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ABSTRACT

This report, prepared in response to a requirement in the Academic Research Facilities Modernization Act, proposes a plan for the modernization of general research facilities in which academic research is conducted, including research buildings, research laboratories, support rooms, and other institutional or departmental facilities in scientific and engineering disciplines. Federal research facility support programs of the 1960s and early 1970s are described as instrumental in helping to build and strengthen the academic research facility base, while the 1980s have seen few such programs. Recent studies indicate that U.S. academic research facilities have deteriorated and there is a growing need for additional research space. The roles of various key groups in supporting and investing in academic research facilities are spelled out; for example, institutions should consider greater use of debt financing, and state and local governments should encourage partnerships and consortia. A combination of funding support mechanisms should be established to provide the balanced and sustained support necessary to develop modern research facilities. The Academic Research Facilities Modernization Act calls for a competitive grant program for the repair, renovation, and, in exceptional cases, replacement of academic research facilities. Special features of the program are described. The appendix provides program guidelines (a revision of a draft published in the Federal Register April 20, 1989) that describe a two-phase annual proposal cycle for organizations seeking grants for the repair, renovation, or replacement of a research facility or facilities. A 37-item bibliography concludes the plan. (JDD)

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MODERNIZING ACADEMIC RESEARCH FACILITIES:

A COMPREHENSIVE PLAN

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

JUNE 1989

FOREWORD

Scientific and engineering research is critical to our nation's growth, well-being, and economic competitiveness. Scientific and engineering personnel, instrumentation, and research facilities are the three key elements of our research system. Fundamental research at our nation's colleges, universities, and other research institutions provides not only the knowledge and understanding for tomorrow's advancements and technology, but also the training for our future scientists and engineers. The laboratories and facilities in which this research and training are carried out are of vital importance.

There is increasing concern regarding our research facilities - their condition, what can be done about it, and who should do it. In response to the Academic Research Facilities Modernization Act of 1988, this report presents a proposed comprehensive plan for the modernization of our nation's research facilities.

I want to thank the Research Facilities Office and especially Richard J. Green, Director, William B. Cole, Jr., Executive Officer, and Altie H. Metcalf, Staff Assistant, for their leadership, dedication, and hard work in preparing this comprehensive report.

Erich Bloch
Director
National Science Foundation

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MODERNIZING ACADEMIC RESEARCH FACILITIES: A COMPREHENSIVE PLAN

SUMMARY

ACADEMIC RESEARCH FACILITIES MODERNIZATION ACT

- The Academic Research Facilities Modernization Act of 1988, signed into law in October 1988, was the result of a number of legislative initiatives to deal with research facilities modernization. The Act provides authority for the National Science Foundation and its Director to establish and carry out an Academic Research Facilities Modernization Program and to prepare and submit this report to Congress.

IMPORTANCE OF FACILITIES

- Academic research laboratories are important to the research enterprise of the United States. These facilities are a national resource. Here is where most fundamental scientific and engineering research and training of future scientists and engineers occur. State-of-the-art facilities and equipment are important determinants of the quantity and quality of research done. The highest quality research and research training are essential to our nation's general scientific and technological advancement, well-being, productivity, and overall economic competitiveness. It is important that research facilities be sufficient in terms of numbers, size, condition, adequacy, and location -- to support the nation's basic research and research training efforts.

FEDERAL FACILITIES SUPPORT

- Federal research facility support programs and other initiatives of the 1960s and early 1970s were instrumental in helping to build and to strengthen our national academic research facility base. During the 1980s there have been few programs directed toward research facilities. Federal obligations for academic R&D plant have grown from less than $50 million in 1980 to approximately $200 million in 1987. It is estimated that roughly half of the FY87 amount resulted from Congressional earmarking of appropriations in the Departments of Energy, Agriculture, and Defense and other agencies.

RESEARCH FACILITY NEEDS

- Recent studies, surveys, and assessments indicate that U.S. academic research facilities have deteriorated and that there is a need to repair, renovate, and modernize existing facilities as well as to expand and build additional ones. Major factors contributing to the research facilities issues cited by institutions include: (a) the rapid changes and advancements in science and research; (b) the high cost of research facilities and support space; (c) the impact of regulatory and other requirements on building standards; (d) the cost of upgrading older buildings and

facilities, many of which are structurally inflexible and obsolete; and (e) chronic underfunding due to higher priorities. These studies further indicate that existing research facilities are often inadequate or obsolete and frequently do not meet health, safety, and other standards. Further, there is a growing need for additional research space. While these studies capture an overall picture of the current status of facilities, they were not intended to assess the impact of facilities on the quality of research being conducted at academic institutions.

ROLES AND FUNDING SOURCES

- Several key groups have an interest, stake, and role in supporting and investing in academic research facilities. They are academic institutions, state and local governments, the federal government, private industry, foundations, and individuals. These groups must share in the responsibility for research facilities and increase their efforts if significant progress is to be made in meeting facility needs. Each has a different interest and role to play, yet all must work cooperatively to leverage their efforts and funds for maximum impact.

- Institutions, state and local governments, the federal government, private industry, and others must consider and determine where research facilities needs fit relative to other priorities. Research facilities support will have to continue to compete for funding resources against other high priority programs.

- *Institutions* should prioritize their needs, consider greater use of debt financing, consider more effective strategies and mechanisms for facilities budgeting, planning, maintenance, management and utilization for both the short and long term, and explore opportunities for more shared use of facilities and collaborative efforts.

- *State and local governments* should recognize the facilities needs and determine their priority, explore additional mechanisms to increase support for academic research facilities, encourage partnerships and consortia, develop joint programs and initiatives, and consider additional incentives to encourage support for facilities.

- The *federal government* should take a more active leadership role in considering and developing policies and strategies toward a systematic and balanced approach to research facilities. Agencies should give greater recognition to the importance of research facilities, the need to provide support, and the priority of this need.

- *Industry* should give greater recognition to the value of and need to support academic research facilities and strengthen its overall commitment in this area. It should consider and identify actions that would increase industry's incentive to provide facility support. *Private foundations* should consider additional programs and initiatives including cooperative programs among themselves and with others to leverage their support.

SUPPORT MECHANISMS

- There is a need for a sustained investment strategy using a combination of funding mechanisms. Such a strategy must be executed by each group that has a role in supporting research facilities. No single institutional group or organization has the resources or responsibility to effectively deal with this issue.

- Existing and potential support mechanisms in various combinations should be considered by each of the key groups. Only a combination of support mechanisms, used by all groups and appropriately balanced, can effectively provide the balanced and sustained support necessary to have modern research facilities in the future.

- To provide additional support for research facilities, consideration should be given by the federal government and others to a number of possible initiatives, including:
  - targeted programs in various agencies with appropriate funding
  - modifying the federal cost principles with regard to use allowances, depreciation, and other facility-related costs
  - removing or increasing the $150 million cap on tax-exempt bonds
  - additional tax and other incentives to encourage support of academic research facilities and equipment.

ACADEMIC RESEARCH FACILITIES MODERNIZATION PROGRAM

- The Academic Research Facilities Modernization Act specifically calls for a competitive grant program for the repair, renovation, and, in exceptional cases, replacement of academic research facilities at institutions of higher education, nonprofit research institutions, research museums, and consortia thereof.

- Although the Academic Research Facilities Modernization Program has not yet been funded, the Foundation, pursuant to the legislative requirements, has developed detailed program guidelines, obtained public comment, and prepared an overall plan. The Program contains a number of special features including a two-phase proposal process, a limit on proposal length, competition within three separate groups for a targeted percentage of program funds, one proposal per institution, substantial matching requirements, and emphasis on research and research training facilities. Evaluation criteria include research merit, facility need, project impacts, and plans and funding. Additional consideration will be given to several special factors such as size and geographic distribution, previous facility funding, and a 12% minimum for minority institutions. The revised Program Guidelines are included as Appendix A. However, it must be noted that there are many issues concerning roles and support mechanisms that can impact the level of direct federal funding. These issues, many of which are listed in this report, need to be be further explored and the program and guidelines revised accordingly in the future.

I. INTRODUCTION

Academic research laboratories are important elements in our nation's research enterprise. These facilities are a national resource in that it is here that fundamental scientific and engineering research and the training of future scientists and engineers occur. State-of-the-art facilities and equipment are important determinants of what research can be done and how productive those efforts will be. The highest quality research and research training are essential to our general scientific and technological advancement, our nation's well-being, our future productivity, and our overall economic competitiveness. It is important that sufficient research facilities exist in terms of numbers, size, condition, adequacy, and location to support the nation's basic research and research training efforts.

Specialized and General Research Facilities

Federally supported research facilities can be divided into two broad categories: specialized facilities and general facilities. Specialized facilities, usually large or unique facilities, are often focused on a specific mission or purpose and typically are directly funded by one or more mission agencies. Frequently national or regional in scope, specialized research facilities may include oceanographic research vessels, accelerators, aircraft, telescopes, observatories, supercomputing facilities, federally funded research and development centers, and national research centers.

General facilities are more broadly focused facilities in which academic research is conducted. They include research buildings, research laboratories, support rooms, and other institutional or departmental facilities in the various scientific and engineering disciplines. Mission agencies typically do not provide direct support for general research facilities. When they do, it is usually through separate "bricks and mortar" programs for funding repair and renovation as well as new construction. Such programs are expensive and often must be funded at the expense of direct, mission-related research programs. In those cases, support for general research facilities must compete with other higher priorities, and this has resulted in reduced funding for general facilities.

This Report is in response to a requirement in the Academic Research Facilities Modernization Act (102 Stat. 2873, 42 U.S.C. 1862a-1862d) and only addresses general research facilities.

II. FEDERAL FACILITIES SUPPORT

As early as 1956 there were concerns about the condition of academic research facilities and the role of the federal government in providing assistance to improve them. In response to a request by the then Bureau of the Budget, in 1957 NSF issued *Federal Financial Support of Physical Facilities and Major Equipment for the Conduct of Scientific Research.* This report concluded that (a) the nation's laboratories were deteriorating due to long use (caused in part by a moratorium on new construction during World War II and rising construction costs), (b) rapidly rising college enrollment would place added stress on science laboratory needs, and (c) the pace of scientific development and innovation would shorten the useful life of much of the equipment and instrumentation in use at that time. Although the report emphasized the responsibility of colleges and universities to seek non-federal funds for support of facilities, the launching of *Sputnik* shortly after the report was published served as a catalyst for substantially increased Federal support for facilities. In addition, *Scientific Progress, the Universities, and the Federal Government*, a 1960 report (commonly referred to as the *Seaborg Report*) issued by the President's Science Advisory Committee recommended expanding the research base by increasing the number of high quality research universities.

It was in this climate that a number of programs for construction or renovation of general research facilities were established. The National Institutes of Health's Health Research Facilities Program, in existence from the late 1950s, was directed at expanding physical facilities. The program, which required a 50 percent match, awarded approximately $500 million to over 400 institutions, resulting in the construction of 19 million net square feet of laboratory space.

A private program, notable for the amount of funds provided and designed to expand the research base, was the Ford Foundation's Special (Challenge) Program in Education. Administered for seven years (1959-1966), it awarded $349 million to 84 institutions. These funds were leveraged substantially because the program required a 70-80 percent match.

The Sustaining University Program, administered by the National Aeronautics and Space Administration from 1962-1971, had as its overall objective building competence in the space sciences and fostering government/university/industry partnerships. The program awarded approximately $43 million to 31 institutions for support of specialized facilities.

During the 1960s and 1970s the National Science Foundation established a number of programs providing support for facilities. The primary objective of the Graduate Science Facilities Program, which required 50 percent cost sharing, was to provide buildings and equipment for university research. In ten years the program provided $188 million to 182 institutions. From 1960-1962 the funds were used primarily for renovations and fixed equipment, after 1962 most of the funds supported new construction.

