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Los Alamos National Laboratory Institutional Plan

FY 1983—FY 1988

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1. DIRECTOR'S OVERVIEW

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I. DIRECTOR'S OVERVIEW

In the past, Los Alamos National Laboratory was a multidisciplinary laboratory with one job--to design and test nuclear weapons. Since those early days of one job and one sponsor, we have become a laboratory with multiple tasks and sponsors. Although our largest single program still is weapons research and development, we also have substantial programs in energy, health, environment, and basic scientific research. There is hardly an area in the physical and life sciences in which we cannot rapidly respond to specific national needs.

This Institutional Plan is based on our primary mission, the advancement and application of science and technology in programs that contribute to a strong national defense, but it also emphasizes fulfilling arms control commitments and guaranteeing a secure energy supply for the future. The foundation for this mission is a staunch science and technology base composed of the many talents of our scientists and engineers and our unique facilities. We will continue developing the broad staff capabilities and the specialized facilities needed for work on important national security issues.

The Past Year

In FY 1982 we saw continued growth and strengthening of Defense Programs, increased support for Energy Research, and significant decline in national priorities for Nuclear Energy, Solar, Geothermal, and Conservation programs. Our worst expectations were not realized, since the Laboratory was able to obtain new programs. In spite of major changes, such as loss of the Molecular Laser Isotope Separation program, we maintained relative stability in our scientific and technical staff.

Our role, mission, and capabilities have been examined by various panels, boards, and committees such as the Energy Research Advisory Board (ERAB). These reviews are beneficial because they provide a basis for communicating our strengths and potential contributions to national needs to a broader audience.

This past year was one of significant scientific accomplishments. During FY 1982, we at Los Alamos achieved the following:

- The number of nuclear weapons tests was increased, and successful tests were conducted at extreme temperatures.
- In life sciences, we were designated by the National Institutes of Health as a national resource for flow cytometry and a national Genetic Sequence Data Bank (GENBANK).

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- The Tritium Systems Test Assembly (TSTA), for the development and demonstration of tritium technology required for fusion energy programs, was completed.
- An extremely sensitive x-ray detector for x-ray sources in space was developed, which could also lead to reductions in medical x-ray dosage.
- A cooperative agreement with Mexico for the exchange of information in nuclear energy research was signed.
- New laser techniques for applied problems such as monitoring gases in coal gasifiers were successfully applied.
- Preliminary studies of parallel processing computers, which promise greatly increased computing speeds, were completed.
- Very high speed photoconductive detectors for diagnostic measurements at the Nevada Test Site were developed.

In addition, we accomplished several institutional management tasks. These major accomplishments, which occurred during the last three years, include the following:

- Our approach to administering the nuclear weapons program was completely reformulated and restructured.
- Three research centers were established: the Institute for Geophysics and Planetary Physics, the Center for Nonlinear Studies, and the Center for Materials Science.
- Institutional Supporting Research and Development as an investment strategy for future programs was implemented.
- Fellow and Senior Fellow positions were created, with our first appointments made in 1980.
- The Distinguished Performance Awards program was initiated to recognize outstanding employee contributions.
- A long-range facility and site development plan was completed.
- The Laboratory publication process was streamlined, which included creation of the Los Alamos Science, the Annual Report, and the Public Affairs Office.
- A review of management information systems needs was conducted, and preliminary steps toward implementation were initiated.

- An employee orientation program was reinstituted.
- A coordinated review process for construction projects was established.

Looking to the Future

Our commitment to maintaining the nation's nuclear deterrent continues. Programs reflected in this Plan will allow weapons R&D to grow slightly through 1984 and then continue at stable levels. We anticipate some growth in verification and control activities in support of arms control measures. Thus the national security programs at Los Alamos should remain the major source of overall Laboratory stability in the foreseeable future.

We are concerned about the downward trend in the Office of Energy Research (OER) sponsorship for Los Alamos research. Although we project relatively level support beyond FY 1982, we are below historical levels. The historically broad base of supporting research at Los Alamos has been a key factor in our ability to provide innovative technical solutions to national problems. We must not allow this capability to deteriorate.

A crucial area of uncertainty, with potential loss of Laboratory programs, continues to be in energy technology R&D. The Administration's basic policy is that much of the energy R&D previously conducted by the government would be better carried out by private industry, except for certain high-risk, long-term programs that are appropriate for Federal funding. We are not certain that this transition is indeed occurring. Although we stand ready to assist, we fear that many valuable resources paid for by public dollars will be lost. In the meantime, we feel that support for nuclear energy programs at the Laboratory is an important and appropriate Federal investment in the future of nuclear power.

The national debt and deficit continue to symbolize the pressures facing government economic policy. We expect the Administration to continue its efforts to reduce Federal spending and to interpret more clearly the Federal role in energy R&D to assure that long-term, high-risk R&D is supported with Federal funds. Our best strategy in this environment is to protect and maintain the quality of the Laboratory's scientific and engineering capabilities as new national priorities are established.

The overall effect of these changes is that, although we experienced a modest decline in the total number of full-time equivalents (FTEs) from our peak of approximately 7,200 in FY 1982, we expect to support approximately 6,900 FTEs in 1983. Beyond 1983 we project a total laboratory staff of 7,000 FTEs, which could vary by 100 to 200.

New Pursuits

We anticipate that our major areas of emphasis will remain the same, but the details of our activities may change substantially. The Laboratory cannot do everything that we or our sponsors may wish us to do. We are limited by the size and capabilities of our staff and our facilities. However, we do have some choice in determining those areas of science we strengthen or maintain and the relative emphases placed on them. Our decisions concerning programs will be based on technical and scientific challenge, suitability for the Laboratory, long-term prospects, and the relative benefits to the nation. We prefer programs that will take three to ten years to complete, so we can apply our staff and facilities effectively.

We believe that our multidisciplinary capabilities, our record of successes, and our defense orientation make us well suited for certain new pursuits. We would like to accomplish several activities at Los Alamos in the next few years:

- increased Basic Energy Sciences support in chemical and materials sciences;
- increased OER support of basic research in plasma and particle physics, magnetic fusion, medium-energy physics, underground science, and neutrino research;
- substantial Department of Defense (DoD) support of accelerator technology, free-electron lasers, conventional munitions, defense energy security, and counterterrorist technology;
- continued growth in our analytical capability to assist intelligence agencies;
- a strong role in assisting the Department of Energy (DOE) with technical direction for a new production reactor; and
- nuclear reactors for space and defense applications.

To help stabilize our staff in the face of declining programs, we will pursue opportunities with other Federal and state agencies and particularly with industrial concerns that can use our science and technology base. Our goal is to make the Laboratory's science and technology base available to industry, consistent with the DOE guidelines of assuring that such efforts do not conflict with our primary mission. We do not expect that these activities will exceed 15% of Laboratory effort.

Maintaining and Using Laboratory Facilities

Many of our facilities were constructed in the early 1950s and so are expensive to maintain. Under current budgetary constraints and with very few new construction projects approved, we are unable to replace old facilities as needed. Therefore, as our facilities grow older, we must invest the resources needed to maintain them at acceptable performance levels. We are trying to acquire additional maintenance funds and to devote a larger fraction of our budget to maintaining and upgrading these facilities.

Planning Ahead

Institutional Planning continues to be a useful tool for Laboratory management. We are striving to improve our internal planning during each annual planning cycle. However, a mechanism should be found in DOE to avoid reissue of outlay associated with multiyear appropriations. More consistent adherence to the DOE's forward financing policy is needed. Effective R&D, which occurs over a period of years, cannot be accomplished in an environment of continual budget uncertainty. Long-term R&D projects require consistent year-to-year funding, permitting project leaders to focus their attention on technical management rather than on pursuit of next year's funds.

Implementing the ERAB recommendations for two-year funding and for allowing Laboratory Directors to reprogram a small fraction of the funds in their financial plans would be major contributions to more effective use of R&D funds. We strongly support these recommendations.

The institutional planning and budgeting process would be improved if DOE could realize its goal of a coordinated long-range planning and budgeting process that includes setting long-range goals, defining major missions for laboratories and field offices, and permitting greater discretion at the laboratories. Such long-range planning should result in mutual commitment to accomplishing the goals of multiyear programs.

Donald M. Kerr, Director

II. LABORATORY ROLE AND MISSION

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II. LABORATORY ROLE AND MISSION

A. Mission

The primary mission of the Los Alamos National Laboratory since its founding in 1943 has been the advancement and application of science and technology in national security programs. During the Manhattan Project, the goal was to develop and build the world's first nuclear weapon. The Laboratory's mission now is much broader; namely, support for our military posture of nuclear deterrence, our arms control commitments, and our need to provide a secure energy supply for the future. Thus the first part of our mission statement is

- to advance science and technology and to apply them in programs that contribute primarily to the maintenance of a strong defense, and also to the fulfillment of arms control commitments, and the guarantee of a secure energy supply for the future.

A strong science and technology base is the foundation for our success in implementing our mission. Los Alamos researchers have designed 65 percent of the weapons in the nation's stockpile, including all new strategic-warhead designs entering the stockpile since 1979 -- the W78 for Minuteman III, the W76 for the C4 missile on Trident and Poseidon submarines, and the W80 for cruise missiles. In addition, Los Alamos is providing the baseline warhead (W78) for the proposed MX missile, the designs for the B61 strategic bombs, the Navy's ship defense Standard Missile-2 warhead (W81), and the Pershing II (airburst/surface burst W85 and earth penetrator W86 warheads). Each leg of the American triad of deterrence is supported by these new designs.

We must also continue to develop the multidisciplinary capabilities and specialized facilities necessary to solve important national security problems. The second part of our mission statement is then as follows:

- To ensure that this mission is fulfilled, the Laboratory will maintain and enhance a vital scientific research and technology base and remain alert and responsive to new demands for solutions to emerging national problems.

B. Role

The Laboratory role is best defined by our relation to others and the character of our programs and facilities. Therefore, the Los Alamos National Laboratory

- is an integral scientific and technical element of the nation's nuclear weapons program;

Los Alamos

- provides the nuclear design and associated research, development, and test activities for all phases of a nuclear weapon from concept development through stockpile maintenance and retirement;
- contributes multidisciplinary skills for solving national problems;
- emphasizes basic science, engineering, and technological innovation;
- conducts basic and applied research and development;
- undertakes long-term, complex programs;
- has unique facilities;
- engages in technical initiatives with universities, industry, and foreign governments; and
- supplies informed and independent scientific opinion.

III. DESCRIPTION OF THE LABORATORY

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III. DESCRIPTION OF THE LABORATORY

Los Alamos National Laboratory is one of the nation's foremost scientific research institutions; it encompasses 125 facilities on 43 square miles of mesas and canyons in the Jemez Mountains of northern New Mexico. These facilities and their associated equipment occupy nearly 4.5 million square feet of floor space and would cost approximately three billion dollars to replace. The Laboratory was established in 1943 as part of the Manhattan Project to develop the first nuclear weapons; it diversified to include nonnuclear research in the early 1970s. Today our research includes nuclear weapons design, development, and testing; magnetic and inertial fusion; nuclear fission; nuclear safeguards and security; solar, fossil, and geothermal energy; energy conservation; environmental sciences; and basic research in physics, chemistry, mathematics, engineering, computer, and life sciences.

The Laboratory's operating budget for the fiscal year ending September 30, 1982, was \$497 million; an additional \$77 million was allocated for capital equipment and construction. Nearly 50 percent of this budget went toward salaries and benefits for the Laboratory's 6,800 full-time employees.

About 2700 of the Laboratory's FTEs hold one or more college degrees, distributed approximately as follows:

<u>By Degree</u>		<u>By Degree Field</u>	
PhD	51%	Physics	33%
MS	25%	Engineering	33%
BS	24%	Chemistry	13%
		Math & Computer Science	8%
		Other	13%

Los Alamos is managed by the University of California for the United States Department of Energy.

A. Laboratory Strengths

Among the unique strengths of the Laboratory are weapons research, the capability to fabricate complete weapons, the plutonium facility, the Los Alamos Meson Physics Facility (LAMPF), accelerator technology and particle beams, explosives science research, and the Central Computing Facility. These strengths are well matched to our mission.

1. Weapons Research

We examine the vulnerability of our strategic weapons deterrent as well as the effects of one nuclear blast on another from the aspect of recent scientific advancements. Such fundamental work cannot be done as effectively

anywhere else in the Western world and may well prove essential to the nation's future defense and deployment of MX missiles. The Laboratory is striving to improve its working knowledge of high-explosives (HE) assembled devices, device performance, weapon output, thermonuclear weapon behavior, and pure fusion research, which will enhance substantially our design capabilities for future weapons.

2. Capability to Fabricate Complete Weapons

It is a source of pride at Los Alamos that our prototype devices are so well engineered that few changes are required when they go into production. One reason for this is that we have the knowledge, skills, and facilities to completely fabricate a weapon at Los Alamos. This requires that we not only employ gifted scientists and technologists but also talented engineers who understand the production process.

3. Plutonium Processing

The plutonium facilities plant was designed and constructed to meet the latest DOE criteria for plutonium operations. These facilities are the most complete and versatile research and development plutonium facilities in the country. The technical staff has a wide range of expertise in the fields of plutonium metallurgy and chemistry and has the laboratory equipment to make outstanding technical achievements. Their work has produced a number of notable "firsts," including purification, preparation, and fabrication of plutonium and its alloys; plutonium parts for the first nuclear weapons (including all associated metallurgy and chemistry); development of recycling operations for the reclamation of plutonium from the scrap; preparation of the core for the first plutonium-fueled nuclear reactor; preparation of the first "medical grade" ^{238}Pu ; preparation of the first prototypical SNAP and artificial-heart isotopic power sources; preparation and studies on the first plutonium ceramic and cermet materials; and preparation of the plutonium analytical standard for the National Bureau of Standards.

4. Los Alamos Meson Facility (LAMPF)

We operate an 800-MeV, 1-mA proton accelerator, LAMPF, as a unique international nuclear facility. LAMPF research includes fundamental studies of weak interactions, muonic x-rays, strong force (pion-nucleon) interactions, nucleon-nucleon scattering, studies of muon-induced activation, chemical structure effects on meson capture, properties of proton-rich nuclei far from stability, nuclear chemistry studies, and radiation damage studies. A design study is under way for an extension of the facility to higher energy, which will provide important new capabilities for research in LAMPF II nuclear and particle physics. We have given very high priority to the use of pi mesons for cancer radiation therapy in a program funded by the National Cancer Institute. The LAMPF accelerator is also used to inject protons for neutron

production into a new facility, the weapons neutron research (WNR) pulsed neutron source. The Proton Storage Ring (PSR), now under construction, will make the WNR the best pulsed neutron source in the world. The application of neutron scattering techniques to a broad range of problems in condensed matter science is an important new area of our materials science programs.

5. Accelerator Technology and Particle Beams

Los Alamos National Laboratory is extending the science and art of subatomic particle accelerators to a wide spectrum of contemporary needs:

We are building a PSR that will be used in conjunction with LAMPF and WNR to make the world's most intense pulsed neutron source.

We are building a very high intensity deuteron accelerator for the Fusion Materials Irradiation Test program.

We are designing an efficient high-power, free-electron laser that will operate at 10.6 μm .

We are investigating the defense applications of particle beams.

We are building an electron microtron accelerator in collaboration with the National Bureau of Standards that will demonstrate basic technology for high-intensity electron machines for physics research.

We developed, under a National Cancer Institute program, the components of a hospital-based accelerator for cancer therapy using pions. This technology can serve a variety of needs by altering the configuration of the component parts. Pions, neutrons, or light-to-heavy ions could be provided for radiotherapy. Radioisotopes also could be produced in copious quantities.

We place heavy emphasis on the development and application of a major new type of accelerator structure, the radio-frequency quadrupole (RFQ), that has attracted attention around the world.

We are developing electron linac components and systems for a wide range of radiographic applications, for example, a machine that could obtain x-rays of turbine engines operating under simulated flight-maneuver conditions on a centrifuge.

6. Explosives Science Research

The explosives science research program at Los Alamos seeks to establish (1) a fundamental understanding of explosives behavior, (2) more accurate determination of explosives behavior, and (3) the discovery of new explosive materials with unique properties and capabilities. Our research includes

reactive hydrodynamics, synthetic chemistry, analytical chemistry, physical and thermal chemistry, chemical physics, and molecular physics.

7. Central Computing Facility

Since the development of the first atomic bomb, scientists at Los Alamos have relied heavily upon numerical calculations to design nuclear weapons. The detonation of a nuclear weapon involves complex, interacting physical processes that occur simultaneously. Exact solutions of equations that include all the interactions are beyond present capabilities. Consequently, designers must rely on numerical approximation methods to solve the problems, and there is always a demand for the next generation of computers. The first Cray Research supercomputer ever produced was installed at Los Alamos in March 1976. A second Cray-1 was installed in 1979. Los Alamos scientists have demonstrated that the Cray-1 can execute as many as 100 million floating-point operations per second on frequently occurring computational tasks (such as solving partial differential equations). By upgrading the memory of one of its Cray-1s in 1981, Los Alamos became the first installation whose users have the benefit of a multimillion-word Cray-1.

B. Long-Range Trends and Projections

During the past decade the Laboratory experienced a relatively high growth rate, approximately 7% per year. Near the end of that growth period, constraints to our physical abilities to pursue new programs became apparent. Although we pursued many exciting and challenging programs during this period, the unplanned growth led to crowding conditions and the need to use facilities under nonoptimal conditions. This lack of optimum facilities and space, compounded by transportation problems, etc., has led us to conclude that the Laboratory should maintain a relatively constant size of approximately 7,000 FTEs for the foreseeable future. Currently, however, growth is not our major problem. Indeed, maintaining a level of 7,000 FTEs has been our major focus of attention in the last 2 years. We must continually balance between closing down low-priority programs and seeking new initiatives which will maintain the desired level.

Figure III-1 depicts activity by Assistant Secretary. National Security programs comprise approximately 53% of the efforts of the Laboratory. Approximately 17% of our efforts are devoted to Energy Research, and 9% is devoted to Nuclear Energy. The remaining 21% of Laboratory efforts are spread over a number of small programs for DOE and non-DOE sponsors.

Figure III-2 depicts historical and projected personnel levels broken down by Direct and Indirect personnel. We plan to maintain a ratio of approximately 23% Indirect to Total Laboratory personnel during the planning period.

Figures III-3 and III-4 show recent trends and future projections for program mix and for overall Laboratory growth. In order to assure continuing

turnover of programs and thus the maintenance of vital and challenging technical and scientific programs, we pursue a portfolio of new initiatives as shown in Table III-1. These new initiatives are discussed in detail in Section IV.

Defense Programs: As sponsoring Secretarial Officer for Los Alamos, the Assistant Secretary for Defense Programs (ASDP) funds programs in nuclear weapons, inertial confinement fusion, verification and control technology, nuclear materials safeguards and security, and nuclear materials production. DOE laboratories and contractors reporting to the ASDP sponsor a small number of additional projects at Los Alamos. In FY 1982 these programs comprised approximately 56% of the total Laboratory budget. Of this, 39% was weapons research, 7% was inertial confinement fusion, 2% was weapons production and surveillance, 3% was materials production, 2% was verification and control technology, 2% was nuclear materials safeguards and security, and the remaining 1% was defense waste management.

Defense Programs have shown a modest but continuing increase in level of effort during the past eight years (Fig. III-5). We expect this trend to continue and possibly accelerate somewhat as nondefense programs activities decline.

Energy Research: Major Los Alamos programs funded by the Office of Energy Research (OER) include basic energy sciences, health and environmental research, a large component in medium-energy nuclear physics, and magnetic fusion. These programs comprised approximately 14% of the total Laboratory FY 1982 budget. Basic Energy Sciences is 1%, Health and Environmental Research is 2%, Nuclear and Medium Energy Physics is 7%, and Magnetic Fusion is 4% of the total FY 1982 Laboratory efforts.

These programs show a slight decline in the past eight years (Fig. III-6). We would like to see this trend reversed and project an increase over the next five to eight years in Energy research.

Energy Programs: Nuclear Energy has suffered most significantly in the last two years as nuclear programs, particularly Laser Isotope Separation activities, have declined by more than 50% over previous levels (Fig. III-7). Although we do not expect to regain the peak in Nuclear Energy achieved in the late 70s, we would like to see our Nuclear programs, particularly Nuclear Safety and Advanced Concepts, increase by 400 FTEs.

Other DOE programs such as Solar, Geothermal, and Fossil energy grew significantly in the late 70s, peaked in the early 1980s, and are now declining to a modest level of 250 FTEs in the mid-to-late 80s (Fig. III-8). The decline in these programs, as well as Nuclear Energy, requires an emphasis on new initiatives, which we project will increase as we pursue non-DOE Work for Other Initiatives.

Fig. III-1. Activity by Assistant Secretary

Fig. III-2. Personnel Level

Fig. III-3. Major Technology Programs

INSTITUTIONAL PLAN FY 1983 - FY 1988

Fig. III-4

TABLE III-1

INSTITUTIONAL PLAN FY 1983 - FY 1988
PROPOSED INITIATIVES (FTE)

	FY82	FY83	FY84	FY85	FY86	FY87	FY88
<u>DEFENSE PROGRAMS</u>							
INTERNATIONAL TECHNOLOGY							
NEW PRODUCTION REACTOR	5	13	30	50	50	50	50
MILITARY ENERGY SECURITY		15	32	50	64	80	
<u>ENERGY RESEARCH</u>							
REVERSED FIELD PINCH (RFP)							
IGNITION TEST REACTOR/ ENGINEERING TEST REACTOR							
LAMPF II		8	16	32	48	60	70
NATIONAL UNDERGROUND SCIENCE FACILITY			5	10	13	13	13
NEUTRINO FACILITY		1	3	3	5	5	
<u>NUCLEAR ENERGY</u>							
REACTORS FOR DEFENSE AND SPACE APPLICATIONS	5	7	30	50	60	100	100
<u>CONSERVATION AND RENEWABLE ENERGY</u>							
FUEL CELLS		13	20	20	20	20	20
<u>FOSSIL ENERGY</u>							
UNCONVENTIONAL GAS			10	15	15	15	15
OIL SHALES AND TAR SANDS			7	9	10	10	10
COAL/WATER MIXTURES			4	8	8	8	8
<u>INTERNATIONAL AND ENERGY POLICY PROGRAMS</u>							
CARIBBEAN BASIN INITIATIVE							
U.S. - MEXICO COOPERATION							
<u>WFO - DoD</u>							
DIRECTED ENERGY	12	42	54				
TECHNOLOGY DEMONSTRATION ACCELERATOR			(CONSTRUCTION ONLY)				
FREE ELECTRON LASER			(CONSTRUCTION ONLY)				
COUNTERTERRORISM		4	8	10			
CONVENTIONAL MUNITIONS		3	20	30	40	40	40
TOTAL	20	106	239	357	353	401	326

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Fig. III-5

Fig. III-6

INSTITUTIONAL PLAN PROJECTIONS FY 1983 - 1988 NUCLEAR ENERGY

Fig. III-7

INSTITUTIONAL PLAN PROJECTIONS FY 1983 - 1988 ALL OTHER DIRECT PROGRAMS

Fig. III-8

TECH AREA NUMBER	NOMENCLATURE	REMARKS
TA-0	UNASSIGNED LAND RESERVE	
TA-1		REMOVED 1964-1965
TA-2	OMEGA SITE	
TA-3	SOUTH MESA SITE	
TA-4		REMOVED 1956
TA-5	BETA SITE	ABANDONED 1960
TA-6	TWO MILE MESA SITE	
TA-7	GOMEZ RANCH SITE	ABANDONED 1945
TA-8	ANCHOR SITE WEST	
TA-9	ANCHOR SITE EAST	
TA-10		REMOVED 1963
TA-11	K-SITE	
TA-12	L-SITE	ABANDONED 1953
TA-13	P-SITE	INCORPORATED WITH S-SITE
TA-14	Q-SITE	
TA-15	R-SITE	
TA-16	S-SITE	
TA-17		CANCELLED
TA-18	PAJARITO LABORATORY	
TA-19		REMOVED 1975
TA-20	SANDIA CANYON SITE	ABANDONED 1957
TA-21	DP-SITE	
TA-22	TD-SITE	
TA-23		REMOVED 1950
TA-24	T-SITE	INCORPORATED WITH S-SITE
TA-25	V-SITE	INCORPORATED WITH S-SITE
TA-26		REMOVED 1966
TA-27	GAMMA SITE	ABANDONED 1945
TA-28	MAGAZINE AREA A	
TA-29	MAGAZINE AREA B	ABANDONED 1957
TA-30		REMOVED 1948
TA-31		REMOVED 1954
TA-32		REMOVED 1954
TA-33	HP-SITE	
TA-34		CANCELLED
TA-35	TEN SITE	
TA-36	KAPPA SITE	
TA-37	MAGAZINE AREA C	
TA-38		CANCELLED
TA-39	ANCHO CANYON SITE	
TA-40	DF-SITE	
TA-41	W-SITE	
TA-42	INCINERATOR SITE	ABANDONED 1970
TA-43	HEALTH RESEARCH LABORATORY	
TA-44	LOS ANGELES SHOP	ABANDONED 1956
TA-45		REMOVED 1967
TA-46	WA-SITE	
TA-47	BR-SITE BRUNS RAILHEAD	ABANDONED 1958
TA-48	RADIOCHEMISTRY SITE	
TA-49	FRIJOLAS MESA SITE	
TA-50	WASTE MANAGEMENT SITE	INACTIVE
TA-51	RADIATION EXPOSURE FACILITY	
TA-52	REACTOR DEVELOPMENT SITE	
TA-53	MESON PHYSICS FACILITY	
TA-54	WASTE DISPOSAL SITE	
TA-55	PF-SITE	
TA-56	SUBTERRANEAN BASALT SITE	ABANDONED 1976
TA-57	FENTONHILL SITE	
TA-58	TWO MILE NORTH SITE	
TA-59	OH-SITE	PROPOSED

* APPROX. 32 MILES WEST OF LOS ALAMOS)

LEGEND

▨ ACTIVE TECHNICAL AREAS

17	9-29-80	REVISED TO STATUS OF 9-29-80	SV	
16	4-12-77	REVISED DWG. NO. (FORMERLY R2402)	MM	
15	10-5-76	REVISED TO STATUS OF 10-5-76	MM	
14	10-2-72	REVISED TO STATUS OF 10-2-72	CNA	
13	8-1-72	REVISED TO STATUS OF 8-1-72	LRA	
12	11-8-68	REVISED TO STATUS OF 11-8-68	DND	
11	1-10-63	REVISED TO STATUS OF 1-1-63	COF	
10	8-10-61	REDRAWN TO STATUS OF 8-1-61 (WAS ENG-R11)	DND	
9			W	

NO. DATE REVISIONS

LOS ALAMOS SCIENTIFIC LABORATORY
FACILITIES MANAGEMENT
UNIVERSITY OF CALIFORNIA - LOS ALAMOS, NEW MEXICO

TECHNICAL AREA LOCATION PLAN

CHECKED BY DATE DESIGNED BY DATE DRAWN BY DATE AS NOTED	RECOMMENDED BY DATE RECOMMENDED BY DATE RECOMMENDED BY DATE AS NOTED	APPROVED DATE DRAWING NO. ENG- R5101
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HEALTH SAFETY FIRE PROT. SEC.

