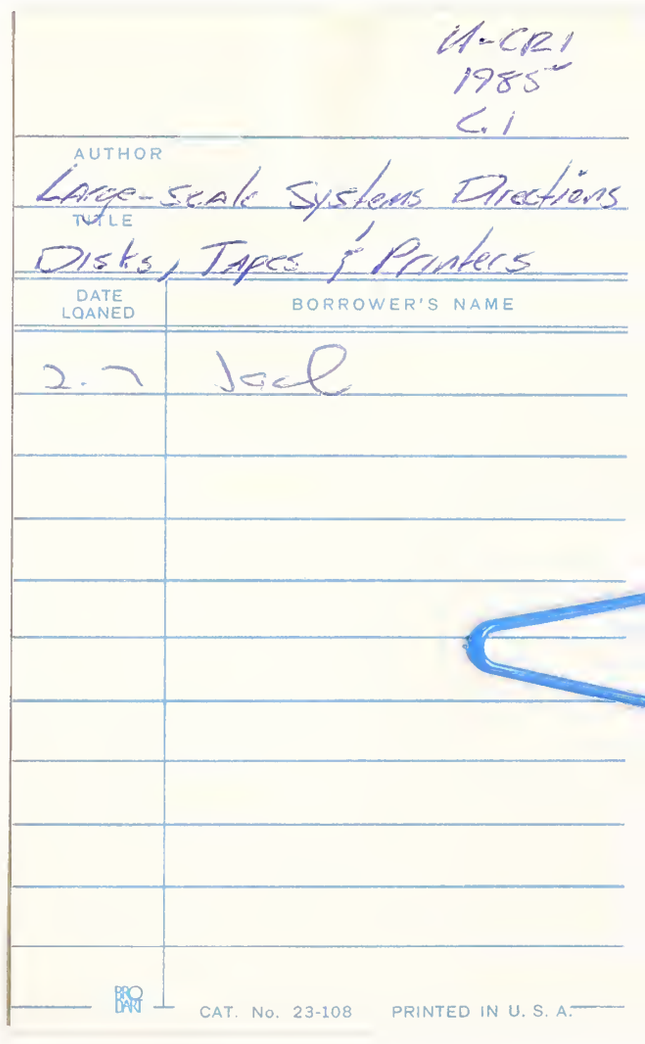
Large-Scale Systems Directions: Disks, Tapes, and Printers

INPUT®

LARGE-SCALE SYSTEMS DIRECTIONS: DISKS, TAPES, AND PRINTERS



LARGE-SCALE SYSTEMS DIRECTIONS: DISKS, TAPES, AND PRINTERS

CONTENTS

LARGE-SCALE SYSTEMS DIRECTIONS:
DISKS, TAPES, AND PRINTERS

EXHIBITS

I INTRODUCTION

- During the past year, INPUT has explored many aspects of large-scale systems directions, and in the normal course of things we have cycled around to the report that addresses large-scale disk, tape, and printer systems. In early February, IBM announced its long-awaited extended capability models of the 3380, and it looked as if we could have a relatively routine report.

- Then, in the following week, Sierra was announced along with a lot of software, including UNIX, and the pot was really stirred up. Considering delivery schedules, it was obvious that the basic large-scale systems for the remainder of the 1980s were now in place. In the process of updating both the cost capacity of DASD and the price performance of processors, it is apparent that the orderly progression of each during the past several decades, has been impressive. It almost seems as if inventions can be scheduled.

- In fact, the only thing more predictable than large-scale systems price performance and cost capacity is IBM revenue growth. Since IBM announced 1984 financial results in January, it occurred to us that, while IBM might not be able to control technological innovation, it certainly has been able to control the practical application of large-scale processor and storage technology through pricing.

- Chapter II of this report reviews historic trends in price performance, cost capacity, and IBM revenues; projects 1990 growth in installed MIPS, memory, and DASD (according to IBM); analyzes a fundamental problem in achieving

the balance of that growth; and presents possible shifts in large-scale systems directions necessary to achieve that balance.

- Chapter III presents residual value forecasts for large-scale disk, tape, and printer systems and updates selected residual value forecasts for IBM and software-compatible mainframes based on the Sierra announcement. However, a full technical analysis of that announcement (and its associated software) will not be available from INPUT until the Large-Scale Systems Directions: Midyear Update is published (August of this year).

- In order to obtain full benefit from the large-scale systems directions reports, it is strongly recommended that the reader be familiar with the content of those published in the preceding year. In 1984 the following reports were published:

  - Large-Scale Systems Directions--Disk, Tape, and Printer Systems.

  - Large-Scale Systems Directions: Midyear Update--1984.

  - Large-Scale Systems Directions--Large IBM and Software-Compatible Mainframes.

II LARGE-SCALE SYSTEMS DIRECTIONS ARE UNDER CONTROL

A. HISTORICAL TRENDS ESTABLISH DIRECTION

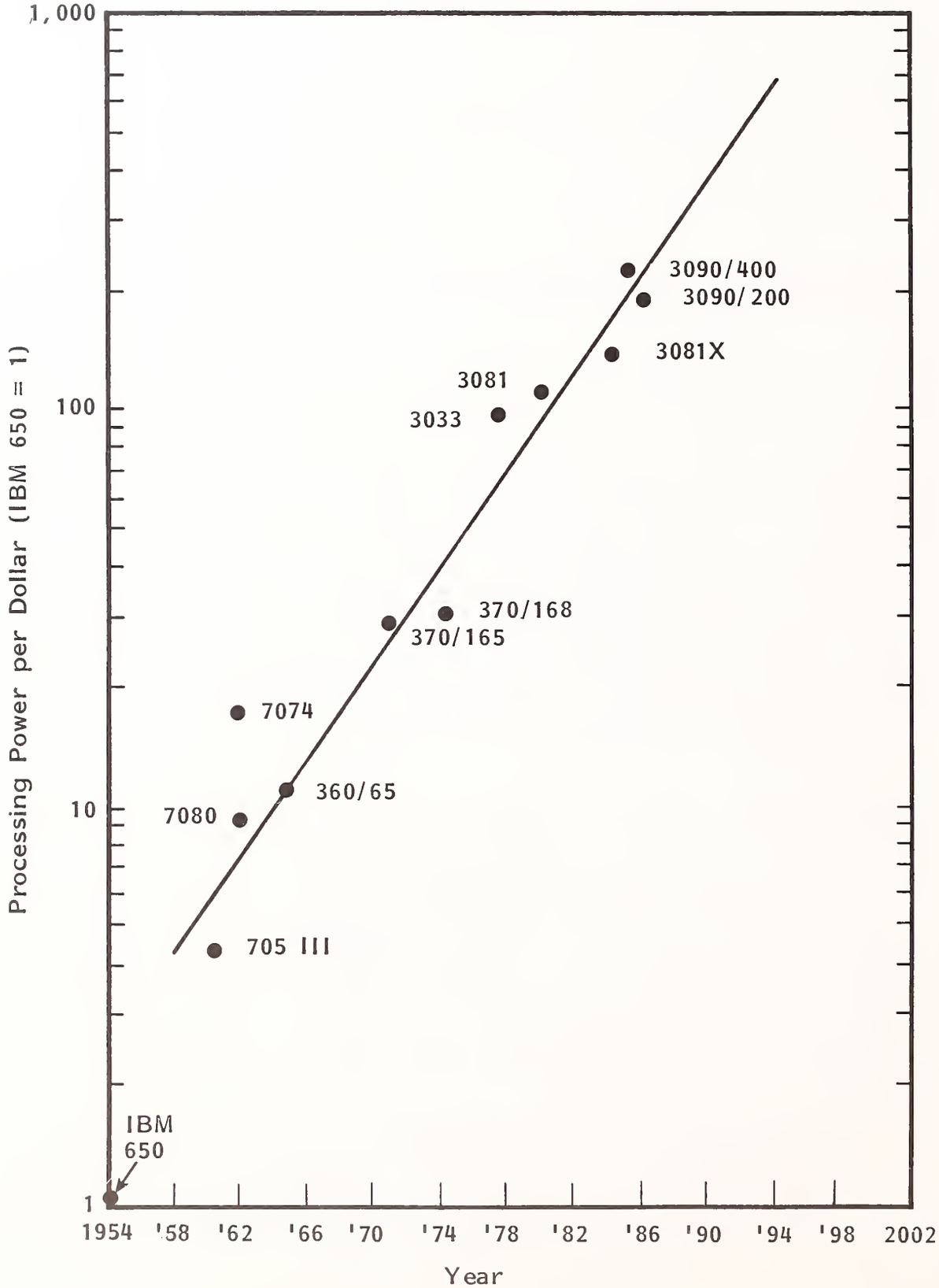
- Mr. John R. Opel, Chairman of the Board of IBM, wrote a letter to an industry publication recently in which he stated: "one dollar now buys 200 times the processing power it did 30 years ago. IBM is responsible for some of this innovation." The implication was that IBM contributed to the introduction of new technology that supported this dramatic increase in price performance, and INPUT recognizes IBM's substantial contribution to technological innovation. However, this report will emphasize the price side of the price-performance equation, for it is here that the IBM planning process has established control of large-scale systems directions.

- First let's take a look at Mr. Opel's statement concerning processor price-performance. INPUT published historical processor price-performance trends starting with New Hardware Economics in 1977. The price-performance charts have been updated to include IBM's recently announced 3090 models 200 and 400 (Sierra), and we find they confirm the "200 times" price-performance statement from IBM, as shown in Exhibit II-1. Some explanation and analysis of the chart will be helpful in understanding its significance.

  - The processing power being measured is not in MIPS. Rather, it is the internal systems performance in a commercial (or mixed) environment. The performance rating system was first published by INPUT in

EXHIBIT II-1

PROCESSING POWER PER DOLLAR, 1954-1985



1976 and has been applied consistently since then. INPUT's remarkable agreement with IBM's statement is important for several reasons:

. It is a clear indication that IBM has been especially concerned with the large-scale commercial market.

. It would appear that IBM and INPUT are applying roughly the same price-performance measures.

. The trend has been so clear over the last 25 years that it must correspond closely to IBM's business plan for the release (as opposed to the availability) of new technology.

. Therefore, the price-performance direction of large-scale processors in the commercial environment is predictable because it is under IBM control.

- The trend line from the 705 model III in 1959 to the 3090 in 1985 does not show many significant deviations and those are easily explainable.

. The 7074 was directed specifically against the RCA 601 (a processor of imaginative design and aggressive pricing that missed its window of opportunity) and had nearly two times the price performance of its stablemate, the 7080.

. The 370/168 had lower price performance initially in order to recover development costs for virtual storage hardware and software.

. The 3033 was priced to compete with the new plug-compatible mainframes (specifically, the Amdahl V-6), and had approximately 50% more price performance than would have been "normal."

. The 3081 continued to apply pressure to the plug-compatible mainframes (PCMs), and the 3081X was designed to pick up profits lost during the PCM battle, now that Amdahl and NAS have been subdued and Trilogy no longer poses a threat.

- It should be pointed out that, in terms of sheer processing power per dollar, there are better price performers than the large IBM mainframes. Minicomputers provide better processing price performance, and, when measured in MIPS, the IBM 43XX series has been priced to more than compensate for traditional economies of scale. However, IBM's strategy for the remainder of the 1980s is still large host oriented because IBM is firmly in control and feels comfortable with that strategy.

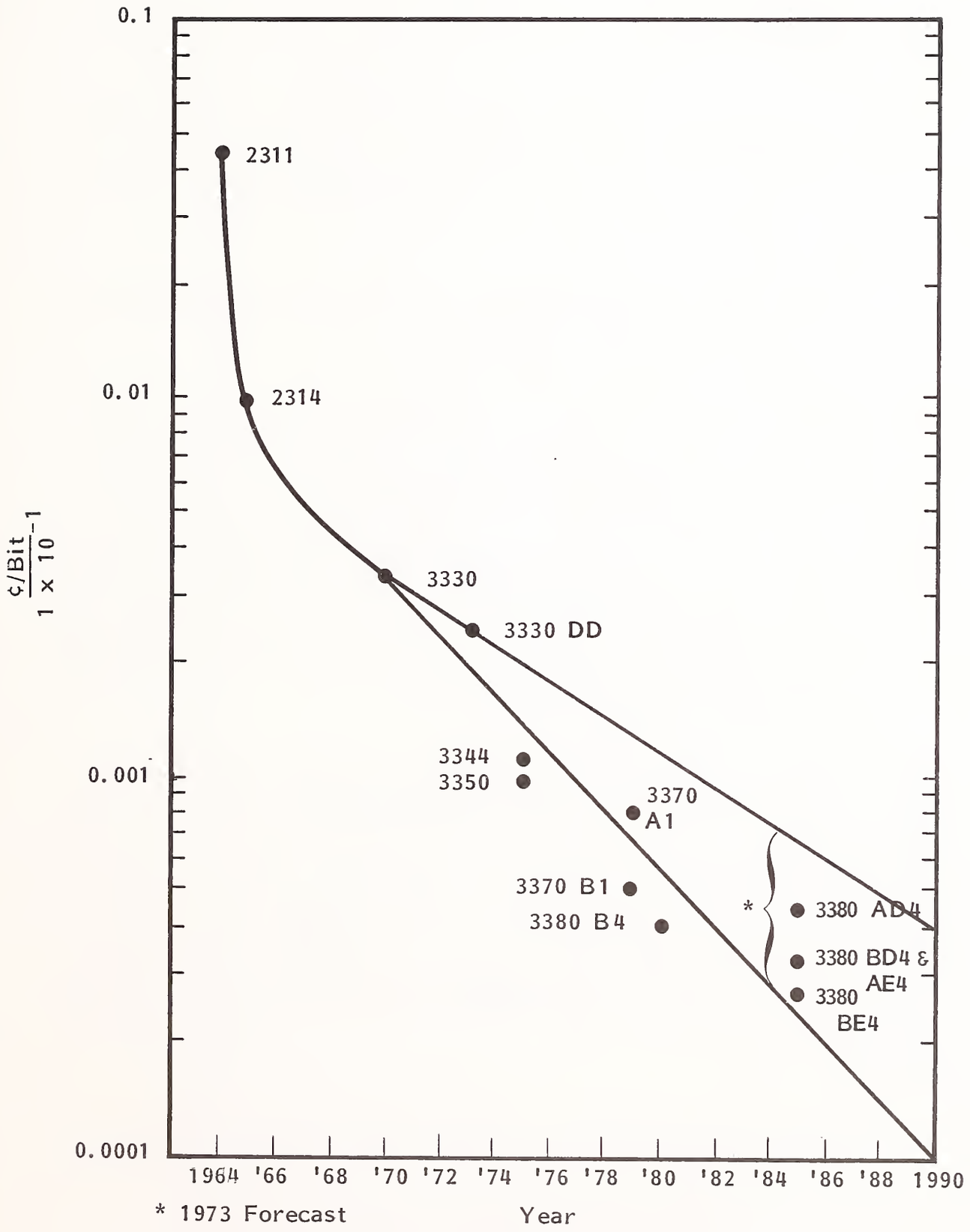
- Although it is comforting to know that INPUT has been tracking mainframe price performance on a basis compatible with IBM, INPUT is especially proud of a 12-year-old forecast of disk storage costs that has recently been confirmed by the announcement of the IBM 3380 extended capability disk drives. The forecast was made in 1973 and was based on the assumption that, unlike processor technology, magnetic disk technology would progress to the point where development costs and manufacturing economies of scale would essentially give IBM control of the technology. The forecast, as presented in its original cost-per-bit format, has been used by INPUT, unchanged since that time, as shown in Exhibit II-2.

  - The last year of the original forecast was 1985, when the cost per bit of magnetic disk storage was projected to be between .00025 and .0007 cents. All models of the recently announced 3380 extended capability disk drives fall within that range.

  - The PCMs were not prominent in the magnetic disk market in 1973, but their impact can clearly be seen, as IBM consistently priced models

EXHIBIT II-2

MAGNETIC DISK COST FORECAST CONFIRMED



below the forecasted range in order to put pressure on the PCMs. However, INPUT retained the forecast and pointed out that certain announcements and delivery schedules seemed to support the forecast. For example:

  - When the 3380 was originally announced, certain models, such as the AAF and A4F (not shown on the exhibit) did fall within the range. (They were priced at .0007 and .00065 cents per bit respectively.)

  - In addition, delayed delivery schedules of the 3380 pushed availability more in line with the forecast.

- In the recent past, the absence of competition has also had an impact on prices. During the past year, Storage Technology Corporation has gone bankrupt, Control Data Corporation has gone out of the disk business, and IBM has started to sell 3380 type drives to Honeywell as OEM. Without significant competition, prices have been increased back into the area of the long-range forecast. Magnetic disk revenues are key to IBM's growth for the remainder of the 1980s, and IBM is firmly in control of the market.

