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# LBL

## DRAFT PLANNING DETAIL

### FY 1981-1986

July 1980

This volume is a part of the LBL-DOE institutional planning process, and supplements the *LBL Institutional Plan, FY 1981-1986*.

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## I. Introduction

This Planning Detail\* supplements the LBL Institutional Plan, FY 1981-86 as part of the FY 1981-86 institutional planning process. The discussions of LBL programs are grouped under their cognizant assistant secretarial level offices, and within these groupings, by DOE Budget and Reporting codes for FY 1980. LBL resource tables are given in the appendix.

Actual FY 1980 budgetary support levels have been included in the text to help define the present scope of these programs; the names of cognizant LBL staff members have been provided. New work proposals and new initiatives are described in labeled sections separate from the descriptions of the ongoing programs.

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\* This document is also referred to in the DOE Institutional Planning Process Format Specifications as the "WPAS Summary."





Director, Officer of Energy Research

CURRENT EFFORT

## Director, Office of Energy Research

## CURRENT EFFORT

MAGNETIC FUSION (AT) (FY-80 \$5.7 M)

Applied Plasma Physics (AT 05) (FY-80 \$0.6 M)Plasma Theory

Kaufman

In support of magnetic fusion applications, basic plasma theory is carried out in related areas, including: development of canonical formalisms for plasma dynamics in tokamaks and mirrors, study of stochasticity of particles and waves, use of Lie transform approaches to perturbation theory, and trial of symplectic approaches for non-canonical dynamics.

Neutral Beam Plasma Research

Kunkel

Basic plasma physics research is conducted to understand and improve the operation of neutral beam sources and the physics of neutralizer plasmas, and to support the technology development of fusion systems.

Experimental Atomic Physics

Pyle

Atomic collision data are obtained on production rates for various ion species. This information is essential for all neutral beam development schemes. Some of this work is performed at the SuperHILAC.

Confinement Systems (AT 10) (FY-80 \$4.7 M)Tokamak

The Neutral Beam System Test Facility (NBSTF) will be completed in FY-80.

Development and Technology (AT 15) (FY-80 \$0.2 M)Neutral Beam Development and Technology

Pyle

The neutral beam R&D effort, consisting of positive and negative ion-source development and test stand development and operation, is the largest part of the LBL Magnetic Fusion Energy program.

LBL is one of two major U.S. laboratories with a positive-ion-based neutral beam program. Development of the long-pulse (1 to 30 sec) capability of the Advanced Positive Ion Source (APIS) is directly applicable to the injection requirements for MFTF-B, TFTR/TFM, DIII-U, ETF, and MNS.

Research into negative ion-based systems, centering on the production and acceleration of  $H^-$  and  $D^-$  ions, has been started and will increase in FY-81. These sources may be essential to achieve efficient, long pulse neutral beam systems at energies of 150 to 200 keV and higher.

The development and operation of test stand facilities is also a critical component of neutral beam R&D. LBL test stands IIIA and IIIB operate in the 120 kV range; the Neutral Beams System Test Facility (NBSTF) operates in the same energy range but with more total energy per pulse. A proposal to upgrade this facility to the Neutral Beam Engineering Test Facility (NBETF), with greater neutron shielding and higher energy (170 kV) is discussed as a New Initiative.

Neutral beam R&D, traditionally funded through LLL where much joint research is conducted, will be funded directly by DOE, at a level of \$3 million, beginning in FY-81.

Structural Materials and Weldments for High-Field  
Superconducting Magnets

Morris

Improved structural materials are designed and developed for use in structural supports of high-field superconducting magnets. The research also addresses the problem of improving the cryogenic properties and weldability of high strength austenitic steels, which are preferred in current magnet designs. Research tools include microstructural characterization, mechanical testing, failure analysis, metallurgical analysis, and chemical and microstructural modification.

ZEPHYR Neutral Beam Design

The U.S. will collaborate with IPP/Garching during FY 1980-81 on the design of a neutral beam system for ZEPHYR, an ignition test facility to be built in Germany. The basic parameters for the ZEPHYR neutral beam systems are for 1.5-sec injection of 20 MW of 160 keV neutral deuterium beams.

LBL will conduct a one-year conceptual design study of sufficient detail to give confidence in schedule, design feasibility and cost to allow finalization of a formal agreement between the U.S. and Federal Republic of Germany.

Compact Torus Formation by Hot Electrons

Kunkel

The goal of this project is to form a compact torus configuration from a microwave-heated hot electron plasma over a relatively long time-scale (hundreds of milliseconds) compared to present fast start-up techniques. The compact torus configuration would last for seconds, long enough to allow study of stability, equilibrium and slow heating. A detailed parameter study, engineering design, and construction is proposed for FY-81, with completion and preliminary results in FY-82.

HIGH ENERGY PHYSICS (KA) (FY-80 \$11.1 M)

Physics Research (KA 01) (FY-80 \$6.7 M)

Time Projection Chamber (TPC)

The Time Projection Chamber (TPC) presently being developed for PEP is a major innovation in detector technology. Through its capability to generate intrinsically 3-dimensional spatial data combined with high-density ionization measurements, the TPC technique provides particle identification, pattern recognition and event reconstruction efficiencies that surpass any other available technique.

The initial research goal (after construction and debugging of the facility) is to search for evidence of new processes or the production of new particles at PEP. The ratio of hadron to muon pair production will be measured to high precision; the details of hadronic events will be observed in order to measure multiplicities, sphericity and inclusive particle spectra; scaling will be tested; and, search for bumps in invariant mass spectra reconstructed from these final state hadrons will be made. It should be emphasized that if a new hadronic threshold is reached at PEP, the TPC facility is exceptionally well instrumented to spot new mass bumps, even far above threshold, because of the high quality particle identification available. An attempt to detect weak interaction effects will be made during this phase.

Mark II Magnetic Detector

The Mark II Magnetic Detector, the first general purpose facility at PEP, is an instrument of substantially greater sophistication than the Mark I which made numerous discoveries ( $\psi$  particles, charmed particles) over a period of four years at the SLAC storage ring SPEAR.

The Free Quark Search

A large part of the experimental results of present day high energy physics can be explained with quarks being the fundamental building blocks of elementary particles; but as yet no quarks have been observed. PEP opens up a completely new domain for the search for charged particles. This experiment offers a simple detector that would be able to detect quarks of mass up to the maximum PEP energy at 15 GeV.

Theoretical Physics

Theoretical physics research includes work on gauge theories of weak, strong, and electromagnetic interactions. Much of the work is directly related to the LBL experimental program, for example, analysis of charmed meson decays, production of charmonium states in  $\bar{p}p$  annihilation, tests of integral and fractional charge quark models, and studies of radiative transitions among charmonium states. Research on unified electro-weak theories and QCD has a direct bearing on future experimental work.

### Neutrino Interactions and the External Muon Identifier

Currently studies of neutrino interactions of high momentum transfer are being made to search for effects of the hypothetical gluons of quantum chromodynamics. In addition a careful search is underway for neutral current events.

### The Particle Data Group

The "Review of Particle Properties" and other compilations of descriptive and bibliographic information on published articles, preprints, and current experiments are issued by the LBL Particle Data Center. The Berkeley Database Management System is used to maintain and query the various LBL data bases, which are open to outside users.

### Muon Reactions

LBL has led a major program in high energy muon scattering by constructing and using the Multi-Muon Spectrometer. This innovative detector has produced data with high statistics, which are being used to test QCD models for lepto-production of charm.

### Astrophysics and Astronomy

This work is concerned with measurement of properties of the primordial blackbody radiation and with study of compact astronomical objects such as neutron stars and black holes.

### Facility Operations (KA 02) (FY-80 \$ 0.7 M)

This program is concerned with the operation of PEP detectors and the LBL contribution to the PEP Facilities coordination group. Current work involves testing and mechanical and electrical maintenance of the Time Projection Chamber and its superconducting magnet.

### Superconducting Solenoid Magnets

This is a study of the design of superconducting magnets required for particle detectors in high energy physics. The physics of quench phenomenon and techniques of quench protection are included. Techniques resulting from this study can be used in other laboratories such as CESR, as well as in private-sector laboratories.

### Accelerator Theory

Theoretical work on accelerators encompasses a broad range of activities, from direct contributions to design and development of operating and proposed accelerator facilities at LBL to collaboration with other laboratories on projects of mutual interest.



High Energy Technology (KA 03) (FY-80 \$4.2 M)Advanced Accelerator Studies

Elioff, Taylor, Lambertson

This program consists of three activities: PEP and future colliding beam projects, development of high field superconducting accelerator magnets, and studies of beam cooling.

Turn-on of the PEP beam was achieved on schedule in April 1980. LBL participation will continue, as required, to assure maximum operating efficiency during the start-up period and to investigate future PEP development and improvement. The Single-Pass Collider Project at SLAC is currently studied as the next step in  $e^+e^-$  physics.