AUTHORIZED FOR

IV. SCIENTIFIC AND TECHNICAL ACTIVITIES

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IV. SCIENTIFIC AND TECHNICAL ACTIVITIES

DEPARTMENT OF ENERGY PROGRAMS

A. Defense Programs

<u>B & R Code</u>	<u>Major Program (Title)</u>	(\$ in Millions - BA)		
		<u>FY 1982</u>	<u>FY 1983</u>	<u>FY 1984</u>
AR	Defense Waste Management	4.0	4.5	2.0
GB-01	Weapons Research	193.1	214.4	256.3
GB-02	Inertial Confinement Fusion	35.7	39.4	41.6
GB-03	Weapons Prod/Surveillance	10.0	8.7	8.5
GC	Verification & Contr Tech.	12.6	13.6	18.1
GD	Nuc Mtls Safeguards & Sec	8.8	8.8	12.5
GE	Materials Production	<u>13.1</u>	<u>13.8</u>	<u>30.6</u>
<u>Total</u>		277.3	303.2	369.6
Percent of Total Laboratory Funding		56	61	63

1. Current Defense Programsa. Weapons Activities

(1) Nuclear Weapons. The primary goal of the Los Alamos nuclear weapons program is the development of state-of-the-art nuclear weapons that will continue to ensure our national security commitments. Weapon requirements are determined through close interactions between the DoD, military services, their contractors, and the DOE Office of Military Application. Through the years, to meet these requirements we have developed warheads that are safer, smaller, more efficient, more reliable, and more survivable. Since 1979, all new strategic warheads that have entered the stockpile have been Los Alamos designs. These include the W76, W78, and the W80. We continue to provide designs for the B61 bomb, the warhead for the Navy's Standard Missile II (W81), and the airburst/surface burst warhead (W85) for the Pershing II. We are currently working on conceptual and feasibility studies for several future nuclear weapons systems, most notably the Trident II.

We have just completed the FY 1983 budget allocation process at Los Alamos for the nuclear weapons RD&T program. This process, initiated about a year ago, was designed to produce a weapons program aimed at responsiveness to programmatic needs, rather than what could be done for a fixed budget. It involved a complete restructuring of the program to try to enhance the balance in research, development, and weaponization activities so necessary in meeting

Los Alamos

our goals. Management of the program was also restructured to unite technical leadership and program management responsibilities.

The first of the three major categories, Research Activities, constitutes about 22% of the overall effort and is typically high-risk/high-payoff studies. The second category, Development Activities, is the technology base directed to improving state-of-the-art technologies available for applying to Weaponization activities, including our nuclear test execution activities. These constitute 51% of the total. The Weaponization category consists of 27% of the total and involves theoretical and engineering design, of current and future weapons, and management of the Los Alamos-developed portion of the stockpile.

The research category consists of three elements: institutional supporting research, new concepts, and weapons physics. This category is designed to be the generator of new ideas directed to high-risk research which, if successful, could lead to major improvements in our defense posture. Among our new research facility plans are the Proton Storage Ring to increase the capabilities of the Weapons Neutron Research facility for national defense studies using pulsed neutrons and a synchrotron beam line for improved x-ray physics measurements of importance to weapons work.

The development category is subdivided into six program elements: advanced design technology, computation, advanced weapons engineering, materials and fabrication, high-explosives technology, and test operations. The advanced technology element consists of theoretical and experimental studies to improve nuclear weapons technology directed toward reduced size and weight and increasing yield. The computation element strives to improve our modeling capabilities through advances in computer codes and the maintenance of existing codes. The advanced weapons engineering and materials and fabrication elements investigate problems, with the former specializing in the engineering and design areas and the latter concentrating on the materials aspects. All aspects of high explosives are studied in the high-explosives technology element. Studies on detonators, new classes of HE, safety, dynamic experiments, and chemical behavior of high explosives lead to safer and more efficient weapons systems. The last major program element in this series is test operations, which is the responsibility for the execution of our nuclear test effort.

The weaponization and applications category involves weapons studies, current weapons development, new production, and evaluation and maintenance of the stockpile. Weapons studies include our efforts in the areas of concept and feasibility studies of future weapons. In the current weapons program element, we include the development of specific weapon systems, such as the development of the warhead for the new Trident II missile.

With this new structure, during the past year we developed in-depth plans for the weapons program that specified directions, objectives and goals,

anticipated time scales, and resource requirements. This planning activity was performed from the bottom up and iterated back down through the performing organizations in reaching the final plan. This new planning process clearly revealed the condition that has been created in recent years by operating in a mode where the budget constrains the program. In the planning process, we identified activities by priority levels 1, 2, and 3. The complete plan totaled \$298 M, 40% greater than the FY 1983 Presidential budget mark. Detailed screening of the activities reduced the budget figure to \$240 M, which was still >\$30 M over the Presidential budget mark.

The \$242-M program was a lean, Priority 1 program. The trimming of this programmatic, Priority 1 program in the resource plan to fit within the \$211.9 M Presidential budget mark required difficult decisions, which again force us to live within a crisis environment. Because of this, our outyear projections for FY 1984 through FY 1988 are based upon our just-completed Priority 1 programmatic plan, assuming that in FY 1984 we are at that activity level which would be consistent with a \$240-M FY 1983 level. More detailed information regarding program content and plans for the nuclear weapons activities is available only in classified documents.

(2) Inertial Confinement Fusion. Los Alamos is actively engaged in the pursuit of inertial confinement fusion with the primary emphasis on evaluating CO₂ lasers as the driving energy source. The primary goals of the present program are (1) to examine and understand the ICF physics at a level needed to determine the scientific feasibility of CO₂ lasers as drivers for practical ICF targets, (2) to investigate weapons physics issues, and (3) to develop and implement plans to determine the feasibility of affordable future ICF drivers.

We are also involved as the lead laboratory in the investigation of heavy ion accelerators as a driver. This program is viewed as having primarily commercial applications, and funding under the Office of Energy Research is being sought for FY 1984 and beyond.

At the present time the central issue of the nation's ICF program is the demonstration of scientific feasibility through efficient thermonuclear burn of small fuel masses. This near-term objective must be accomplished before proceeding with any of the various long-range applications.

By the end of FY 1982, candidate target configurations were determined with Helios experiments. During FY 1983, a selection of the most promising target concepts will be made for the initial Antares tests. Experiments will begin with Antares in FY 1984. If target performance at the Antares energy level demonstrates the viability of 10-micron light to scale to ignition, Los Alamos will recommend implementing a development program to provide prototype modules for a CO₂ laser capable of driving fusion targets to energy break-even. A conceptual design of the next generation CO₂ system has been completed by a team from Los Alamos and industry and indicates no major

technical obstacles to further energy scaling. This possibility emphasizes that it is of crucial importance to maintain a key technology base in laser engineering intact until the decision is made concerning the feasibility of a CO₂ laser driver.

If the target physics reveals major, fundamental problems with compression and preheat that are uniquely traceable to irradiation by CO₂ laser light, then Los Alamos will recommend no further development of large CO₂ lasers for fusion and effort will be directed to development of an affordable short wavelength gas laser. Even if no new CO₂ laser facilities are developed, the commonality of inertial confinement fusion and weapon physics may permit Antares to provide a great deal of data useful to the weapons design effort. This facility should receive operational support for this purpose as long as it is able to provide critical data in a cost effective fashion.

The ultimate weapon goal for the ICF program is the attainment of a laboratory facility in which fusion burn can be studied from pellet performance. From present estimates this is believed to require several megajoules of driver energy. At the present time no laser system can be projected to this size with costs that are under roughly \$500 M. Hence, cost reductions in driver technology are critical to future program objectives. We have therefore initiated a low-level technology demonstration to investigate the feasibility of low-cost gas excimer lasers.

The current program includes research and development in both classified and unclassified areas of the following: laser-target interaction physics; target implosion studies; theory and code development, including both nuclear design codes and plasma physics codes; target interaction experiments with CO₂ lasers; target fabrication for such experiments; the Centurion program; diagnostics development; advanced laser R&D; ICF systems studies; and weapons applications experiments.

The major facility now in operation is the Helios 8-beam, 8-kJ laser-target system. Supporting physics experiments have been conducted with the Gemini, 2-beam, 1-kJ facility which was shut down early in FY 1982. Helios is used to explore laser-target interaction physics and to provide the experimental basis for target design for the Antares, 24-beam, 40-kJ facility now under construction on which definitive ignition scaling experiments are to be performed.

b. Verification and Control Technology

The goals of the verification and arms control technology program are to provide technical, analytical, and other support to the DOE arms control measures. These include foreign technology assessments, technology transfer issues, and detection of nuclear explosions underground, in the atmosphere, and in space.

(1) Nonseismic Nuclear Explosion Detection. The ionospheric monitoring and infrasonic programs are directed to verification of nuclear test ban treaties. The programs seek to detect and measure atmospheric and underground nuclear explosions by observing ionospheric and atmospheric signatures which result. As a longer range goal, we hope to develop the capability to estimate yields from these data. With this effort, Los Alamos will provide technical guidance to DOE and other agencies to ensure that adequate verification provisions are included in negotiated treaties.

(2) Satellite-Based Nuclear Explosion Detection. Satellite-based test detection is a continuing Los Alamos program that began about 1960 with design and preparation of the first pair of Vela satellites, launched in 1963. Of all of the Vela satellites that were launched, none are totally operational and only a few are partially functional. Satellite-based test detection is continuing in multimission Air Force satellite programs for which Los Alamos and Sandia National Laboratories (SNLA) jointly provide instrumentation for verification of its Limited Test Ban Treaty. In general, Los Alamos is responsible for instrumentation to detect the direct x-ray, gamma-ray, neutron, and charged-particle radiations from nuclear detonations in space; SNLA provides optical instrumentation for sensing atmospheric detonations and provides electronic logic for data handling.

In addition to providing surveillance of foreign nuclear explosions in space and in the atmosphere, this joint project supports DoD requirements for wartime information on tactical nuclear bursts. It also supplies data on natural and artificial space radiation. Finally, the project conducts R&D in related technologies, including those for potential detection of directed-energy weapon testing.

There is a recognized need to augment the deep-space and Southern Hemisphere detection capability. In the past, satellite deployment has emphasized and has been designed for detection of explosions relatively near the earth and in the Northern Hemisphere. Deep space may offer an attractive region for clandestine tests with yields larger than allowed by the Threshold Test Ban Treaty; the September 22, 1979, event pointed out the need for improved surveillance of the Southern Hemisphere for verification of the Limited Test Ban and Nonproliferation Treaties. Achieving an effective deep-space detection capability will require both instrumentation development and deployment on either dedicated or multimission satellite systems in low-radiation background orbits. Southern Hemisphere coverage will be enhanced when new satellite systems become operational in the next few years, but new diagnostic techniques and deployment scenarios are needed to provide independent corroborative evidence that otherwise ambiguous signals are of nuclear origin.

(3) Other Verification Research. We are implementing research programs in innovative nuclear explosion detection techniques and yield verification

analysis, and we plan to consider policy implications of detecting nuclear tests by states previously not known to possess nuclear weapon capabilities.

c. Nuclear Material Safeguards and Security

The Safeguards and Security R&D Program at Los Alamos is designed to address current, evolving, and future needs, primarily in the area of materials control and accounting (MC and A). Strong interfaces with physical protection, containment/surveillance, and nuclear facility operations are necessarily included, as well as substantial activities in computer and operations security. The program activities range from development of individual measurement devices to complete systems integrated with physical protection and process operations elements, from fundamental measurement physics through engineering of the hardware and software to implement those measurements. The applications of the program cover the DOE complex, the commercial nuclear industry, and the international community. Consequently, the program includes not only R&D efforts but applications in operating facilities. The program structure comprises four tasks:

- Task I: Directed Facility Support
- Task II: Security Development and Support
 - Computer Security
 - Operations Security
- Task III: Safeguards Technology
 - Equipment Development
 - Methods Development
- Task IV: International Support

The program is carried out in close cooperation with nuclear facility designers and operators and operational safeguards and security personnel. The intent is twofold: (1) to ensure effective application of the best available technology and (2) to direct the technology development at identified and emerging needs.

d. Special Isotope Separation

This program has the goal of producing weapons-grade material from existing DOE-owned N-Reactor fuel-grade material. The production plant will be constructed utilizing existing facilities at either the Savannah River Plant or at the Rockwell-Hanford site. An integrated Molecular Laser Isotope Separation (MLIS) prototype system will be constructed at Los Alamos using existing plutonium facilities at TA-55 by the end of FY 1984.

e. Defense Waste Management

Complementary emphasis in the defense waste effort is on nondestructive waste assay instrumentation development, volume reduction through incineration, and the development of safe means for disposing of low-level waste in shallow land burial sites. Advances in assay instrumentation have greatly enhanced our ability to distinguish accurately between low-level wastes and TRU wastes, and the improved segregation is permitting us to reduce the volume of TRU waste that must be stored for long periods of time.

2. Defense Initiatives

a. New Production Reactor Project

To assure an adequate supply of reactor products for weapons needs, the Assistant Secretary for Defense Programs (ASDP) has formed a New Production Reactor (NPR) Program Office at DOE headquarters. An NPR Program Requirements Office has been formed at Los Alamos to provide technical support to the Program Office.

In FY 1982 the Program Requirements Office is providing technical support in the following three areas:

- (1) A Concept and Site Selection Federal Advisory Panel is being commissioned by ASDP to rank the candidate NPR concepts and sites. The Laboratory is providing direct technical support to this Panel, including publishing the Panel's final recommendation report.
- (2) Los Alamos will be responsible for the safety review of the NPR. During FY 1982, the Laboratory is developing general design criteria for the safety review.
- (3) Los Alamos is providing, on a continuing basis, up-to-date projections of U.S. weapons program nuclear material requirements and production rates.

In future years, the activities of the Program Requirements Office will shift to independent technical evaluation and review activities, with the safety review constituting a major share of the effort.

Projected staffing (FTEs) for the Program Requirements Office is as follows:

<u>NEW PRODUCTION REACTOR PROJECT</u>							
(\$ in millions)	<u>FY82</u>	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Personnel	5	13	30	50	50	50	50

b. Military Energy Security

The Laboratory is vigorously pursuing the establishment of a Military Energy R&D Center at Los Alamos and Albuquerque Operations Office. This will provide DoD with a single point of contact for energy R&D, similar to that which we provide for nuclear weapons. The major differences are that Los Alamos would serve as a lead center including a technical management role, and Albuquerque would have oversight responsibility.

MILITARY ENERGY SECURITY

(\$ in millions)	FY83		FY84		FY85		FY86		FY87	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Operating	2.0	2.0	7.0	7.0	6.25	6.25	8.0	8.0	10.0	10.0
Capital Equipment	-	-	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5
Total	2.0	2.0	7.2	7.2	6.55	6.55	8.4	8.4	10.5	10.5
Direct Personnel	15		32		50		64		80	

c. International Technology

Although this existing program is a small part of the Laboratory (approximately 75 FTEs), it represents a rapidly expanding area of activity. Growth in this area in the last 3 years has been approximately 20% per year; we expect it to continue. It is included in the "New Initiatives" section because of projected rapid growth and to state our intentions to pursue aggressively special analyses for Federal agencies including DOE where they match our unique and expanding capabilities.

3. Proposed Defense Program Construction

During the last year Los Alamos performed an extensive evaluation of its facility requirements, tying it directly to its developed weapons program plan. This effort was initiated in support of the weapons complex test revitalization study, expanded because of a request to evaluate our R&D facility needs to support our weapons program, resulting in establishment of priorities for the consolidated weapons program facilities. The last effort resulted from the realization that test facilities, in many cases, cannot be completely or cleanly separated from R&D facilities.

The list of project candidates that surfaced during these studies was much more extensive than had been anticipated, as this was the first time we had worked a total weapons program resource plan, as opposed to a separate operating plan and a separate facilities plan. We have reviewed the list and divided it into those projects for which we would maintain up-to-date engineering studies and those for which such studies must be postponed. This final step of consolidating our lists was a difficult one in which we took a

hard look at priorities from an overall view of the weapons program, prioritizing the FY 1984 and FY 1985 lists and deleting from formal submission all projects of lower priority.

GB-01-Weapons Activities

Advanced Radiochemical Weapons Diagnostics Facilities (TEC \$8.1 M, FY84): This project will provide necessary laboratory, laboratory support space, and equipment to support advanced radiochemical diagnostics of weapons tests. The proposed facilities include two new buildings to be constructed adjacent to the existing Radiochemistry Laboratory Building.

Test Fabrication Facility, Phase I (TEC \$8.1 M, FY84): This project will consolidate, upgrade, and expand critical test facilities to meet current and projected Nevada Test Site test schedules.

It will provide for the procurement and installation of special equipment at the TA-3-38 Zia Fabrication Shop, construction of a Dry Run and Alignment Facility, construction of a wire rope Harness Fabrication and Tensile Testing Facility with provisions for storage of both raw materials and completed assemblies, construction of a Painting Facility, and relocation of the tensile test equipment.

Dual-Axis Radiographic Hydrotesting Facility (TEC \$24.9 M, FY84): The project provides for a weatherproof facility to maintain the radiographic system and for the modification and upgrade of explosives firing site R-280, the principal feature being the procurement and installation of a second, high-intensity, flash x-ray machine for dual-axis radiography.

Nuclear Materials Storage Facility (TEC \$20.0 M, FY84): Construction of a hardened repository for the storage of nuclear materials (long-term and intermediate shelf storage of nuclear materials) designed to meet the appropriate criteria for the storage and protection of nuclear materials and as a Safe and Secure Transport (SST) shipping/receiving port.

X-Ray Calibration Capability Upgrade (TEC \$4.6 M, FY84): This project consists of two parts: (1) the design, procurement, and installation of beam line components at a major synchrotron radiation facility and (2) the expansion and upgrade of x-ray characterization equipment and facilities at Los Alamos. This project will provide important new R&D capabilities for the weapons program, particularly the development of new test diagnostics.

Improved Central Guard Facility (TEC \$6.0 M, FY84): This is a strengthened subterranean building with a capability to withstand a light weapons fire attack while maintaining the communications, armory, and vault support functions necessary to coordinate security resources as required.

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Salt Facility Upgrade (TEC \$2.8 M, FY84): This project will modify seven existing rooms located adjacent to the present Salt Fabrication Facility in Building 209 at Technical Area 21. The conversion of this space (2300 sq. ft.) to laboratory and support space use will permit the installation of new equipment, support equipment, and staff.

TA-55 Control Room Upgrade (TEC \$3.0 M, FY85): This project will provide for upgrading of the existing computer controls and instrumentation in our Plutonium Handling Facility. The controls and instrumentation are rapidly becoming obsolete and should be upgraded to assure proper operation of the facility.

Compressed Gas Facility (TEC \$2.5 M, FY85): It is Laboratory management's desire to relocate the Compressed Gas Facility (CGF) to a less populated area. The CGF was formerly isolated from most of the Laboratory, which has since grown up around the present location at SM-170.

The new facility will permit the CGF to have modern equipment with better and shorter flow patterns for the movement of heavy gas cylinders and dewars. More space will permit installation of argon and air compressors for the safe and economic filling of high-pressure trailers and cylinders.

Device Fabrication R&D Facilities (TEC \$44.0 M, FY85): This project will provide additions to some facilities, upgrade other facilities, and provide new state-of-the-art equipment at numerous facilities throughout the Los Alamos National Laboratory. It will provide metal fabricating equipment, composite material equipment, facilities for electroplating and electroforming, new plastics forming equipment, and facilities for nondestructive testing and assembly of weapons subcomponents. These facilities are badly in need of updating.

Laboratory Communications Center (TEC \$25.0 M, FY85): This building is necessary to house a government-owned telecommunications facility, expand the network equipment for the Integrated Computer Network (ICN), and expand the data communications needed for the ICN.

Materials Science Laboratory (TEC \$29.0 M, FY85): Needed laboratory space and facilities for the materials work important in national security programs [a two-story building of approximately 43,000 sq. ft. combining laboratory space (27,000 sq. ft.) and office space (16,000 sq. ft.)].

The materials requirements in modern sophisticated weapons systems are very stringent and often unique. Nonradioactive materials with special nuclear properties are usually of little academic or commercial interest but can be crucial components of weapons systems. These and other more common materials are often subjected to conditions and loadings not encountered elsewhere. As a result, much of the materials science research on processing,

structure, and properties important in weapons design, production, and stockpile must be conducted by the weapons complex. A recent report by the Materials Science Working Group at Los Alamos pointed out the need for renewed emphasis within the weapons community on some general areas of materials science including physical metallurgy, fracture mechanics, environmental fracture, constitutive relations, polymers, composites ceramics, powder metallurgy, and behavior of materials under high pressure/temperature/strain. Los Alamos facilities and capabilities to deal with such topics have not kept pace with developments in modern materials science and technology. The condition will continue until project funding occurs. It is envisioned that the Laboratory's Center for Materials Science would eventually be housed in this facility.

Weapons Design Engineering Complex (TEC \$21.0 M, FY85): A multistory office and laboratory facility of approximately 110,000 sq. ft. is to be constructed at Tech Area 16. Office and work space for about 320 Design Engineering Division employees along with laboratory facilities for physical testing, electronics and diagnostics development, and specialized plastic material research and development will be provided.

High-Energy Radiographic Facility (TEC \$8.8 M, FY86): This project consists of replacing an existing betatron with a higher energy electron accelerator. Building modifications will be necessary to permit vertical radiography of Nevada Test Site (NTS) devices and for installation of the machine. Additional shielding will be required to operate the machine at full capacity for photon activation analysis.

Explosives Physics Experimental Facility (TEC \$25.8 M, FY86): The Explosives Physics Experimental Facility will provide Los Alamos with the capacity for high-resolution, state-of-the-art physics experimentation on detonation of high explosives.

New capabilities resulting from this project will be the ability to study detonation in large and small charges with the new physics techniques of laser interferometry and spectroscopy, laser-doppler measurements, multiple flash x-ray illumination that could permit tomographically assembled 2-D views of interior phenomena, and multiple corroboration by conventional and developmental diagnostics by streak cameras, image intensifier cameras, and pin diagnostics.

WNR Office/Laboratory Building (TEC \$7.1 M, FY86): An office-laboratory building is proposed to provide facilities for the research programs and for the operations at the Weapons Neutron Research/Proton Storage Ring (WNR/PSR) neutron source. These efforts are now being performed using temporary facilities (transportable buildings). When construction of the proton storage ring is completed and the research program at the WNR is fully developed, there will be a need for approximately 30 additional offices as well as additional laboratory spaces.

Test Fabrication Facility, Phase II (TEC \$21.0 M, FY86): The purpose of this project is to provide a new administration and craft operations complex for the Support and Fabrication Contractor, adjacent to the existing Supply and Transportation Facility at TA-3, Sigma Mesa. The new facility would centralize and consolidate the Contractor's operations and would be occupied by all of the personnel and functions presently located in the TA-3, SM-37 and SM-38 area. This would make available, in the core area of TA-3, highly desirable facilities and land for Laboratory use with moderate modifications and routine refurbishing.

Safeguards and Security Upgrade I (TEC \$14.5 M, FY86): Increased security of classified/nuclear material and physical plant security (new construction and upgrading of existing Laboratory facilities, i.e., additional perimeter fencing, enhanced and additional alarm and lighting systems complete with back-up power, back-up to the central alarm system computer, and special communications installations).

