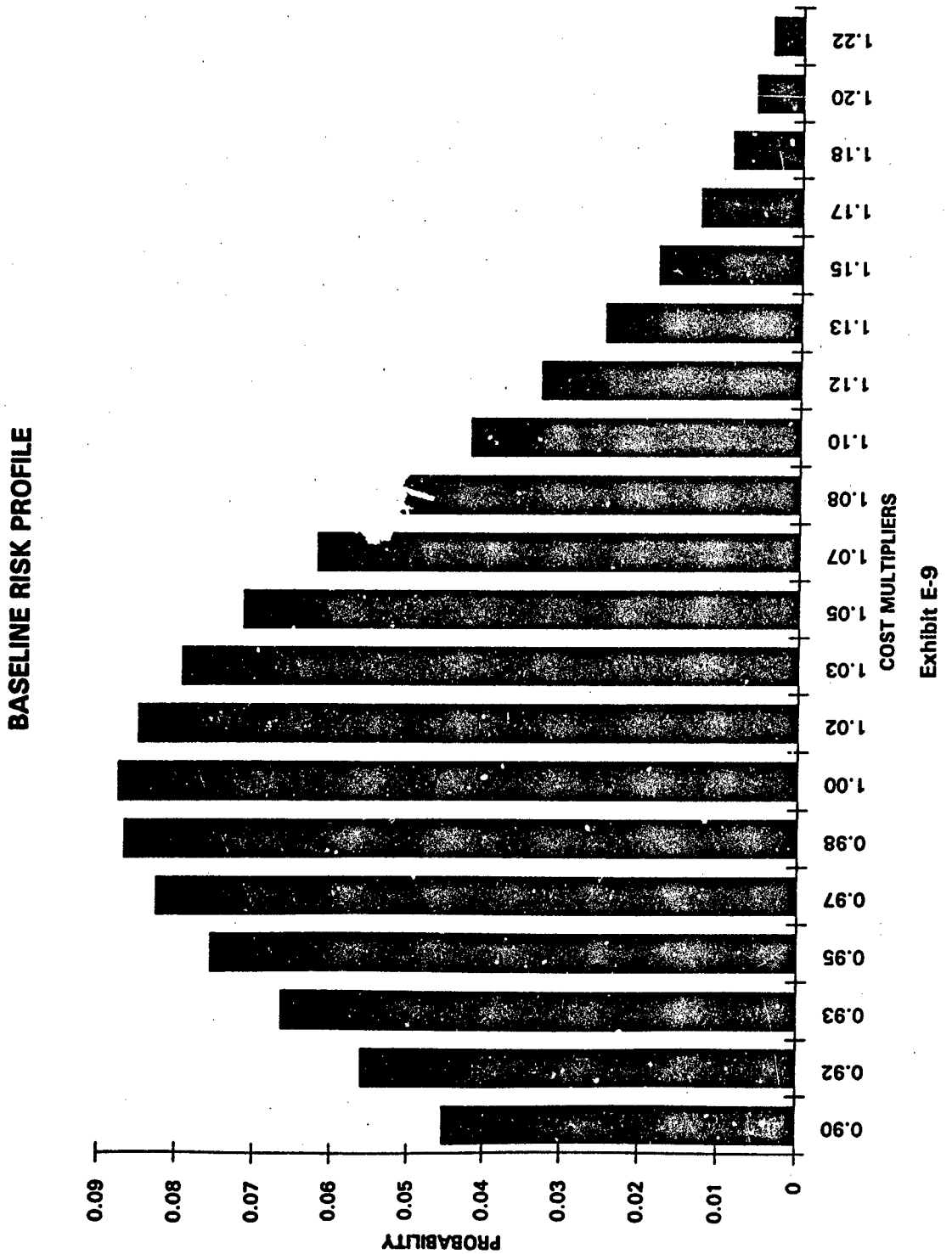
BASELINE RISK PROFILE
PROBABILITY
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
COST MULTIPLIERS
0.90
0.92
0.93
0.95
0.97
0.98
1.00
1.02
1.03
1.05
1.07
1.08
1.10
1.12
1.13
1.15
1.17
1.18
1.20
1.22

