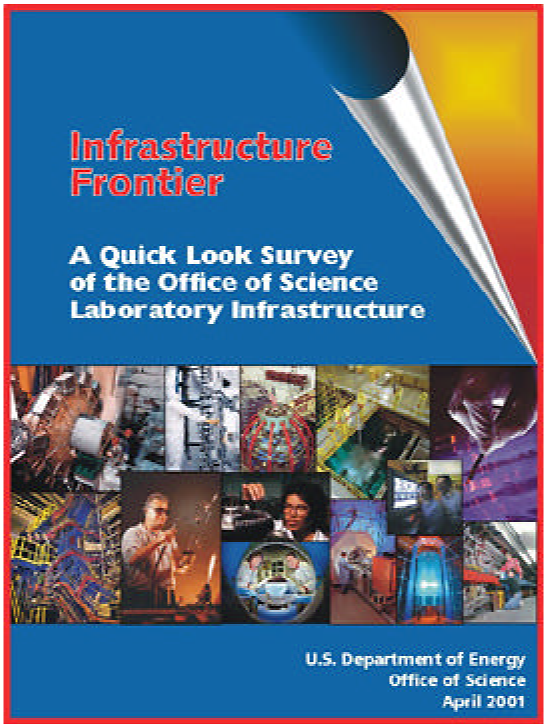

Infrastructure Frontier:

A Quick Look Survey

of the

Office of Science

Laboratory Infrastructure

April 2001

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GLOSSARY OF TERMS AND ACRONYONS

ALS	Advanced Light Source
ASC	Advanced Scientific Computing
Ames	Ames Laboratory
ANL-E	Argonne National Laboratory, East
APPA	Association of Higher Education Facilities Officers
ATP	Adenosine triphosphate
BES	Basic Energy Sciences
BNL	Brookhaven National Laboratory
CEBAF	Continuous Electron Beam Accelerator Facility
COMMERCE	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
D&D	Decontamination and Decommissioning
EM	Office of Environmental Management
EMSL	Environmental Molecular Sciences Laboratory
Energy	Department of Energy
ERA	Energy Research Analyses
ES&H	Environment, Safety and Health
ESPC	Energy Savings Performance Contracts
FIMS	Facility Information Management System
FY	Fiscal Year
Fermi	Fermi National Accelerator Laboratory
GOCO	Government Owned – Contractor Operated
GPI	General Purpose Infrastructure

GPP	General Plant Projects
GPE	General Purpose Equipment
HEP	High Energy Physics
HHS	Health and Human Services
HVAC	Heating, Ventilation, and Air Conditioning
INTERIOR	Department of Interior
JGI	Joint Genome Institute
LAN	Local Area Network
LBNL	Lawrence Berkeley National Laboratory
MEL-FS	Multiprogram Energy Laboratories--Facilities Support
NP	Nuclear Physics
NRC	National Research Council
NSF	National Science Foundation
NSTX	National Spherical Torus Experiment
LI	Line Item
O&M	Operation and Maintenance
OBER	Office of Biological and Environmental Research
OFES	Office of Fusion Energy Sciences
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
PCM	Parallel Climate Model
PD	Program Direction
PNNL	Pacific Northwest National Laboratory
PPPL	Princeton Plasma Physics Laboratory
RHIC	Relativistic Heavy Ion Collider

RPV	Replacement Plant Value
S&M	Surveillance and Maintenance
SC	Office of Science
SF	Square Footage
SFP	Strategic Facilities Plan
SLAC	Stanford Linear Accelerator Center
SNS	Spallation Neutron Source
TJNAF	Thomas Jefferson National Accelerator Facility
TRANS	Department of Transportation
UIP	Utility Incentive Program
USDA	United States Department of Agriculture
VLAN	Virtual Local Area Network

EXECUTIVE SUMMARY

The Department of Energy (DOE) Office of Science (SC) plays a unique role in the nation's science enterprise through its state-of-the-art research facilities and equipment. Major instruments of science such as accelerators, light sources, neutron beam facilities, plasma, and fusion science facilities, genome centers, and advanced computational centers are essential to today's and tomorrow's discoveries and breakthroughs. These instruments provide the means for conducting the world-class research that has positioned the DOE SC as a top performer in the physical sciences, as well as in the biological, environmental, and computational sciences.

Thousands of scientists from the national laboratories, private companies, universities, other Federal agencies, and the international scientific community government are users of these instruments to advance the frontiers of knowledge (see Exhibit E-1). The new science frontiers include nanoscale science, engineering, and technology; advanced computational modeling and simulation; understanding the workings of microbes at the molecular level; and applications of science and engineering expertise to problems in the life sciences.

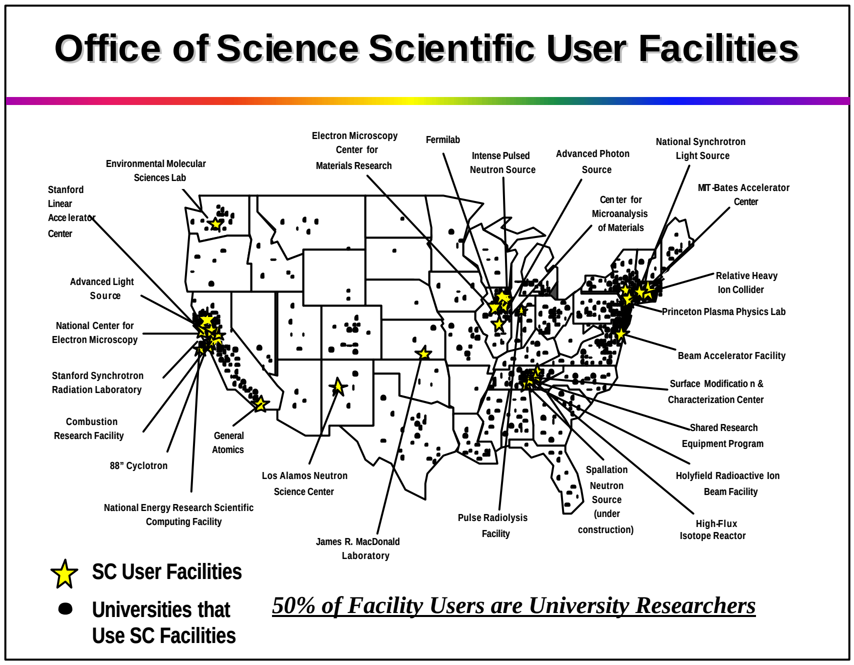


Exhibit E-1

Over the last half-century, our Nation's economic prosperity, quality of life, and security stemmed from strong public commitments to basic science research. Public-funded science is expected to take on even greater importance in the new century.

Maintaining and nurturing these instruments of science, along with the SC Laboratory Complex housing them, is a continued and important responsibility for DOE. This complex includes 2,500 buildings (including 700 trailers), 20.5 million gross square feet of space for offices, laboratories, and many unique scientific facilities, a replacement value of approximately $13.5 billion, a total annual operating budget of $3 billion, and staff of 22,500. Exhibit E-2 provides a summary of the laboratories including contractor, location, year established, funding and staffing. Appendix A provides additional information concerning their program activities and funding, and infrastructure.

Exhibit E-2 SC Laboratory Complex

Laboratory	Contractor	Location	Year Est.	Est. FY00 $ Millions BA Total	Staffing (Full Time Equiv.)
Multiprogram Laboratories					
Argonne National Laboratory (ANL-E)	University of Chicago	Chicago, IL	1948	431	3,550
Brookhaven National Laboratory (BNL)	Brookhaven Science Associates	Upton, NY	1947	415	2,978
Lawrence Berkeley National Laboratory (LBNL)	University of California	Berkeley, CA	1931	416	2,734
Oak Ridge National Laboratory (ORNL)	Univ of TN-Battelle, LLC	Oak Ridge, TN	1943	670	4,130
Pacific Northwest National Laboratory (PNNL)	Battelle Memorial Institute	Richland, WA	1965	358	2,821
Program-Dedicated Laboratories and Facility					
Ames Laboratory (Ames)	Iowa State University	Ames, IA	1942	24	300
Fermi National Accelerator Laboratory (Fermi)	University Research Assoc., Inc	Batavia, IL	1968	303	2,151
Princeton Plasma Physics Laboratory (PPPL)	Princeton University	Princeton, NJ	1951	70	397
Oak Ridge Institute of Science and Education (ORISE)[1]	Oak Ridge Associated Universities	Oak Ridge, TN	1951	95	427
Stanford Linear Accelerator Center (SLAC)	Stanford University	Palo Alto, CA	1962	208	1,442
Thomas Jefferson National Accelerator Facility (TJNAF)	Southeastern Univ. Research Assoc., Inc.	Newport News, VA	1986	97	611
			TOTALS	$ 3,087	21,541

(Note: FY00 dollars are from the laboratory Institutional Plans and inc ludes operating, equipment and construction funding. Values include DOE funding and non-DOE funding from Work for Others.)

This report includes only SC owned laboratories operated under a management and operating contract and ORISE. This report does not include laboratories funded by SC through grants and cooperative agreements with universities or facilities at other DOE laboratories (e.g. Los Alamos National Laboratory and Lawrence Livermore National Laboratory).

Most laboratories comprising the SC Laboratory Complex are like small cities – they have extensive sites and infrastructure including a variety of laboratories, high-performance computing and communications services, a large complement of office space, and utilities plants and distribution systems (e.g., electricity, water, sewer, and gas), roads, fire and emergency

[1] ORISE is a facility, but hereinafter is referred to as a laboratory for purposes of this report.

response services, and waste disposal facilities. These facilities are referred to as the General Purpose Infrastructure (GPI).

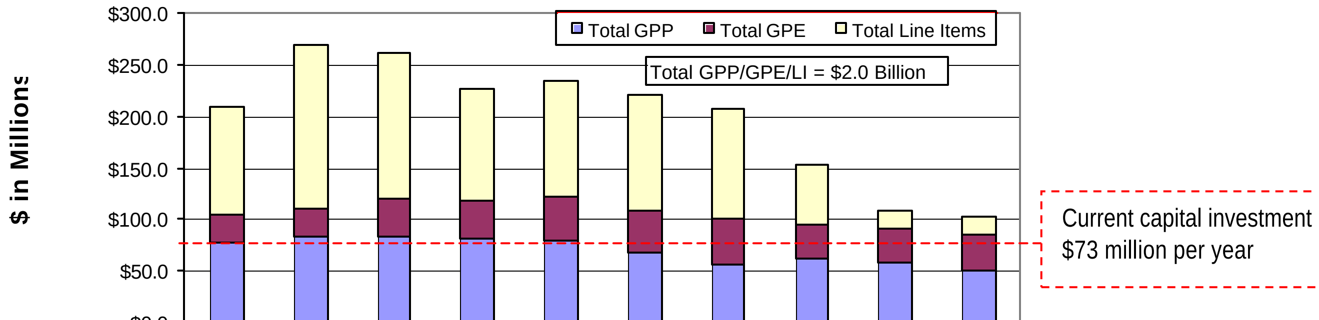
As noted in DOE Strategic Plan (SP) issued in September, 2000, "many of the support facilities and buildings [i.e., the GPI] that are essential to the continuation of the science are aging and in disrepair—some as old as 50 years. The poor condition of these facilities has adverse implications for the safety, security, cost, and continuity of DOE's science laboratories. Further, it will be increasingly difficult, to attract and retain the next generation of qualified scientists under the current working conditions in such facilities."

Example of Outdated Building at ORNL

Indeed, the SC Laboratory Complex is old: over 60 percent of the complex space is over 30 years old and 35 percent is over 40 years old. Only 50 percent of the space is considered in "adequate" condition and, of that, portions are not suitable or functional for the required scientific research work. There is less need today for hot cells and an increased need for modern, easy to configure, and economic computer research, electronic, genomic, and biology laboratories. Outdated facilities and inadequate infrastructure are affecting productivity, costs, the ability to undertake the next evolution of technology intensive science research, and the ability to attract and retain scientific talent. Space for the 15,000 or more on-site and visiting scientists is often in short supply and inadequate for the planned use. There are contaminated and uncontaminated surplus facilities needing retirement to reduce operating costs, free up space and land, and reduce safety and environmental risks. Many utility systems and components are out-of-date, difficult to maintain, and represent safety and environmental liabilities. Because of these problems and their impact on the cost, productivity, safety, and viability of the research endeavor, SC has initiated an Infrastructure Modernization Initiative to better define the modernization needs, clarify management responsibilities, improve planning and coordination, request appropriate capital investment and maintenance funding, and improve facilities management practices and processes in the field and laboratories.