Health Instrumentation and Measurement Facility (TEC \$4.3 M, FY86): This facility would consolidate related programs in radiation health instrumentation and measurements presently being conducted at three widely separated facilities and would provide improved health and safety support to weapons programs in areas such as dosimetry, maintenance, calibration, supply of instruments, and analytical data from sampling programs. This facility would provide for a state-of-the-art calibration capability to replace the existing 25-year-old radiation instrument calibration range.

Utility Operations Center (TEC \$1.3 M, FY86): The purpose of this project is to provide a building for consolidating personnel and upgrading the functions of the Support and Fabrication Contractor's Utilities Department. The new facility will be adjacent to the west side of the existing TA-3-22 Power Plant.

Hypervelocity Impact Facility (TEC \$15.6 M, FY87): This project is composed of an electromagnetic projectile accelerator, an experimental area, and a facility to house both. The accelerator consists of 25-35 modular sections. Each section contains a capacitor bank, a rail section, and the required controls and diagnostics. The experimental area will require EMI shielding, a projectile stop, and provisions for protecting apparatus from high-velocity fragments. This project would provide projectile velocities in the 25-50 km/sec range, which is of direct interest in the solution of many weapons problems.

Antares Upgrade Project (TEC \$20.0 M, FY87): An Antares upgrade is proposed to ensure that Los Alamos has a useful facility for conducting weapons physics, directed-energy, and inertial fusion experiments in the late 1980s. The decision to upgrade the Antares facility now nearing completion is to be based on a critical assessment of current laser-target physics experiments.

The proposed modifications would not interfere with the timely execution of the CO₂ experimental program currently planned for Antares.

Weapons Subsystem Laboratory (TEC \$16.2 M, FY87): This project will provide upgrading and modernization of our weapons laboratories, including new remote-control, high-pressure gas test cells and hydraulic test cells, with contaminants control for toxic materials. It will be constructed at TA-16 near other weapons laboratories for improved effectiveness in weapons component development.

Weapons Chemistry and Radiochemistry R&D Laboratory (TEC \$34.6 M, FY87): The weapons-related effort in the Isotope and Nuclear Chemistry Division is located in widely separated facilities built shortly after or during World War II. Replacement and consolidation of these activities at a single site would enhance the experimental effort in the detailed understanding of thermonuclear burn, the verification of predictive weapons explosion code calculations, the understanding of the structural basis for sensitivity and energy propagation of explosives, and the development of ultrasensitive analytical techniques for weapons diagnostics. Failure to provide funding for such a centralized facility will result in continued loss of productivity due to substandard physical plant and geographic separation of related programs.

Relocation of Salvage and Surplus Operations and Roads and Grounds Operations (TEC \$1.6 M, FY88): This project consists of relocating the Salvage and Surplus Operations and the Roads and Ground Operations of the Support and Fabrication Contractor to a location on Sigma Mesa in proximity to other contractor operations. The project will provide for the consolidation and centralization of facilities to an area designated for industrial land use in accordance with the Los Alamos National Laboratory Master Plan. Major benefits include the vacating of high-value and prominent real estate near the entrance to Tech Area 3, relocation of existing facilities and operations to a more desirable area defined for industrial land use, and improved services for the Laboratory.

Sanitary Landfill (TEC \$1.7 M, FY88): A sanitary landfill dedicated to Laboratory use will permit us to dispose of low-hazard waste without involvement with the public and also will reduce the volume of waste stored more expensively at TA-54.

Safeguards and Security Upgrade, Phase II (TEC \$14.2 M, FY88): Continuation of work to be initiated in Phase I.

Equipment and Service Facility (TEC \$3.6 M, FY88): This building will house instrumentation and machine maintenance units for the weapons test diagnostic program. It will allow economies in stocking, travel of personnel, and number of machines needed.

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Supply and Distribution Warehouse Relocation (TEC \$25.0 M, FY88): It is Laboratory management's desire to remove the Supply and Distribution Warehousing functions from TA-3. The buildings SM-30, 31, and 142 will be reoccupied by Laboratory technical and scientific groups, which will improve the functional interaction and effectiveness of scientific efforts.

It will also allow the Materials Management Division (MAT) to apply new and modern techniques to acquisition, receipts, storage, inventory management, and distribution.

GE--Materials Production

Site Preparation SNM Complex (TEC \$10.0 M, FY86): Future planning indicates a need to make preparation for a SNM Complex at TA-55.

This project will provide design and site preparation for such a complex, including earthwork and a separate utility building to provide all required utilities for future construction, including HVAC, electrical, water, etc.

GD--Nuclear Materials Safeguards and Security

Nuclear Safeguards Technology Laboratory (TEC \$12.2 M, FY85): Construction of a laboratory office facility to consolidate elements of the nuclear safeguards research and development program (facilities and equipment necessary to develop systems to safeguard against terrorist nuclear threat, to provide nuclear material accountability, and to enhance the nuclear community's ability to control and respond to nuclear problems worldwide). Funding is required during the planning period in order to consolidate critical safeguards R&D activities.

B. Energy Research1. Current Energy Research Programs

Our long-range objective for the fundamental sciences at Los Alamos is to maintain our existing commitment to excellence while increasing our awareness of and contribution to solving specific national problems.

Major Los Alamos programs funded by the Office of Energy Research (OER) include basic energy sciences, health and environmental research, a large component in medium-energy nuclear physics, high-energy physics, and magnetic fusion.

B & R Code	Major Program (Title)	(\$ in Millions - BA)		
		FY 1982	FY 1983	FY 1984
AT	Magnetic Fusion	18.0	18.1	24.4
HA	Biomed & Environ Research	6.4	5.8	7.4
HB	Life Sci Res & Nuc Med App	4.4	3.9	4.5
KA	High-Energy Physics	0.3	0.3	1.1
KB	Nuclear Physics	33.4	36.3	41.9
KC	Basic Energy Sciences	8.0	8.0	9.3
KD	Technical Assessment Projects	0.4	0.0	0.0
<u>Total</u>		70.9	72.4	88.6
Percent of Total Laboratory Funding		14	15	15

a. Basic Energy Sciences

Los Alamos conducts a comprehensive program of basic research to support applied work in national security and energy technology programs, to strengthen its multidisciplinary scientific base, and to expand possibilities and future options for the nation. Basic research is fundamental to the health of the Laboratory and crucial to our overall success. We view a lack of broad-based support from DOE as a serious deficiency and are striving to correct it by making all funding elements aware of the need.

(1) Materials Sciences. Materials sciences activities at Los Alamos provide knowledge essential to national defense technologies and to development of materials required in advanced energy technologies and in strategic materials substitution. Relatively fundamental and long-term research efforts are categorized into three major areas: metallurgy and ceramics, materials chemistry, and solid state physics. Ongoing projects in metallurgy and ceramics include structural ceramics, study of materials under multiaxial deformation, self-irradiation damage of ceramic nuclear waste, and ultrasonic

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wave scattering as a technique for determining the structural properties of materials. Materials chemistry constitutes studies of mechanisms of compound formation on surfaces and of selective modification of chemisorption properties. Solid state physics work includes compilation of an equation-of-state library, properties of hydrogen under ultrahigh pressure, and heat engines.

In the materials science program, several significant new research areas will receive emphasis in future years. Los Alamos has a small but high-quality program, unique in the United States, of muon spin rotation studies at the LAMPF muon channel. This program was developed under nuclear physics funding; it is now appropriate to move it to basic energy sciences. In another area, we propose to study the fundamental mechanisms in high-rate deformation that control plastic flow over a large range of strain rates. An understanding of microscopic deformation mechanisms will permit us to develop realistic constitutive relations for high-rate deformation associated with many transient and impact problems associated with numerous energy technologies.

A major thrust in Los Alamos' materials science research programs is the application of neutron-scattering techniques using the Weapons Neutron Research (WNR) Facility for a broad range of problems in condensed matter science. When the Proton Storage Ring (PSR) is brought on line in 1985, this facility will be the most intense pulsed source in the world for this field of materials science studies. The experimental program with the more modest intensity presently available with the WNR alone is aimed at developing the full capability for the PSR era.

To further the study of materials science and technology, the Laboratory has created a Center for Materials Science (CMS). The objectives of the CMS are to enhance the contributions of materials science and technology to the Laboratory's defense, energy, and scientific missions. The long-range plan is to locate the CMS in the new Materials Science Laboratory that is part of the Laboratory's FY 1985 construction request.

(2) Chemical Sciences. Chemical sciences projects provide fundamental understanding in a broad range of topics. These include the formation and properties of complexes of helium and hydrogen isotopes; the chemistry of SO_2 bonding to catalytic substrates; actinide chemistry in near-neutral solutions; the effects of ion size and radiation on actinide valence stabilities in selected oxide matrices; the measurement of the heat and entropy of vaporization of actinide elements and their compounds; computation of thermophysical properties of mixtures; production of exotic nuclei at LAMPF; and the synthesis of thermochemical cycles, potentially capable of "splitting" water to produce hydrogen and oxygen.

(3) Engineering, Mathematics, and Geosciences. Geosciences research focuses on basic questions relevant to radioactive waste disposal and to

geothermal, fossil fuel, and fusion energy. Geophysics comprises studies in rock mechanics and fracture, geodynamics, petrology, and seismology. Geochemistry work includes coal and peat maturation studies, aqueous geochemistry, mineralogy, and geothermometry. Thermal regimes constitute several site investigations (in the Jemez Mountains and Rio Grande Rift region of north-central New Mexico) that yield geophysical and structural information pertinent to continental scientific drilling investigations of magma-hydrothermal systems. Space plasma physics deals with the structure and flow of plasma energy in the solar wind, magnetosphere, and ionosphere and with the electro-dynamical aspects of the solar wind-magnetosphere interaction.

An engineering research project is intended to develop the concept of thermionic integrated circuits for instrumenting and providing electronic control systems in high-temperature and high-radiation environments. The program has emphasized developing fundamental device understanding, manufacturing techniques, and finally prototype circuitry.

Nuclear data continue to play a major role in improvements of nuclear fission energy technology and will play a major role in the engineering of practical nuclear fusion reactors of the future. This Laboratory has unique capabilities in the WNR/PSR and in its versatile Van de Graaff laboratory for satisfying these data needs. A program is presently under way concentrated in studies of charged-particle cross sections required by the fusion program and of gamma-ray production in neutron-nuclear processes.

Numerical mathematical models at the heart of current energy research problems involve, in an essential way, the numerical solution of complicated systems of nonlinear partial differential equations. Another project in mathematics is to unify and simplify new solution algorithms for such systems. Recent developments emphasize adaptive mesh methods such as adaptive multigrid and front tracking to resolve subgrid scale structures of discontinuous solutions. We also are creating software to resolve large nonsymmetric, nonlinear algebraic systems arising on irregular meshes. In multi-dimensional computational fluid dynamics, this program has partially supported numerical methods development in a particle-fluid model for spray dynamics, a new free-Lagrangian computing technique, and documenting a general code for calculating transient aerodynamics flows.

Recent fundamental discoveries at Los Alamos in the mathematical properties of nonlinear transformations promise to improve understanding of the onset and development of turbulence. To emphasize studies of nonlinear systems and to develop closer connections with other workers in this important field, a Center for Nonlinear Studies (CNLS) has been established at the Laboratory. The CNLS uses its extensive external visitor program, coupled with internal collaboration from personnel within existing technical divisions at Los Alamos, as the basis for its research efforts. Much of the external

visitor program and the internal collaboration is coordinated with general research themes.

(4) Advanced Energy Projects. The basic unit of electric charge is one-third that of the electron. Negative fractionally charged particles are interesting because they could replace electrons in atoms, molecules, and solids, leading to superdense states of matter. A combined theoretical and experimental effort is under way to search for fractionally charged particles in a wide variety of materials, to determine which materials are most abundant in fractionally charged particles, and to enrich the fractional charge content of sample materials.

Another Advanced Energy Project, in the science of magnetic refrigeration, promises significantly greater efficiency for cooling in the temperature range from 4-300 K. The program involves the testing and selection of materials, the evaluation of innovative mechanical designs, and the construction of refrigerators of pilot model size to demonstrate practical applications. Applications are in cryogenic methods for gas production, liquid H₂ fuel for space launch vehicles, heat control in satellite systems, and eventually air conditioning for large structures such as apartment complexes and industrial buildings.

(5) Fusion Materials Irradiation Project. This project is in collaboration with the Hanford Engineering Development Laboratory. Los Alamos is designing and developing the 35-MeV, 100-mA CW deuteron linear accelerator for materials irradiation studies.

(6) Racetrack Microtron. This project is in collaboration with the National Bureau of Standards. Los Alamos will demonstrate electron microtron technology for proposed high-intensity electron physics facilities.

b. Nuclear and High-Energy Physics

(1) High-Energy Physics. To broaden the scientific base of our theoretical nuclear physics research and to develop new mathematical techniques to study nonlinear phenomena that have applications in materials sciences, fluid dynamics, and laser physics, we maintain a high-quality research program in the frontier area of theoretical high-energy nuclear physics. The research emphasizes understanding models that unify strong, electromagnetic, weak, and gravitational forces; understanding the confinement of quarks; and understanding the dynamics and symmetries of various field theories.

We also have an excellent program in astrophysics, including the new areas of particle physics and cosmology. The theoretical astrophysics program presents a great opportunity for symbiosis of physics at the forefront of basic science and physics in the weapons program. Many of the phenomena studied in astrophysics have direct applications in weapons physics, and many of the numerical techniques used are the same.

(2) Medium-Energy Physics. The Los Alamos role as the lead laboratory in medium-energy physics is fulfilled by the operation and development of LAMPF and Los Alamos participation in the research programs using LAMPF. This, the world's largest and most sophisticated nuclear science facility, provides unique accelerator-generated beams of protons, pions, muons, neutrons, and neutrinos to carry out a research program that includes fundamental studies of weak interactions and conservation laws, nuclear structure studies, nucleon-nucleon and pion-nucleon interactions, mesonic x-rays, condensed matter physics, atomic physics, and nuclear chemistry. Practical application usage of the facility includes isotope production, biomedical studies, investigations of radiation effects in materials, and national-defense-related studies.

Nuclear chemistry research at LAMPF is dominated by two major areas: pion-nucleus studies and thin target area studies. The first area involves utilization of activation and on-line counter techniques to study the interactions of pions with complex nuclei resulting in single- and multiple-nucleon removal, single charge exchange, and pion production by pions. The second area of study involves the systematic investigation of the very neutron rich and neutron deficient nuclei produced in high yields by the intense 800-MeV proton beam on medium and heavy mass targets. The main objective of the program is the direct measurement of the masses of an entire region of light nuclei that lie far from beta stability. These mass measurements are of fundamental importance, not only as a test of current atomic mass models, but as a means of exploring important nuclear structure effects. These studies will be greatly facilitated by means of a unique, time-of-flight magnetic spectrometer that is currently under development.

These research programs are conducted by a combination of Los Alamos scientists and visitors, primarily university-based; experiments, especially the most difficult ones, are often conducted by collaborations of local and visiting scientists.

We maintain a very active theoretical group and also involve eminent theoreticians from the academic community. This program provides support and guidance for the LAMPF experimental program and seeks to interpret the experimental results from research here and from other laboratories. This research is directed toward elucidating those aspects of nuclear structure, and other nuclear properties, determined by medium-energy probes of the nucleus, as well as understanding the characteristics of the fundamental meson-nucleon interaction inside the nuclear medium. This program includes research into strong interaction amplitudes, reaction theory, nuclear structure, electromagnetic interactions with nuclei, weak interactions, hadron structure and decay, and manifestations of unified theories at low and medium energies. Theoretical investigations are conducted within the group in close collaboration with participants in the extensive visitor program. Effort is divided between fundamental theoretical developments and phenomenological

analyses. The latter requires close ties between the theorists and the experimentalists working in Medium Energy Physics Division, in Physics Division, and at experimental facilities in this country and abroad; special emphasis is directed at understanding those experiments performed at LAMPF.

Several programs not employing LAMPF will also make major contributions in nuclear and particle physics. Among these are a search for exotic states of nuclear matter using antiprotons and studies of the fission process using heavy-ion reactions.

c. Magnetic Fusion

The current need to control government spending will delay the expansion of the Magnetic Fusion Energy (MFE) program called for in the MFE Engineering Act of 1980. The start on a fusion engineering device (FED) or engineering test reactor (ETR) authorized in the act will now be postponed to the late 1980s, and program emphasis will shift to improving the scientific and technical basis on which the ETR decision will ultimately be made. The Los Alamos MFE program will make important contributions during this phase.

A substantial part of the Los Alamos program is devoted to the development of two advanced fusion concepts, the reversed field pinch and the compact toroid, that could lead to a more economic fusion reactor than presently envisioned for the mainline confinement concept. These systems derive their qualitative superiority from potential compactness and utilization of higher power densities that approach those of fission reactors.

Complementing the experimental work, the theoretical and computational group provides analytical and numerical support for the MFE program. Plasma equilibrium and stability are studied in straight and toroidal geometries, using MHD, Vlasov, and hybrid particle simulation codes as required by the physical conditions of a particular experiment.

Los Alamos also makes a significant contribution to the national effort in magnetic fusion technology with its work in the areas of tritium handling, neutronics, insulators and ceramics, reactor system studies, and engineering support for the Fusion Engineering Design Center (FEDC) at ORNL. The Laboratory expects to fulfill an increasingly important role in developing the needed technologies for compact high-power-density systems.

Los Alamos is also developing a capability in the Stellarator magnetic confinement area, with view to providing the national program with crucially needed equilibrium and stability information by utilizing a relatively low-cost experimental approach.

(1) Reversed Field Pinch Program. The RFP is a toroidal, magnetically confined plasma system that has the potential of being ohmically heated to

ignition, of achieving stable plasma behavior at the high ratios of plasma pressure to magnetic pressure (β) required for economic reactor operation, and of reducing reactor complexity. The ZT-40M experiment has significantly extended RFP performance by achieving plasma temperatures of 350 eV for a toroidal current of 200 kA and sustaining RFP configurations for 20 to 25 ms. These favorable results have considerably exceeded the milestone objectives originally set down for ZT-40. We plan to design a follow-on experiment, the ZT-40 Upgrade. This will result in a proposal by the end of CY 1982.

(2) Compact Toroid Program. A CT is a toroidal plasma configuration in which the major confining fields are created by internal currents in the plasma, rather than by currents in external conductors. Experiments began in FY 1980 on the newly completed CTX facility studying spheromak-type compact toroids.

In addition to work on advanced fusion concepts, Los Alamos is pursuing projects that will make major contributions to the technology required by the ETR and other fusion reactor systems.

(3) Magnetic Field Systems Design and Development. This program develops superconducting magnets and associated energy storage and transfer systems to supply programmable poloidal and equilibrium magnetic fields needed for future tokamaks and other toroidal systems. The program includes design and assessment of poloidal-field coil systems and low-aspect-ratio, equilibrium-field coil systems; this work is in support of and coordinated with the Fusion Engineering Design Center at Oak Ridge. The program also designs, develops, and tests high-current interrupters as switching systems for poloidal and toroidal field coil systems.

(4) Tritium Systems Test Assembly Program. The Tritium Systems Test Assembly (TSTA) will integrate and demonstrate all technologies related to the deuterium-tritium fuel cycle for fusion reactor systems and for the ETR. The construction of TSTA was completed on schedule and within budget in FY 1982; preliminary operation with tritium will begin in January 1983, followed by full operation in June 1983.

(5) Fusion Reactor Insulators and Ceramics Program. This program assesses and develops electrical insulators and ceramics for fusion reactor applications and provides design information for the ETR. The effects of neutron irradiation on the electrical and mechanical properties of various first-wall and insulator materials are also studied.

(6) Reactor Systems Studies Program. This effort evaluates the reactor potential of various alternative fusion confinement concepts. The broad nature of this task requires extensive, multidisciplinary interaction with groups inside and outside the Laboratory. These reactor studies are extremely useful in guiding research in alternative approaches to fusion.

d. Health and Environmental Research

(1) Biological and Environmental Research. Human health studies consist of a series of studies of cancer incidence and causes of mortality in workers at six major DOE plants, where exposures to plutonium occur, and the determination of the distribution of plutonium in tissues obtained at post-mortem examinations. The data provide needed knowledge about the dose distribution to various tissues and allow comparison with occupational exposure records, plutonium deposition estimates, and plutonium fallout exposure estimates.

Studies of oil shale toxicology constitute a major program at Los Alamos and include health studies of oil shale workers; pulmonary and epidermal studies of animals exposed to oils and by-products produced in the mining, retorting, and upgrading of oil shale; and cellular studies of the cytotoxic, mutagenic, and clastogenic potentials existing in various oil shale related materials.

The environmental studies integrate modeling, chemistry, and field ecology experiments to the problems of the transport and the ultimate fate of pollutants in the environment. Two unique resources, the National Environmental Research Park (NERP) and the low-level waste simulation site, provide the opportunity to study pollutant transport and behavior in both undisturbed ecosystems and controlled simulations. Of particular interest are the migration of radioactive elements in a spectrum of ecosystems and the use of data thus gained in controlling contaminant mobility in the environment and understanding the various transport pathways leading to man.

The atmospheric sciences program consists of studies of terrain-influenced meteorological transport and diffusion in the boundary-layer, studies of the constituents of the upper troposphere and lower stratosphere, and the development of specialized tracers and detection systems for studies of atmospheric dispersion.

(2) Life Sciences Research and Nuclear Medicine Applications. The Life Sciences Research program at Los Alamos studies the basic mechanisms of carcinogenesis, develops and validates systems for determining carcinogenic activity, and applies these systems in the context of integrated programs designed to define the hazards posed by nuclear and oil shale technologies. Our basic and applied studies in regulation of gene expression and structure, genetic protective mechanisms, chromosome structure and function, chromosome damage assessment, heterogeneity of tumor cells, and the molecular basis of cell growth provide a unique combination of capabilities for exploring basic questions in carcinogenesis. They enable us to determine the roles of mobile genetic elements, chromosome alterations, mutations, gene amplification, and DNA methylation in the transformation of normal cells to malignancy. The combination of flow cytometry, molecular genetics and somatic cell genetics is especially useful in exploring the relationship of aneuploidy to cancer. At

present, the sorting of chromosomes with specific cancer-associated aberrations is being followed by cloning and isolation of the affected genes.

Our long-standing expertise in flow cytometry led to the establishment of the National Flow Cytometry Resource on July 1, 1982, through joint sponsorship of NIH and DOE. The major goals of this resource are to make advanced instrumentation available to the biomedical community, to perform research and development on flow instrumentation and relevant methodology, and to identify new investigative and clinical applications.

The medical radioisotopes program utilizes the unique Los Alamos Meson Physics Facility to prepare a wide range of medically useful radionuclides. Expertise in target encapsulations, irradiations, radiochemical separations, remote chemical processing, and supporting analytical capabilities has been developed over the years. In addition, a major programmatic effort is directed toward radiopharmaceutical labeling research, and we are developing a strong effort in organic synthesis. We have also developed the capability to perform in vivo studies of the biodistribution and metabolism of labeled biochemicals in animals. Our high-resolution gamma camera permits sequential imaging of labeled compounds in vivo.

The program to investigate the use of negative pions for cancer therapy, funded by the National Cancer Institute, provided treatment at LAMPF for about 250 patients in the period 1976-1981 with encouraging results. Although the program is presently in abeyance, important work in three-dimensional treatment planning code development is continuing and the biomedical channel is being maintained in operational status with the expectation that patient treatments will be resumed.

LAMPF accelerator-related technology is being applied to the development of biomedical instrumentation for electrosurgery, radio-frequency hyperthermia for cancer therapy, and electrothermal techniques for corneal shape modification. An extensive network of collaboration has evolved permitting the transfer of instrumentation and design to medical schools, hospitals, and the private sector.

2. Energy Research Initiatives

a. National Underground Science Facility

There are a number of extremely important scientific experiments that should be performed but which require enormous amounts of shielding greatly exceeding what can be supplied in a normal laboratory environment on the earth's surface. These experiments include searches for spontaneous nucleon decay and for magnetic monopole catalyzed nucleon decay, solar neutrino, cosmic ray muon, and cosmic-ray neutrino experiments, neutrino oscillation

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experiments, and double beta decay experiments. In addition, the "quiet" environment offered at great depth will make possible new gravity wave experiments.

To provide a location in which such experiments can be conducted, the Los Alamos National Laboratory proposes to establish and operate a National Underground Science Facility dedicated to basic research. The Facility will be located in an open area of the Nevada Test Site and will be available to any scientist with an appropriate experiment to pursue, subject only to peer review and availability of space.

The Facility will consist of a twelve-foot-diameter vertical shaft that will ultimately extend to a depth of 4,500', with laterally excavated chambers to accommodate experiments. In addition to hoist and elevator, power, and other utilities, the Facility will provide surface technical support in the form of a modest machine shop, an electronics shop, computer capacity, and dormitory space for scientists. Those working at the facility will therefore have technical support approximating that in their home laboratories and making possible experiments utilizing the most advanced technology of modern science. Operating and support staff will be required, but no increase in scientific FTEs from Los Alamos is anticipated.

In the initial phase of the facility the shaft will extend to 3600' and two chambers (40' x 200' x 46' and 30' x 50' x 25') will be excavated at a total estimated cost of \$42 M. The design will allow for an extension to a depth of 4500' or more and for the addition of other chambers as needed.

