

109103

REPORT BY THE
Comptroller General
OF THE UNITED STATES

988761

**National Bureau Of Standards
Needs Better Management Of Its
Computer Resources To Improve
Program Effectiveness**

Good planning, management, and use of the National Bureau of Standards computer resources--hardware, software, information, and personnel--are critical to agency mission and program objectives. However, the Bureau is experiencing problems in these areas. The Bureau can correct these problems and more effectively carry out its objectives by

- providing better computer resources for scientists and administrators,
- increasing efforts in requirements studies to demonstrate the need for added computer capabilities,
- improving management controls over hardware and software,
- developing an effective management system and centralizing computer management, and
- increasing top management involvement.



004970

CED-79-39
APRIL 17, 1979





COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-114821

To the Chairman, Senate Committee *SEN06200*
on Commerce, Science and
Transportation and the
Chairman, Subcommittee on Science,
Technology and Space *SEN06205*

In an October 13, 1977, joint request, the Senate Committee on Commerce, Science and Transportation and its Subcommittee on Science, Technology and Space requested that we review certain activities of the National Bureau of Standards. As agreed with both offices, this report focuses on the effectiveness of Bureau computer resources--hardware, software, personnel, and information--in meeting mission and program objectives.

Recently, we provided you with a report "National Bureau of Standards--Information and Observations on its Administration," (CED-79-29). This report was preceded by a briefing made to both offices on January 13, 1978, on the Bureau's response to specific assignments contained in 13 public laws.

As arranged with both offices, we will make this report available to other interested parties.

James B. Atwater
Comptroller General
of the United States



COMPTROLLER GENERAL'S REPORT
TO THE COMMITTEE ON COMMERCE,
SCIENCE AND TRANSPORTATION
AND ITS SUBCOMMITTEE ON
SCIENCE, TECHNOLOGY AND SPACE
UNITED STATES SENATE

NATIONAL BUREAU OF
STANDARDS NEEDS BETTER
MANAGEMENT OF ITS
COMPUTER RESOURCES TO
IMPROVE PROGRAM EFFEC-
TIVENESS

D I G E S T

The National Bureau of Standards computer resources are not fulfilling the needs of many administrators and scientists who depend on these resources to analyze data, control experiments, and provide needed information. Better computer resources are needed to improve productivity and to do work that is not done by the Bureau's present computer resources.

The Bureau's computer hardware--over 100 minicomputers and the Univac 1108, a large-scale computer--cannot handle some of today's more sophisticated problems, and many users are not receiving prompt services. The Univac 1108 has been in use since 1967 and is not cost effective. Also, computer software support needs improvement for both the large computer and the minicomputers. As a result, scientists are frequently attempting to solve automatic data processing problems rather than scientific issues. (See ch. 2.)

GAO estimates the Bureau's costs for computer-related services, including programming time spent by scientists, are \$20 million, or 14 percent, of its annual budget. This sum includes \$4 million for research conducted by the Bureau's Institute for Computer Sciences and Technology to (1) develop Federal automatic data processing standards and (2) aid Federal agencies in selecting, acquiring, and using computer technology. (See pp. 6 and 7.)

The Bureau recognizes some of these problems and has conducted a computer requirements study to show the Department of Commerce that additional computer resources are needed.

GAO's analysis showed that the study did not clearly develop Bureau computer needs or evaluate all the alternatives in terms of costs and benefits. (See p. 19.)

The inadequacy of computer resources has been apparent to National Bureau of Standards top management since 1970. Many ad hoc studies have been made to identify the problems and recommend solutions. The Bureau's Executive Board, however, has not actively participated in that process. Also, the Bureau has established an Automatic Data Processing Policy Committee to coordinate computer resources, but no Executive Board member is represented on this committee. The Executive Board should take an active role in overseeing the acquisition, management, and use of computer resources.

Computer resources need to be planned just as any other valuable resource. The Bureau, however, does not have an effective long-range management plan for its computer hardware, software, information, and personnel. With such a plan, the Bureau would be better able to justify acquisition of needed computer resources. (See p. 38.)

To help manage computer resources, a computer performance management program is needed. Such a program would help assure maximum productivity of the Bureau's central computer facility and other support services, assist in long-range planning, and help identify additional computer requirements. (See p. 40.)

The Bureau has decentralized the management of its computer resources into three divisions. Management of these resources can be improved by centralization. Better automatic data processing policymaking, planning, computer performance, and software management could also be achieved by a central management office. (See p. 44.)

In addition, better management controls over computer hardware and software are needed in

- physical security,
- disaster recovery,
- payroll operations,
- computer program changes,
- computer program documentation,
- software development, and
- hardware and software inventories. (See ch. 4.)

RECOMMENDATIONS

The Secretary of Commerce should direct the National Bureau of Standards to:

- Conduct a new requirements study to justify the acquisition of needed computer resources.
- Develop automatic data processing policies and objectives and furnish them to the requirements committee.
- Directly involve top management in the computer requirements study and procurement approval process by appointing at least one member of the Executive Board to the requirements committee.
- Provide the requirements committee with adequate staff resources to carry out the study.
- Establish better management controls over computer resources--hardware, software, information, and personnel.
- Establish a central computer management office to develop and carry out a management system for computer resources. This management system should include a long-range planning process, a Computer

Performance Management program, clearly defined policies, and measurable objectives. This office should be a part of the Office of the National Bureau of Standards Director in order to maximize results.

- Strengthen the Automatic Data Processing Policy Committee by (1) appointing members of the Executive Board to serve on the committee and (2) establishing a written charter setting forth its authority and responsibilities. GAO suggests that the Bureau appoint two Board members to serve 2 years on the committee. Thereafter, at least one member could serve permanently.
- Establish a permanent computer users group which would report to the Executive Board.

AGENCY COMMENTS

The National Bureau of Standards concurs with the principal conclusions of this report and has initiated a number of actions consistent with GAO's recommendations, with others to follow.

The Department of Commerce said in its comments that it will direct the Bureau to comply with all of GAO's recommendations with the exception of establishing a central computer management office and the appointment of two members of the Executive Board to serve on the Automatic Data Processing Policy Committee. In place of these two recommendations, Commerce will direct the Bureau to establish a task force to (1) evaluate alternative organizational configurations to the current management structure and (2) review ways to increase top management involvement on the Policy Committee.

C o n t e n t s

		<u>Page</u>
DIGEST		i
CHAPTER		
1	INTRODUCTION	1
	Computer resource organization and management structure	3
	Computer resources at NBS	6
	Scope of review	7
2	NBS NEEDS IMPROVED COMPUTER RESOURCES	9
	Central computing facility is not responsive	9
	NBS central computer is 12 years old	11
	ADP hardware not suitable for many users	12
	Better central computer software and support is needed	13
	Administrative information problems	16
	Agency comments and our evaluation	17
3	NBS EFFORTS TO UPGRADE ITS COMPUTER RESOURCES	18
	Management is aware of the need for additional resources	18
	NBS 1978 ADP requirements study needs further work	19
	ADP requirements study needs additional top management support	23
	Conclusions	25
	Recommendations	26
	Agency comments	26
4	IMPROVED MANAGEMENT CONTROLS OVER COMPUTER RESOURCES ARE NEEDED	27
	Controls over central computer facility need to be strengthened	27
	Controls over program documentation and system development are weak	31
	Need for an inventory of computer software	32
	Controls over minicomputers could be improved	32
	Responsibility for management controls is diffused	33

CHAPTER		<u>Page</u>
	NBS is aware of the need for management controls over computer operations	34
	Conclusions	35
	Recommendations	35
	Agency comments	36
5	NBS NEEDS AN EFFECTIVE MANAGEMENT SYSTEM FOR COMPUTER RESOURCES	37
	Computer problems still hamper NBS	37
	Need for long-range ADP planning process	38
	An effective program to measure and assess computer performance is needed	40
	Need for ADP policies and objectives	43
	Need for central computer management office	44
	Strengthening ADP Steering Committee will improve management	49
	Conclusions	51
	Recommendations	51
	Agency comments	52
 APPENDIX		
I	ADP planning efforts undertaken by NBS January 1970 to September 1978	53
II	Letter dated March 12, 1979, from the Assistant Secretary for Administration, Department of Commerce	55

ABBREVIATIONS

ADP	automatic data processing
CPM	computer performance management
DBMS	data base management systems
FIPS	Federal Information Processing Standards
GAO	General Accounting Office
NBS	National Bureau of Standards
NOAA	National Oceanic and Atmospheric Administration

CHAPTER 1

INTRODUCTION

VAGC00126

The Congress established the National Bureau of Standards (NBS) on March 3, 1901, (c. 872, 31 Stat. 1449). Under this organic act NBS was to establish standards for physical measurements, determine properties and test methods, and provide advisory services for other Government agencies. Since that time the scope of NBS work has grown enormously with the passage of several public laws, which present various scientific problems that NBS must solve. For example, under the Noise Control Act NBS is responsible for developing improved methods and standards to measure and monitor noise, and under the Fire Prevention and Control Act NBS performs and supports research on all aspects of fires. The Federal Nonnuclear Energy Research and Development Act directs NBS, as part of a national program for nonnuclear energy sources, to evaluate promising energy-related inventions for the Department of Energy to support. These laws require NBS to be staffed with scientists, engineers, and technicians from diverse fields. Table 1 on page 2 shows the major public laws passed in the last 15 years which affect NBS work.

To keep up with its expanding responsibilities, NBS scientists are relying more on automatic data processing (ADP). Scientists use computers to control experiments, record and analyze experimental data, and calibrate equipment. ADP allows scientists to perform hundreds of thousands of calculations in seconds, take extremely accurate measurements, simulate physical phenomena, and maintain numerous data bases. NBS program effectiveness largely depends on computers and related resources (hardware, software, information, and personnel). Computers affect almost every technical program and administrative operation. Scientific and administrative staffs consider sophisticated computing services and facilities necessary for carrying out their functions, and NBS officials see the computer becoming an even more significant tool in improving productivity.

Some examples of computer applications at NBS are:

- A computer program simulating the energy consumption of a specific building design. This computer program helps design an energy efficient building which helps minimize construction and life-cycle costs.
- A computer model simulating a fire in a particular building, including the quantification of variables which influence fire growth, such as rate of heat

TABLE 1

Major Public Laws Passed In

The Last 15 Years Which Affect NBS Work

- Standard Reference Data Act of 1968 (15 U.S.C. 290 et seq.).
- Noise Control Act of 1972 (42 U.S.C. 4901 et seq.).
- Fair Packaging and Labeling Act of 1966 (15 U.S.C. 1451 et seq.).
- Brooks Act of 1965 (40 U.S.C. 759).
- Solid Waste Disposal Act of 1976 (42 U.S.C. 6901 et seq.).
- Fire Prevention and Control Act of 1974 (15 U.S.C. 2201 et seq.).
- Federal Nonnuclear Energy Research and Development Act of 1974 (42 U.S.C. 5901 et seq.).
- Solar Heating and Cooling Demonstration Act of 1974 (42 U.S.C. 5501 et seq.).
- Energy Policy and Conservation Act of 1975 (42 U.S.C. 6201 et seq.).
- Energy Conservation Standards for New Buildings Act of 1976 (42 U.S.C. 6831 et seq.).
- Metric Conversion Act of 1975 (15 U.S.C. 205a et seq.).
- Consumer Product Safety Act of 1972 (15 U.S.C. 2051 et seq.).
- Privacy Act of 1974 (5 U.S.C. 552a).
- Earthquake Hazards Reduction Act of 1977 (Public Law 95-124).
- Environmental Research, Development, and Demonstration Authorization Act of 1978 (Public Law 95-477).
- National Energy Conservation Policy Act of 1978 (Public Law 95-619).

release and flame spread. This enables a fire researcher to obtain a greater understanding of how fires progress.

--Both minicomputers and large scale computers are used for measuring and analyzing electromagnetic interference. The scientific community is studying the possible harmful effects of electromagnetic waves on biological life and electronic systems.

--NBS physicists maintain a bibliographic data base containing over 100,000 references to cryogenics. These references discuss the behavior of materials under extremely low temperatures. For a nominal charge anyone may search this data base to locate published information on cryogenics.

--Computer programs analyzing test results submitted by the 700 member laboratories of the National Voluntary Laboratory Accreditation Program. For example, the paper industry maintains laboratories which need assurance that their machines and tools are making proper measurements. NBS sends paper samples to these laboratories to be tested and receives back test results. After NBS analyzes the data, each laboratory receives a report on the accuracy and precision of such tests.