NSF's Institutional Grants for Science Program (1961-1974) broadened support for already established or first-tier institutions. Over 675 institutions received awards in 1974. Although there were no restrictions on how the funds were spent, approximately 16 percent of the total program funds

of $120 million were spent on facilities, primarily laboratory renovation or inexpensive construction.

NSF's Science Development Grants, a program that ran from 1964-1972, had the goal of broadening the base of research, with emphasis on geographic distribution and funding second-tier or emerging institutions (the top 20 institutions were excluded from the program). Cost sharing of at least 50 percent was required, and funds could be used for new faculty and graduate students as well as constructing new facilities. In eight years this program awarded $233 million to 104 institutions; an estimated 23 percent of the funds were used for facilities.

Although a few facilities programs continued through the 1970s and into the 1980's (notably the National Cancer Institute's construction program), many federal facilities programs were phased out, responding in part to more austere budgets and inflation and a resulting reordering of priorities. Under these circumstances NSF generally encouraged individual project support over support for facilities, and universities and colleges tended to postpone facilities renovation and construction as a result of a combination of factors.

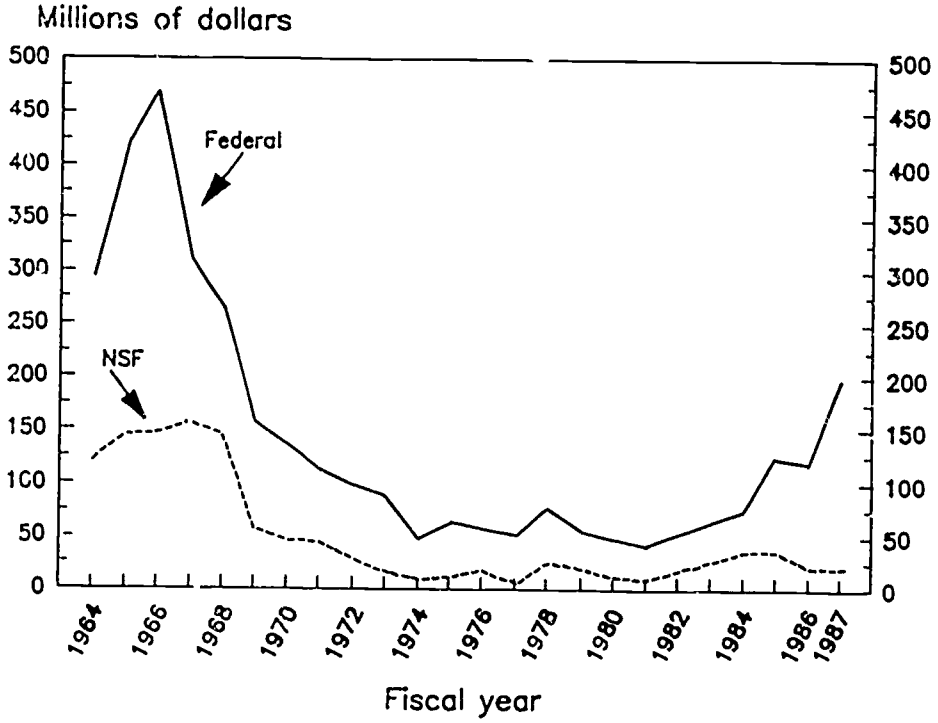
Federal research facility support programs and other initiatives of the 1960s and early 1970s were instrumental in helping to build and strengthen our nation's academic research facility capacity.

Since 1965, the Department of Education (and its predecessor, the Office of Education) has awarded over $3 billion in grants and loans for academic facilities under a variety of construction and renovation programs authorized by Title VII of the Higher Education Act. Most of these programs tapered off or were phased out by the mid 1970s. Unlike the facilities programs of federal agencies with research missions, the Department of Education's programs support academic facilities projects of all types and do not necessarily directly benefit research activities.

During the 1980s there have been few programs directed toward research facilities. Those that do exist or have been authorized have not received major funding. From 1980 through 1987 the National Cancer Institute provided an average of $5.5 million a year for extramural cancer research facilities. In addition, the National Eye Institute and the National Heart, Lung and Blood Institute each provided $2 to $3 million annually for construction of facilities from 1985 through 1987. The AIDS infrastructure and facilities program at NIH has current appropriations for FY88-89 at over $20 million. NIH also has provided funds since the mid 1980s for animal care facilities. However, NIH does not have broad research facilities construction authority.

Direct federal obligations for academic R&D plant have grown from less than $50 million in 1980 and over $70 million in 1984 to approximately $200 million in 1987. This includes support for general and specialized research facilities. Most of the growth in R&D facilities funding since the mid 1980's has been due to Congressional earmarking of appropriations, particularly for the Departments of Energy, Agriculture and Defense. It is estimated that nearly $100 million of the $200 million obligated for academic R&D plant in FY87 resulted from such earmarks.

Federal obligations for R&D plant to universities and colleges: FYs 1964–87
(Constant 1982 dollars)



SOURCE: National Science Foundation, STIA, SRS

III. RESEARCH FACILITY NEEDS

This section briefly (a) highlights facility needs in general, based on recent surveys; (b) identifies some unique circumstances, characteristics, and needs of various types of institutions, including doctoral and nondoctoral institutions, minority institutions, nonprofit research institutions, and research museums; and (c) identifies some specific science and engineering research facility needs.

NSF Surveys

Although the issue of repairing, renovating, or constructing new research facilities led to a number of legislative initiatives in the 1980s, no systematic assessment of academic research facility needs was conducted until the National Science Foundation was directed by statute to conduct surveys biennially to identify and assess the research facilities needs of universities and colleges (42 U.S.C. 1886). *Scientific and Engineering Research Facilities at Universities and Colleges: 1988* (NSF 88-320) is the second and most recent study conducted by NSF's Division of Science Resources Studies (SRS) as a result of that legislation and was published in September 1988.

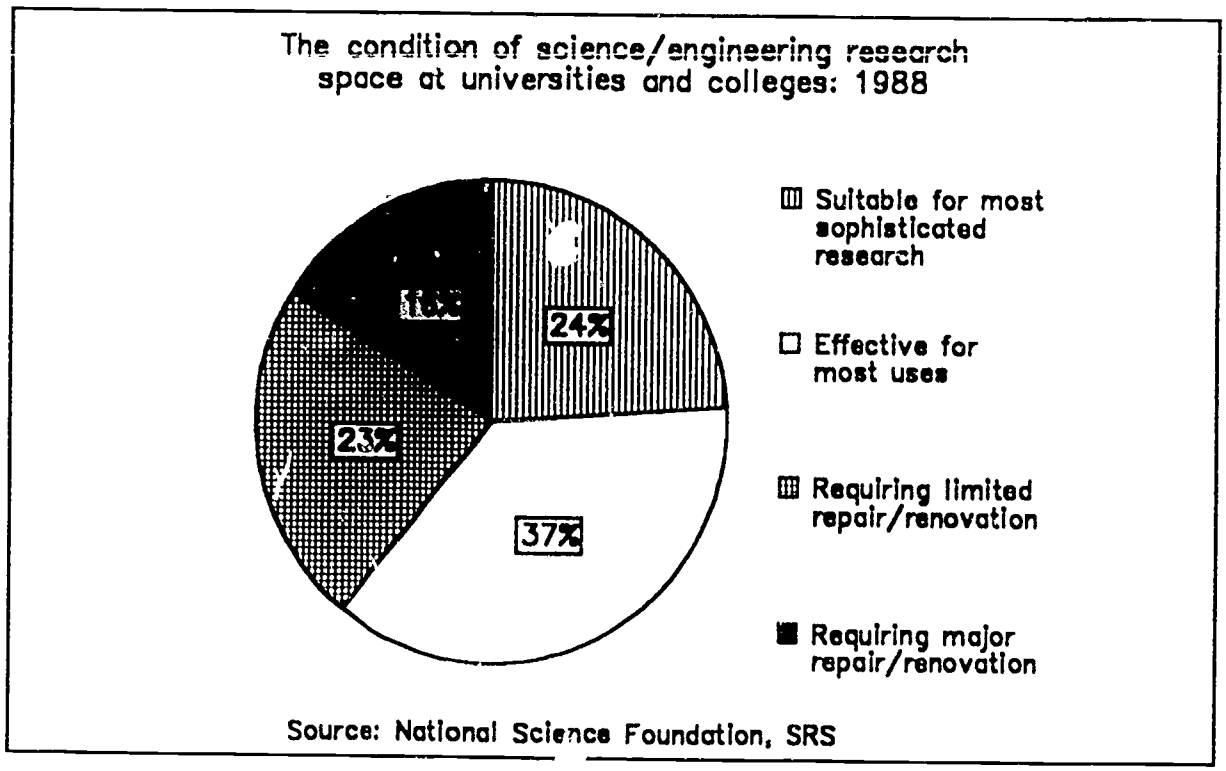
The 1988 SRS survey used a statistical sample of 244 institutions drawn from a universe of 525 institutions encompassing all universities and colleges that award doctoral or master's degrees in the sciences and engineering, all other institutions that have separately budgeted research expenditures of $50,000 or more, and all historically Black colleges and universities (HBCUs) with any research expenditures. The sample institutions, both doctoral and nondoctoral, were sent a questionnaire developed in coordination with several higher education associations and universities. The questionnaire requested information on the amount of available research space, the condition and adequacy of the research space, and the cost, net assignable square feet, and sources of funding for capital improvements or construction. The survey's response rate of 90 percent is an indicator of the strong interest, both at doctoral and nondoctoral institutions, in the facilities issue.

Key Findings of NSF Survey

Of the 114 million net assignable square feet of research space available at American universities and colleges, the top 50 R&D institutions account for 50 percent of the space; 96 percent of the space is at doctoral granting institutions; 73 percent is at public institutions; 1 percent of the space is at HBCUs.

The adequacy of the amount of research space varies by discipline. In mathematics, for example, 25 percent responded that the amount of research space was inadequate; in engineering, however, 51 percent responded that the amount of research space was inadequate.

In terms of the condition of the research space, 24 percent was considered suitable for the most sophisticated research in its field, 37 percent was considered effective for most uses, and 39 percent required either minor or major repair or renovation to be used effectively.



Institutions' planned construction in 1988-89 totals $3.4 billion, and although this is an increase over the 1986-87 figures, for every $1.00 spent, institutions have estimated that $2.50 in needed construction will be deferred. In contrast, institutions' planned repair or renovation for 1988-89, estimated at $777 million, is about 10 percent lower than the $863 million spent in 1986-87. Additionally, institutions indicated that for every $1.00 spent for repair or renovation, $3.60 in needed work will be deferred.

Institutional Characteristics

DOCTORAL INSTITUTIONS

A significant mission of doctoral institutions is research and graduate education in science and engineering. The importance of this role in the nation's research enterprise is evident when considering the amount of available R&D space at doctoral institutions, the amount of funds being spent for either the construction of new research facilities or the repair or renovation of existing research facilities, and the amount of overall federal research and development funding at such institutions.

Doctoral institutions account for 96 percent of the nation's total net assignable square feet of research space at academic institutions. On average, 45 percent of the science and engineering space at doctoral institutions is devoted to research (the equivalent at nondoctoral institutions is 16 percent); doctoral institutions have an average of 374,000 square feet of research space (this compares to an average of 19,827 square feet at nondoctoral institutions). Not surprisingly, doctoral institutions

account for 95 percent of the funds spent on facilities repair/renovation and 97 percent of the funds spent on new construction.