NATIONAL UNDERGROUND SCIENCE FACILITY

(\$ in millions)	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Operating	0.2	0.2	0.2	2.0	2.0	2.0
Capital Equipment		5.2	0	0.3	0.3	0.3
Construction		11.5	18.9	6.7	0.0	0.0
Total	<u>0.2</u>	<u>16.9</u>	<u>19.1</u>	<u>9.0</u>	<u>2.3</u>	<u>2.3</u>
Personnel (FTE)	0.0	5.0	10.0	13.0	13.0	13.0

The operating amount for FY 1983 is for geological exploration, evaluation, and test-drilling to prepare for actual Phase I construction in FY 1984 and FY 1985. Phase II is planned for FY 1987 and FY 1988.

b. Neutrino Facility

The Laboratory is proposing the construction of a national facility for neutrino physics in conjunction with the Proton Storage Ring at LAMPF. This facility will provide a unique capability unmatched anywhere in the world for experiments with low-energy neutrinos. The project calls for the construction

of a 19- x 3- x 3-m beam tunnel, a 30- x 4- x 4-m decay volume with railroad tracks to vary the production target position, four detector buildings (two adjacent to the decay volume, one at a distance of 20 m and one at a distance of 3,800 m from the decay volume), shielding for the near buildings, and additional shielding on an existing beam line. It also calls for an upgrade of the Proton Storage Ring to 24-Hz operation, so that there will be no interference with previous commitments to BES and OMA.

The project is required to obtain the best measurements of possible oscillation modes of muon neutrinos, to make precision measurements of neutrino-electron scattering, and to conduct experiments on electron and muon neutrino interactions in nuclei. Construction during the planning period is required to permit the conduct of early experiments.

This facility, coupled with the LAMPF II initiative, results in the further development of the accelerator facilities at Los Alamos for nuclear and high-energy physics.

NEUTRINO FACILITY

(\$ in millions)	<u>FY82</u>	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>
Operating	0	0.15	0.5	0.5	1.5	1.5
Construction	<u>0</u>	<u>0</u>	<u>2.1</u>	<u>10.84</u>	<u>14.4</u>	<u>10.66</u>
Total		<u>0.15</u>	<u>2.6</u>	<u>11.34</u>	<u>15.9</u>	<u>12.16</u>
Personnel (FTE)	0	1.0	3.0	3.0	5.0	5.0

c. LAMPF II Facility

We are developing a proposal for a major upgrade of LAMPF, which will extend U.S. leadership in medium-energy physics into the decade of the 1990s. Under consideration is a high-intensity, rapid-cycling synchrotron that will increase the maximum energy to 16 GeV and the beam power by a factor of 3 to 6. Such a machine would increase the scope of the nuclear-physics programs to include kaons, hyperons, and antinucleons. Existing beams of pions and muons would be increased in intensity by a factor of 10 (100 for negative muons), and duty factors would be improved either by increases from the present 6% to 90% or, in some instances, by reduction to as little as 10^{-5} . The program of decay experiments will be expanded to include the exciting fields of kaon decays and CP violation. The increased intensity will allow rare decay experiments of a sensitivity greater than possible anywhere else in the world. The upgrade would also provide the world's best facility for low-energy neutrino physics. For example, the counting rate in neutrino-electron-scattering experiments will be 1000 times higher than the counting rates available at existing facilities, allowing precision narrow-band measurements where only crude total cross sections exist today. The basic machine will be versatile and conservative and, even though its initial goals include beam

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intensity 100 times higher than existing machines in this energy region, options for future improvements will be open.

The initial cost estimate for such a facility is \$150 million (in 1982 dollars), equally divided between the new accelerator and new experimental areas. An increase in the present LAMPF operating budget by \$15 million will be required to operate the new facility and to carry out the experimental program.

The Los Alamos National Laboratory is presently evaluating the physics justification for the proposed facility and is carrying out a feasibility study for the accelerator and experimental areas. During the next two years, we will hold additional physics workshops and prepare a facility proposal. The proposal will be ready by the end of CY 1984. Given timely funding, a construction start in FY 1987 will be possible. Completion of the construction will be in CY 1991, with commissioning for research in 1992.

LAMPF II FACILITY

(\$ in millions)	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>	<u>FY89</u>	<u>FY90</u>
Operating	1.5	2.5	4	7	10	13	16	19
Capital	0	0.5	0.5	1	1	1.5	1.5	2
Construction	0	0	0	0	50	88	25	25
Total	<u>1.5</u>	<u>3.0</u>	<u>4.5</u>	<u>8</u>	<u>61</u>	<u>102.5</u>	<u>42.5</u>	<u>46</u>
Personnel (FTE)	8	16	32	48	60	70	60	50

d. Reversed Field Pinch (RFP) Ignition Test Reactor (ITR)/Engineering Test Reactor (ETR)

Successful achievement of the ZT-40 Upgrade experimental goals will contribute significantly to demonstrating that the Reversed Field Pinch (RFP) will lead to a uniquely viable, highly competitive magnetic fusion energy (MFE) reactor concept and that it can be extended to a practical, high-power-density, compact reactor, using largely state-of-the-art technology. This achievement can also be accomplished faster than with any other concept. The timely implementation of the ZT-40 Upgrade experiment and subsequent successful results will allow the proposal of a staged ITR/ETR device based on the RFP principle in the 1987-1988 time frame. The goal of the RFP program is a compact, steady-state, D-T reactor with a direct and credible extension to a D-D reactor system.

The ITR/ETR device will address the following reactor issues: (1) reactor current densities for D-T and D-D fuels; (2) ohmic heating to ignition; (3) fusion burn physics, including both D-T and D-D ignition and burn, and refueling/exhaust systems; (4) efficient long-pulsed or ideally steady-state operation using either low-frequency current drive ($F-\theta$ pumping, which

is unique to the RFP) or an RF drive being considered for tokamaks; (5) impurity control using divertors and a neutral gas blanket; (6) successful design and operation of a high-heat-flux first-wall; (7) high-power-density breeding blanket design; (8) radiation damage and component lifetimes; (9) remote maintenance; and (10) net power production.

The ITR/ETR device will require an initial design period of two years followed by a five-year construction period. Approval for design in 1987-1988 would allow construction completion and initial operation in 1995-1996. Preliminary costing has not been carried out.

3. Proposed Energy Research Construction

AT--Magnetic Fusion

Motor Generator Set Facility (TEC \$6.1 M, FY84): Procurement and installation of a 100-MVA motor generator set to be used in support of the magnetic fusion energy (MFE) research program.

The Laboratory experimental program in advanced fusion concepts and in fusion engineering programs requires a high-power (100-MVA), high-energy (250-MJ) storage system. These requirements will be cost effectively satisfied by a 100-MVA motor generator set (MGS). The MGS will store and provide energy to large dc power supplies used in existing and in future Los Alamos magnetic fusion energy (MFE) experiments: the proposed ZT-40 Upgrade experiment as well as extended-performance operation of the current ZT-40M device will require the MGS power facility. Immediate procurement and installation of the 100-MVA MGS are required to capitalize on recent achievements in the RFP program and to extend present program capabilities.

(\$ in millions)	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Construction	0	0.8	2.3	3.0		

ZT-40 Upgrade Experiment (TEC \$60.0 M, FY85): The ZT-40 Upgrade experiment is proposed to extend the performance of the reversed field pinch (RFP) toward the conditions required for compact high-power-density reactor systems. The ZT-40 Upgrade will exceed the operational limits of the present ZT-40M experimental facility principally in terms of higher current, high plasma temperatures, longer confinement times, and longer pulse duration. It will also have the potential of achieving larger current densities. These extended capabilities are required to develop accurate scaling laws for evaluation of the compact reverse field pinch reactor (CRFPR) concept. The ZT-40 Upgrade will be an axisymmetric toroidal device with a 40-cm minor radius and a 2-m major radius. The device will develop toroidal plasma currents of 2 MA and demonstrate energy confinement times of more than 20 ms. A 100-MVA MGS will be used to power an inductive energy storage system. The MGS will store and transfer 250 MJ of energy to the system.

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(\$ in millions)	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Construction	0	5.3	13.2	19.1	13.2	9.2

Engineering Building (TEC \$8.0 M, FY86): A new facility to support the engineering feasibility activity in the national Magnetic Fusion Energy (MFE) program (to develop and test various technologies in sizes that culminate with the prototypical units required by the Fusion Engineering Test Facility and to make Los Alamos engineering experience fully available to the national MFE program).

The present physics-oriented MFE program will shift to a more engineering-oriented program to prove engineering feasibility of magnetic fusion. In particular, the building is needed to develop technology for the proposed large Fusion Engineering Device. Failure to fund the project will result in a less than optimum effort.

Laboratory/Office Building (TEC \$1.5 M, FY87): A new facility to provide laboratory space and to replace office space presently confined to crowded temporary buildings.

The new facility is needed to provide a conference room, a report library, and laboratory space and to replace present office space in crowded temporary buildings, thereby significantly enhancing the Laboratory's capability for carrying out its Magnetic Fusion Energy (MFE) program, including confinement experiments, development and technology activities, and associated research programs. Funding is required during the planning period in order to provide adequate space and facilities.

KB--Nuclear Physics

Accelerator Improvements (TEC \$3.5 M, FY84): Continuing program to provide upgraded equipment at the Clinton P. Anderson Meson Physics Facility.

Construction during the planning period is required to permit orderly improvements to the facility.

Engineering Support Building (TEC \$3.1 M, FY86): A new building of approximately 24,000 square feet proposed as a two-level, 14,000-square-foot office structure and an attached 10,000-square-foot shop and laboratory structure.

This building is needed to provide space for research and development work related to new facilities and experimental programs at the Clinton P. Anderson Meson Physics Facility. Funding during the planning period will permit the orderly support required.

HA 02--Health and Environmental Research - Biological and Environmental Research

Toxic Chemical Containment Facility (TEC \$1.4 M, FY84): Expansion of specialized facilities for handling toxic chemicals and for housing and exposing small animals to potential toxins.

As the environment, health, and safety program at the Laboratory has changed over the past five years from a predominantly nuclear research effort to major emphasis on the health effects of nonnuclear energy sources, it has become increasingly apparent that the current physical plant cannot remain in compliance with Federal regulations controlling the use of toxic chemicals. Moreover, Federal regulations are changing in the direction of stringency in a manner that leads to uncertainties in the Laboratory's capability to continue these studies. The project will upgrade an existing facility to meet the new requirements. Construction during the planning period will permit compliance with Federal regulations.

Biomedical Research Facility (TEC \$19.0 M, FY87): Expansion of the Health Research Laboratory (HRL) to reestablish adequate working facilities and to satisfy new facility needs for conducting current and future biomedical and environmental research. Built 30 years ago for 60 occupants engaged in radio-biology studies, HRL now houses more than double that number of scientists who are pursuing a far wider range of research. Expansion is needed for work in inhalation and genetic toxicology, immunology, flow cytometry, and recombinant DNA technology.

The proposed 29,700-sq.-ft. structure provides specialized laboratories and improved additional animal quarters as well as office and core space critically needed to relieve crowded quarters. This building would complement the \$1.9-million toxic containment facility by providing long-term specialized animal quarters and hazardous material laboratories.

C. Nuclear Energy

<u>B & R Code</u>	<u>Major Program (Title)</u>	(\$ in Millions - BA)		
		<u>FY 1982</u>	<u>FY 1983</u>	<u>FY 1984</u>
AE	Space Nuclear Systems	3.6	4.4	10.0
AF	Breeder Reactors	11.2	9.4	11.3
AG	Converter Reactors	0.7	0.9	1.2
AH	Remedial Action Programs	0.7	0.2	0.3
AP	Comm Nuclear Waste Mgt	0.5	0.3	0.0
AW	Adv Isotope Separ Techn	18.4	0.0	0.0
CD	Uran Supply and Enrichmnt	<u>0.3</u>	<u>0.0</u>	<u>0.0</u>
<u>Total</u>		35.4	15.2	22.8
Percent of Total Laboratory Funding		7	3	4

1. Current Nuclear Energy Programs

Los Alamos conducts major programs in space reactor design, breeder reactor fuel development, and waste management sponsored by the Assistant Secretary for Nuclear Energy (ASNE).

a. Space and Terrestrial Applications

(1) Space Technology Advanced Reactor. Los Alamos is currently conducting a technical research program to establish the technology base for a high-temperature, compact nuclear reactor (10-100 kWe) for use in space. Los Alamos provides the mainline technology in a broader based space power effort referred to as the SP-100 program. This program became a joint DOE and NASA activity in FY 1982 with DOE providing Los Alamos \$1 M and NASA \$700 K. In addition, NASA will spend \$1.4 M on the electric conversion system at the Jet Propulsion Laboratory (JPL). It is expected that the funds for this program will be augmented by funds from the Defense Advanced Research Projects Agency (DARPA) starting in FY 1983.

The overall objective is to develop a compact, lightweight nuclear sub-assembly that, when combined with direct energy conversion technology being developed by the JPL, will provide spacecraft power for exploration of the solar system and cislunar satellites and, potentially, support of DoD's surveillance and communications programs. The characteristics of such a power system are low weight, low volume, long life, high reliability, flexibility, minimum integration complexity, and low costs compared to other alternatives. The current Los Alamos power system is the combination of a fast fission heat pipe reactor with an advanced modular thermoelectric conversion subsystem for multimission applications.

The nuclear subassembly objectives are to

- establish the technology base for the heat pipe reactor by designing, fabricating, and testing the key components that comprise the nuclear subassembly;
- ground demonstrate a prototype power plant; and
- establish a design that meets safety requirements.

To support the component technology base, analytical design activities and safety studies will define the form and functions for the principal components to be demonstrated. Experimental work will demonstrate the technology readiness of the core heat pipe transfer system, material characterization and compatibility, irradiation component testing, and reactor control actuators. In the ground demonstration phase, a nuclear subassembly will be run as a complete unit and be supported by vibrational assemblies, critical assemblies, assembly models, and long-term component and module testing.

(2) Radioisotope Heat Source. The radioisotope heat source program provides support to DOE in the areas of safety assessment, safety testing, safety technology, environmental testing and evaluation, heat source design, and heat source production. As part of this program, fuel-form fabrication procedures were developed for SNAP-19 (cermet), multihundred watt, and general purpose heat source. Safety analyses and tests were carried out for Pioneer, Transit, LES 8/9, and Voyager. The design of the Lightweight Radioisotope Heater Unit was completed and put into production, and the design of the General Purpose Heat Source was completed. Testing of derivative General Purpose Heat Source designs was carried out, and the environmental exposures of various fueled units to simulated terrestrial and aquatic environments were accomplished.

b. LMFBFR Base Program

A major thrust of our reactor fuel development effort has been the development of an advanced fuel for the liquid metal fast breeder reactor (LMFBFR). This work capitalizes on intrinsic properties of the mixed uranium-plutonium carbide that promises improved breeding capability and reduced fuel cycle costs. Our advanced LMFBFR fuel development project includes development of processes for the production of the carbide material, design of fuel pins, irradiation testing of candidate materials and designs, and maintenance of a strong quality-assurance activity providing standards and reference material to others. Its overall mission is to build the technology base that will permit commercial manufacture and licensing of LMFBFR cores fueled with uranium-plutonium carbide instead of the uranium-plutonium oxide of conventional design. The project is concluding a highly successful phase of test irradiations in the Experimental Breeder Reactor II. Highly reliable

performance has been demonstrated at power and temperature conditions typical of those expected to be experienced in large, commercial LMFBRs. Process development and irradiation tests in the new Fast Test Reactor at the Fast Flux Test Facility are continuing activities.

Other projects in reactor fuel development exploit unique facilities at Los Alamos, such as our new Plutonium Facility, or special technologies, such as graphite-composite fabrication, in the supply of various services and products to the nation's reactor development programs.

A new emphasis in 1983 will integrate our historically disparate efforts in fuels and materials development, reactor physics and safety analysis, and core component design. These efforts will be combined to address the analysis of LMFBR advanced cores optimized for performance, safety, and economy of construction and operation through materials developments and innovative design features.

In addition to the reactor fuel development effort, DOE supports work bearing on the safety of the LMFBR. This work emphasizes the analysis of the response of the plant to anticipated transients, emergency events, and hypothetical accidents leading to core disruption. Such accidents played a large role in licensing CRBR and are expected to be equally important in licensing larger plants. We are investigating advanced safety licensing strategies for large (1000-MWe) plants.

c. Commercial Waste Management

The Los Alamos waste management program is an integrated activity embracing commercial and defense radioactive wastes and nonradioactive hazardous wastes. Highlights of all these activities are discussed together here, but only the commercial radioactive waste efforts funded by ASNE are emphasized in this section. These efforts will lead to improved methods for managing, treating, and disposing of radioactive contaminated wastes generated by industry. They also include evaluation of tuff at the Nevada Test Site (NTS) to determine its seismic, geologic, and radionuclide sorptive properties. The latter studies (funded by ASNE through the Nevada Operations Office) are designed to assess NTS tuff as a medium for a high-level waste depository.

Controlled air incineration as a means of reducing the volume of transuranic (TRU) combustible waste has been proven; transfer of this technology to other DOE contractors and to the nuclear power industry is an objective of the ongoing commercial program. Included in the process are equipment for waste packaging, receiving, assay, incineration, and handling of aerosol and ash. Emphasis in the low-level waste research program is on finding means to dispose of low-level wastes in shallow land burial sites, the development of techniques to prevent infiltration by plants and animals, and the demonstration of remedial action programs.

d. TMI Support

A modest program supporting TMI diagnostics was initiated in FY 1982 and will carry over through FY 1984. The work primarily involves use of the Los Alamos MIMAS code to produce a quasi two-dimensional TMI-2 core damage assessment. Follow-on efforts will integrate the MIMAS code into the Los Alamos TRAC code to predict fission product transport and hydrogen concentrations in the primary system. This computational effort will introduce the specific thermal, hydraulic, and structural models needed to achieve the necessary results.

e. Remedial Action

These efforts are phasing down in FY 1983. An elaborate and comprehensive array of actual samples representative of all principal mill tailings in CONUS are stored at Los Alamos. However, primary responsibility for storage and further analytical work have been transferred to another contractor. Close-out efforts during FY 1983 will involve Health Effects Guides of Formerly Utilized Sites and certain engineering aspects of Trinity Ground Zero.

2. Nuclear Energy Initiatives

Reactors for Defense and Space Applications

Currently, we are funded to carry out technology development on a 10- to 100-kw_e space power plant (SP-100). Anticipated time for a flight qualified demonstration of this system will be in the latter years of this decade. Military uses for SP-100 include (1) space-based radar, (2) hardened C³, (3) blue-green laser subcommunicator, (4) high-altitude large optics, (5) electronic jammers, (6) chemical lasers, and (7) electric propulsion systems.

The military has a number of requirements for power to fulfill future operational demands of their assigned missions. A logical expansion of the ongoing SP-100 work is to develop the vastly increased power levels dictated by particle beam weapons systems. The Laboratory's background in nuclear rocket technology (Rover Program) has left a strong cadre of skilled personnel with appropriate technical backgrounds and experience in precisely these areas.

Other future military reactor needs include a power source for the underground MX concept, remote site power, and secure base power. Current dependence on fossil fuels for these requirements introduces vulnerabilities to disruption of energy supplies for the worldwide deployment of U.S. forces. Modification of the SP-100 or modern high-efficiency reactor technology to meet any of these needs is clearly within the existing capability at Los Alamos.

The basic resources to initiate any single one of these programs are:

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REACTORS FOR DEFENSE AND SPACE APPLICATIONS

(\$ in millions)	<u>FY82</u>	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Operating	0.3	0.7	3.0	5.0	8.0	10.0	10.0
Capital Equipment	<u>0.03</u>	<u>0.07</u>	<u>0.3</u>	<u>0.5</u>	<u>0.8</u>	<u>1.0</u>	<u>1.0</u>
Total	.33	.77	3.3	5.5	8.8	11.0	11.0
Personnel	3	7	30	50	80	100	100

Note: The ongoing SP-100 studies are already included in our resource tables (Section IX).

D. Conservation and Renewable Energy

B & R Code	Major Program (Title)	(\$ in Millions - BA)		
		FY 1982	FY 1983	FY 1984
AK	Electric Energy Systems	0.0	0.0	0.0
AL	Energy Storage Systems	3.2	1.5	0.0
AM	Geothermal	10.4	7.5	5.3
EB	Solar Energy	2.8	0.0	0.0
EC	Bldg & Community Systems	0.1	0.0	0.0
EE	Transportation Energy Con	0.7	0.0	0.0
EG	Multi Sector	0.5	0.6	0.0
<u>Total</u>		17.7	9.6	5.3
Percent of Total Laboratory Funding		4	2	1

1. Current Conservation and Renewable Energy Programs

Programs sponsored by the Assistant Secretary for Conservation and Renewable Energy (ASCE) include solar applications, solar technology, energy storage and conservation, and geothermal energy. Current budget guidance indicates that these programs will be severely curtailed or terminated in FY 1983.

a. Solar Applications

Passive solar systems for heating and cooling buildings can be used for both near-term and long-term reduction of oil use. Los Alamos is recognized as the national leader in this field. This is budgeted for termination in FY 1983.

b. Solar Technology

The study of the hydrodynamic stability of salt-gradient stratified solar ponds is a program that utilizes the hydrodynamic modeling capability unique to Los Alamos. A small research pond has been constructed to provide data with which to verify the computer models. This is budgeted for termination in FY 1983.

c. Conservation

The superconducting magnetic energy storage (SMES) program is investigating the use of large, superconducting magnets for diurnal energy storage and other load management problems. A 30-MJ coil system, operating at 0.3 Hz, has been assembled to provide stabilization for the Bonneville Power

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Administration's transmission lines from Washington state to Los Angeles. This program is scheduled for close-out in FY 1983.

The fuel cell program, budgeted for termination in FY 1983, is described in the section on Initiatives.

d. Geothermal Energy

Virtually all geothermal energy produced today involves extraction of naturally occurring subsurface hot water or steam, removal of the thermal energy, and reinjection of the spent fluid. The Los Alamos Hot Dry Rock (HDR) concept is unique in that it requires only high subsurface temperatures and relatively impermeable rock. Naturally occurring hot rock is far more abundant than the combination of hot rock, adequate permeability, and water or steam. Extraction of thermal energy from hot dry rocks requires creation of a subsurface fracture system (heat exchanger) connected to the surface by wellbores capable of injecting cold fluid, providing pathways through the fracture system for fluid heating, and returning the hot fluid to the surface. At the surface, the thermal energy is extracted and the fluid is then reinjected in a continuous closed-loop operation.

A small (about 5-MW) HDR research reservoir has been constructed at Fenton Hill west of Los Alamos. The fracture system was created hydraulically in low-permeability rock almost two miles deep and at a temperature of about 200 degrees C. Tests over a period of about three years, and with one single extraction test covering nine months, have proven the concept. Electricity was generated by a specially designed 60-KVA binary turbo-alternator. Two deeper, hotter wells have been completed to a depth of nearly three miles and with rock temperatures of about 320 degrees C. During FY 1983 plans are to complete the engineering reservoir by creating connecting fractures between the inclined wellbores. This may lead to a 3- to 10-MWe pilot electrical demonstration plant constructed and operated by a local utility.

Through an International Energy Agency Implementing Agreement, the Federal Republic of Germany and the government of Japan participate both financially and with resident staff in the planning and conduct of the Fenton Hill effort. The Agreement spans four years and concludes (if not extended) at the end of FY 1983. Reductions in the DOE geothermal budget have resulted in \$7.5 M for this program for FY 1983. This, coupled with the \$2.5 M from FRG and \$2.5 M from Japan, permits us to continue on a somewhat reduced level toward the program goals.

2. Conservation and Renewable Energy Initiatives

Fuel Cells

The fuel cell program, budgeted for termination in FY 1983, is presented as an initiative.

Fuel cells for transportation applications, funded by the Office of Energy Systems Research (OESR), is a two-part program to determine the feasibility of fuel cells as power supplies for consumer vehicles, buses, locomotives, and ships. The basic research part of the program takes advantage of the Laboratory's capability in electrochemistry and catalysis, focusing on alternate catalysts, size reduction, performance increases, and cost reduction. The applied research portion utilizes the systems integration, modeling, technology assessment, and economics capabilities of the Laboratory.

FUEL CELLS

(\$ in millions)	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Operating	2.0	4.0	4.5	5	5	5
Personnel (FTE)	13	20	20	20	20	20

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E. Fossil Energy

<u>B & R Code</u>	<u>Major Program (Title)</u>	(\$ in Millions - BA)		
		<u>FY 1982</u>	<u>FY 1983</u>	<u>FY 1984</u>
AA	Coal	2.8	1.4	1.7
AB	Gas	0.8	0.3	0.0
AC	Petroleum	1.8	1.2	0.9
CG	Multi-Resource	0.0	0.0	0.0
CV	Oil and Gas Dev Proj	<u>0.0</u>	<u>0.0</u>	<u>0.0</u>
<u>Total</u>		5.4	2.9	2.6
Percent of Total Laboratory Funding		1	1	<1

1. Current Fossil Energy Programs

The Fossil Energy program at Los Alamos is based upon our unique capability in four areas: Computer Modeling, Basic and Process Chemistry and Engineering, Instrumentation and Control, and Advanced Materials Development.

The largest fossil program deals with the explosive fracture of oil shale. Los Alamos researchers are developing a technology for rubblizing and evaluating in situ oil shale retorts by performing field tests and evaluating the resulting fragmentation using finite difference multicomponent fluid flow hydrocodes. Stress wave propagation and material failure analysis are being used to predict and interpret explosive fragmentation events. The field component of this work is taking place at the Anvil Points Oil Shale Mine in Colorado.