Additional collider efforts are pursued, particularly collaboration on the  $\bar{p}p$  project at Fermilab. LBL's program in stochastic beam cooling has achieved substantial progress this year. Success in beam cooling is essential to any  $\bar{p}p$  scheme, and LBL's contributions to Fermilab's collider system are important to the success of the project.

LBL's program in high-field superconducting accelerator magnet development addresses both the immediate and long-term needs of the national high energy physics program. The long-term goal is to achieve 7-11 tesla magnets for the next generation of HEP facilities. On the immediate side is the full understanding of current technical problems and provision of a sound engineering base for superconducting magnet design. A comprehensive program, including a fundamental effort in underlying physics, component development, instrumentation, engineering and materials science is proposed as a New Initiative.

## NUCLEAR PHYSICS (KB) (FY-80 \$17.3 M)

Medium Energy Physics (KB 01) (FY-80 \$0.2 M)

The Physics Division has no immediate plans for Medium Energy research, but this should not preclude future involvement.

Heavy Ion Nuclear Physics (KB 02) (FY-80 \$16.5 M)SuperHILAC and Bevalac Research (FY-80 \$3.4 M)

Various

This project covers basic nuclear physics investigations with heavy ions at the SuperHILAC and Bevalac accelerators. It supports developments in instrumentation, provides collaboration with visiting researchers, trains graduate students, and stimulates the development of accelerators and facilities.

Experiments at the SuperHILAC use ions from  $^{40}\text{Ar}$  to  $^{208}\text{Pb}$  for research in nuclear reactions and nuclear structure, and in the search for exotic elements and isotopes. Particular studies have focused on understanding the nature of energy and angular-momentum transfer in deep inelastic collisions;

on Coulomb excitation with Xe and Pb beams; and on completing two instruments designed to search for short-lived super-heavy elements and to identify spontaneously fissioning isotopes of heavy but unknown masses.

Research at the Bevalac continues to employ beams up to  $^{56}\text{Fe}$  at energies up to 2 GeV/amu to study the basic nuclear physics of interactions induced by relativistic heavy ions. Recent emphasis has been on projectile and target fragmentation studies with increasing focus on exclusive measurements and high multiplicity events. The streamer chamber facility will continue as a device for survey experiments and for the study of complicated events. Two important new detectors, both of which will come on line in early 1981, are the large-gap, 3 tesla-field Heavy-Ion Superconducting Spectrometer (HISS) and the plastic ball/wall array (a  $4\pi$  particle-identifying multi-detector system constructed by the GSI-LBL collaboration). Another new facility, the Low-Energy Beam Line, provides high quality beams from 30-200 MeV/amu.

Completion of the "uranium beams" project at both accelerators in FY-81 and early FY-82 will add immeasurably to the research potential at these national facilities by making available beams of all masses at energies from several MeV/amu to at least 1 GeV/amu.

#### 88-Inch Cyclotron Research (FY-80 \$1.7 M)

Various

This project covers basic nuclear physics investigations with heavy ions at the 88-Inch Cyclotron. It supports developments in instrumentation, provides support for and collaboration with outside users, trains graduate students, and stimulates the development of accelerators and facilities. Although the 88-Inch Cyclotron has not been designated as a national facility, it supports a strong outside user program with about as many hours of outside use per year as each of the two LBL national facilities.

The 88-inch Cyclotron accelerates beams of ions from protons to  $^{40}\text{Ca}$  ions at energies from 55 to 6 MeV per nucleon, respectively. Important advantages of the 88-Inch Cyclotron are: continuous rather than pulsed beams and very high energy resolution. Experimental research at the 88-Inch Cyclotron focuses primarily on (1) investigations of heavy ion reaction mechanisms, (2) the study of exotic nuclei far from the valley of stability, (3) the spectroscopy of high spin states of nuclei, (4) studies of collective motion in heavy-ion induced reactions, and (5) searches for and studies of unusual transuranium isotopes and elements.

#### 88-Inch Cyclotron Operations (FY-80 \$1.1 M)

Harvey, Clark

The project operates, maintains, and improves the cyclotron and beam-transport facilities up to the experimental areas, maintains the building and shop facilities, and coordinates the use by 33 LBL scientists, 19 graduate students and approximately 56 scientists from laboratories other than LBL. The Cyclotron operates 20 eight-hour shifts per week for in-beam experiments in nuclear physics and nuclear science, isotope production and beam development.

Recent major developments include the increase of the main magnet's field to give an energy constant of  $K = 160$ . This will permit acceleration of light heavy-ions such as  $^{16}O(7+)$  to 30 MeV/amu, providing a useful overlap with the Bevalac's Low-Energy Beam Line. Another development is the installation of a new ionizer to provide a tenfold increase in the intensity of polarized proton and deuteron beams.

Bevalac/SuperHILAC Nuclear Physics Operation (FY-80 \$11.0 M) Grunder

The SuperHILAC and the Bevalac are operated as National Research Facilities for studies in nuclear physics, nuclear chemistry, astrophysics and biomedical applications. Beams of different ions, from lithium to lead, can be accelerated to 8.5 MeV/amu on alternate SuperHILAC pulses and delivered to one or two of 13 different target areas plus the transfer line to the Bevalac. At the Bevalac, beams of ions from hydrogen to iron are delivered at energies from approximately 50 MeV to 2.1 GeV per nucleon; eight beams and several general and specialized target areas are used.

Outside users account for about half of the research time at each accelerator. The Accelerator Research Coordination Office, two users associations and a group of physicists, engineers and support staff are dedicated to assisting users, particularly those from other institutions, in successfully mounting their research.

Constant attention is given to improving the two accelerators, both in terms of machine operation and experimental facilities, to enable them to effectively serve the research interests of the national and international community of users.

A major improvement, now in progress, is the High Intensity Uranium Beams development. When completed in FY-82, the SuperHILAC will produce at least 1 particle microampere of all masses at up to 8.5 MeV/amu. The Bevalac will be able to deliver relativistic beams ( $\geq 1$  GeV/A) of all mass numbers including uranium, as well as high-intensity intermediate-energy beams between 40 and 200 MeV/amu.

A 12% budget increase (in real terms) will be necessary starting in FY-82 to support the more complex machine and experimental operations entailed in delivering exotic beams. This increase will cover an additional 13 FTE and the power to operate the third injector at the SuperHILAC.

Nuclear Theory (KB 03) (FY-80 \$0.7 M)

Nuclear Theory

Glendenning

This program concentrates on areas of nuclear theory that guide and interact strongly with LBL experimental research. The current work of the scientific staff focuses on two main areas: (1) the study of nuclear collisions from the Coulomb barrier to multi GeV/amu and (2) the study of hadronic matter, including possible phase transitions under extreme conditions of temperature and density.

Work in the first area includes the development of a new macroscopic theory of the nuclear dynamics of large-scale shape evolutions, which is expected to have applications in the production of super-heavy nuclei. In the high energy region, the research includes analysis of  $\pi^+\pi^-$  correlations and pp correlations, the theory of composite fragment production, and the dynamics of pion and kaon production.

The second category concerns possible new phases of matter under abnormal conditions of density or temperature. There is an intermediate range between normal and extreme conditions where condensed fields of mesons such as the pion condensate may appear; this is being studied in a relativistic field theory of nuclear matter. Under extreme conditions, the internal structure of the baryons is excited; the implications of this for production of multi-strange and anti-nuclei are being studied.

BASIC ENERGY SCIENCES (KC) (FY-80 \$16.4 M)

Nuclear Sciences (KC 01) (FY-80 \$2.4 M)

Low Energy Nuclear Sciences

Various

This activity supports experimental research with light ions, supplying instrumentation, computer, and detector development for work at LBL and other laboratories.

Studies of light nuclei far from stability utilize light-ion beams and the on-line mass analysis system RAMA. Searches are conducted for nuclei near the proton and neutron "drip" lines which may decay by new or exotic radioactivities. Even with reduced funding, significant research with the excellent polarized proton and deuteron beams from the 88-Inch Cyclotron has continued, based substantially on strong LBL- outside user collaborations. The advent of fission-like phenomena in deep inelastic collisions is also investigated.

88-Inch Cyclotron Operations

Harvey, Clark

This activity supports the development and acceleration of beams of protons, deuterons,  $^3\text{He}$  and  $^4\text{He}$  at the 88-Inch Cyclotron. The 88-Inch Cyclotron continues to be the sole DOE supported facility with polarized proton and deuteron beams in the 20-55 MeV range. Faced with a tremendous increase in electric power costs (from 3.5¢/kWh in early 1980 to 6¢ in June), additional operating funds are required to maintain the Cyclotron's highly efficient running schedule.

Isotopes Project

Dairiki, Lederer

The Isotopes Project compiles and evaluates nuclear structure and decay data and develops compilation methodology. The project operates as a member of the U.S. Nuclear Data Network (NDN); LBL has been assigned principal responsibility for the authorship of Nuclear Data Sheets covering the mass regions  $A = 146-152$  and  $A = 163-194$ . In addition, the Project has been asked to produce, on behalf of the NDN, a Radioactivity Handbook for applied users, to be published at four-year intervals beginning in 1982.