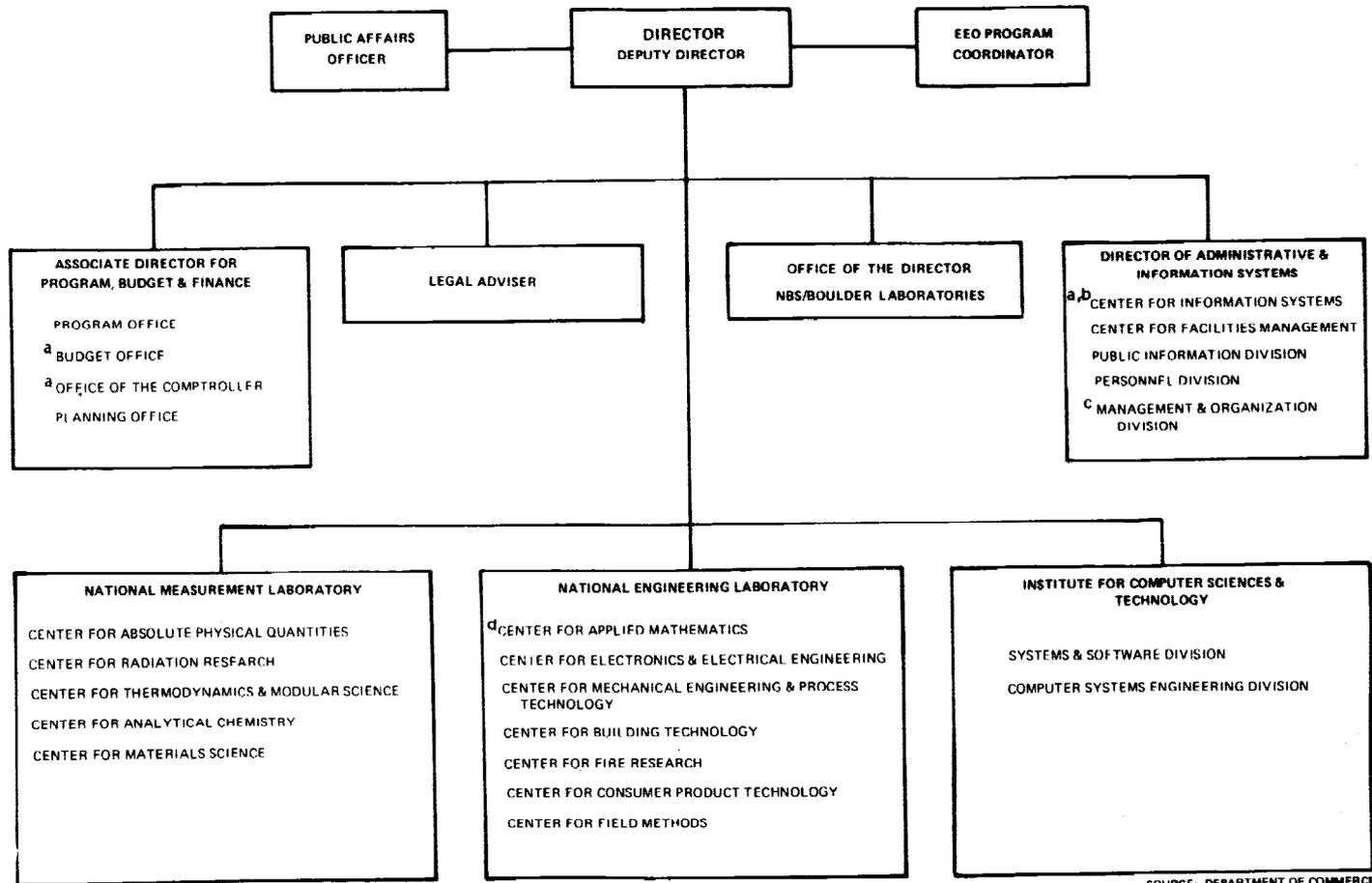
COMPUTER RESOURCE ORGANIZATION AND MANAGEMENT STRUCTURE

The responsibility for managing, controlling, and using NBS computer resources is decentralized among several operating and support groups. The current organizational structure for computer services includes three divisions and two committees. (See chart on p. 4.) These are the Computer Services Division, the Computing Systems Design Division, the Scientific Computing Division, the ADP Policy Committee, and the Computer Finance Committee. In addition, there is an "ADP Manager" who is assigned certain functions required by the Department of Commerce. The functions of these groups and the ADP Manager are described below.

The Computer Services Division, which is in the Office of the Director of Administrative and Information Systems, operates the central computing facility. The division is responsible for providing computing and information processing services to NBS and other agencies on a reimbursable basis. Prior to the April 1978 NBS reorganization, it had been part of the Institute for Computer Sciences and Technology.

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS



SOURCE: DEPARTMENT OF COMMERCE

^a The Computer Finance Committee consists of three members: one from the Budget Office, Office of the Comptroller, and Computer Services Division.

^b The Center for Information Systems includes two divisions which provide computer support. These divisions are the Computer Services Division and the Computing Systems Design Division.

^c The chief of the Management and Organization Division is NBS "ADP Manager" and Chairman of the ADP Policy Committee.

^d The Center for Applied Mathematics' Scientific Computing Division also provides central computer support.

The Computing Systems Design Division designs, programs, implements, and maintains the automated administrative information systems. It provides consulting, advisory, training, and user-communication services on computing and information processing. It also identifies the need for and implements improvements in central computer resources, such as data base management systems, computer graphics, and text handling facilities. The division is also in the Office of the Director of Administrative and Information Systems.

The Scientific Computing Division, located in the National Engineering Laboratory's Center for Applied Mathematics, provides scientific computing support. The division provides consultative services, performs research, and collaborates in applying computer science and technology to computational problems in physical science and engineering. The division includes a laboratory automation group, a staff which assists scientists in automating laboratory experiments.

The ADP Policy Committee was established as a standing administrative committee of NBS effective May 16, 1978. The committee is chaired by the Chief of the Management and Organization Division and also includes the Comptroller, two center directors, and a research community representative. The committee's main responsibility at present is supervising and coordinating the acquisition of a new computer system for the central facility. In preparing studies and analyses, the committee generally obtains support from ad hoc working groups staffed with individuals from the Management and Organization Division and the computer support divisions.

The Chairman of the ADP Policy Committee also serves as NBS ADP Manager. The ADP Manager fulfills the functions required by Department of Commerce Administrative Order 212-1 on Management of Automatic Data Processing Resources. These functions include

- reviewing each ADP activity at least once every 3 years to assess the feasibility of using commercial sources in lieu of existing facilities;
- reporting the progress on implementing Federal ADP standards;
- reviewing requisitions for ADP equipment, software, or services; and
- making periodic reviews to determine the adequacy of existing security measures.

The ADP Manager is usually assisted by the Management and Organization Division staff.

The Computer Finance Committee was established in 1967 to review the operations of the central computer facility to see that costs are fully recovered. The committee analyzes costs, revenues, equipment utilization, user charges, equipment lives, and amortization rates. The membership consists of three persons--a representative from the Computer Services Division, the Budget Office, and the Office of the Comptroller.

Substantial computer resources are also under the decentralized control of NBS operating units. For example, the Institute for Computer Sciences and Technology and the nuclear research reactor maintain separate computer facilities responsive to their respective program needs. To some degree, each facility has its own management, technical support, and operating staff.

COMPUTER RESOURCES AT NBS

During fiscal year 1978, NBS had about 3,050 full-time employees--about 2,600 at Gaithersburg, Maryland, and about 450 at the Boulder, Colorado, laboratory. A UNIVAC 1108 provides the Gaithersburg staff with most of its computing services. NBS scientists and administrators use about 75 percent of that machine's capacity. Non-NBS users account for the other 25 percent. The Boulder staff is collocated with a larger National Oceanic and Atmospheric Administration (NOAA) staff and uses about 13 percent of NOAA's CDC 6600 computer's capacity.

The UNIVAC 1108 and CDC 6600 are large-scale general purpose digital computer systems designed to handle various scientific and administrative applications. The systems' software provides for batch and interactive processing modes through the communication networks. Computer terminals operating at remote scientific laboratories and administrative offices access the computer systems. The UNIVAC 1108 and CDC 6600 computer systems include the conventional magnetic disk and tape devices along with the internal core memory to store data and computer/communication instructions. The UNIVAC 1108, which is about 12 years old, was acquired by NBS in 1967; the CDC 6600, which is about 10 years old, was acquired by NOAA in 1975.

In fiscal year 1978, NBS spent about \$3.2 million to operate its three computer services divisions. This amount does not include certain costs, such as minicomputer rental or scientists' computer programming time, charged to individual programs. NBS accounting system does not specifically identify these costs as ADP-related. However, in 1977 a special study estimated annual ADP-related personnel costs at \$16.3 million. A substantial portion of this figure represented scientists'

programming time. On the basis of this study and other documents, we estimated that total NBS ADP-related costs are \$20 million annually, or 14 percent of its budget. This estimate includes \$4 million in research conducted by NBS Institute for Computer Sciences and Technology. The Institute conducts research to develop Federal ADP standards and aid Federal agencies in selecting, acquiring, and using computer technology. NBS believes that the Institute for Computer Sciences and Technology's research costs should not be included in overall NBS computing costs, but are correctly assessed as a scientific research program cost.

A recent development in scientific computing is the expanding use of minicomputers. At NBS, there are over 100 minicomputers performing many of the same functions as large computers except on a smaller scale. Scientists use minicomputers to automate and control experiments, collect data 24 hours a day, and analyze data.

With declining hardware costs and technological advances, the scientific community expects the capability and use of minicomputers to increase. Typically, these machines could cost \$20 thousand to \$50 thousand for the central processing unit and over \$100 thousand with peripheral equipment.

SCOPE OF REVIEW

Our review was one of two assignments made pursuant to a joint request dated October 13, 1977, from the Senate Committee on Commerce, Science and Transportation and its Subcommittee on Science, Technology and Space. Our other report, "National Bureau of Standards--Information and Observations on its Administration," (CED-79-29) provides information and observations on selected areas of NBS administration, whereas this report addresses the effectiveness of NBS computer resources.

As agreed with the committee, we were to evaluate how effectively NBS computer resources support NBS scientists and administrators in carrying out their mission and program responsibilities. We conducted a comprehensive review of NBS computer operations. Specifically, we

- examined the NBS implementation of policies, procedures, standards, and guidelines established by the Office of Management and Budget, the General Services Administration, the Department of Commerce, and the General Accounting Office which relate to managing and procuring computer resources;
- analyzed plans, studies, and other documents relating to NBS computer resource management;

- interviewed 85 NBS scientists and administrators who rely heavily on computers;
- interviewed officials responsible for managing NBS computer resources;
- interviewed NBS top management; and
- interviewed officials from the Department of Commerce's Office of ADP Management.

Our work was carried out primarily at NBS headquarters in Gaithersburg, Maryland, and the NBS facility in Boulder, Colorado. We also visited Argonne National Laboratory, Argonne, Illinois; Brookhaven National Laboratory, Upton, New York; and the National Institutes of Health, Bethesda, Maryland, to examine how other national laboratories manage their computer resources. Both Argonne and Brookhaven are Government-owned contractor-operated laboratories under the Department of Energy, while the National Institutes of Health is a Federal agency responsible for conducting and supporting research in the biomedical sciences.

We discussed the content of this report with Department and Bureau officials. Written comments on our findings, conclusions, and recommendations are contained in appendix II.

CHAPTER 2

NBS NEEDS IMPROVED COMPUTER RESOURCES

Many users of NBS computer services have experienced reduced efficiency and effectiveness because of

- untimely computer services,
- hardware which cannot provide needed capability, and
- inadequate software and software support.

ADP is a support function for NBS scientists and administrators, which should be oriented towards their use. The objective of all ADP efforts should be to satisfy the needs of ADP users. Many NBS users, however, are not receiving adequate ADP services. As a result, scientists are frequently attempting to solve ADP problems rather than scientific issues.