For several years now, Los Alamos researchers have been developing laser-based diagnostic techniques for in situ measurements of the composition of coal gasification process streams. Laser-induced breakdown studies (LIBS), infrared absorption, laser-induced fluorescence (LIF), and coherent anti-stokes raman spectroscopy (CARS) are among those techniques which have been developed and tested to date. Field tests of LIBS and CARS were conducted at METC in FY 1982. In addition to composition of majority, minority, and trace molecular species, total elemental assays and other process variables such as temperature, pressure, and velocity can be measured by the laser-based techniques. Also in the area of instrumentation development, an innovative in situ nuclear magnetic resonance (NMR) measurement tool has been developed. This tool has the ability to characterize the fluid saturations in gas stands. Porosity, permeability, and other pertinent reservoir properties can also be determined by NMR.

The Los Alamos expertise in structural ceramics is being applied to solving fossil-related materials problems. One program investigates utility of whisker reinforcement technology for producing structural ceramic composites of improved strength and fracture toughness. A second program is designed to develop specific brittle-materials design methodology and accompanying fabrication methods for the development of a ceramic type III Lock hopper valve.

2. Fossil Energy Initiatives

a. Unconventional Gas

We are proposing a comprehensive study designed to detect possible sources of natural gas originating primarily in the mantle. Identification of deep gas sources could lead to identifying new reservoirs in unconventional locations and to new prospecting techniques.

UNCONVENTIONAL GAS

(\$ in millions)	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Operating	1.0	1.5	1.5	1.5	1.5
Personnel (FTE)	10	15	15	15	15

b. Oil Shales and Tar Sands

The objective of this program would be to develop and analyze innovative oil extraction techniques from oil bearing shales. Internal funds have been provided in order to build a small high-temperature, high-pressure retorting facility. This facility will be used to test and evaluate innovative oil extraction processes. The ASPEN process simulation code will be used in order to determine the cost effectiveness of various research efforts under consideration.

OIL SHALES AND TAR SANDS

(\$ in millions)	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Operating	0.7	0.9	1	1	1
Personnel (FTE)	7	9	10	10	10

c. Coal/Water Mixtures

The objective of this program would be the combination of Los Alamos capabilities to study the entire technology involved in the use of coal/water mixtures as a fuel for IC engines, turbines, and direct combustors. Los Alamos has relevant expertise in the areas of comminution, beneficiation, nozzle design, combustion modeling, and instrumentation.

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COAL/WATER MIXTURES

(\$ in millions)	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Operating	0.5	1.0	1.0	1.0	1.0
Personnel (FTE)	4	8	8	8	8

F. Environmental Protection, Safety, and Emergency Preparedness (ASEPSEP)

<u>B & R Code</u>	<u>Major Program (Title)</u>	(\$ in Millions - BA)		
		<u>FY 1982</u>	<u>FY 1983</u>	<u>FY 1984</u>
HA	Biomed & Environ Research	2.9	1.6	2.1
Percent of Total Laboratory Funding		1	<1	<1

Current Environmental Protection, Safety, and Emergency Preparedness Programs

Ongoing programs provide technical support and management of projects designed to identify health and environmental hazards relating to energy resource development and hazardous waste management. Technical support and guidance are also provided to DOE to ensure that DOE and DOE contractor personnel are equipped with adequate protective equipment and safety training. Proposed regulations and standards are reviewed and guidance is provided to DOE in the preparation of regulations, reports, and technical documentation relating to radiation protection.

Hazardous Waste Management. Los Alamos has been designated the principal DOE Laboratory for nonradioactive hazardous waste R&D activities. Current activity is concentrated on the design of a management system to assure DOE compliance with provisions of the Resource Conservation and Recovery Act. Rapidly changing direction and staff in Washington have caused some management lags in this program. However, recent realignments have stabilized program direction and scope, and some modest growth for outyears is cautiously anticipated.

G. International and Energy Policy Programs

1. Current International and Energy Policy Programs

Current international energy programs aim at creating a Los Alamos program of international technology cooperation in support of foreign policy initiatives by the Department of State (DOS), Agency for International Development (AID), and Department of Energy (DOE).

There are several current activities in support of the above objective, including development of cooperative laboratory agreements with the Mexican Nuclear Research Institute (ININ) and the Mexican Petroleum Institute (IMP) for the purpose of conducting joint research.

Los Alamos is also conducting research for DOE on the application of sensitivity techniques to the National Energy Policy Plan model and determination of the impact of different deregulation schemes on electric utilities. Analytical support is being provided on other electric utility policy issues in areas such as financing of capacity expansion, electricity conservation efforts, power wheeling for oil and gas use reduction, acid rain, and severance tax issues.

An energy and minerals component of the Caribbean Basin Initiative has been developed to assist countries in that region to develop indigenous energy and mineral resources essential to economic development and reduction of their dependence on high-cost imported oil. Preliminary discussions have been initiated with government officials in Barbados, St. Vincent, St. Lucia, and Dominica, which were favorably received. Follow-up proposals requested by these governments are being developed in areas such as geothermal, mineral reconnaissance, and volcanic hazard prediction.

2. International and Energy Policy Initiatives

a. Caribbean Basin Initiative

The Caribbean countries which were recently visited have expressed considerable interest in various aspects of the energy and minerals component as an essential vehicle for developing secure energy sources which will assist their economic development. The Dominican Republic and Jamaica have also expressed interest in the component, and visits to those countries are planned for early 1983.

The primary difficulty in implementing a substantial program in the region is funding. AID and the Caribbean Development Bank appear to be the most likely sources for funds. If the program can be reasonably funded initially, there appears to be a likelihood that other countries in Latin America will be interested in participating and sharing the cost of work done within their countries.

b. U.S.-Mexico Cooperation

Los Alamos-ININ nuclear cooperation has a good beginning despite Mexico's current economic problems and the budget constraints of the U.S. Government. In FY 1982 Los Alamos and ININ scientists conducted joint research in economies of scale by reactor size, expansion of the Mexican nuclear electrical system, and design and construction of a research reactor. Plans for joint sensitivity testing in economies of scale and additional reactor experiments are being developed for FY 1983. In addition, implementation of exchanges of scientific personnel between Los Alamos and the Center for Nuclear Studies at the National Autonomous University of Mexico (UNAM), in such areas as neutron activation analysis and radioisotopes and nuclear medicine, would greatly enhance the scope of cooperation if DOE support can be obtained. It is also hoped that the Los Alamos-Mexican Petroleum Institute (IMP) agreement, which was negotiated in FY 1982, will receive the approval of the new Mexican Government and that implementation of joint research activities will begin in FY 1983.

WORK FOR OTHER THAN DOE (WFO)

Los Alamos capabilities are also applied to the solution of national problems that either lie outside the DOE charter or that derive portions of their support outside DOE. Such projects generally are accepted only if they complement and benefit Los Alamos activities, use available staff and facilities, and can be conducted without interference to our major commitments to DOE. In FY 1983, reimbursable projects of this nature supported by non-DOE sponsors total about 11% of the Laboratory workload. Three-fourths of this is work performed for the major non-DOE sponsors, DoD and NRC, and is described more fully in this section. The bulk of the remainder is work performed for other Federal agencies, but support is also given to the needs of other governmental units, universities, and industry. Highlights of these activities are described below.

A. Department of Defense

Los Alamos has a sizable effort on programs carried out under DoD funding. While some of this work supports the DoD role in nuclear defense, the Laboratory's main effort is in programs such as directed energy weapons, laser photochemistry applications, and nonnuclear ordnance that exploit unique Los Alamos capabilities for developing nonnuclear weaponry and countermeasures.

1. Current WFO Programs

a. Laser Photochemical Applications

As a result of Los Alamos' research on laser isotope separation, we have established a unique capability in precision photochemistry. Techniques of laser photochemistry show high promise for application to battlefield detection and detoxification of chemical and/or biological agents. Other areas under assessment for military application are laser diagnostics of transient phenomena (including opacity), explosive products, and diagnostics of trace materials associated with the weapons program.

b. Conventional Ordnance and Materials Technology

Expert knowledge about materials, high explosives, and the interactions so essential for nuclear weapons development is being applied to DoD materials and conventional ordnance problems. Examples are nonnuclear warheads to attack ballistic missiles and cruise missiles, antiarmor and antisubmarine warheads, advanced armors, and improved high-speed cutting tools. Work is also being done to develop inexpensive AN-based bomb fills and ceramic armors and to understand deflagration-to-detonation transition in high-energy propellants. We are currently developing a 3-D calculation technique including the coupling of a hydrodynamic code to a finite element code so that we can calculate the complete nonnuclear ABM process from fragments striking the reentry vehicle through the warhead structural response.

c. Chemical and Biological Warfare (CBW) Countermeasures

The CBW countermeasures program exploits R&D capabilities to develop antidotes to chemical agents and toxins, evaluate protective systems, provide adequately sensitive detection and warning systems, devise strategies for avoiding contamination, and devise effective and economical methods for demilitarizing the current chemical weapon stockpile. The program includes the aggregate of human effects-oriented projects supported by the DoD. Individual projects utilize special Laboratory facilities required by the DoD, but inordinately expensive to duplicate in the services laboratories. By comparison, modest improvements in existing Laboratory facilities allow pursuit of integrated effects studies with combinations of conventional, nuclear, chemical, biological, and directed-energy weapons. Results are crucial for planning defenses and countermeasures on the integrated battlefield.

d. Other

This group of activities includes improved methods for weapons test detection; ongoing nuclear weapons effects evaluation and support of Defense Nuclear Agency effects tests; and space-radiation evaluation wherein Los Alamos assists military agencies to interpret data from space and to select instrumentation for space.

2. WFO Initiatives

a. Directed Energy

We are focusing a number of our new concept activities toward directed-energy applications. The Los Alamos effort includes an effort in scientific investigations of lasing media, with most of our emphasis being placed on a variety of concepts involving electromagnetic effects and directed particles and fragments. Work which we had been carrying out over the last five years in the areas of plasma production and magnetohydrodynamics with explosives has also shown the dominance of plasma effects and uncovered the opportunities to apply them to a variety of directed-energy missions. We have discovered within the Inertial Fusion program major effects due to plasma production throughout irradiated pellets. We believe it is appropriate that these efforts be increased in size and scope in order to take advantage of the exciting possibilities.

These efforts will require enhanced budgetary support if we are to augment the efforts without wholesale reductions in other parts of the weapons program. While we intend to initiate such efforts within our presently projected budgets, we solicit additional DOE support for future years. This type of frontier R&D activity had been given far too little emphasis in the past decade and must be revived if the Laboratory is to carry out its advanced technology mission.

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DIRECTED ENERGY

(\$ in millions)	<u>FY82</u>	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>
Operating	1.7	3.8	9.6	12.5
Capital	0.2	0.4	0.7	0.7
Total	1.9	4.2	10.3	13.2
Personnel	12	42	54	70

b. Free-Electron Laser - Defense Advanced Research Projects Agency
(DARPA)

Recent results obtained at Los Alamos National Laboratory have demonstrated an order of magnitude increase in the efficiency of free-electron lasers and confirmed theoretical predictions. These results, which represent the best efficiency achieved to date, have generated considerable interest in free-electron lasers for high-power strategic applications. Los Alamos is uniquely capable of developing such lasers owing to its broad expertise in lasers and electron accelerators. At the present time, the Laboratory has an important DARPA-sponsored program whose objective is to demonstrate, on a small scale, a complete high-efficiency free-electron laser system embodying the technology required for a high-power device. This program will be completed in FY 1985 and would logically be followed by the construction of a high-power device over the period FY 1984 to FY 1988. This will require that some preparation be carried out in parallel with the small-scale study to examine subsystems, preliminary design, and site planning. The estimated large unit construction costs are summarized below (FY 1982 dollars).

FREE-ELECTRON LASER

(\$ in millions)	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Construction	3.0	18.0	60.0	83.0	25.0

c. Technology Demonstration Accelerator - (DARPA)

This facility should serve as an invaluable tool in the program for assessing the feasibility of using neutral particle beams weapons. Although not intended to serve as a prototype, this accelerator facility should be most useful in verifying chosen designs and in identifying problem areas. This facility will contain all the major components to allow testing of the negative ion accelerator, output optics, and neutralizer cell.

TECHNOLOGY DEMONSTRATION ACCELERATOR

(\$ in millions)	<u>FY85</u>		<u>FY86</u>		<u>FY87</u>		<u>FY88</u>	
	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>
Construction	10.0	7.0	10.0	7.0	30.0	23.0	0	13.0

d. Counterterrorism

We are in the early developmental stages of a Laboratory Counterterrorism Program and are presently brainstorming project ideas that can be submitted for outside sponsorship. The successful development of this program depends largely on the quality of these project proposals; moreover, some will undoubtedly need small amounts of seed money for proof of principle or other demonstration. There will be small, quick turnaround experiments best funded out of a modest, undivided category of money.

COUNTERTERRORISM

(\$ in millions)	<u>FY82</u>	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>
Operating	0	0.4	0.8	1.1
Capital	0	0	0.1	0.2
Total	0	0.4	0.9	1.3
Personnel	0	4	8	10

e. Conventional Munitions

The Laboratory, along with LLNL and SNLA, is evaluating the possibility of an expanded role in conventional munitions development. This joint Los Alamos, LLNL, SNLA initiative would be block funded by the DoD and would be under Laboratory technical management. Los Alamos would apply its unique capabilities in the areas of explosives technology, computer simulation, and engineering development to the research and development of improved conventional munitions.

CONVENTIONAL MUNITIONS

(\$ in millions)	<u>FY83</u>	<u>FY84</u>	<u>FY85</u>	<u>FY86</u>	<u>FY87</u>	<u>FY88</u>
Operating	0.5	5.0	7.5	10.0	10.0	10.0
Capital Equipment	0					
Total	0.5	5.0	7.5	10.0	10.0	10.0
Personnel (FTE)	3	20	30	40	40	40

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B. Nuclear Regulatory Commission (NRC)

The NRC work at Los Alamos focuses on providing an understanding of the behavior of nuclear reactors under postulated accident conditions and on providing assistance in reactor licensing. This is done mainly through development, testing against experimental data, and applications of advanced computer codes that model accident behavior. All major reactor types are considered, with the emphasis adjusted as NRC needs and priorities evolve. The focus of the safety effort has been light water reactors.

The cornerstone of the Los Alamos effort is the well-developed TRAC computer code, which has been tested satisfactorily against data from pertinent experiments throughout the world and has comprehensively analyzed the events of the Three-Mile-Island (TMI) accident. This code has evolved from development to application almost in coincidence with the shift in NRC priorities from less interest in development of large computer codes to greater emphasis on providing direct applications help to the regulatory side of NRC for LWR licensing, and the code is now being used for the latter purpose. An international program with Germany and Japan in LWR safety - involving computer codes, analysis, experimentation, and instrumentation - is continuing. The need to look at potentially severe LWR accident sequences - using sophisticated codes like TRAC - is apparent, and we are participating in a multilaboratory effort to help NRC better understand these conceptual accident sequences and to identify how they can be prevented or mitigated. We are also performing computer analyses of many other less severe accident sequences, modeling experiments, and assessing structural problems in reactor systems and containments.

A wide variety of technical assistance projects are also undertaken for the NRC using the strong base of experienced engineering talent available at the Laboratory ranging from safeguards and security expertise to respirator research. These assistance projects pertain to many of the nuclear facilities under NRC jurisdiction, including power reactors, nonpower reactors, and fuel cycle facilities.

A strong effort in the advanced reactor field is continuing with emphasis on the LMFBR. The Laboratory has been able to maintain a strong and unique LMFBR capability with the expectations of continued effort in the future. Continued development and experimental assessment of the fast reactor SIMMER code to better understand LMFBR fuel melting is being supported by the NRC, and the capability to model entire LMFBR accident sequences using a combination of codes, including SIMMER, is the goal. Such studies have already shown that previously used techniques tend to substantially overestimate system damage that could result from a core meltdown accident. The expertise developed and maintained in the LMFBR area is being directed toward the Clinch River Breeder Reactor licensing review where the Laboratory is the principal technical assistance contractor.

C. Other Federal Agencies and Other Entities

Research and Development presently totalling around \$10 M annually is done for the National Aeronautics and Space Administration, Environmental Protection Agency, Department of Interior (primarily U.S. Geological Survey), Department of Health and Human Services (primarily National Institutes of Health and National Cancer Institute), Department of Agriculture, the Department of State, and other Federal departments and agencies. For them we study such things as solar terrestrial phenomena, reduced gravity fluid dynamics, space power systems, oil shale operations, waste incineration, hydrocarbon production analysis, seismic evaluation of coal, flow cytometry, therapeutic particles, serological tests, cell analysis, industrial hygiene sampling, trace contaminants, and nuclear material safeguards.

We also fabricate lightweight radioisotope heater units (LWRHUs) for the Galileo space mission; investigate and maintain a national stable isotopes resource; and collect and maintain (with some DOE support as well) a computer-based national data bank of DNA sequences (GenBank) that supports basic and applied research in biology, medicine, and agriculture. We have established a hearing laboratory to study speaker-independent machine recognition of natural speech in the presence of noise, with the aim of finding general algorithms for solving problems in speech recognition; and, for the Department of State, we provide safeguards training for IAEA inspectors.

We also do work supporting non-Federal public and private sponsors, ranging from aiding the many universities conducting research at LAMPF to doing pipe break analysis and developing nuclear data for reactor analysis for the Electric Power Research Institute. We receive about \$3.1 M combined support and participation in the Fenton Hill geothermal energy project from Japan and the Federal Republic of Germany. We study klystrons for the Stanford Linear Accelerator Center and assist the Saclay accelerator in France. And we study fluid migration, examine fiber aerosol inhalation toxicity, and conduct analogous projects for other sponsors, all subject to the ground rules initially mentioned.

Fig. IV-1. Distribution of Work for Other than DOE.

V. TECHNOLOGY TRANSFER PROGRAM

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V. TECHNOLOGY TRANSFER PROGRAM

A. Overview

The Laboratory's program has two sets of goals: external and internal. On a national scale, the goals are to help affect the optimum use of Laboratory technology by industry to contribute to the nation's industrial strength and to strengthen the Laboratory's science and technology base. The regional goal is to provide appropriate technical assistance to state and local governments, private industry, Indian tribes, educational institutions, and other regional entities.

The internal goals are to strengthen the value of the Laboratory's applied programs through early and sustained liaison with the ultimate developers and suppliers of the resulting technology and to enhance the scientific, technical, and managerial vitality of the staff through collaboration with industry and others.

In context, this program is part of a larger effort to develop a full range of liaison in both applied (typically energy-related) programs and in the basic sciences and underlying technology areas.

The Laboratory is located in a sparsely populated region, and its expertise and technology are typically at the frontiers of the physical and mathematical sciences. Because of this smaller concentration of state/local governments and level of technology, the Laboratory's technology transfer efforts relatively emphasize the private sector over the public sector more than other national laboratories might.

The full-time professional responsible for the Office of Research & Technology Applications (ORTA) functions reports to the Assistant Director for Institutional Relations. The individuals responsible for outreach and technical assistance to neighboring local and state governments and regional entities also report to this Assistant Director. Because the technical resources for these functions are spread throughout the Laboratory, there are formal or informal lines of communication with virtually every level of management in both discipline and program, weapons and nonweapons areas. There is specifically assigned legal support for this function in the Patent Law Division. The Laboratory's institutional planning organization relies upon the ORTA-equivalent to develop and describe the technology-transfer plans.

B. Process

The Technology Transfer Program uses a five-part process to develop the supply, demand, and execution of appropriate transfers:

Industry: To establish beneficial liaison with industry, the strategy is to work simultaneously on development of Laboratory interest,

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industry contacts, and methods for cooperation and on identification and reduction of barriers. Large companies are targeted nationwide to develop liaison in both technology and programmatic areas, typically through invited visits with planned personal follow-up in specific technical areas. Work with small business is focussed regionally, with particular attention to liaison with the University of New Mexico's Technical Innovation Center, existing small businesses, and interest in the spinoff of companies locally to exploit Laboratory technology.

Outreach: Personal contacts are made with local and state government officials, chambers of commerce and tribal officials. Discussions and projects in both technical and nontechnical areas are intended to develop an environment of mutual trust that will increase the opportunities for technology transfer.

Federal Laboratory Consortium: Through active participation in the FLC network, the Laboratory is able to draw upon the unique expertise of other Federal Laboratories in addressing requests for assistance and is conversely a resource to entities outside its geographical region.

Information Development: Although most "information dissemination" is passive and yields little direct technology transfer, it can have an important role in establishing personal contacts, from which productive transfer can result. Information targeted directly to potential users, e.g., trade journal articles, and distribution of applications assessments have particular emphasis; and professional publications, press releases, and the magazine Los Alamos Science also have an important role.

Internal Laboratory: Develop motivation and interest within the Laboratory's staff and management in technology-transfer-related activities; institute an ongoing inventory of new ideas, technologies, and research results for review and transfer; provide an environment which encourages working-level staff to propose and pursue technical initiatives with industry.

C. Estimated Resources: Personnel and Funding

<u>Funding</u> (\$ in thousands)	<u>FY 1982</u>	<u>FY 1983</u>	<u>FY 1984</u>	<u>FY 1985</u>	<u>FY 1986</u>	<u>FY 1987</u>	<u>FY 1988</u>
ORTA	200	230	260	260	260	260	260
Other (estimate)	4100	4650	5200	5200	5200	5200	5200
Total	4300	4880	5460	5460	5460	5460	5460

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Staffing (in FTEs)

Professional Staff

ORTA	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Other	20	20	20	20	20	20	20
Total	21.5	21.5	21.5	21.5	21.5	21.5	21.5

Support Staff

ORTA	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Other	10	10	10	10	10	10	10
Total	10.5	10.5	10.5	10.5	10.5	10.5	10.5

VI. PERSONNEL RESOURCES

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VI. PERSONNEL RESOURCES

A. Trends

Major factors influencing planned personnel trends at Los Alamos continue to be the Administration policy of strengthening the national defense posture and the Department of Energy guidance which shifts emphasis to long-term, high-risk, high potential payoff energy R&D programs. The Plan projects growth in Defense Programs while Energy Programs are expected to experience limited growth in some programs and decline in others.

We expect to maintain a total Laboratory strength of approximately 7,000 FTEs for the foreseeable future. The ratio of indirect- to direct-funded FTEs, currently about 1 to 3, will be maintained through reorganization of support functions to achieve increased efficiency.

B. Requirements

Projected increases in Defense Programs and decreases in Energy Programs will necessitate some realignment of skills to effectively execute Laboratory programs. The Laboratory will pursue realignment of skills and any necessary reductions in operating strength in a manner that retains the qualified personnel best able to efficiently execute programs that are to continue.

Plans for realignment emphasize internal reassignment of personnel where feasible. Control of Laboratory strength to minimize involuntary reductions-in-force features management of backfill for normal attrition by controlled external hiring, which allows external hire to fill only the most critical needs that cannot be satisfied internally.

Planned recruiting will be primarily targeted toward professional and technical staff with weapons, diagnostics, and engineering expertise. Additionally, to support both defense and energy R&D, there is a continuing need to maintain high-quality technical support personnel in the computer sciences, mechanical design and assembly, electronics design and assembly, and chemical processing, which are key recruiting areas.

The current distribution of professional staff experience is presented in Fig. VI-1:

Fig. VI-1. Professional Staff Experience¹

¹INCLUDES FULL-TIME REGULAR EMPLOYEES ONLY.

VII. UNIVERSITY AND INDUSTRY INTERACTIONS

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VII. UNIVERSITY AND INDUSTRY INTERACTIONS

A. Subcontracting

Subcontracting to industry and universities is an integral part of Laboratory programs, permitting the support of specialized expertise not available within the Laboratory. In some cases, subcontracting of either R&D or hardware fabrication is undertaken in a deliberate effort to develop commercial sources of Laboratory technology or to help develop areas of excellence within universities. In this context, some of our strongest interactions with industry and universities occur in the process of technical contract monitoring.

The Laboratory has an active Socio-Economic Program which is administered by a full-time Liaison Officer. The programs include diligent and affirmative action placement of subcontracts and purchase orders with small businesses, small disadvantaged businesses, women-owned businesses, and businesses located in labor-surplus areas.

In furtherance of goals established for each of these program areas, the Laboratory attends numerous trade fairs across the country, is an active member of the New Mexico Minority Supplier Development Council, and has sponsored in-house socioeconomic trade shows. The Laboratory has developed an automated socioeconomic vendor listing which enables buyers and requesters quick access in matching procurement needs with qualified socioeconomic vendors. The Laboratory is also a subscriber and user of the Procurement Automated Source System (PASS), which was developed jointly by the Small Business Administration (SBA) and the DOE. It presently has eight computer terminals which the Laboratory purchased and tied into the system.

The Laboratory has participated in numerous conferences and provided speakers to discuss its programs in this area and throughout the country, i.e., the National Association of Purchasing Management, the New Mexico Minority Supplier Development Council, and the DOE Procurement Managers Conference.

During the previous four years, the Laboratory has received the rating of "excellent" on its joint review by the SBA and the DOE for program compliance. In 1981, the Laboratory received recognition for outstanding accomplishments in the Small Business Program by DOE Secretary Edwards.