In terms of the source of funds for repair/renovation, doctoral institutions rely heavily on institutional sources (39 percent), less so on state/local government (29 percent), and to some extent on tax-exempt bonds (15 percent). Their reliance on the federal government, which provides only 4 percent of their repair/renovation funding, is relatively minimal. Sources of funds for new construction are more evenly divided: 35 percent from state/local government; 23 percent from private sources; 18 percent from tax-exempt bonds; 12 percent from institutional sources. Again the federal role is relatively small, accounting for only 7 percent of the funds for new construction. An indication of the substantial role doctoral institutions play in the nation's research enterprise is the fact that in 1987 over 300 doctoral institutions received over $7 billion in federal R&D funding, accounting for approximately 98 percent of the total federal R&D funding of academic institutions. These institutions also receive substantial amounts of R&D funding from non-federal sources.

NONDOCTORAL INSTITUTIONS

Although nondoctoral institutions share with doctoral institutions the missions of instruction and research, they place a greater emphasis on undergraduate research training. By preparing students for graduate school ("contributing to the pipeline"), a role which is critical to the nation's research enterprise, nondoctoral institutions make their most significant contribution. Statistically these institutions occupy a small portion of the nation's research space (4 percent of the net assignable square feet), and a small percentage (16 percent) of the science and engineering space at the institutions is devoted to research. Correspondingly, funds spent by nondoctoral institutions for either new construction or repair/renovation account for 3 percent and 5 percent, respectively, of the total funds spent; this is reflected in a higher deferral rate, with $7.60 being deferred for every $1.00 spent on repair/renovation.

Nondoctoral institutions also differ from doctoral institutions in the source of funds for repair/renovation and new construction. In both cases, nondoctoral institutions rely quite heavily on state/local government which provide 75 percent of the funding for repair/renovation and 69 percent of the funding for new construction. It should be noted that the majority of nondoctoral institutions reporting capital projects were public; private institutions receive very little support from state and local governments. The federal role in both cases is small, providing 4 percent for repair/renovation and 4 percent for new construction. Tax-exempt bonds play almost no part in the funding picture, providing only 1 percent of the funds for either repair/renovation or construction. Overall federal R&D funding for nondoctoral institutions provided 439 institutions with approximately 2 percent of the total funds expended for R&D at academic institutions in FY87.

Although nondoctoral institutions may appear to play a small part in the overall research picture, statistics can be misleading. Because one of the primary missions of nondoctoral institutions is research training and instruction, much of the space used for these purposes is not "primarily devoted to research" and as such may be multi-use space not classified as research space.

MINORITY INSTITUTIONS

Historically Black colleges and universities (HBCUs), most of which are 50 to 100 years old, are institutions that were founded primarily for the education of Black Americans. Out of the 107 HBCUs nationally, 29 HBCUs were identified as having separately budgeted science and engineering research programs; these 29 institutions provided the input for the survey.

HBCUs have one million net assignable square feet of space available for research which represents one percent of the total net assignable square feet for all U.S. research institutions. The proportion of space at HBCUs used for organized research is 19 percent of the total science and engineering space. In 1986 and 1987, 135,000 square feet or 13 percent of all research space was under renovation or repair. For 1988 and 1989, 85,000 square feet or 8 percent is projected for repair and renovation.

As reported by the institutions, only 37 percent of HBCU research space was considered suitable for the most sophisticated research in its field; 39 percent was considered effective for most uses; and 25 percent required minor or major repair and renovation. Overall federal R&D funding for 54 HBCU's in FY87 was approximately one percent of the total for academic institutions.

In addition to HBCUs there are other institutions that have substantial minority enrollments. Included as minority institutions are institutions whose enrollments are: (a) more than 50 percent of a combination of any of the following groups: Alaskan Native (Eskimo or Aleut), American Indian, Black, Hispanic, Puerto Rican, or Native Pacific Islander; or (b) 20 percent or more of any one of the above eligible minorities.

Over 20 of these minority institutions received approximately 2 percent of the total federal R&D funding for academic institutions in FY87. Information on the amount of and condition of research space for these institutions is included within the data on doctoral and nondoctoral institutions, but unlike that for HBCUs, it has not been broken out separately.

NONPROFIT RESEARCH INSTITUTIONS

There are several hundred independent nonprofit research institutions that conduct basic and advanced scientific research, much of which is in the biomedical fields. These institutions, like the major research universities, compete for and receive merit-based research awards from the federal government. They are noted for their strong commitments to research training, and doctoral and post-doctoral students and researchers serve as fellows and research assistants.

Many of these institutions have collaborative or special arrangements with local universities. Unlike large research universities, most of them are small and their research efforts highly focused. Many have played a major role in the advancement of science. They have a need for modern, state-of-the-art laboratories, equipment and instrumentation. Sources of funds are more limited than for

public or private universities and the nonprofits place heavy reliance on individual donors and sponsored research sources.

RESEARCH MUSEUMS

Most research museums in the United States are natural history museums, including botanical gardens. Their primary research mission is to describe the earth's biological diversity in a historical context and to determine the relationships among organisms. Central to this mission are systematics collections, collections of specimens arranged taxonomically so that they can be used for comparative purposes. These collections are required for research in a number of fields. Although fewer than 100 research museums have significant permanent research programs, they represent the bulk of research efforts in biological diversity and related fields and are active in training students. Many universities have arrangements with research museums to allow graduate students and others to pursue degrees in systematics, conservation biology, and related fields using resources of the museums.

Because they are the repositories of collections of specimens often not found elsewhere, research museums have a unique responsibility to maintain specimens, old and new, and make them available to researchers and students for study. Research museums have indicated they have serious difficulties in raising funds for collections and research space which are not often visible to the public. They have identified repair and renovation needs which are not being met with available resources.

Specific Research Facility Needs

Research in many fields increasingly requires facilities that have the following features:

- mechanical systems that can maintain air changes, temperature, and humidity under a variety of conditions within a particular building where the research may involve working with hazardous biological or radioactive materials or may require ultra clean conditions that eliminate dust or other materials that can impact the environment or the research experiments
- electrical systems that provide vast quantities of stable voltage and current at different levels
- necessary and acceptable plumbing systems for access to water and gases and disposal of wastes
- vibration-free spaces, often shielded from electromagnetic forces, and building structures that have the capacity to carry heavy floor loads
- compliance with safety and environmental code requirements as well as various societal requirements (e.g., accessibility for the physically impaired)
- building space design responsive to human interaction and personal security

- facilities capable of reliably sustaining research activities 24 hours a day, seven days a week in circumstances where high penalties are associated with system failure.

APPA/NACUBO Study

The NSF survey findings are similar to those in *The Decaying American Campus: A Ticking Time Bomb*, a 1989 report by the Association of Physical Plant Administrators of Universities and Colleges (APPA) and the National Association of College and University Business Officers (NACUBO). The APPA/NACUBO study, which includes all academic facilities, indicates that most institutions that have a master facilities plan include plans for new construction, but many do not include renewal/replacement in their plan. The study also found that in 1987 the average institution had 51,000 gross square feet of new facilities space under construction while only 27,000 gross square feet of existing facility space was under renovation. Repairs and renovations considered "urgent" by the institutions responding to the APPA/NACUBO survey would have an approximate total cost of $20 billion. The deferral rate reported by the APPA/NACUBO report was similar to that in the SRS survey: in 1988 for every $1.00 spent for needed maintenance, $4.00 was deferred.

These studies, surveys, and other assessments indicate that our academic research facilities have deteriorated and that there is a need to repair, renovate, and modernize existing facilities as well as to expand and build additional research facilities. Major factors identified by institutions as contributing to the research facilities issue include the following: (a) the rapid changes and advancements in science and research; (b) the high cost of research facilities and support space; (c) the impact of regulatory and other requirements on building standards; (d) the cost of upgrading older buildings and facilities many of which are structurally inflexible and obsolete; and (e) chronic underfunding due to more visible or higher priorities. Institutions have indicated that existing research facilities are often inadequate or obsolete and frequently do not meet current health, safety, and other standards. Further, they report there is a growing need for additional research space. The data in these surveys provides estimates of overall facilities patterns. Although reports of the condition of facilities and the adequacy of selected aspects of facilities may be, by their very nature, subjective, they do capture an overall picture of the current status of facilities. However, they were not intended to assess the impact of the facilities on the quality of research being conducted at academic institutions.

IV. ROLES AND FUNDING SOURCES

Several key groups have an interest, stake, and role in supporting and investing in academic research facilities. These groups include: academic institutions, state and local governments, the federal government, private industry, foundations, and individuals.

Maintaining the nation's research facilities in adequate, if not state-of-the-art, condition is important to all groups involved in scientific and engineering research and training. The scope of the facilities problem is so large that neither institutions, state and local government, the federal government, industry nor private sources can solve the problem alone. The long-range solution is multi-faceted and requires commitments from all involved parties.

These groups must share in the responsibility for research facilities and increase their efforts if significant progress is to be made in meeting facility needs. Each has a different interest and role to play, yet all must work cooperatively in order to leverage their efforts and maximize the effectiveness of applying limited resources to strengthen our research facilities.

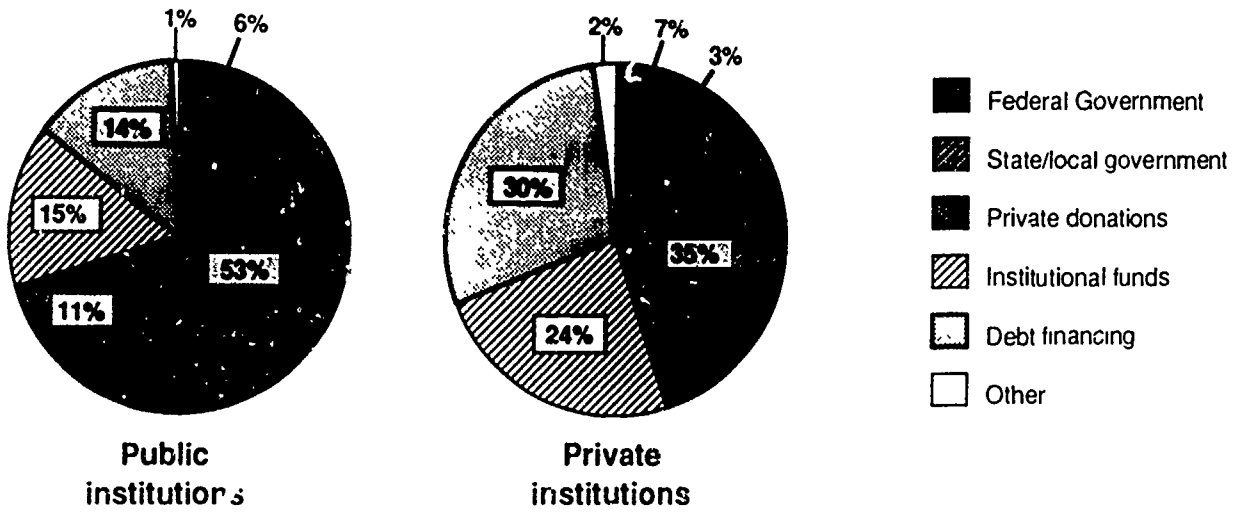
Given the roles and vested interest in and benefits from the research enterprise, all parties should increase their efforts and assume greater responsibilities in supporting research facilities.

Institutions

Institutions of higher education have an obvious stake in the condition of their own research facilities because of their responsibility for research and for educating undergraduate and graduate students in science and engineering. Modern facilities attract better researchers and the overall quality of research and research training is improved.

Not surprisingly, sources of funding for facilities projects vary depending upon whether the institution is public or private. Public institutions receive more than half (53 percent) of their funding for facilities from state and local governments; they receive only 6 percent from the federal government. Private institutions receive 89 percent of their funding for facilities from a combination of private donations, debt financing, and institutional funds; they receive only 7 percent from the federal government. Sources of funding for facilities at HBCUs are significantly different, with the federal government contributing 35 percent of funding for construction (state and local governments provide 52 percent) and 54 percent of the funding for repair/renovation (state and local governments provide 37 percent).