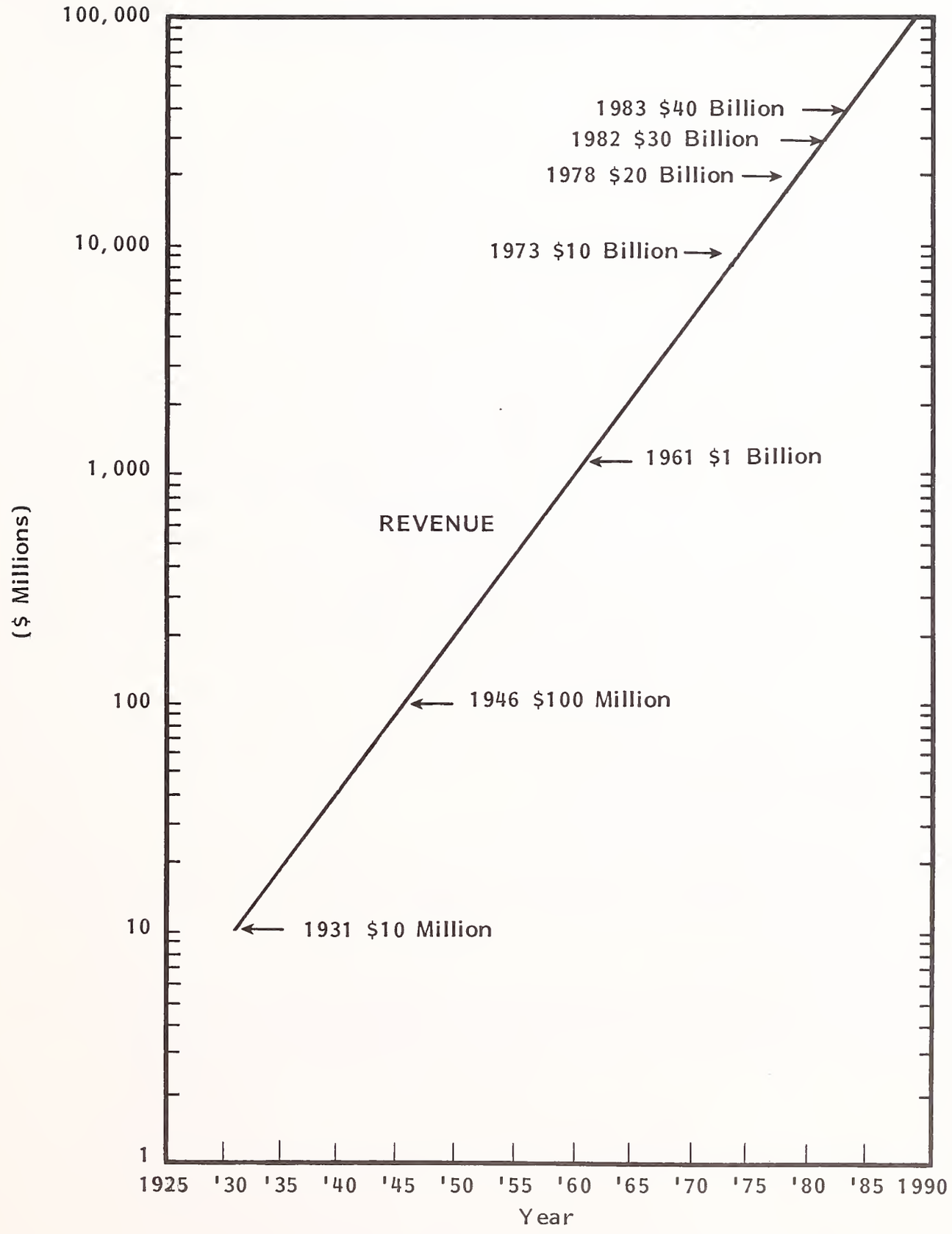
- In the 1984 report Market Impact of IBM Software Strategies, INPUT forecast that IBM would grow to become a $100 billion company by 1990. (IBM has publicly announced this goal since then.) It really wasn't difficult to forecast, since IBM growth is more predictable than either processor price performance or the cost of magnetic disk storage. Exhibit II-3 plots IBM revenue since the 1930s on a five-cycle semilog scale. It is enough to make anyone humble, and it is presented in tribute to IBM's planning process and not to technical innovation.

  - Actually, the growth is not as smooth as indicated by the major milestone on the chart. In the late 1960s, when leasing companies started

EXHIBIT II-3

IBM's HISTORIC GROWTH

(1931 - Present)



the trend toward purchase of IBM equipment, IBM "lost control" of its revenue and grew more rapidly than it would like to have grown; but the recession in the early 1970s, the antitrust action against IBM, and IBM's aggressive pricing against competition have all combined to get things back to "normal." (Although IBM remains ahead of schedule--it should pass $50 billion this year).

- Back in the early 1960s, before System/360 was announced, many planners in IBM were known to complain, "We can't keep growing this way--it is unrealistic." IBM management didn't buy that argument then, and 20 years later IBM is still growing at traditional rates; earnings of $6.5 billion in 1984 aren't bad either.

- To the degree that IBM growth is dependent upon large-scale systems revenues through the 1980s, it is assumed that IBM's strategic plan must call for substantial revenue growth from large-scale systems even as price performance of processors improves and the cost per bit of magnetic disk storage declines. Despite repeated reports of declining mainframe markets and current industry fascination with personal computers, it has remained INPUT's opinion that IBM growth through 1990 is dependent upon large-scale systems.

B. THINKING BIG

- The reported death of the mainframe market has been prompted by a number of factors:

  - The demise of mainframe vendors (GE and RCA) over the years and the slow growth of those remaining such as Honeywell and Univac.

- The superior price performance of minicomputers, and the high growth rates of vendors such as DEC and Data General.

- The surge of interest in personal computers, and their obvious price-performance advantages for many applications.

- Annual surveys and analyses of DP budgets that show mainframe expenditures shrinking as a percent of total DP expenditures.

- In the meantime, IBM has continued to consolidate its hold on the large-scale systems area and will grow according to plan. However, even in IBM, the continuing obituaries for the mainframe market have had an impact. One IBM employee who was interviewed a year ago in connection with an INPUT project stated, "We have made a lot of money on big systems for a long time and we think it can go on forever." The interviewer assured him that INPUT feels the mainframe market may go on, at least through the remainder of this decade. Why is INPUT so confident that this will be the case?

  - One of the primary reasons has to do with the nature of INPUT's task. Most surveys do not attempt to determine what is going to happen, but rather what the respondent thinks is going to happen (or wants to happen). For example, consider one case cited in the recent "1985 Datamation DP Budget Survey" (March 15, 1985), which again predicted that mainframes would be down as a percent of 1985 expenditures.

    . Users were reported to be "going crazy" with VM/CMS information center applications by doing a lot of spreadsheet analysis, which made heavy demands on the 4381 mainframe.

    . It was concluded that such applications could be done more economically on PCs, and the plan is to move 60 users from the 4381 to PCs in 1985.

- Then the remaining 500 users of the information center 4381--who have PROFS, SAS, and Dynaplan applications--will be moved to an installed 3033, and the 4381 will be "eliminated."

- INPUT seriously doubts that the company will, in fact, eliminate its 4381 in 1985.

- A well-known analyst for a major financial institution explained the phenomenon. As a guest speaker at an INPUT client conference, he addressed the assembled IS executives:

  - "Last year I asked you whether you were going to lease or purchase your computer equipment, and you said you were going to lease."

  - "What did you do?"

  - "You purchased!"

  - "This year I am not going to ask you what you are going to do, because you are going to do what IBM wants you to do."

- What IBM wants IS managers to do is think big. For the past ten years, IBM strategy has been to grow the large, host-oriented, SNA environment and put pressure on minicomputer manufacturers. This strategy was outlined in some detail in INPUT's 1984 Large-Scale Systems Directions report series, and has been emphasized over the years in the earlier Residual Value Forecast series of reports. This strategy has been continued down to the announcements of the 3380 extended capability disk systems and the 3090 model 200 and 400 processors; and, as the charts in the previous section indicate, what IBM wants IBM gets. That means that IBM customers usually do what IBM wants them to.

C. WHAT IBM WANTS I.S. MANAGERS TO DO

- IBM met with financial analysts to explain why the 3090-400 would not be delivered until 1987. (The answer is that IBM doesn't have enough people to test both the 400 and 200 at the same time.) At the meeting, IBM gave a hint of what its clients are expected to do between now and 1990. Essentially, IBM wants the average large customer to:

  - Increase installed processing power from 100 MIPS to 1,000 MIPS.

  - Increase installed system memory from 200 MB to 10,000 MB.

  - Increase installed direct access storage (DASD) from 300 GB to 6,000 GB.

- These increases are plotted in Exhibit II-4 and reveal the following:

  - Installed processing power is expected to increase tenfold by 1990 (actually, during 1990). This is pretty much in line with reports that large users are growing about 50% per year in terms of installed MIPS.

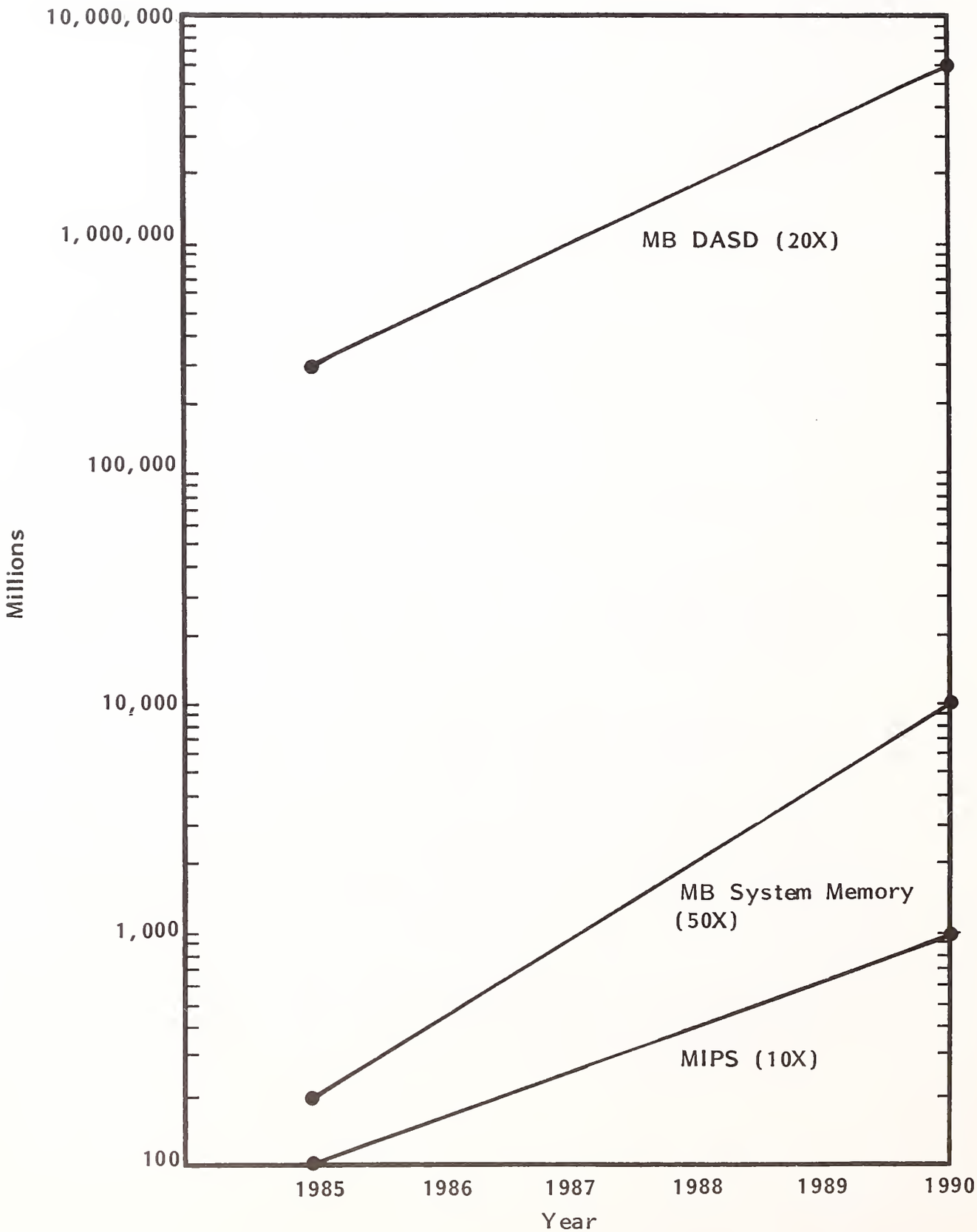
  - Installed systems memory is expected to increase 50 times, from an average of 2 MB per MIP to 10 MB per MIP. IBM's announcement of expanded storage on the 3090 (Sierra) certainly heads in the direction of at least permitting that type of memory/MIP ratio. Whereas the 308X had a maximum ratio of approximately 4 to 1, the 3090 will permit up to 6.5-7.5 to 1, depending upon the model.

  - Installed DASD is expected to increase 20 times from a current average of 3 GB per MIP to 6 GB per MIP. This is an important ratio for several reasons:

EXHIBIT II-4

LARGE-SCALE SYSTEMS GROWTH TO 1990

(IBM Projections)



- With installed DASD capacity increasing twice as fast as processing power, the cost of DASD (even without controller costs) will exceed processor costs by 1990, and this clearly indicates the importance of DASD revenues for IBM growth.

- INPUT's characterization of large hosts as data base machines (in Large-Scale Systems Directions: Midyear Update--1984) is confirmed by the projections.

- INPUT believes that increased DASD is, in fact, driving the demand for MIPS; the projected ratio of 6 to 1 (GB of DASD per MIP) may be impossible to obtain with the current systems architecture.

- The problems associated with having enough MIPS to power the big data base machines is explored in detail in Large-Scale Systems Directions--Large IBM and Software-Compatible Mainframes (INPUT, 1984), and the announcement of the 3090 (Sierra) has not given INPUT any reason to change its opinion.

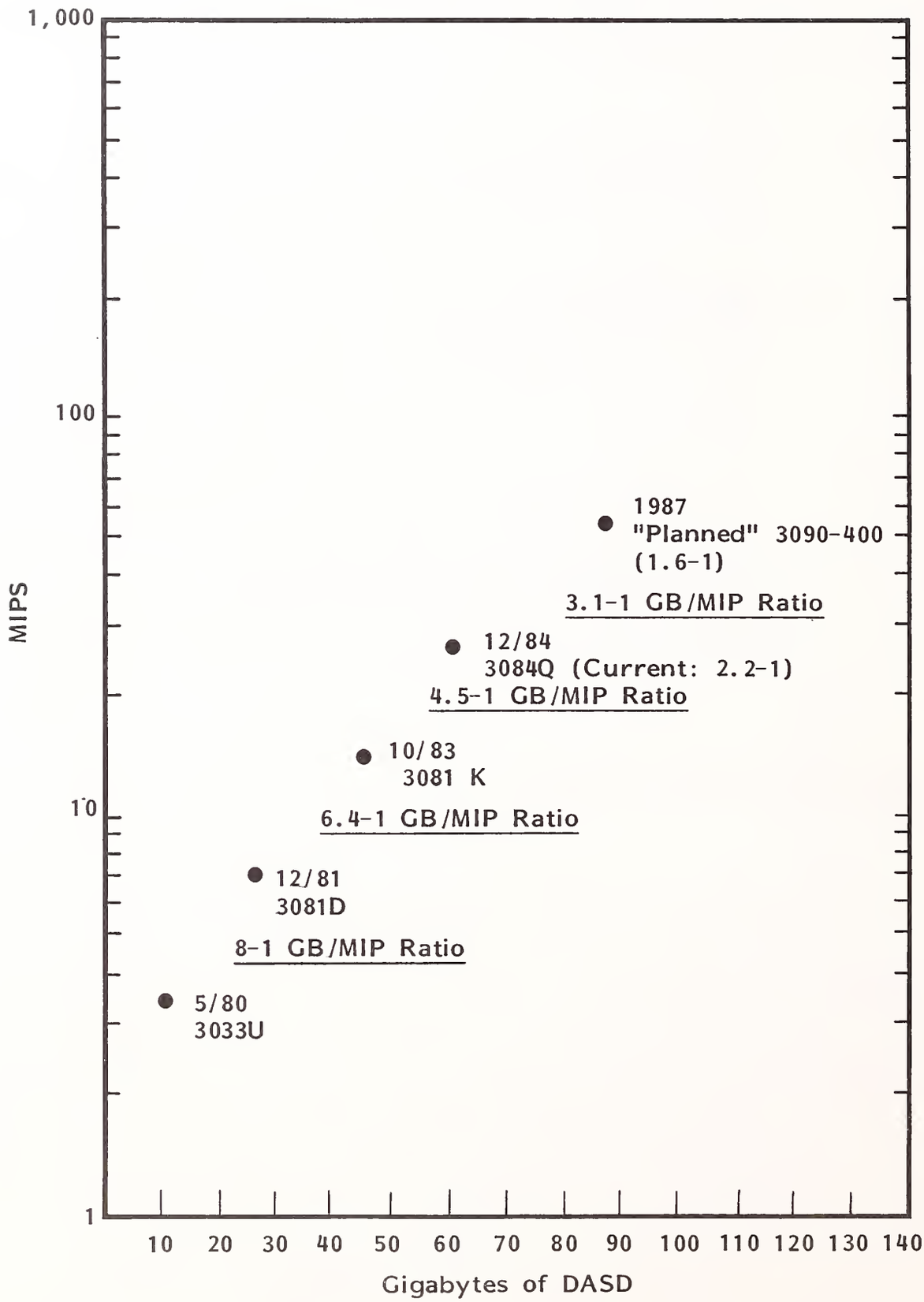
D. THE GIGABYTE/MIPS PROBLEM

- The GB/MIPS problem, as INPUT has identified it, is primarily one that we have described loosely as the data base "entropy problem." Simply stated, it postulated that, as data bases increased in size and complexity, there would be a tendency toward chaos which would require substantially increased processing power if order was to be maintained. In other words, the required MIPS would increase more rapidly than data base size increased. For this report, a carefully selected site was analyzed to determine whether the entropy problem really existed, and the analysis tended to confirm the problem. See Exhibit II-5.