The following are dollar statistics for the Small Business and Small Disadvantaged Business Programs, commencing with Fiscal Year 1979. Dollars are being shown, rather than percentages, because in FY 1980 the bases for computing percentage was changed from "Total Available Commercial Procurement Dollars" to "Total Procurement Dollars." The figures below are a more realistic trend of the Laboratory's commitment to these programs:

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	<u>FY 1979</u>	<u>FY 1980</u>	<u>FY 1981</u>	<u>FY 1982</u>
SMALL BUSINESS	\$51.671 M	\$63.648 M	\$70.248 M	\$73.200 M
SMALL DISADVANTAGED BUSINESS	\$2.025 M	\$2.577 M	\$3.484 M	\$3.500 M

TRANSFER TO OTHER DOE LABORATORIES 1/	6.7	4.2	3.8	4.0	2.6	3.0	2.6	2.6	2.7	2.7	2.7
UNIVERSITY SUBCONTRACTS & PURCHASES 2/	1.2	.4	.4	.3	.4	.4	.4	.4	.4	.5	.5
ALL OTHER SUBCONTRACTS & PURCHASES 3/	29.3	34.9	37.8	37.8	31.2	35.4	32.5	35.4	38.5	41.8	47.7
TOTAL LAB. FUNDING BA (MILLIONS)	368.5	367.6	379.9	429.6	579.7	562.8	671.2	669.3	660.3	658.8	646.0

1/ TRANSFERS THAT REPRESENT DOE FUNDING TO THE LABORATORY THAT WILL BE USED TO REIMBURSE ANOTHER DOE CONTRACTOR FOR WORK DONE

2/ TOTAL FUNDING FOR PROCUREMENTS AND SUBCONTRACTS TO UNIVERSITIES

3/ ALL OUTSIDE TRANSFERS, SUBCONTRACTS, AND PURCHASES, INCLUDING CONSTRUCTION (WITHDRAWALS FROM STOCK INCLUDED IN OVERHEAD OR INDIRECTLY CHARGED SHOULD NOT BE INCLUDED)

Fig. VII-1. Procurements, Subcontracts, and Transfers

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B. Laboratory User Facility Participation

Los Alamos has made a major commitment to a broad range of scientific collaboration with universities and industry and backs that commitment by providing access to many of its facilities, both designated users' facilities and others available on a noninterference basis. Descriptions of 30 such facilities, with arrangements and contacts, are available to potential users.

The major dedicated users' facility in FY 1982 was the Los Alamos Meson Physics Facility (LAMPF). Most all experiments are collaborative efforts between Laboratory staff and experimentalists from other institutions, primarily universities. For this reason, we cannot accurately apportion the relative use by outside participants, although the numbers of experimental personnel given below provide a crude measure.

	<u>FY 1978</u>	<u>FY 1979</u>	<u>FY 1980</u>	<u>FY 1981</u>	<u>FY 1982</u>
<u>Experimenter Personnel</u>					
Los Alamos	100	131	123	128	102
Other (mostly university)	289	242	319	314	346
Operating Budget (\$ M)	18.8	21.0	22.8	23.2	26.3

C. University-Laboratory Programs

The Laboratory develops and maintains relationships with approximately 335 universities and colleges and encourages research of mutual benefit to the Laboratory, the universities and colleges, and the individuals involved. Approximately 140 guest scientists, 40 alien guest scientists, 530 visiting scientists, 370 short-term visiting staff members, 15 panel members, and a variable number of consultants participate in a variety of programs annually. Additionally, the Laboratory sponsors approximately 80 postdoctoral appointees annually.

D. Minority Institution-Laboratory Programs

The Laboratory actively supports the Graduate Minorities in Engineering (GEM) Program and sponsors a variety of special outreach programs principally oriented toward training and development. The special programs foster an acquaintance with the Laboratory as it relates to the local geographic area and local universities. Various programs also support other broad social purposes, such as opportunities for disadvantaged persons.

Special employee programs include the Machinist Apprenticeship Program, Skills Training Employment Program, Undergraduate Co-op Program, Summer Undergraduate Student and Graduate Research Assistant Programs, the Associated Western Universities Program, and Long-Term Visiting Staff Members.

Typical of the approximately 10 universities and other organizations that participate with the Laboratory in these programs are the National Consortium for Graduate Degrees for Minorities in Engineering, the University of New Mexico, New Mexico State University, the New Mexico Institute of Mining & Technology, and Eastern New Mexico University. The Laboratory High School Student Honors Program, Undergraduate Student program, and others also feature interaction with local high schools and vocational schools.

E. Industry-Laboratory Programs

Los Alamos seeks to interact with industry both to help ensure that the U.S. economy can take full advantage of Laboratory technology and to strengthen its internal scientific and technical expertise and its applied programs. These interactions can take many forms ranging from strictly informal to contractual relationships.

In recognition of the potential importance of Laboratory-industry interactions, a Director-appointed committee operated during FY 1982 to recommend policy and initiatives.

We are happy to arrange visits for company representatives for either general or focused exposure to Laboratory technology and programs. When industry identifies specific technologies or expertise of interest, the transfer process can include written communications, meetings, workshops, or extended visits to Los Alamos.

Staff assignments or exchanges are of particular interest to Los Alamos. Under the Industrial Staff Member Program, industry staff can work at the Laboratory for typically one to two years to gain hands-on knowledge in specific technical areas. The DOE has recently approved a Laboratory-industry staff exchange program for Los Alamos. Under this program, staff can be exchanged on a general quid pro quo basis, not necessarily in the same technical area. Each organization bears the full cost of its employee's salary, etc; intellectual property developed on an exchange assignment belongs to the organization where the work is done.

Technical collaborations have been undertaken with and without financial support flowing in either direction. These can include government-sponsored or industry-sponsored programs. We have worked with privately held firms, publicly traded companies, industry consortia, and industry trade associations.

Los Alamos cosponsored with Sandia National Laboratories and the Federal Laboratory Consortium a major technical meeting, the Showcase for Technology, in October 1981. This was a major introduction of industry to the technology and programs of several Federal laboratories and universities, attended by 250 industry representatives. Introductory visits to the Laboratory were conducted during FY 1982 for companies such as 3M, Combustion Engineering, Rohm

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and Haas, Gould, Gearhart Industries, and Hughes Aircraft. The Commercial Development Association sponsored a visit of representatives from 15 companies for two days of in-depth presentations and discussions.

Technical collaborations with industry are under way in areas such as multiphase fluid-flow system modeling; combustion modeling; hot rock geothermal energy; a nucleic acid sequence (DNA) data bank; radiation-detection instrumentation. In addition to these outstanding programs, there are countless informal interactions between Laboratory staff and industry.

Special technology-transfer workshops are held occasionally in areas such as accelerator technology, personnel radiation dosimetry, solar energy, geothermal energy, and optics technology.

Future Plans: In recognition of the Laboratory's commitment to appropriate interactions with industry, several new or strengthened initiatives are under consideration. These include the newly approved Staff Exchange Programs, strengthened efforts to obtain partial or full industry support for new reimbursable programs, conduct of an inventory of Laboratory technology as a basis for broader interactions, work with trade associations and industry research consortia to develop interaction opportunities, and consideration of a program to encourage some Laboratory staff to move into industry as a means of direct technology transfer.

VIII. SITE AND FACILITIES DEVELOPMENT

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VIII. SITE AND FACILITIES DEVELOPMENT

A. Laboratory Site and Facilities Development

Los Alamos National Laboratory was founded in 1943 and still has many facilities that were constructed in the early 1950s. Consequently, we need to replace and upgrade buildings and certain research tools and mechanical facilities. In many instances, the present arrangements limit the efficiency of the staff, inadequately satisfy or even impede experimental needs, and generate heavy costs for maintenance and utilities because of their obsolescence and their energy inefficiency. The modernization program begun in the FY 1979 budget continues in FY 1982, and we strongly support further efforts to strengthen it.

The Test Complex Revitalization and R&D Revitalization programs are vitally needed by the Laboratory. In FY 1983 the space shortfall will exceed 300,000 square feet. This will require the Laboratory to continue to utilize temporary and leased space.

Fig. VIII-1. Laboratory and Office Space.

The Long-Range Site Development Plan will be used as a guide by the Laboratory in its future development.

Requested construction projects are summarized in Fig. VIII-2 and Table VIII-1. In view of the limited number of construction projects approved by DOE in recent years, our most urgent facilities needs have moved forward into FY 1985 and beyond. To meet these needs, the level of approximately 50 to 100 million dollars per year should be maintained.

Fig. VIII-2. Construction Projects

TABLE VIII-1

MAJOR CONSTRUCTION PROJECTS

Funded Construction (\$ in millions)	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988		TEC
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	
ASDP															
GB-01 - Weapons R&D Activities															
Proton Storage Ring	12.7	9.0	4.1	6.0	-	2.2									21.8
Upgrading Indus Waste Treat Plants	7.0	4.0	-	3.8											8.7
Water Systems Upgrade	7.0	5.0	-	2.7											9.4
New Tritium Facility	5.0	2.2	1.0	2.0	-	1.5	-	0.3							7.1
New Detonator Facility	4.0	4.0	13.1	9.0	-	4.1									18.2
Collection System Improvements	0.4	0.4	3.5	1.5		2.0									12.5
Subtotal GB-01	36.1	24.6	21.7	25.0	0.0	7.6	0.0	0.3	0.0	0.0					77.7
GB-02 - Inertial Confinement Fusion															
High-Energy Gas Laser Fac (Antares)	9.8	6.2		4.5											62.5
Target Fabrication Facility	8.5	10.6		2.8											15.3
Subtotal GB-02	18.3	16.8		7.3											77.8
TOTAL ASDP	61.5	48.5	32.7	43.3	18.7	26.3	21.4	21.7	31.9	31.9					252.1
GB-03 - Production and Surveillance															
Equip/Utility Restoration FY81	1.4	1.4													7.9
Equip/Utility Restoration FY82	5.7	5.7	11.0	11.0	18.7	18.7	21.4	21.4	31.9	31.9					88.7
Subtotal GB-03	7.1	7.1	11.0	11.0	18.7	18.7	21.4	21.4	31.9	31.9					96.6
OER															
KB-01 - Nuclear Physics															
Accelerator Improvements	0.7	0.7													0.7
ASNE															
AW-AIST															
AW-00 Isotopes R&D Lab		0.4													1.2
ADMINISTRATION															
WB-00 - In-House Energy Management															
High-Temperature Water															
Distribution System	2.1	0.6	2.0	3.0	6.4	4.9	0.0	2.0							10.5
Energy Conservation Retrofit	0.8	0.4		0.4											0.8
Subtotal ADMINISTRATION	2.9	1.0	2.0	3.4	6.4	4.9	0.0	2.0							11.3
TOTAL FUNDED	65.1	50.6	34.7	46.7	25.1	31.2	21.4	23.7	31.9	31.9	12.6	12.6			265.3

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Budgeted Construction (\$ in millions)	FY 1982 BA BO	FY 1983 BA BO	FY 1984 BA BO	FY 1985 BA BO	FY 1986 BA BO	FY 1987 BA BO	FY 1988 BA BO	TEC
<u>OER</u>								
<u>KB-01 - Nuclear Physics</u>								
Accelerator Improvements		0.2 0.1	- 0.1					0.2
<u>KC-00 - Basic Energy Sciences</u>								
Improvements to Weapons Neutron Res. Facility		<u>2.7 2.7</u>	<u>—</u>					<u>2.7</u>
TOTAL BUDGETED		2.9 2.8	0.1					2.9

TABLE VIII-1 (continued)

Proposed Construction (\$ in millions)	FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988		TEC
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	
<u>ASDP</u>													
<u>GB-01 - Weapons Activities</u>													
Adv. Radio. Chem. Wpns. Diag. Fac.			3.0	2.0	5.1	6.1							8.1
TEST Fabrication Fac. (Phase 1)			8.1	8.1									8.1
Dual Axis Radio. Hydro Fac.			9.6	7.2	15.3	17.7							24.9
Nuclear Mat. Storage Facility			2.0	1.6	18.0	16.5	1.2		0.7				20.0
X-Ray Calibration Cap. Upgr.			3.0	2.6	1.6	1.4	0.6						4.6
Central Guard Fac.			0.6	0.6	5.0	3.9	0.4	1.5					6.0
Salt Facility Upgrade			2.8	2.8									2.8
TA-55 Control Room Upgrade					3.0	3.0							3.0
Compressed Gas Fac. Reloc.					2.5	2.0	-	0.5					2.5
Device Fabrication Facility					9.0	8.0	35.0	22.0	-	14.0			44.0
Laboratory Communications Center					3.0	2.5	15.0	10.0	7.0	8.0		4.5	25.0
Materials Science Laboratory					3.5	2.5	13.0	9.0	12.5	14.5	-	3.0	29.0
Weapons Design Engng. Complex					5.0	4.0	16.0	16.0		1.0			21.0
High-Energy Radiographic Fac.							6.7	5.1	2.1	2.8		0.9	8.8
Explosives Physics Exp. Fac.							3.6	3.0	13.0	11.0	9.2	11.8	25.8
WNR Office/Laboratory Bldg.							1.0	0.6	5.5	4.5	0.6	2.0	7.1
Test Fabrication Fac. (Phase 2)							7.0	5.2	11.0	9.5	3.0	6.3	21.0
Safeguards & Security Upgrade I							7.8	6.0	6.7	8.5			14.5
Health Inst. & Meas. Fac.							0.5	0.4	3.8	3.0		0.9	4.3
Utility Operations Center							1.3	1.3					1.3
Hyper-Vel Impact Fac.									2.0	1.5	13.6	10.0	15.6
Antares Upgrade Project									2.0	2.0	18.0	18.0	20.0
Weapons Subsystem Laboratory									2.0	1.5	14.2	14.7	16.2
Weapons Chem & Rad Chem R&D Lab									4.5	3.5	19.5	15.5	34.6
Relocate Salvage & Road Operations											1.6	1.6	1.6
Sanitary Landfill											1.7	1.7	1.7
Safeguards & Security Upgrade II											7.0	6.0	14.2
Equipment Service Facility											3.6	3.6	3.6
Supply & Dist. Warehouse Reloc.											2.6	2.0	25.0
Subtotal GB-01	29.1	24.9	71.0	67.6	107.3	82.4	72.1	86.0	94.6	102.5	414.3		
<u>GE-02 - Materials Production</u>													
Site Preparation SNM Complex							1.0	1.0	9.0	9.0			10.0
<u>GD-00 - Nuclear Mat'ls S&S</u>													
Nuclear Safeguards Technology Lab					5.6	1.0	6.6	5.3		5.9			12.2
TOTAL ASDP	29.1	24.9	76.6	68.6	114.9	88.7	81.1	100.9	94.6	102.5	436.5		

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TABLE VIII-1 (continued)

Proposed Construction (\$ in millions)	FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988		TEC
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	
<u>OER</u>													
<u>AT-00 - Magnetic Fusion</u>													
Motor Generator Set Facility		4.1	0.8	2.0	4.7		0.6						6.1
ZT-40 Upgrade Experiment				15.0	10.0	20.0	20.0	25.0	10.0		20.0		60.0
Engineering Building						3.0	0.4	5.0	2.6		5.0		8.0
Lab/Office Building								1.5	0.2				1.5
Reversed Field Pinch (RFP)													
Subtotal AT		4.1	0.8	17.0	14.7	23.0	21.0	31.5	12.8	0.0	26.3		75.6
<u>KB-01 - Nuclear Physics</u>													
Accelerator Improvements		0.7	1.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7		3.5
Engineering Support Building						3.1	0.5		2.6				3.1
Subtotal KB		0.7	1.0	0.7	0.7	3.8	1.2	0.7	3.3	0.7	0.7		6.6
<u>HA-02 - Health and Environmental Research - Biological and Environmental Research</u>													
Toxic Chemical Containment Facility		0.5	0.2	0.9	1.2								1.4
Biomedical Research Facility								5.0	3.0	14.0	16.0		19.0
Subtotal HA		0.5	0.2	0.9	1.2			5.0	3.0	14.0	16.0		20.4
<u>General Purpose Facilities</u>													
CMR Building Upgrade						6.0	4.0	10.5	6.0		6.5		16.5
Road Improvements		0.3	0.2	2.5	2.6								2.8
Electronics Lab/Office								7.5	0.8		6.7		7.5
Subtotal GPF		0.3	0.2	2.5	2.6	6.0	4.0	18.0	6.8		13.2		26.8
TOTAL OER		5.6	2.2	21.1	19.2	52.8	26.2	55.2	25.9	14.7	56.2		129.4

TABLE VIII-1 (continued)

<u>Proposed Construction</u> (\$ in millions)	<u>FY 1983</u>		<u>FY 1984</u>		<u>FY 1985</u>		<u>FY 1986</u>		<u>FY 1987</u>		<u>FY 1988</u>		<u>TEC</u>
	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	
<u>ASMA</u>													
<u>WB-00 - In-House Energy Management</u>													
Energy Monitoring and Control Sys.							1.5	1.0	9.2	9.7			10.7
Sigma Building Heat Recovery							1.7	0.4		1.3			1.7
Energy Management							<u>5.0</u>	<u>1.0</u>	<u>3.3</u>	<u>5.0</u>		<u>2.3</u>	<u>8.3</u>
TOTAL ASMA							<u>8.2</u>	<u>2.4</u>	<u>12.5</u>	<u>16.0</u>		<u>2.3</u>	<u>20.7</u>
TOTAL PROPOSED			34.7	27.1	97.7	87.8	175.9	117.3	148.8	142.8	109.3	161.0	586.6

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B. Multiprogram General Purpose Facilities

The Laboratory has a need for facilities in this funding category. The identified needs have been selected as those considered to be the most urgent of the general purpose projects.

Proposed Construction

CMR Building Upgrade (TEC \$16.5 M, FY86): Enhanced air filtration and replacement of vital existing building services (such as chilled water) that are no longer adequate. Other approaches are also being considered.

The CMR Building (largest single laboratory facility at Los Alamos) is nearly 30 years old. Many services are no longer adequate to meet the demands of changing program needs and to meet current codes and standards. Failure to fund this project during the planning period will result in continued operations in a substandard facility.

Road Improvements (TEC \$2.8 M, FY84): Reconstruction, widening, and upgrading of arterial roads and intersections along the spine of the Laboratory where 75% of its working population is located.

The rugged topography of alternating mesas and canyons limits traffic circulation to a few major arterial roads, the majority of which were constructed 30 to 35 years ago. Although the roads have been maintained, there are major design deficiencies which no maintenance program is capable of correcting. This project will correct current congestion and safety problems by constructing additional turning lanes, by selective road widening, by adding more lanes, by providing pedestrian/bicycle sidewalks and paths to reduce conflicts with motor vehicles, and by improving intersection capacities in accordance with the long-range plan. Funding during the planning period will permit orderly upgrading of the road system.

Electronics Laboratory/Office (TEC \$7.5 M, FY87): 30,000 square feet of offices and electronics laboratories for approximately 150 engineers and support personnel (centralization of electronic engineering support and R&D functions -- enhancement of the total effort by providing efficiencies that cannot be realized with scattered activities).

Until funded, operations must continue to be carried out under less than satisfactory conditions.

C. General Plant Projects

The issue of General Purpose Plant (GPP) funding is an important aspect of facilities management because it is used for both major repairs as well as minor improvements. The demand for the latter is higher at sites engaged in

research because of the need for frequent space reconfigurations and utility changes to accommodate changing program needs. Underfunding in this area results in the consumption of the capital plant through the uneconomical deferral of repairs, which ultimately results in the requirement for major replacements later. At the same time a lack of GPP funding can prevent space and utilities from being improved in a timely manner to keep pace with program requirements, thus reducing the capabilities and efficiency of operations. We have a need for increased funding support in this area. Our requests for projects in this funding category for FY 1983 were over \$20 M.

Fig. VIII-3. General Plant Projects (GPP)

TABLE VIII-2
GENERAL PLANT PROJECTS^a

(\$ in millions)	<u>FY 1982</u>	<u>FY 1983</u>	<u>FY 1984</u>	<u>FY 1985</u>	<u>FY 1986</u>	<u>FY 1987</u>	<u>FY 1988</u>
<u>ASDP</u>							
AR-0A - Defense Waste Management	0.5	0.3	1.0	1.0	1.0	1.0	1.0
GB-01 - Weapons Activities	6.2	4.0	6.9	9.0	9.0	9.0	9.0
GD-00 - Nuclear Materials S&S			1.1	1.1	1.1	1.1	1.1
GE-03 - Materials Production	<u>0.6</u>	—	<u>0.5</u>	<u>0.2</u>	<u>0.2</u>	<u>0.2</u>	<u>0.2</u>
Subtotal ASDP	<u>7.3</u>	<u>4.3</u>	<u>9.5</u>	<u>11.3</u>	<u>11.3</u>	<u>11.3</u>	<u>11.3</u>
<u>OER</u>							
AT-20 - Magnetic Fusion	0.2	0.5	1.1	1.1	1.1	1.1	1.1
HA-02 - Environ. R&D/LSR	0.5		0.8	0.8	0.8	0.8	0.8
KB-01 - Nuclear Physics	0.7	0.2	0.6	0.6	0.6	0.6	0.6
Other ER	—	—	<u>0.3</u>	<u>0.3</u>	<u>0.3</u>	<u>0.3</u>	<u>0.3</u>
Subtotal OER	<u>1.4</u>	<u>0.7</u>	<u>2.8</u>	<u>2.8</u>	<u>2.8</u>	<u>2.8</u>	<u>2.8</u>
<u>NE</u>							
AW-00 - Isotopes R&D	0.2						
TOTAL GPP REQUIREMENTS	<u>8.9</u>	<u>5.0</u>	<u>12.6</u>	<u>14.1</u>	<u>14.1</u>	<u>14.1</u>	<u>14.1</u>

^aGPP requirements are based on estimated funding support through FY 1983 and comparable requirements thereafter, with all figures expressed in constant dollars without adjustment for escalation. FY 1982 figures include BA reallocated from the prior year.

D. Facility Maintenance

The facility maintenance activity in FY 1982 has decreased slightly since FY 1979. Custodial support for FY 1982 has decreased 6% from FY 1979. While the reduced maintenance funds have little, if any, adverse effect on the overall operation of the Laboratory, this situation has caused the backlog of "must do" maintenance to grow substantially. Some Buildings, Roads and Grounds Maintenance funds have been diverted into the electrical and mechanical maintenance programs to keep critical systems operational. Appearance items such as painting, floor, and grounds have received little attention.

The planned restoration of maintenance funds in FY 1984 will bring the Laboratory maintenance effort to an acceptable level.

E. Utility Costs

Costs are escalated annually to FY 1984 and are constant FY 1984 dollars through FY 1988 with one exception. Natural gas costs have been escalated through FY 1985 to reflect the abnormality of deregulation of natural gas, which will occur January 1, 1985. In order to minimize the cost increase to the consumer in 1985, the Federal Energy Regulatory Commission is planning to administratively allow increases in the selling price of natural gas prior to the legislative deregulation occurring in 1985 and this is also reflected in this estimate. Energy conservation measures will contribute to holding the rate of increase in electricity use to approximately two percent per year. Natural gas consumption for power generation was drastically reduced from FY 1978 through FY 1981 time frame by refinement of procedures as a result of the Time of Day Study in FY 1977. Although there was an increase in FY 1982, continued benefits from this study and energy conservation efforts are projected to hold level the consumption of natural gas through FY 1988. Los Alamos will continue to purchase low-cost hydroelectric power from the Colorado River Storage Project to the maximum extent possible. Purchase of surplus power at favorable rates from Public Service Company of New Mexico will also be made when it is economically feasible. Despite cost saving measures, the cost of both electricity and natural gas will continue to increase significantly through FY 1988. As a percent of the total Laboratory operating funds, electricity costs will rise from 3.0 percent in FY 1982 to 4.5 percent in FY 1988. Fuel (natural gas) costs will rise from 1.7 percent in FY 1982 to 2.5 percent in FY 1985 where they will stabilize in constant dollars through FY 1988. Essentially all operating programs will be impacted by these utility cost increases.

NOTE: Includes natural gas used in generating electricity

Fig. VIII-4. Utilities Cost-Electrical

TABLE VIII-3
UTILITY AND FUEL COST AND CONSUMPTION DATA
(\$000)⁽¹⁾

Year	Electricity Costs				Fuel Costs ⁽³⁾			
	KW	KWH	TOTAL	% of Oper Budget	Usage ⁽²⁾ GWH	Natural Gas	% of Oper Budget	Usage Billions Cubic Feet
1978	3,147	4,009	7,156	2.6	290.6	5,059	1.8	3.00
1979	4,150	5,284	9,434	2.8	315.4	5,779	1.8	2.82
1980	4,018	5,117	9,135	2.4	305.4	6,205	1.7	2.62
1981	5,752	6,349	12,101	2.7	308.6	7,042	1.6	2.33
1982	6,894	7,352	14,851	3.0	317.8	8,562	1.7	2.48
1983	7,352	9,131	16,483	3.3	331.4	10,275	2.1	2.45 ⁽⁵⁾
1984	9,047	11,112	20,159	3.6	334.5	12,330	2.2	2.45
1985	11,264	13,533	24,797 ⁽⁴⁾	4.2	337.6	14,796 ⁽⁴⁾	2.5	2.45
1986	11,489	13,804	25,293	4.3	344.4	14,796	2.5	2.45
1987	11,719	14,080	25,799	4.4	351.3	14,796	2.5	2.45
1988	11,953	14,362	26,315	4.5	358.3	14,796	2.5	2.45

(1) Constant FY 1984 \$ used for FY 1985 through FY 1988. [See (4) for exception.]

(2) Energy/usage is not linear in relationship to either demand cost or total electricity costs. Therefore, total energy consumption is provided.