Sources of funds for construction and repair/renovation of research facilities, 1986-89



Note: Percents may not sum to 100 because of rounding
Source: National Science Foundation, SRS

Institutions can raise funds internally through endowment, tuition, and other sources. Since debt is an obligation incurred on the future income of the institution, debt financing can also be considered institutional funding. Private universities rely heavily on tax-exempt bond financing (about 30 percent of their science and engineering research facility construction funds come from the financial markets), while public institutions use this mechanism for about 14 percent of their science and engineering facilities. Taxable issues are used only in very small amounts. It appears that debt financing, particularly for public institutions, is a funding mechanism that could be utilized more.

Institutions' role in facilities financing should go beyond exploring funding sources for new facilities or repair and renovation as needs arise. They bear the responsibility of developing workable plans for financing not only the routine maintenance of their physical plant, but the repair or replacement of facilities.

Institutions should continue to consider cooperative efforts involving consolidating facilities and resources, either between departments within an institution or between institutions themselves. This might be particularly effective if more collaborative activities were undertaken between research universities and smaller undergraduate institutions and research museums.

In addition, institutions should:

- identify the nature, extent, and impact of their facilities needs
- prioritize these needs, not only among facilities, but also among competing needs or opportunities

- obtain the strongest possible consensus within the community on such needs and priorities
- develop more effective strategies and mechanisms for facilities planning, budgeting, maintenance, management, and utilization for both the short and long term
- effectively utilize debt financing and other funding sources and strategies.

State and Local Governments

State and local governments have an interest in the condition of research facilities at both public and private institutions of higher education and related research organizations in their jurisdictions. These institutions are responsible for educating and training researchers who contribute to the state and regional economic well-being. Furthermore, the research base in a state is often directly tied to its industry profile, its natural and developed resources, its goals and interests, and specialized expertise. State and local governments provide 53 percent of all direct funds for facilities for public institutions and only 3 percent of the funds for private institutions. State appropriations to public institutions are funded by tax revenues of the state as well as by some federal block grant programs or pass-throughs. However, state appropriations also include funds raised from general obligation bonds issued by the state. There is no accurate measure of state-issued, general obligation, tax-free bonds that are used for higher education facilities.

States may also employ other mechanisms to encourage funding of facilities, including loans, guaranteed loans, and other subsidies and incentives. Given the growing interest in science and technology activities that relate to economic growth, states may become increasingly responsive to well-articulated justifications for the need to improve academic research facilities as well as federal initiatives in this area. Some states are already taking steps or special initiatives to help address the problem. The states should consider setting aside additional resources, developing special funding authorities, and other funding mechanisms that may be available to them.

State and local governments should recognize the facilities needs and determine their priority. Additional ways to increase their support for academic research facilities should be explored. They can encourage partnerships and consortia, develop joint programs and initiatives, and consider additional incentives to encourage support for facilities.

The Federal Government

The federal government's interest is based on the fact that facilities are integral to the vitality of the nation's research enterprise. There is also a growing realization that the nation's economic well-being and competitiveness are based on continued leadership in science and technology and broadening the research base. The federal government, each year, provides about 6 percent of all the funds for new construction of academic research facilities in science and engineering. For repairs and renovation, the federal government provides only about 4 percent of all funds. Some of these funds represent agency mission research needs, either through direct grant awards or through direct Congressional actions.

The federal government, as a primary sponsor of basic research, as a sound investment strategy to help maintain and strengthen our nation's scientific and technical base, and as a long-term policy to increase our productivity and improve our nation's economic competitiveness, must take a more active and prominent role in supporting and encouraging others to support research facilities. The federal government should examine both short- and long-term efforts and mechanisms to assist in facilities financing. Specifically, the federal government should consider the following:

- a greater leadership role in developing policies and strategies that encourage a systematic and balanced approach to research facilities
- support for research facilities through a combination of direct funding of appropriately leveraged facility support programs in the various agencies and indirect funding through changes in the cost principles
- tax and other incentives to encourage others to support research facilities

Industry, Foundations, Individuals

Private industry has an interest in the condition of academic research facilities because it directly benefits from the education, experience, and research training received by undergraduate and graduate students utilizing such facilities who work in industry. Industry often contracts for or sponsors research projects and related activities at academic institutions which require access to and utilization of modern and state-of-the-art facilities. Industry support of education in the U.S. is approximately $2 billion annually. About three quarters of those funds go to colleges and universities. The average corporate capital contribution to academia has been well below 10 percent of all corporate giving and can be estimated at less than $200 million annually. It is unlikely that a significant amount has been donated for repairs and renovations.

Significant tax incentives exist for corporate donations of scientific equipment, and the research tax credit has a provision that encourages corporate contracts for the conduct of basic research. Facilities and equipment expenditures under those contracts may qualify for the tax credit. A major incentive for individuals and industry to donate property and funds to nonprofit organizations stems from the tax deduction for qualifying gifts to qualifying organizations. Private universities receive over one-third of their science and engineering research facility funds from private sources (individuals and industry), while public institutions get only about 11 percent from such donations. Some wealthy individuals donate large amounts for new construction; however, relatively small amounts are for repairs and renovation. Donors seldom receive recognition or benefit from having their name on new heating units or other "invisible" but still tangible long-term assets.

Industry should give greater recognition to the value of and need to support academic research facilities and strengthen its overall commitment in this area. It should provide support for facilities through indirect costs when it funds research. In addition, it should consider and identify what actions it or others might take to increase industry's incentive to provide facility support. Industry should consider increasing its cooperative partnerships with universities to help support facilities and the research and research training being performed. Additional tax or other incentives may be necessary to encourage greater industry support and assistance for research facilities.

Foundations donated over $1.6 billion to colleges and universities in 1988. However very little of it was for new construction, let alone the repair and renovation of new facilities; most of it went to research, and a good part of the research grants was in the form of "seed" money. Three foundations that routinely provide construction funds are the Kresge Foundation, the Olin Foundation, and Pew Charitable Trusts. In fact, the Kresge Foundation has recently established a new Science Initiative which is a challenge grant program to upgrade and endow research equipment and facilities.

Private foundations should consider additional programs and initiatives for supporting academic research facilities and enter into joint or cooperative programs among themselves and with others to leverage their support. They should also consider joint Foundation initiatives and cooperative grant programs with the federal government to help leverage these sources of funds.

Institutions, state and local governments, the federal government, private industry, and others must consider and determine where research facilities needs and priorities fit in relation to other priorities, needs, and opportunities. Research facilities support will have to continue to compete for funding resources against other high priority programs. It will then be necessary to utilize the various funding mechanisms creatively and change them where appropriate.

V. SUPPORT MECHANISMS

There are a number of support or funding mechanisms, many of which have different purposes and impacts. Various support mechanisms which need to be considered by each group, as appropriate, include the following:

- direct facility awards
- the cost reimbursement principles for research project awards
- interest subsidies
- loans and loan guarantees
- other debt financing
- various tax incentives such as tax-exempt bonds, R&D tax credits, gifts/donations, etc.

Direct Facility Awards

Basically, these awards occur either by direct Congressional action or through competitive grant programs. Direct Congressional action, or earmarking, is an approach increasingly used by Congress to designate a certain portion of an agency's appropriation for a specific project. Essentially political in nature, this approach often lacks competitive scientific, technical merit reviews or comparative analyses based on need or impact. Substantial matching or cost sharing by the recipient or leveraging of the public funds may not be required.

Competitive grants, in which awards are made based on merit review and relative rankings, are based on published evaluation criteria. This is a more generally accepted approach. Since most grant programs for facilities require a substantial matching commitment, federal funding is leveraged so that others must also determine priorities and make financial commitments to facility financing. As previously indicated, this approach has been used by a number of federal agencies to fund both new construction and renovation of facilities.

Parts A and B of Title VII of the Higher Education Act provide for direct grants to undergraduate and graduate institutions for repair or renovation of academic facilities. There is no specific priority for research facilities. Except for Congressional earmarking there has been no major funding under these programs in recent years. Increased funding under these programs would aid instructional and other facilities.

Cost Reimbursement Principles

GENERAL

OMB Circulars A-21 and A-122 contain federal cost principles. These are applicable to all agencies' research project awards to academic and nonprofit institutions. They provide a vehicle through which the federal government assists institutions with the cost of constructing, renovating, and maintaining research facilities. Facility support using the cost principles may be provided through

allowing certain direct costs of individual projects to be charged to federal awards or through allowing certain costs to be included in the pool of indirect costs ultimately charged to individual awards on the basis of an indirect cost rate. Approaches using the cost principles have the advantage of being built into the system and applicable to all federal agencies. This approach would provide funds for those institutions that do much of the nation's basic research.

DIRECT COSTS

The cost principles and research project awards can and occasionally do permit costs of necessary alteration and renovation of research space (which is used for the specific project) to be charged as direct costs to the project. To the extent this occurs, individual research programs pay for the cost of construction and related facility improvements directly associated with the project.

In addition, it has been suggested that consideration be given to permitting each project award to carry a direct facilities surcharge or research capacity allowance specifically directed toward facility support or other capital expenditures. This fixed percentage allowance of the direct costs of a project could be shown as a separate line item of the award budget. The allowance could be restricted to the department or discipline generating the award and used to help defray costs of maintenance, operations, or replacement of its research facilities. This approach would spread the costs of research facilities support among the various federal agencies which fund research and keep the funding in areas or disciplines being supported by the agencies. It would not require a separate facilities program and associated administrative costs within each agency.

INDIRECT COSTS

Indirect cost recovery under project awards is another important method to assist institutions with the cost of research facilities. Specifically, charges are permitted for depreciation, use allowance, and interest expense for facilities. A number of facility-related changes in the indirect cost area have been suggested in various studies and reports and include the following:

- changing the use allowance for facilities and equipment to a basis that recognizes a more realistic useful life (e.g., useful life of buildings and facilities of 20 years rather than 50 years; useful life of equipment and instrumentation of 5 to 10 years rather than 15 years)

- considering policies which would liberalize depreciation on new facilities, such as accelerated depreciation

- splitting the indirect cost rate into two rates: one for facilities and equipment components (including operation, maintenance, and depreciation expenses) and one for all other indirect cost elements. This would help identify more clearly the costs associated with research facilities and equipment but in and of itself would not increase indirect costs

- permitting reasonable conversion from the use allowance to depreciation without penalizing the institution

- permitting some systematic recovery method, currently not allowed, for future repair or replacement of facilities and equipment acquired with federal funds

- requiring institutions to dedicate or set-aside the incremental recovery (or equivalent increases) resulting from any of the above changes to maintaining, repairing, or replacing facilities and equipment. Currently, indirect cost recoveries at most institutions go directly to a general fund.

- other changes that have been suggested include: permitting institutions to treat the "shell" of a building separately from its infrastructure in applying use allowances; permitting an institution to use a reasonable combination of depreciation or use allowance rather than using one method exclusively; permitting interest costs on all facility and equipment acquisition debt to be included in indirect costs; permitting the use of replacement cost rather than acquisition cost as the basis for recovering costs of facilities and equipment; and restricting any changes to new facilities and renovations.

Some changes may require more detailed analysis and the development of more definitive data on the potential costs and implications. In the case of reducing the useful life of facilities and equipment as the basis for a use allowance, it has been estimated that the incremental cost per year for educational institutions would be on the order of $200-300 million.

Adoption of these types of changes would increase indirect cost charges to the government but would provide a more systematic, sustained approach to funding facilities and equipment, spread the costs among all research-funding agencies, as well as reduce the need for separate direct facility grant programs in the long term for those institutions that receive substantial federal funds for research.