EXHIBIT II-5

GB/MIP RATIOS

(Entropy Case Study)



- Exhibit II-5 should be alarming to both users and IBM alike (although, as usual, users should be more alarmed than IBM). The message on the chart is clear.

  - Starting with the 3033 (in 5/80) and 10 GB of DASD, it was possible for DASD to grow to 28 GB (8-1 GB/MIP ratio) before the 3033 ran out of power and had to be replaced with the 3081D in December 1981.

  - DASD then grew to 45 GB (6.4-1 GB/MIP ratio) before the 3081D had to be replaced with a 3081K in October 1983.

  - Continued DASD growth to 60 GB (4.5-1 GB/MIP ratio) resulted in the 3081K being upgraded to a 3084Q in December 1984.

  - The 3084Q currently has a 2.2-1 GB/MIP ratio; and it is projected that, with DASD continuing to grow at its historic rate of approximately 1 GB per month, there will be 84 GB (3.1-1 GB/MIP ratio) installed in 1987.

  - It is anticipated that the 3084Q will run out of power at that ratio and the 3090-400 will arrive just in time.

- The case study tends to confirm the data base entropy problem and the premise that required processing power increases more rapidly than data base size.

  - The user is therefore caught on an accelerating processor escalator as central data bases increase in size. The problem is that the increasing speed of the escalator may propel the user through the roof (the processing power may not be available on schedule). For example, there is no assurance that the 3084Q can maintain acceptable performance as the 3.1-1 GB/MIP ratio is reached (or the central data base may grow more rapidly than it has historically), and the 3090-400 may be needed before it is available.

- IBM's problem appears to be more severe (if this installation is representative), since the growth of DASD is not nearly as rapid as required by the projected growth to 20 times that currently installed by 1990 (Exhibit II-4). In addition, the trend of GB/MIP ratios is negative rather than positive and thus could be a real problem, especially since, as INPUT believes, the installation selected for the case study is more favorable than that for a more typical IBM installation.

- INPUT selected the installation analyzed because it had a consistent, proprietary data base management system (DBMS), text editing, and an electronic mail system installed since 1980. The DBMS and interactive environment at the case study site has less processing overhead than a comparable IMS/TSO environment. And, if INPUT is correct, IBM is headed toward an IMS/DB2/SQL/QBE-type of environment (Large-Scale Systems Directions: Disk, Tape, and Printer Systems, March 1984) and the IBM data base management strategy will require even more host-processing power. Therefore, it is concluded that GB/MIP ratios for the typical IBM installation will be even more severely impacted than those in the case study as data bases increase in size.

- It is possible that IBM is still focusing on the problem of being sure that processing power is absorbed as processor price performance improves, and the company may not be aware of the full extent of the entropy problem. INPUT prefers to believe that IBM does have a plan that not only will increase demand for DASD (GBs), but will facilitate an increased GB/MIP ratio. However, the 3090 announcement gives little indication that IBM is interested in doing anything except create more demand for host CPU cycles. For example:

  - The support of a multi-operating-system environment (the VM/MVS/UNIX three-headed monster described in INPUT's Executive Bulletin "Megaflops and Miniflaps") is certainly not designed to decrease systems overhead.

- The IBM announcement of the Extended Recovery Facility (XRF) under the MVS/SP Version 2 Release 1.3 has an especially ominous ring to it when it states, "Availability (of IMS/VS Version 2 DB/DC transaction processing) is improved by using additional resources to lessen the impact of certain events that disrupt service to the end user." It is too early to estimate how many additional resources will be used; but, if past experience is any guide, you can be sure it is not going to be cheap.

- Then there is also the strengthening of the scientific processing capability of the 3090 processors and software designed to attract computer-intensive work to the host mainframes (and eliminate the need for minicomputers).

- It all adds up to a lot of additional processing burden on the general purpose host mainframe and does not point in the direction of higher GB/MIP ratios. However, since IBM growth depends upon control of large-scale systems directions, it must be assumed they know what they are doing when they project the 1990 installed MIP, memory, and DASD increases (depicted in Exhibit II-4).

E. IBM'S POSSIBLE PROBLEM SOLUTION

1. DASD GROWTH

- From IBM's point of view, magnetic DASD revenue growth is critical for the remainder of the 1980s. It is not currently running at a level that will see the installed base grow to 20 times its current level by 1990. However, it would appear that everything points to explosive growth.

- Every time density is doubled, the waste associated with track size increases even more rapidly and the 3380 extended capability has been announced and is ready to go.

- Double density relieves the space problem, which can be a serious constraint to growth. (The case study installation is expanding its building to accommodate more DASD and communication equipment.) And the 3044 Fiber Optic Channel Extender Link will permit the distribution of low- to medium-speed I/O devices so more DASD can be installed near the host.

- As more personal computers and departmental processors are linked to central hosts, they will be used to back up distributed data bases. The impact of micro-mainframe links has not yet been felt by most installations, but it will be substantial.

- The multiple DBMS environment mentioned earlier will result in multiple levels of duplicate data bases: sequential files, VSAM files, and DL/I data will all be run through extract programs to create relational tables that will, in turn, be used to create departmental and personal data bases. The flexibility and ease of use inherent in the relational model will be paid for not only with processing burden but explosive demands for DASD.

- Office automation requires electronic file cabinets to store not only text, but images in support of devices like Scanmaster. Images gobble up DASD bits at a rate of approximately 300,000-500,000 per page.

- In addition, there are software systems (such as PROFS) that "protect the user" by making it virtually impossible to delete files, thereby creating enormous electronic waste baskets. And the use of XRF and improved availability for IMS will surely result in a lot of duplication.

- Then, as if all that were not enough, the problems of archiving DASD on tape is a major problem. In fact, a pretty good argument can be made that archiving on disk can now be justified economically.

- It is highly probable that customers are "going to do what IBM wants them to do." And IBM wants them to buy lots of magnetic DASD. The only thing that might have impact on IBM's solution would be if optical disk catches on early and destroys DASD revenue. However, this is unlikely to occur until IBM gives its blessing (especially considering STC's demise). (See Large-Scale Systems Directions: Disk, Tape, and Printer Systems, March 1984 for a summary on optical memory.)

2. GIGABYTE/MIP RATIOS

- INPUT assumes the demand for DASD will escalate substantially, with a big assist from IBM, but the GB/MIP ratio problem remains. Can the big engines drive the enormous data bases? It is possible that IBM is counting on factors contributing to DASD growth to solve part of the problem. For example:

  - It doesn't take as many MIPS to process wasted (unused) space, archival files, and infrequently used electronic file cabinets (and waste baskets) as it does an active, transaction-oriented data base.

  - INPUT concedes this point but also believes that new problems of data base synchronization and integrity, along with protection and security, will increase entropy dramatically in the distributed data base environment. Enormous amounts of processing power will be required if chaos is to be avoided.

- Perhaps IBM is counting on the 50-fold increase in systems memory to improve performance enough to reverse the negative trend in the GB/MIP ratio. The case study site stated that indexes for data bases were growing so rapidly that it might be necessary to install a 3090-200 just for the expanded

storage (which would serve as a paging memory for multiple-level indices) to improve performance. (The 3090-200 would replace the 3084 and then be upgraded to the 3090-400 in 1987.)

- The full ramifications of the expanded memory are not clear, but the 3090 announcement did give performance information that showed improvements (regarding paging, and as opposed to using an IBM 3380) in both TSO and IMS environments. Although average response time was reduced significantly, the only statement about throughput was that there was "some improvement."

- INPUT has made the point that the big host data base machines will be heavily batch oriented when they serve as enormous file servers for distributed departmental processors and intelligent workstations. In other words, their primary functions will include joining, selecting, sorting, moving, and encrypting (if necessary) data bases being transferred from one processor and/or storage location to another. Batch processing against large data bases requires improved throughput--vastly improved throughput. Expanded memory will help, but it is doubtful that it can reverse the decreasing MB/MIP ratio, much less increase it to 6-1.

- If the 3380 Expanded Capacity and the 3090 are the primary large-scale systems to get us to 1990, and if IBM's estimates of installed MIPS, systems memory, and DASD are even roughly accurate, there is only one solution: at long last, IBM is going to have to distribute processing and actually off-load the large host processors. This off-loading must proceed in two ways:

  - Geographic distribution of processing to departmental processors (including both midrange mainframes and minicomputers) and to intelligent workstations.

- Architectural distribution to intelligent controllers, data base machines, and specialized processors.

- This is the same inevitable trend that INPUT has been emphasizing for years and was the general theme of our last Large-Scale Systems Direction--Large IBM and Software-Compatible Mainframes (December 1984). IBM announcements and public statements of the last three months have only confirmed our analysis of the situation. Improvements in processor price performance, DASD cost capacity, and IBM revenue and earnings require a delicate balance between processors, storage, and software. IBM has recently reorganized and established a new Information Systems and Storage Group that, according to IBM president and chief executive officer John Akers, is intended to "sharpen (IBM's) focus on high-performance processors, storage, and programming."

- Establishing this group is a step in the right direction, and INPUT hopes IBM understands data entropy. It is becoming increasingly difficult to maintain predictable control over large-scale systems directions--even with reduced competition. Miscalculation at this point could have severe impact on some customers' businesses and even disrupt IBM's historic growth curve.

III RESIDUAL VALUE FORECASTS

A. ANNOUNCEMENTS

- IBM's announcements of the 3380 extended capability and 3090 (Sierra) both give indications of the basic technologies that will extend through the 1980s. Put less delicately, it is cash cow milking time at IBM. The positive side is that the IS systems hardware and software investment has been protected.

- The highlights of the disk system announcement, which preceded the Sierra announcement by a week, are as follows:

  - The two 3380 extended capability models come in single- and double-capacity versions, with the double-capacity models capable of storing up to 5.04 GB of data.

    . The single-capacity AD4 and BD4 cost $88,780 and $64,440 respectively.

    . The double-capacity AE4 and BE4 cost $134,740 and $110,400.

    . Single-capacity drives were announced as being available in March 1985 and can be upgraded to the double capacity scheduled for delivery in the fourth quarter of 1985.

- Cache memory on the 3880 models 21 and 23 disk controllers was increased from 32 MB to 48 or 64 MB. Purchase price for the 48-MB unit is $349,975, and the 64-MB costs $429,975.

- Enhanced data facility software was also announced.

- Current 3380 drives cannot be upgraded.

- The long-awaited announcement of the Sierra processors was nearly overshadowed by the other large systems announcements that accompanied it on February 12, 1985. The full impact of these combined announcements will be analyzed in the next issue of Large-Scale Systems Directions. Processor highlights are as follows:

  - The 3090, model 200, is a dyadic processor with 1.7 to 1.9 times the internal speed of the 3081 KX. In other words, it is approximately equivalent to the 3084QX.

    . It has 64 MB of shared central storage and up to 128 MB of expanded storage in 64 MB increments.

    . Up to 48 integrated channels are available.

    . The price of a 64 MB model 200 is $5 million. Delivery is scheduled for November 1985, and the system is upgradable to the model 400 for $4.3 million.

  - The model 400 offers 1.7 to 1.9 times the "instruction execution rate" of the model 200 and is a four-way processor.

    . It has 128 MB of shared central storage and up to 256 MB of shared expanded storage in 128 MB increments.

  - . Up to 96 integrated channels are available.

  - . The price of a 128 MB model 400 is $9.3 million, and delivery is scheduled for early 1987.

- Purchase prices of 3080 series processors were cut by 5% and maintenance reduced from 10.2% to 12.5%. This certainly protects IS's investment, but INPUT is inclined to take a more pragmatic view of IBM's action:

  - . As we pointed out when the 3080 X series was announced a year ago, the 3080 series is highly profitable and IBM has little reason to replace them rapidly.

  - . IBM Credit's investment in the 3080 series is larger than any customer's, and the price protection may be more self-serving than altruistic.

- Amdahl promptly responded to the IBM announcements in February by lowering its prices.

  - A new model of its 6380 model B4 disk unit, which sells for $48,700, was announced; it is called the model M4, costs $38,950, and is available immediately.

  - The response to Sierra was to lower prices of the 580 series by 6-12%. For example, the Amdahl 5880, with roughly the same power of the IBM 3090-200, would now sell for $4,590,000.

- NAS took a more aggressive approach by announcing, in March, its AS/XL high-end processors. These processors are impressive for the following reasons:

- The AS/XL model 60 is a uniprocessor that operates at the approximate speed of the IBM 3090-200 dyadic. A model 60 with 64 MB has a purchase price of $4.84 million and will be shipped in the second quarter of 1986.

- The AS/XL model 80 is a dyadic processor with the approximate power of the IBM 3090-400. It has a purchase price of $8.97 million and will be delivered in the second quarter of 1986--nearly a year before its IBM rival.

B. USED MARKET ACTIVITY

1. DISKS

- Trading is strong in 3380 disks, with brokers attempting to buy all those available for delivery prior to the newly announced extended capability models. Current retail price for 30- to 45-day delivery is around 80-82% of list.

- There is little demand for 3350 disks, and they can be purchased from reputable brokers for less than 10% of list price. The only real remaining market seems to be for attachment to IBM 3880 cache controllers.

- The 3370 market remains strong, and the supply is limited. This is primarily because the 4300 series of processors do not have alternative technology available. And it is interesting that IBM requires two 3370 drives on each new 3090 processor. (How is that for control of technology?)

- There is little demand for 3375 disks because too many attractive alternatives are available.

- There is very little market for used disk drives from the remaining plug-compatible vendors (Amdahl, NAS, and Memorex). The market that exists is primarily a spot market that fluctuates significantly based on the condition of the primary used market (which is dominated by IBM products). For this reason, INPUT does not attempt to track this market closely or to forecast residual values for IBM-compatible DASD.

2. TAPE DRIVES

- The 3420 used market remains very much a mixed bag, especially since IBM has not firmed up delivery schedules on the new 3480 drives announced a year ago.

  - The market for odd-numbered 3420 models is practically nonexistent, with an overabundance of supply and virtually no demand.

  - For the even-numbered models, there is limited supply and demand for the model 004; but demand remains high for both the 006 and the 008, with most of the trading occurring among the model 008s.

  - Major IBM customers still need a high-speed tape drive for dumping 3380 disks for data base archiving and backup. Since 3480s are not compatible with 3420s, it is anticipated that the demand for model 008s will remain strong even after 3480s are delivered.

  - The used market for 3420 model 008s will remain strong for at least another 12-18 months or until IBM can sell DASD archiving (see previous section). Even then, there will have to be some way of restoring all of those archived 10-1/2-inch tape reels. (Oh well. . .card readers stayed around for a long time, too.)

3. PRINTERS

- There is little used market activity in 3800 printers. Since IBM has made the model I field upgradable to the model III there is no replacement technology to force used 3800s into the secondary market.

- There does not appear to be any new development activity underway, and the 3800 will probably remain stable until distributed printing becomes faster, more cost-effective, and of higher quality.

4. LIST AND SECONDARY MARKET PRICES

- Exhibit III-1 presents current vendor list prices for selected IBM and software-compatible mainframes, as well as disk, tape, and printer systems. When a secondary market has been established, both retail and wholesale prices are given. At any given time, three price levels exist in the used market:

  - Retail price is the amount the end user pays for the equipment.

  - Dealer price is the amount a dealer pays another dealer to acquire equipment to complete a contracted sales obligation.

  - Wholesale price is the amount a dealer pays to acquire equipment for resale.