(3) Total cost of natural gas includes cost and quantity of natural gas used in generation of electricity. [NOTE: Fuel costs and electricity costs are not additive due to partial duplication of costs.]

(4) Natural Gas cost escalated through FY 1985 to reflect impact of deregulation occurring January 1, 1985.

(5) Natural Gas consumption for power generation was drastically reduced in the FY 1978 through FY 1981 time frame by refinement of procedures as a result of the Time of Day Study.

F. Automatic Data Processing Requirements

The Laboratory's historic emphasis on computing is motivated primarily by the needs of national defense, energy, and basic research programs. Starting at the birth of electronic computation shortly after World War II, Los Alamos has operated one of the world's largest computing facilities and continues to be at the forefront of scientific computing. Defense programs are the heaviest users of the total computing resources (see Fig. VIII-5). DOE and DoD programs gain important military, technical, and economic advantages by providing supercomputers to the Los Alamos scientists and engineers. These advantages include

- the development of superior quality products for the DOE and DoD,
- the ability to perform advanced development and research projects that could not otherwise be attempted,
- significant reductions in the development costs of these products, and
- significant reductions in the time needed to develop these products.

If the nuclear weapons currently under development are compared with those of 10 years ago, it is clear that modern weapons technology is far superior in terms of meeting today's national defense needs. A large share of this advance is due to the steady improvement in the capabilities of the computing resources available to weapons designers. Ultimately, it is the ability to model theoretically and to calculate accurately that determines the quality of our nuclear weapons stockpile. This, in turn, is governed by the quality and quantity of computing resources available. In a similar manner, computing is crucial not only to the Laboratory's defense programs but to virtually all of the Laboratory's R&D programs.

The most powerful of the Laboratory's computers are four Cray Research, Inc., Cray-1 systems and four Control Data Corporation 7600 systems. These are located in the Central Computing Facility, which also houses a number of smaller computers and two supporting subsystems: the Common File System and the Print and Graphics Express Station.

Major weapons codes have been "vectorized" to adapt them to the special-purpose architecture of the Cray-1s, and significant gains have been made in their performance, so that each Cray-1 has an overall effectiveness of about four times that of a CDC 7600.

All of the large Los Alamos computers are connected to an Integrated Computing Network that provides complete interactive and batch services to the 3,500 Laboratory computer users and allows rapid access to the computers while minimizing duplication of resources. The network is divided into three partitions: Secure, for classified computing; Administrative, for processing of sensitive data; and Open, for unclassified scientific and nonsensitive administrative activities.

The power of the centralized major computers is supplemented by that of Digital Equipment Corporation VAX minicomputers that are installed at various Laboratory sites. These Distributed Processors are connected to the network and communicate with the central systems, data bases, and output equipment, as well as with other computers and people on the network.

Plans for the acquisition of computers and their necessary support and peripheral equipment are detailed in the Los Alamos input to the DOE ADP Long-Range Plan. Significant items in that plan are summarized in Table VIII-4, "Los Alamos National Laboratory Major ADP Leases and Purchases."

The table indicates that additional major scientific computers will be acquired in FY 1984 and FY 1986. The earlier one is identified as a Class VI/VII Computer, i.e., either another of the Cray-1 series or else a Class VII system. The latter term is used to describe a system that is, at the very least, four times as powerful as what we now have. The Laboratory's need for computing power is such that we could effectively apply a Class VII machine if one were available in the marketplace by FY 1984; however, if such is not the case, another Class VI system will be installed. The FY 1986 acquisition is identified as a Class VII Computer because it is generally assumed that such a system will have been introduced by that time.

Three of our four Cray-1s are listed in Table VIII-4 because of expenditures, for lease or purchase, during the period covered by the table. The line item labelled Administrative Computers addresses the upgrade of obsolescent processors in the Administrative partition of the network.

Four items labelled Mass Storage Upgrade identify enhancements of the Laboratory's Common File System. This data storage facility serves the entire network; its capacity must grow as additional machines are installed, and its bandwidth must be increased to avoid degradation in the speed with which data can be accessed.

Another network resource that must keep pace with the growth in the number of machines is the Print and Graphics Express Station, which processes the printed and graphical output generated by the computers. Plans for its enhancement appear in the table as Output Station Upgrades.

The FY 1984 line item, Input/Output Station, describes a centralized data media-handling station to support the network in functions that involve magnetic tape, small disks, punch cards, and miscellaneous other storage media.

Interactive Graphics for Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM), a line item that appears in the FY 1984 through FY 1986 columns of the table, deals with equipment that will support conceptual and engineering design and manufacture of more complicated weapon components.

**Fig. VIII-5. Percent of CCF computing by program
FY 1982**

TABLE VIII-4

LOS ALAMOS NATIONAL LABORATORY MAJOR ADP LEASES AND PURCHASES

		FY 83	FY 84	FY 85	FY 86	FY 87	FY 88
CRAY-1 (2nd)	PURCHASE	7500					
	(LEASE)	(500)					
CRAY-1 (3rd)	(LEASE)	(3400)	(3400)	(3400)	(3400)	(600)	
CRAY-1 (4th)	(LEASE)	(2650)	(3200)	(3200)	(3200)	(3200)	(550)
CLASS VI/VII	PURCHASE			13100			
COMPUTER	(LEASE)		(2175)	(1090)			
CLASS VII	PURCHASE						13500
COMPUTER (1st)	(LEASE)				(2300)	(4500)	(1100)
CLASS VII	(LEASE)						(2300)
COMPUTER (2nd)							
ADMINISTRATIVE	PURCHASE			710			
COMPUTERS	(LEASE)	(185)	(370)	(95)			
MASS STORAGE	PURCHASE	290					
UPGRADE (1st)	(LEASE)	(40)					
MASS STORAGE	PURCHASE		1600				
UPGRADE (2nd)							
MASS STORAGE	PURCHASE					3000	
UPGRADE (3rd)							
MASS STORAGE	PURCHASE						1300
UPGRADE (4th)							
ELECTRONIC SWAPPING	PURCHASE	1200					
SYSTEM							
OUTPUT STATION	PURCHASE			1500			
UPGRADE (1st)							
OUTPUT STATION	PURCHASE						1500
UPGRADE (2nd)							
INPUT/OUTPUT	PURCHASE		1000				
STATION							
INTERACTIVE GRAPHICS	PURCHASE		2500	5400	2900		
FOR CAD/CAM							

IX. RESOURCE PROJECTIONS AND ANALYSES

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IX. RESOURCE PROJECTIONS AND ANALYSES

- A. Overall Laboratory Summary
- B. Funding by Assistant Secretarial Level Office
- C. Personnel by Assistant Secretarial Level Office
- D. Resources by Subprogram
- E. Phases of R&D Analysis
- F. Organization Chart

A. OVERALL LABORATORY SUMMARY
FUNDING SUMMARY

(\$ IN MILLIONS)	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	COST	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
DOE Effort	437.7	443.2	436.9	437.5	522.0	494.8	527.7	522.2	520.6	520.0	517.8	518.3	516.9	517.2
Work for Others	54.1	54.1	62.2	62.2	65.4	65.4	61.5	61.5	62.5	62.5	63.8	63.8	64.9	64.9
Total Operating	491.8	497.3	499.1	499.7	587.4	560.2	589.2	583.7	583.1	582.5	581.6	582.1	581.8	582.1
Capital Equipment	27.9	26.8	33.8	30.8	50.9	50.9	49.4	49.4	46.0	46.0	45.9	45.9	45.4	45.4
Program Construction	69.9	43.8	37.6	49.5	25.1	31.3	21.4	23.7	31.9	31.9	0.0	0.0	0.0	0.0
Gen. Purpose Fac.(GPF)														
Gen. Plant Proj.(GPP)	8.9	5.1	5.0	5.0	12.6	12.6	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1
Gen. Purpose Eq.(GPE)	(None as such at Los Alamos)													
Total Lab Funding	598.5	573.0	575.5	585.0	676.0	655.0	674.1	670.9	675.1	674.5	641.6	642.1	641.3	641.6
Proposed Const.	0.0	0.0	0.0	0.0	34.7	27.1	97.7	87.8	175.9	117.3	148.8	142.8	109.3	161.0
Total	598.5	573.0	575.5	585.0	710.7	682.1	771.8	758.7	851.0	791.8	790.4	784.9	750.6	802.6

PERSONNEL SUMMARY

(IN FTE)	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988
Direct							
DOE Effort	4,099	3,880	3,989	4,064	4,055	4,047	4,038
Work for Others	469	520	466	441	450	458	467
Total Operating	4,568	4,400	4,455	4,505	4,505	4,505	4,505
Construction	163	120	120	120	120	120	120
Total Direct Charge	4,731	4,520	4,575	4,625	4,625	4,625	4,625
Direct Recharge(Support)	850	800	800	800	800	800	800
Total Direct	5,581	5,320	5,375	5,425	5,425	5,425	5,425
Indirect	1,603	1,580	1,575	1,575	1,575	1,575	1,575
Total Lab Personnel	7,184	6,900	6,950	7,000	7,000	7,000	7,000

B. FUNDING BY ASSISTANT SECRETARIAL LEVEL OFFICE

(\$ in Millions)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	COST	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AS-Defense Programs														
Defense Programs Total														
Total Operating	277.3	277.4	303.2	300.1	369.6	354.3	387.8	384.3	383.2	383.5	377.6	379.0	374.3	375.4
Capital Equipment	20.5	15.9	28.4	25.5	40.4	40.4	35.9	35.9	32.8	32.8	32.3	32.3	31.7	31.7
Construction	63.4	40.1	32.7	43.3	18.7	26.3	21.4	21.7	31.9	31.9	0.0	0.0	0.0	0.0
Total DP	361.2	333.4	364.3	368.9	428.7	421.0	445.1	441.9	447.9	448.2	409.9	411.3	406.0	407.1
AS-Energy Research														
Energy Research Total														
Total Operating	70.9	72.6	72.4	72.6	88.6	83.7	84.5	84.3	84.7	84.6	85.1	85.0	85.4	85.3
Capital Equipment	5.2	6.6	5.1	5.0	6.7	6.7	6.7	6.7	6.8	6.8	6.8	6.8	6.8	6.8
Construction	1.4	2.6	2.9	2.8	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total ER	77.5	81.8	80.4	80.4	95.3	90.5	91.2	91.0	91.5	91.4	91.9	91.8	92.2	92.1
AS-Nuclear Energy														
Nuclear Energy Total														
Total Operating	35.4	39.9	15.2	15.6	22.8	17.6	22.1	20.5	23.6	22.8	26.0	25.2	28.1	27.4
Capital Equipment	1.0	2.5	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Construction	0.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total NE	37.3	43.2	15.4	15.8	23.2	18.0	22.5	20.9	24.0	23.2	26.4	25.6	28.5	27.8
AS-Conservation/Renew Total														
Conservation/Renew Total														
Total Operating	17.7	16.6	9.6	12.4	5.3	4.0	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.7	1.3	0.0	0.0	0.5	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total CE	18.4	17.9	9.6	12.4	5.8	4.5	4.5	4.5	0.0	0.0	0.0	0.0	0.0	0.0
AS-Fossil Energy														
Fossil Energy Total														
Total Operating	5.4	5.4	2.9	3.2	2.6	2.2	2.4	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Capital Equipment	0.4	0.4	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total FE	5.8	5.8	2.9	3.2	2.8	2.4	2.6	2.4	2.4	2.4	2.4	2.4	2.4	2.4
AS-Env. Pro./Safety/EP														
Env Pro/Safety/EP Total														
Total Operating	2.9	3.1	1.6	1.6	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Capital Equipment	0.1	0.1	0.1	0.1	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total EP	3.0	3.2	1.7	1.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6

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B. FUNDING BY ASSISTANT SECRETARIAL LEVEL OFFICE (cont.)

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(\$ in Millions)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	COST	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AS-EI and PE Combined														
EI and PE Combined Total														
Total Operating	0.9	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total RB	0.9	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AS-Management & Administration														
Management & Admin Total														
Total Operating	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	4.2	0.3	2.0	3.4	6.4	4.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Total MA	4.3	0.4	2.0	3.4	6.4	4.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
AS-Work for Other DOE Contr														
Work for Other DOE Total														
Total Operating	27.1	27.1	32.0	32.0	31.0	31.0	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9
Capital Equipment	0.0	0.0	0.0	0.0	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total XA	27.1	27.1	32.0	32.0	32.6	32.6	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5
Total DOE Programs														
Total Operating	437.7	443.2	436.9	437.5	522.0	494.8	527.7	522.2	520.6	520.0	517.8	518.3	516.9	517.2
Capital Equipment	27.9	26.8	33.8	30.8	50.4	50.4	45.9	45.9	42.4	42.4	41.9	41.9	41.3	41.3
Construction	69.9	43.8	37.6	49.5	25.1	31.3	21.4	23.7	31.9	31.9	0.0	0.0	0.0	0.0
Total DOE	535.5	513.8	508.3	517.8	597.5	576.5	595.0	591.8	594.9	594.3	559.7	560.2	558.2	558.5
WFO-Non DOE DoD Programs														
Total Operating	23.5	23.5	28.7	28.7	28.7	28.7	29.8	29.8	30.8	30.8	32.1	32.1	33.2	33.2
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	23.5	23.5	28.7	28.7	28.7	28.7	29.8	29.8	30.8	30.8	32.1	32.1	33.2	33.2
WFO-Non DOE NRC Programs														
Total Operating	15.1	15.1	14.5	14.5	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7
Capital Equipment	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	15.1	15.1	14.5	14.5	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2
WFO-Non DOE Other														
Total Operating	15.5	15.5	19.0	19.0	19.0	19.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.1	3.1	3.5	3.5	3.6	3.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	15.5	15.5	19.0	19.0	19.0	19.0	17.0	17.0	17.1	17.1	17.5	17.5	17.6	17.6

B. FUNDING BY ASSISTANT SECRETARIAL LEVEL OFFICE (cont.)

(\$ in Millions)	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	COST	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Total WFO - Non DOE														
Total Operating	54.1	54.1	62.2	62.2	65.4	65.4	61.5	61.5	62.5	62.5	63.8	63.8	64.9	64.9
Capital Equipment	0.0	0.0	0.0	0.0	0.5	0.5	3.5	3.5	3.6	3.6	4.0	4.0	4.1	4.1
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lab Non DOE	54.1	54.1	62.2	62.2	65.9	65.9	65.0	65.0	66.1	66.1	67.8	67.8	69.0	69.0
General Plant Projects	8.9	5.1	5.0	5.0	12.6	12.6	14.1	14.1	14.1	14.1	14.1	14.1	14.1	14.1
Total Laboratory Funding														
Total Operating	500.7	502.4	504.1	504.7	600.0	572.8	603.3	597.8	597.2	596.6	595.7	596.2	595.9	596.2
Capital Equipment	27.9	26.8	33.8	30.8	50.9	50.9	49.4	49.4	46.0	46.0	45.9	45.9	45.4	45.4
Construction	69.9	43.8	37.6	49.5	25.1	31.3	21.4	23.7	31.9	31.9	0.0	0.0	0.0	0.0
Total Laboratory	598.5	573.0	575.5	585.0	676.0	655.0	674.1	670.9	675.1	674.5	641.6	642.1	641.3	641.6
Proposed Construction	0.0	0.0	0.0	0.0	34.7	27.1	97.7	87.8	175.9	117.3	148.8	142.8	109.3	161.0
Total-Including Proposed Const														
Total Operating	500.7	502.4	504.1	504.7	634.7	599.9	701.0	685.6	773.1	713.9	744.5	739.0	705.2	757.2
Capital Equipment	27.9	26.8	33.8	30.8	50.9	50.9	49.4	49.4	46.0	46.0	45.9	45.9	45.4	45.4
Construction	69.9	43.8	37.6	49.5	25.1	31.3	21.4	23.7	31.9	31.9	0.0	0.0	0.0	0.0
Total	598.5	573.0	575.5	585.0	710.7	682.1	771.8	758.7	851.0	791.8	790.4	784.9	750.6	802.6

C. PERSONNEL BY ASSISTANT SECRETARIAL LEVEL OFFICE

Los Alamos

(Personnel in FTE)	<u>FY 1982</u>	<u>FY 1983</u>	<u>FY 1984</u>	<u>FY 1985</u>	<u>FY 1986</u>	<u>FY 1987</u>	<u>FY 1988</u>
AS-Defense Programs Direct Personnel	2439	2499	2731	2818	2811	2777	2745
AS-Energy Research Direct Personnel	784	750	754	758	761	765	769
AS-Nuclear Energy Direct Personnel	412	200	174	204	226	248	267
AS-Conservation/Renew Energy Direct Personnel	135	100	27	27	0	0	0
AS-Fossil Energy Direct Personnel	52	30	18	18	18	18	18
AS-Env. Pro./Safety/EP Direct Personnel	28	21	19	19	19	19	19
AS-EI and PE Combined Direct Personnel	10	0	0	0	0	0	0
AS-Management & Administration Direct Personnel	1	0	0	0	0	0	0
AS-Work for Other DOE Contr Direct Personnel	238	280	266	220	220	220	220
Total DOE Programs Direct Personnel	4099	3880	3989	4064	4055	4047	4038
WFO-Non DOE DoD Programs Direct Personnel	223	262	218	226	235	243	252
WFO-Non DOE NRC Programs Direct Personnel	140	133	135	135	135	135	135
WFO-Non DOE Other Direct Personnel	106	125	113	80	80	80	80
Total WFO - Non DOE Direct Personnel	469	520	466	441	450	458	467
Direct Recharge	850	800	800	800	800	800	800
Construction	163	120	120	120	120	120	120

C. PERSONNEL BY ASSISTANT SECRETARIAL LEVEL OFFICE (cont.)

(Personnel in FTE)	<u>FY 1982</u>	<u>FY 1983</u>	<u>FY 1984</u>	<u>FY 1985</u>	<u>FY 1986</u>	<u>FY 1987</u>	<u>FY 1988</u>
Total Laboratory - Direct	5581	5320	5375	5425	5425	5425	5425
Total Laboratory - Indirect	1603	1580	1575	1575	1575	1575	1575
Total Laboratory Programs Direct Personnel	7184	6900	6950	7000	7000	7000	7000

D. RESOURCES BY SUB PROGRAM
 ASSISTANT SECRETARY FOR DEFENSE PROGRAMS
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AR05 Defense Waste														
Total Operating	4.0	4.2	4.5	4.4	2.0	2.6	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Capital Equipment	0.6	0.5	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.7	0.7
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	4.6	4.7	5.1	5.0	2.3	2.9	3.4	3.3	3.3	3.3	3.3	3.3	3.7	3.7
Direct Personnel		52		54		31		36		36		36		36
AR-Defense Waste Management														
Total Operating	4.0	4.2	4.5	4.4	2.0	2.6	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Capital Equipment	0.6	0.5	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.7	0.7
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AR	4.6	4.7	5.1	5.0	2.3	2.9	3.4	3.3	3.3	3.3	3.3	3.3	3.7	3.7
Direct Personnel		52		54		31		36		36		36		36
GB01 Weapons Research														
Total Operating	193.1	191.8	214.4	211.9	256.3	253.1	265.7	261.4	259.1	259.7	254.0	255.4	254.1	254.4
Capital Equipment	12.7	9.9	17.8	16.1	25.7	25.7	18.8	18.8	18.7	18.7	18.4	18.4	18.4	18.4
Construction	39.1	22.1	21.7	25.0	0.0	7.6	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	244.9	223.8	253.9	253.0	282.0	286.4	284.5	280.5	277.8	278.4	272.4	273.8	272.5	272.8
Direct Personnel		1,601		1,681		1,865		1,832		1,819		1,792		1,784
GB02 Inert Conf Fus														
Total Operating	35.7	38.3	39.4	39.4	41.6	37.6	52.5	52.5	52.5	52.5	52.5	52.5	52.5	52.5
Capital Equipment	2.5	2.8	5.8	5.8	3.9	3.9	9.5	9.5	9.5	9.5	9.3	9.3	9.3	9.3
Construction	18.5	15.9	0.0	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	56.7	57.0	45.2	52.5	45.5	41.5	62.0	62.0	62.0	62.0	61.8	61.8	61.8	61.8
Direct Personnel		320		324		259		368		368		368		368
GB03 Weap Prod/Surv														
Total Operating	10.0	9.8	8.7	9.1	8.5	8.5	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0
Capital Equipment	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	5.8	2.1	11.0	11.0	18.7	18.7	21.4	21.4	31.9	31.9	0.0	0.0	0.0	0.0
Subtotal	15.8	11.9	19.7	20.1	27.5	27.5	38.4	38.4	48.9	48.9	17.0	17.0	17.0	17.0
Direct Personnel		130		104		87		119		119		119		119
GB-Weapons Activities														
Total Operating	238.8	239.9	262.5	260.4	306.4	299.2	335.2	330.9	328.6	329.2	323.5	324.9	323.6	323.9
Capital Equipment	15.2	12.7	23.6	21.9	29.9	29.9	28.3	28.3	28.2	28.2	27.7	27.7	27.7	27.7
Construction	63.4	40.1	32.7	43.3	18.7	26.3	21.4	21.7	31.9	31.9	0.0	0.0	0.0	0.0
Subtotal GB	317.4	292.7	318.8	325.6	355.0	355.4	384.9	380.9	388.7	389.3	351.2	352.6	351.3	351.6
Direct Personnel		2,051		2,109		2,211		2,319		2,306		2,279		2,271

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR DEFENSE PROGRAMS
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
GC01 Ver & Cntr Tech														
Total Operating	12.6	12.3	13.6	13.1	18.1	16.3	17.2	17.0	19.7	19.0	21.7	21.0	23.7	23.0
Capital Equipment	0.3	0.2	0.5	0.5	1.6	1.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	12.9	12.5	14.1	13.6	19.7	17.9	17.8	17.6	20.3	19.6	22.3	21.6	24.3	23.6
Direct Personnel		110		128		149		155		172		187		206
GC-Verification & Contr Tech														
Total Operating	12.6	12.3	13.6	13.1	18.1	16.3	17.2	17.0	19.7	19.0	21.7	21.0	23.7	23.0
Capital Equipment	0.3	0.2	0.5	0.5	1.6	1.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal GC	12.9	12.5	14.1	13.6	19.7	17.9	17.8	17.6	20.3	19.6	22.3	21.6	24.3	23.6
Direct Personnel		110		128		149		155		172		187		206
GD01 Nuclear Mat Saf														
Total Operating	8.8	9.7	8.8	8.8	12.5	12.0	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Capital Equipment	1.2	1.2	1.2	0.9	2.4	2.4	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	10.0	10.9	10.0	9.7	14.9	14.4	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3
Direct Personnel		107		86		108		108		108		108		108
GD-Nuc Mtls Safeguards & Sec														
Total Operating	8.8	9.7	8.8	8.8	12.5	12.0	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Capital Equipment	1.2	1.2	1.2	0.9	2.4	2.4	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal GD	10.0	10.9	10.0	9.7	14.9	14.4	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3
Direct Personnel		107		86		108		108		108		108		108
GE02 Nuclear Mtls														
Total Operating	4.7	4.2	5.2	5.0	6.6	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
Capital Equipment	0.2	0.2	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	4.9	4.4	5.3	5.1	6.8	6.4	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
Direct Personnel		61		54		60		59		59		59		59
GE03 Support Serv														
Total Operating	0.4	0.5	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.4	0.5	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		4		3		0		0		0		0		0

Los Alamos

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR DEFENSE PROGRAMS
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
GE06 Spec Isotope														
Total Operating	8.0	6.6	8.3	8.1	24.0	18.0	13.5	14.6	13.1	13.5	10.6	11.3	5.2	6.7
Capital Equipment	3.0	1.1	2.4	1.5	6.0	6.0	5.0	5.0	2.0	2.0	2.0	2.0	1.0	1.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	11.0	7.7	10.7	9.6	30.0	24.0	18.5	19.6	15.1	15.5	12.6	13.3	6.2	7.7
Direct Personnel		54		65		172		141		130		108		65
GE-Materials Production														
Total Operating	13.1	11.3	13.8	13.4	30.6	24.2	19.7	20.8	19.3	19.7	16.8	17.5	11.4	12.9
Capital Equipment	3.2	1.3	2.5	1.6	6.2	6.2	5.0	5.0	2.0	2.0	2.0	2.0	1.0	1.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal GE	16.3	12.6	16.3	15.0	36.8	30.4	24.7	25.8	21.3	21.7	18.8	19.5	12.4	13.9
Direct Personnel		119		122		232		200		189		167		124
Defense Programs Total														
Total Operating	277.3	277.4	303.2	300.1	369.6	354.3	387.8	384.3	383.2	383.5	377.6	379.0	374.3	375.4
Capital Equipment	20.5	15.9	28.4	25.5	40.4	40.4	35.9	35.9	32.8	32.8	32.3	32.3	31.7	31.7
Construction	63.4	40.1	32.7	43.3	18.7	26.3	21.4	21.7	31.9	31.9	0.0	0.0	0.0	0.0
Total DP	361.2	333.4	364.3	368.9	428.7	421.0	445.1	441.9	447.9	448.2	409.9	411.3	406.0	407.1
Direct Personnel		2,439		2,499		2,731		2,818		2,811		2,777		2,745