We interviewed 85 ADP users assigned to 26 of the 31 NBS centers and offices and reviewed available documents to gain an understanding of the adequacy of NBS central computer support and minicomputers, including hardware, software, and personnel. Another purpose of the interviews was to confirm the existence and severity of computer related problems disclosed by various NBS studies. The interviewees were scientists and administrators who use the NBS-owned UNIVAC 1108 at Gaithersburg, NOAA's CDC 6600 at Boulder, several types of minicomputers at both locations, and outside ADP services. The NBS staff at Boulder has used the NOAA computer facility for over 10 years. Generally, the NBS staff at both Boulder and Gaithersburg need improved computer resources, although the need at Boulder is not as great.

The problems which NBS is having with certain brands or models of computer equipment and software are not inherent in these brands or models. Instead, the problems are due to needs which are no longer met by the particular equipment or to a lack of effective management.

CENTRAL COMPUTING FACILITY IS NOT RESPONSIVE

The NBS central computer performs many administrative and scientific applications. Computer programs can be submitted to run interactively or as one of four batch priorities. Interactive processing provides the user with immediate access to the Central Processing Unit and the ability to redirect

and provide new input in a person-to-computer mode. Through this interactive method, NBS users may interrupt the computer to modify the program or data. Interactive processing charges are considerably higher than batch processing charges, particularly when lower batch priorities are used. Batch processing is an operation mode where several input runs are processed by the computer with no user interaction or intervention possible. Scientific programs are often run in either an interactive mode or under higher batch priorities because scientists require quick response. NBS usually processes administrative applications at the lower batch priorities because immediate response and user interaction are not required.

Interactive delays cause problems

Scientific users of data processing were dissatisfied with the UNIVAC 1108 interactive processing delays. They reported the response time to enter a line of computer instructions or execute commands over a remote terminal was frequently several minutes rather than seconds, even in the late evening and early morning hours when computer use should be at its lowest level. Several scientists employing terminals also had difficulty obtaining access to the central computer, particularly during peak periods.

All 36 interactive users we interviewed said that when they entered computer instructions or commands by remote terminals, they incurred delays before receiving a response. For users running or entering large computer programs, such delays were unacceptable. While many endured these frustrations, three interviewees used less efficient means. For example, one mathematician reverted to batch processing and used punch cards. By key punching the computer program on cards, it was possible to directly enter the program into the central computer without using the terminal.

Interactive users told us that the availability of access lines to the UNIVAC 1108 is decreasing because the number of users is increasing while the number of access lines has not increased proportionally. Increased interactive capability could be provided by a faster computer. One engineer stated that if a faster computer were available he could use minicomputers to feed data directly to the central computer, allowing a large number of calculations to be generated in the interactive mode.

Batch mode delays are increasing

A January 1978 NBS study showed that the average turnaround time for batch mode processing had increased to a level

which some scientists considered unacceptable for continuing their experiments.

Batch runs may be run at four different priorities. The central computer selects for processing the oldest job (based on time submitted) of the highest priority available. To shorten the delays in batch processing, a user must assign a higher priority to the job. If a higher priority is selected, a greater charge is incurred.

Almost all the scientists we interviewed who use the batch mode said the turnaround time has been increasing at an unacceptable rate. If same day turnaround is desired, programs are submitted at the higher priorities. If overnight service is acceptable, however, the lowest priority is selected. Scientists confirmed that the central computer facility was taking longer to process batch runs even at the highest priority. In addition, an engineer could not obtain overnight service by using the overnight priority. The engineer's project required analysis of each computer run before proceeding; because of delays, he claimed his effectiveness was only about 25 percent. External time-sharing services were used to minimize this negative effect; however, use of these services was limited because they usually are more expensive than accessing the NBS UNIVAC 1108.

NBS CENTRAL COMPUTER IS 12 YEARS OLD

NBS central computer is the UNIVAC 1108 which was installed in 1967. At the time of installation the computer had an expected useful life of 8 years; however, the earliest possible replacement date for the computer is 1982. At that time it will be 15 years old. According to a special study by the President's Federal Automatic Data Processing Reorganization Project, equipment is obsolete when it is no longer produced by the original manufacturer. An NBS official said that UNIVAC has discontinued manufacturing the UNIVAC 1108 series and plans to "destandardize" this line of equipment by 1982, meaning that after that date, the manufacturer will not be responsible for supporting the 1108 computer system's software and hardware.

Operating with existing equipment is not cost effective

The advanced technology of modern computers has resulted in reduced operating costs. According to the study by the President's Federal Automatic Data Processing Reorganization Project, computer memory costs have been declining at a rate of 44 percent a year, processing costs have been declining at

a rate of 29 percent a year, and communications costs have been declining at a rate of 19 percent a year. Studies show that unit operating costs of obsolete equipment usually exceed the cost of operating new equipment. For example, the average estimated cost to perform 100,000 multiplications on a machine like NBS is 12 cents while the same task on a modern computer is 1 cent.

Using NBS current computer equipment limits its computer users to technology which is already 12 years old. This results in software problems and severely limits the staff's skills. Such obsolescence reduces the capability of computer resources to the extent that mission and program objectives are not effectively and efficiently carried out.

ADP HARDWARE NOT SUITABLE FOR MANY USERS

Besides the lack of available computer time, the NBS central computer and peripherals are incapable of supporting certain types of applications. One problem is the central computer's relatively small core memory. Core memory is the amount of storage that can be retained within the central processing unit without transferring data to disk, tape, or other storage medium. NBS graphics capability in terms of hardware and software is also limited. Hardware limitations are resulting in (1) more expensive external computer time being procured, (2) experiments and analyses being scaled down to fit the NBS computer, and (3) work being deferred or not performed.

The UNIVAC 1108 is too small for NBS users in terms of computer power and core memory. The system's available computer power is 1 million instructions per second. Large computing problems require more computer time and resources on the NBS UNIVAC 1108 than on current state-of-the-art computers. Modern computers provide computer power up to 50 million instructions per second. Fewer jobs can be run and fewer types of computing can be done on the UNIVAC 1108 than on a more modern computer. For example, in 1977 NBS ran a computer program on the UNIVAC 1108 in 39 hours and used all the computer's Central Processing Unit resources. The same run performed on a more modern computer required 8 hours of computer processing time.

Computer modeling and simulation projects are applications which require more core memory than the NBS central computer can provide. Some of today's modeling problems at NBS could use over 1 million words of core memory; the NBS central computer has a core memory of only 262 thousand words. In some cases, it is possible to scale down a modeling

application to enable the NBS computer to process the model. The inherent danger in such an approach is that the model may be less representative of actual conditions and may yield inaccurate results.

Another application which requires large core memory is solving large two-dimensional matrices. Such a problem may be solved on the limited NBS computer by breaking a matrix into quadrants. Recently, one scientist did this and had to invest considerable additional programming effort to fit his problem on the NBS computer. Additional computer time was also needed for the considerable debugging required for the more difficult programming.

Another application limited by the NBS central computer's size is array analysis--an analysis in three or more dimensions. Array analysis, or vector analysis, is a means to predict the movement velocity or acceleration vector. It is a special type of modeling with increasing scientific usage. The NBS central computer is incapable of undertaking this type of analysis.

Further, adding special graphic terminals for design work could enhance the effectiveness of NBS scientists. For example, the design of integrated test circuits could be improved by acquiring a specialized graphics terminal. Such a terminal would allow for viewing cross sections of circuits and using a light pen on a video screen to make changes and move test posts. This could greatly increase the electronic engineers' effectiveness and would reduce the need for expensive high-quality hard-copy graphics.

BETTER CENTRAL COMPUTER SOFTWARE AND SUPPORT IS NEEDED

While the term "computer" usually connotes hardware, computer software (e.g., programs and languages) is equally important in performing tasks. Software determines the degree of a computer's effectiveness in solving scientific problems. While hardware costs are declining, software costs are rising. Industry sources say software costs are more than twice hardware costs. Because scientific computing generally uses more and larger computer programs, this ratio could be much higher at NBS.

A computer language must be used to direct the computer to perform calculations and analyses. Computer languages vary in ability to efficiently direct the computer to perform assorted tasks. The most popular languages available on the NBS computer are COBOL and FORTRAN, used for business/administrative and scientific applications, respectively. NBS

scientists like to have higher level languages and canned programs available to reduce the programming effort required for solving scientific and administrative problems.

Many NBS scientists told us their effectiveness is limited because a variety of higher level languages and/or canned programs are either not available or not well supported. Although the NBS computer facility provides several statistical software packages and one graphics package, some NBS scientists feel they are of limited use because they are difficult to use and/or produce low quality results. Because of this situation, scientists were required to individually program solutions to common problems. However, at the Boulder Laboratory, adequate software packages providing graphics capability and solutions to simultaneous ordinary differential equations were available. As we completed our review, NBS officials informed us that they are in the process of strengthening these areas.

Better use of data base management systems needed

Data base management systems (DBMS) could be important software aids as managers and scientists need timely and useful information. Under a DBMS, information may be collected in a common data base and may be retrieved by several users. NBS use of DBMS has not been as successful as it could be. NBS Gaithersburg has two DBMS available to users of its central computer facility. The National Aeronautics and Space Administration developed one DBMS and UNIVAC provided the second. Eight users we interviewed characterized the Space Administration-developed DBMS as difficult to use, clumsy, and expensive. NBS recently acquired the DBMS provided by UNIVAC and expects its use to increase. In addition, a NOAA Computer Center official at the Boulder laboratory stated that although a DBMS is needed at that facility, it was not provided because NOAA management believed its users would increase demands on the CDC 6600 computer system beyond its capacity.

Adequate software support is lacking

Software support is essential to a central computing facility as well as to its users. Such support may include aiding users by identifying and providing software packages available from other sources and assisting in programming. Programming assistance may include writing or providing the entire program or acting as a consultant when problems occur. Both forms of programming assistance were lacking from an NBS central support group, resulting in many scientists doing

their own programing. Also, some NBS centers have established separate programing support units, assigned computer programing duties to scientists, or relied on other scientists for programing advice.

Many scientists believe that programing service and assistance could not be provided unless the programmer was well versed in the scientific discipline. Several scientists, however, acknowledged that their computer programing projects were routine and could have been accomplished more efficiently by a central staff of trained programmers not necessarily versed in scientific disciplines.

Minicomputer users need software and hardware support

Throughout NBS laboratories, minicomputers are used to control experiments, record test results, and analyze information. At NBS, individual scientists and, to a limited extent, a laboratory automation group provide software and hardware support for minicomputers. The laboratory automation group has eight staff members to support over 100 minicomputers at Gaithersburg and Boulder. Our interviews with users identified the following areas where software and hardware support is weak:

- All minicomputer users we interviewed said that NBS has not acquired commonly used software packages and computer programs. Needed general purpose software includes higher level language compilers, standard mathematical and statistical routines, and operating systems. The lack of this support means individual users must duplicate efforts to solve the same problems.
- Because of limited staff resources, the laboratory automation group has not provided users an adequate consulting service on setting up and tailoring their experiments to the minicomputer.
- According to the laboratory automation group, it has been unable to handle such hardware problems as selecting, retrofitting, and setting up minicomputers. The group has been limited to dealing with the most critical problems.
- A central inventory of spare and replacement parts for minicomputers is lacking. Some parts which frequently fail are maintained in-house; but, in general, users can expect considerable delays in obtaining

needed parts. In some instances machines of a similar make have had to be dismantled in order to keep other machines running.

ADMINISTRATIVE INFORMATION PROBLEMS

Although most computing at NBS is part of some scientific effort, administrative management information is also computerized. Our review showed that NBS accounting, personnel, payroll, project status reports, and other management information systems could be more effective and efficient if (1) the same information was collected in a common data base, (2) more attention was focused on managing administrative information systems, and (3) response time was improved for one-time requests for information.

NBS does not use the common data base method to reduce duplication. Instead, the personnel, accounting, and payroll offices maintain separate data bases which include duplicative information. This can lead to increased NBS administrative costs. One approach to the problem of computerizing administrative information systems is to implement a DBMS. Under this method, information may be collected in a common data base which may be retrieved by several users. For example, when a new employee is hired, the personnel office would prepare the proper documentation and add the necessary information to a computer data base. Subsequently, the personnel, accounting, or payroll office could retrieve from a single data source needed information on the new staff member. Because a DBMS offers potential for significantly reducing costs and improving service to users, we believe that NBS should consider studying the feasibility of using this method to store, process, and retrieve administrative data.