Actinide Chemistry (FY-80 \$0.9 M)

Edelstein

Studies are carried out of actinide materials to provide basic knowledge necessary for their safe use in present and future nuclear technologies. Preparation and characterization of new gaseous, liquid, and solid phases. Design of sequestering agents for the actinide ions, in particular plutonium (IV), to be used in the treatment of actinide poisoning as well as for possible applications in the reprocessing of nuclear fuels.

Materials Sciences (KC 02) (FY-80 \$5.5 M)Electron Microscopy

Various

High-resolution electron microscopy is used to advance the understanding of phase transformations of importance in alloy design. It is planned to add 500-kV instrument and support facilities to include atomic resolution microscopy of close-packed structures used in energy technologies. Recent LBL research in ceramics, crystal structure determination, and defect analysis have led to the addition of a new 1.5-MeV electron microscope, scheduled for operation in late 1980.

Physical Metallurgy

Various

Studies are made of the relationship of microstructure to mechanical, electrical, and magnetic properties. Ferrous alloys are prepared with predictable characteristics, unusual compositions and structures. Major efforts are placed on alloy design, especially in ferrous metallurgy: low-alloy silicon steels of increased toughness for automotive use, nickel-free cryogenic steels, tough high-strength low-alloy steels for applications in mining and other fields. Structures of solar absorber coatings are investigated.

Ceramic Science

Various

Goals of this program are: identification and control of subtle material parameters that influence ceramic properties and behavior; influence of materials parameters on piezoelectricity, on graphitization kinetics, on sintering rates, and on fracture strengths; sintering and strength studies; identification of impurity phases at grain boundaries by ultra-high-resolution transmission electron microscopy; thermodynamics and kinetics of decomposition and recombination reactions; catalysis of SO<sub>3</sub> and metal sulfate decompositions; kinetics and mechanisms of reduction of transition-metal-oxide spinels by gases; martensite transformations as toughening mechanisms for ceramics with high erosion, wear, thermal shock, and impact damage resistance.

Engineering Materials

Various

Goals of this program are: understanding of mechanisms of erosion and combined erosion-corrosion of metals, ceramics, coatings, and scales on metals in two-phase, solid-gas, and solid-liquid flows representative of those in coal conversion processes; enhancement of erosion-corrosion-wear resistance by chemical and morphological modifications of surface layers

and the deposition of coatings; material design criteria for erosion-corrosion resistant materials.

Solid-State Physics

Various

Goals of this program are: development of new energy-related uses of advanced materials such as superconductors, superconducting devices, nonlinear optical materials and processes, semiconductors, and far-infrared detectors; theoretical solid-state studies and far-infrared spectroscopy of solids directed to surface reaction and catalysis programs of interest to fossil-fuel conversion. Studies are made of relaxation of hot carriers in semiconductors; temporal behavior of Raman and Brillouin scattering in solids, spatial dispersion effects in the vicinity of an exciton-polariton in semiconductors; picosecond nonlinear spectroscopy of solids; multiphoton dissociation of molecules for new laser isotope separation processes; and electron droplets in semiconductors as a novel state of matter.

High-Temperature and Surface Chemistry/Chemical Structure

Various

Topics under study are: structure and composition of surfaces on the atomic scale; kinetics and mechanisms of elementary surface reactions; correlation with macroscopic surface phenomena of corrosion, mechanical failure, passivation, surface reactions, and electrode processes; chemistry and materials problems in energy production technologies, and radiation-enhanced high-temperature corrosion; expansion of the scientific foundation and range of useful applications of electrochemical transformations; elucidation of chemical bonding and phase transformations in solids; prediction of crystal structure and phase diagrams on the basis of electron orbitals; physical properties of solids at high temperatures, as well as in high magnetic fields and at low temperatures; ultrahigh molecular weight organic polymers and organometallic polymers; block and graft copolymer synthesis to yield useful polymeric alloys.

Chemical Sciences (KC 03) (FY-80 \$5.7 M)

Photochemical and Radiation Sciences

Various

Studies are made of: atmospheric photochemistry with primary emphasis on stratospheric ozone; photon-assisted chemical reactions at the solid-vapor interface, including photodissociation of water to produce hydrogen and oxygen, and photon-assisted reactions of carbon dioxide and water to produce simple hydrocarbons (photosynthesis).

Chemical Physics

Various

Studies are made of chemical reaction mechanisms, molecular collision dynamics, and molecular structure. Reactions of ions and molecules in the gas phase are investigated by the application of lasers and molecular beams. Results are used for the development of a theoretical chemical foundation for reactions of interest in combustion and MHD processes. Chemical binding energies and electronic structure, which determine the properties of materials, are studied by photoelectron spectroscopy of metals, semiconductors, and

insulators. This technique has recently been expanded to the investigation of solid surfaces.

Atomic Physics

Marrus

The validity of relativistic quantum mechanics is being investigated by the use of optical and radiofrequency spectroscopy with highly stripped ions, in a program of precise measurements of physical processes of atoms, molecules, and ions. Among the applications of this work are use of line widths for plasma diagnostics in fusion research. A positive parity violation effect has been discovered in atomic thallium. This effort comprises an important test of gauge theories of the weak and electromagnetic interactions.

Artificial Photosynthesis

Calvin, Otvos

The purpose of this project is development of methods for storage of solar energy based on the principles of green plant photosynthesis but not restricted to aqueous media. Among the processes under study are energy transfer in condensed media, near-infrared-induced chemical reactions, photosensitized electron-transfer in heterogeneous systems, and photovoltaic devices using organic dyes as sensitizers.

Unimolecular Kinetics

Brown

This research is directed toward extending and applying unimolecular reaction rate theory to important combustion reactions. (Part of Combustion program.)

Chemical Analysis

Giauque, Clem

Analytic techniques and instruments are developed for measuring fossil fuel-produced chemical contaminants at ppm and ppb levels. These are applied to support other energy- and environment-related research projects.

National Resource for Computation in Chemistry (NRCC)

Lester

The NRCC was conceived as an organization to serve the needs of both experimental and theoretical chemists throughout the nation. The breadth of this unique responsibility has led to the creation of a professional staff with expertise in most areas of numerical analysis and computer science, as well as the major areas of computational chemistry including chemical kinetics, crystallography, macromolecular science, physical organic chemistry, quantum chemistry, and statistical mechanics. One of the staff's primary responsibilities is the maintenance and extension of the recently established chemistry software library which now has a base of holdings in the major areas. This library is unique in having a professional staff that serves as consultants in its use.

The technical goals of the NRCC are inherent in its objectives: progress toward full use of theoretical and computational research in chemistry, and wide availability of state-of-the-art software and high-speed computer facilities. Improvement of codes and application of new computer hardware to computational chemistry are also primary concerns.

The establishment of priorities for additions to the software library and activity in other areas is greatly aided by NRCC workshops. Some workshops are directed towards advancing the state of the art in specific areas of chemistry and defining the possible role of the NRCC to assist such efforts.

Chemical Energy

Various

Unusually high oxidation states of elements, intercalated layer compounds, and compounds with new structures and bonding that cannot be explained by present theoretical concepts are synthesized and characterized by modern physical-chemical techniques. This program includes the chemistry of sulfur dioxide for SO<sub>2</sub> removal; the structure and bonding of metal carbonyls of importance in the catalytic processing of fossil materials; the determination of trace elements in coal, oil, water, and biological specimens; the conversion of coal to liquid products by action of homogeneous catalysts at temperatures below the coal pyrolysis temperature.

Novel synthetic methods are designed to achieve transition-metal-catalyzed substitution of nitrogen and sulfur moieties in coal and coal-derived liquids by alternative structure units (carbon monoxide, ethylene, methylene, oxygen). The catalytic potential of polymer-supported transition metal catalysts is being studied as well as homogeneous carbyne clusters capable of methanation and Fischer-Tropsch synthesis.

Analysis

Brown

New electrochemical techniques are being developed for analysis of uranium and transplutonium elements in dilute solution by use of staircase voltammetry and square-wave polarography.

Chemical Engineering Science

Prausnitz

Experimental and theoretical research has been initiated to determine the phase behavior of aqueous natural-gas systems found in deep high-pressure reservoirs in the Gulf of Mexico.

Turbulent Combustion

Robben

Combustion in a turbulent heated-wall boundary layer is being studied experimentally and computationally with the aim of developing and testing numerical models of turbulent combustion. (Part of Combustion program.)

Bioconversion of Cellulose and Production of Ethanol

Wilke, Blanch

Fundamental studies are conducted on the mechanics and kinetics of cellulose hydrolysis by cellulase enzymes and acids.



Engineering, Mathematical and Geosciences (KC 04) (FY-80 \$2.2 M)Ignition Studies

Oppenheim

Studies are being made of the fundamentals of ignition of gaseous fuel-air mixtures using jets of radicals, with an emphasis on both thermochemistry and fluid mechanics. (Part of Combustion program.)