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR ENERGY RESEARCH
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AT05 Appl Plasma Phy														
Total Operating	13.2	13.1	14.0	13.7	17.7	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8
Capital Equipment	0.8	1.0	0.7	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	14.0	14.1	14.7	14.3	18.7	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8
Direct Personnel		146		145		146		146		146		146		146
AT15 Develop & Tech														
Total Operating	4.5	4.6	4.1	4.1	5.9	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4
Capital Equipment	0.5	1.2	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	5.0	5.8	4.4	4.4	6.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Direct Personnel		38		38		38		38		38		38		38
AT25 Mag Fusion Eng														
Total Operating	0.3	0.3	0.0	0.0	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Capital Equipment	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.3	0.3	0.0	0.0	0.9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Direct Personnel		3		0		5		5		5		5		5
AT-Magnetic Fusion														
Total Operating	18.0	18.0	18.1	17.8	24.4	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8	21.8
Capital Equipment	1.3	2.2	1.0	0.9	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AT	19.3	20.2	19.1	18.7	26.1	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
Direct Personnel		187		183		189		189		189		189		189
HA02 Bio & Envrn Res														
Total Operating	6.4	6.4	5.8	5.8	7.4	7.0	7.3	7.2	7.5	7.4	7.7	7.6	7.9	7.8
Capital Equipment	0.7	0.8	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	7.1	7.2	6.4	6.4	8.1	7.7	8.0	7.9	8.3	8.2	8.5	8.4	8.7	8.6
Direct Personnel		88		75		74		76		78		80		82
HA-Biomed & Environ Research														
Total Operating	6.4	6.4	5.8	5.8	7.4	7.0	7.3	7.2	7.5	7.4	7.7	7.6	7.9	7.8
Capital Equipment	0.7	0.8	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal HA	7.1	7.2	6.4	6.4	8.1	7.7	8.0	7.9	8.3	8.2	8.5	8.4	8.7	8.6
Direct Personnel		88		75		74		76		78		80		82

Los Alamos

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR ENERGY RESEARCH
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
HB01 Genl Life Sci														
Total Operating	1.7	1.7	1.2	1.2	2.1	1.9	2.0	2.0	2.1	2.1	2.2	2.2	2.3	2.3
Capital Equipment	0.1	0.2	0.1	0.1	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	1.8	1.9	1.3	1.3	2.6	2.4	2.6	2.6	2.7	2.7	2.8	2.8	2.9	2.9
Direct Personnel		21		11		16		17		18		19		21
HB02 Nuclear Medicine														
Total Operating	2.7	2.7	2.7	2.7	2.4	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	2.7	2.7	2.7	2.7	2.4	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6	2.6
Direct Personnel		33		31		36		36		36		37		37
HB-Life Sci Res & Nuc Med App														
Total Operating	4.4	4.4	3.9	3.9	4.5	4.4	4.5	4.5	4.6	4.6	4.8	4.8	4.9	4.9
Capital Equipment	0.1	0.2	0.1	0.1	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal HB	4.5	4.6	4.0	4.0	5.0	4.9	5.1	5.1	5.2	5.2	5.4	5.4	5.5	5.5
Direct Personnel		54		42		52		53		54		56		58
KA01 Physics Research														
Total Operating	0.3	0.3	0.3	0.3	1.1	0.9	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.3	0.3	0.3	0.3	1.1	0.9	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Direct Personnel		3		3		8		10		10		10		10
KA-High Energy Physics														
Total Operating	0.3	0.3	0.3	0.3	1.1	0.9	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal KA	0.3	0.3	0.3	0.3	1.1	0.9	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Direct Personnel		3		3		8		10		10		10		10
KB01 Med Energy Phy														
Total Operating	32.5	34.3	35.2	35.7	40.0	38.9	38.9	38.9	38.6	38.7	38.7	38.7	38.6	38.6
Capital Equipment	2.3	2.6	2.1	2.1	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Construction	1.4	2.6	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	36.2	39.5	37.5	37.9	42.5	41.5	41.4	41.4	41.1	41.2	41.2	41.2	41.1	41.1
Direct Personnel		355		349		335		334		333		333		332

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR ENERGY RESEARCH
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
KB02 Heavy Ion Phys														
Total Operating	0.1	0.1	0.1	0.1	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4
Capital Equipment	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.1	0.1	0.2	0.2	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5
Direct Personnel		1		1		2		2		2		2		3
KB03 Nuclear Theory														
Total Operating	0.8	0.8	1.0	1.0	1.5	1.1	1.1	1.1	1.4	1.3	1.3	1.3	1.3	1.3
Capital Equipment	0.0	0.0	0.4	0.4	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.8	0.8	1.4	1.4	1.6	1.2	1.2	1.2	1.5	1.4	1.4	1.4	1.4	1.4
Direct Personnel		9		10		10		10		11		11		11
KB-Nuclear Physics														
Total Operating	33.4	35.2	36.3	36.8	41.9	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3	40.3
Capital Equipment	2.3	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Construction	1.4	2.6	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal KB	37.1	40.4	39.1	39.5	44.6	43.1	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Direct Personnel		365		360		347		346		346		346		346
KC00														
Total Operating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	2.7	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.0	0.0	2.7	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		0		0		0		0		0		0		0
KC01 Nuclear Sci														
Total Operating	1.4	1.5	1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	1.5	1.6	1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		14		14		0		0		0		0		0
KC02 Material Sci														
Total Operating	3.1	3.1	3.4	3.4	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Capital Equipment	0.4	0.4	0.6	0.6	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	3.5	3.5	4.0	4.0	5.7	5.7	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
Direct Personnel		35		37		45		45		45		45		45

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D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR ENERGY RESEARCH
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
KC03 Chemical Sci														
Total Operating	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Capital Equipment	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	1.0	1.0	1.0	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Direct Personnel		9		12		10		10		10		10		10
KC04 Eng Math & Geo														
Total Operating	2.3	2.3	2.0	2.0	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Capital Equipment	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	2.5	2.5	2.2	2.2	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Direct Personnel		24		22		29		29		29		29		29
KC05 Adv Energy Proj														
Total Operating	0.3	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.3	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		2		2		0		0		0		0		0
KC-Basic Energy Sciences														
Total Operating	8.0	8.0	8.0	8.0	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3
Capital Equipment	0.8	0.8	0.8	0.8	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Construction	0.0	0.0	2.7	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal KC	8.8	8.8	11.5	11.5	10.4	10.4	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3
Direct Personnel		84		87		84		84		84		84		84
KD01 Assessment Proj														
Total Operating	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		3		0		0		0		0		0		0
KD-Techn Assessment Projects														
Total Operating	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal KD	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		3		0		0		0		0		0		0

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR ENERGY RESEARCH
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>
Energy Research Total														
Total Operating	70.9	72.6	72.4	72.6	88.6	83.7	84.5	84.3	84.7	84.6	85.1	85.0	85.4	85.3
Capital Equipment	5.2	6.6	5.1	5.0	6.7	6.7	6.7	6.7	6.8	6.8	6.8	6.8	6.8	6.8
Construction	1.4	2.6	2.9	2.8	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total ER	77.5	81.8	80.4	80.4	95.3	90.5	91.2	91.0	91.5	91.4	91.9	91.8	92.2	92.1
Direct Personnel		784		750		754		758		761		765		769

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR NUCLEAR ENERGY
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AE20 Space & Terr Appl														
Total Operating	3.6	4.4	4.4	4.3	10.0	8.6	10.6	9.8	12.9	12.1	15.3	14.5	17.4	16.7
Capital Equipment	0.3	0.5	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	3.9	4.9	4.6	4.5	10.3	8.9	10.9	10.1	13.2	12.4	15.6	14.8	17.7	17.0
Direct Personnel		50		49		78		89		110		132		151
AE-Space Nuclear Systems														
Total Operating	3.6	4.4	4.4	4.3	10.0	8.6	10.6	9.8	12.9	12.1	15.3	14.5	17.4	16.7
Capital Equipment	0.3	0.5	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AE	3.9	4.9	4.6	4.5	10.3	8.9	10.9	10.1	13.2	12.4	15.6	14.8	17.7	17.0
Direct Personnel		50		49		78		89		110		132		151
AF05 Fuel Cycle R&D														
Total Operating	0.2	0.2	0.1	0.1	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.2	0.2	0.1	0.1	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct Personnel		2		1		2		2		2		2		2
AF15 LMFBR Base Pgm														
Total Operating	11.0	11.7	9.3	9.7	11.0	7.6	10.3	9.6	9.6	9.6	9.6	9.6	9.6	9.6
Capital Equipment	0.4	0.3	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	11.4	12.0	9.3	9.7	11.1	7.7	10.4	9.7	9.7	9.7	9.7	9.7	9.7	9.7
Direct Personnel		158		133		84		104		105		105		105
AF-Breeder Reactors														
Total Operating	11.2	11.9	9.4	9.8	11.3	7.8	10.5	9.8	9.8	9.8	9.8	9.8	9.8	9.8
Capital Equipment	0.4	0.3	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AF	11.6	12.2	9.4	9.8	11.4	7.9	10.6	9.9	9.9	9.9	9.9	9.9	9.9	9.9
Direct Personnel		160		134		86		106		107		107		107
AG30 3 Mile Island														
Total Operating	0.5	0.5	0.7	0.6	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.5	0.5	0.7	0.6	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		4		8		2		0		0		0		0

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR NUCLEAR ENERGY
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AG36 Lgt Water React														
Total Operating	0.2	0.2	0.2	0.2	0.9	0.7	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.2	0.2	0.2	0.2	0.9	0.7	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Direct Personnel		2		2		6		9		9		9		9
AG-Converter Reactors														
Total Operating	0.7	0.7	0.9	0.8	1.2	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AG	0.7	0.7	0.9	0.8	1.2	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Direct Personnel		6		10		8		9		9		9		9
AH10 Remedial Action														
Total Operating	0.7	0.8	0.2	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.7	0.8	0.2	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		9		2		2		0		0		0		0
AH-Remedial Action Programs														
Total Operating	0.7	0.8	0.2	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AH	0.7	0.8	0.2	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		9		2		2		0		0		0		0
AP05 Comm Waste Mgt														
Total Operating	0.5	1.0	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.5	1.0	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		9		5		0		0		0		0		0
AP-Comm Nuclear Waste Mgt														
Total Operating	0.5	1.0	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AP	0.5	1.0	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		9		5		0		0		0		0		0

Los Alamos

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR NUCLEAR ENERGY
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AW00														
Total Operating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		0		0		0		0		0		0		0
AW01 Adv Isotope														
Total Operating	18.4	20.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.3	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	18.7	22.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		174		0		0		0		0		0		0
AW-ADV Isotope Separ Techn														
Total Operating	18.4	20.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.3	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AW	19.6	23.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		174		0		0		0		0		0		0
CD20 Hydrogeo Survy														
Total Operating	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		4		0		0		0		0		0		0
CD-Uran Supply and Enrichment														
Total Operating	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal CD	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		4		0		0		0		0		0		0
Nuclear Energy Total														
Total Operating	35.4	39.9	15.2	15.6	22.8	17.6	22.1	20.5	23.6	22.8	26.0	25.2	28.1	27.4
Capital Equipment	1.0	2.5	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Construction	0.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total NE	37.3	43.2	15.4	15.8	23.2	18.0	22.5	20.9	24.0	23.2	26.4	25.6	28.5	27.8
Direct Personnel		412		200		174		204		226		248		267

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR CONSERVATION/RENEW ENERGY
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AK05 Power Delivery														
Total Operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		0		0		0		0		0		0		0
AK-Electric Energy Systems														
Total Operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AK	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		0		0		0		0		0		0		0
AL05 Battery Storage														
Total Operating	1.6	0.3	1.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	1.6	0.3	1.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		3		19		0		0		0		0		0
AL10 Thermal Mech St														
Total Operating	1.6	1.1	0.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	1.7	1.6	0.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		9		11		0		0		0		0		0
AL-Energy Storage Systems														
Total Operating	3.2	1.4	1.5	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AL	3.3	1.9	1.5	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		12		30		0		0		0		0		0
AM10 Geothermal Tech														
Total Operating	10.2	11.0	7.5	7.5	5.3	4.0	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.4	0.6	0.0	0.0	0.5	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	10.6	11.6	7.5	7.5	5.8	4.5	4.5	4.5	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		80		60		27		27		0		0		0

Los Alamos

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR CONSERVATION/RENEW ENERGY
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AM15 Hydrothermal Re														
Total Operating	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		0		0		0		0		0		0		0
AM-Geothermal														
Total Operating	10.4	11.0	7.5	7.5	5.3	4.0	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.4	0.6	0.0	0.0	0.5	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AM	10.8	11.6	7.5	7.5	5.8	4.5	4.5	4.5	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		80		60		27		27		0		0		0
EB01 Solar App/Bldg														
Total Operating	2.7	2.4	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	2.9	2.5	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		28		5		0		0		0		0		0
EB02 Solar App/Indy														
Total Operating	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		1		0		0		0		0		0		0
EB-Solar Energy														
Total Operating	2.8	2.6	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal EB	3.0	2.8	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		29		5		0		0		0		0		0
EC01 Building Systems														
Total Operating	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		2		0		0		0		0		0		0

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR CONSERVATION/RENEW ENERGY
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
EC04 Urban Waste														
Total Operating	0.1-	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.1-	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		0		0		0		0		0		0		0
EC-Building & Community Systems														
Total Operating	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal EC	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		2		0		0		0		0		0		0
EE02 Alt Fuels Util														
Total Operating	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		1		0		0		0		0		0		0
EE03 Elect Vehicle														
Total Operating	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		6		0		0		0		0		0		0
EE-Transportation Energy Con														
Total Operating	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal EE	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		7		0		0		0		0		0		0
EG05 Energy Cnv Tech														
Total Operating	0.5	0.5	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.5	0.5	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		5		5		0		0		0		0		0

Los Alamos

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR CONSERVATION/RENEW ENERGY
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>
EG-Multi Sector														
Total Operating	0.5	0.5	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal EG	0.5	0.5	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		5		5		0		0		0		0		0
Conservation/Renew Total														
Total Operating	17.7	16.6	9.6	12.4	5.3	4.0	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.7	1.3	0.0	0.0	0.5	0.5	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total CE	18.4	17.9	9.6	12.4	5.8	4.5	4.5	4.5	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		135		100		27		27		0		0		0

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR FOSSIL ENERGY
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AA05 Adv Envrntl Ctl														
Total Operating	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		4		0		0		0		0		0		0
AA15 Adv Research & Text														
Total Operating	0.6	0.6	0.6	0.6	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Capital Equipment	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Direct Personnel		4		5		3		3		3		3		3
AA45 Fuel Cells														
Total Operating	0.7	0.3	0.1	0.1	0.7	0.5	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.7	0.3	0.1	0.1	0.7	0.5	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Direct Personnel		3		1		4		4		4		4		4
AA65 Insitu Coal Gas														
Total Operating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		0		0		0		0		0		0		0
AA75 Mines R&D														
Total Operating	0.7	0.7	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.8	0.7	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		6		3		0		0		0		0		0
AA85 Surf Coal Gas														
Total Operating	0.4	0.3	0.3	0.3	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Capital Equipment	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.4	0.3	0.3	0.3	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Direct Personnel		3		3		3		3		3		3		3

Los Alamos

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR FOSSIL ENERGY
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AA-Coal														
Total Operating	2.8	2.4	1.4	1.4	1.7	1.3	1.5	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Capital Equipment	0.2	0.2	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AA	3.0	2.6	1.4	1.4	1.9	1.5	1.7	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Direct Personnel		20		12		10		10		10		10		10
AB05 Enhanced Gas														
Total Operating	0.8	0.8	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.8	0.8	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		9		2		0		0		0		0		0
AB-Gas														
Total Operating	0.8	0.8	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AB	0.8	0.8	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		9		2		0		0		0		0		0
AC15 Enhances Oil														
Total Operating	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		0		1		0		0		0		0		0
AC20 Oil Shale														
Total Operating	1.8	2.0	1.2	1.4	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Capital Equipment	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	2.0	2.2	1.2	1.4	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Direct Personnel		21		15		8		8		8		8		8
AC-Petroleum														
Total Operating	1.8	2.0	1.2	1.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Capital Equipment	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal AC	2.0	2.2	1.2	1.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Direct Personnel		21		16		8		8		8		8		8

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR FOSSIL ENERGY
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
CG01 Federal Lease														
Total Operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		1		0		0		0		0		0		0
CG-Multi-Resource														
Total Operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal CG	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		1		0		0		0		0		0		0
CV02 Enh Gas Recov														
Total Operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		1		0		0		0		0		0		0
CV-Oil and Gas Dev Proj														
Total Operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal CV	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		1		0		0		0		0		0		0
Fossil Energy Total														
Total Operating	5.4	5.4	2.9	3.2	2.6	2.2	2.4	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Capital Equipment	0.4	0.4	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total FE	5.8	5.8	2.9	3.2	2.8	2.4	2.6	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Direct Personnel		52		30		18		18		18		18		18

D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR ENV. PRO./SAFETY/EP
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
HA01 Overview/Assmt														
Total Operating	2.9	3.1	1.6	1.6	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Capital Equipment	0.1	0.1	0.1	0.1	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	3.0	3.2	1.7	1.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Direct Personnel		28		21		19		19		19		19		19
HA-Biomed & Environ Research														
Total Operating	2.9	3.1	1.6	1.6	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Capital Equipment	0.1	0.1	0.1	0.1	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal HA	3.0	3.2	1.7	1.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Direct Personnel		28		21		19		19		19		19		19
Env Pro/Safety/EP Total														
Total Operating	2.9	3.1	1.6	1.6	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Capital Equipment	0.1	0.1	0.1	0.1	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total EP	3.0	3.2	1.7	1.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
Direct Personnel		28		21		19		19		19		19		19

D. RESOURCES BY SUB PROGRAM (cont.)
EI AND PE COMBINED
(\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
PE01 Policy Analys														
Total Operating	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		9		0		0		0		0		0		0
PE-Policy Anal & Sys Studies														
Total Operating	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal PE	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		9		0		0		0		0		0		0
TA01 Energy Appl An														
Total Operating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		0		0		0		0		0		0		0
TA-Energy Applied Analysis														
Total Operating	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal TA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		0		0		0		0		0		0		0
TD03 Data Info Serv														
Total Operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		1		0		0		0		0		0		0
TD-Data Information Services														
Total Operating	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal TD	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		1		0		0		0		0		0		0

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D. RESOURCES BY SUB PROGRAM (cont.)
 ASSISTANT SECRETARY FOR MANAGEMENT & ADMINISTRATION
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>
WB00 Energy Mgmt														
Total Operating	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	4.2	0.3	2.0	3.4	6.4	4.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	4.3	0.4	2.0	3.4	6.4	4.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		1		0		0		0		0		0		0
WB-In-House Energy Mgt														
Total Operating	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	4.2	0.3	2.0	3.4	6.4	4.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal WB	4.3	0.4	2.0	3.4	6.4	4.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		1		0		0		0		0		0		0
Management & Admin Total														
Total Operating	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	4.2	0.3	2.0	3.4	6.4	4.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Total MA	4.3	0.4	2.0	3.4	6.4	4.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct Personnel		1		0		0		0		0		0		0

D. RESOURCES BY SUB PROGRAM (cont.)
 WORK FOR OTHERS
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
Work For Other DOE Contr														
Total Operating	27.1	27.1	32.0	32.0	31.0	31.0	24.9	24.9	24.9	24.9	24.9	24.9	24.9	24.9
Capital Equipment	0.0	0.0	0.0	0.0	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	27.1	27.1	32.0	32.0	32.6	32.6	26.5	26.5	26.5	26.5	26.5	26.5	26.5	26.5
Direct Personnel		238		280		266		220		220		220		220
Total DOE Programs														
Total Operating	437.7	443.2	436.9	437.5	522.0	494.8	527.7	522.2	520.6	520.0	517.8	518.3	516.9	517.2
Capital Equipment	27.9	26.8	33.8	30.8	50.4	50.4	45.9	45.9	42.4	42.4	41.9	41.9	41.3	41.3
Construction	69.9	43.8	37.6	49.5	25.1	31.3	21.4	23.7	31.9	31.9	0.0	0.0	0.0	0.0
Total DOE	535.5	513.8	508.3	517.8	597.5	576.5	595.0	591.8	594.9	594.3	559.7	560.2	558.2	558.5
Direct Personnel		4,099		3,880		3,989		4,064		4,055		4,047		4,038
WFO-Non DOE DoD Programs														
Total Operating	23.5	23.5	28.7	28.7	28.7	28.7	29.8	29.8	30.8	30.8	32.1	32.1	33.2	33.2
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	23.5	23.5	28.7	28.7	28.7	28.7	29.8	29.8	30.8	30.8	32.1	32.1	33.2	33.2
Direct Personnel		223		262		218		226		235		243		252
WFO-Non DOE NRC Programs														
Total Operating	15.1	15.1	14.5	14.5	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7	17.7
Capital Equipment	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	15.1	15.1	14.5	14.5	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2	18.2
Direct Personnel		140		133		135		135		135		135		135
WFO-Non DOE Other														
Total Operating	15.5	15.5	19.0	19.0	19.0	19.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
Capital Equipment	0.0	0.0	0.0	0.0	0.0	0.0	3.0	3.0	3.1	3.1	3.5	3.5	3.6	3.6
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	15.5	15.5	19.0	19.0	19.0	19.0	17.0	17.0	17.1	17.1	17.5	17.5	17.6	17.6
Direct Personnel		106		125		113		80		80		80		80
Total WFO - Non DOE														
Total Operating	54.1	54.1	62.2	62.2	65.4	65.4	61.5	61.5	62.5	62.5	63.8	63.8	64.9	64.9
Capital Equipment	0.0	0.0	0.0	0.0	0.5	0.5	3.5	3.5	3.6	3.6	4.0	4.0	4.1	4.1
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lab Non DOE	54.1	54.1	62.2	62.2	65.9	65.9	65.0	65.0	66.1	66.1	67.8	67.8	69.0	69.0
Direct Personnel		469		520		466		441		450		458		467

D. RESOURCES BY SUB PROGRAM (cont.)
 LABORATORY TOTALS
 (\$ IN MILLIONS - PERSONNEL IN FTE)

	FY 1982		FY 1983		FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>	<u>BA</u>	<u>BO</u>
Total Laboratory Programs														
Total Operating	491.8	497.3	499.1	499.7	587.4	560.2	589.2	583.7	583.1	582.5	581.6	582.1	581.8	582.1
Capital Equipment	27.9	26.8	33.8	30.8	50.9	50.9	49.4	49.4	46.0	46.0	45.9	45.9	45.4	45.4
Construction	69.9	43.8	37.6	49.5	25.1	31.3	21.4	23.7	31.9	31.9	0.0	0.0	0.0	0.0
Total Laboratory	589.6	567.9	570.5	580.0	663.4	642.4	660.0	656.8	661.0	660.4	627.5	628.0	627.2	627.5
Direct Personnel		4,568		4,400		4,455		4,505		4,505		4,505		4,505

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E. PHASES OF R&D ANALYSIS^a
(\$ in Millions -- Operating B0)

	<u>FY 1982</u>	<u>FY 1983</u>	<u>FY 1984</u>
<u>Office of Energy Research</u>			
Basic Research	19.7	23.3	26.1
Applied Research	19.6	19.6	23.9
Exploratory Development	3.5	3.6	4.1
Advanced Development	25.7	22.5	25.6
Engineering Development	<u>3.7</u>	<u>3.6</u>	<u>4.0</u>
Total	72.2	72.6	83.7
 <u>Assistant Secretary for Nuclear Energy</u>			
Basic Research	2.8	1.4	1.6
Applied Research	10.8	4.3	4.9
Exploratory Development	17.5	6.7	7.5
Advanced Development	3.9	1.6	1.8
Engineering Development	<u>4.7</u>	<u>1.6</u>	<u>1.8</u>
Total	39.7	15.6	17.6
 <u>Assistant Secretary for Conservation and Renewable Energy</u>			
Basic Research	1.5	1.0	.3
Applied Research	4.4	3.0	1.0
Exploratory Development	7.2	4.3	1.4
Advanced Development	3.8	2.1	.7
Engineering Development	<u>3.2</u>	<u>2.0</u>	<u>.6</u>
Total	20.1	12.4	4.0

^aWeapon-related activity and Work for Others are excluded.

E. PHASES OF R&D ANALYSIS^a (continued)
 (\$ in Millions -- Operating B0)

	<u>FY 1982</u>	<u>FY 1983</u>	<u>FY 1984</u>
<u>Assistant Secretary for Fossil Energy</u>			
Basic Research	.8	.6	.4
Applied Research	3.9	1.7	1.1
Exploratory Development	.8	.4	.3
Advanced Development	.7	.4	.3
Engineering Development	<u>.3</u>	<u>.1</u>	<u>.1</u>
Total	6.5	3.2	2.2
 <u>Miscellaneous DOE Programs</u>			
Basic Research	--	--	--
Applied Research	2.0	1.1	1.4
Exploratory Development	2.0	1.1	1.4
Advanced Development	--	--	--
Engineering Development	<u>--</u>	<u>--</u>	<u>--</u>
Total	4.0	2.2	2.8
 <u>Total Laboratory</u>			
Basic Research	24.8	26.3	28.4
Applied Research	40.7	29.7	32.3
Exploratory Development	31.0	16.1	14.7
Advanced Development	34.1	26.6	28.4
Engineering Development	<u>11.9</u>	<u>7.3</u>	<u>6.5</u>
Total	142.5	106.0	110.3

LOS ALAMOS NATIONAL LABORATORY

F. Organization Chart