- At the present time, no secondary market prices have been established for IBM 3080 X series mainframes or for Amdahl or NAS equipment.

EXHIBIT III-1

LIST VERSUS SECONDARY MARKET PRICE FOR
SELECTED VENDOR EQUIPMENT (March 1985)

VENDOR	PRODUCT MODEL	VENDOR LIST PRICE (Dollars)	SECONDARY MARKET ($)	
			RETAIL	WHOLESALE
IBM	Processor			
	3083-E8	$1,158,414	$ 715,000	$ 675,000
	3083-EX8	958,414		
	3083-B16	2,033,414	1,225,000	1,150,000
	3083-BX16	1,683,414		
	3083-J16	2,558,414	1,650,000	1,575,000
	3083-JX16	2,103,414		
	3081-G16	3,083,414	2,025,000	1,925,000
	3081-GX16	2,598,414		
	3081-K16	3,613,414	2,350,000	2,250,000
	3081-KX16	3,043,414		
	3084-Q32	6,431,828	4,450,000	4,325,000
	3084-QX32	5,806,828		
	Disk			
	3350-A2	32,030	2,700	2,100
	3350-B2	25,360	2,200	1,600
	3370-A1	35,480	19,500	17,500
	3370-B1	26,600	17,500	15,500
	3380-AA4	88,780	79,000	76,000
	3380-B04	64,440	58,000	55,000
	Tape			
	3420-003	15,635	1,000	750
	3420-004	17,545	7,000	5,500
	3420-005	19,705	4,000	3,200
	3420-006	20,125	12,000	10,000
	3420-007	21,625	6,500	5,000
	3420-008	22,085	19,250	17,250
	Printer			
	1403-N1	40,487	1,200	300
	3211-001	57,765	9,500	6,800
	3800-001	315,000	140,000	125,000
	3800-003	315,000	265,000	250,000

EXHIBIT III-1 (Cont.)

LIST VERSUS SECONDARY MARKET PRICE FOR
SELECTED VENDOR EQUIPMENT (March 1985)

VENDOR	PRODUCT MODEL	VENDOR LIST PRICE (Dollars)	SECONDARY MARKET	
			RETAIL	WHOLESALE
Amdahl	Processor			
	5840-16	$1,550,000		
	5850-32	1,950,000		
	5860-24	2,380,000		
	5867-32	3,080,000		
	5868-32	3,410,000		
	5870-32	3,470,000		
	5880-64	4,590,000		
	Disk			
	6280-AA4	49,300		
	6280-B4	35,800		
	6380-AA4	71,200		
	6380-B4	48,700		
NAS	Processor			
	AS/8023-8	699,000		
	AS/8043-8	1,067,000		
	AS/8053-8	1,492,000		
	AS/8063-8	1,905,000		
	AS/8063-16	3,074,000		
	AS/9040-8	1,492,000		
	AS/9050-8	1,909,000		
	AS/9060-16	2,308,000		
	AS/9070-16	3,249,000		
	AS/9080-16	4,140,000		
	Disk			
	7380-A4	85,500		
	7380-B4	58,500		
	Tape			
	7420-88	25,000		

C. RESIDUAL VALUE FORECASTS

1. DISK, TAPE, AND PRINTER PRODUCTS

- Exhibit III-2 projects future average used retail values on January 1, 1986 through 1990 for selected disk, tape, and printer products.
- Exhibit III-3 projects these values as a percent of current IBM list price.
- Exhibits III-4 through III-13 graph the range of anticipated values for specific products for the 1986 through 1990 time frame.

2. IBM AND SOFTWARE-COMPATIBLE MAINFRAMES

- Exhibit III-14 projects future average used market retail values on January 1, 1986 through 1990 for selected IBM and software-compatible mainframes. These projections are included in the peripherals report to update residual value forecasts, made prior to IBM's recent announcement of Sierra (3090, models 200 and 400).
- Exhibit III-15 projects these values as a percent of current IBM list price.
- Exhibits III-16 through III-23 graph the range of anticipated values for specific products for the 1986 through 1990 time frame.

EXHIBIT III-2

LIST PRICE VERSUS PROJECTED USED MARKET VALUE
FOR DISK, TAPE, AND PRINTER PRODUCTS

EQUIPMENT TYPE	MODEL NUMBER	CURRENT LIST PRICE (Dollars) 3/1/85	PROJECTED USED MARKET RETAIL VALUE (Dollars) ON JAN. 1				
			1986	1987	1988	1989	1990
Disk	3350-A02	$ 32,030	$ 1,602	$ 961	$ 641	$ 320	$ 0
	3350-B02	25,360	1,014	761	507	254	0
	3380-AA4	88,780	60,370	44,390	24,858	14,205	6,215
	3380-B04	64,440	41,886	30,931	17,399	9,666	3,222
Tape	3420-003	15,635	469	313	313	156	0
	3420-005	19,705	2,365	1,379	788	394	197
	3420-007	21,625	5,406	3,460	2,163	1,298	649
	3420-004	17,545	6,316	3,860	2,456	1,755	877
	3420-006	20,125	11,673	8,453	5,031	3,623	2,013
	3420-008	22,085	18,772	15,018	9,938	6,626	2,650
Printer	1403-N01	40,040	400	0	0	0	0
	3211-001	40,080	6,012	4,008	2,405	1,202	401
	3800-001	315,000	113,400	78,750	50,400	22,050	15,750
	3800-003	315,000	173,250	132,300	88,200	47,250	25,200

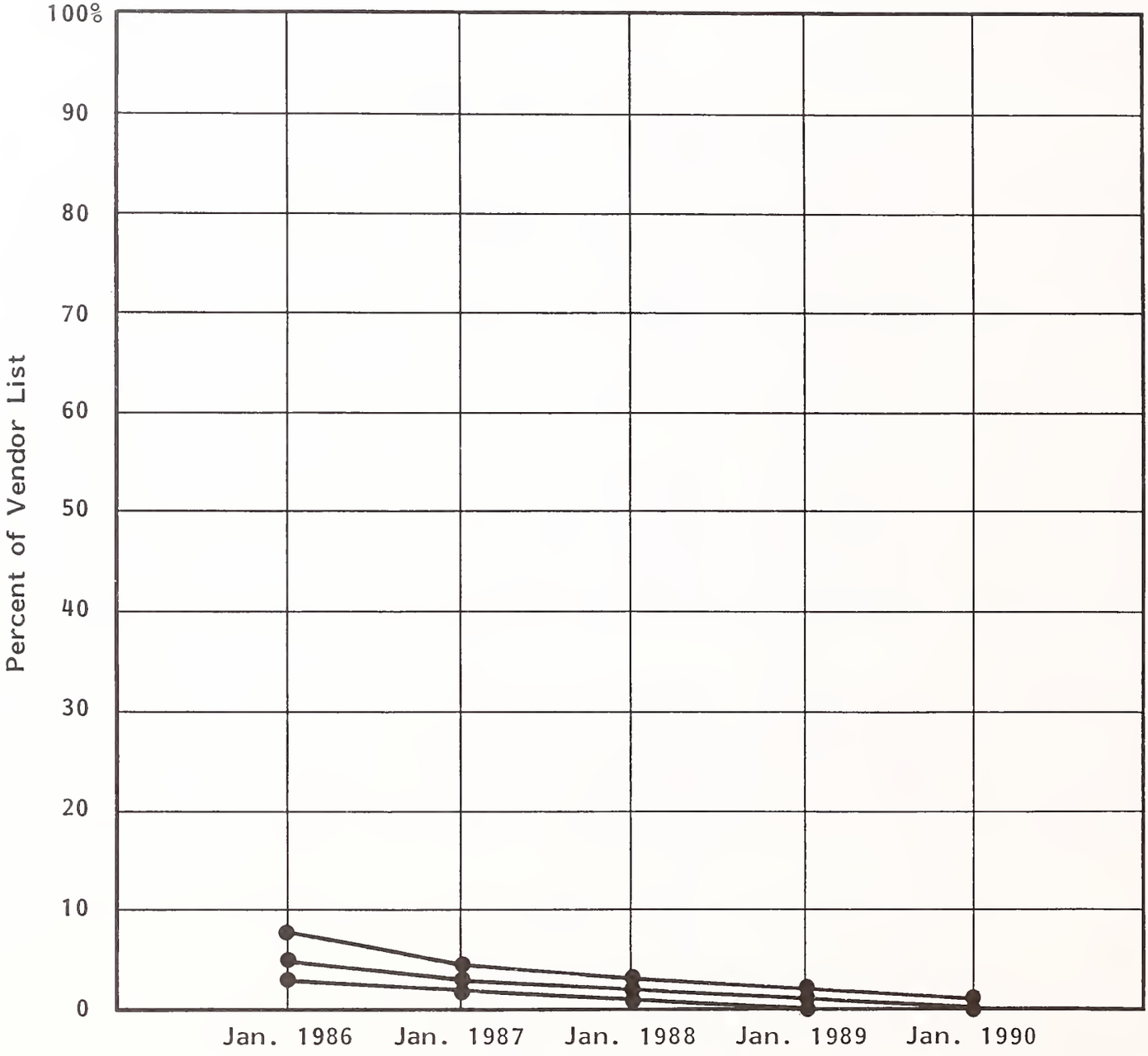
EXHIBIT III-3

LIST PRICE VERSUS PROJECTED RESIDUAL VALUE
FOR DISK, TAPE, AND PRINTER PRODUCTS

EQUIPMENT TYPE	MODEL NUMBER	CURRENT LIST PRICE (Dollars) 3/1/85	PROJECTED RESIDUAL VALUE AS A PERCENT OF VENDOR LIST PRICE VALUE ON JAN. 1				
			1986	1987	1988	1989	1990
Disk	3350-A02	32,030	5%	3%	2%	1%	-
	3350-B02	25,360	4	3	2	1	-
	3380-AA4	88,780	68	50	28	16	7%
	3380-B04	64,440	65	48	27	15	5
Tape	3420-003	15,635	3	2	2	1	-
	3420-005	19,705	12	7	4	2	1
	3420-007	21,625	25	16	10	6	3
	3420-004	17,545	36	22	14	10	5
	3420-006	20,125	58	42	25	18	10
	3420-008	22,085	85	68	45	30	12
Printer	1403-N01	40,040	1	-	-	-	-
	3211-001	40,080	15	10	6	3	1
	3800-001	315,000	36	25	16	7	5
	3800-003	315,000	55	42	28	15	8

EXHIBIT III-4

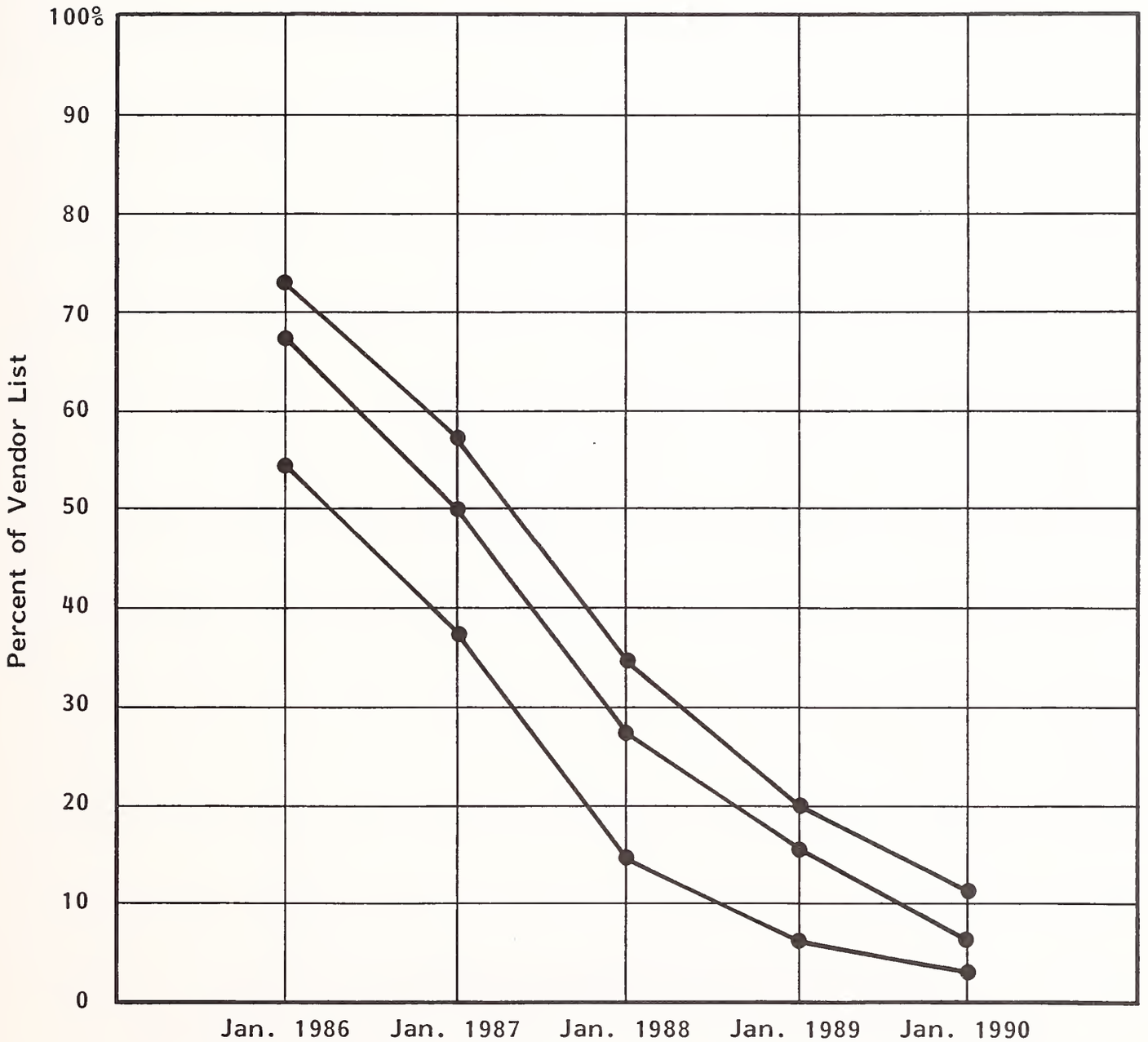
PROJECTED RESIDUAL VALUES FOR THE
IBM 3350 DISK DRIVE



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	8%	5%	3%	2%	1%
Expected	5	3	2	1	-
Low	3	2	1	-	-

EXHIBIT III-5

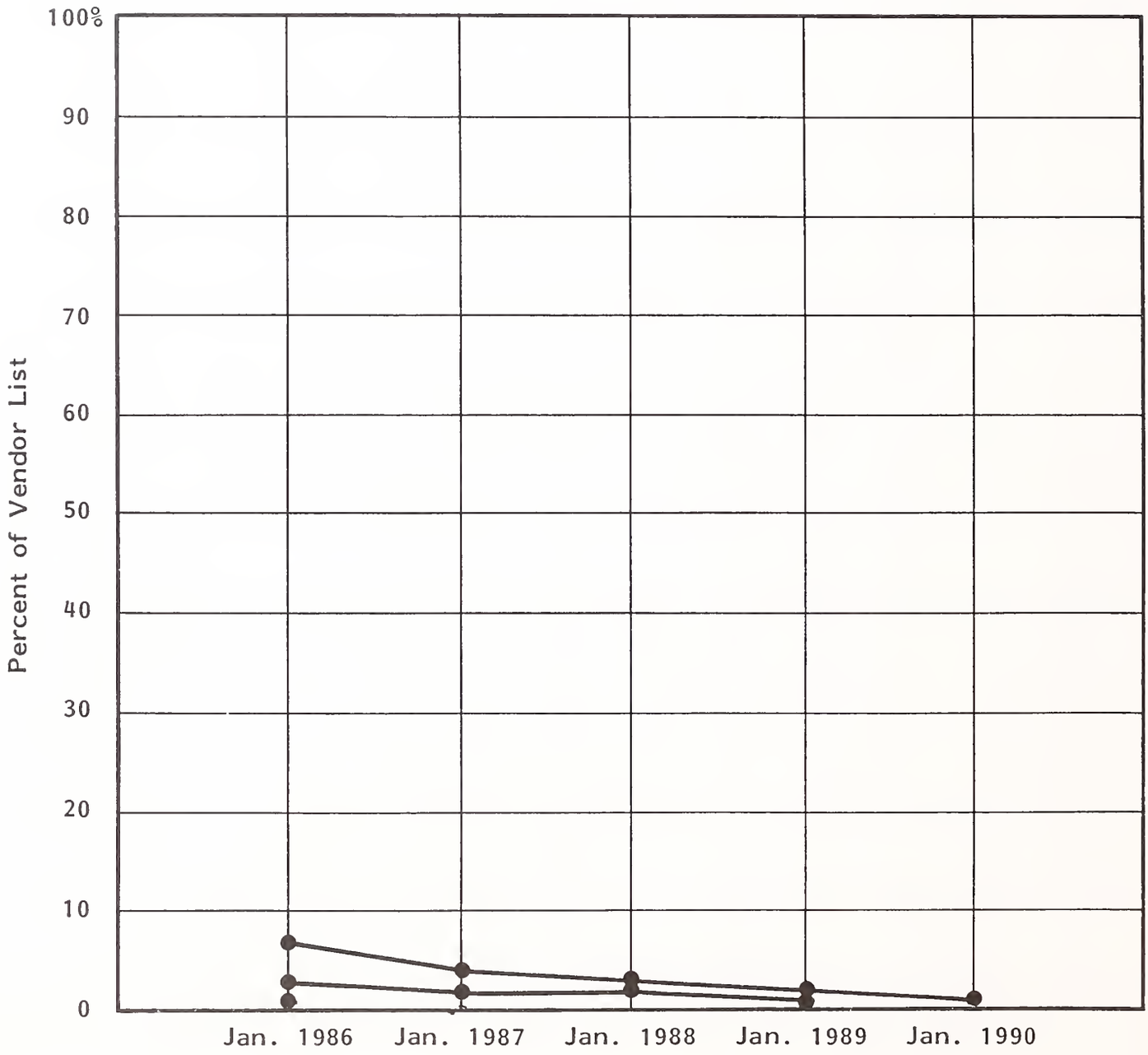
PROJECTED RESIDUAL VALUES FOR THE
IBM 3380 DISK DRIVE