Applied Mathematical Sciences

Quong

This program focuses on three areas for advancing the state of the art in mathematics and computer science. (1) Analytical and numerical methods for the solution of specialized classes of partial differential equations are being developed for the construction of realistic models suitable for comparison with experiments and capable of being used for engineering design. (2) Research in information analysis techniques include modeling of large, complex, data sets, design of query languages, development of user interfaces and integration of rapidly changing mass storage and display technology with the objective of developing innovative approaches to the storage, retrieval, analysis and display of large data sets. (3) Software engineering research addresses issues of improved design and production of software to enhance access to and productivity of computational resources.

Geosciences

Various

Theoretical, laboratory and field investigations are conducted in fundamental geological processes that relate to energy technologies. Individual activities address basic scientific questions in geochemical, mineralogical, geophysical, hydrological and rock mechanics areas. Results have application in the DOE program areas of geothermal energy development, isolation of nuclear waste, recovery of fossil fuels and storage of thermal energy in underground systems. Data are compiled and evaluated on aqueous electrolytes for applications in geothermal energy development and nuclear waste isolation.

Biological Energy Conversion and Conservation (KC 06) (FY-80 \$0.7 M)Photochemical Conversion of Solar Energy

Packer

This program seeks to identify the molecular and electrical aspects of light energy conversion by bacteriorhodospin, the simplest and most stable biological energy converter presently known, in order to make use of its photovoltaic effect.

Photosynthetic Energy Conversion

Sauer

Study is made of the organization of the molecular constituents of photosynthetic membranes, kinetics and mechanisms of photosynthetic light reactions, the role of manganese in photochemical oxidation of water leading to oxygen evolution.

Plant Biochemistry

Bassham

This project studies: photosynthetic carbon dioxide fixation and reduction; subsequent biosynthesis in green plants; regulation of plant metabolic pathways; formation of alkaloids, pigments, lipids, terpenoids and steroids; and conversion of sugars to hydrogen in photosynthetic bacteria.

Photosynthesis, Resonance Studies

Bearden

This is an experimental investigation of the mechanisms of light excitation and energy transfer, photochemical energy transfer and storage, and subsequent electron-transfer and chemical-free energy production in both green-plant and bacterial photosynthesis.

## TECHNICAL ASSESSMENT PROJECTS (KD) (FY-80 \$0.2 M)

Solar Powered Satellite (KD 03)Solar Powered Satellite Health and Safety Effects,  
Non-Microwave

White

Research is carried out on health hazards to workers in an orbiting solar power station, from sources other than microwaves; identification and assessment of the hazards; selection and management of research at LBL and elsewhere.

## EDUCATION, BUSINESS AND LABOR AFFAIRS (LB) (FY \$0.3 M)

Information Studies

Wakerling

Two projects carry out information research in support of Laboratory and DOE scientific programs. The Information Research Group studies improved methods for use of bibliographic databases. The Information Methodology Research Project studies improved methods for design and operation of both bibliographic and numeric/fact databases.

Laboratory Coop Program

Asaro

Top U.S. university undergraduate students (during the summer), faculty from colleges and universities with large minority enrollments (during the summer), and local undergraduate students (during the academic year) participate in research projects and attend lectures at LBL relevant to the DOE mission. These programs encourage students to make their careers in the energy field. (Also funded under HA 01.)

Director, Office of Energy Research

NEW WORK

## Director, Office of Energy Research

## NEW WORK

## MAGNETIC FUSION (AT)

Finite Larmor Radii Theory

Sessler

This work is designed to investigate plasma suitability problems in situations where finite Larmor radii effects are important, such as in reversed field configurations in compact tori. Close collaboration with Livermore theory and experiment groups will permit prompt application of new techniques.

Beam Turbulence Electron Heating

Kunkel

Beam plasma electron heating, which uses beam instabilities for in situ generation of plasma waves, has been demonstrated as a potentially efficient alternative to microwave heating in magnetic fusion devices. In this program, off-axis beam injection will be developed that can be applied to any fusion concept in which an effective magnetic mirror would benefit from electron heating.

## HIGH ENERGY PHYSICS (KA)

Time Projection Chamber Operating Improvements

Operation of the complete detector will allow the highest possible reconstruction efficiency of any operational detector. OCD mechanisms, decay chains and the search for subtle and unexpected phenomena will be emphasized. After an initial period of operation at PEP, significant improvements of the detector are planned.

Mark II Magnetic Detector Operating Improvements

The Mark II is a veteran general purpose detector with the capability of producing early results on particle production surveys. Some improvements to the detector are anticipated.

Particle Detectors

The physics of vector bosons and quarks should be accessible to a number of new accelerators under construction or presently in the proposal stage. All of these machines will require very large detectors, capable of measuring jet-like final states with very high multiplicities. LBL's previous experience with large scale detectors, especially at colliding-beam machines, will provide an excellent basis for designing the detectors needed during the next decade. The simplicity of  $e^+e^-$  annihilation physics and LBL's history of previous research in this field lead us to be most enthusiastic about this option. At the same time, we are actively working on the design for detectors appropriate to very high energy hadron machines.

### SLAC Linear Collider

Construction of a Single Pass Collider at SLAC would present very attractive research possibilities. It would permit the study not only of many of the properties of the  $Z^0$ , but would in addition produce copiously all the quarks, presumably through the t-quark, heavy leptons, and possibly some new surprises. Either the TPC or Mark II might be appropriate for direct transfer to the SPC. Alternatively, a new detector might be constructed, using the basic features of one of these two PEP detectors.

### Muon Reactions

Fermilab plans to build a new high intensity muon beam at the Tevatron. A proposal has been submitted to move the multimMuon spectrometer to this new beam. Some of the physics objectives of a new muon experiment are a determination of the  $Z^0$ -quark and  $Z^0$  lepton structure functions, and a study of multi-muon final states to determine their production mechanisms, i.e., through heavy mesons or through the hypothetical gluons.

### Experiments Using Polarized Proton and Anti-proton Beams

Lambda and anti-lambda production at Fermilab energies is so abundant that enriched antiproton, polarized proton, and polarized antiproton beams with reasonable intensity can be constructed for the use of counter physics. Such a facility will be constructed to study the substructure of hadrons through spin effects at high energy. Total cross-section differences and high  $x_F$  low- $p_T$  inclusive pion production will be measured by using a polarized beam and a polarized target.

### $\bar{p}p$ Interactions at BNL

A program is planned to search for charmed mesons such as the  $\eta_c$  and  $\eta_c'$  in  $\bar{p}p$  reactions is planned.

### Radioisotope Detection with Accelerators

A new technique has been developed for measuring very low concentrations of radioisotopes by using an accelerator as a high energy mass spectrometer. This new method is more sensitive by orders of magnitude than the conventional decay counting technique. However, it is not yet a working tool. Accuracy, reliability, and reproducibility must be tested and studied before large efforts at sample collection and analysis can be made.

These studies will emphasize making the technique a useful tool for those isotopes of particular applicability to Department of Energy problems. The program will emphasize  $^{14}C$  detection, which has application to the analysis of atmospheric samples in the study of the origin of carbonaceous pollutants and climate impacts. The development of a technique to measure  $^{36}Cl$  will be completed and exploratory work toward the measurement of  $^{81}Kr$  will be pursued. Measurement of these isotopes is extremely important for dating old ground water at potential nuclear storage sites.

## NUCLEAR PHYSICS (KB)

Materials and Weldment for High Field  
Superconducting Magnets

Morris

The purpose of this work is the design and laboratory development of improved structural materials for use in structural supports of high field superconducting magnets. New alloys having suitable strength and toughness in welded structures in high magnetic fields at 4.2 K are needed to satisfy the needs of future generations of high field superconducting magnets. The research also addresses the problem of improving the cryogenic properties and weldability of high strength austenitic steels since these non-magnetic alloys are preferred in current magnet designs and since operational constraints will require the use of high strength non-magnetic alloys in at least certain structural applications within future magnets. The technical approach builds on initial success obtained in this and other laboratories in the use of composition and heat treatment modification to dramatically improve the properties of structural alloys and weldments at 4.2 K. The research tools include microstructural characterization, mechanical testing, failure analysis, metallurgical analysis, and chemical and microstructural modification.

Heavy Ion Nuclear PhysicsSuperHILAC and Bevalac Research; 88-Inch  
Cyclotron Research

Various

High-energy uranium beams, available only at LBL, will open up a new area of heavy-ion research with the study of nuclear systems of high charge and mass under conditions of extremely high density and temperature. At the SuperHILAC, fusion-type reactions will continue to be pursued in the search for the elusive superheavy elements. At the Bevalac, fragmentation of high-energy high-mass projectiles is expected to lead to copious production of very neutron rich nuclei. Knowledge of particle-creation effects in the nucleus, needed to verify predictions of the nuclear equation of state under conditions of extreme nuclear densities (such as those present near the centers of stars), will be sought in new experiments on kaon, lambda, anti-proton, and lepton pair production at the Bevalac.