Another way for NBS to reduce administrative costs is to more effectively manage its information systems. For example, during our work at the Boulder facility, we noted that the Boulder staff receives the same administrative reports as the Gaithersburg staff. However, these reports are untimely due to the distance they must be shipped and the lengthy administrative process at Gaithersburg. To provide timely interim reports, the Boulder staff has automated their own version of accounting reports through the local NOAA CDC 6600 computer. NBS Boulder officials told us they found the Boulder report format to be more useful because information is consolidated into fewer and shorter reports and managers need not go through several reports to obtain current project information.

NBS has not done enough to monitor the design and distribution of administrative reports and to assure that these reports are efficiently or effectively used. To provide adequate service to ADP users, there must be sufficient assurance that the information produced is needed and is being provided in a usable format and on a timely basis.

Finally, NBS managers told us they frequently need information that is not available from administrative reports and that cannot be easily retrieved from computer files. To obtain such information, special requests must be made to the respective administrative offices. We were told that collecting and processing such data under a manual method results in unacceptable delays and, at times, incomplete and inaccurate data. Such inaccuracies and delays to produce one-time reports handicaps a manager when making decisions. This is another area where we believe increased efforts are needed by NBS to improve the effectiveness and efficiency of computerized administrative information systems.

AGENCY COMMENTS AND OUR EVALUATION

In its written response to our report, NBS stated that it recognizes its central computer system's shortcomings and that they must be corrected. In chapter 3 we discuss NBS efforts to replace its central computer.

We must emphasize, however, that inadequate computing resources is only one of the many causes of NBS problems. In chapters 3, 4, and 5 we discuss the lack of top management involvement and other weaknesses in NBS management of computer resources. We believe that NBS must also address these weaknesses if it is to achieve and maintain the quality computer environment it needs.

CHAPTER 3

NBS EFFORTS TO UPGRADE ITS COMPUTER RESOURCES

NBS conducted a requirements study in 1978 to justify the need for replacing the UNIVAC 1108. The requirements study did not result in acquiring needed computer capabilities because Federal procurement regulations were not complied with and users' needs were not adequately considered and documented. An adequate study was not prepared because sufficient staff was not assigned to the task and top management was not sufficiently involved.

MANAGEMENT IS AWARE OF THE NEED FOR ADDITIONAL RESOURCES

NBS recognized the need for augmenting its central computer facility in a 1972 ad hoc study on computer utilization. The need for additional resources was again noted in similar studies in 1974 and 1976. In 1977, NBS prepared a requirements study based on current utilization reports and a 1975 user questionnaire. NBS recognized that the 1977 requirements study did not adequately justify a replacement facility and began two additional requirements studies.

The first study, intended to investigate the feasibility of installing an interim computer, was released on January 9, 1978. The report was transmitted to the Department of Commerce's Office of ADP Management for review. This office informally returned the report because it proposed a sole source procurement action to accomplish an interim upgrade of present facilities. At that time NBS took no further action regarding the interim upgrade.

The second NBS study was intended to support the replacement of the central facility. This study, completed in July 1978, considered using a commercial facility as well as continuing an in-house NBS operation. This requirements study was completed under the NBS ADP Policy Committee's guidance and was informally transmitted to the Office of ADP Management. NBS also requested that funds for a replacement be included in Commerce's 1980 budget submission to the Congress. The Office of ADP Management returned the study because NBS did not meet criteria to establish a budget priority. For example, the Bureau did not formally transmit the requirements study to Commerce. Also, the office staff told us that the study lacked adequate documentation and did not comply with procurement regulations. As a result, the NBS request for funding was not included in the 1980 budget.

NBS 1978 ADP REQUIREMENTS STUDY NEEDS
FURTHER WORK

We reviewed the 1978 ADP requirements study and identified the following problems:

- Computer needs were not directly related to agency mission and goals.
- Analysis of user requirements was not adequately documented and is virtually not auditable.
- Computer needs were described in terms of hardware rather than functional 1/ specifications.
- The determination of the personnel support required for a new computer system was incomplete.
- The benefits of a replacement facility were not sufficiently specific to be measurable.
- The cost analysis document supporting the requirements study was based on an incorrect set of user requirements.
- All alternatives were not adequately considered, therefore, NBS requirements may have been significantly understated or overstated.

Each of these problems is discussed below.

Relating needs to mission and goals

According to the Office of Management and Budget Circular A-109, "Major System Acquisitions":

"Determination of mission need should be based on an analysis of an agency's mission reconciled with overall capabilities, priorities and resources. When analysis of an agency's mission shows that a need for a new major system exists, such a need should not be defined in equipment terms, but should be defined in terms of the

1/Functional specifications provide objectives and data processing requirements to meet user needs. They should include such items as functions to be performed, characteristics of data to be processed, data output and its intended uses, data input, processing frequency, response time for interactive processing, and turn-around time for processing data and generating reports.

mission, purpose, capability, agency components involved, schedule and cost objectives, and operating constraints."

NBS needs to clearly define and quantify ADP objectives for its programs. Before initiating a requirements study, agency programs should be prioritized and a basic funding level should be established. NBS did not adequately perform these tasks before preparing the 1978 requirements study. Because the study did not directly relate ADP needs to mission and program objectives, NBS has little assurance that the current plan will meet long-range information processing needs.

NBS should have prioritized its basic functions, determined its processing and schedule requirements, and established funding for each program.

Lack of auditable documentation

We reviewed the 1978 requirements study and found incomplete documentation supporting the user requirements. Insufficient documentation precludes an audit of user needs shown in the study. Also, it raises a question of whether all user needs were adequately considered. The requirements committee interviewed personnel working in various research areas but did not develop functional requirements on a program-by-program basis.

Need for functional rather than hardware specifications

In its requirements study, NBS prepared specifications, such as the following, which are hardware rather than functionally oriented:

- Initial core memory of 10 million bytes 1/ expandable to 24 million bytes.
- Mass storage capability of 15 billion bytes expandable to 30 billion bytes.
- Two large computers for Gaithersburg.
- A dedicated 50,000 baud 2/ common-carrier link between Gaithersburg and Boulder.

1/A byte is a group of characters or numeric values.

2/A baud is a unit of signaling speed equal to the number of signal events per second.

The use of hardware specifications is contrary to Office of Management and Budget, General Services Administration, and Department of Commerce guidance. Using hardware specifications severely limits the ability to develop requirements to meet NBS needs and establishes a bias which is not supportable.

Lack of support personnel requirements

NBS recognized that a replacement computer system would increase the need for additional support personnel. Without adequate support NBS could not effectively and efficiently use a new system. NBS did not, however, adequately determine or document the additional personnel support computer users would require.

We believe NBS needs to determine the number of additional people the new system would require for

- administrative programming applications,
- scientific programming applications,
- the communications network,
- documentation,
- consulting,
- training users and computer staff,
- developing general purpose computerized systems, and
- graphics applications.

Lack of benefit analysis

Department of Commerce guidance on computer acquisitions requires an analysis of benefits to be derived from acquiring a new system. In preparing its requirements study, NBS did not specify and quantify the expected benefits. To appropriately quantify the expected benefits, the proposed increase in resources should be tied to specific mission and program objectives. Additionally, NBS needs to show the effect of improved capabilities on research projects versus the effect of continuing under the current system or using alternatives. These capabilities and associated benefits should be reviewed and developed separately for interactive processing, batch processing, graphics, and minicomputers.

Among the benefits which NBS may specify and quantify are (1) reduced costs from using outside commercial computing

to a lesser degree, (2) increased data collection when conducting laboratory experiments, and (3) savings on staff time because of improved programing and other software aids. Additionally, NBS could show benefits from conducting experiments using large models and simulation which cannot be processed on the current system.

Problem with cost analysis

Developing a cost analysis before selecting alternatives to meet ADP needs is required by the Office of Management and Budget and the Department of Commerce. We noted that the cost analysis and the cost figures supporting the 1978 requirements study were based on an incorrect set of user requirements. NBS prepared a cost analysis to support the 1977 requirements study and subsequently applied those figures to the 1978 requirements study. The 1978 study calls for double the mass storage of the 1977 requirements study and two computers for NBS Gaithersburg instead of one. Because of the large differences in these requirements and associated costs, NBS has little assurance that it has selected the most cost-effective option for meeting its needs.

Evaluating alternatives

The current 1978 requirements study translates many separate and distinct classes of user needs into a single ADP requirement. This approach limits the alternatives available to satisfy NBS needs. If NBS evaluated each class of needs separately, it may find one alternative preferable for one class and a different alternative better for another. We identified the following classes of computer services which NBS needs: small batch, interactive, large batch, graphics, and minicomputers.

The 1978 requirements study evaluated the following five options for meeting NBS computer needs in the various classes of computer services.

- Support all needs except minicomputers by contracting ADP work to the private sector. No central facility would exist at NBS.
- Meet all computing needs for interactive users and administrative batch processing in-house. Meet all scientific computing excluding interactive processing through the private sector.
- Meet all needs through a central facility owned and run by NBS.

- Hire a contractor to own and run a facility dedicated to meeting NBS needs. The facility would be located at NBS.
- NBS would retain its current facility but augment it to the largest extent possible.

Data required to evaluate these options was incomplete. We believe that in order to properly evaluate the alternatives, information such as the following should be developed for each class of service:

- Total processing time required for computer applications.
- Turnaround or response times needed for each class and subclass of computer services.
- A breakdown showing the percentage of computing capability needed during prime versus non-prime time.
- Workload statistics on peaks and valleys for processing data.

Furnished with such information, NBS should examine the most effective and economical alternative for each class of service as well as the overall ADP requirement.

ADP REQUIREMENTS STUDY NEEDS ADDITIONAL
TOP MANAGEMENT SUPPORT

The requirements study may have met its objectives if top management had provided needed support. Top management should provide

- adequate guidance on policies and goals for computer operations,
- sufficient staff resources to conduct the study, and
- adequate involvement by Executive Board members. 1/

1/Members of the Executive Board: Director and Deputy Director, NBS; Director, National Measurement Laboratory; Director, National Engineering Laboratory; Director, Institute for Computer Sciences and Technology; Director, Boulder Laboratories; Director of Administrative and Information Systems; and Associate Director for Programs, Budget and Finance.

In examining a requirements study at another Federal laboratory we noted that top management was involved and its participation was critical to the study's success.

Policies and goals needed in a requirements study

Officials at one Department of Energy laboratory stressed the need for a framework encompassing policies and goals on which to build a requirements study. The 1978 ADP requirements study did not include such a framework. In interviewing users and staff involved in the NBS requirements study, the following examples where policy guidance was necessary but not furnished were identified.

--What level of service can and should NBS provide users: adequate, above average, or state-of-the-art?

--What priority is to be placed on the different classes of computer services needed by NBS?

--How large a budget will be allocated to program managers for purchasing computer resources and what will the resources cost?

We noted that Argonne National Laboratory, in preparing its 1977 requirements study, provided a framework of policies and goals. Users were required to determine needs based on estimated costs for ADP services and such estimates were related to each program's future budget. By management providing estimated costs and budgets to program managers (computer users), management helped assure uniform and objective assumptions for all computer users.

The requirements committee lacked adequate staff resources

The Bureau's requirements study committee consisted of one full-time member and two part-time members. In contrast, a requirements study for the Census Bureau used about 15 full-time staff members for several months in addition to assistance provided by Commerce's Office of ADP Management and us. Argonne National Laboratory, a research institution of comparable size to NBS, expended over 20 staff-years on its 1977 computer requirements study. Although we have not determined the number of staff persons required for an adequate NBS study, the NBS commitment of staff resources was not sufficient.

The requirements study needed active involvement by top management

Although the NBS Director and other members of the Executive Board are concerned over the agency's inadequate computing resources, they have not been adequately involved in efforts to replace the central facility with more modern equipment. According to NBS, the 1978 requirements study was presented to the Executive Board and discussed in detail before submission to the Department of Commerce for review. However, no member of the Executive Board was a member of the requirements study committee. In addition, our review of the study showed a lack of information on the priority the Executive Board placed on the need for computer resources compared to other NBS needs.

Officials of Commerce's Office of ADP Management told us they are also concerned with the lack of NBS commitment to meeting its computing needs and the lack of information on the program's priority. They believe that if NBS management considered the computer situation critical, stronger top management involvement and support would have been evident.