Exhibit E-9

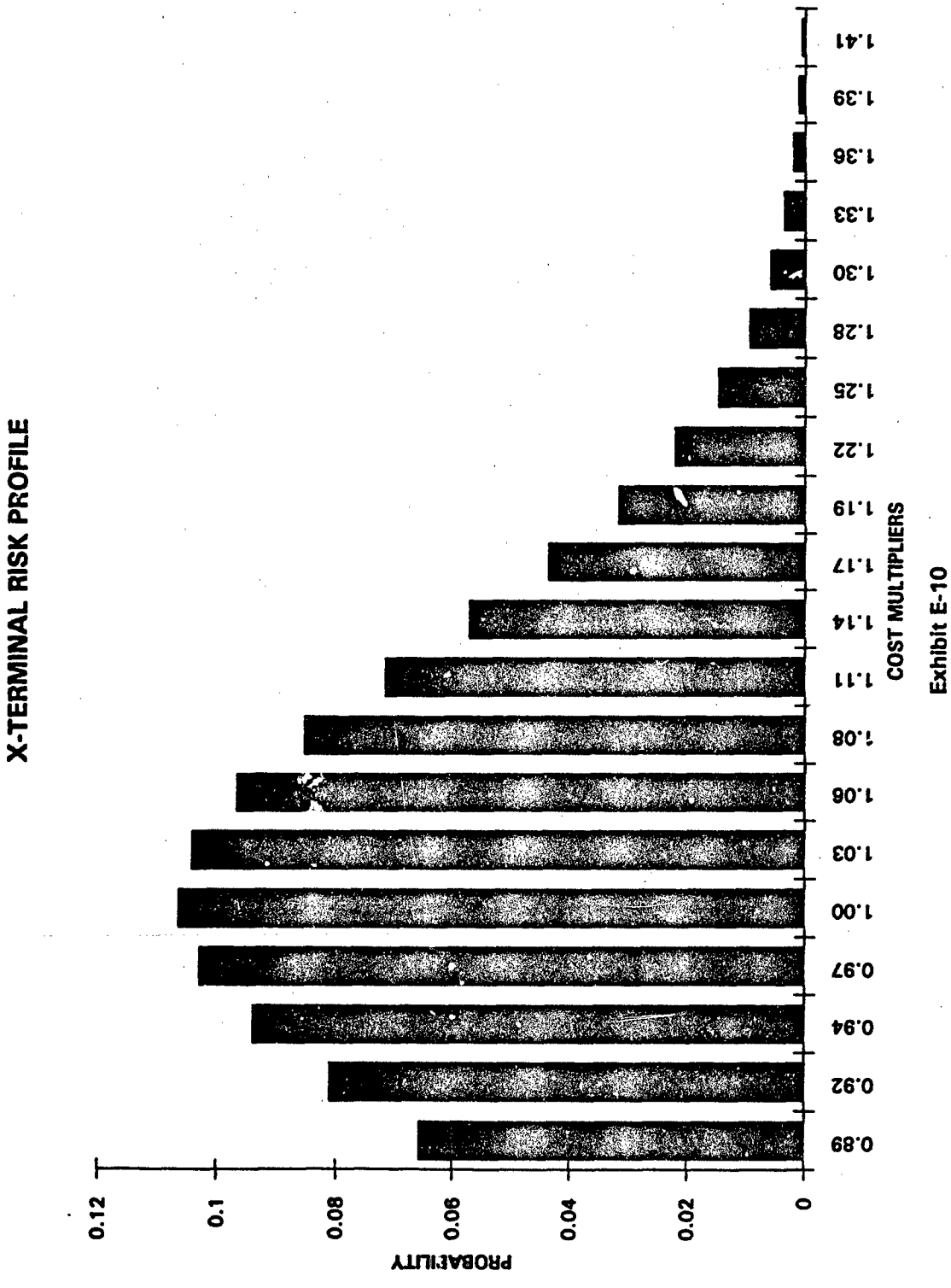
X-TERMINAL RISK PROFILE
PROBABILITY
0.12
0.1
0.08
0.06
0.04
0.02
0
COST MULTIPLIERS
0.89
0.92
0.94
0.97
1.00
1.03
1.06
1.08
1.11
1.14
1.17
1.19
1.22
1.25
1.28
1.30
1.33
1.36
1.39
1.41