Most of the experiments to be performed with the upgraded accelerators will be of substantially increased technical complexity. Major new research equipment such as HISS and the plastic ball detector require additional support for their effective utilization. Increased manpower will have to be devoted to detector development, computer interfacing of experiments, a new modular approach to interactive data analysis, and support of the increased flow of outside users. This program requires an increase of 6 FTE's and \$545 K operating support in FY-82, including increased computer support.

A project essential to the research programs at the SuperHILAC and the 88-Inch Cyclotron is the construction of a high-resolution 4  $\pi$ -ray detection system referred to as the "Crystal Ball." This need arises from the considerable interest in studying the properties of nuclei excited to

states of extremely high angular momentum (60-70h). An alternative detection medium to the multiple NaI counters previously proposed involves the use of liquid xenon. Based on demonstrated performance of liquid xenon detectors, it would appear that they have unique advantages over NaI--notably improved resolution with maintained high photopeak efficiency. Because no large scale liquid xenon system has ever been studied, R&D efforts to investigate technical problems are underway. This exciting prospect is being followed with great interest by the nuclear research community. Currently the final design plan calls for a major item of equipment expenditure of \$750 K (FY-80 \$, MIE estimate) in FY-81 and -82.

Electron Beam Ion Source (EBIS)

Kunkel

The most significant improvement program for the 88-Inch Cyclotron consists of the development, construction, and implementation of an advanced high-charge-state ion source. An Electron Beam Ion Source (EBIS) of the type currently operating at Saclay (France) will significantly extend the performance of the 88-Inch Cyclotron for medium mass ions in the 10-30 MeV/amu range at a relatively low cost. A small EBIS test stand is being built as the developmental facility for detailed design of the final device. A formal proposal for a major item of equipment expenditure of \$1.5 M (FY-80 \$, MIE estimate) in FY-81, -82 and -83 will be submitted in September 1980.

Superconducting Conversion of Bevatron EPB Magnets

Grunder

Stimulated by the recent dramatic increases in electric power costs, investigation of the Bevatron experimental beam line magnets has shown that 3/4 of the energy currently consumed in the experimental hall could be saved by replacing most of the magnets (26 dipoles and 42 quadrupoles) with superconducting magnets. At the projected rate of consumption of  $2.5 \times 10^4$  MWh per year (10 months operation) and the present electricity cost of 6¢ per kWh, this conversion project represents a potential savings of \$1.2 M per year. The preliminary cost estimate of \$7.6 M, indicates a payback period of six years, but this payback period will decrease with further expected rate increases. Efforts to refine the magnet designs for the most cost-effective solutions continue.

BASIC ENERGY SCIENCES (KC)

Fixed Actinide Removal Agents

Raymond

A new research project is proposed that involves the incorporation of actinide-specific sequestering agents on polymeric materials. The object is the production of a resin or other material that could be used to remove actinide ions at extremely low concentrations in the presence of much higher concentrations of many other metal ions. Chelating agents similar to siderophores are being prepared, in a biomimetic approach, for the sequestration of actinide(IV) ions. (Siderophores are extremely specific chelating agents for Fe(III) that have been evolved by microbes. The development of such agents could be of extreme importance in the treatment of existing nuclear wastes, particularly those in which the actinide elements are present in very low concentrations.

Local Atomic Configurations in Solid Solutions

de Fontaine

The general aim of this task is to study local atomic configuration in solids, both theoretically and experimentally. The theoretical aspect consists in using newly developed statistical-mechanical methods (e.g., cluster variation method) to describe and calculate states of short and long-range order, clustering and phase equilibria for defects in solids such as solute atoms, vacancies, and magnetic dipoles. The experimental technique will include high-voltage and high-resolution electron microscopy and x-ray diffraction.

Refractories Project: Chemical-Mechanical Stability

Various

High temperature chemical-mechanical interactions are studied in the aluminum oxide-calcium-oxide system. Alumina ceramics containing measured amounts of calcia are prepared, and their behavior is studied upon exposure to high temperature  $H_2O/H_2$  gas mixtures and to simulated liquid coal slags. Of importance will be the chemical response of the bonding of intergranular phases, the kinetics of the formation of reaction layers, and the mechanical response at high temperature. Microcharacterization techniques are used in conjunction with creep deformation, creep fracture, and low-stress creep testing of two-phase refractories with low and high porosity. A facility is being constructed for the mechanical environmental testing of refractory materials up to  $1700^\circ C$  in a corrosive gaseous environment at pressures up to 1 atmosphere.

Time-Resolved Spectroscopies in Solids

Yu

The purpose of this program is to develop an optical system capable of measuring the absorptivity, reflectivity, photoluminescence, Raman and Brillouin spectra of a sample as a function of time with the precision of a few picoseconds. This system will be utilized to study the following problems: (1) Relaxation of hot carriers in semiconductors via carrier-carrier interaction and carrier-phonon interaction; (2) temporal behavior of Raman and Brillouin scattering in solids as the excitation frequency is varied from the non-resonant regime to the resonant regime; (3) transient optical response in solids exhibiting spatial dispersion effects (such as in the vicinity of an exciton-polariton in semiconductors); (4) Transient photoconductivity in semiconductors with deep traps; (5) Transient non-equilibrium superconductivity in superconductors with fast recombination times, such as alloys of Nb, Pb, and Pb.

Picosecond Chemistry

Clark

The vast majority of chemical reactions take place in solution. The goal of this research is to study directly the dynamics of such reactions at the molecular level. The systematic study of the mechanism and kinetics of proton-transfer and electron-transfer reactions will result in a new and detailed understanding of reaction dynamics in solution. Because chemical reaction is a collisional process, and since effective collision rates in liquids are exceedingly high, reaction dynamics in solution are often simply too rapid for direct study with conventional experimental techniques. Thus this research is centered around the use and development of picosecond laser



spectroscopic techniques for the direct study of ultrafast reactions. The results of this research--the ability to understand, model, and predict chemical reactions in solution--will be of broad practical importance to many areas of energy technology. Among these are coal liquefaction, battery and fuel-cell technology, biomass conversion, nuclear fuel reprocessing and photochemical fixation of solar energy.

#### Minicomputer Code Development

Lester

A new direction stimulated by recent advances in hardware and the interest of the national chemical community is the development of portable software for minicomputers. We have identified selected high-activity areas where conversion of large mainframe codes to run on minicomputers should have considerable impact, and we have begun the necessary software modifications. These include trajectory codes for chemical kinetics, Monte-Carlo and molecular dynamics programs for statistical mechanics, and self-consistent-field and limited configuration-interaction programs for quantum chemistry. To aid the research and software development activities; the NRCC has acquired a DEC VAX-11/780 minicomputer and an Evans and Sutherland interactive vector refresh graphics system. Also in progress are investigations of the capabilities of array processors and the promise of such machines for computation in all areas of chemical research.

#### Combustion Research

Lester

Based on recent analysis of NRCC capabilities and a review of problems of importance to DOE, the NRCC has recently begun the study of the electronic structure and chemical kinetics of selected combustion systems. Such applications provide a plethora of physical systems of basic scientific interest that can serve to identify the need for extension of software capability.

Other activities include the improvement of key subroutines of wide utility as exemplified by our recent modification of a commonly used matrix diagonalization that achieves improved execution times without loss of accuracy. In addition, computational studies are in progress in such timely research areas as the structure of presumed intermediates in catalysis, quantum statistical mechanics, structure determination of intermediates in chemical reactions, and calculation of infrared intensities of organic molecules.

#### New Salts of TCNQ

Lemmon

This project will explore the electrochemistry of conducting salts prepared by combining the radical ion of TCNQ with the protonic-conducting cation of choline. Combination of TCNQ, salts of which are employed as organic semiconductors, with the high temperature conducting form of choline, could provide new basic information about both semiconductivity and superconductivity.

Applied Mathematical Science: Human-Computer Interaction

A new project is proposed in the area of human-computer interaction. A research collaboration of personnel at LBL, UC Berkeley and industrial research organizations is anticipated under joint support by DOE and the U.S. Navy Office of Naval Research. The general goal is to enhance the information processing and decision-making capabilities of researchers, planners and analysts through a better understanding of human-computer interactions. The research is interdisciplinary, emphasizing synthesis of behavioral and computer science, with the goal of influencing the development of hardware and software.

Polymer Electrochemistry and Photophysics

Schroeder

The electrochemistry and photophysics of electroactive polymer films is being studied in order to understand and be able to control the electronic and photophysical properties of condensed, amorphous organic materials. The emphasis of this work is to develop new materials for modifying metal and semiconductor surface properties to produce systems with optical and semiconductive properties suitable for solar photovoltaic applications.



**A/S Environment**

**CURRENT EFFORT**

## A/S Environment

## CURRENT EFFORT

## ENVIRONMENTAL RESEARCH AND DEVELOPMENT (HA) (FY-80 \$6.9 M)

Overview and Assessment (HA 01) (FY-80 \$1.6 M)Technology Assessments

Siri

In this program integrated analyses and special studies are performed on energy technologies to assess their economic, environmental, health, social, and institutional impacts. These multidisciplinary studies, employing advanced analytical methods, focus on technologies currently under research, development, and/or demonstration, and are conducted either independently by LBL or jointly with other national laboratories. Findings enable DOE RD&D programs to anticipate and mitigate potential adverse impacts.