Non-federal organizations may or may not reimburse institutions for indirect costs, depending on the specifics of the research contract and other relationships between the organizations. In particular, foundations that provide "seed money" for research may not reimburse the institution for indirect costs. State governments that fund public universities also may not specifically reimburse for indirect costs on their own research awards to in-state institutions because the state government is the prime funder of the construction and maintenance of the facilities. To the extent these other funding sources do not pay indirect costs, they are not providing indirect support for facilities, equipment, and other infrastructure expenses.

As previously noted, the reimbursement of indirect costs is associated with the institution's individual research project awards, thus changes in indirect cost recoveries would only benefit those which receive research funds. This mechanism and these changes would not significantly help the historically underfunded institutions where direct competitive facility grants may be most appropriate.

Interest Subsidies

Another type of mechanism is a grant for the payment of interest costs on debt. For example, Part D of Title VII of the Higher Education Act provides for subsidizing debt on construction of college facilities. This program, which has not subsidized new loans since 1973, was designed to supplement efforts from private industry. This type of mechanism could be particularly helpful to institutions with poor credit ratings and high interest charges on debt.

The direct payment of a subsidy for interest is also an alternative to the tax-exempt financing mechanism. If the tax-exempt status of qualifying debt issues was eliminated as a financing mechanism, the government could substitute a program of interest subsidy payments directly to the affected institutions to compensate for the higher interest payments they would have to make on taxable issues.

Loans and Loan Guarantees

Governmental loan programs can provide up-front funds at below-market interest rates. For example, Part F of Title VII of the Higher Education Act authorize loans at 5.5 percent interest, repayable within 50 years, for construction, reconstruction, or renovation of college housing and academic facilities. Research facilities are not specifically targeted. These loans are financed by annual borrowing from Treasury and by annual appropriations to finance the interest differential between Treasury rates and the 5.5 percent charged institutions. The program made $62 million in new loans in 1988 and is authorized to make $30 million in new loans in 1989.

A governmental organization can also provide incentives and encourage financing of facilities by others through guaranteeing loans. A guaranteed loan is one made by a private financial institution with repayment guaranteed by a governmental organization. The guarantee represents a commitment by the agency; however, the agency does not have to have appropriations in advance to cover any default. Guaranteed loans usually are issued at below market rates because of their lower credit risk.

Part E of Title VII of the Higher Education Act established and chartered, as a private, for-profit corporation, the College Construction Loan Insurance Association (Connie Lee). Its purpose is to guarantee, insure, and reinsure debt instruments for higher education facilities, but it has only recently begun operating. There is no priority for research facilities. At the present time Connie Lee is in business as a reinsurance company and is insuring higher education facilities currently on the books of the major primary bond insurance companies. This permits the industry to underwrite additional higher education bond issues.

Tax-Exempt Bonds

Tax-exempt bonds are those issued by governmental organizations, the interest payments of which are exempt from federal, and sometimes, state income tax. These bonds are of two general types:

general obligation and revenue. General obligation bonds are backed by the taxing power of the governmental entity; revenue bonds are dependent on the income generated from the facility for which the proceeds of the bond are used. Revenue bonds tend to have higher interest payments than general obligation bonds because of the higher risk associated with specific projects. Tax-exempt bonds can be issued below market interest rates. They are, therefore, less expensive than similar taxable issues. The difference between yields on taxable and tax-exempt bonds reflects the current federal and state tax rates as well as the actual supply and demand for the bonds.
Under Section 145 of the Internal Revenue Code of 1986 (26 U.S.C. 145), private nonprofit institutions cannot have over $150 million in outstanding tax-exempt debt at any one time. At present, a number of the major private institutions have reached or are approaching the $150 million cap. This is becoming a significant funding limitation for some of the major research universities.

Pooling the needs of small institutions and small financing needs of several institutions is an effective way of lowering the cost of debt financing. Significant economies of scale can be realized by spreading the administrative, legal, and printing costs associated with any tax-exempt issue among a number of institutions. Additionally, the interest rate may be lower for a pooled fund since the ability to cover a default is spread over a number of institutions. However, most pooled funds of tax-exempt bonds have been eliminated as a result of the 1986 tax law that prohibited "blind pools." However, "dedicated pools" are a new mechanism that avoids the tax restriction.

Other Tax Incentives

The R&D tax credit mentioned previously is a relatively new (1981) provision (26 U.S.C. 41) that enables private companies to reduce their taxes by a percentage of their incremental R&D expenditures. The rules are complex. With Congressional renewal, the provision has been significantly modified. The current version, which was due to expire at the end of 1988, has now been extended to the end of 1989. Various bills are before Congress to make it permanent, but they have not as yet been passed. Of special interest to academic institutions is the feature of the research tax credit that gives special incentives for corporations to fund basic research (26 U.S.C. 41(e)).

The deduction that a donor can take on contributions to qualifying institutions is a very important tax incentive for stimulating all types of gifts. It is of particular importance to private universities, which receive over one-third of all of their funds for facilities from donations. Two provisions of the 1986 Tax Reform Act have led to reductions in donations. First, the marginal tax rates have been cut. The effect is that each dollar contributed now represents less of a tax break to the donor than when the marginal tax rates were higher. Second, new rules act to restrict the tax value of donations of appreciated property.

Other Debt Financing

Although not limited by law, many institutions' borrowing power is limited by their ability to repay loans. Those that are tuition dependent and whose prospects for growth are not optimistic may effectively be capped by the financial community's unwillingness to underwrite loan issues at any

reasonable interest rate. Loan guarantees by a governmental agency or a government-sponsored enterprise (e.g., Connie Lee) or interest subsidies may be useful in permitting certain institutions to reasonably access the financial markets.

Only a combination of support mechanisms, balanced appropriately, can effectively meet such large, costly facilities needs. Such mechanisms must provide immediate assistance as well as provide continuing systematic support to keep facilities up to date and minimize future problems.

SOURCES OF FUNDS AND FUNDING MECHANISMS FOR ACADEMIC RESEARCH FACILITIES

INSTITUTION	STATE AND LOCAL GOVERNMENT	FEDERAL GOVERNMENT	INDUSTRY, FOUNDATIONS, PRIVATE INDIVIDUALS
o Tuition Revenues o Endowment Income o Other Operating Income o Debt Financing -- Tax-exempt Bonds -- Taxable Bonds, Notes, Commercial Paper o Direct Transfers from Other Sources	Direct Transfers. o State Appropriations (Mainly to Public Institutions) o Other (see Federal Direct Transfers for examples) Incentives. o Authorities for Issuing Tax-exempt Bonds o Other Authorities o State Tax Exemptions o Pools of Funds Available for Special Loans	Direct Transfers. o Direct Facility Grants o Loans o Research Project Awards -- Direct Cost Reimbursements -- Indirect Cost Reimbursements o Interest Subsidies Incentives. o Tax Exemption for Bonds o Tax Exemption for Gifts o Special Tax Rules for R&D and Gifts of Scientific Equipment o Corporations for Bond Insurance and Reinsurance o Guaranteed Loans	Direct Transfers: o Gifts and Donations of Funds and Property o Direct Facility Grants o Research Project Awards

A combination of these funding mechanisms must be used to address the repair, renovation, and construction of research facilities since the impact of each mechanism is different and some mechanisms are not applicable to all institutions. A number of steps should be considered, including:

- establishing and funding facility programs aimed at repair, renovation, or construction of research-related facilities

- targeting existing authorized loan, loan guarantee, and other debt financing programs on research facility needs
- modifying the A-21 and A-122 cost principles with regard to use allowance, depreciation, and other facility-related costs
- removing or increasing the $150 million cap on tax-exempt bonds
- providing access to normal financial markets for those institutions that cannot qualify through special interest subsidies or other creative financing methods
- modifying tax laws to provide greater incentives for pooling of tax-exempt bond issues and increased corporate donations and funding of research facilities and equipment
- developing and providing information about the markets, debt financing and available resources to institutions that do not normally access capital markets.
- developing an analytical model of the likely impact of various policy and investment strategies, particularly when used in combination with each other.

VI. RECENT LEGISLATIVE INITIATIVES

During the 1980s a number of bills were introduced in Congress in an effort to address the growing facilities needs of academic institutions. The University Research Capacity Restoration Act of 1983, introduced by Senator Danforth (R-MO), was intended to be a 5-year plan to restore the research capacity of universities by increasing the research programs at NASA, NIH, the Departments of Agriculture, Energy, and Defense, and NSF. At NSF alone, this bill, if passed, would have provided $75 million per year to NSF for research laboratory rehabilitation. Representative Fuqua (D-FL) introduced the University Research Facilities Revitalization Act of 1985, the goal of which was to establish a 10-year program aimed at rebuilding and modernizing scientific research facilities at colleges and universities. Under this program a target of 10 percent of the funds of six agencies (NSF, HHS, DOD, DOE, NASA, and USDA) would be set aside for a matching grant program for research facilities. The total federal share that would have been provided under this program was estimated at $5 billion. This bill also called for NSF to conduct a complete assessment of university and college research facility needs. The 1986 NSF Authorization Act repeated the requirement, calling for a systematic, biennial collection of data on research facilities needs.

During the mid 1980s efforts to fund academic facilities were increasingly directed toward specific projects at individual institutions, and Congressional appropriations, particularly for the Departments of Energy, Defense, and Agriculture, were frequently earmarked for specific projects.

In 1987 both Senator Dodd (D-CT) and Representative Roe (D-NJ) introduced different versions of the University Research Facilities Revitalization Act of 1987, the purpose of which was to assist in modernizing and revitalizing the nation's research facilities. In 1988 the Trade Bill was enacted and provided for a College and University Research Facilities and Instrumentation Modernization Program. Ultimately this legislation was superseded by Title II of the NSF Authorization Act of 1988, the Academic Research Facilities Modernization Act (102 Stat. 2873, 42 U.S.C. 1862a-1862d), which was signed into law on October 31, 1988.

The Academic Research Facilities Modernization Act of 1988 maintains that the Nation's capacity to conduct high quality research and education and to maintain its competitive position in science, engineering, and technology is threatened because many national research and related education programs are hindered by obsolete research facilities and insufficient resources to repair, renovate, or replace them.

This Act stated that "a national effort to spur reinvestment in research facilities is needed, and national, State, and local policies and cooperative programs are required that will yield maximum return on the investment of scarce national resources and sustain a commitment to excellence in research and education." It also stated that "the National Science Foundation, as part of its responsibility for maintaining the vitality of the Nation's academic research, and in partnership with the States, industry, and universities and colleges, must assist in enhancing the historic linkages between Federal investment in academic research and training and investment in the research capital base by reinvesting in the capital facilities which modern research and education programs require."

Accordingly, the purpose of the Academic Research Facilities Modernization Act is "to assist in modernizing and revitalizing the Nation's research facilities at institutions of higher education, independent nonprofit research institutions and research museums, and consortia thereof, through capital investment."

The Act provides authority for the National Science Foundation and its Director to establish and carry out an Academic Research Facilities Modernization Program. The Act specifically calls for a competitive grant program for the repair, renovation, and, in exceptional cases, replacement of academic research facilities at institutions of higher education, nonprofit research institutions, research museums, and consortia thereof. In addition, in order to implement a facilities program, NSF should (a) establish procedures for the program; (b) conduct comprehensive planning activities, including surveys of research facility needs and other information-gathering activities necessary to develop and implement the program; (c) publish the proposed program guidelines in the *Federal Register* for public review and comment; (d) develop a comprehensive plan after gathering appropriate information and considering comments on the proposed guidelines; (e) prepare and submit a report to the Congress; (f) publish the final program guidelines in the *Federal Register*; and (g) consult with the Secretary of Education and the heads of other related agencies. Funds were authorized for this program for five years; however, no funds have been appropriated or budgeted.