Further, the requirements committee lacked the necessary authority to obtain significant responses from individual users and program managers. Officials at a Federal laboratory said they obtained acceptable realistic user estimates only when upper level management was directly involved. For example, this laboratory included top laboratory managers on all working committees. The laboratory also required each user to develop requirements and have them certified as reasonable by first line managers. Each level of management was then held responsible for collecting and certifying the requirements specified to carry out programs under its control.

CONCLUSIONS

NBS computer resources are inadequately supporting NBS programs. In addition, problems with the 1978 requirements study are delaying the acquisition of needed computer resources.

Two principal factors contributed to this problem--the 1978 requirements committee lacked staff needed to prepare the study and NBS top management was not adequately involved in the study and did not provide the working committee with sufficient guidance on policies and objectives.

RECOMMENDATIONS

To correct NBS computer resource problems, we recommend that the Secretary of Commerce direct NBS to

- conduct a new requirements study to justify the acquisition of needed computer resources,
- develop ADP policies and objectives and provide them to the requirements committee,
- directly involve top management in the computer requirements study and procurement approval process by appointing at least one member of the Executive Board to the requirements committee, and
- provide the requirements committee with adequate staff resources to carry out the study.

AGENCY COMMENTS

We discussed our findings on the 1978 requirements study with NBS requirements committee members, the ADP Policy Committee, and the Executive Board. Generally, these officials agreed with our findings and said they recognize the requirements study needs more work.

In its written comments on our report, NBS concurs with the principal conclusions and has initiated a number of actions consistent with our recommendations, with others to follow. NBS also said that it is preparing an updated requirements report and looks forward to counsel from the Department of Commerce and us on strengthening the new draft.

The Department of Commerce stated in its comments that it will direct NBS to comply with all the recommendations made in this chapter.

CHAPTER 4

IMPROVED MANAGEMENT CONTROLS OVER

COMPUTER RESOURCES ARE NEEDED

Management controls over the central facility's computer operations need improvement. We found control problems with software security, documentation, software inventory, payroll processing, and disaster recovery procedures. We also determined that the physical inventory and physical security procedures for minicomputers need to be improved. There is little assurance that computer assets and valuable data are properly protected. We identified two primary causes for these control problems: lack of central management responsibility over controls and insufficient management involvement with controls and associated documentation.

CONTROLS OVER CENTRAL COMPUTER FACILITY NEED TO BE STRENGTHENED

Centralizing and concentrating data in computerized environments increases the potential for major losses or misuses of ADP resources and data. As a result, ADP facility managers should be concerned with this potential affect on the successful accomplishment of agency mission and goals.

Federal Information Processing Standards (FIPS) Publication 31, "Guidelines for Automatic Data Processing Physical Security and Risk Management," is a basic reference document, which guides agencies in planning and evaluating computer security programs for ADP systems. In reviewing NBS controls over the central computer facility we found deficiencies in:

- Software controls over information contained in computer files and data bases.
- Disaster recovery procedures.
- Program controls over NBS payroll procedures.
- Program change procedures.

Each of these is discussed below.

Software security

With the growth of timesharing and computer networking, using remotely accessed computers has become commonplace. According to NBS officials, there are more than 300 terminals in use at NBS Gaithersburg. Easy access to computer terminals results in increased operational risks. Systems without adequate access controls are more vulnerable to threats, such as theft, fraud, and vandalism. Potential problems range from unauthorized use of computing time to unauthorized access, modification, or destruction of confidential data.

The technique of using passwords to authenticate a computer terminal user sharing a computer system is well known. Passwords alone, however, are not sufficient to assure system security. To be an effective deterrent to computer system penetration, a password should be confidential, frequently changed, and well protected.

According to NBS officials, passwords and access codes are frequently found in waste baskets, taped to computer terminals, and left on desks. The officials said any unauthorized person desiring codes or passwords could obtain them quite easily.

During our review we found that passwords were not changed on a regular basis nor were passwords changed after knowledgeable personnel left the project or organization. We also observed passwords taped to computer terminals.

Disaster recovery procedures

In the event of a disaster, NBS would not be able to run computer programs and process data unless backup computer facilities were available and programs and data were stored at an offsite location. Critical to disaster recovery is the location of another ADP facility to provide backup during emergencies. Critical computer programs and current data must be available at an offsite location so that computer operations may resume at another facility. We learned that NBS has negotiated for 10 years with a Federal computer center to arrange for a formal backup agreement. At the time of our review, however, NBS had not obtained such an agreement and no further efforts were continuing.

NBS officials said they had an understanding with the Economic Development Administration to serve as a backup facility. This arrangement provides NBS with limited protection in the event of a disaster because (1) NBS does not regularly run tests on the Economic Development Administration's facility to assure compatibility, (2) program and data tapes are not stored

at the Economic Development Administration or at an offsite location, and (3) NBS has no assurance that the Economic Development Administration's computer resources will be available if needed.

NBS officials stressed the point that another computer facility with adequate capacity to provide 100-percent backup is not available. Because of the limited backup facilities available, NBS should identify critical computer programs and should test and run such programs at the backup computer facility on a regular basis. However, NBS has not identified its critical ADP systems or programs or assigned responsibility for carrying out this function.

We noted that NBS prepared duplicate copies of computer programs and data, but stored these duplicates in the same building as the central ADP facility. In the event a disaster strikes the main computer facility, the risk of losing duplicate copies of programs and data is high. We suggest using offsite storage facilities for NBS programs and data. This is one of the less costly and more effective disaster recovery approaches available. Additionally, the added costs would be low since NBS is already producing the backup copies and has an arrangement--not presently used--to use an offsite storage facility.

NBS controls over computerized payroll operations are inadequate

In 1976 the Department of Commerce's internal audit staff audited NBS controls over its computerized payroll processing system. The objective was to determine whether these controls assure accurate results and prevent incorrect payments. The internal audit focused on whether controls over data entered into the payroll system, processing of data, and output were adequate. The Department of Commerce auditors used a test deck of simulated transactions to evaluate controls over the computerized payroll system. The test deck of simulated input records contained incomplete, incorrect, and invalid information in order to test and evaluate the effectiveness of edit checks. In a properly controlled computer system, the computer programs include instructions--called edit checks--to identify and reject from further processing information that is invalid, incorrect, or unreasonable. The NBS controls tested did not prevent the computer system from accepting and processing a number of the invalid payroll transactions.

The Commerce auditors recommended that NBS incorporate additional edit checks in the computerized payroll programs to screen out invalid or erroneous data. Such edit checks

included flagging and listing rejected transactions or reducing payments to allowable limits.

Examples of invalid transactions processed by the payroll system when it was tested by the Commerce auditors include:

- Paying employees more than the maximum allowed for a 2-week pay period.
- Accepting and paying employees for promotions which were not permissible under Federal law.

In response to the Department of Commerce's report, "Internal Audit of Controls Over Computerized Payroll Processing Operations--National Bureau of Standards," January 1977, NBS said that the recommended edit checks were subsequently added to the payroll programs. However, NBS officials told us that only 3 of the 11 edit checks Commerce recommended were incorporated into the payroll system. Although the Commerce auditors found the payroll system to be working well overall and adequate manual controls in place, the inclusion of all recommended edit checks would improve the controls over the payroll process and provide greater assurance over the accuracy of payroll transactions.

Program change controls

Program change controls assure management that computer programs are not intentionally or unintentionally modified without proper authorization and assure that the integrity and reliability of the computer system are maintained. According to FIPS Publication 31, "every change, even those involving only one statement, should be authorized, approved, and documented with no exception."

NBS has not implemented or developed program change controls. Based on limited tests of programs, we noted that program changes prior to implementation were not authorized in writing or documented to provide auditability. NBS officials agreed that the problem was widespread and was not limited to those programs we tested. Government guidance states that computer changes should be documented to permit auditing the adequacy of controls over computer systems and data. If program changes are not controlled, any unauthorized person having access to a program's password and knowledge of programming can alter the program. As a result, the program could be modified to permit destruction of program integrity, theft of data and funds, or concealment of theft.

CONTROLS OVER PROGRAM DOCUMENTATION AND
SYSTEM DEVELOPMENT ARE WEAK

According to FIPS Publication 38, ^{1/} documentation for computer programs (software) is intended "to maximize the return on this investment (software) and to provide for cost-effective operation, revision and maintenance." System development controls are intended to promote efficiency and effectiveness by assuring that computerized systems are

- of high quality,
- needed by users to accomplish mission and program objectives,
- meeting system development milestones and cost estimates, and
- properly planned and managed.

Developing computer software today is often riskier and more costly than providing computer hardware. A primary risk is that computer software systems may be developed but may not be usable or needed. Federal guidance on developing computer software systems stresses that software development without proper management controls and procedures can result in mismanagement that can ruin Government projects and public services. Additionally, it is only through implementing uniform procedures that management control can be assured. These procedures should include instructions for preparing functional requirements, program specifications, data base specifications, a feasibility study, and a cost/benefit analysis.

In reviewing NBS documentation of three software systems under development, we noted the lack of system development controls. According to NBS officials, these deficiencies were typical of NBS system development controls. An additional problem is that the central programming group functions as a service bureau without authority to disapprove systems which are not needed or cost effective. Further, in developing systems, cost/benefit analyses and feasibility studies are not conducted.

We found that the Computer Systems Design Division has developed administrative computer systems which have not been accepted by users and are not used on a regular basis.

^{1/}"Guidelines for Documentation of Computer Programs and Automated Data Systems," (Feb. 15, 1976).

In these cases NBS did not follow approved management procedures, as outlined in Government guidance, specifically relating to feasibility studies and developing specifications prior to system development. We believe that adequate management controls would have provided greater assurance that these administrative systems would have met the needs of intended users.

Generally, we found the documentation of existing computerized systems and programs to be incomplete and out of date. Although NBS published FIPS Publication 38, it has not effectively applied such guidelines in documenting its own computer programs and systems.

We discussed our findings with NBS officials responsible for computer programming and they agreed that documentation was a significant problem. The officials said the problem will require a long term solution because of limited staff and the large number of computer programs and systems which need documentation.

NEED FOR AN INVENTORY OF COMPUTER SOFTWARE

To properly manage computer resources, management and users need accurate information on software. Computer managers need to know the types and quantity of programs they must support and users need information on programs available within the Bureau.

NBS has not developed an inventory of its computer programs and related software. NBS scientists expressed concern over the lack of a software inventory. In starting new work, scientists were unable to determine if programs which met their needs were already available. For example, one scientist mentioned that he had expended considerable effort developing a program to use on minicomputers which he felt other researchers could use. He was concerned that a software inventory system was not available to communicate information on his program to other potential users.

CONTROLS OVER MINICOMPUTERS COULD BE IMPROVED

In reviewing NBS use of minicomputers, we found two control problems--NBS inventory listing of minicomputers was incomplete and the physical security procedures were inadequate.

Inventory control procedures for minicomputers need improvement

Problems exist with NBS procedures for classifying computer hardware. The NBS inventory system depends on the ultimate ADP equipment user to classify its computer inventory. This has resulted in the placement of identical equipment in different equipment categories and in an inaccurate and incomplete inventory of minicomputers. Our review of NBS inventory documents and interviews with NBS officials produced conflicting inventory counts of minicomputers.

At our request, NBS initiated a study to determine the number of minicomputers located at NBS. In its study, NBS identified 63 minicomputers, but based on an analysis of information collected from agency officials, we estimate NBS has 100 to 120 minicomputers valued at \$4 million to \$6 million.

Physical security of minicomputers is weak

NBS officials said the security of minicomputers is the responsibility of the machines' users. The officials told us security may be weak or strong depending on the user's perception of security requirements. Some users at the Bureau have established adequate physical security procedures in their laboratories. When their laboratories are unattended, the doors to the laboratories are locked and only recognized personnel are granted entrance. But, in other cases, no physical security procedures are practiced.

We tested the security of 27 laboratories equipped with minicomputers. In conducting the test we examined one aspect of security--the locking of the laboratory doors. We noted unlocked doors in 22 of the 27 laboratories checked.

RESPONSIBILITY FOR MANAGEMENT CONTROLS IS DIFFUSED

NBS has three ADP organizational units with responsibilities over narrowly defined areas. One computer group is responsible for central programming, another for operating the central computer, and a third for providing central support of minicomputers, including programming. Since each group is responsible for developing and implementing its own controls, the controls are not uniformly adopted Bureau-wide.