Environmental Impact Analysis

Siri

The primary functions of this program are to develop new analytical tools and data systems and to apply them to generic environmental and economic problems associated with energy supply and use. Secondary functions include holding technical workshops and producing special issue papers.

Regional Analysis

Siri

Under this program integrated assessments are performed of the regional impacts of National Energy Plans, policies, and energy-related special issues. Through the use of advanced analytical techniques, multidisciplinary studies quantify or otherwise evaluate the environmental, economic, health, safety, and social impacts, and identify potential constraints on policy implementation that need to be mitigated.

Alternatives for Small Communities

Berman

The purpose of this research is to examine the potential for using nonconventional technologies in small, rural communities and as mitigation strategies in rapidly growing, energy-impacted "boom" towns that are experiencing a surge in demand for municipal services.

Environmental Effects - Coal/Water

Fox

The purpose of this program is to investigate the environmental effects of and controls for aqueous wastes produced during slurry transport of coal and by the beneficiation of coal.

Condensate Water Treatment

King

Physicochemical processing schemes are being developed for roughing treatment of process condensate waters from coal conversion, so as to make them suitable for recycle as make-up water for cooling-towers. These schemes are based primarily upon innovative uses and combinations of solvent extraction and stripping.

Control Technology of In-Situ Oil-Shale Retorting

Fox

The purpose of this program is to develop control technology for air, water, and solid-waste problems associated with in-situ oil-shale retorting. Wastewater treatment using spent shale is being investigated, methods to safely abandon in-situ retorts are being identified and studied in laboratory and field studies (see AC 20), and mercury emissions from in-situ retorts are being characterized and methods identified to control them.

Coal Particulates

Robben/Greif

The primary aim of this work is to determine the possibilities for control of the formation of submicron particulates by variations in the combustion and heat-transfer parameters of pulverized coal combustors. (Part of Combustion program.)

Biomedical and Environmental Research (HA 02) (FY-80 \$5.3 M)Pollutant Effects on the Immune System

Goodman

This is a study of the physiology and the pollutant-induced pathology of (continually renewing) lymphatic tissue and bone marrow cell populations, which are especially vulnerable to injury.

Pollution Effects on Endocrine System

Garcia

This is a study of the effects on the endocrine system of gaseous and solid pollutants associated with non-nuclear energy.

Pollution Effects on the Reproductive System

Connell

This is a study of possible effects of non-nuclear pollutants on steroid hormone processes, threshold concentrations at which damage can be determined, and methods for avoiding further damage.

Metabolism in Brain Disorders

Sargent

This is an investigation of brain metabolism with regard to schizophrenia, manic depression, multiple sclerosis, convulsions, senility, and cerebrovascular disease using radioactive tracers. The role of ozone in these disorders will be investigated.

Magnetic Field Effects on Humans

Budinger

This is an epidemiological study of effects on humans from magnetic fields such as those produced by thermonuclear reactors and high-voltage transmission lines.

Magnetic Field Effects, Biological

Tenforde

This is a study of effects of high magnetic fields biological systems at the molecular, cellular, and whole animal levels.

Plutonium Removal from Human Body

Durbin

This is a study of sequestering agents for removing hazardous actinide ions, such as byproducts of nuclear fuel cycles, from the human body. Tetra-catechoyl cyclam designs are being tested.

Heavy-Ion Caused Lesions in Genes

Freeling

Study is being made of the mutagenic effects of heavy ions on pollen grains from maize and of the relationship of these effects to human health and disease.

Light Damage to Mammalian Cells

Burki

This is a study of the response of cells to sunlight and fluorescent light, to determine effects on cellular DNA and incidence of cancer.

Scanning Electron Microscopy

Hayes

This program develops methods for measuring directly the variation in major element concentrations among individual respirable-size fly-ash particles.

Heavy-Particle Effect on Cells

Chatterjee

This is a study of effects of heavy particles on living cells, including energy deposition by penetrating charged particles, correlation of energy deposition with biochemical changes, and evaluation of biological effects.

Effect of Heavy-Ion Effect on Cells

Tobias

The purpose of this program is to quantitate the response of cultured mammalian cells to accelerated heavy ions, and to understand the molecular processes that lead to lethality, cell transformation, and mutation.

LET Radiation, Long-Term Effects

Alpen

This is an assessment of acute and chronic effects, especially carcinogenic and impaired organ function, of high-ionizing radiation levels.

Effect of BaP on Humans

Hackett

This is a study of the metabolism of benzo(a)pyrene (a proven carcinogenic precursor) in epithelial cells, the type of cell in which 90% of all human cancers originate.

Microdosimetry of Particulates

Hayes

This project Investigates the relative toxicity of fly-ash particles of varying matrix composition, and the lung microdosimetry of uniquely toxic particles.

Tritium Damage in Eucaryotic Cells

Burki

This is a study of the basic mechanisms that lead to chromosome damage and mutation, and inactivation of the proliferation ability in mammalian cells.

Populations at Risk to Environmental Pollution (PAREP)

Quong

Relationships between disease and environmental quality are under investigation by use of an integrated database containing environmental quality, human health and socio-economic data at the county level for the United States. The project encompasses development and evaluation of analytical methods as well as specific investigations.

Mutagenesis and Carcinogenesis - Cellular

Bartholomew

This project investigates mechanisms of susceptibility of human and animal cells to coal-derived chemical carcinogens by examining damage to DNA and effects of this damage on cell reproduction and cancer induction.

Mutagenesis and Carcinogenesis - Chemical

Hearst

This is an investigation of reactions of polycyclic aromatic carcinogens from fossil fuels with DNA. The goal is to establish mechanisms of reactions, structures, conformations of products, and consequences of chemically modified DNA following repair and replication.

Mechanism of Tumor Promotion

Bissell

This project studies mechanisms whereby phorbol esters, a natural constituent of many Euphorbia species being considered as renewable sources of hydrocarbon from biomass, promote viral or chemical carcinogenesis following exposure of cells to chemical carcinogens. Determination is made of chemical features required for promotion by chemical synthesis and by isolation from plants of compounds, which are then tested with animal cells in culture.



Combustion Diagnostics

Brown

This project is developing measurement techniques for nitrogen and sulfur compound quantification in combustion systems utilizing fossil and other fuels. (Part of Combustion program.)

Organic Pollution in the Atmosphere

Novakov

This project focuses on speciation and origin of carbonaceous particles in the atmosphere. This information is utilized to elucidate the principal factors, responsible for the formation of secondary organic material under nonphotochemical atmospheric conditions.

Gas Detection

Amer

This project conducts research on laser photoacoustic spectroscopy of gases, liquids, solids, and aerosols with the objective of developing ultra-sensitive multiparameter molecular and elemental photoacoustic detectors. Also under investigation are photothermal spectroscopy, which was developed at LBL, for remote sensing of gaseous pollutants, and liquid-crystal gas detectors.

Instrumentation Survey

Quinby-Hunt

The Survey of Instrumentation for Environmental Monitoring consists of four volumes (Air, Water, Radiation and Biomedical Monitoring), a survey describing instrumentation and instrumental techniques, as well as information on sources, characteristics, and effects of various pollutants and an overview of regulatory control.

Aerosol Chemistry

Novakov

The objective of this project is to understand and differentiate the respective roles of homogeneous (gas-phase) and heterogeneous (gas-liquid-particle) reactions in the formation of aerosols caused by fossil-fuel combustion.

Indoor Air Pollution

Hollowell

The goal of this project is to assess impacts on human health of indoor pollution sources, especially combustion-generated pollution, and to investigate various methods for mitigating these impacts.

Atomic and Molecular Detection

Hadeishi

This project is developing very sensitive optical absorption methods for detection of atoms and molecules in a wide variety of gaseous samples.

Microwave Spectroscopy for Monitoring  
Gaseous Pollutants

Leskovar

Methods based on microwave rotational spectroscopy are being developed for highly specific detection of gaseous pollutants in air.

Semiconductor Radiation Detectors and Materials

Haller

This work involves development of semiconductor detectors and basic studies of materials for these detectors.

Physical Measurement of Pollutants

Jaklevic

The purpose of this work is development of optical absorption methods for detection of atoms and molecules in a wide variety of gaseous samples.

Magnetic Field Dosimetry

Goulding

This project is developing small portable magnetic field dosimeter and readout station for use by workers exposed to intense magnetic fields.

Determination of Atmospheric CO<sub>2</sub>-O<sub>2</sub>/N<sub>2</sub>  
Molecular Ratio

Bloom/Muller

Predictions of the future rise of atmospheric CO<sub>2</sub> concentration arising from fossil-fuel combustion are impaired by the fact that the present CO<sub>2</sub> budget does not seem to be in balance. Precise measurements of changes in the global atmospheric O<sub>2</sub>/N<sub>2</sub> ratio over a few years could help to solve the "missing CO<sub>2</sub>" problem. The technique to be used is Raman scattering from <sup>16</sup>O<sub>2</sub> and <sup>14</sup>N<sub>2</sub> molecules, whereby O<sub>2</sub>, N<sub>2</sub>, and CO<sub>2</sub> can be determined simultaneously in the same sample.