ACADEMIC RESEARCH FACILITIES MODERNIZATION PROGRAM FUNDING

YEAR	*AUTHORIZED*	*APPROPRIATED*
FY 89	$ 80 M	NO FY89 FUNDS MAY BE MADE AVAILABLE FOR THIS PROGRAM
FY 90	$125 M	NONE BUDGETED
FY 91	$187.5 M	---
FY 92	$250 M	---
FY 93	$250 M	---

VII. ACADEMIC RESEARCH FACILITIES MODERNIZATION PROGRAM

NSF Actions

In recognition of the growing interest regarding research facilities and also to respond to the Academic Research Facilities Modernization Act, on December 15, 1988, NSF Director Erich Bloch established the Research Facilities Office (RFO).

In addition to developing NSF's plan for the Academic Research Facilities Modernization Program, RFO is also responsible for providing leadership, coordination, and oversight for NSF research facility support activities, assessing current research facility capacity and future needs, developing initiatives and mechanisms to support research facilities, and helping delineate the roles of those investing in and supporting research facilities.

To get input from various sources on current facilities problems and the program's structure and ultimate design, the staff from RFO met with Congressional staff, representatives from OMB and various Executive departments and agencies, and officials of eligible organizations, as well as of associations representing eligible organizations. From February 23 to March 9, RFO staff conducted public regional meetings in Atlanta, Boston, Chicago, Denver, Houston, and San Diego to provide information about the legislation and to solicit comments on the program. These meetings, attended by approximately 500 individuals, also provided an opportunity for NSF officials to conduct site visits at a variety of facilities to see and learn firsthand the condition of a cross section of facilities and the needs of different types of organizations. Approximately 100 different laboratory facilities in 26 different institutions were visited.

On April 20, 1989, draft guidelines based on input from the various meetings were published in the *Federal Register* for a 30-day comment period. Comments from 15 groups and associations representing over 1200 institutions were received; in addition, over 50 comments from individuals and organizations were received. All comments were carefully considered in developing the revised guidelines included in this report. (Summary information on the comments is included in Appendix B.)

Program Summary

The Academic Research Facilities Modernization Program is a competitive grant program with two primary goals: to promote the modernization of graduate and undergraduate academic science and engineering research laboratories and related facilities at eligible institutions; and to assist those academic institutions that historically have received relatively few federal research and development funds to improve their academic science and engineering infrastructures and broaden and strengthen the nation's science and engineering base. The program is carried out through grant awards for the

repair, renovation, or, in exceptional cases, replacement of facilities used for research and research training.

Open to institutions of higher education, independent nonprofit research institutions, research museums, and consortia thereof, the program allows eligible organizations to submit one proposal per annual cycle. In addition, an eligible organization may participate in one consortium proposal. Proposals must be either for the renovation of one research facility (single or multi-disciplinary) or for the renovation of facilities within one discipline. Facilities proposed for renovation are limited to those used for any field of science, mathematics and engineering ordinarily supported by the National Science Foundation, including astronomy, atmospheric sciences, biological and behavioral sciences, chemistry, computer sciences, earth sciences, engineering, information science, materials research, mathematical sciences, oceanography, physics, and social sciences. The research activities being conducted in the facilities need not be supported by NSF or the federal government. Organizations are expected to cost share (from non-federal sources) a minimum of 50 percent of the total project costs.

The proposal submission and review process is conducted in two phases, with organizations submitting an abbreviated Phase I proposal without detailed specifications or construction plans. After a review of Phase I proposals, organizations that submit the most competitive Phase I proposals will be invited to submit more detailed Phase II proposals.

For the purposes of competition, review, evaluation, and final rankings in both Phase I and Phase II, eligible organizations are divided into three groups based on the average amount of NSF research and development funds received by the proposing organization in the previous three fiscal years. Group I organizations have received an average of $2 million or more per year; Group II organizations have received at least $400,000 but less than $2 million per year; Group III organizations have received less than $400,000 per year. (See Appendix A for listing of institutions by groups) Proposals will be evaluated on the basis of research merit, facility need, project impacts, and plans and funding. In addition, the Foundation will consider the following in making final award decisions: (a) equitable distribution of funds among organizations of different sizes and geographic locations; (b) the extent to which an organization has received awards for the repair, renovation, construction, or replacement of academic facilities from any other federal funding source within the 5-year period immediately preceding the application; and (c) ensure that at least 12 percent of the funds available under the program will go to historically Black colleges and universities and other institutions with substantial minority enrollment. Awards are expected to range from $100,000 to $7 million, and total awards under this program to any eligible organization shall not exceed $7 million during any five-year period.

The revised program guidelines are included as Appendix A. However, it must be noted that there are many issues concerning roles and support mechanisms that can impact the level of direct federal funding. These issues, many of which are listed in this report, need to be further explored and the program and guidelines revised accordingly in the future.

Program Features

TWO-PHASE PROPOSAL PROCESS

This program includes a number of key features. Its two-phase proposal process eliminates unnecessary effort, paperwork, and expense on the part of proposers. Phase I proposals are more abbreviated than standard Foundation proposals, and at this stage proposers are not required to submit detailed construction plans or schematics. This helps reduce time, effort, and expense in the initial proposal preparation process, encourages more organizations to develop and submit proposals, and allows a more expedient review to determine the most competitive proposals in each of the three groups. After the Foundation's evaluation of the Phase I proposals, a proposing organization either is invited to submit a Phase II proposal (those considered to be most competitive for further evaluation and funding) or is sent a declination letter. Only Phase II proposals are required to have additional details, drawings, specifications, etc., and only one copy of drawings and specifications is required. This approach should assist institutions with limited resources for proposal development and planning.

ONE PROPOSAL PER INSTITUTION

The limit of one proposal per annual cycle encourages organizations to assess and prioritize their own needs and resources, and where necessary, to begin at least preliminary consideration and planning about future needs. Given the sheer numbers of organizations eligible for this program, the two-phase process and limitation on numbers of proposals also makes evaluation and review more manageable. A slight variation to the limitation is permitted in that an eligible organization, in addition to submitting its own proposal, may participate in one consortium proposal. This may encourage institutions to "link up" with another institution (or institutions) in order to share or consolidate research facilities and other research resources. This collaborative, cooperative approach hopefully will also encourage formal interaction between large research institutions and smaller undergraduate institutions or historically underfunded institutions, or between academic institutions and research museums, and assist in broadening the research base and strengthening the nation's research enterprise.

ELIGIBLE FACILITIES

Although the Academic Research Facilities Modernization Act stipulates that awards should be made for renovation of facilities "primarily devoted to research," the program guidelines have broadened that coverage to make all facilities used for research and research training eligible for funding based on the percentage (space or time) that the facility is used for research or research training. By not limiting the program to facilities devoted solely or primarily to research, the program helps address the needs of many undergraduate and other institutions which, although they have a research component, often do not have facilities devoted solely or even primarily to research or research training. This broadened approach and the fact that proposals may be either for the renovation of one research facility (single or multi-disciplinary) or for the renovation of facilities within one discipline makes it possible for an institution to renovate an individual research

laboratory, a floor of a building, an entire building, or to renovate and possibly consolidate research laboratories within one discipline.

MATCHING REQUIREMENT

The program's cost-sharing requirement for all organizations is a minimum of 50 percent from non-federal sources. The effects of this requirement are that: (a) limited program monies can be used to fund more organizations and facilities; (b) it requires the proposing organization's serious financial commitment to the project; and (c) it encourages organizations to leverage the Federal funds and raise additional funding from a variety of sources including state and local governments, industry, and private foundations. This program allows a proposer to apply for and receive an NSF award with a commitment from a non-federal source as cost sharing; actual receipt of cost-shared funds is not necessary to receive the NSF award, but no NSF funds may be expended until the cost-shared funds are received by the awardee. This flexibility allows the awardee to use federal funds as leverage while ensuring that the matching requirement is met before federal funds are expended. This is particularly important since some state governments and other organizations have programs to match federal or other awards, but often make the release of these funds contingent on an institution's having the federal or other funding assured.

COMPETITION WITHIN GROUPS

For the purposes of evaluation, eligible organizations are divided into three groups based on the average annual amount of NSF research and development funds received by the proposing organization in the previous three fiscal years (three years are used to eliminate one-year funding anomalies). This grouping, which includes all eligible organizations (including graduate and undergraduate institutions, minority institutions, research museums, and nonprofit research institutions), makes it possible for organizations to compete against other organizations which are similar in terms of their competitiveness in receipt of research and development funds from the Foundation. A percentage range of program funds will be targeted for each group. Group I organizations (which includes those with the highest average funding levels) are expected to receive from 45 percent to 55 percent of total program funds; Group II and Group III organizations (with lower average funding levels) are each expected to receive from 20 percent to 30 percent of total program funds. This approach helps ensure that major research institutions, as well as emerging, developing, and historically underfunded institutions (including other doctorate-granting institutions, undergraduate institutions, small liberal arts colleges, research museums, and others) have an opportunity to receive significant funding under the program.

AWARD SIZE

Awards are expected to range from $100,000 to $7 million. The $7 million is the upper limit over a 5-year period established by the legislation. A minimum amount is included because repairs or renovation costing under a certain threshold can be funded more efficiently outside this program with institutional or other non-federal resources.

Program Management

NSF management of the Academic Research Facilities Modernization Program will ensure adherence to requirements of the program and its underlying Act.

PROPOSAL EVALUATION

Review of both Phase I and Phase II proposals will be based on four evaluation criteria: research merit, facility need, project impact, and plans and funding. Although proposals are divided into Groups I, II, and III for evaluation purposes, evaluation panels for all three groups will include representatives of different eligible institutions. NSF program officials from the various science and engineering divisions will assist in the review process.

ADDITIONAL CONSIDERATIONS

After the relative ranking in each group has been determined by the review process, additional factors will be considered before final award decisions are made. These include (a) avoiding undue concentration of awards in any geographic area; (b) giving higher priority to those proposers who have received less (or no) federal funds for the repair, renovation, construction, or replacement of academic facilities in the preceding five years; (c) ensuring that awards go to different sized institutions; and (d) ensuring that at least 12 percent of the funds awarded go to historically Black colleges or universities and other institutions of higher education whose enrollment includes a substantial percentage of students who are Black Americans, Hispanic Americans, or Native Americans.

The dollar ranges for the three competitive groups and the target award percentages for each assure that a substantial percentage of program funds will go to institutions of all sizes and types including undergraduate and other institutions that may have been historically underfunded. Significantly, the three-group approach also results in HBCUs and minority institutions being grouped with institutions with whom they are competitive in terms of research funds rather than as a separate set-aside group. This is deemed appropriate since there are also differences in competitiveness among these institutions just as in all institutions. Further, while being assured of at least 12 percent of the program funds, competing within the appropriate group permits these institutions to be eligible for an even larger share of program funds.

POST-AWARD ADMINISTRATION

NSF program management plans for this program include not only the pre-award planning, evaluation, and selection aspects already discussed, but also post-award activities. RFO staff, assisted by staff in the NSF program divisions, will be responsible for post-award administration; the extent of oversight will be dependent on the size and nature of the award and the management plans and capability of the awardee. Appropriate staff will be needed to review the proposals, monitor the progress of projects, and ensure that projects are appropriately managed and completed.

NSF will monitor all awards and provide appropriate assistance or guidance in the following areas: (a) meeting matching fund commitments within the required time period; (b) assuring projects are undertaken as approved; (c) assuring that schedules are reasonably followed; (d) minimizing or resolving management and other problems; and (e) assuring the appropriate use and expenditure pf the federal investment.

APPENDIX A

ACADEMIC RESEARCH FACILITIES MODERNIZATION PROGRAM

PROGRAM GUIDELINES

BACKGROUND

The Academic Research Facilities Modernization Program was established by the National Science Foundation Authorization Act of 1988 (102 Stat. 2873, 42 U.S.C. 1862a-1862d) to assist in modernizing and revitalizing the nation's research facilities. The Program will be carried out through projects which involve the repair, renovation, or, in exceptional cases, replacement of obsolete science and engineering research facilities at eligible organizations.