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	73%	58%	35%	20%	11%
Expected	68	50	28	16	7
Low	55	38	15	7	3

EXHIBIT III-6

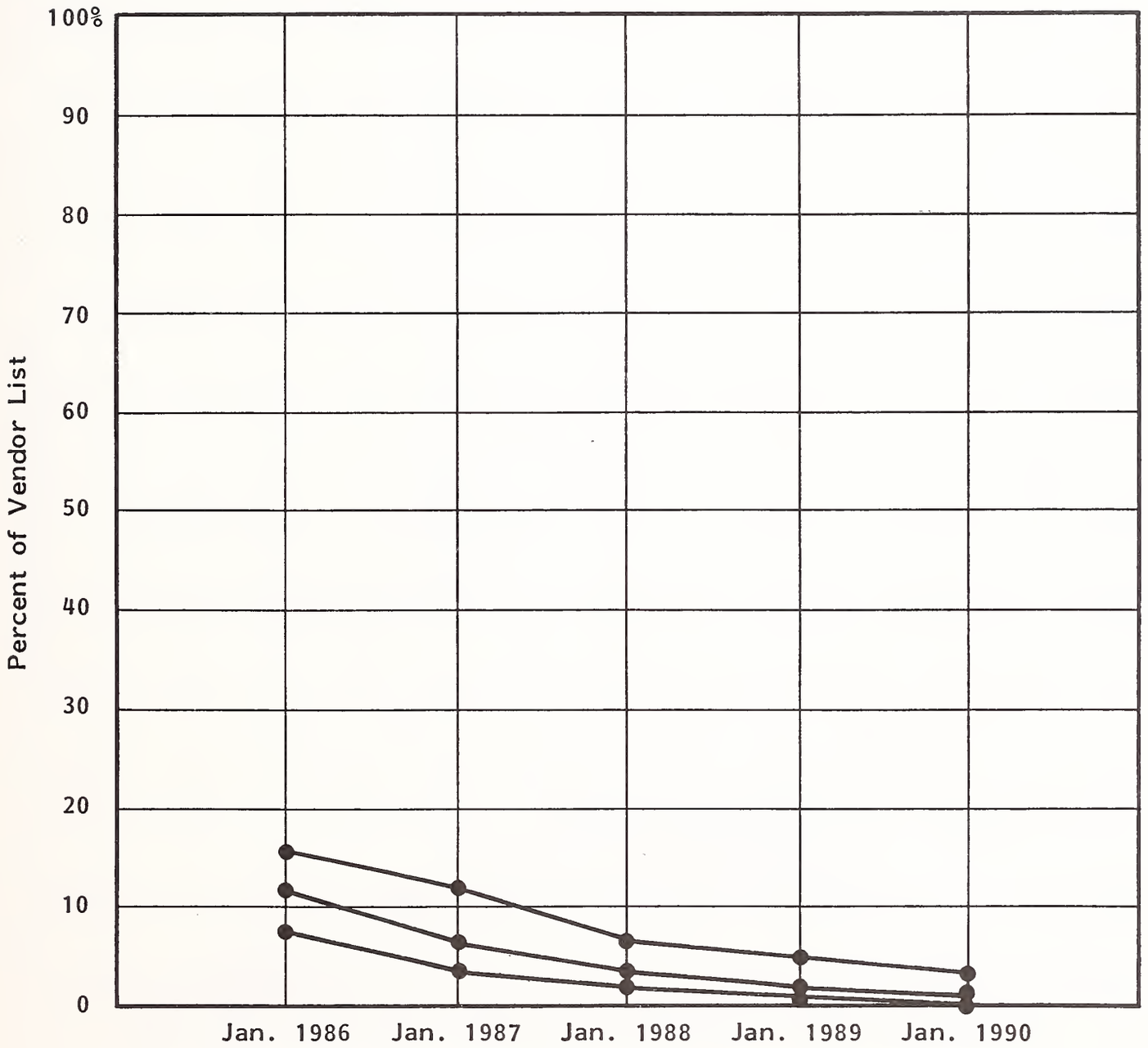
PROJECTED RESIDUAL VALUES FOR THE
IBM 3420-003 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	7%	4%	3%	2%	1%
Expected	3	2	2	1	-
Low	1	-	-	-	-

EXHIBIT III-7

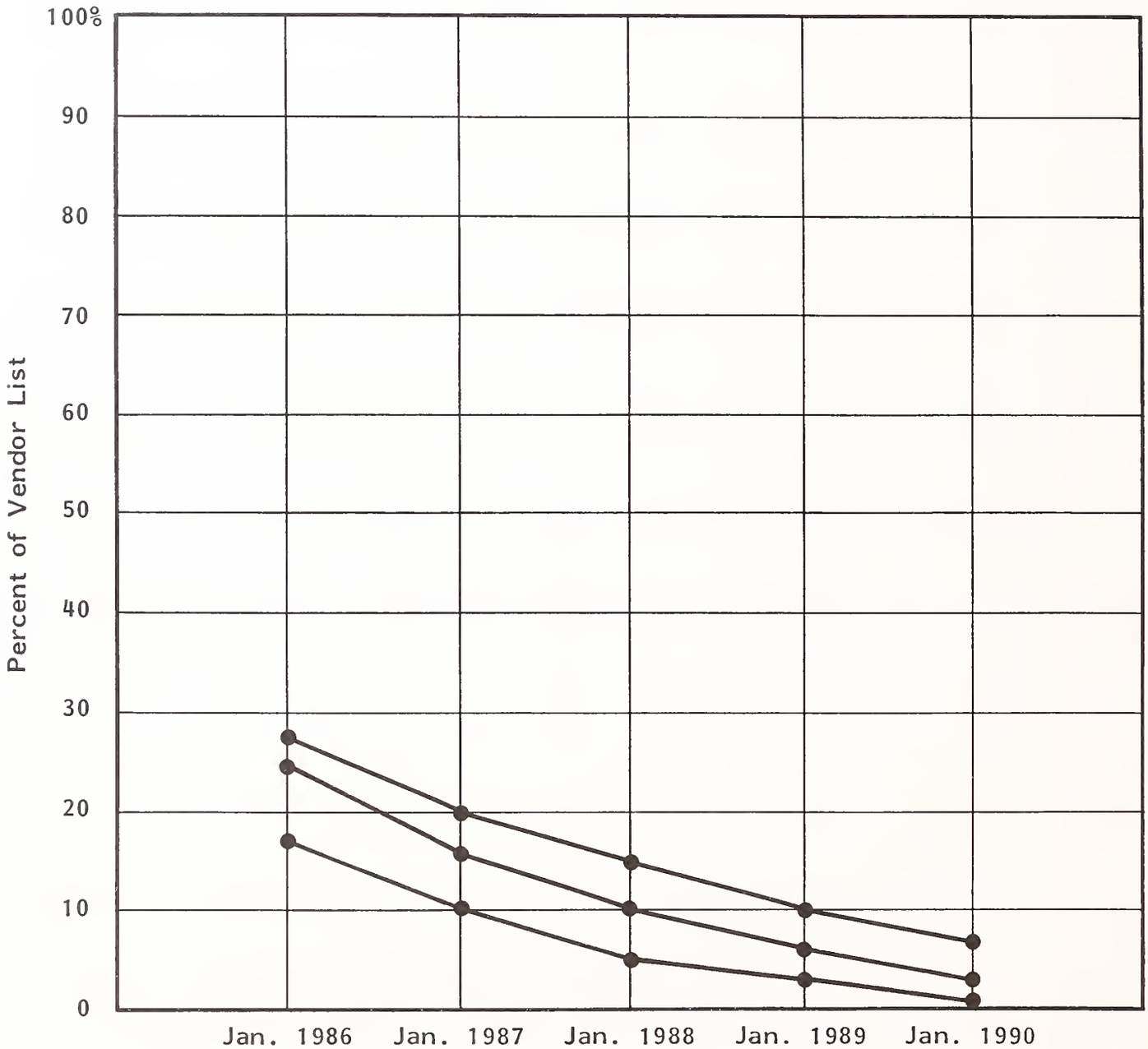
PROJECTED RESIDUAL VALUES FOR THE
IBM 3420-005 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	16%	12%	7%	5%	3%
Expected	12	7	4	2	1
Low	8	4	2	1	–

EXHIBIT III-8

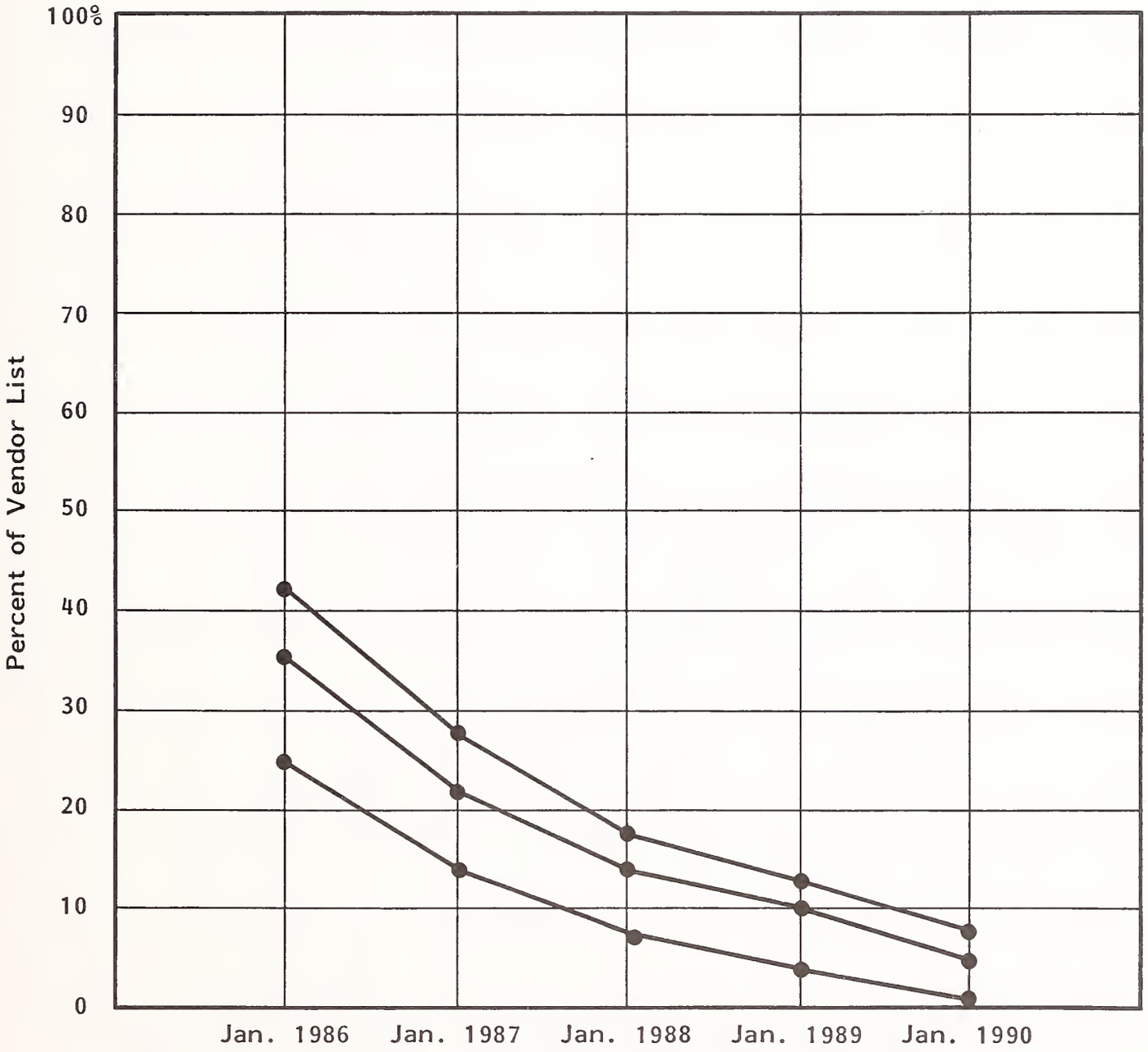
PROJECTED RESIDUAL VALUES FOR THE
IBM 3420-007 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	28%	20%	15%	10%	7%
Expected	25	16	10	6	3
Low	18	10	5	3	1

EXHIBIT III-9

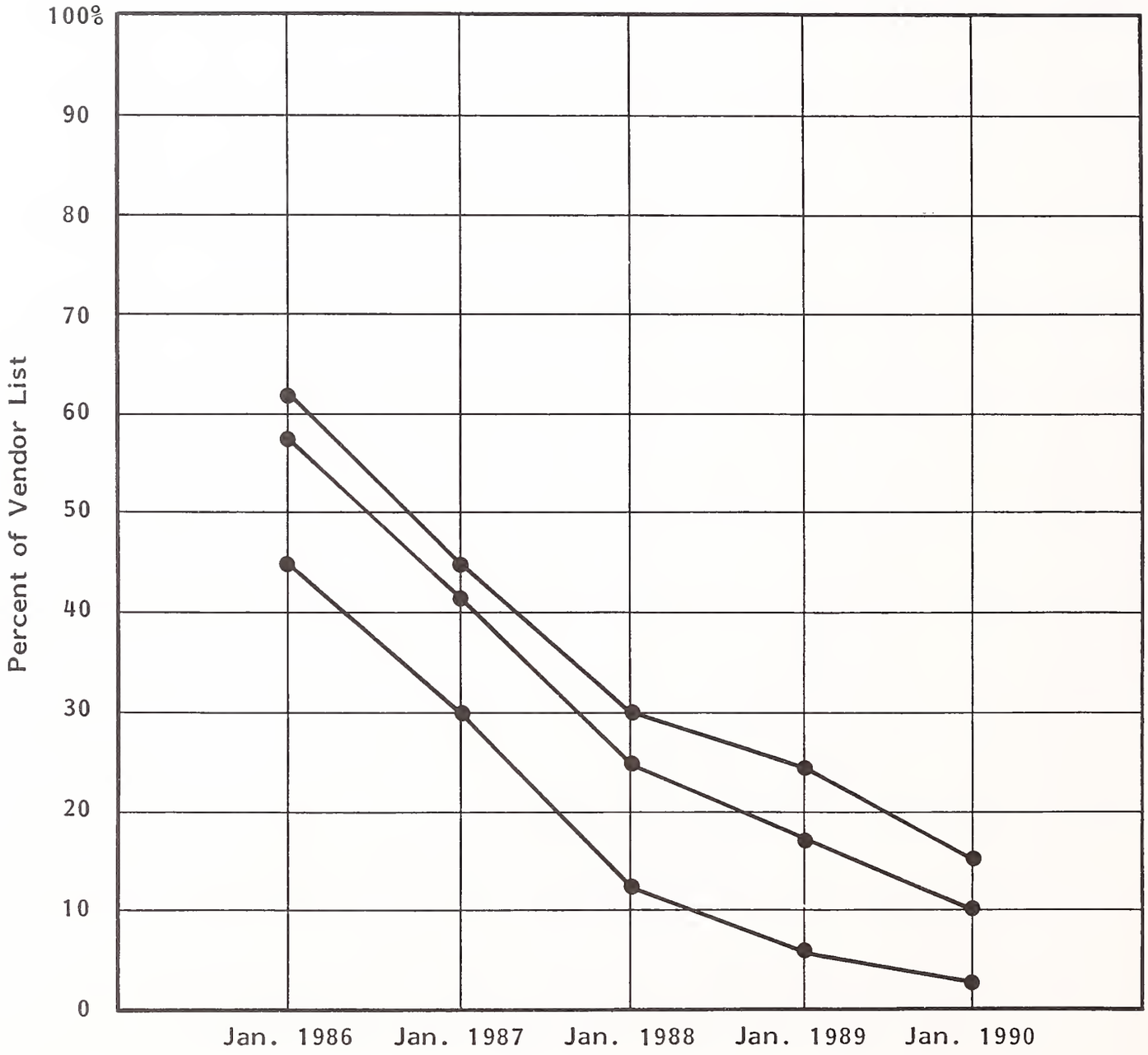
PROJECTED RESIDUAL VALUES FOR THE
IBM 3420-004 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	42%	28%	18%	13%	8%
Expected	36	22	14	10	5
Low	25	14	8	4	1