Exhibit E-10

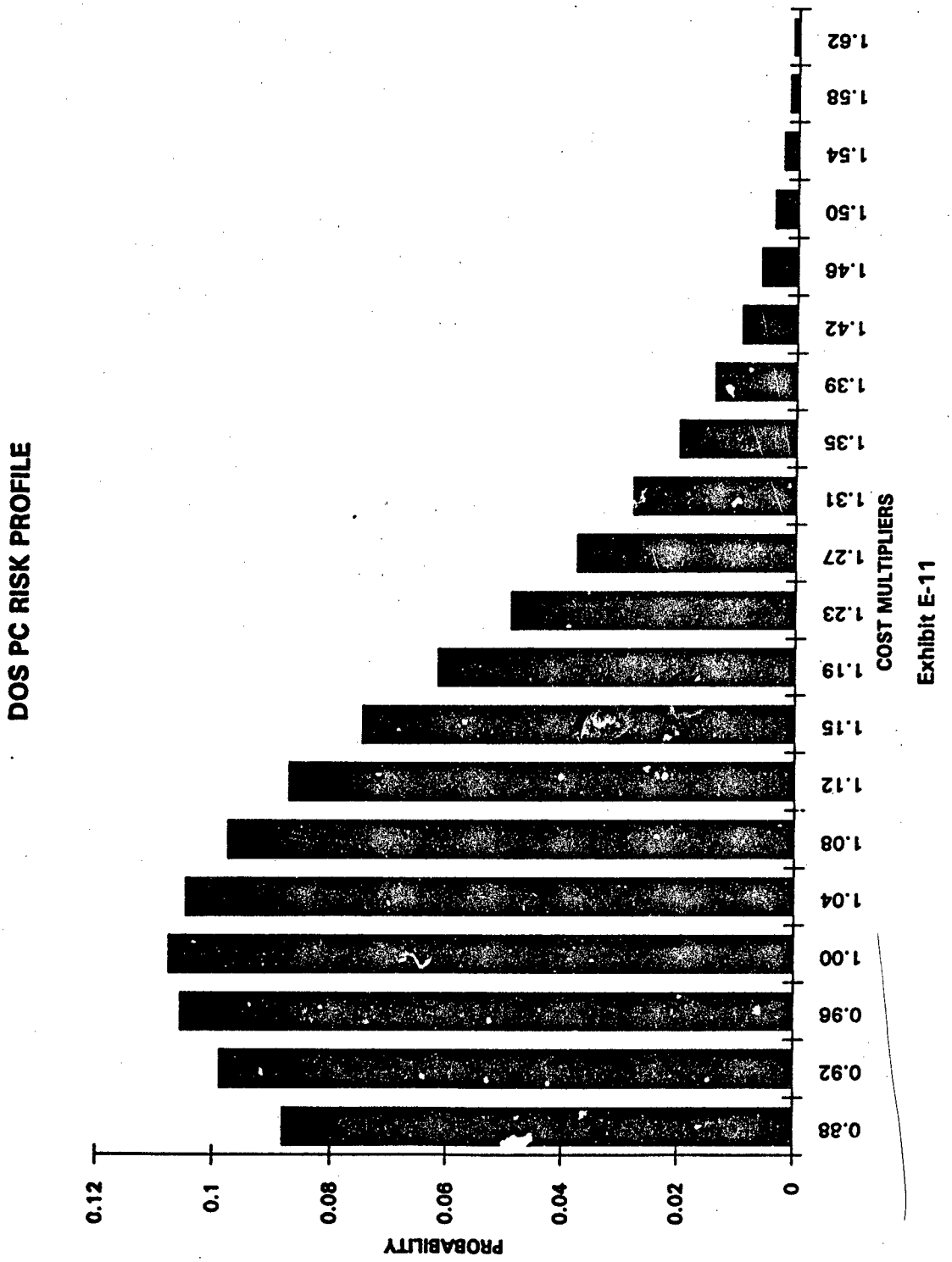
DOS PC RISK PROFILE
PROBABILITY
0.12
0.1
0.08
0.06
0.04
0.02
0
COST MULTIPLIERS
0.38
0.92
0.96
1.00
1.04
1.08
1.12
1.15
1.19
1.23
1.27
1.31
1.35
1.39
1.42
1.46
1.50
1.54
1.58
1.62