To better identify infrastructure projections, SC requested each laboratory prepare a Strategic Facilities Plan (SFP) in October 2000, to identify their expected GPI modernization projections for a 10-year period (Fiscal Year [FY] 2002 through FY 2011). This Quick Look Survey is the subject of this report.

The laboratories identified almost $2 billion of capital investment projections over the ten-year period (FY 2002 through FY 2011). Capital investment projections are those directly funded by SC and consist of General Plant Projects (GPP), General Purpose Equipment (GPE), and Line Item (LI) projects. Both GPP and LI are construction projects. Those construction projects with a total cost of $5 million or more are referred to as LI while those below $5 million are designated GPP. The ten-year projections are each laboratory's preliminary estimates and have not been validated and approved by DOE; however, they do provide a good order-of-magnitude projection. Because the SC is already providing capital investments of $73 million per year the un-funded portion of the $2 billion request is $1.25 billion over the 10-year period. See Exhibit E-3 for capital investment projections by funding type (GPP, GPE and LI) by year. Nearly 85 percent of LI funding identified is related to the building revitalization.



	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11
Total Line Items	103.9	158.4	141.0	107.3	111.8	110.6	107.1	57.7	17.0	17.6
Total GPE	27.5	26.8	36.7	37.0	41.4	42.0	44.2	31.8	33.0	34.0
Total GPP	77.8	82.8	83.1	81.6	80.4	67.1	56.3	62.5	58.3	50.4

Total $209 $268 $261 $226 $234 $220 $208 $152
$108 $102

Exhibit E-3 Capital Investment Resource Projection to Support Requests

The survey also identified maintenance funding projections for the laboratories. Maintenance activities are those directed toward keeping fixed assets in a condition to effectively support the mission. Activities include preventive maintenance, repairs, replacement of parts and structural components, and other activities needed to preserve the assets so that they continue to support the mission. Maintenance excludes activities aimed at expanding the capacity of an asset or otherwise upgrading it to serve needs different from or significantly greater than its current use. Maintenance as defined here does not include snow removal, janitorial, or facility operations. Maintenance is funded from laboratory overhead and space charges. Total laboratory maintenance was $65 million in FY 99 and is expected to grow by 5 percent per year through FY 2011.

SC laboratory maintenance spending is currently about 0.7 percent of replacement plant value; this level is well below the 1.5 percent to 3 percent benchmarks from industry and academia and guidelines from the National Research Council for Federal Facilities. As a result, deferred maintenance at SC laboratories has been increasing since the data were collected starting in FY 99 and totals nearly $300 million as of January 2001. Deferred maintenance is maintenance that was not performed when scheduled, thereby put off or delayed for a future period.

The un-funded backlog of capital investment projections and deferred maintenance is due to aging of the laboratories, changing technology and mission activities, and insufficient capital investment and maintenance spending in the past.

With respect to the excess facilities, the survey identified about $138 million for normal facility retirements and $130 million for accelerated retirements. The $138 million for normal facility retirements would address two kinds of facilities – contaminated ones to be transferred to the Office of Environmental Management (EM) for final disposition and non-contaminated ones for which SC will perform final disposition. Funds cover surveillance and maintenance (S&M), other deactivation costs, and actual clean up in the case of non-contaminated facilities. Currently, SC laboratories fund these activities from overhead; the laboratories are requesting direct funding to speed the process and to avoid negative impact to planned research activities.

The $130 million for accelerated retirements would place the final clean-up of certain excess facilities on a much more accelerated schedule than currently planned. The benefits to SC of earlier investments are: cost savings, reduced liabilities, and re-use of valuable land. An example is the clean-up of the Bevatron at LBNL. This decommissioned accelerator occupies 20 percent of the available buildable land at LBNL yet can not be re-developed until the old contaminated facilities are removed (this action is not currently scheduled).

The survey also identified $180 million of projects with the potential to be Third Party financed. These are projects financed by the private sector, non-profit organizations, state or local government, or others. An example is the three office/laboratory buildings to be constructed by the State of Tennessee at ORNL. These are the Joint Institute of Biological Sciences ($8 million), Joint Institute for Computational Sciences ($6 million), and the Joint Institute for Neutron Sciences ($8 million). Such projects help defray Federal capital investments providing modern research space, and promoting partnering with others.

As follow-up to the survey, and in fulfillment of the Infrastructure Modernization initiative, SC will prepare an "SC Infrastructure Modernization Plan" that will provide a multiyear road map for modernizing the SC laboratories. The plan will include an integrated infrastructure planning and budgeting process, a multiyear budgeting plan, and performance measures that will be used to monitor the condition of the GPI and SC's progress in modernizing and revitalizing the GPI as well as the laboratories and field facilities management performance.

This report can be found along with the SFPs at http://www.sc.doe.gov/production/er-80/er-82/labs21/. The DOE Science White Paper titled "Department of Energy Science Infrastructure Modernization Strategy 21st Century Laboratories for the Nation", prepared by a working group of laboratory representatives to recommend ways for DOE to maintain adequate infrastructure at its laboratories in order to sustain advances in science and technology, can also be found at this web site.

1.0 PURPOSE, SCOPE, AND OBJECTIVES OF THE REPORT

1.1 Purpose

This report was developed to provide the basis for an initiative by DOE to upgrade and revitalize the SC laboratory infrastructure which is vital to its science mission. Specifically, this report will convey an understanding of the infrastructure problem and its magnitude, including:

- A description of current infrastructure conditions at SC laboratories and the impact of these conditions on the effectiveness and quality of science conducted therein.
- Identification of mission-critical issues directly related to infrastructure quality, including the difficulty of recruiting and retaining the caliber of scientists and other technology researchers necessary to carry out DOE's scientific research program goals.
- A summary of projected infrastructure needs of SC Laboratories over a 10-year period (FY 2002 – FY 2011).

1.2 Scope

This report provides a preliminary infrastructure assessment of SC's 10 laboratories and the ORISE facility. The laboratories are: Ames, ANL-E, BNL, Fermi, LBNL, ORNL, PNNL, PPPL, SLAC, and TJNAF. This report does not include programmatic initiatives (funded by SC's Program Offices) requiring new facilities.

1.3 Objectives

The objective of this report is to support the laboratory modernization initiative by assessing the projected infrastructure needs of SC laboratories based on information provided by each laboratory in their Strategic Facility Plans (SFPs). In the future, DOE will prepare a Laboratory Infrastructure Roadmap to address these needs, site-specific issues, project prioritization, budgeting strategy, performance measures for accomplishing the plan, and innovative funding approaches.

2.0 DOE MISSIONS, ACTIVITIES, AND STRATEGIC GOALS

The mission of DOE is to foster a secure and reliable energy system that is environmentally and economically sustainable; be a responsible steward of the Nation's nuclear weapons, including clean up of its own facilities; and support continued United States leadership in science and technology. DOE achieves its mission through four business lines:

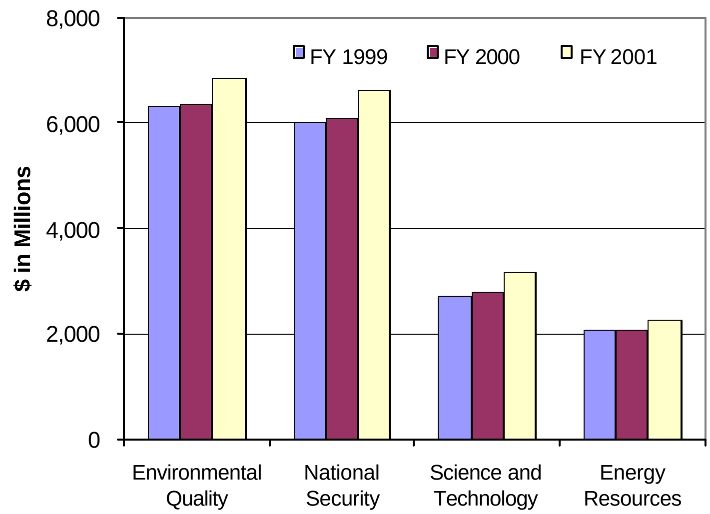


Exhibit 2-1 Department of Energy Funding

- Environmental quality
- National security
- Science and technology
- Energy resources

Funding of these four business lines is shown in Exhibit 2-1[2].

2.1 Role of SC Laboratories in Accomplishing DOE Missions

SC has primary responsibility for the science and technology business line, which has five strategic goals[3]:

- ***Fuel the future*** with science for clean and affordable energy.
- ***Protect our living planet*** with scientific understanding of energy impacts on people and the biosphere.
- ***Explore matter and energy*** as elementary building blocks from atoms to life.
- ***Provide the extraordinary tools***, scientific workforce, as well as (LBNL) infrastructure that ensure our Nation's leadership in the physical, biological, and computational sciences and its multidisciplinary research.
- ***Manage as stewards of the public trust,*** addressing the need for excellence in the management, planning, and execution of SC programs.

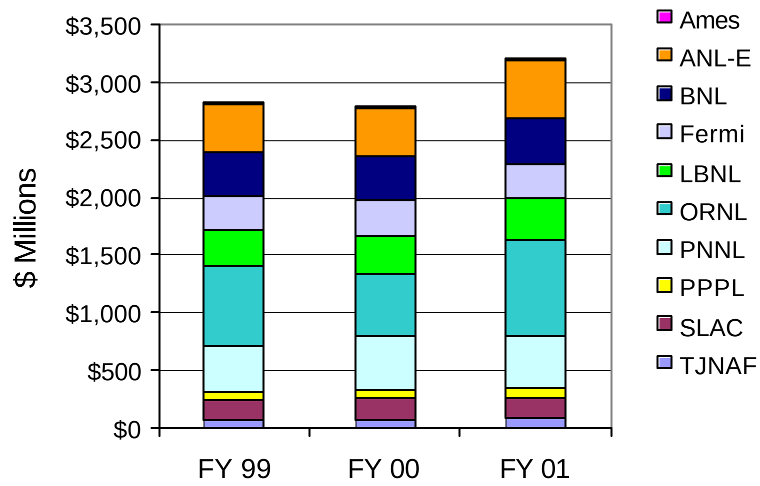
[2] DOE Strategic Plan, September 2000, Page 1.

[3] SC Strategic Plan, June 1999, Page vii.

SC's science programs and the infrastructure that supports them, advance basic research and provide the technical foundation and resources for DOE's other missions in national security, energy, and environment. Exhibit 2-2 shows DOE funding by laboratory. Total funding allocated to SC laboratories for FY 2001 is provided in Exhibit 2-3.

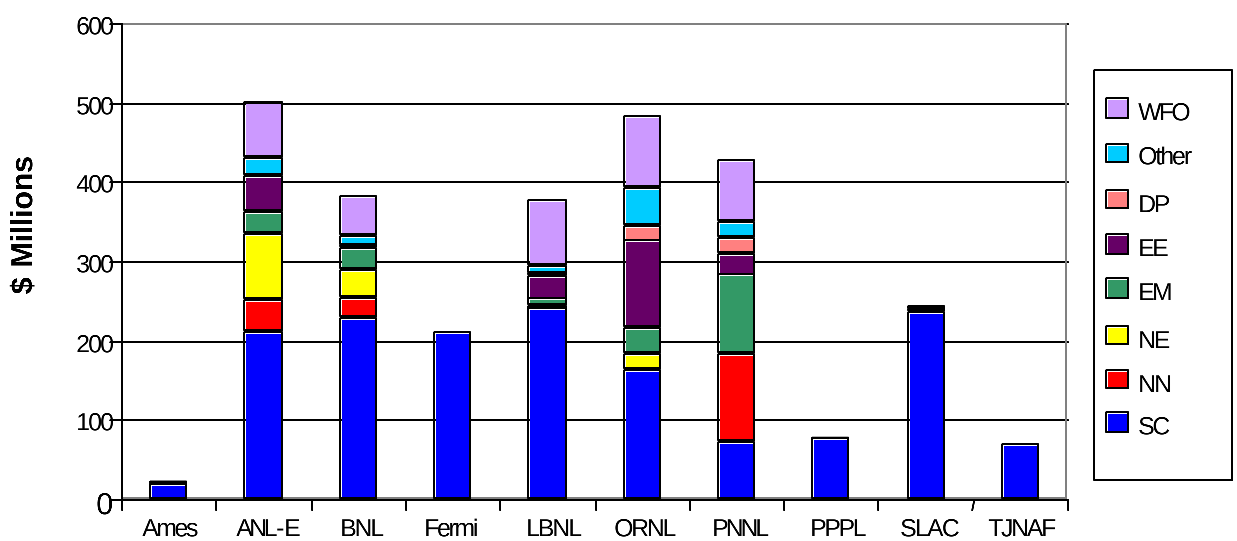
2.2 SC Stewardship Responsibility

Continued leadership in science and technology is a cornerstone of our nation's economic prosperity and growth. Many technologies fueling today's economy build upon government research investments in the previous years and decades, such as the Human Genome Project. Continuation of this scientific leadership and growth depends heavily on the existence and operating efficiency of SC laboratories. Infrastructure is an essential part of the stewardship of SC's scientific mission. Facilities must be sufficiently modern to accommodate high technology equipment, computing and networking infrastructure needs, rapidly evolving research needs, and to meet standards for the protection of workers, local communities, and the environment. Over the years, SC and DOE have directed public funds to maximize the



*ORISE not included.