EXHIBIT III-10

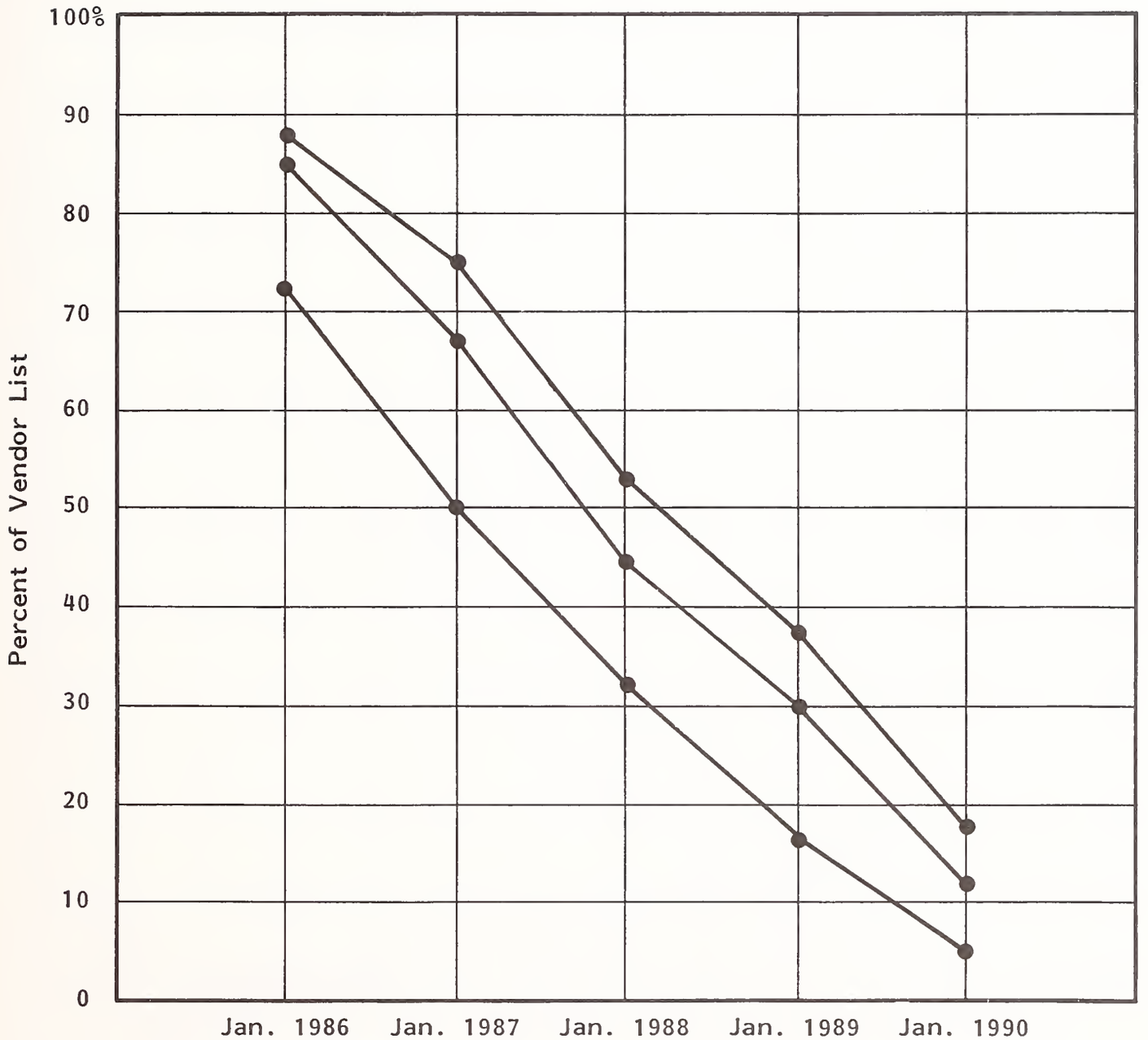
PROJECTED RESIDUAL VALUES FOR THE
IBM 3420-006 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	62%	45%	30%	25%	15%
Expected	58	42	25	18	10
Low	45	30	12	6	3

EXHIBIT III-11

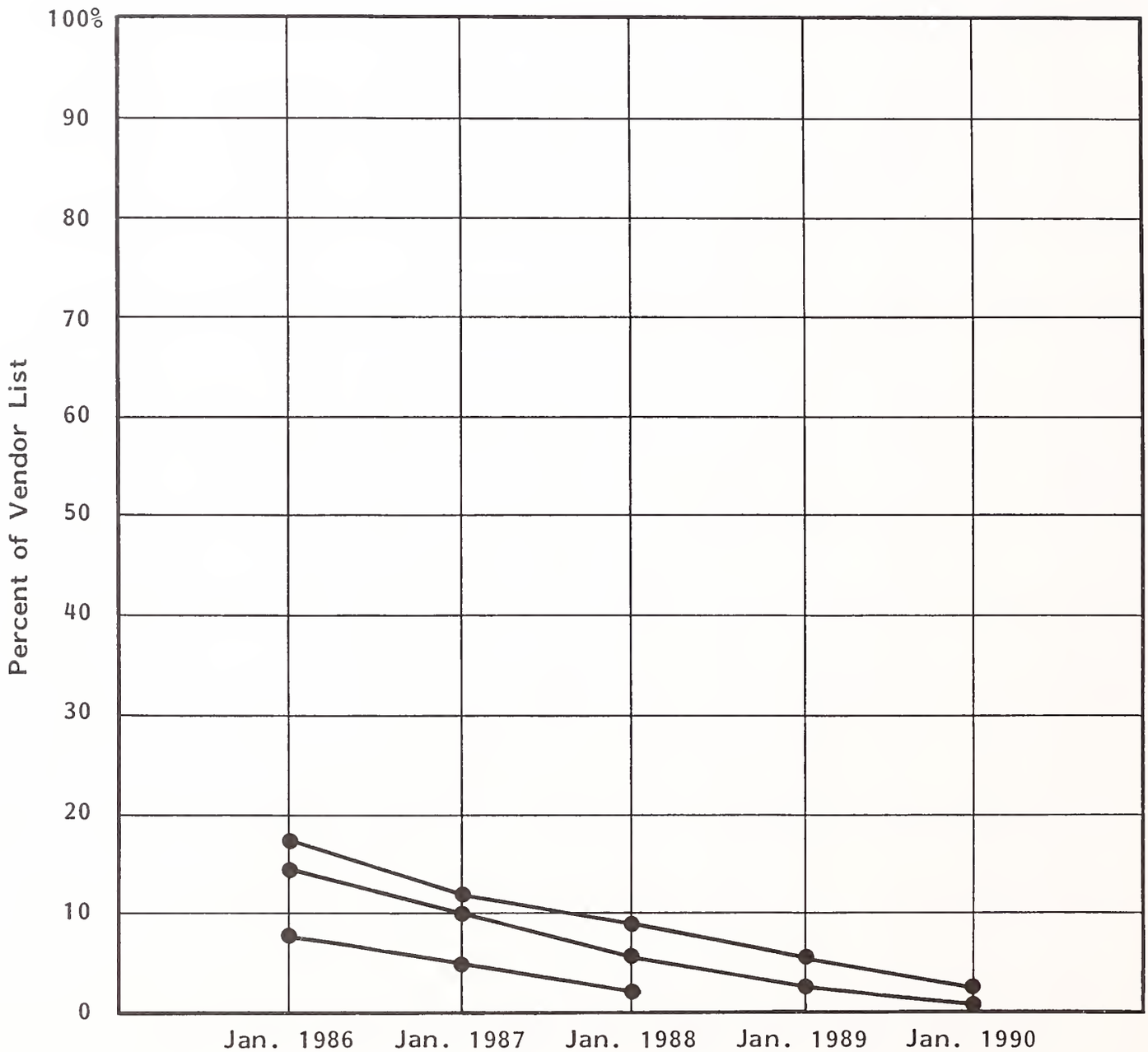
PROJECTED RESIDUAL VALUES FOR THE
IBM 3420-008 TAPE DRIVE



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	88%	75%	53%	38%	18%
Expected	85	68	45	30	12
Low	72	50	32	17	5

EXHIBIT III-12

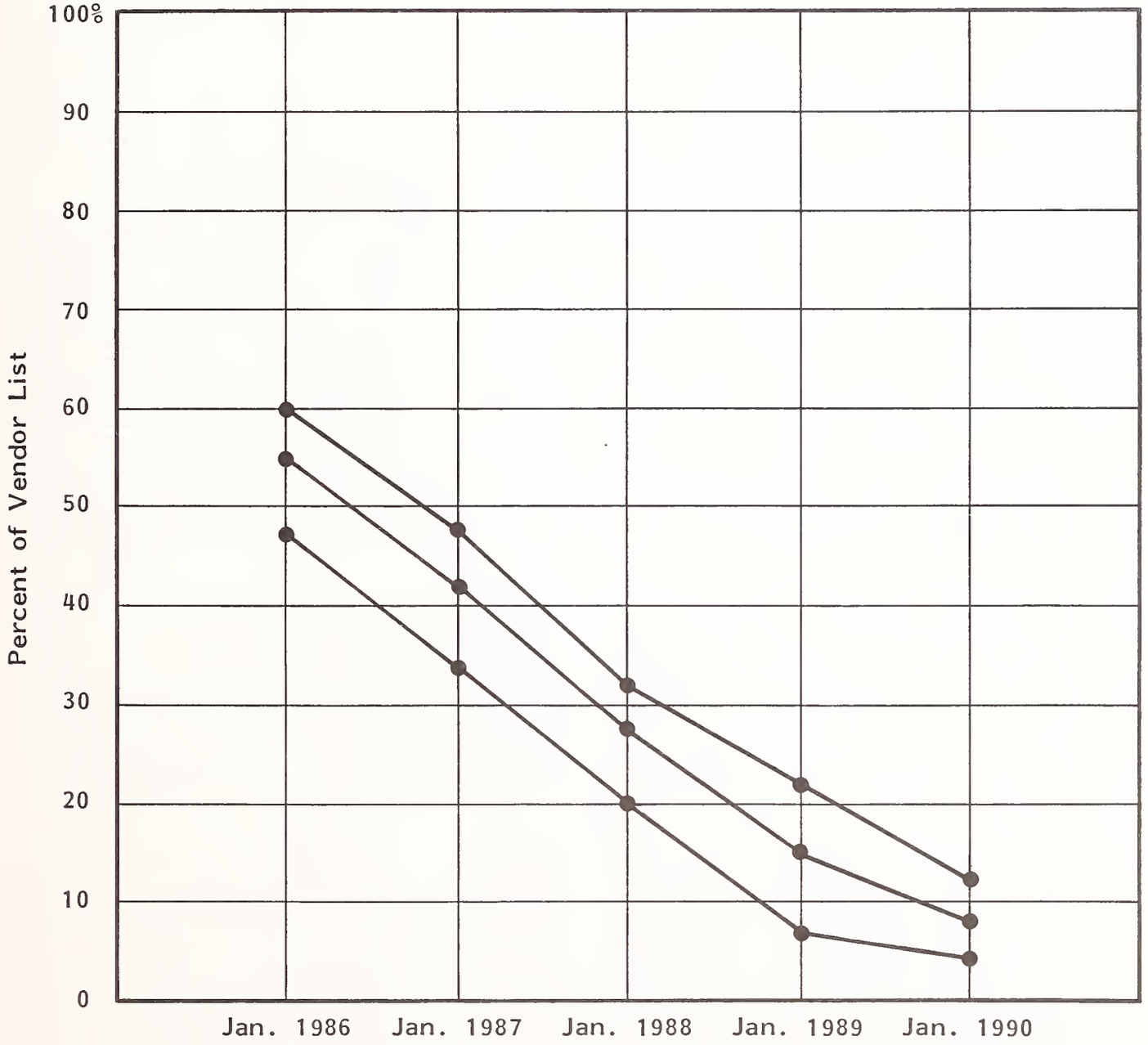
PROJECTED RESIDUAL VALUES FOR THE
IBM 3211-001 PRINTER



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	18%	12%	9%	6%	3%
Expected	15	10	6	3	1
Low	8	5	2	–	–

EXHIBIT III-13

PROJECTED RESIDUAL VALUES FOR THE
IBM 3800-003 PRINTER



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	60%	48%	32%	22%	12%
Expected	55	42	28	15	8
Low	47	34	20	7	5

EXHIBIT III-14

LIST PRICE VERSUS PROJECTED USED MARKET VALUE
FOR PROCESSORS

VENDOR	PROCESSOR MODEL	CURRENT LIST PRICE (Dollars) 3/1/85	PROJECTED USED MARKET RETAIL VALUE (Dollars) ON JAN. 1				
			1986	1987	1988	1989	1990
IBM	3083-CX8	$ 735,000	$ 308,700	$ 205,800	$ 110,250	$ 44,100	$ 14,700
	3083-EX8	760,000	342,000	190,000	114,000	45,600	15,200
	3083-BX16	1,350,000	634,500	364,500	216,000	108,000	40,500
	3083-JX32	1,975,000	987,500	592,500	355,500	197,500	79,000
	3081-GX16	2,350,000	1,410,000	822,500	470,000	282,000	117,500
	3081-KX24	3,195,000	2,076,750	1,214,100	766,800	479,250	223,650
	3084-QX64	5,610,000	3,927,000	2,244,000	1,683,000	1,122,000	561,000
Amdahl	5840-16	1,550,000	852,500	465,000	263,500	93,000	15,500
	5850-24	1,950,000	1,072,500	624,000	351,000	156,000	19,500
	5860-24	2,380,000	1,428,000	833,000	476,000	238,000	71,400
	5867-32	3,080,000	2,002,000	1,139,600	677,600	338,800	92,400
	5868-32	3,410,000	2,284,700	1,261,700	750,200	375,100	102,300
	5870-32	3,470,000	2,429,000	1,388,000	902,200	451,100	208,200
	5880-64	4,590,000	3,213,000	1,927,800	1,285,200	826,200	413,100
NAS*	AS/8023-8	699,000	363,480	230,670	83,880	41,940	13,980
	AS/8043-8	1,067,000	586,850	373,450	160,050	85,360	42,680
	AS/8053-8	1,492,000	850,440	537,120	223,800	134,280	74,600
	AS/8063-8	1,905,000	1,143,000	742,950	323,850	209,550	133,350
	AS/8083-1	3,074,000	2,151,800	1,321,820	614,800	430,360	245,920
	AS/9040-8	1,492,000	298,400	134,280	74,600	29,840	14,920
	AS/9050-8	1,909,000	477,250	229,080	133,630	76,360	38,180
	AS/9060-1	2,308,000	692,400	415,440	230,800	138,480	92,320
	AS/9070-1	3,249,000	1,364,580	779,760	487,350	259,920	194,940
	AS/9080-1	4,140,000	1,945,800	1,242,000	745,200	414,000	289,800