Exhibit E-11

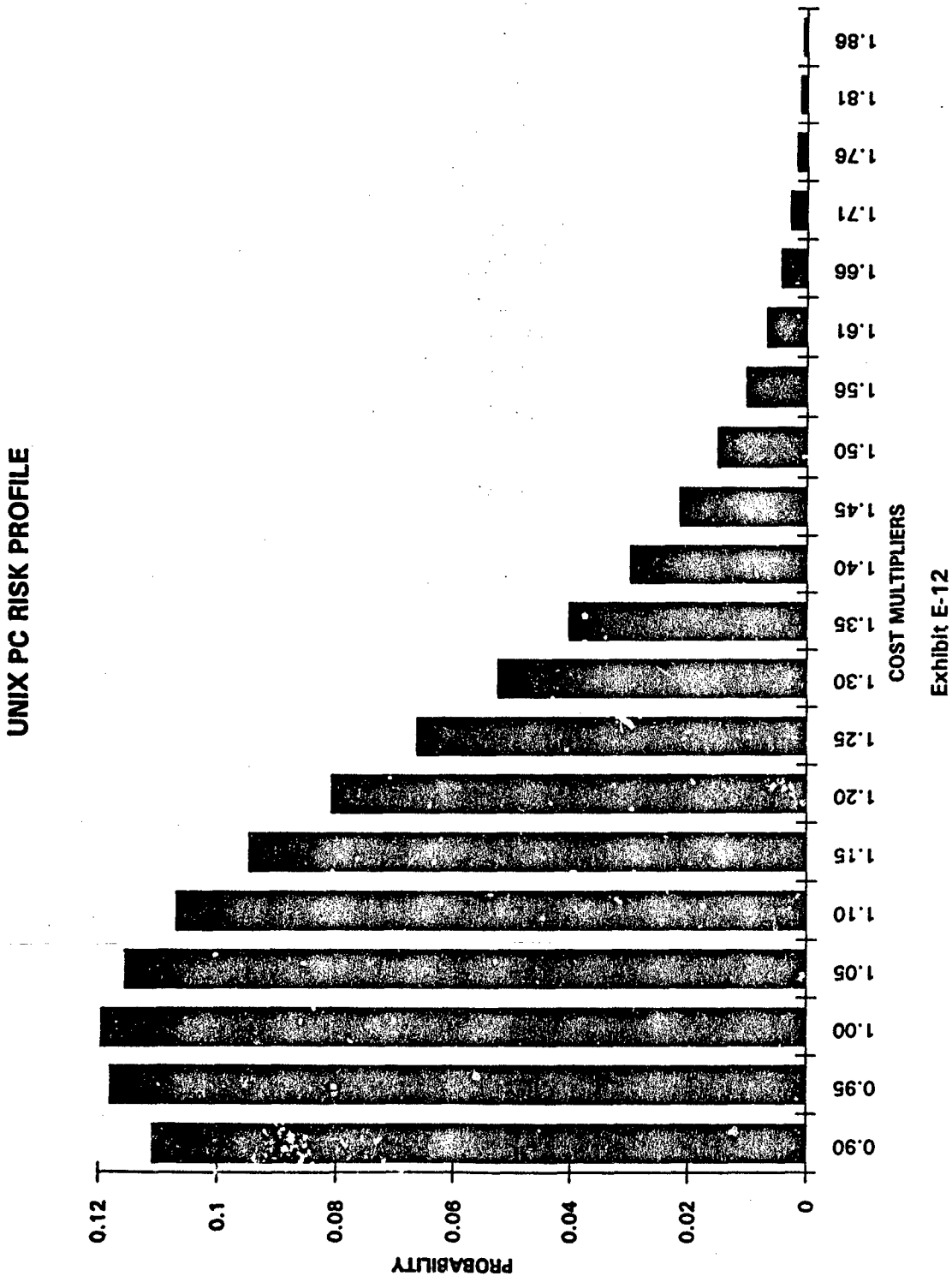
UNIX PC RISK PROFILE
PROBABILITY
0.12
0.1
0.08
0.06
0.04
0.02
0
COST MULTIPLIERS
0.90
0.95
1.00
1.05
1.10
1.15
1.20
1.25
1.30
1.35
1.40
1.45
1.50
1.56
1.61
1.66
1.71
1.76
1.81
1.86

Exhibit E-12