Exhibit 2-2 DOE Annual Funding by Laboratory (All DOE Program Offices)



**Data from Institutional Plans. No data available for ORISE*

Exhibit 2-3 FY 2001 DOE Budget Allocation to SC Laboratories by DOE Programs

research and development mission and have given a lower priority to general-use facilities and infrastructure.

SC provides the primary support for 32 major scientific user facilities. Together, these facilities host more than 15,000 users annually from all research sectors. University-based scientists are among the principal users of these facilities. New research capabilities came on line during FY 1999 and FY 2000 at the Continuous Electron Beam Accelerator Facility (CEBAF) at TJNAF, and the B-factory at SLAC. Other recent major facilities completed include: the Relativistic Heavy Ion Collider (RHIC) at BNL, the Advanced Photor Source at (ANL), the National Spherical Torus Experiment (NSTX) at PPPL, Environmental Molecular Sciences Laboratory (EMSL) at PNNL, the Fermi Main Injector at Fermi, and the Joint Genome Institute's (JGI) Production Sequencing Facility in Walnut Creek, California. Ground was broken on December 15, 1999, for the Spallation Neutron Source (SNS), SC's newest construction start. These world-class scientific facilities require sophisticated support systems, such as HVAC, electrical transmission and distribution systems, high-speed data networks, advanced wastewater treatment, energy management and control systems, and advanced fire protection systems.

DOE is the dominant supporter of the physical sciences in the U.S. and plays a major role in other major scientific fields, including life sciences, mathematics, computation, engineering and environmental research. In addition, SC has been a principal supporter of graduate students and postdoctoral researchers in their early careers, and is the steward of a vast network of major scientific facilities that are essential to the vitality of the U.S. research community.

Department of Energy Science

Top Five Government Research Organizations for*:

Physical Sciences	Environmental Sciences	Mathematics & Computing	Engineering	Life Sciences
1. Energy (2,012)	1. NASA (1,051)	1. DOD (657)	1. NASA (1,948)	1. HHS (11,838)
2. NASA (1, 019)	2. NSF (481)	2. Energy (623)	2. DOD (1,837)	2. USDA (1,215)
3. NSF (515)	3. DOD (383)	3. NSF (399)	3. Energy (851)	3. DOD (519)
4. DOD (412)	4. INTERIOR (364)	4. HHS (127)	4. NSF (484)	4. NSF (403)
5. HHS (205)	5. Energy (335)	5. COMMERCE (89)	5. TRANS (323)	5. Energy (288)

* *Numbers are FY 1999 Dollars in Millions - Source: NSF -- Preliminary Federal obligations for research, by agency and field of science and engineering: fiscal year 1999*

Past investments in SC continue to pay off handsomely for the U.S. taxpayer. Nobel prize winning research projects funded by SC have resolved some of the major scientific questions of our time, including development of the Standard Model of elementary particle physics and helping to understand the origins and fate of the universe, life on this planet, and our global climate. In addition, major advances in medical diagnostic tools, microelectronics, advanced materials, computation, lasers, and other scientific discoveries supported by SC continue to improve the lives of millions of Americans and have added greatly to our store of knowledge.

There are two types of SC laboratories: multiprogram laboratories and program dedicated laboratories. The five multiprogram energy laboratories are ANL-E, BNL, LBNL, ORNL, and PNNL. These laboratories are government-owned, contractor-operated (GOCO) and have over 1,100 buildings with 14.3 million gross square feet of space with an average age of 35 years and an estimated replacement value of over $10 billion excluding surplus facilities and reactors/accelerators. Total operating funding for these laboratories is over about $2.7 billion per year. These laboratories serve many SC and DOE programs as well as other Federal agencies, universities, and private industry. As stewards of the multiprogram laboratories, SC is responsible not only for the SC missions performed at these laboratories, but also the "health and well-being" of these laboratories to serve DOE and other missions.

The five program-dedicated laboratories (Ames, PPPL, Fermi, SLAC, TJNAF) and ORISE are also GOCOs, and have more than 600 buildings with 5.6 million gross square feet of space and an estimated replacement value of $3.5 billion. Fifty percent of the space at the program-dedicated laboratories is between 20 and 40 years old. Total operating funding for these laboratories is more than $600 million per year. Program-dedicated laboratories are primarily funded by one SC program (e.g., High Energy Physics funds Fermi.).

3.0 LABORATORY INFRASTRUCTURE ISSUES

The state of infrastructure at SC laboratories is at a critical juncture. This section addresses how various factors have contributed to the existing infrastructure conditions at SC labs, and shows how these factors affect mission and future costs.

3.1 Aging

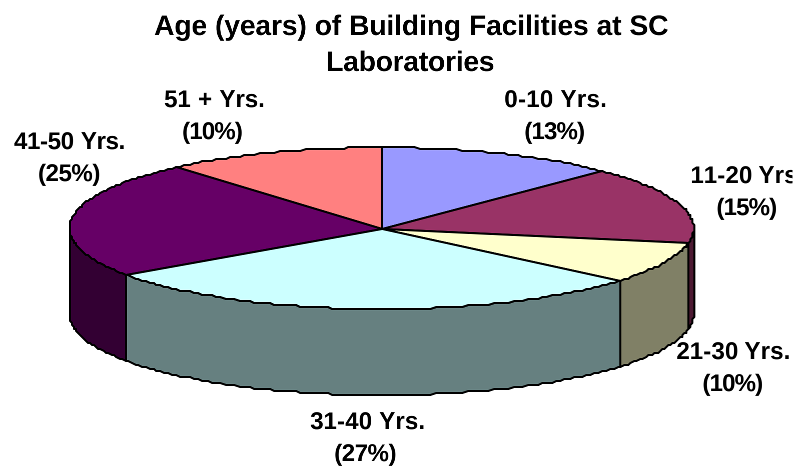


Exhibit 3-1 Overall SC Laboratory Facility Age Distribution

Many of the national laboratories were built during World War II and early Cold War (1950s). As shown in Exhibit 3-1, over 60 percent of space in gross square feet is more than 30 years old, and 35 percent of the space is more than 40 years old. Appendix B contains two detailed exhibits: 1) Exhibit B-1 is a detailed age distribution for individual SC laboratories; and 2) Exhibit B-2 which shows the replacement plant value (RPV), number of trailers, and average age of the facilities. Many of these facilities are reaching the end of their service life as demonstrated in Exhibit 3-2. These buildings require extensive maintenance and replacement of deteriorating systems, subsystems and components to meet mission, safety standards, and other needs. Age makes much of the building systems, subsystems and components (e.g., electrical, heating, air conditioning, and ventilation) difficult to repair, because equipment becomes obsolete and replacement parts are often unavailable.

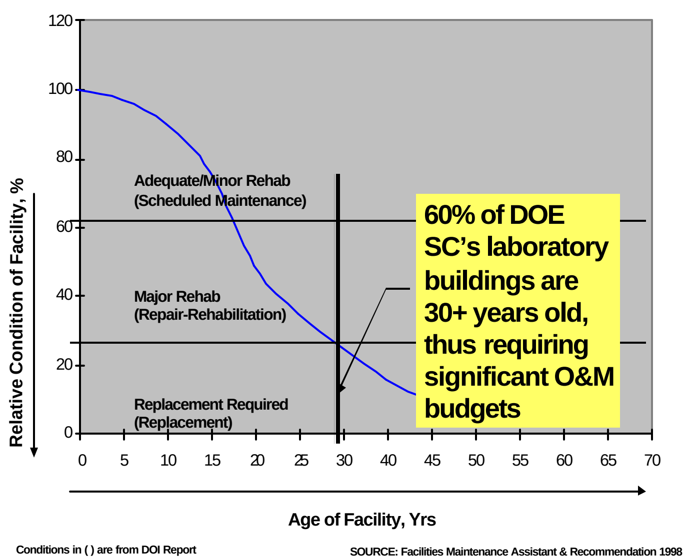


Exhibit 3-2 Facility Life-Cycle Curve

Many buildings were built for other purposes, and are not appropriate for the current research program. Indeed, many of the most serious problems impacting research stem from the continued use of temporary single-wall buildings such as Quonset huts, wooden barracks buildings from the Manhattan Project, etc. These facilities once served by 1940s utilities and do not have the mechanical systems (e.g., air handling, heating, cooling, and plumbing) and electrical systems necessary to effectively or efficiently conduct current research. Many of these systems are vital to providing adequate cleanliness, fume removal, treatment, climate control (i.e. temperature and humidity) necessary for today's and tomorrow's programs. In other instances, the buildings are not structurally sound, and some are condemned or have occupancy limitations. In many cases, the buildings were intended for temporary occupancy or for specialized functions that are no longer being conducted. Use of unsatisfactory space is costly and requires reliance on administrative controls to ensure that operational safety requirements continue to be attained.

Exhibit 3-3 shows the existing condition of overall SC laboratory infrastructure according to DOE criteria, as defined below: adequate, minor rehabilitation, major rehabilitation, and replacement required.

- Adequate: Repair costs < 10 percent of RPV
- Minor Rehabilitation: 10 percent of RPV< Repair costs < 25 percent of RPV
- Major Rehabilitation: 25 percent of RPV< Repair costs < 60 percent of RPV
- Replacement Required: Repair costs > 60 percent of RPV

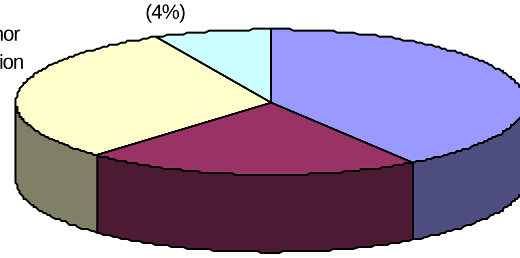


Exhibit 3-3 Infrastructure Condition at SC Laboratories

As shown, in Exhibit 3-3, 20 percent of laboratory space is in need of replacement or major rehabilitation. However, these substandard facilities are still in service because SC laboratories need the space to perform their research missions and have no satisfactory alternatives. Aging laboratory infrastructure continues to deteriorate because funding is insufficient to support major maintenance projects and recapitalization projects, and to conduct research at the same time.

SC maintenance expenditures, as reported in the DOE's Facilities Information Management System (FIMS) database, totaled $66 million in FY 1999.

A useful indicator is the maintenance[4] investment compared to replacement value. SC's maintenance spending was 0.7 percent of replacement value, which is well below the industry benchmark 1.5 to 3.0 percent for the first 30 to 40 years of facility life. This value is also well below the 2 to 4 percent replacement value cited in a National Research Council Report (NRC,

[4] Full definition is: recurring, annual real property maintenance and repairs funded including maintenance of structures and utilities; roofing, chiller/boiler replacement, electrical/lighting; preventive maintenance; preservative/cyclical maintenance; maintenance to address the deferred maintenance backlog; and service calls. It does not include facilities related operations such as custodial, utilities operation, snow removal, waste collection, pest control, security services, grounds care, parking or fire protection, building managers or ES&H support. Nor, does it include Alternation and Capital Improvements, New Construction or Total Renovation Activities.

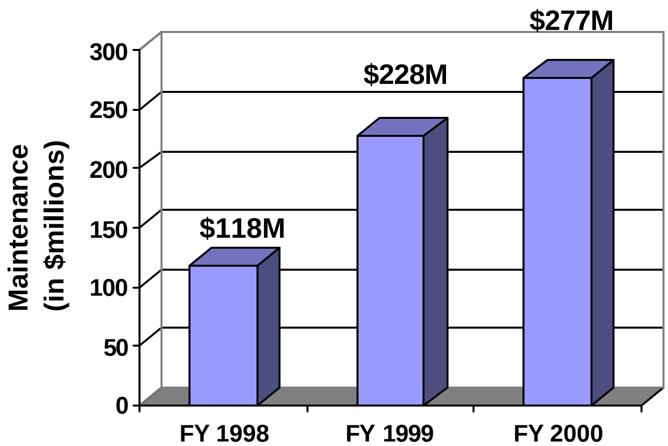


Exhibit 3-4 Deferred Maintenance as of 2000

1990). Also, the Association of Higher Education Facilities Officers (APPA) reported an average of 3.14 percent in a 1995/96 benchmarking survey of universities.