No individual or organization at NBS has responsibility or authority to establish NBS-wide computer controls. This presents a problem because of the high degree of user

involvement in NBS computer systems. Users prepare the majority of computer programs at the Bureau and are responsible for many computers and computer-related equipment. Users lack guidance on controls required and no organizational unit has been assigned the responsibility for helping users develop and implement controls. NBS should assign responsibility to one organizational unit to develop, implement, and enforce management controls.

NBS IS AWARE OF THE NEED FOR MANAGEMENT
CONTROLS OVER COMPUTER OPERATIONS

Under the Brooks Act (Public Law 89-306) NBS has been responsible for developing ADP standards for the entire Federal Government. NBS has issued FIPS Publications which provide management control procedures and policies for all Government agencies, including NBS. In its FIPS Publication series, NBS has stressed the need for management controls to achieve maximum efficiency and effectiveness in computer operations.

Because of its responsibility for issuing guidance to all Federal ADP operations, we believe NBS has an even greater responsibility to follow them. Applying these guidelines should help NBS promote effective computer support and improve controls over its computer resources.

NBS FIPS and Special Publications which address management controls and which serve as standard references in managing Federal computer operations are shown in table 2 below.

Table 2

Major NBS Publications Applicable To

Management Controls Over Computer Operations

- FIPS Publication 31, "Guidelines for Automatic Data Processing Physical Security and Risk Management."
- FIPS Publication 38, "Guidelines for Documentation of Computer Programs and Automated Data Systems."
- NBS Special Publication 500-8, "The Use of Passwords for Controlled Access to Computer Resources."
- NBS Special Publication 500-11, "Computer Software Management: A Primer For Project Management and Quality Control."
- NBS Special Publication 500-19, "Audit and Evaluation of Computer Security."

CONCLUSIONS

NBS management controls over documentation, program development, and software inventory need improvement to insure effective and efficient use of computer resources. NBS controls over program changes, payroll, and disaster recovery are insufficient to protect against processing errors, incorrect payments, fraud, and potential disasters to operations. NBS physical security controls over minicomputers are inadequate to protect them against theft or misuse. Further, NBS inventory procedures over minicomputers do not provide management with an accurate and complete inventory.

RECOMMENDATIONS

We recommend that the Secretary of Commerce direct NBS to:

- Assign responsibility to one office for developing, implementing, and enforcing management controls over computer resources.
- Develop a formal backup computer agreement with another computer facility. At a minimum, identify critical NBS programs and test them at a backup facility on a regular basis.
- Store backup copies of all critical programs and data at an offsite location.
- Establish formal review and approval procedures for developing computerized systems.
- Develop a plan to document all critical NBS programs to assure effective use of software.
- Assign responsibility to an organizational unit for developing and maintaining the software inventory.
- Implement adequate security procedures over minicomputers, including locking laboratory doors when the laboratories are unattended.
- Conduct a complete and periodic inventory of minicomputers.
- Include in the Bureau's payroll system all edit checks recommended by the Department of Commerce's internal audit staff.

AGENCY COMMENTS

We discussed our findings with NBS officials responsible for management controls. The officials generally concurred with our findings and said they plan to take corrective action on the management control problems noted in this report.

In its written comments, NBS concurs with the principal conclusions of our report and has initiated a number of actions consistent with our recommendations, with others to follow. Specifically, NBS said they have initiated actions on physical security, disaster recovery procedures, hardware and software inventories, and documentation.

The Department of Commerce stated in its comments that it will direct NBS to comply with all the recommendations made in this chapter.

CHAPTER 5

NBS NEEDS AN EFFECTIVE MANAGEMENT

SYSTEM FOR COMPUTER RESOURCES

Since 1970 NBS management has expressed concern that NBS is behind other laboratories in applying modern computer technology to its scientific work. As a result, numerous committees and task forces have been established to study the computer needs of NBS scientists and recommend improvements. Despite these efforts, our review showed that problems which existed in 1970 still hamper NBS. In addition, weaknesses in management controls over computer operations and problems with recent NBS efforts to prepare an adequate requirements study exist.

We believe that NBS difficulty in solving its computer problems partly stems from its approach to managing computer resources. This approach relies on decentralized management and emphasizes short term budget considerations while long term needs are generally examined in ad hoc studies. Although the approach provides for collecting information on the central computer facility's performance, this information is not part of a formally structured program nor is it useful to top management. Finally, the approach is carried out with little direction from top management--few policies and measurable objectives have been established.

We believe that NBS needs a formal management system for its computer resources. Such a system would include (1) a long-range planning process, (2) a structured program to measure and assess computer performance, and (3) clearly defined policies and measurable objectives communicated to and understood by management, scientists, and computer specialists. This management system would be most effectively developed and implemented by a central computer management office. Responsibility for evaluating this office's performance would be assigned to the ADP Steering Committee, thus assuring that adequate plans are prepared and that NBS computer resources are used efficiently and effectively.

COMPUTER PROBLEMS STILL HAMPER NBS

Computer problems which existed 8 years ago still hampered NBS at the time of our review. In January 1970, the then Director of NBS established an ad hoc study group to examine computer issues at the agency. The Director and the study group identified a number of computer-related problems including:

- An ADP planning process had not been established for dealing with long term NBS program needs.
- NBS was behind other laboratories in applying computer technology to scientific work.
- A chronic shortage of advanced programming assistance existed resulting in many senior scientists writing their own computer programs.
- The extent of computer use throughout the agency was difficult to determine because sufficient information was not available.

At the time of our review, NBS had not solved these problems. NBS still did not have a process to develop long-range ADP plans. Further, an August 1977 NBS study stated that a survey of comparable laboratories indicated that the support level for computing at NBS is substantially lower than is required for modern science and technology. NBS could not provide us with complete information on the extent of computer use at the agency. Information was not readily available on the number of minicomputers, expenditures for computer services obtained from commercial sources or other Government agencies, and computer programs and data bases which could be shared or exchanged among members of the scientific community.

NEED FOR LONG-RANGE ADP PLANNING PROCESS

Developing a comprehensive long-range plan is a recognized way to (1) achieve efficient and effective use of resources, (2) assure that these resources support agency missions and objectives, and (3) commit top management to action. The importance of ADP planning is emphasized in Office of Management and Budget Circular A-71, "Responsibilities for the Administration and Management of Automatic Data Processing Activities." The lack of ADP planning has also been a concern of congressional committees.

NBS does not have a formal long-range planning process to help acquire, manage, and use its computer resources. Although ad hoc plans have been prepared in response to problems, a comprehensive long-range ADP plan has not been prepared. Further, under NBS decentralized computer management, responsibility for developing such a plan is not clearly fixed.

NBS has recently acted to strengthen its program planning. A central planning office was established on October 1, 1978, in response to an Office of Management and Budget directive. Also, at the time of our review NBS National Engineering

Laboratory and National Measurement Laboratory were developing long-range program plans. In discussions with laboratory officials, however, we learned that their laboratories are not required to develop ADP plans along with their program plans. In our opinion, NBS has an opportunity to improve its ADP planning by making it an integral part of its current program planning efforts.

NBS efforts to plan for ADP

Since 1970 NBS has prepared various studies and plans which have analyzed the computer needs of its professional staff and recommended improvements. As previously discussed in this report, these efforts have not achieved the computer environment NBS needs.

Present and former NBS computer resource managers offered the following reasons why the ADP studies and planning efforts were not successful:

- Until the Bureau's April 1978 reorganization, the central computer facility was under the control of the Institute for Computer Sciences and Technology. The Institute placed more emphasis on addressing Government-wide ADP issues than on running a computer facility for NBS and, consequently, did not adequately support ADP planning efforts.
- Top management was not sufficiently involved in ADP planning efforts and did not commit the necessary staff resources for implementing recommendations.
- The Computer Services Division, which managed the central facility, did not have sufficient authority or influence.

We believe that these plans and studies have not been adequate because they were not comprehensive or prepared as part of a formal ADP planning process. Except for the 1970 policy study, individual NBS ADP planning efforts have been limited in scope and have addressed only segments of the overall computer problem. For example, a May 1972 plan and the requirements studies conducted during 1977 and 1978 have concentrated on the central facility; a 1971 study emphasized laboratory automation; and two plans prepared in 1976 reviewed only the needs for technical support. (See app. I for a list of NBS ADP planning efforts.) All of these are closely related and should have been dealt with collectively. A comprehensive plan which treats all aspects of

ADP would help insure that NBS-wide ADP needs are being effectively and efficiently examined. Also, all of NBS ADP planning efforts were undertaken on an ad hoc basis in response to problems which had surfaced. A formal planning process carried out on a continuous basis would help NBS anticipate problems rather than react to problems as they surface.

Importance of planning

NBS will find acquiring needed computer resources increasingly difficult if it cannot show that its requirements are part of a comprehensive long-range plan. NBS ADP Manager told us that the agency's lack of planning has been a serious problem in recent efforts to replace the central computer.

For the past 10 years, congressional committees have expressed concern over the failure of Federal agencies to adequately plan for and use computer resources. For example, the House Committee on Government Operations reported in October 1976 that the failure of Federal agencies to prepare effective long-range plans was a major hindrance to achieving economical procurements, an objective of the Brooks Act (Public Law 89-306).

A comprehensive NBS-wide plan for acquiring, managing, and using computer resources is also necessary for decisionmaking and setting priorities. The plan is the final product of the planning process and should reflect agency strategies, goals, and objectives. It should help ensure that the NBS-wide computer program is meeting mission requirements in an efficient and effective manner. By setting milestones, the plan can also be a valuable management tool for measuring and controlling activities. In addition, an NBS-wide plan can identify opportunities for eliminating waste and duplication.

AN EFFECTIVE PROGRAM TO MEASURE AND ASSESS COMPUTER PERFORMANCE IS NEEDED

A formally structured program providing reasoned, quantitative, and well documented information on performance is an effective method for managing computer resources. Such a program is usually referred to as a Computer Performance Management (CPM) program. Although NBS has established some elements of a CPM program, these elements have not been consolidated in an effective and logical manner nor have reports been provided to top management on a regular basis.

The need for CPM programs was recognized by NBS in 1977 when it published FIPS Publication 49, "Guideline on Computer

Performance Management: An Introduction." The General Services Administration has also recognized the need for developing such programs. In November 1978 the General Services Administration published a very detailed document titled "Management Guidance for Developing and Installing an ADP Performance Management Program." These publications are only two of many that provide guidance on the use of CPM programs.

What is a CPM program?

FIPS Publication 49 defines a CPM program as "any structured effort * * * to measure and evaluate the performance of a computer facility in support of established management goals and objectives."

"The EDP Performance Management Handbook," published by Applied Computer Research, defines performance management as a process for (1) negotiating service level objectives between data processing and its users, (2) tracking actual service levels provided users, and (3) "tuning" the data processing organization until objectives are met. The definition also suggests capacity planning for equipment and staff to meet established service level objectives.

A critical concept in CPM is integrating data collected from various sources within the computer organization into a formally structured program to measure performance. This data must be recognized as a valuable resource and treated, handled, and maintained as a data base. This data base should be the source of regular and meaningful reports to the various management levels within the computer facility and elsewhere in the agency. These reports, in turn, can become the source for management decisions on planning, operations, and procurement. This data can serve the functions of operational control, management control, and strategic planning. The performance management data base can also provide a vital element in an overall computer management system which is responsive to the needs of top management, computer users, and computer operations personnel.

NBS current method for measuring performance is incomplete

At the time of our review, the Bureau's method for measuring performance did not provide management with the kind of information necessary to effectively manage its computer resources. Although measurement reports of various types are prepared, they have not been integrated into a formally structured program.

NBS routinely develops the following reports on elements of computer operations:

- System Utilization Data Report.
- Subsystem Downtime.
- Distribution of Use by Type and Area.
- Workload Analysis Routine.
- Log Data Summary.

Although these reports provide technical information to ADP managers, they do not provide the structured data base necessary for a CPM program. These reports also lack clearly defined performance objectives by which the success of ADP managers can be measured. For example, these reports include information showing that the workload is increasing but they do not indicate how much capacity is available, how much will be needed in the future, and what changes will be necessary to improve the computer system's performance.

Another weakness in the approach to measuring computer performance is the lack of sufficient information flowing to top management. A CPM program serves top management by regularly providing information which will describe in understandable terms how efficiently and effectively computer resources are being managed.