GOALS

The goals of the Academic Research Facilities Modernization Program are to:

- Promote the modernization of science and engineering research laboratories and related facilities at institutions of higher education (including graduate and undergraduate institutions), independent nonprofit research institutions, research museums, and consortia thereof.

- Assist those academic institutions (including graduate and undergraduate institutions) that historically have received relatively little Federal research and development funds to improve their academic science and engineering infrastructures and broaden and strengthen the nation's science and engineering base.

SCOPE

The purpose of the program is to repair or renovate, or, in exceptional cases, replace scientific or engineering research and research training facilities. It is *not* the intent of the program to fund construction or renovation of: (1) new facilities; (2) facilities not devoted to scientific or engineering research; (3) major, highly specialized research facilities, such as research vessels, airplanes, telescopes, supercomputer centers or Federally Funded Research and Development Centers; or (4) facilities used in fields of research not normally funded by NSF, e.g. biomedical research with disease-related goals; nor is it intended to fund: (5) the operation and maintenance of facilities; or (6) non-fixed laboratory equipment or instrumentation.

DEFINITIONS

The following definitions apply specifically to the Academic Research Facilities Modernization Program and these program guidelines:

Institution: A separate legal and fiscal entity, whether at the central or system level, main campus level, or branch campus level, which can receive awards and which is separately and consistently identified at that level for federal research and development reporting purposes.

Institutions of Higher Education: Institutions legally authorized and accredited at the college level by a nationally recognized accrediting agency to offer and which are offering at least a two-year program of college-level studies leading toward a degree.

Independent Nonprofit Research Institutions: Independent legal entities, other than institutions of higher education, which are generally recognized as separately incorporated, nonprofit, tax exempt organizations, and which conduct research as one of their primary purposes.

Research Museums: Independent nonprofit science museums, zoological parks, aquaria, natural history museums, etc., which conduct research as one of their primary purposes.

Consortia: Recognized groups consisting exclusively of two or more eligible organizations. For the purposes of evaluation and review, a consortium proposal will be identified with the organization where the facility proposed for renovation is located. This does not preclude a third-party organization from submitting a proposal on behalf of two or more eligible organizations.

Research Facilities: The physical plant in which sponsored or non-sponsored research activities (including research training) take place, including related infrastructure and systems (e.g., HVAC and power systems, toxic waste removal systems), and fixed equipment (e.g., clean rooms, fume hoods). This includes all or parts of buildings in which research activities take place some percentage of the time.

Repair: Fixing existing research facilities or otherwise putting them in a usable, adequate and acceptable condition.

Renovation: The renewing, restoring, upgrading, updating, or modernizing of existing research facilities.

Replacement: Taking the place of an existing research facility which is obsolete, beyond repair or for which renovation is not cost-effective. Replacement includes, but is not limited to: razing an existing research facility and constructing one in its place; and relocating or consolidating existing research facilities.

Research Training: Training of individuals (including advanced undergraduates and graduate students) in research techniques where such activities utilize the same facilities as research activities. Research training does not include introductory science or engineering instruction, whether in a classroom or instructional laboratory.

Minority Institutions: Historically Black colleges and universities defined as "part B institutions" by section 322(2) of the Higher Education Act of 1965 (20 U.S.C. 1061(2)) and other institutions whose enrollments are: (a) more than 50 percent of a combination of any of the following groups: Alaskan Native (Eskimo or Aleut), American Indian, Black, Hispanic, Puerto Rican, or Native Pacific Islander; or (b) 20 percent or more of any one of the above eligible minorities.

ELIGIBLE ORGANIZATIONS

Proposals may be submitted by institutions of higher education, independent nonprofit research institutions, research museums, and consortia thereof.

ELIGIBLE FIELDS OF SCIENCE

Proposals will be considered for research facilities used for any field of science, mathematics and engineering ordinarily supported by the National Science Foundation, including astronomy, atmospheric sciences, biological and behavioral sciences, chemistry, computer sciences, earth sciences, engineering, information science, materials research, mathematical sciences, oceanography, physics, and social sciences. The research activities being conducted in these facilities need not be supported by NSF or the federal government.

MATCHING REQUIREMENTS

Organizations must propose matching or cost-sharing at the level of at least 50% of total eligible project costs. The matching or cost-sharing may be from any private or non-Federal public source and may be in cash or in kind, fairly evaluated (see OMB Circular A-110, Attachment E).

PROPOSALS

Proposals must be either for the repair, renovation, or replacement of one facility (single or multi-disciplinary) or for the repair, renovation, or replacement of facilities within one discipline. Proposals are limited to one per eligible organization per proposal cycle. In addition, an eligible organization may participate in one consortium proposal each proposal cycle.

In order to simplify and facilitate proposal preparation and processing and to manage the proposal evaluation process efficiently and effectively, the program is conducted in two phases. This two phase process requires organizations to submit proposals in the first phase without detailed specifications or construction plans. Based on the evaluation criteria below, the Foundation will select from Phase I those organizations with the most competitive Phase I proposals. Those organizations will be invited to submit more detailed Phase II proposals.

PHASE I PROPOSALS

Phase I proposals are directed at describing the current research activities, the research facility problem and the proposed repair, renovation, or replacement project. Phase I proposals should be brief, direct, and concise and address the following:

1. *Research Activities*. Describe the type(s) of research and research training being conducted in the research facility. Identify by number and types (e.g., senior personnel, postdocs, graduate students, undergraduate students) the personnel using the facility for research and research training on a regular basis.

2. *Description of the Research Facility and Needs*. Identify and describe the research facility including its nature, location, size, configuration, purpose, age, condition, and date of last renovation, if any. Discuss the adequacy, limitations, and constraints of the facility. Provide an estimate of the percentages of time or space or combination thereof the facility is used for research and research training.

3. *Project Impacts*. Describe how the repair/renovation/replacement will contribute to improving the organization's research and research training capabilities, improving the academic science and engineering infrastructure, and broadening and strengthening the nation's science and engineering base.

4. *Project and Management Plans*. Describe the scope, extent, type, and nature of the proposed repair/renovation/replacement project. If the project is for replacement, describe why it is necessary and why repair or renovation is inappropriate.

5. *Budget and Funding*. On the budget form provided, indicate the estimated total eligible project costs and the amount and percentage NSF is being asked to fund. (No awards will be made in the Phase I part of the proposal process; awards will follow selection of successful Phase II proposals.) Identify the expected sources of matching funds.

(NOTE: Eligible project costs are those total project costs properly and reasonably allocable to the research facility portion of the project based on the percentage of time or space or combination thereof that the facility is used for research and research training. Eligible project costs may include: A&E services, surveys, testing, inspections, relocation, demolition, removal, construction, fixed equipment, contingencies, and related construction management costs. Indirect costs of the proposing organization, instrumentation costs, and operation and maintenance costs are *not* allowed. Costs incurred prior to the effective date of an award under this program are not eligible project costs.)

Length:

Five (5) single-spaced, standard size, typewritten pages, excluding the cover sheet and budget (no attachments are permitted).

Where To Submit:

Ten (10) copies of the Phase I proposal, one of which bears the original signatures of the Project Director and Authorized Organizational Representative, should be submitted to the following address:

Proposal Processing Unit
Room 233
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550
Attn: Research Facilities/ Phase I Proposal

Deadlines and Timing:

October 1 annually. Approximately two months after the deadline of Phase I proposals, proposers will be notified as to the status of their proposals. Each proposing organization either will be invited to submit a Phase II proposal or its proposal will be declined. (No awards will be made in the Phase I part of the proposal process; awards will follow selection of successful Phase II proposals.)

PHASE II PROPOSALS

Only those who submitted a Phase I proposal and are invited to submit a Phase II proposal are eligible to compete in Phase II. In addition to the *NSF Cover Page*, indicating the proposal number assigned to the Phase I proposal, and the *Table of Contents*, containing page numbers of the major sections of the proposal, Phase II proposals should be self contained, address all of the information required in Phase I in greater detail, as appropriate, and in addition address the following:

1. *Research Activities.* Describe the research activities and projects being conducted in the research facility and sources of support, if any. (The research activities need not be supported by NSF or the federal government.) Identify the senior personnel using the facility for research, and for each provide a brief biographical sketch and list up to five recent publications most relevant to the research being conducted in the research facility.

2. *Description of the Research Facility and Needs.* Describe in detail the adverse impacts the limitations have on the quality of research and research training performed by those who utilize the facility. Indicate the percentage of time or space or combination thereof the facility is used for research and research training and how the percentage was determined.

3. *Project Impacts.* Describe how the upgraded facility will contribute to meeting the research needs of the organization, the region, and the nation. Discuss the potential of the improved facility to contribute to the improvement of the quality, distribution and effectiveness of the nation's research

and research training capabilities. Indicate how the project will attract researchers and students and contribute to increasing the number of students entering the pipeline leading to advanced degrees in science and engineering and improving the quality of their research training.

4. *Project and Management Plans.* Describe the management organization for the conduct of the project. Specify the key manager for the project and relevant experience. State the overall schedule for completion of the project. Provide detailed plans on the proposed repair/renovation/replacement. Explain who will do the work, e.g., in-house personnel or competitive contracting. One set of schematic drawings and an outline specification should be provided as an appendix to the Phase II proposal.

Provide detailed schedules through project completion. Discuss the relationship to other organizational facility plans and activities, the expected use of experts, plans for continuing current research activities during the renovation phase, and other relevant plans. Also indicate plans and funding for the operation/maintenance of the facility.

5. *Budget and Funding.* Provide a detailed budget of total eligible project costs, by categories, on the budget form provided. Specify the expected sources of cost-shared or matching funds (e.g., state appropriations, endowment, debt financing); the plans for obtaining such matching; and when such cost-sharing or matching will be available.

(NOTE: Eligible project costs are those total project costs properly and reasonably allocable to the research facility portion of the project based on the percentage of time or space or combination thereof that the facility is used for research and research training. Eligible project costs may include: A&E services, surveys, testing, inspections, relocation, demolition, removal, construction, fixed equipment, contingencies, and related construction management costs. Indirect costs of the proposing organization, instrumentation costs, and operation and maintenance costs are *not* allowed. Costs incurred prior to the effective date of an award under this program are not eligible project costs.)

6. *Previous Federal Awards.* Identify by agency, purpose, date of award, and amount any federal awards received for the repair, renovation, construction, or replacement of academic facilities in the previous five years.

Length:

Fifteen (15) single-spaced, standard size, typewritten pages, excluding the cover sheet, contents page, and budget. One set of schematic drawings and an outline specification should be provided as an appendix.

Where To Submit:

Fifteen (15) copies of the Phase II proposal, one of which bears the original signatures of the Project Director and Authorized Organizational Representative, should be submitted directly to the Research Facilities Office at the following address:

Research Facilities Office
Room 1240
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550
Attn: Research Facilities/Phase II Proposal

Deadlines and Timing:

April 1 annually. A Phase II proposal must be submitted in the Phase II cycle immediately following submission of the Phase I proposal.

REVIEW AND SELECTION

For the purposes of competition, review, evaluation, and final rankings, Phase I and Phase II proposals will be separated into three different groups based on the average amount of NSF research and development funds received by the proposing organization in the previous three fiscal years (as determined by NSF).

- Group I consists of those organizations that have received an average of $2 million or more;
- Group II consists of those organizations that have received an average of less than $2 million but equal to or greater than $400,000;
- Group III consists of those organizations that have received an average of less than $400,000 and includes those organizations which have not received R&D funds from NSF or the federal government.