As shown in Exhibit 3-4, the deferred maintenance backlog as of October 31, 2000, was over $277 million compared with $228 million in 1999 and $118 million in 1998 – a 100 percent increase over two years. Deferred maintenance is maintenance that is planned but not undertaken due to funding limitations. Increased deferred maintenance has resulted because of insufficient maintenance funding.

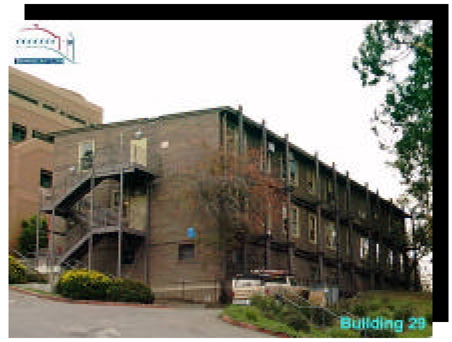
The consequences of inadequate maintenance could be serious and costly: scientific mission failure, work disruptions from leaking roofs and burst pipes, computer and equipment breakdowns, occupational health and safety risks, lost productivity, and millions of dollars in emergency repairs. As already old space continues to age, more and more maintenance dollars will have to be expended just to maintain minimal structural and safety conditions. Energy efficiency is poor due to inadequate heating, ventilation & air conditioning, inadequate insulation, and poor lighting. The NRC report (NRC, 1990) notes: "*Where neglect of maintenance has caused a backlog of needed repairs to accumulate, spending must exceed this minimum level until the backlog has been eliminated*." However, maintenance funding alone can not make deteriorated non-permanent buildings new (i.e. replacing systems and subsystems in such buildings is a poor investment).

Below are pictures of some laboratory buildings that have reached the end of their useful life, are not functional, and where upgrade costs would greatly exceed 50 percent or more of the replacement costs. It is a general rule that when the cost to upgrade a facility exceeds 50 percent of the replacement costs and the building is not designed to meet functional needs, it is better to replace it. Facility replacements are funded via capital funding.

Building 2000 - ORNL

Building 2001 - ORNL

Building 7 - LBNL



Building 29 - LBNL

Building 185 - BNL

Building 134 - BNL

Capital investments to replace such buildings have not kept pace with the aging infrastructure. Exhibit 3-5 shows the combined capital investment by SC for the last nine years has averaged $55million at the multiprogram laboratories. At this level of annual investment, it would take 182yearsto "replace" their general purpose infrastructure. This is substantially longer then the normal industry rate of 30 to 50 years. To achieve a 50-yearreplacementcycle, annual capital investments would need to be $200 million per year.

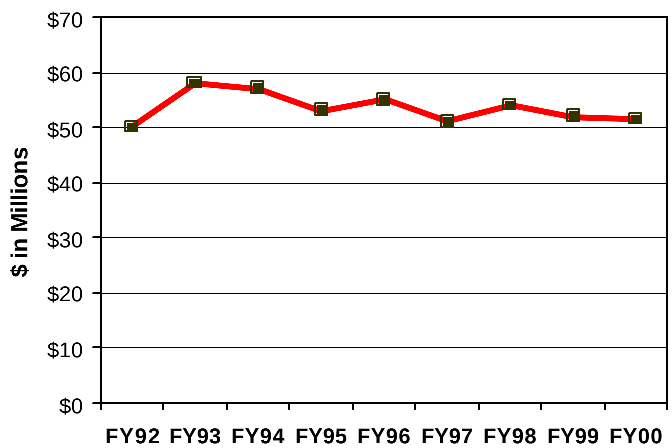


Exhibit 3-5 Combined GPP/GPE/LI Capital Infrastructure Budgets for SC Multiprogram Laboratories

Laboratory SFPs and site visit data show low maintenance and capital investment levels have already affected the SC laboratories in the following ways:

- Noise and vibration from ventilation units in older buildings have interfered with sensitive scientific work, necessitating renovation to accommodate precision equipment (e.g., the Advanced Light Source [ALS] at LBNL).

- Scientific equipment has failed due to poor control of temperature and humidity (ORNL and others).

- Worker discomfort from crowding and inadequate climate control has decreased productivity (LBNL and BNL project justifications).

- Buildings have proven structurally unsatisfactory for the research mission; in one instance, a floor began to collapse under the weight of heavy equipment (BNL Autoclave).

Investment in science has significantly contributed to the nation. Infrastructure funding for science laboratories must keep pace. Some examples of achievement in science include the following:

1. **The Human Genome Project and the Sequencing of Human Chromosomes 5, 16, and 19.** DOE was the first Federal agency to argue the human genome could be sequenced and it launched the Human Genome Project in 1986. In April 2000, DOE's Joint Genome Institute completed high-quality draft sequences of human chromosomes 5, 16 and 19, as part of an international consortium whose draft sequence of the entire human genome was announced by former President Bill Clinton and Prime Minister Tony Blair in June 2000. Chromosomes 5, 16, and 19 contain 10,000 to 15,000 genes, including genes implicated in forms of kidney disease, prostate and colorectal cancer, leukemia, hypertension, diabetes, and atherosclerosis. The Joint Genome Institute's DNA Production Genomics Facility is one of the most productive and cost-effective public-sector DNA sequencing laboratories in the world.

2. **ATP, the Energy Currency of Life.** The energy cycle of all living organisms involves the molecule adenosine triphosphate (ATP), which stores and releases chemical energy related to electron flow across a membrane. From the early 1960s through 1994, the Energy Biosciences program at DOE and its predecessors supported Dr. Paul D. Boyer's research at the University of California at Los Angeles on ATP synthase, the enzyme responsible for synthesizing ATP. His research examined the detailed chemical reactions involved in ATP synthesis and the roles specific parts of the ATP synthase enzyme complex played in converting the energy in electron flow into chemical energy in the form of ATP. In 1997, the Nobel Prize in Chemistry was awarded to three biochemists – Dr. Boyer of the United States and Dr. John E Walker of the United Kingdom for "elucidation of the enzymatic mechanism underlying the synthesis of adenosine triphosphate (ATP)," and Dr. Jens C. Skou of Denmark for "the first discovery of an anion-transporting enzyme, Na+, K+-ATPase."

3. **Tau Lepton Discovery.** Discovery of the tau lepton at SLAC in the late 1970s (for which Martin Perl won the1995 Nobel Prize) established the existence of the third generation of leptons (weakly interacting particles). The final establishment of the tau as a lepton was

achieved by measuring its lifetime with the invention of a new detection method (the vertex detector method), which was also used for lifetime measurements of mesons containing the charm and beauty quarks.

Continuation of trends in maintenance and recapitalization funding will exacerbate the cost of operating and maintaining SC laboratories. Section 5 of this report provides a preliminary projection of the funding needs for the next 10 years to revitalize the laboratory facilities, improve hiring and staff retention, and ES&H compliance.

3.2 Changing Research Focus and Methodology

The research missions in SC laboratories have been changing and evolving continuously over the last 50 years, and this change is accelerating in the computer age. Change in research focus and technology necessitates infrastructure improvements.

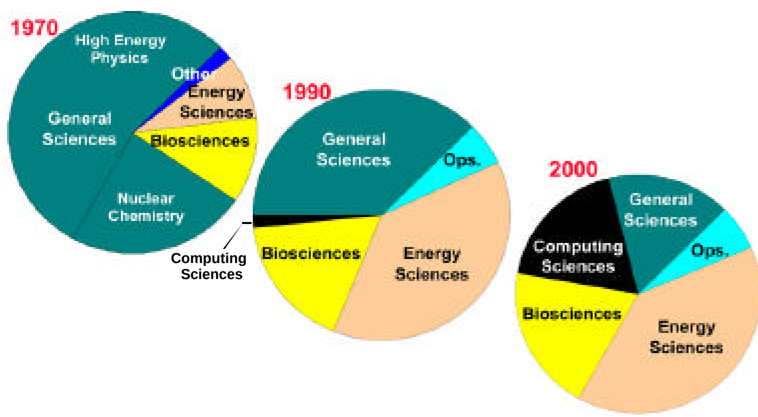


Exhibit 3-6 Changing Research and Technology in LBNL

Exhibit 3-6 shows changes in technology and research areas at LBNL, which is typical of SC's laboratories. LBNL's buildings, systems, and layout have limited the laboratory's ability to address science's new frontiers, take advantage of new research technologies and limited researcher access. ORNL has evolved from a defense mission in the early 1940's, to a nuclear energy development mission in the 1950's and 1960's, to science and energy missions in the last 30 years without significant recapitalization for mission needs. Similarly, BNL is the former WWII Camp Upton site and most of the wooden buildings there are 1940's construction.

Changing research methodology requires different space configurations and versatile equipment to conduct research. Research today is far more equipment-intensive than in the past, and facilities need to be more flexible in accommodating rapidly changing equipment configurations with different utility and infrastructure requirements.

Recent examples are the shift to genomics and proteomics research; nanoscale science, engineering, and technology; advanced computational modeling and simulation; and understanding the workings of microbes at the molecular level.

There has been a significant increase in utilization of SC's scientific user facilities, including particle accelerators, high-flux neutron sources, synchrotron radiation light sources, and other specialized facilities. Each year, more than 15,000 university-, industry-, and government-sponsored scientists conduct cutting edge experiments at these facilities. These visitors require office space, laboratory and experiment preparation space, and other support facilities (e.g., check-in center, conference center, telecommunications, housing).

3.3 Changing Work Practices and Impact of Information Technology

Modern laboratory space requires being increasingly flexible, scalable, and sustainable to accommodate changing work practices and the impact of information technology in the areas of computing and networking infrastructure. Increasingly, research is being performed from remote locations (e.g., co-located work centers, scientists working off-site). Twenty-first century researchers must be able to manage and monitor experiments at locations remote from where the experiments are actually being performed, transfer large data files, obtain remote access to high-speed computers, and communicate with each other by video teleconferencing and other means. A reliable, expandable, high-capacity, cost-efficient information technology and computing and networking infrastructure has become a necessity for the research missions.

Modern research and the digital revolution require upgrades in utilities and infrastructure to keep up with new technologies for computing, information sharing, and telecommunications. Older spaces require nearly continuous upgrading of wiring, computer local area network (LAN) connections, and electrical power supplies. These needed changes have not been systematically funded; laboratories have been forced to draw heavily on their overhead funds to make required changes.

3.4 Staff Recruitment and Retention

Increasingly, staff recruitment and retention is becoming difficult in part due to aging and deteriorating facilities. World-class researchers will not want to work in a converted Army barracks or even a 40-year-old lab building that has never seen a major renovation. These personnel losses are impacting SC's leadership in science. Many facilities are near the end of their life cycle. They also lack the laboratory equipment, modern lighting, ventilation/cooling, and space high-level research staffs require. As noted in the laboratories' SFPs, infrastructure problems have affected staff retention and recruitment in the following ways:

- The private sector is luring away key research personnel with better-equipped research facilities.
- Post doctorates have indicated they are leaving or intend to leave because of inadequate facilities.
- Recruits often compare DOE laboratory facilities with what they experience in the private sector, and reject offers; experienced research staff will not accept substandard facilities.

3.5 Site Layout

Many SC laboratory facilities were built using a traditional, dispersed, office/laboratory space layout in which researchers work in isolation. Buildings tend to be small (90 percent are less than 20,000 gross square feet) are dispersed across the sites, result in increased operation and maintenance (O&M) costs. Today's research craves multi-discipline, collaborative environments. These environments require technology zones that collocate related equipment, information technologies, and workflows to enhance the organizational culture of the collaborators. This collocation provides savings from the consolidation of multiple facilities and promotes idea exchange among scientists and engineers with resulting improvements in innovation.

3.6 Environment, Safety and Health (ES&H) and Security

SC laboratories put a very high priority on protecting the health of workers, communities, and the environment, and complying with all applicable Federal, state, and local regulations. Many of the upgrades in the SFPs have been driven by ES&H requirements that are difficult to reliably meet with 35- to 50-year old electrical, HVAC, and water treatment equipment.

Exhibit 3-7 shows environmental releases as a rate based on the number of releases per 200,000 hours worked. An environmental release is defined as the controlled, uncontrolled, or accidental release of radionuclide, hazardous substance, regulated pollutant, or oil that must be reported to a Federal, state, or local agency or exceeds what is expected as a result of normal operations. From April 1999 to April 2000, approximately 40 percent of SC's environmental releases were associated with infrastructure: natural gas leaks, oil and hazardous material spills, refrigerant loss, and sewage treatment problems.