## LIFE SCIENCES RESEARCH AND BIOMEDICAL APPLICATIONS (HB) (FY-80 \$6.1 M)

General Life Sciences (HB 01) (FY-80 \$1.3 M)

This program includes biophysical, chemical and biological investigations of energy and information transfer and regulation of cellular processes. Investigations are made of physical and chemical properties of membranes, nucleic acids and nerves, regulation of cellular metabolism, differentiation, and growth, brain biochemistry, and effects of chemical pollutants on cells.

Cellular - Molecular Biology of Cancer

This project investigates mechanisms of cell interactions with other cells and with the environment to determine controlling factors in cell regulation for metabolism, growth, division, differentiation, and other functions. It also examines changes in control accompanying transformation to malignant cells in culture.

Molecular Biology of Nerve Function

Bennett

Studies are made of fundamental biochemical properties of nerve cell function, including characterization of acetylcholine receptors involved in nerve signal transmission, examination of steps involved in memory formation, and a search for biochemical differences resulting from environmental stimulation.

Biophysical Chemistry

Klein

Studies are made of fundamental properties of membranes, cells, nucleic acids, proteins and nerves, with use of biophysical techniques including magnetic resonance, optical and x-ray spectroscopy, theoretical modeling, and chemical synthesis. Storage and utilization of energy and information by biological systems are principal concerns of this project.

Effects of Pollutants on Membranes

Packer

This program seeks to identify mechanisms of environmental pollutant-mediated free-radical damage to the membranes of mammalian cells, by developing sensitive biophysical, biochemical and physiological assays to characterize the initiation and propagation of such damage.

Structure Analysis, Electron Diffraction

Glaeser

This is a development of methods of electron diffraction and high-resolution electron microscopy for investigations of complex biological structures at the molecular and atomic level.

Genetic Study of Yeast

Mortimer

This program investigates advanced yeast genetics and molecular biology as a test system for evaluation of the mutagenic and carcinogenic potential of toxic agents.

Biomedical Applications (HB 02) (FY-80 \$4.8 M)Clinical Outpatient Facility

Ebbe

This is the central facility for much of the medical research in the Donner Laboratory. Long-term follow-up is made of patients exposed to, or treated with, ionizing radiation. Techniques for analysis of the hematopoietic system of human beings are under development.

Radiopharmaceutical Development

Yano

Radionuclides and radiopharmaceuticals are developed for scintigraphic and dynamic quantitative studies at Donner Laboratory.

Pollution Effects on Hematopoietic Stem Cells

Schooley

This investigation aims to determine the direct effects of heavy metals and oxidizing gases on the hematopoietic stem cells and various intermediate precursors.

Diagnostic Techniques with Radionuclides

Budinger

This is a non-invasive investigation of human biochemistry using methods involving three-dimensional reconstruction of the organ distribution of injected or inhaled material at various times after administration.

Biomedical Imaging Instrumentation

Anger

Instruments are developed that utilize radioisotopes for diagnostic purposes and for fundamental medical research. The imaging detects the distribution of gamma-ray and positron-emitting isotopes in animals and humans.

Positron 3D-Imaging Instrument

Derenzo

This project involves development of new gamma-ray detection devices and techniques having sufficient speed and sensitivity to provide improved statistical accuracy and spatial resolution for three dimensional imaging of radionuclide distributions in the human body.

Bevalac Biomedical Operations

Ainsworth

The Bevalac is a unique ion accelerator facility which provides (1) beams of heavy charged particles for radiation therapy and radiographic examination of cancer patients, (2) biomedical and dosimetric experiments obtaining critical data for the radiotherapy/radiography programs, (3) biomedical studies that focus on induction of cancer, mutations or other deleterious (late) effects of heavy charged particles, and (4) fundamental physical investigations on modes of interaction between charged particles and matter.

Tracer Studies with Radioactive Beams

Chatterjee

The aim of this project is demonstration of the feasibility of using high-energy radioactive beam particles for diagnostic procedures with phantoms used for practical demonstration.

Growth and Differentiation of Lung

Schooley

A study of the immune response mounted by pollutant-exposed animals against their own lung proteins, and the characterization of lung and serum proteins in growing and mature animals.

A/S Environment

NEW WORK

## A/S Environment

## NEW WORK

## ENVIRONMENTAL RESEARCH AND DEVELOPMENT (HA)

Fog Chamber

Novakov

The goal of this project is to develop a laboratory fog chamber to investigate gas-liquid water-particle reactions in order to establish their relative importance. When  $\text{NH}_3$ ,  $\text{SO}_2$ ,  $\text{NO}_x$ ,  $\text{O}_3$  and hydrocarbons are introduced into the chamber with fog droplets, the secondary particulate matter will be monitored by a variety of particle-sizing instruments and chromatographs.

Mutagens from Fossil Fuels

Risebrough

A program of integrated environmental sampling will be undertaken in the vicinity of the fossil-fueled electricity-generating facility at Moss Landing, California to determine whether the combustion of fuel oil produces an elevated level of mutagens and potential carcinogens in the local environment. Environmental components to be sampled include atmospheric fallout, air, local fresh and marine waters, the mussel, Mytilus, the clam, Macoma sp., and inshore sediments. The presence and levels of mutagens and potential carcinogens will be determined during the first year of the study by the Ames mutagenicity test, and characterization of organic compounds will be accomplished by high resolution FID and EC gas chromatography. Atmospheric fallout samples will also be examined for heavy metals and trace elements.

Indoor Air Quality Monitors

Hollowell

This project will design air quality monitors to measure indoor levels of CO, HCHO, and NO which are recognized as major indoor pollutants. Such passive monitors will be capable of measuring 24-hour to weekly integrated pollutant concentrations on site, requiring minimal attendance. The data obtained will aid in assessing the impact that national energy conservation programs might have on the health and comfort of building occupants.

Radon Characterization

Hollowell

The purpose of this study is to characterize the sources and concentrations of indoor radon and its radioactive decay daughters. It will determine the range and frequency of the daughter concentrations to which humans are exposed indoors; assess the impact on these concentrations of programs that would reduce energy requirements in buildings; and, analyze the effects of strategies to control daughter exposures. Energy-conservation measures, particularly reduced ventilation, may increase indoor concentrations of radon and its daughters, thus increasing the radiation to which occupants are exposed.

Aerosol Physics

Novakov

Carbon particles represent the single most important contributor to the submicron aerosol mass. A major fraction of these particles is due to soot emissions which have a very large optical absorption coefficient. This program will assess the role of these large optical absorption coefficients in visibility degradation and climate modification. Furthermore, preliminary measurements indicate that soot particles can also be effective scatterers of light, and therefore the contribution of these particles to the scattering coefficient of the urban haze will also be evaluated.

## LIFE SCIENCES AND BIOMEDICAL APPLICATIONS (HB)

Effects of Heavy Particle Irradiation

Fabrikant

A major program reorientation is underway, as the studies of pituitary ablation are now completed. The new program is focused toward the short- and long-term effects of focal irradiation with heavy ions of centers in the central nervous system, using stable and radioactive carbon and neon beams. The program is directed toward an understanding of biological effects of heavy-ion irradiation on the central nervous system relating to dose, dose-rate, volume, temporal patterns of pathophysiological change, extent of CNS damage, patterns of recovery, and application of this information for diagnosis and management of human central nervous system disease.

280-Element Ring Camera

Budinger

The ring camera is used for computer reconstruction of the distribution of positron emitting isotopes in a transverse section of the body. It represents a quantum jump forward in the use of radioactive isotopes in nuclear medicine, since for the first time the distribution of isotopes can be examined in three dimensions in the body rather than in a plane projection.

The camera presently in use determines the isotope distribution in one planar section through the body with a thickness of one or two centimeters. To examine the distribution in adjoining planar sections it is necessary to move the subject and reinject isotope. The proposed new multiring device will permit the examination of isotope distributions in several adjoining sections with a single isotope injection. The new camera will enable acquisition of significant new data to be obtained without increasing the dose to the patient.

 $^3\text{H}$  Labeling for Biomedical Research

Lemmon

With use of the present facilities for tritium labeling of organic compounds a study would be made of mechanisms for maximizing both specific activity and radiopurity of products through systematic investigation of several methods of tritiation.

Structural Biophysics

Kim

It is proposed to apply x-ray crystallographic techniques to establish three-dimensional details of nucleic acid interactions with environmental factors, both proteins that regulate gene expression, and environmental chemicals such as carcinogens, mutagens and drugs.