EXHIBIT III-15

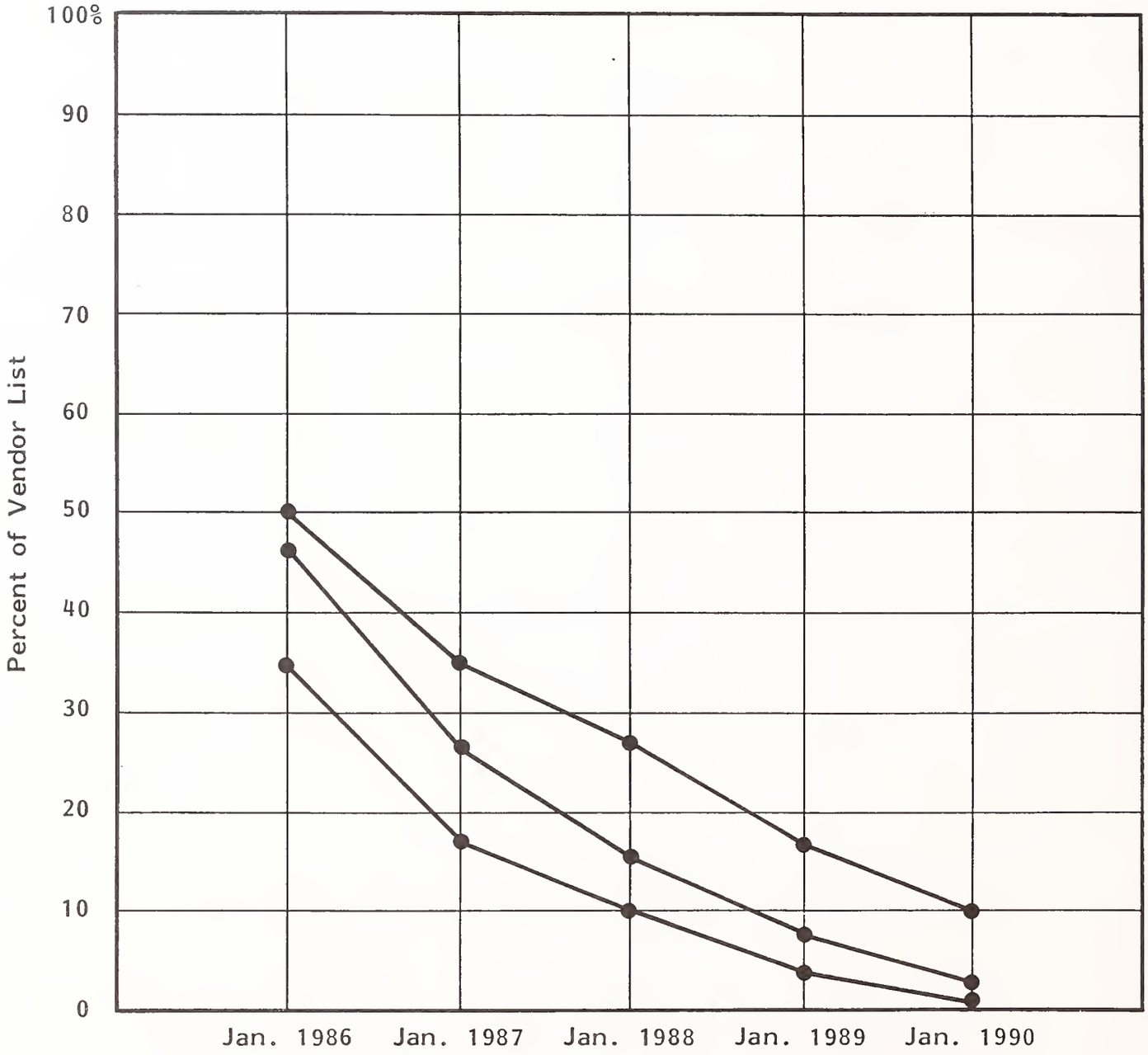
LIST PRICE VERSUS PROJECTED RESIDUAL VALUE
FOR PROCESSORS

VENDOR	PROCESSOR MODEL	CURRENT LIST PRICE (Dollars) 3/1/85	PROJECTED RESIDUAL VALUE AS A PERCENT OF VENDOR LIST PRICE VALUE ON JAN. 1				
			1986	1987	1988	1989	1990
IBM	3083-CX8	$ 735,000	42%	28%	15%	6%	2%
	3083-EX8	760,000	45	25	15	6	2
	3083-BX16	1,350,000	47	27	16	8	3
	3083-JX32	1,975,000	50	30	18	10	4
	3081-GX16	2,350,000	60	35	20	12	5
	3081-KX24	3,195,000	65	38	24	15	7
	3084-QX64	5,610,000	70	40	30	20	10
Amdahl	5840-16	1,550,000	55	30	17	6	1
	5850-24	1,950,000	55	32	18	8	1
	5860-24	2,380,000	60	35	20	10	3
	5867-32	3,080,000	65	37	22	11	3
	5868-32	3,410,000	67	37	22	11	3
	5870-32	3,470,000	70	40	26	13	6
	5880-64	4,590,000	70	42	28	18	9
NAS*	AS/8023-8	699,000	52	33	12	6	2
	AS/8043-8	1,067,000	55	35	15	8	4
	AS/8053-8	1,492,000	57	36	15	9	5
	AS/8063-8	1,905,000	60	39	17	11	7
	AS/8083-16	3,074,000	70	43	20	14	8
	AS/9040-8	1,492,000	20	9	5	2	1
	AS/9050-8	1,909,000	25	12	7	4	2
	AS/9060-16	2,308,000	30	18	10	6	4
	AS/9070-16	3,249,000	42	24	15	8	6
	AS/9080-16	4,140,000	47	30	18	10	7

* NAS does not quote processor prices separately. List price here includes power distribution unit, controller, and console, as appropriate.

EXHIBIT III-16

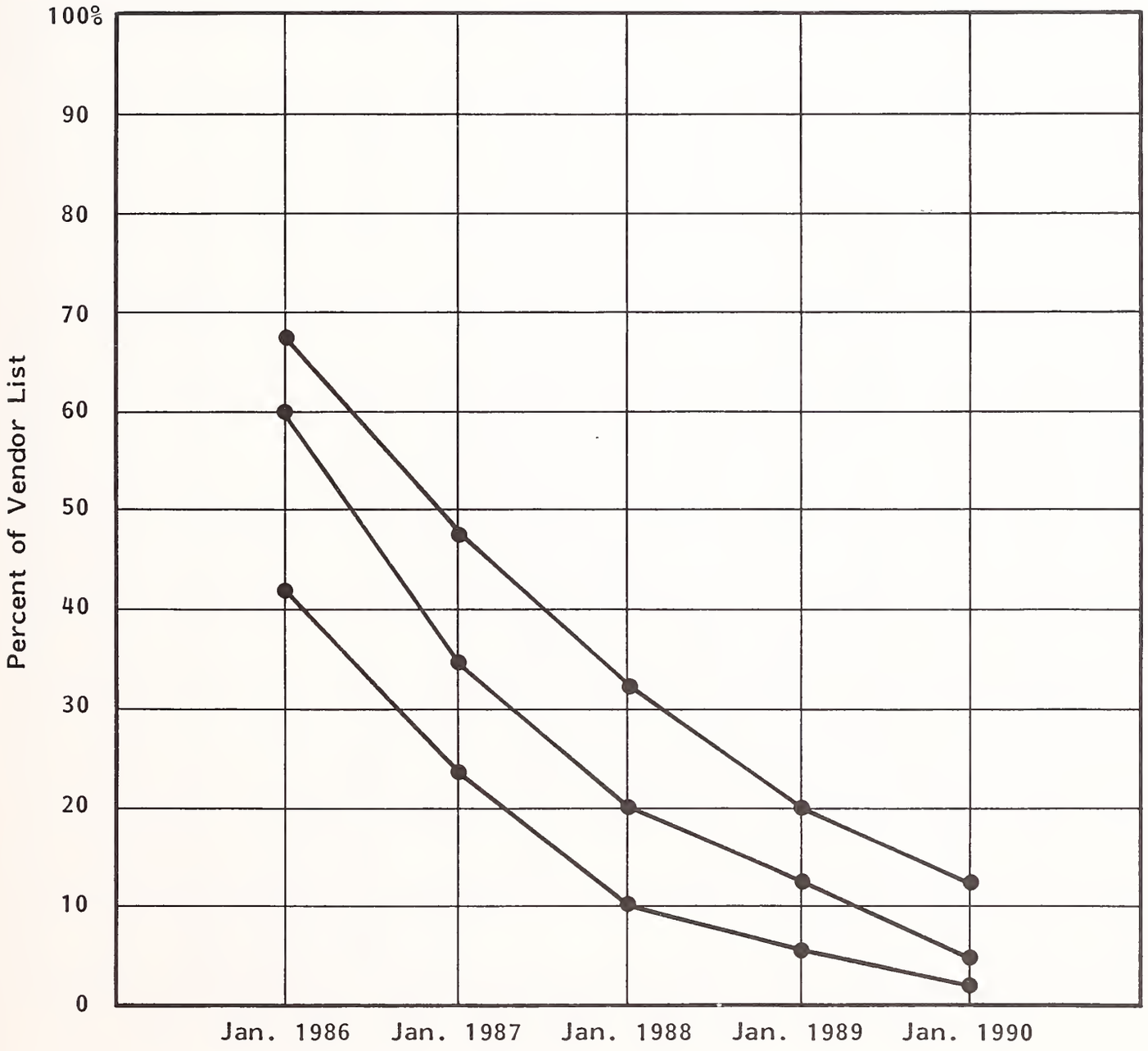
RESIDUAL VALUE FORECAST FOR THE
IBM 3083 SERIES PROCESSORS



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	50%	35%	28%	17%	10%
Expected	47	27	16	8	3
Low	35	18	10	4	1

EXHIBIT III-17

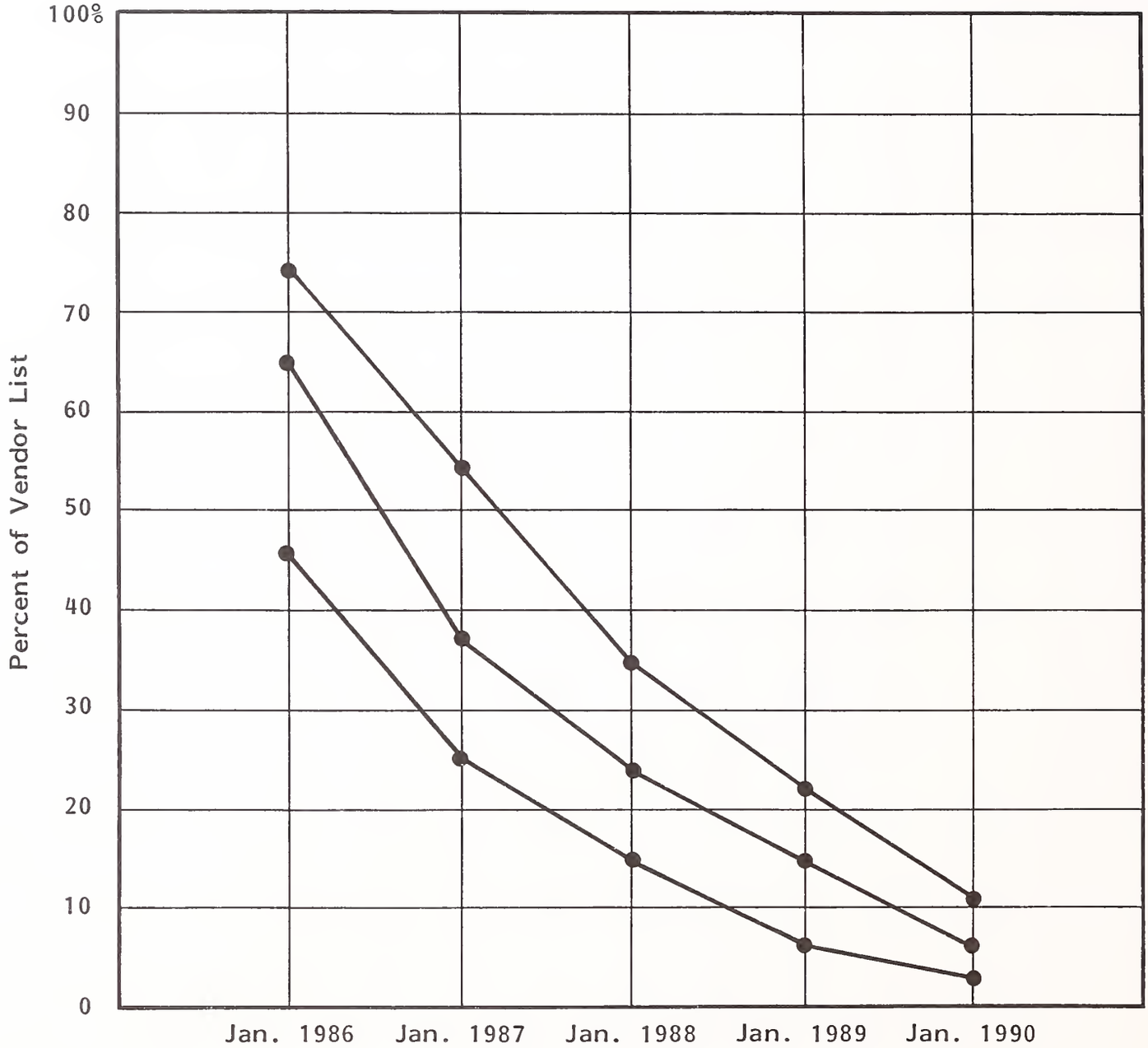
RESIDUAL VALUE FORECAST FOR THE
IBM 3081-GX16 PROCESSOR



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	68%	48%	32%	20%	12%
Expected	60	35	20	12	5
Low	42	24	10	6	2

EXHIBIT III-18

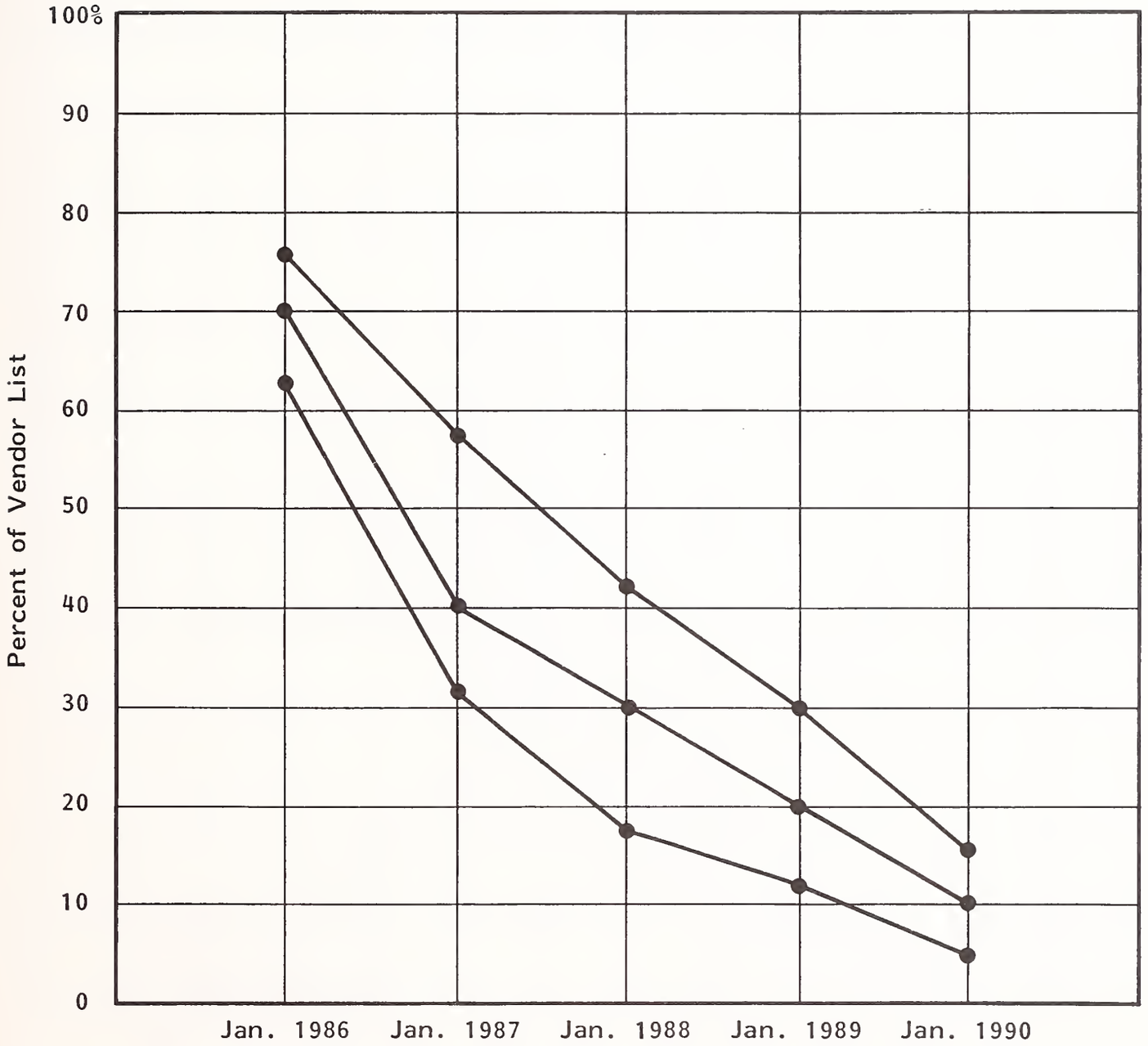
RESIDUAL VALUE FORECAST FOR THE
IBM 3081-KX24 PROCESSOR



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	74%	54%	35%	22%	11%
Expected	65	38	24	15	7
Low	46	26	15	7	3