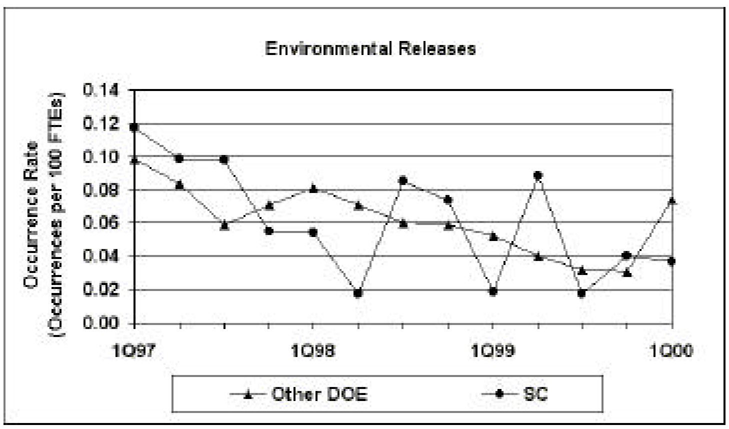


Exhibit 3-7 Environmental Releases at SC and Other DOE Laboratories

SC laboratories must devote scarce infrastructure resources to labor-intensive administrative controls and inspections to maintain environmental compliance in older facilities. They must also dedicate infrastructure resources to simple, basic safety maintenance, such as repairing stairs and rails. This basic safety maintenance is one part of the escalating maintenance costs associated with facilities more than 30 years old. Deactivated or excess facilities incur ES&H costs as well. Inactive facilities must be maintained to safety standards and be monitored for environmental compliance, particularly when they house radioactive control areas. Appendix C contains exhibits which provides a preliminary estimate of the amount of resources needed to transfer contaminated facilities to EM. Retaining these building sites in the SC portfolio will incur O&M costs just to prevent and limit environmental releases and maintain the facilities in a safe, shutdown condition. Maintenance and monitoring costs can be minimized by early funding of Decommissioning and Decontamination (D&D) efforts, as called for in the SFPs.

Security, including cyber security, was one of the drivers for the information technology architecture upgrades recommended in the SFPs. Consolidation of a laboratory's onsite facilities into a series of campuses fosters positive conditions for synergy and increased collaboration but also facilitates patrolling and monitoring by security staff. It solves the problems of employees working in remote, isolated laboratories. Cyber security in the SC laboratories, for the most part, does not involve national security issues. SC servers have been subject to mischief, such as viruses, spamming, and denial-of-service attacks. These attacks can lead to loss of vital research data costing millions of dollars to repair or replace. SC laboratory SFPs call for upgrades of information technology architecture to include firewalls, biometric authentication, virtual local area network (VLAN) security, voice recognition, and vicinity identification.

4.0 APPROACH TO PREPARING THE NEEDS ASSESSMENT

4.1 Basis for Establishing Needs (SC Vision of "Laboratories of Distinction" for the 21st Century)

Each laboratory was asked to consider and define a Vision for the future of their research and science programs for the 21st Century in support of the DOE mission. Using that Vision, the laboratories were asked to establish multi-discipline planning groups to determine and to project their infrastructure needs based on their first-hand knowledge of the impact that infrastructure has on the quality of science and people in effectively achieving their goals.

DOE's Strategic Plan identified four substantive strategies that guided the laboratories as they developed their needs assessment:

- Provide leading research facilities and instrumentation expanding the frontiers of the physical and natural sciences, with emphasis on accelerators and detectors for high-energy and nuclear physics; light sources and neutron beam facilities; and specialized scientific facilities.
- Advance scientific computation and simulation as a fundamental tool for discovery, with emphasis on science applications software, ultra-high performance computation and communications facilities, and computer science and enabling technologies.
- Strengthen the Nation's institutional and human resources for basic science and multidisciplinary research, with emphasis on the national laboratory system, disciplines essential to our missions, scientific and technical information access and use, science education, and broadening the scope of research performers.
- Identify infrastructure needs of the SC laboratories to ensure their continued viability to perform DOE research missions into the 21st century by correcting long-standing facilities, infrastructure and site layout deficiencies, and anticipating the changing nature of research activities and their concomitant facilities needs while achieving excellence in environment, safety, and health, energy usage, sustainable design, functionality, utilization, cost effectiveness, working environment, and a world class research setting.

Laboratories identified the facilities and infrastructure projects needed to support the planned research activities. The plan focused on existing facilities. If a laboratory determined the nature of the research would change in terms of new programs or new research activities within a program, the laboratory was asked to identify the trends and their expected impacts on facilities and infrastructure. The laboratories also identified facilities and infrastructure condition and operational and performance issues that must be addressed to meet the modernization goal and objectives stated above. SC program office staff then reviewed the proposals and made further modifications to project lists.

4.2 Benefits of Modernization

An up-to-date modern environment for conducting research must be able to accommodate:

- *Collaborative Research* - requires facility modifications in order to accommodate the advancements in science and the way modern research is conducted. Many of the facilities, built to accommodate the type of research equipment and collaborations of the 1950's, 1960's, and 1970's, do not serve the modern approach to research. This approach requires more collaborative space, different types of equipment, and the user facility concept. Changes in physical size and layout need to accommodate computer equipment for modeling support, as well as bench top and wet chemistry capability to experimentally test the modeling theory.

- *Technology Evolution* - requires different types of space and more equipment to conduct research. Research today is far more equipment-intensive than in the past and changes in facility structures are required to be more flexible in accommodating equipment configurations with different utility and infrastructure requirements.

- *Technology Zoning* - drives facility modifications to enhance the ability to co-locate synergistic research activities and to eliminate conflicting interference among sensitive technology studies and experiments. Advancements in equipment with higher levels of detection/sensitivity require significant improvements in noise, vibration, temperature, and other environmental factors to ensure the accuracy of reported data.

The Integrated Workplace concept relies heavily on "smart" infrastructure (that is infrastructure appropriate for the task at hand) and on continuing attention to the relationship of working conditions to productivity. The Integrated Workplace approach helps develop facilities that support changing business practices by involving all those affected by the workplace, maximizing worker productivity and job satisfaction. This approach to designing smart buildings combines work practice innovations and technology, including expanded use of the Internet and advanced computing with skillful management to maximize return on investment and make better use of limited resources – namely people, space, time, and money.

Projects for general purpose laboratory facilities with modern capabilities that consolidate cross-disciplinary research staff, especially for older inadequate facilities, foster increased scientific productivity. They also ensure a rapid response to new DOE mission areas and evolving national issues. Continuing to provide support to the 60 Nobel Laureates and to future prize winning scientists, in outdated facilities, is a great challenge.

4.3 Assumptions

For this survey, it was assumed operating funding for each laboratory would grow by no more than inflation during the 10-year planning period, though mission mix could change substantially. If different overall funding was assumed, it had to be agreed upon by the cognizant SC program office. Operating funding assumptions were provided in each laboratory's plan.

Also, the plans identify operating funding needed for removal of retired facilities, preparation of facilities for transfer to the Office of Environmental Management, etc. All activities were listed and prioritized. Demolition costs (if any) for buildings to be replaced by a new building were included in the proposed new building cost estimate.

The laboratories also incorporated the following design and construction principles:

- Provide for flexibility, e.g., interior design facilitates the dynamic changes in the scientific programs associated with the site; versatility, e.g., interior space/layout is adaptable, with minimal modification and relocation, for new programs and personnel; durability and longevity, e.g., construction materials and technology used will yield structures with a lifetime greater than 50 years without major renovation.

- Incorporate state-of-the-art sustainable design principles regarding selection of building materials and furnishings, construction techniques, energy and water conservation, habitability features, etc., where economically feasible.

- Ensure proposed investments yield what the laboratory considers to be a significant high rate of return (i.e., > than 10 percent) and help reduce O&M costs.

4.4 Process

SC and its laboratories followed the process briefly outlined below:

1. Each laboratory created or employed an in-house planning process to identify and assess their proposed list of projects for the purposes of their Strategic Facilities Plan.

   - Integrate Organization Goals into the Capital Decision Making Process.

     - Conduct a comprehensive assessment of needs to meet results-oriented goals and objectives in DOE Program Plans, other strategic plans, and laboratory Institutional Plans.

     - Identify current capabilities, including capital assets utilization and condition.

     - Determine the "gap" between the capacity of current assets and needed capabilities.

   - Evaluate and Select Capital Assets Using an Investment Approach.

     - Decide how best to close the "gap" by identifying and evaluating alternative infrastructure improvement or financing approaches, including non-capital approaches and third party funding.

     - Establish, review, and approve framework supported by analysis.

     - Assess investments as a portfolio.

     - Use an executive review committee (and decision-support software as appropriate) to make final recommendations.

     - Develop measurable goals and performance metrics.

2. Following receipt of the individual SFPs from the laboratories, SC applied the following process to prepare this report:

   - Office of Laboratory Operations and Environment, Safety and Health confirmed the receipt of each SFP and reviewed it for consistency with the provided guidance.

   - The cognizant program offices (e.g., Offices of Basic Energy Sciences, High Energy and Nuclear Physics, Fusion Energy Sciences, and Biological and Environmental Health) were asked to review and discuss the SFPs with their laboratories.

   - Follow-up discussions were held with each laboratory where information was unclear or not complete. In some cases, revised SFPs were submitted. Each final SFP was placed on the web: http://www.sc.doe.gov/production/er-80/er-82/labs21/ .

   - A master database was prepared and maintained. Changes to the database were made as mutually agreed upon.

   - A joint meeting was held with the Program Associate Directors' representatives to review each site's proposed LIs to determine the appropriateness for inclusion in the Report.

   - The Director of SC and the Program Associate Directors were briefed on the summary charts and listings and issues.

   - The Report was prepared and reviewed by the Program Associated Directors and was submitted to the Director, Office of Science for approval.

5.0 SUMMARY OF RESOURCE PROJECTIONS

This section summarizes the Resource Projections submitted by SC Laboratories in their individual SFPs. Exhibit 5-1 shows the breakdown of projected resource needs by funding source. Each is discussed below.

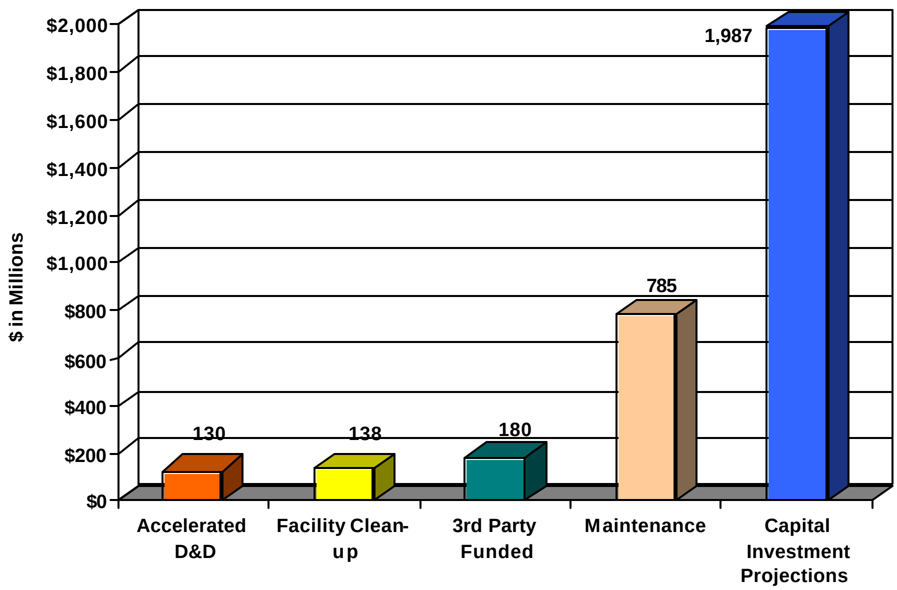
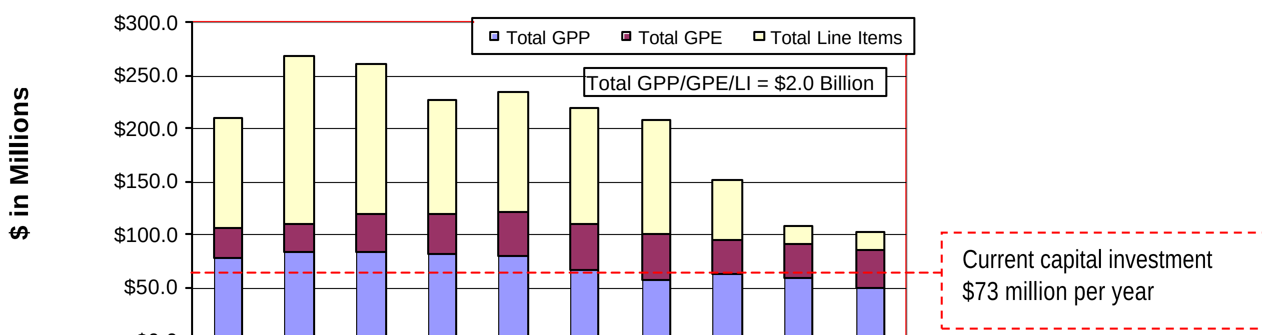