(The attached list indicates the organizations in Groups I and II. Organizations not identified in I or II may assume they are in Group III, unless otherwise advised by NSF. Inclusion on the listing does not necessarily mean an organization is eligible under this program; see the section on "Eligible Organizations," above.)

Phase I and Phase II proposals will be evaluated on the basis of merit review. Reviews may include staff reviews, ad hoc mail reviews, panel reviews, and site visits. Outside reviewers will be broadly representative of the various types of eligible organizations.

Evaluation criteria will include:

1. *Research Merit.* Consideration of the existing research (and research training) activities, whether sponsored or non-sponsored and regardless of funding source, and assessment of the impact the facility renovation/ repair/replacement project will have on the overall quality and significance of the current and expected research and research training activities carried out in the facility.

2. *Facility Need.* The adequacy and appropriateness of the facility for current and expected research activities and research training, as well as any demonstrated need based on age and condition analysis.

3. *Project Impacts.* The contribution of the project toward:

a) the future research (including research training) needs of the nation and the research mission of the Foundation;

b) meeting national, regional, and organizational research and related training needs;

c) improving the organization's academic scientific and engineering infrastructure and broadening the nation's science and engineering base; and

d) improving the quality, distribution, or effectiveness of the nation's scientific and engineering research (including research training) capabilities.

4. *Plan and Funding.* This criterion covers project and management plans and budget and funding, specifically the qualifications and experience of the project director and project team to plan, lead, coordinate, and manage the project. The technical soundness of the proposed plans and approach. The reasonableness and appropriateness of the costs and budget, matching, and organizational and management plans.

The first two criteria are of approximately equal weight. The third and fourth criteria are of lesser weight than the first two. The fourth criterion is of critical importance, and projects must be acceptable in this area in order to be funded.

Additional Considerations

In addition to the four evaluation criteria stated above, NSF must, by law, consider the following factors in making awards under this program:

- equitable distribution of funds among organizations of different sizes and geographic locations;
- the extent to which an organization has received awards for the repair, renovation, construction, or replacement of academic facilities from any other Federal funding source within the 5-year period immediately preceding the application; and
- a minimum 12% of the funds available under this program must go to Minority Institutions as defined in this Program Announcement.

AWARDS

Awards will be grants or other assistance instruments. NSF award amounts may range from $100,000 to $7 million. Total awards under this program to any eligible organization shall not exceed $7 million during any five year period.

Costs incurred prior to the effective date of an award under this program are not eligible project costs.

NSF awards may be made contingent on the awardee obtaining the required matching or cost-sharing within a specified time period. However, NSF award funds cannot be expended until required matching or cost-sharing commitments have been met. The duration of NSF awards is not expected to exceed three years. Awards and supported projects may be subject to certain federal or other standards, codes, regulations, or requirements.

GROUP I ORGANIZATIONS

Arizona State University
Boston University
Brandeis University
Brown University
California Institute of Technology
Carnegie-Mellon University
Case Western Reserve University
Children's TV Workshop
Colorado State University
Columbia University
Consortium for Scientific Computing
Cornell University
CUNY-City College
Dartmouth College
Drexel University
Duke University
Florida State University
Georgia Institute of Technology-All Campuses
Harvard University
Indiana University-All Campuses
Iowa State University of Science & Technology
Johns Hopkins University
Joint Oceanographic Institutions, Inc.
Lehigh University
Louisiana State University-All Campuses
Massachusetts Institute of Technology
Mathematical Sciences Research Institute
Michigan State University
National Academy of Sciences
New York University
North Carolina State University-Raleigh
Northeastern University
Northwestern University
Ohio State University-All Campuses
Oregon State University
Pennsylvania State University-All Campuses
Princeton University
Purdue University-All Campuses
Rensselaer Polytechnic Institute
Rice University
Rutgers State University of New Jersey
SRI International
Stanford University
SUNY-Albany
SUNY-Buffalo
SUNY-Stony Brook
Syracuse University-All Campuses
Texas A&M University-All Campuses
University of Alaska-Fairbanks
University of Arizona
University of California-Berkeley
University of California-Davis
University of California-Irvine
University of California-Los Angeles
University of California-Riverside
University of California-San Diego
University of California-Santa Barbara
University of California-Santa Cruz
University of Chicago
University of Cincinnati-All Campuses
University of Colorado
University of Connecticut
University of Delaware
University of Florida
University of Georgia
University of Hawaii-Manoa
University of Houston
University of Illinois-System Office
University of Illinois-Urbana
University of Iowa
University of Kansas
University of Kentucky
University of Maryland-College Park
University of Massachusetts-System Office
University of Miami (FL)
University of Michigan
University of Minnesota
University of Missouri-Columbia
University of Nebraska-Lincoln
University of New Mexico
University of North Carolina-Chapel Hill
University of Notre Dame

University of Oklahoma
University of Oregon
University of Pennsylvania
University of Pittsburgh
University of Rhode Island
University of Rochester
University of South Carolina-All Campuses
University of Southern California
University of Tennessee-Knoxville
University of Texas-Austin
University of Utah
University of Virginia
University of Washington
University of Wisconsin-Madison
University of Wyoming
Utah State University
Vanderbilt University
Virginia Polytechnic Inst & State University
Washington State University
Washington University
Woods Hole Oceanographic Institute
Yale University

GROUP II ORGANIZATIONS

American Association of Physics Teachers
American Mathematical Society
American Statistical Association
American University
Auburn University-All Campuses
Baylor College of Medicine
Boston College
Brigham Young University-All Campuses
California State Univ., Fullerton
California State Univ., Los Angeles
Carnegie Institution of Washington
Catholic University of America
Clarkson University
Clemson University
Cold Spring Harbor Lab
College of William and Mary
Colorado School of Mines
Columbia University Teachers College
Center for Advanced Study Behavioral Science
CUNY-Brooklyn College
CUNY-Hunter College
CUNY-Mount Sinai School of Medicine
CUNY-Queens College
DOSECC, Inc.
Education Development Center
Emory University
Field Museum of Natural History
Franklin Institute-Bartol Research Foundation
George Washington University
Georgetown University
Georgia State University
Howard University
Illinois Institute of Technology
Institute for Cancer Research
Kansas State University of Ag & Applied Science
Kent State University-All Campuses
Marine Biological Lab
Marquette University
Medical University of South Carolina
Meharry Medical College
Miami University-All Campuses (OH)
Michigan Technological University
Missouri Botanical Garden
Montana State University
N E Research Foundation
National Opinion Research Center
National Public Radio
National Bureau of Economic Research, Inc.
National Science Teachers Association
N E Radio Observatory Center
New Mexico Institute of Mining & Technology
New Mexico State University-All Campuses
New York Botanical Garden
Northern Arizona University
Northern Illinois University
Ohio University-All Campuses
Oklahoma State University
Old Dominion University
Oregon Graduate Center
Polytechnic University
Portland State University
Rand Corporation
Rockefeller University
Saint Louis University
San Diego State University
San Jose State University
Scripps Clinic and Research Foundation
South Dakota School of Mines
Southern Illinois University
Southern Methodist University
SUNY-Binghamton
Swarthmore College
Technical Education Research Center
Temple University

Texas Tech University
Tufts University
Tulane University of Louisiana
University of Akron-All Campuses
University of Alabama
University of Alabama-Birmingham
University of Alabama-Huntsville
University of Arkansas-Fayetteville
University of California-San Francisco
University of Denver
University of Idaho
University of Illinois-Chicago
University of Maine-Orono
University of Maryland-Baltimore
University of Medicine & Dentistry of New Jersey
University of Mississippi
University of Missouri-Rolla
University of Nevada-Reno
University of New Hampshire
University of Puerto Rico-Mayaguez
University of South Florida
University of Southern Mississippi
University of Texas-Dallas
University of Texas-Health Science Center Dallas
University of Texas-Health Science Center San Antonio
University of Toledo
University of Tulsa
University of Vermont
University of Wisconsin-Milwaukee
Virginia Commonwealth University
Wayne State University
Wesleyan University
West Virginia University
Worcester Polytechnic Institute
Yeshiva University

APPENDIX B

COMMENTS ON AND CHANGES TO PROGRAM GUIDELINES

In response to the draft program guidelines published April 20, 1989, in the *Federal Register*, comments were submitted by 15 associations representing over 1,200 institutions. In addition, comments were submitted by over 50 individuals and organizations.

Virtually all comments were supportive of the program, the overall guidelines and the specific approach being taken. Features frequently identified as being desirable or beneficial were the two-phase proposal process, having three separate groups for competition and funding, and broadening the coverage to allow facilities which are used for research and research training but which are not "facilities primarily devoted to research" to be eligible for partial support under the program.

All comments on this last subject, with one exception, supported this approach since it prevents many multi-use facilities from being totally excluded, particularly in undergraduate institutions.

Although almost all comments were generally favorable, the following concerns were voiced by several associations or individual organizations:

1. There was general concern regarding the need for additional research facilities and that this program did not cover construction of new research facilities. It was also pointed out that by not covering all academic facilities, or all science and engineering facilities, or not allowing new construction except for replacement, that the program would not benefit those institutions (e.g., some HBCUs, minority and small colleges) that do not have research facilities.

[This particular legislation and program are not intended to address all academic facilities needs at all institutions. Pursuant to the legislation, the program only addresses repair, renovation, and, in exceptional cases, replacement of existing research facilities.]

2. There was concern that as written, the definition of research training was too limiting and might result in certain undergraduate research training facilities being excluded.

[The definition was changed to reflect the definition suggested by the National Association of Independent Colleges and Universities (NAICU) and several other organizations.]

3. There was concern that although the legislation is specifically targeted to include undergraduate institutions, undergraduate institutions were not specifically mentioned.

[The guidelines were changed and now refer specifically to graduate and undergraduate institutions in several prominent places.]

4. It was suggested that NSF allow those institutions not in the top 100 to match only 30 percent instead of 50 percent as permitted by the legislation. It was also suggested that because the 50 percent matching requirement might be difficult to meet for certain institutions (e.g., some HBCUs, minority and small colleges), a waiver of this requirement be made.

[The legislation specifically calls for at least 50 percent matching for all institutions but permits NSF to accept at least 30 percent from all but the top 100 institutions. Thus, while the legislation is permissive in this area, NSF expects to seek at least 50 percent matching from all institutions. This should (a) encourage organizations to propose only high priority projects for which they are willing to make significant financial commitments; (b) encourage organizations to raise additional funding and leverage the federal funds; and (c) permit limited program monies to be used to fund more organizations and facilities. The use of targeted percentages of program funds for each of the three groups and the 12 percent set-aside for minority institutions will assure that the smaller, less affluent institutions receive substantial funding under the program.]

5. There was concern about using amounts of cost sharing above 50 percent as an additional consideration for award.

[The intent was to indicate that higher percentages of cost-sharing, while encouraged, would only be considered to help distinguish between proposals within each group that were otherwise comparable in terms of overall merit and need. However, this has been dropped from the guidelines as an additional consideration.]

6. It was suggested that the 12 percent set-aside for minority institutions be "taken off the top" with the remaining 88 percent being divided among the three groups.

[This change could limit the funding for minority institutions to 12 percent and provide an advantage to larger minority institutions with stronger research capabilities. Although minority institutions will be assured of receiving 12 percent of the funds awarded, they should compete with other organizations in the groups and not be limited to 12 percent.]

7. It was suggested that the program guidelines state explicitly what percentage of the funds will be awarded to each competitive group.

[The percentages of program funds targeted for each group will be included in the report to Congress.]

8. In response to a few suggestions, the due dates for proposals were changed to allow additional time for preparation of Phase II proposals. In addition, the weighting of the evaluation criteria were changed to indicate greater emphasis on research merit and facility need.

9. In addition to the above comments, a number of other suggestions and editorial comments have been adopted.

10. Finally, a number of comments expressed concern that the program has not been funded.

APPENDIX C

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