EXHIBIT III-19

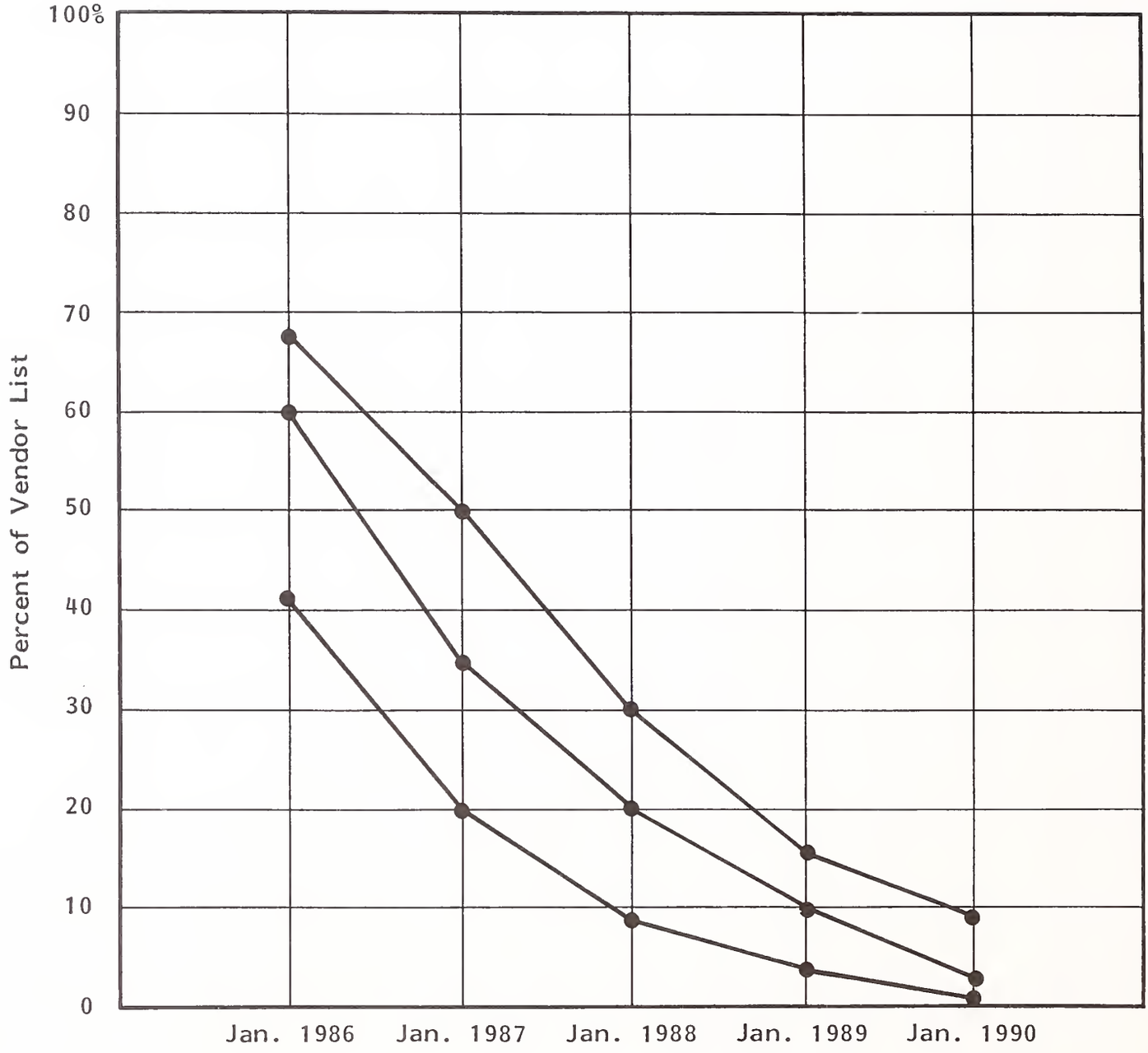
RESIDUAL VALUE FORECAST FOR THE
IBM 3084-QX64 PROCESSOR



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	76%	58%	42%	30%	16%
Expected	70	40	30	20	10
Low	63	32	18	12	5

EXHIBIT III-20

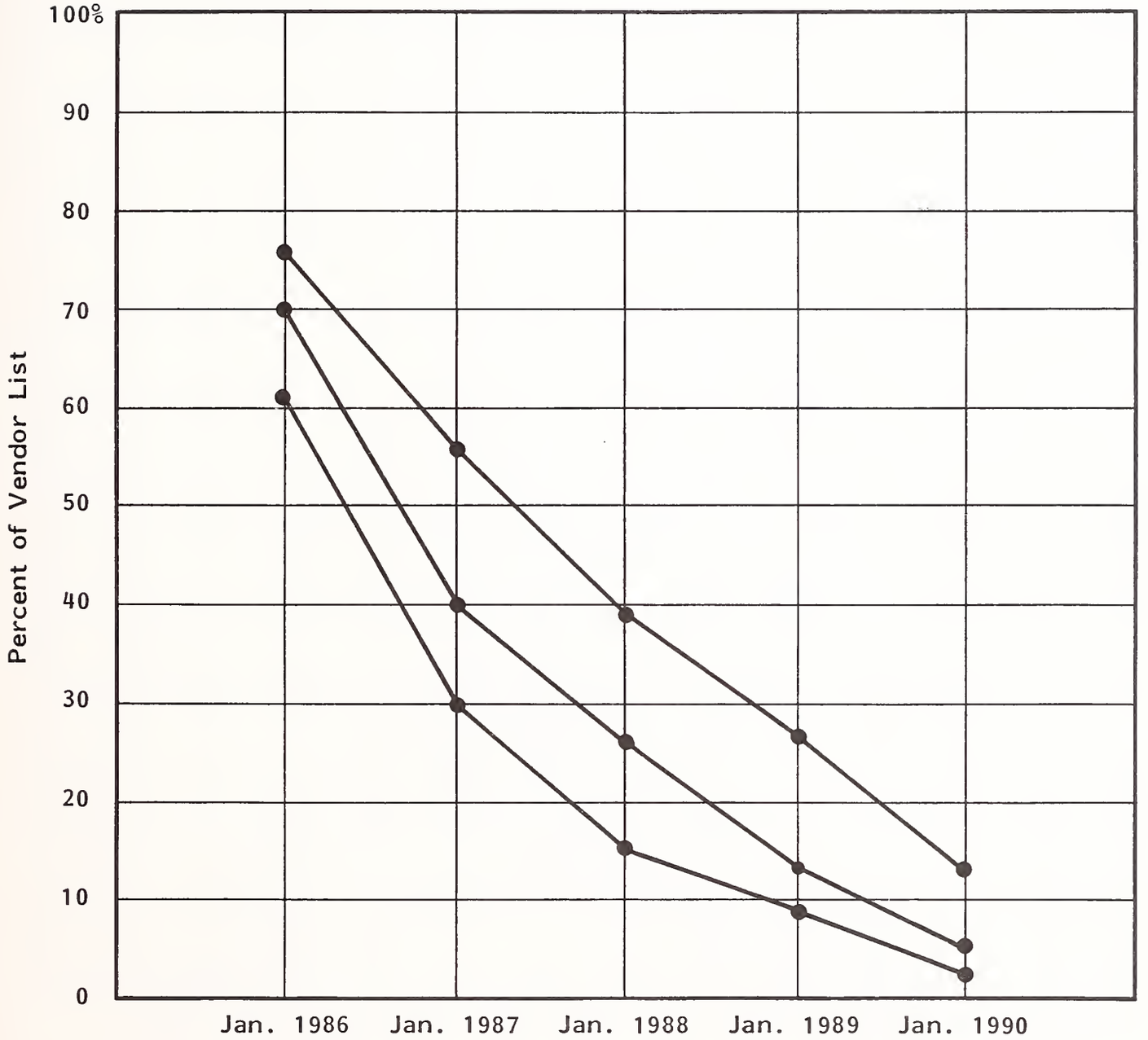
RESIDUAL VALUE FORECAST FOR THE
AMDAHL 5860-24 PROCESSOR



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	68%	50%	30%	16%	9%
Expected	60	35	20	10	3
Low	41	20	9	4	1

EXHIBIT III-21

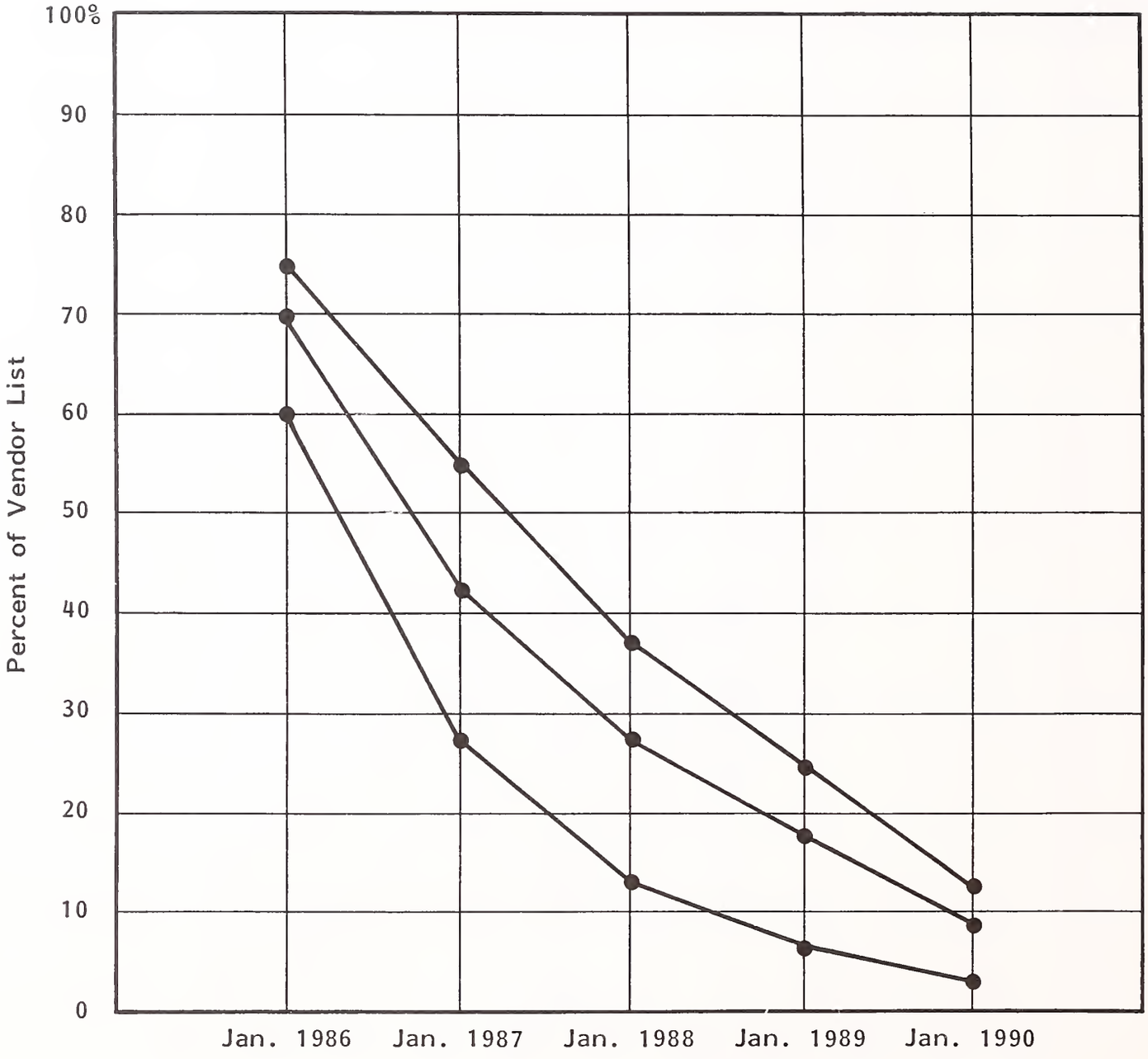
RESIDUAL VALUE FORECAST FOR THE
AMDAHL 5870-32 PROCESSOR



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	76%	56%	39%	27%	13%
Expected	70	40	26	13	6
Low	61	30	15	9	3

EXHIBIT III-22

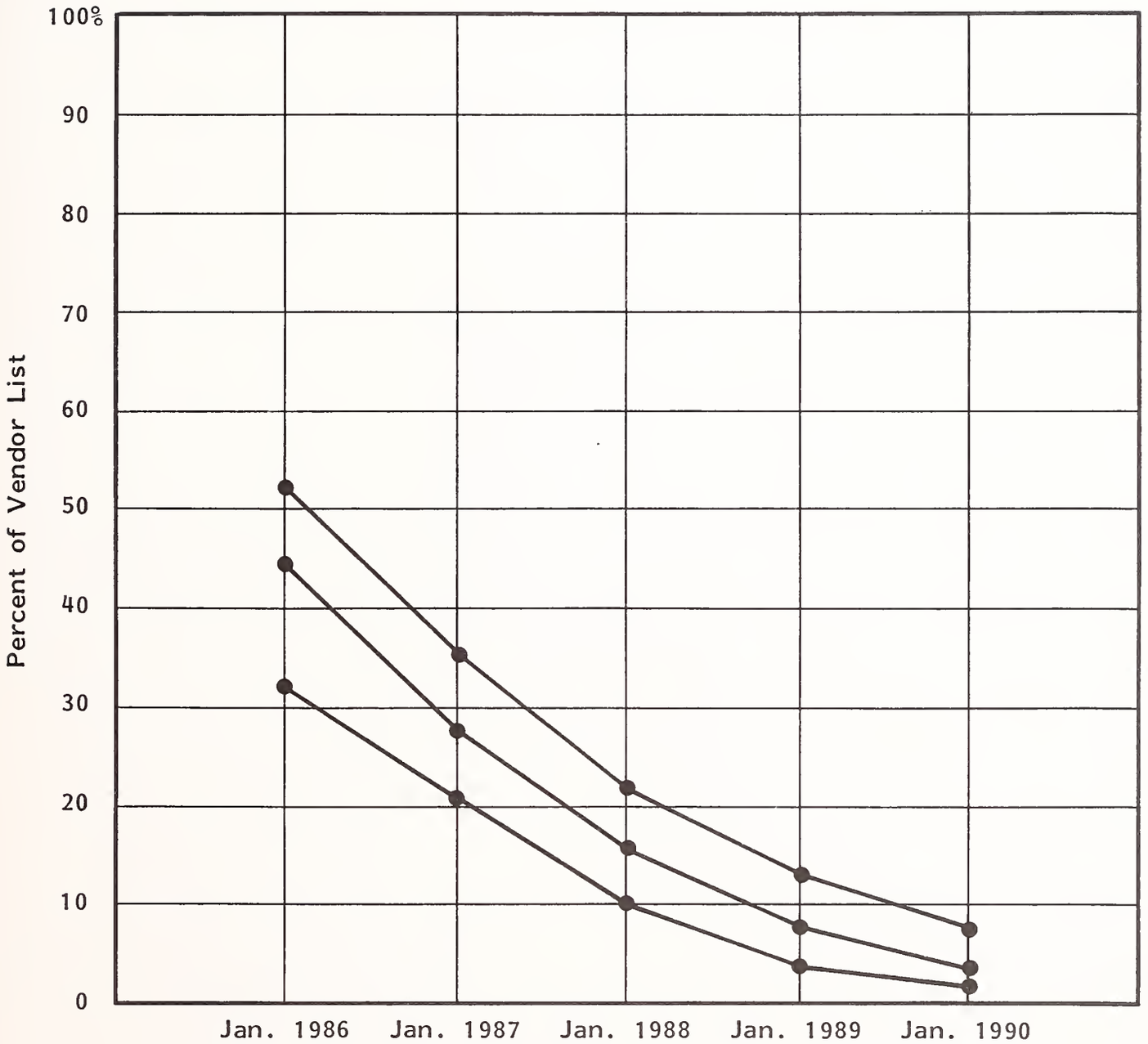
RESIDUAL VALUE FORECAST FOR THE
AMDAHL 5880-64 PROCESSOR



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	75%	55%	37%	25%	12%
Expected	70	42	28	18	9
Low	60	28	13	7	3

EXHIBIT III-23

RESIDUAL VALUE FORECAST FOR THE
NAS AS/9000 SERIES PROCESSORS



PROJECTED VALUES RANGE	JAN. 1986	JAN. 1987	JAN. 1988	JAN. 1989	JAN. 1990
High	52%	36%	22%	13%	8%
Expected	45	28	16	8	4
Low	32	21	10	4	2

About INPUT

INPUT provides planning information, analysis, and recommendations to managers and executives in the information processing industries. Through market research, technology forecasting, and competitive analysis, INPUT supports client management in making informed decisions. Continuing services are provided to users and vendors of computers, communications, and office products and services.

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