Exhibit 5-1 Revitalization Resource Projections

5.1 Capital Investment Projections

Capital investments rehabilitate and replace the general purpose infrastructure that serve all programs at the laboratory. Capital investments are funded as: General Plant Projects (GPP), which are projects under $5 million, General Purpose Equipment (GPE), which is capital equipment, and Line Items (LI), which are projects that are $5 million or more. All are directly funded by SC. Exhibit 5-2 shows the projected funding levels in the SFPs required to modernize the laboratories over the 10-year planning scenario. The capital investment projection for the 10-year period is about $1.95



	FY02	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11
Total Line Items	103.9	158.4	141.0	107.3	111.8	110.6	107.1	57.7	17.0	17.6
Total GPE	27.5	26.8	36.7	37.0	41.4	42.0	44.2	31.8	33.0	34.0
Total GPP	77.8	82.8	83.1	81.6	80.4	67.1	56.3	62.5	58.3	50.4
Total	$209	$268	$261	$226	$234	$220	$208	$152	$108	$102

Exhibit 5-2 Capital Investment Resource Projection to Support Requests

billion. Current investment levels (FY01) <u>if maintained</u> would provide $730 million of this total leaving a substantial $1.25 billion un-funded requests.

Exhibit 5-3 shows LI resource needs by project type. Appendix D contains a complete list of line-item projects from the SFPs. The bulk of the LI projections, $768 million of the $932 million, are to rehabilitate and replace inadequate/obsolete buildings.

5.2 Maintenance Operating Funds

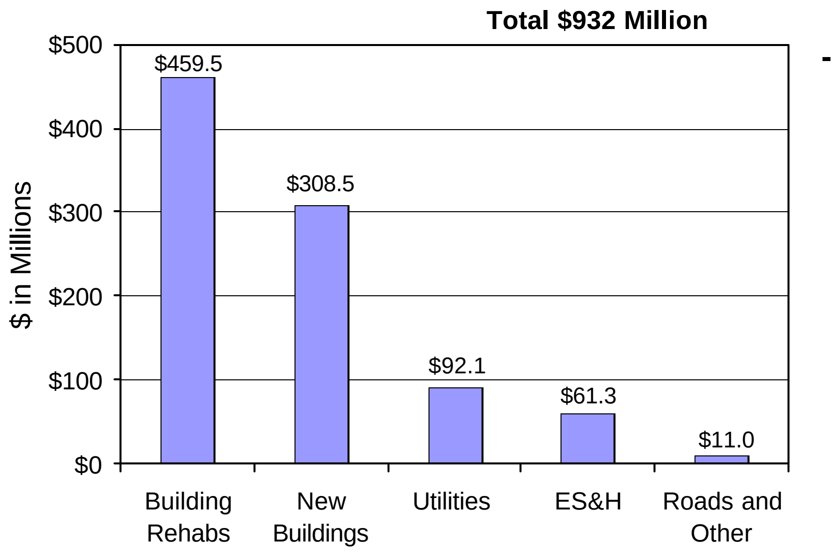


Exhibit 5-3 Line Item Project Type

Maintenance operating funds are used for general laboratory maintenance, which includes routine maintenance, repairs, and replacements. Maintenance as defined here does not include janitorial, snow removal, grounds work, etc., and is consistent with the definition in the DOE Facilities Information Management System. Exhibit 5-4 compares actual and projected maintenance spending with university, industry and Federal guidelines for maintenance. Actual maintenance spending in

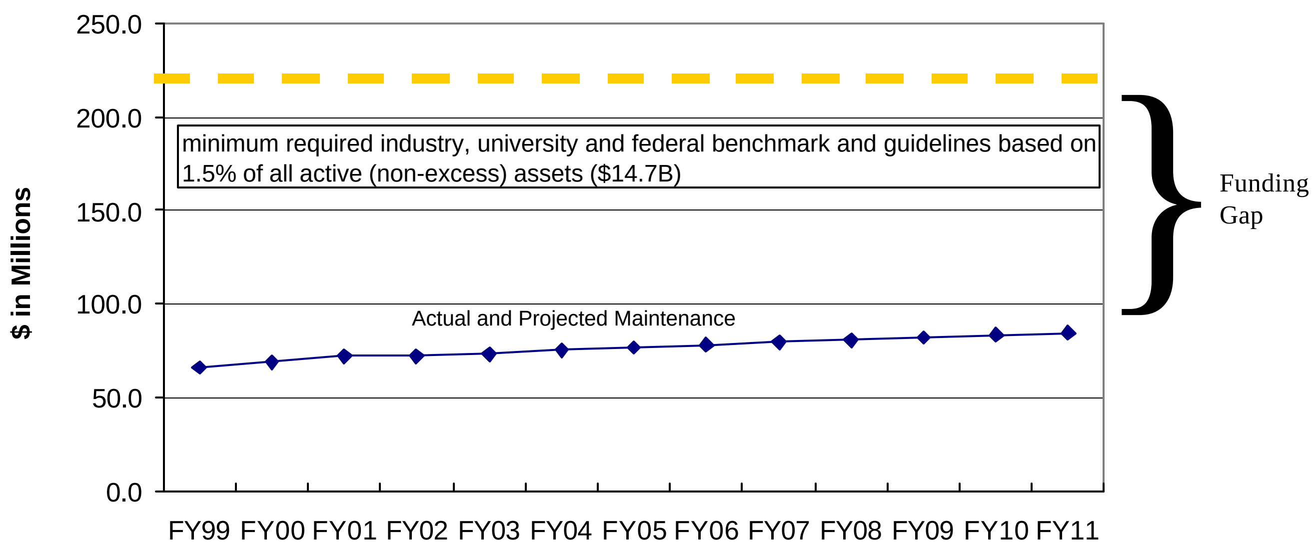


Exhibit 5-4 SC Laboratory Maintenance Resource Projection Compared to Actual and Projected Maintenance Funding (FY 02 Dollars)

2000 (the last year for which complete data are available) was $69 million, and is projected to grow at approximately 5 percent per year through FY11 (essentially, a little above inflation). As seen in Exhibit 5-4, actual and projected maintenance funding is still far below the lowest university, industry, and Federal guidelines and benchmarks of 1.5 to 4 percent.[5] This funding

[5] The industry benchmark is 1.5 to 3 percent and the National Research Council recommendation for federal facilities is 2 to 4 percent for the first 30 to 40 years of facility life. The average for universities per the Association of Higher Education Facilities

gap is partially filled by the use of capital funds (GPP, GPE, and Line Item) to replace system, subsystems and components of existing facilities. This reduces capital available to replace entire facilities. To some extent, this level may reflect financial restrictions put in place many years ago that required the use of capital funds for replacements above a certain size or number (i.e., retirement units). The gap also reflects effort by DOE to level or reduce laboratory "over-head" as a percentage of overall funding.

5.3 Excess Facility Retirements

These funds provide operating funds for excess facility retirements at the SC laboratories to reduce ES&H liabilities and S&M costs, and to free up real estate for future use.

This survey identified about $138 million for normal facility retirements addressing two kinds of facilities as follows:

- **Contaminated facilities – EM performs D&D:** Funding is provided to perform surveillance and maintenance of contaminated excess facilities, as well as other deactivation activities needed to prepare them for Decontamination & Decommissioning (D&D) by the Office of Environmental Management (EM) e.g. stabilization/removal of hazardous and radioactive materials and waste remaining in the facilities.

- **Non-contaminated facilities – SC performs D&D:** Current DOE policy states the facility owner program (i.e. not EM) is responsible for D&D of all non-contaminated facilities. Therefore, SC must fund the removal of these facilities. Although not contaminated, these old, deteriorating facilities still present significant ES&H hazards and should be removed.

Also identified in this survey was about $130 million for accelerated facility retirements placing the final clean up of certain excess facilities on a more accelerated schedule than currently planned. Some SC laboratories noted in their SFPs that expediting D&D of excess facilities will save millions in S&M and environmental compliance costs and free up valuable real estate for other uses. The number of facilities stated they could benefit by not delaying D&D for a decade or longer. The associated funding requirements need further study. A preliminary list of candidate projects typical of those to be considered has been prepared and includes:

- $50 to $90 million Bevatron complex D&D at LBNL which will free up vital real estate for future facilities unavailable elsewhere onsite.

- "300 Area Accelerated Closure Plan" at Hanford/PNNL - If EM does not obtain funding, $40 million of SC funds would be needed to complete this plan. If the accelerated closure plan is not funded, an additional $20 to $30 million would be required to implement the PNNL strategic infrastructure plan for utility and facility revitalization needs in the 300 Area.

Additional funds for demolition are included in the cost estimates of new projects for the removal of old facilities being replaced.

Officers (APPA) is 3.14 percent. These levels assume that systems, subsystems and component replacements are funded as maintenance.

5.4 Third Party Projects

Third party projects are funded by the private sector, non-profit organizations, and state or local governments. These funds complement Federal spending, by providing critically needed facilities such as utilities, laboratory and office buildings, visitor centers, and housing for visiting researchers. Exhibit 5-5 is a preliminary list of projects identified to be financed by third-parties. Additional opportunities for third party financing will be sought out.

Exhibit 5-5 Projected Projects to be Funded by Third Party Financing[6]

Projects	TEC ($ in Millions)
ANL-E	
Steam Supply Upgrade	14.0
TOTAL ANL	**14.0**
BNL	
Short-Term Housing I	15.4
Long-Term Housing I	26.9
Short-Term Housing II	15.5
Long-Term Housing II	26.9
TOTAL BNL	**84.7**
ORNL	
Joint Institute for Biological Sciences	8.0
Joint Institute for Computational Sciences	6.0
OR Center for Advanced Studies	4.0
Joint Institute for Neutron Sciences	8.0
Computational Science Building	10.8
Engineering Technology Building	10.8
Research Office Building	15.0
TOTAL ORNL	**62.6**
PNNL	
Visitor Center	19.0
TOTAL PNNL	**19.0**
TOTAL ALL PROJECTS	**180.3**

Energy Savings Performance Contracts (ESPC) & Utility Incentive Programs (UIP) are a form of third party financing wherein an energy savings contractor or utility will make capital improvements that yield energy savings. Many of the laboratories are using such approaches;

[6] Other SC laboratories are also considering Third Party Financing. There are some possibilities at SLAC for independent financing of laboratory/office and other types of buildings. The third party financing will be provided by Stanford University in several forms. Presently, discussions are underway with Stanford University on building a much-needed User Lodging Facility for the convenience of the large user community at SLAC. The University, from fees paid by the guests, would recover the construction costs.

Fermi's Utility Incentive Program (UIP) will result in substantial 3rd party funding for utility improvements and will result in associated operational savings that will be used to fund the program.

TJNAF is considering Third Party Financing for office and storage buildings to replace leased space and aging trailers.

however, the total impact on the overall infrastructure needs are minor at this time because major energy savings projects for the most part have already been accomplished.

6.0 NEXT STEPS

In order to develop and implement an infrastructure modernization roadmap (Exhibit 6-1), SC and its laboratories are proposing to undertake a series of tasks to aid in program formulation and implementation, including project prioritization, fund allocation, and performance metrics. Examples of these next steps are:

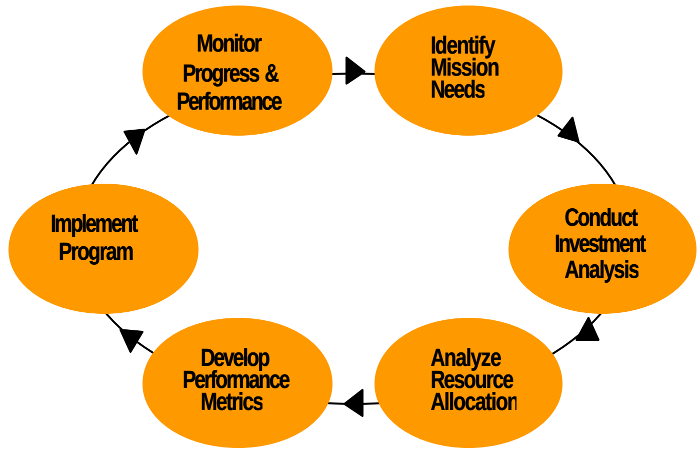


Exhibit 6-1 DOE SC Laboratory Infrastructure Modernization Roadmap

- Identify Mission Needs and Prioritize Projects – update and refine the list of candidate infrastructure projects to the highest priority and most beneficial infrastructure revitalization options. This could be accomplished by developing a prioritization protocol capable of handling multi-attribute decision making with the help of computer software. Apply prioritization and evaluation protocol to each project proposed by the laboratories.