The chief of the Computer Services Division told us that none of the measurement reports prepared in his office are submitted to higher level management on a regular basis. He indicated that top management may not find these reports useful because of their technical nature. We believe, however, that reports addressing performance measurement are needed by top management and could be more useful if they provided summary information in a concise, graphical format and included meaningful performance measures. FIPS Publication 49 emphasizes that computer resource managers have a responsibility to report to upper management on the status, performance, and requirements of their facilities. The publication suggests that such reports should (1) be regular and concise and (2) compare the center's current performance level to a set of predefined performance goals.

Argonne's CPM program is beneficial

During our visit to Argonne National Laboratory, top management representatives, ADP specialists, and computer users told us that Argonne had an effective CPM program that collected detailed and useful data on computer performance. Our examination of selected reports tended to confirm this assessment.

Officials at Argonne said that their CPM program is cost effective and consider it essential for planning, justifying the acquisition of new facilities, achieving efficient use of resources, and communicating with users. For example, recently the CPM program was particularly helpful in planning for and justifying additional computer facilities. The program provided managers with understandable information on computer use and advance warning on when computer facilities would be saturated. The advance warning enabled management to plan for expansion or replacement before the situation became critical.

NEED FOR ADP POLICIES AND OBJECTIVES

Well defined policies and measurable objectives are the foundation of an effective system for acquiring, managing, and using computer resources. NBS does have some policies and objectives; however, existing policies are now outdated and do not reflect the current complex computer environment or the critical importance of computers to the NBS mission. Existing objectives are essentially qualitative as opposed to quantitative. Managers of the central computer facility have been primarily concerned with short term financial viability.

The only formally published NBS policies we identified as dealing with computer management are contained in Policy Guide number 3 and chapter 2.03, appendix K, of the NBS Administrative Manual. Appendix K deals with procedures for reviewing proposals for procuring computer equipment and services, requesting computer services from commercial sources, and reporting on arrangements for obtaining outside computer services.

Policy Guide number 3, approved in 1970, states that NBS computing needs will be met primarily through two systems: a central facility and a laboratory automation network. The policy states that the central facility is to remain financially viable and provide up-to-date service to scientific and administrative users.

A task group was formed in 1977 to study the adequacy of these policies; however, after some preliminary efforts the study was abandoned because the April 1978 NBS reorganization directed the members' interest elsewhere. Before the reorganization, the task group was responsible for examining the consistency and adequacy of NBS management policies governing computer resources. The task group was concerned over the fact that NBS had no overall computer policy beyond that dictated by the General Services Administration, the Office of Management and Budget, and other organizations external to NBS. One crucial policy question that

the task group planned to consider for possible policy development was whether NBS should simply provide adequate computer resources for its scientists or whether it should attempt to become a model research organization in the use of computers. The lack of clearly defined policies was also a factor in NBS not being able to prepare an adequate requirements study.

Management attention is focused on financial viability

The Computer Services Division provides computer services on a fee-for-service basis to NBS and other Government agencies. A Computer Finance Committee was established to review central computer facility operations to see that its rates are set so that costs are fully recovered, as prescribed by Policy Guide number 3. During the last 2 years, the committee has been reviewing rates quarterly to assure that costs are recovered annually.

Based on our discussions with ADP officials and our review of pertinent documents, it is our opinion that management attention is focused on this short term budget matter. One official stated that financial viability is the primary concern of the Computer Services Division. While recovering costs through user charges is an acceptable approach to allocating centralized computer resources, it should not be overemphasized to the detriment of other issues, such as meeting long term user needs.

We believe that ADP management emphasizes financial viability because it is a clearly defined, measurable objective to which management can direct its efforts. NBS needs to develop other measurable objectives, especially for acceptable service levels, to guide its computer resource managers. Measurable objectives also provide a means for top management to evaluate the efficiency and effectiveness of NBS computer support.

NEED FOR CENTRAL COMPUTER MANAGEMENT OFFICE

Under the current organizational structure, responsibility for managing, controlling, and using computer resources is divided among numerous groups. In this report we have mentioned the following ADP management functions that the present NBS decentralized organization has not thoroughly addressed:

- An agency-wide, long-range computer planning process.
- A CPM program.

--Policies and objectives.

--Management controls over minicomputers, documentation, and physical security.

--Management over information (e.g., software and data bases).

We believe that these essential functions and others would be most effectively carried out by a central computer management office. The following discussion describes major functions which we believe should be assigned to this central office.

Developing policies and objectives

The central management office should develop appropriate agency-wide policies and objectives. These would be reviewed by the ADP Steering Committee and approved by the Executive Board. Policies and objectives provide specific direction and guidance to all groups involved in computing and also provide top management with criteria to evaluate the effectiveness of computer usage in the agency. Promulgating agency-wide policies and objectives will also help assure that all the diverse computer users at NBS will be considering overall agency requirements in addition to their own needs.

Planning

Effective computer planning largely depends on how an agency is organized as well as how the responsibilities for planning are assigned. In a diverse, decentralized organization like NBS, a strong central office must be established to accomplish NBS-wide ADP planning. On the basis of top management direction and computer users' input, the office must be assigned the responsibility and authority to direct, coordinate, and review all computer planning.

Developing and enforcing management control procedures

The central ADP management office should be charged with developing and enforcing NBS-wide management control procedures governing the central computer facility, minicomputers, documentation, and physical security. Chapter 4

illustrates the many problems which result from different groups developing and enforcing their own management controls.

Managing a CPM program

One of the most important functions of a central office would be carrying out a CPM program. No requirement exists that a group be formed and dedicated to operating a CPM program. At NBS it is feasible to develop an effective program with in-place staff doing the work. What is important is that those individuals assigned to the task operate in a staff function and report to the head of the central office. It should also be emphasized that a CPM program is not limited to the operation of the central computer facility, but should be applied to all areas of computer use at NBS, including software design and development, scientific computing support, and minicomputers (hardware, software, and personnel).

Managing information

The central management office should develop a system to control and manage the agency's computer software and data. Currently no system exists to catalog and classify frequently used computer programs and data bases that could be shared by NBS scientists. In NBS computer environment software and information is worth considerably more than the cost of hardware. Yet, information does not receive the management attention indicative of its value.

Reviewing and approving procurement

A central office is needed to review and approve procurement requests for computer equipment and services. Centralized review and approval is necessary not only because Government regulations are extensive and complex, but also because individual procurements should meet overall agency requirements. Review and approval by a central office should provide appropriate consideration to the needs of operating units and the agency overall. Operating units should have the right to appeal procurement decisions to the ADP Steering Committee, or a similar group, when necessary.

Operating all central computer support

We believe that the optimum ADP organization at NBS would be a central computer management office that includes all divisions now providing central computing support. These include the Computer Services Division, the Scientific Computing Division, and the Computing Systems Design Division. Currently, the activities of these groups are coordinated by the ADP Steering Committee. Considering the recognized inadequacies of computer support at NBS, a central office, working with these groups on a continuing and frequent basis, could more effectively coordinate and focus their activities on meeting overall NBS computing requirements. NBS scientists, however, would continue to operate computer resources dedicated to meeting specific program requirements. For example, the Institute for Computer Sciences and Technology and the high flux nuclear research reactor unit would continue to maintain separate computer facilities responsive to their respective program needs.

We also believe that some of the functions described above, such as planning and policy development, would be best carried out in a new Planning and Policy Division within the central computer management office. Such a division would better focus accountability and responsibility for these functions.

Placement of central computer management office

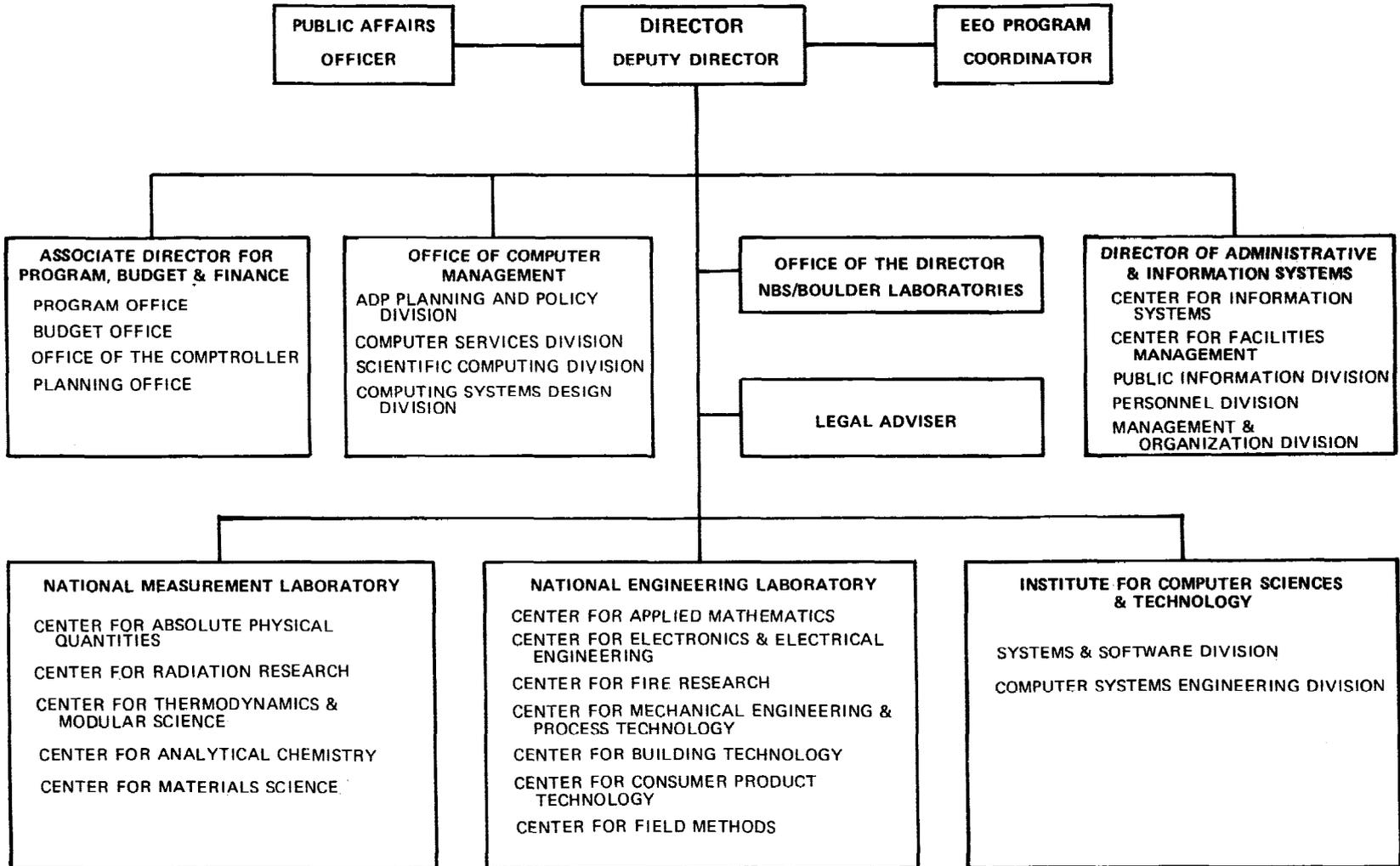
The placement of the central computer management office within the organizational structure of NBS should meet two requirements: the office should be placed at a high management level to have sufficient authority and the office should be so located as to provide an appropriate level of support to both scientific and administrative users.

We believe that placing the central computer management office in the Office of the Director meets these criteria and is the best alternative. A revised organization chart is shown on the following page. We understand that the Director is concerned about having too many people report to him; however, the Director has also emphasized that improving the quality of computing at NBS is one of his top priorities. One way to assure improved computing at NBS is for the Director to give it his personal attention on a regular basis.

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

GAO'S RECOMMENDED PLACEMENT OF OFFICE OF COMPUTER MANAGEMENT



STRENGTHENING ADP STEERING COMMITTEE WILL IMPROVE MANAGEMENT

An ADP Steering Committee is an accepted method for reviewing and evaluating a management system for computer resources. Although NBS has an ADP Steering Committee (officially referred to as the ADP Policy Committee), the committee has certain weaknesses which need to be corrected if it is to effectively carry out its responsibilities.