- Conduct Investment Analysis – ensure proposed investments yield what the SC and the laboratories consider to be a significant high rate of return on its investment. Creative alternative funding approaches would be considered, such as the development of guidance for use of and tracking the use of Energy Savings Performance Contracts (ESPC) and UIP third party financing for utility upgrades (i.e., process for evaluating and selecting the best option for the specific laboratory).

- Analyze Resource Allocation – develop a strategy for program-wide and site-specific infrastructure modernization funding and seek executive and legislative branch commitment for a long-term funding plan to rebuild the national laboratory infrastructure. The Laboratory Stewardship Committee and SC Stewardship Council will review the laboratory submittals.

- Develop Performance Metrics and Monitor Progress and Performance – implement program with tailored performance metrics and measure progress.

  - Jointly develop, by way of a working group comprised of laboratory and DOE SC headquarters and field personnel, a set of performance metrics measuring the infrastructure modernization program against the overall goals and needs. Such a working group may draw from private industry and Federal agencies and conduct benchmarking studies or evaluate metrics used by other sectors (e.g., technology firms, academic institutions). Although qualitative measures can often best describe performance, such measures are difficult to benchmark. Appendix E contains quantitative performance-based metrics which have been suggested to address the use and condition of laboratory assets relative to the research requirements.

- Allow laboratories, SC, and other stakeholders to determine the status of any ongoing infrastructure project for project management and capital asset planning/programming purposes.

- Reassess – repeat this process on a periodic basis in order to reevaluate and update infrastructure modernization roadmap based upon progress and changing needs.

Appendix A – Profile of SC Laboratories

The following table provides an overview of SC laboratory missions, funding, and infrastructure statistics.

SC Laboratory	FY '01 Budget Request by Program (Thousands)		Infrastructure at a Glance	
Ames Laboratory (Ames) is a national center for the synthesis, analysis, and engineering of rare-earth metals and their compounds. Ames conducts fundamental research in the physical, chemical, and mathematical sciences associated with energy generation and storage.	ASC	$1,571	**Total Number of Buildings:**	10
	BES	$16,165	**Total Number of Trailers:**	0
	OBER	$525	**Average Age (Years):**	36
	Total:	**$18,261**	**Total Gross Square Feet:**	324,501
			RPV:	$101.3M
Argonne National Laboratory (ANL) is a multiprogram national laboratory with research projects in basic energy sciences, computer science, bioscience, nuclear physics and technology, and energy-efficient technologies for transportation and industrial sectors.	ASC	$11,958	**Total Number of Buildings:**	107
	BES	$160,726	**Total Number of Trailers:**	19
	HEP	$11,055	**Average Age (Years):**	31
	MEL-FS	$6,660	**Number of Excess Facilities:**	13
	NP	$16,965	**Total Gross Square Feet**	4,636,508
	OBER	$20,780	**Land Acreage:**	1,508
	OFES	$2,270	**RPV:**	$1,632M
	PD	$900		
	Total:	**$231,314**		
Brookhaven National Laboratory (BNL) is a large, multiprogram laboratory with large-scale advanced research facilities. Over 4,000 visiting scientists from the U.S. and abroad come to BNL each year to use its facilities.	ASC	$1,504	**Total Number of Buildings:**	390
	BES	$75,769	**Total Number of Trailers:**	381
	HEP	$38,844	**Average Age (Years):**	33
	MEL-FS	$6,659	**Number of Excess Facilities:**	16
	NP	$145,743	**Total Gross Square Feet:**	4,237,543
	OBER	$16,758	**Land Acreage:**	5,320
	PD	$600	**RPV:**	$3,471.1M
	Total:	**$285,877**		
Fermi National Accelerator Laboratory (Fermi) is a single-program laboratory leading the nation in construction and operation of large facilities for research in high-energy and particle physics.	ASC	$200	**Total Number of Buildings:**	335
	ERA	$60	**Total Number of Trailers:**	112
	HEP	$282,730	**Average Age (Years):**	36
	Total:	**$282,990**	**Number of Excess Facilities:**	1
			Total Gross Square Feet:	2,214,987
			Land Acreage:	6,800
			RPV:	$1,406.3M

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SC Laboratory	FY '01 Budget Request by Program (Thousands)		Infrastructure at a Glance	
Lawrence Berkeley National Laboratory (LBNL) is a multiprogram laboratory providing advanced experimental and computational systems to support research in molecular interactions, biochemistry, genomics, energy resources, and environmental science.	ASC	$64,457	**Total Number of Buildings:**	110
	BES	$68,537	**Total Number of Trailers:**	56
	ERA	$75	**Average Age (Years):**	31
	HEP	$37,786	**Number of Excess Facilities:**	0
	MEL-FS	$2,113	**Total Gross Square Feet:**	1,684,283
	NP	$17,250	**Land Acreage:**	200
	OBER	$40,532	**RPV:**	$747.0M
	OFES	$7,655		
	PD	$500		
	Total:	**$238,905**		
Oak Ridge Institute for Science and Education (ORISE) is an academic and training facility providing specialized scientific and safety training to DOE and other institutions. ORISE is an international leader in radiation-related emergency response and epidemiological studies.	ASC	$20	**Total Number of Buildings:**	20
	BES	$1,114	**Total Number of Trailers:**	1
	HEP	$150	**Average Age (Years):**	40
	NP	$650	**Number of Excess Facilities:**	4
	OBER	$4,079	**Total Gross Square Feet:**	$221,704
	OFES	$800	**RPV:**	$352.3M
	PD	$1,700		
	Total:	**$8,513**		
Oak Ridge National Laboratory (ORNL) is a multiprogram laboratory with unique capabilities in materials science and engineering, neutron science, energy production, mammalian genetics, and ecological research. ORNL has won 96 awards from R&D magazine, a total exceeded only by General Electric and NASA.	ASC	$6,719	**Total Number of Buildings:**	428
	BES	$372,644	**Total Number of Trailers:**	90
	ERA	$40	**Average Age (Years):**	31
	HEP	$240	**Number of Excess Facilities:**	4
	MEL-FS	$6,627	**Total Gross Square Feet:**	3,412,446
	NP	$16,120	**Land Acreage:**	1100
	OBER	$29,144	**RPV:**	$4,948.0M
	OFES	$17,621		
	PD	$800		
	Total:	**$449,955**		
Pacific Northwest National Laboratory (PNNL) is a multi-program laboratory sponsoring research and technology development aims to prevent or mitigate pollution and climate change. Much of PNNL's research directly supports the cleanup of the Hanford Reservation.	ASC	$2,210	**Total Number of Buildings:**	71
	BES	$12,295	**Total Number of Trailers:**	2
	ERA	$300	**Average Age (Years):**	37
	HEP	$0	**Number of Excess Facilities:**	37
	OBER	$65,312	**Total Gross Square Feet:**	1,024,655
	OFES	$1,385	**Land Acreage:**	960
	PD	$750	**RPV:**	$361.4M
	Total:	**$82,252**		

SC Laboratory	FY '01 Budget Request by Program (Thousands)		Infrastructure at a Glance	
Princeton Plasma Physics Laboratory (PPPL) is a collaborative national center dedicated to plasma and fusion science. PPPL has a leading international role in developing the theoretical, experimental, and technology innovations need to make fusion practical and affordable.	ASC HEP OFES **Total:**	$200 $120 $70,219 **$70,539**	**Total Number of Buildings:** **Total Number of Trailers:** **Average Age (Years):** **Number of Excess Facilities:** **Total Gross Square Feet:** **RPV:**	38 0 22 2 728,062 $170.6M
Stanford Linear Accelerator Center (SLAC) is a national user facility for high-energy physics using electron beams in a two-mile long linear accelerator and synchrontron radiation related research. SLAC has over 1200 users in the high-energy physics program, and 1300 scientists in its synchrotron radiation program.	ASC BES HEP OBER OFES PD **Total:**	$450 $31,592 $157,257 $3,500 $0 $150 **$192,949**	**Total Number of Buildings:** **Total Number of Trailers:** **Average Age (Years):** **Total Gross Square Feet:** **RPV*:** * does not include RPV for other structures and program equipment	186 0 21 1,808,013 $500M
Thomas Jefferson National Accelerator Facility (TJNAF) is a national user facility for nuclear science using continuous beams of high-energy electrons to discover the underlying quark and gluon structure of nucleons and nuclei. TJNAF has 1,600 users, about half of which are actively engaged in experiments at a given time.	ASC NP PD **Total:**	$200 $74,715 $150 **$75,035**	**Total Number of Buildings:** **Total Number of Trailers:** **Average Age (Years):** **Total Gross Square Feet:** **RPV:**	64 103 11 660,000 $164M

Appendix B – Detailed List of Age Distribution and Infrastructure Summary by SC Laboratory

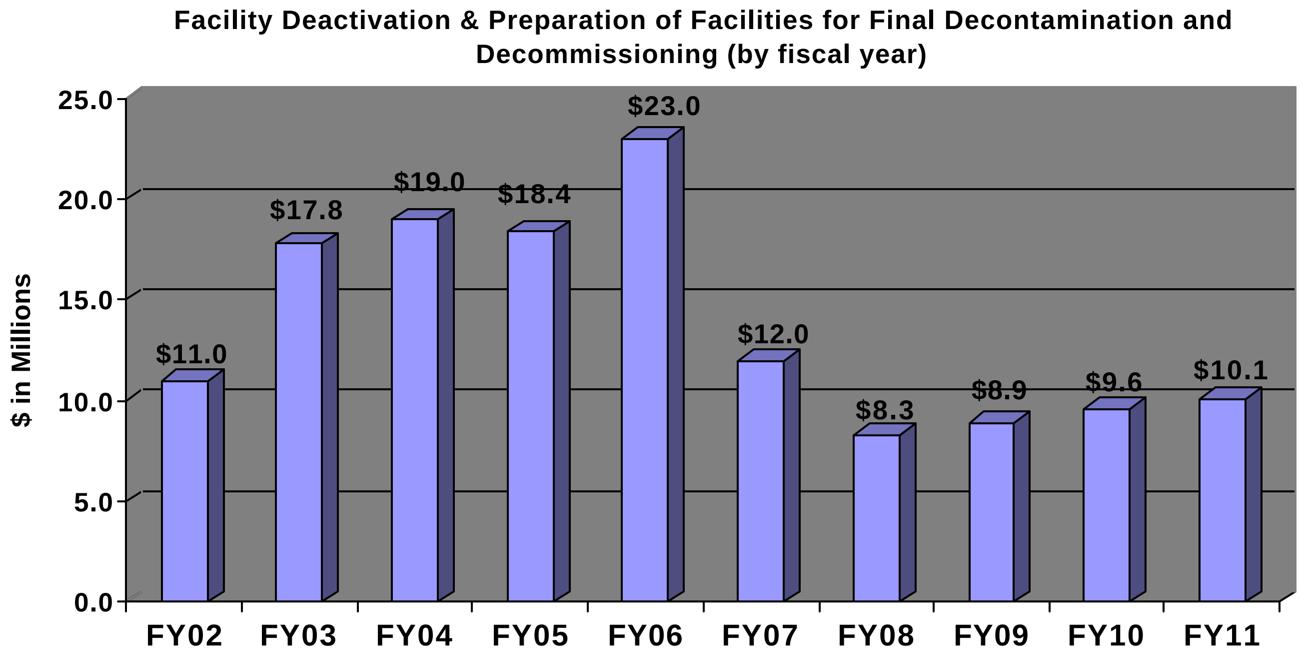
Exhibit B-1. Age of Space Distribution at SC Labs
(Gross square feet)

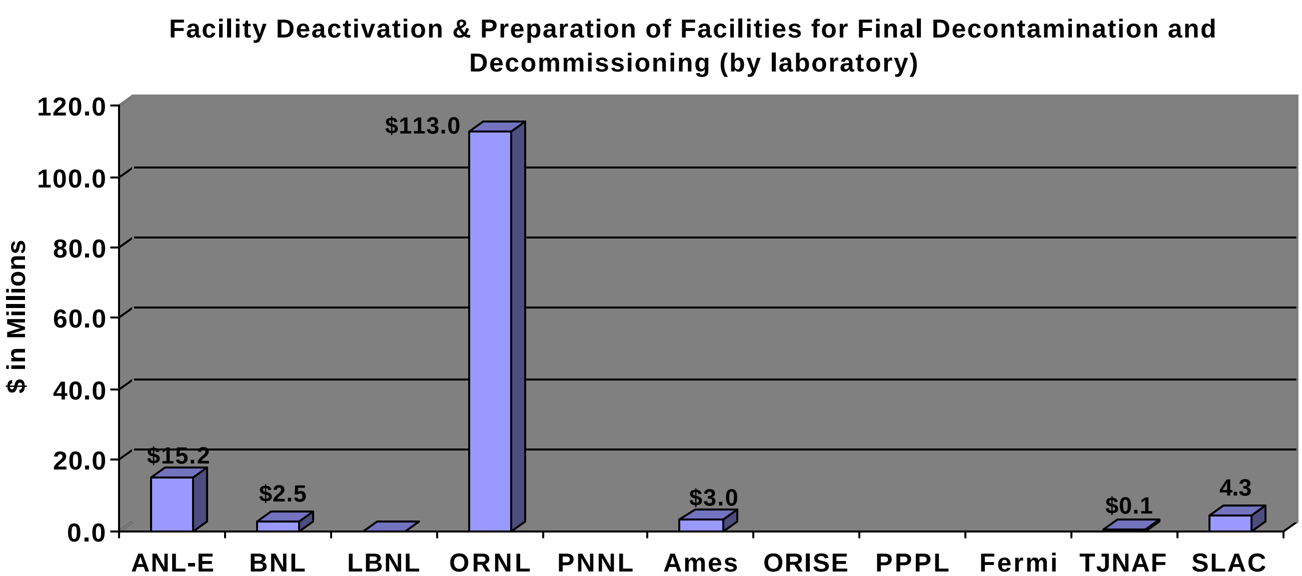
Laboratory	0-10 yrs.	11-20 yrs.	21-30 yrs.	31-40 yrs	41-50 yrs.	50+ yrs.
Ames	46,991	0	0	111,650	107,630	58,230
ANL-E	1,156,315	323,665	105,628	1,315,351	1,640,402	101,277
BNL	364,393	661,057	27,385	1,159,474	745,915	1,397,916
Fermi	121,368	570,686	856,480	455,218	0	78,485
LBNL	184,023	203,138	84,719	672,597	349,908	22,436
ORISE	1,931	0	19,844	43,638	0	156,291
ORNL	270,408	320,356	209,686	839,745	1,339,779	456,376
PNNL	212,384	27,423	208,170	148,302	370,756	59,115
PPPL	20,665	413,592	50,030	20,546	226,513	0
SLAC	73,102	457,685	192,128	1,085,098	0	0
TJNAF	446,000	105,000	0	109,000	0	0
TOTAL	2,897,570	3,082,593	1,754,061	5,960,610	4,780,903	2,330,126

Exhibit B-2. Infrastructure Summary of SC Laboratories

Laboratory	RPV BLDGS ($M)	RPV OTHER ($M)	RPV TOTAL ($M)	# of Buildings	No of Trailers	# of Occupied Trailers	Building Gross Sq Ft	Avg. Age of Buildings
Ames	71.5	29.8	101.3	10	0	0	324,501	36
ANL-E	1,089.0	543.0	1,632.0	107	19	10	4,636,508	31
BNL	3,471.1	592.8	2,613.7	390	381	61	4,237,543	33
Fermi	350.4	1,055.9	1,406.3	335	112	94	2,214,987	36
LBNL	548.0	199.0	747.0	110	56	43	1,684,283	31
ORISE	34.0	318.3	352.3	20	1	0	221,704	40
ORNL	4,942.6	5.4	4,948.0	428	90	29	3,412,446	31
PNNL	361.0	0.4	361.4	71	2	2	1,024,655	37
PPPL	170.6	0.0	170.6	38	0	0	728,062	22
SLAC	500.0	250.0	750.0	186	0	0	1,808,013	21
TJNAF	149.0	15.0	164.0	64	103	38	660,000	11
TOTAL	$11,687.2	$3,009.6	$13,264.6	1,759	766	275	20,952,702	

Appendix C – Preliminary Assessment of Surplus Facility Clean-Up Costs





Appendix D – List of Line Item Projects by Laboratory

Multiprogram Laboratory	Project Title	TEC ($ Millions)	Fiscal Year
ANL-E	Mechanical and Control Systems Upgrades - Phase I - IV	38.1	FY02 to FY 07
ANL-E	Building Electrical Service Upgrades - Phase II - V	32.3	FY02 to FY07
ANL-E	Sitewide Chiller Upgrades	6.0	FY03
ANL-E	Laboratory Space Upgrades - Phases I - IV	49.0	FY03 to FY08
ANL-E	Building Roof Replacements	8.0	FY04
ANL-E	Site Wide Communications System (SWCS) Upgrade	7.5	FY04
ANL-E	Roads/Parking/Walks/Street Lighting Upgrade	11.0	FY04
ANL-E	Fire Safety Improvements - Phase V	6.0	FY04
ANL-E	Building 362 Asbestos Abatement	5.0	FY05
ANL-E	Electrical System Upgrade - Phase IV	10.5	FY06
	SUBTOTAL	**$173.4**	
BNL	Energy Sciences Building	17.0	FY03
BNL	Research Support Center, Phase I	18.2	FY03
BNL	Building Roof Replacements	11.6	FY03
BNL	Chilled Water System Replacement, Phase II	11.0	FY04
BNL	Research Support Center, Phase II	13.4	FY04
BNL	Support Shops Complex Complex - Admin	5.5	FY04
BNL	Renovate Science Labs, Phase I	29.3	FY04
BNL	Central Steam Distribution Sys. Replacement, Phase I	8.0	FY04
BNL	Research Support Center, Phase III	17.0	FY05
BNL	Renovate Science Labs, Phase II	14.3	FY05
BNL	Halon Replacement	5.0	FY05
BNL	Research Support Center, Phase IV	9.2	FY06
BNL	Renovate Science Labs, Phase III	25.3	FY06
BNL	Potable Water System Replacement, Phase II	8.0	FY06
BNL	Support Shops Complex - Bldgs	6.7	FY07
BNL	Renovate Science Labs, Phase IV	22.9	FY07
BNL	Central Steam Distribution Sys. Replacement, Phase II	8.0	FY07
BNL	Electrical System Modifications Replacement, Phase III	10.0	FY07
BNL	Flexible Science Labs	22.8	FY08
BNL	Renovate Science Labs, Phase V	23.4	FY08
BNL	Sanitary System Modifications Replacement, Phase IV	10.0	FY08

Multiprogram Laboratory	Project Title	TEC ($ Millions)	Fiscal Year
BNL	Fire Protection Replacement, Phase IV	5.3	FY08
BNL	Support Shops Complex - Utilities	6.7	FY09
BNL	Renovate Science Labs, Phase VI	12.2	FY09
BNL	Surface Water	5.0	FY09
BNL	Safeguards & Security	12.0	FY10
BNL	Fire Protection Replacement, Phase V	5.0	FY10
BNL	Materials Handling Center	12.6	FY11
BNL	Fiber Optic Cables for SFAS	5.0	FY11
	SUBTOTAL	**$360.4**	
LBNL	Operations Building	13.1	FY02
LBNL	Rehabilitation of Site Mechanical Utilities, Phase 2	8.2	FY02
LBNL	Research Support Building	24.0	FY03
LBNL	Building 77 Rehabilitation of Building System	8.5	FY03
LBNL	Engineering Support Facility	14.5	FY04
LBNL	Replace Building 25 (Seismic Stability)	19.0	FY05
LBNL	Environmental, Health and Safety Support Facility	15.5	FY06
LBNL	Training Center and Auditorium	16.0	FY07
LBNL	Site Support Service Facility	9.5	FY08
LBNL	Replace Building 73	14.0	FY09
	SUBTOTAL	**$142.3**	
ORNL	Research Support Center	16.0	FY02
ORNL	4500N/S Area	148.5	FY02 to FY09
ORNL	Laboratory Fac Vent Sys Upgr - Phase I	10.0	FY03
ORNL	Manipulator Repair Facility	12.0	FY04
ORNL	Primary Substation Upgrades, ORNL	7.4	FY04
ORNL	Potable Water Sys Upgrade - Phase I	7.0	FY05
ORNL	Laboratory Fac Vent Sys Upgr - Phase II	8.5	FY06
ORNL	Potable Water Sys Upgrade - Phase II	7.0	FY07
	SUBTOTAL	**$216.4**	
PNNL	Rehabilitation of 320 Building Infrastructure	7.4	FY02
PNNL	Laboratory Systems Upgrades	9.0	FY02
PNNL	Laboratory Systems & Rehabilitation Upgrade	9.7	FY03
	SUBTOTAL	**$26.1**	

Multiprogram Laboratory	Project Title	TEC ($ Millions)	Fiscal Year
TJNAF	Cebaf Center Addition (office space)	7.9	FY06
TJNAF	Cebaf Center Addition (office space)	5.9	FY08
Ames	None at this time	0.0	
ORISE	None at this time	0.0	
PPPL	None at this time	0.0	
Fermi	None at this time	0.0	
SLAC	None at this time	0.0	
	SUBTOTAL	**$13.8**	

SUMMARY	
Laboratory Type	**TEC ($ Millions)**
Multiprogram	**$918.6**
Program Dedicated	**$13.8**
SUBTOTAL	**$932.4**

Appendix E -- Preliminary List of Quantitative Performance-based Metrics

This appendix identifies a preliminary list of metrics that could be used to measure and track progress in the infrastructure program.

Investment and Condition Performance Measures - Goals could be established for capital investment and maintenance investment along with appropriate performance measures. For example, with respect to infrastructure capital investment, possible performance measures providing management with information to benchmark against others are identified below:

- Recapitalization Rate - the number of years it would take to replace/rehabilitate the existing GPI. This rate is computed by dividing the replacement plant value of the GPI by the annual capital investment level (composed of GPP, GPE and general purpose LIs). At the current funding level of $55M a year for GPP/GPE and LI construction for the SC multiprogram laboratories, it would take 181 years to replace and rehabilitate the GPI. Industry rates are 30 to 50 years.

- Modernization Index – the ratio of the unfunded requests of GPI needs over a 10-year period needed to upgrade and modernize the laboratories to the current funding level if maintained over the 10-year period. Preliminary results from this report indicate an Index of 2.4 ($1.25B unfunded requests versus current funding of $550M over ten years). An acceptable level would be 1 or less.

With respect to maintenance investment, possible performance measures could be:

- Maintenance Investment Rate - the percentage of real property maintenance funding to the replacement plant value of the general purpose facilities and infrastructure. The average for SC multiprogram laboratories is less than .6 percent whereas 1.5 percent to 4 percent is considered an acceptable range for "staying in business."

- Deferred Maintenance Trend – trends in deferred maintenance level for all buildings except those considered surplus over the years. Deferred maintenance is planned maintenance that could not be performed and is postponed. It does not include the cost to replace existing facilities and must be based on a consistent and well-executed condition assessment program. Current SC deferred maintenance levels for buildings only has been rising and is $277M as of October 31, 2000.

Other possible measure related to Condition/Suitability/User Satisfaction could be:

- User Satisfaction Index – survey of laboratory management, employees and building managers as to the usability and functionality of their buildings and supports systems. This survey could be expanded to include sponsors as well.

- Deficiency Correction Index - Square footage (SF) of replaced facilities (including Demolition) divided by SF rated "Replacement Needed" in FIMS. This metric provides direct assessment and benchmarking of efforts to correct the most serious deficiencies. Replacement of these structures is a paramount concern as these structures are significant

ES&H problems, they are exceptionally costly to maintain, and they have significant negative impacts on overall site utilization rates.

- Deferred Maintanance Index - $ Deferred Maintenance divided by $RPV. This widely used metric provides insight into the effectiveness of the maintenance program. This metric measures the relative cost of remedying maintenance deficiencies listed in the deferred maintenance backlog and conveys condition information.

- Facilities Suitability Index - SF of Suitable Space divided by Total SF of Space. This metric provides insight into the management of space. This metric measures the percent of space that is suitable for its current use.