Functions should be clearly defined

No charter has been issued defining the functions of the NBS ADP Steering Committee and minutes of the committee meetings are not retained as an official record. Its chairman sees the committee as coordinating the activities of the three central ADP support groups. The committee is now primarily concerned with meeting the requirements necessary to procure a replacement for the central computer facility. The committee's future role is not clear.

The committee's primary functions should be to periodically review and evaluate the work of the central computer management office in carrying out the ADP management system and to recommend to the Executive Board ways to improve the efficient and effective use of computer resources. Specifically, the committee should review and recommend (1) policies for the effective use of computer resources throughout the agency and (2) measurable objectives so that progress toward their achievement can be measured. The committee should also regularly monitor the central computer management office's performance and report its findings to the Executive Board.

Representation should be strengthened

The existing ADP Steering Committee does not adequately represent top management and users. Although the Comptroller, a division chief, and two center directors are members, no one from the Executive Board serves on the committee. Further, although membership includes a user, we do not believe one can represent all users as adequately as an active computer users organization. We believe that NBS needs to strengthen the representation of top management and users on its ADP Steering Committee.

We believe that the Executive Board views computing as a complex, technical subject which should be handled by specialists rather than as a valuable resource requiring management involvement. In recent years several ad hoc committees have been established to improve various aspects

of computer services. The committees generally identified the same problems and made similar recommendations. Many of the same problems still exist. No member of the Executive Board actively participated on any of these committees. We believe that had top management participated, the current computer problems would be less severe.

We believe that members of the Executive Board should serve on the ADP Steering Committee. We suggest that two members of the Executive Board serve on the committee until NBS has improved the quality of its computer resources. In our opinion, this will take at least 2 years. Thereafter, at least one member of the Executive Board could serve permanently on the committee. Members of the Executive Board have expressed concern over the lack of adequate computing resources at NBS and their desire for improvement. We believe they can demonstrate their concern and desire by becoming actively involved with the ADP Steering Committee.

User involvement in the management and planning process is also necessary to ensure satisfaction of users' needs. Users and computer specialists should work with top management to define requirements; agree on appropriate strategies, policies, objectives, and goals; and develop plans to economically meet those requirements and objectives. Since there is no active organization representing computer users, no effective mechanism exists for users to make their needs known to top managers and computer support groups.

Other Government laboratories we visited have active computer users organizations. Membership in Brookhaven National Laboratory's organization is open to all laboratory employees who use the central facility. Brookhaven's organization is chartered to make known to management the needs and desires of those who use the central computer facility.

Because computer usage at NBS is widely dispersed, it is especially important that a strong, active computer users organization be formed and become involved in improving the acquisition, management, and use of computer resources. There is no single NBS operating unit which is a major user of the central facility. For example, during a recent 3-month period, the largest scientific user (division, center, or office) of the central facility used less than 4 percent of the facility's computer resources. This is contrasted with computer use at Brookhaven National Laboratory where a single user, the high energy physics group, accounts for about 33 percent of total usage on the central computer.

CONCLUSIONS

The Bureau's approach to managing computer resources has not been successful in solving the agency's computer problems. Under the current organizational structure, responsibility for planning, controlling, and using computer resources is diffused among numerous organizational units. Long term needs have been addressed by ad hoc studies only when problems arise, while managers of the central computer facility have been primarily concerned with short term financial viability. In addition, management does not have sufficient information to assess the productivity and performance of the agency's computer resources. Finally, few policies and objectives have been established.

We believe that NBS needs to develop and implement an effective management system for computer resources. Such a system would be based on formally stated policies and measurable objectives and include a long-range planning process and a CPM program. The system would be the responsibility of a central computer management office. The ADP Steering Committee would periodically review the system to assure its effectiveness.

RECOMMENDATIONS

We recommend that the Secretary of Commerce direct NBS to:

- Establish a central computer management office responsible for developing and implementing a computer resource management system. This office should be part of the Office of the NBS Director in order to maximize results. The management system should include a long-range planning process, a CPM program, clearly defined policies, and measurable objectives.
- Strengthen the ADP Steering Committee by naming members of the Executive Board to serve on the committee. One method would be to appoint two Board members to serve 2 years. Thereafter, at least one member of the Executive Board could serve permanently on the committee. Also, this committee should have a written charter setting forth its authority and responsibilities.
- Establish a permanent computer users group to represent the users of computer services. The group should report to the Executive Board, and its chairman should also be a member of the ADP Steering Committee.

AGENCY COMMENTS

We discussed NBS approach to managing computer resources with the Director, the Executive Board, the ADP Policy Committee, and computer managers. Generally, these officials agreed with our findings. In its written comments NBS concurs with the principal conclusions of our report and has initiated a number of actions consistent with our recommendations, with others to follow.

The Department of Commerce said in its comments that it will direct NBS to comply with all of our recommendations with the exception of establishing a central computer management office and appointing two members of the Executive Board to serve on the Automatic Data Processing Policy Committee. In place of these two recommendations, Commerce will direct NBS to establish a task force to (1) evaluate alternative organizational configurations to the current management structure and (2) review ways to increase top management involvement on the Policy Committee.

ADP PLANNING EFFORTS UNDERTAKENBY NBSJANUARY 1970 TO SEPTEMBER 1978

<u>Planning Effort</u>	<u>Date</u>	<u>Purpose</u>
Report of the Ad Hoc Study Group on ADP Policy for NBS	May 1970	Review organization, policies, and facilities for the use of computer and related ADP facilities at NBS.
Computer Augmentation of Laboratory Measurements Survey (CALM)	February 1971	Explore the current status of laboratory automation at NBS, the use of small laboratory computers, the processing of experimental data on the central computer, and the use of commercial time-sharing services.
A Plan for Modernization of the NBS Central Computer Facility	May 1972	Upgrade central computer to meet needed requirements, primarily a need for time-sharing services.
Institute of Basic Standards Automation Committee Report	September 1972	Plan an overall scheme for laboratory automation for the Institute for Basic Standards.
NBS User Requirements for Computer Services	February 1974	Define areas where NBS might provide short term support to the Computer Services Division to help it meet user requirements.
NBS ADP Plan	June 1975	Provide NBS input to a Department of Commerce ADP planning system.

<u>Planning Effort</u>	<u>Date</u>	<u>Purpose</u>
Formation of Ad Hoc Advisory Group on Strategic Planning for NBS Computer Support	October 1975	Function in an advisory capacity in (1) formulating long-range ADP objectives for NBS, (2) evaluating alternative action plans, and (3) developing recommendations for Executive Board approval.
Planning Study of Service Requirements and Resource Allocations for the NBS Central Computing Facility	August 1976	Develop a comprehensive plan of needs and make recommendations concerning the current staffing and funding arrangements in the Computer Services Division.
Plan for Improving the Effectiveness of ADP Utilization at NBS	November 1976	Review and assess the proposed technical projects and recommendations contained in the August 1976 planning study.
Report of Task Team to Devise Alternative Implementations of Computing Resources (Raveche Study)	August 1977	Identify feasible Government and commercial alternatives to an NBS central facility that could satisfy NBS computing requirements.
A Requirements Study on the Installation of an Interim Computer System at NBS for the Period 1978 to 1981.	January 1978	Investigate the feasibility of installing an interim central computer system at NBS.
Requirements Study for a Replacement Computer at the National Bureau of Standards	July 1978	Determine the best solution for obtaining sufficient computational capability to meet the expanding needs of NBS into the 1980s.



UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Administration
Washington, D.C. 20230

12 MAR 1979

Mr. Henry Eschwege
Director, Community and Economic
Development Division
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Eschwege:

This is in reply to your letter of January 8, 1979, requesting comments on the draft report entitled "National Bureau of Standards Needs Better Management of Its Computer Resources To Improve Program Effectiveness."

We have reviewed the enclosed comments of the National Bureau of Standards (NBS) and believe they are responsive to the matters discussed in the report.

The Department will direct NBS to comply with all the GAO recommendations on pages V and VI with the exception of establishing an Office of Computer Management (bottom of page V) and the appointment of two members of the executive committee to serve on the ADP Steering Committee (top of page VI). In place of these, NBS will proceed as follows:

- o The NBS ADP Policy Committee will establish a Task Force to evaluate alternative organizational configurations. The Steering Committee will review the work of the Task Force and make recommendations to the NBS Executive Board. This evaluation will consider certain other functions and activities specified in the GAO audit, e.g., long-range planning processes, a computer management performance program and establishing clearly defined policies and measureable objectives.

- o The Task Force will be chartered to review the membership of the ADP Policy Committee, recommend ways to increase top management participation, and prepare a charter for the committee outlining its authority and responsibilities. In addition, the Task Force will make recommendations on the membership and reporting arrangements of a permanent Computer Users Group.

Sincerely,



Elsa A. Porter
Assistant Secretary
for Administration

Enclosure

GAO note: Page number references in this appendix may not correspond to pages of this report.



UNITED STATES DEPARTMENT OF COMMERCE
National Bureau of Standards
 Washington, D.C. 20234
 OFFICE OF THE DIRECTOR

FEB 23 1979

MEMORANDUM FOR Joseph A. Sickon
 Director, Office of Administration

Through: Assistant Secretary Baruch

FEB 27 1979

From: Ernest Ambler
 Director

Subject: Comments on Draft GAO Report, "NBS Needs Better Management
 of its Computer Resources to Improve Program Effectiveness"

The National Bureau of Standards is keenly aware of the deficiencies in its computer resources, and concurs with the principal conclusions of the GAO Report. In particular, we appreciate the thoughtful analysis of the inadequacy of our present central computer, and the suggestions about the scale of computer system that is appropriate. During the internal review over the last year and a half, and the reorganization that has been implemented, NBS top management devoted a great deal of attention to all the facets of computing equipment, organization, planning and staff, and has initiated a number of actions that are consistent with GAO recommendations, with others to follow.

The internal review made it abundantly clear that NBS had fallen far behind modern levels of computing service. In the same period, Congress assigned additional responsibilities to NBS that depended heavily on modern computing. We are in the process now of preparing an updated requirements report; this is a continuation of the review that has been in progress for over a year. One report was prepared last summer, and we look forward to counsel from DoC and GAO on how to further strengthen the new draft. Among the actions that have been initiated are:

- o The area of physical security and disaster recovery procedures for our ADP operations are being addressed to bring us in line totally with the recent OMB circular A71, Transmittal Memorandum #1. The DoC is in the process of completing Departmental guidelines for compliance.
- o A more accurate inventory of ADP hardware is in process, and steps have been taken to assure that it will remain current. The inventory of software is a much more complex issue because of the way it is acquired, developed, and documented. It is also much more demanding of staff time, but it is crucial to couple the planning of software for the new computer system with the current inventory. Initial steps have been taken, and the effort will be expanded.

- o A commitment to provide complete documentation of existing administrative programs was made before the audit team arrived. Support for this activity has been provided in terms of staff positions and budget authorizations. Efforts will be undertaken to document other programs which have broad application.

Finally, we wish to emphasize our agreement with the GAO conclusion that our current computing resources are inadequate. We are committing significant effort to correcting this situation and are encouraged by the assistance the GAO has given us in this matter.

Beyond these issues, the report contains some passages which we believe should be restated. Attachment A is provided to address these, and other specific difficulties we have identified in the draft report.

Attachment A [See GAO note]

cc: Dr. J. Prokop
Mr. R. Kammer
Mr. J. Hall

GAO note: Revisions have been made to clarify and restate certain report passages to recognize these comments.

(06102)

Single copies of GAO reports are available free of charge. Requests (except by Members of Congress) for additional quantities should be accompanied by payment of \$1.00 per copy.

Requests for single copies (without charge) should be sent to:

U.S. General Accounting Office
Distribution Section, Room 1518
441 G Street, NW.
Washington, DC 20548

Requests for multiple copies should be sent with checks or money orders to:

U.S. General Accounting Office
Distribution Section
P.O. Box 1020
Washington, DC 20013

Checks or money orders should be made payable to the U.S. General Accounting Office. NOTE: Stamps or Superintendent of Documents coupons will not be accepted.

PLEASE DO NOT SEND CASH

To expedite filling your order, use the report number and date in the lower right corner of the front cover.

GAO reports are now available on microfiche. If such copies will meet your needs, be sure to specify that you want microfiche copies.

AN EQUAL OPPORTUNITY EMPLOYER

**UNITED STATES
GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548**

**OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, \$300**

**POSTAGE AND FEES PAID
U. S. GENERAL ACCOUNTING OFFICE**



THIRD CLASS