A/S Conservation and Solar Energy

CURRENT EFFORT

## A/S Conservation and Solar Energy

## CURRENT EFFORT

## ENERGY STORAGE SYSTEMS (AL) (FY-80 \$2.7 M)

Battery Storage (AL 05)Applied Battery and Electrochemical Research

Cairns

LBL is managing the Applied Battery and Electrochemical Research Program. Its objective is to help provide batteries and electrochemical systems that can satisfy performance, schedule and economic requirements of DOE's missions on electric vehicles, electric utility load leveling, solar electricity, and electrolytic technology. To meet this objective, LBL contracts with program participants to conduct applied research on new electrochemical couples, innovative electrode designs, and engineering and materials problems of candidate battery systems.

Electrochemical Systems Support

Various

Program objectives are improvement of energy efficiency, lowering of capital cost and increasing materials yield of electrochemical cell processes employed for the reversible conversion of chemical to electrical energy in galvanic cells and in the production of materials by electrolysis. Investigations are carried out of surface morphology of metals in electrodeposition, anodic surface layers on battery materials, metal couples in non-aqueous solvents, analysis and simulation of electrochemical systems, efficiency of aluminum reduction cells, bifunctional air electrodes for metal-air batteries, electrochemical properties of NASICON, and battery electrodes.

## SOLAR TECHNOLOGY (AN) (FY-80 \$3.0 M)

Biomass (AN 05) (FY-80 \$1.5 M)Catalytic Biomass Liquefaction

Davis

The program goal is to provide a data base for the conceptual design of a commercial scale biomass-liquefaction facility. This is to be done through bench-scale engineering research at LBL on process modifications which are then tested at the DOE's 3 ton/day demonstration unit at Albany, Oregon. A continuous bench-scale liquefaction unit (scheduled to become operational by the end of FY-80) will permit the collection of engineering data required for the design of additional process equipment for Albany. This engineering effort will be backed by an on-going program of basic research involving investigation of novel process concepts and evaluation of product upgrading options including hydrogenation and solvent extraction. It is expected that by 1982 a firm assessment can be provided of economic feasibility based upon the best set of process options.

Hydrocarbons and Energy from Plants

Otvos

Plants rich in hydrocarbon-like compounds and fermentable sugars are cultivated, harvested, and analyzed, with emphasis on crop yield, oil and energy yield, process chemistry and economics.

Measurement of Circumsolar Radiation

Grether

Measurements and analyses are made of the amount of solar and circumsolar radiation available to solar energy conversion systems that operate by concentrating the incident sunlight. (Some funding under AN 15 as well. Task Proposal submitted under AN 15.)

Bioconversion of Cellulose to Ethanol

Wilke

Process development studies are underway on the conversion of cellulose (whole trees and agricultural residues) to sugars and the subsequent fermentation of these sugars to ethanol with simultaneous recovery and concentration of the alcohol. (AN 05 funding ends FY-80).

Ocean (AN 10) (FY-80 \$1.4 M)

Ocean Thermal Energy Conversion (OTEC)

Wilde

Through literature searches, field studies and laboratory work this project will establish the physical, chemical, geological and biological characteristics of candidate OTEC sites. The OTEC environmental program will be extended from present baseline studies through operational pilot facilities and working plants phases at selected sites.

Photovoltaics (AN 15) (FY-80 \$0.038 M)

Grether

Measurements and analyses are made of the amount of solar and circumsolar radiation available to solar energy conversion systems that operate by concentrating the incident sunlight. (Some funding under AN 05 as well. Task Proposal submitted under AN 15.)

Solar Thermal Power (AN 35) (FY-80 \$0.1 M)

Small Particle Solar Heat Exchanger

Hunt

Small particles are injected directly into a gas stream to absorb concentrated sunlight which then heats the particle-gas mixture. The near term goal is to investigate the characteristics of a receiver capable of producing a high temperature gas for operating a heat engine; the longer term goal is to understand and develop the use of particulate systems in a variety of solar applications, including the solar processing of fuels and chemicals.

Hawaii Integrated Assessment

Siri

This research assesses the technical, economic, and institutional feasibility and consequences of a transition from reliance on imported petroleum to dependence on a mix of renewable and geothermal energy in Hawaii. (Also funded under AM 15 in FY-80. No further funding against AM 05 expected; AM 15 and AN 35 will continue.)

SOLAR APPLICATIONS (EA) (FY-80 \$2.6 M)

Systems Development (EA 01) (FY-80 \$2.4 M)

Wahlig

This development project includes both active systems used to heat and cool by the addition of equipment to buildings of conventional design, and passive systems in which the buildings themselves are designed to take maximum advantage of natural energy flows. For active systems, emphasis is on development of advanced components and investigation of the dynamics of multi-component systems. For passive systems, the goal is to provide a sound technical basis for passive solar designs and to examine innovative passive approaches to heating and cooling buildings.

Active Cooling

Dao

Work is underway to develop higher performance absorption air conditioners, based on advanced and innovative thermodynamic cycles. A new prototype single-effect chiller is under test, and advanced absorption systems are in the design phase. LBL has primary responsibility for technical support of the Active Cooling part of the DOE National Program. In this role, LBL provides project monitoring, assesses solar cooling technology options, reviews proposals, and assists in program planning.

Evaluation of Control Strategies

Wahlig

Control strategies are studied, to increase the efficiency of multi-component heating and cooling systems. An experimental test facility allows testing of strategies over a wide range of insulation, building load, and weather conditions.

Passive Systems Analysis and Design

Kammerud

Objectives are to (1) determine the impacts of passive solar design on energy consumption of buildings and (2) develop thermal analysis capabilities and design tools that will allow architects and engineers to use these concepts in their designs. Activities are underway in basic heat-transfer analysis leading to public domain models for passive solar systems, in computerized building energy analysis leading to design tools, and in the definition and evaluation of innovative passive systems that are appropriate for use on large-scale buildings.

Passive Cooling

Martin

A process is being studied by which heat storage materials would be cooled by radiation to the sky, then would provide "coolness" to the building. The effectiveness of the technique depends on the infrared properties of the atmosphere, as well as the characteristics of the radiating surface and any glazing compounds used to reduce convective heating of the radiator. Atmospheric radiation characterization and studies of materials properties are underway. LBL has the primary technical support role in the area of Passive Cooling. In this role LBL monitors DOE projects at other institutions, continually assesses passive cooling developments and options, reviews proposals, and participates in DOE program planning.

Demonstrations (EA 02) (FY-80 \$0.1 M)Solar Demonstration Projects and Program Support

Salter

LBL provides technical support to DOE's Solar Heating and Cooling demonstration program for commercial applications.

Commercialization (EA 05) (FY-80 \$0.1 M)Solar Commercialization

Kahn

This research analyses and models various regulatory arrangements for electric utility financing of residential solar technology to determine the potential economic impacts on customers and the utilities.

BUILDINGS AND COMMUNITY SYSTEMS (EC) (FY-80 \$8.1 M)Building Systems (EC 01) (FY-80 \$4.5 M)Windows, Lighting, and Daylighting

Berman

The goal of this program is a significant reduction in the consumption of non-renewable energy resources in buildings by optimizing the role and function of windows and lighting systems. Principal activities are to: (1) foster development of energy-efficient fenestration and lighting technologies, strategies and design methods by assisting manufacturers, designers and users, (2) minimize possible adverse social, economic and environmental impacts connected with energy efficient windows and lighting practices, (3) provide an information source so that building users, designers and purchasers can make informed choices on effectiveness and cost-benefit, and (4) assist in removal of institutional barriers to adopting these new technologies.

Major decision points and major milestones are listed chronologically: establishment of the opportunity for improved efficiency, conceptualization of product, design or strategy, feasibility evaluation including technical, economic and institutional aspects, laboratory-scale process, prototype testing, pilot-production simultaneously with market-penetration research, volume production simulation, pre-commercialization testing, demonstration and evaluation, information dissemination.

A mobile window thermal test facility (MoWiTT) for testing the net energy performance of fenestration systems under selected conditions of weather and orientation consists of four fully-sized, heavily insulated and instrumented rooms with controlled internal temperature and ability to monitor HVAC systems providing heating and cooling. In the program to develop a viable replacement for the incandescent lamp, subcontracting, is a major thrust. The subcontractors will assist in developing a high-frequency electrodeless lamp, a crated filament lamp, a compact fluorescent lamp, a magnetic arc-spreading lamp and a multipath fluorescent lamp.

#### Building Envelopes and Ventilation

Rosenfeld/Hollowell

This program has two major areas: Infiltration and Ventilation, and the DOE-2 Building Energy Performance Modeling Program. In Infiltration/Ventilation, the objectives are to identify areas in the physical structure of buildings as well as the heating, ventilating and air conditioning systems where modification in construction and/or operation will result in cost effective energy savings while not interfering with the design use of the building and/or the health and comfort of the occupants. Subcontract activity in the BEV group has been primarily concerned with the indoor air quality field monitoring program.

#### Building Energy Analysis Computer Program (DOE-2)

Rosenfeld

DOE-2 is a cost-effective Building Energy Analysis (BEA) Computer Program tool developed at LBL in conjunction with other national laboratories which allows researchers and designers to explore new concepts in building design, construction, and HVAC control to effect minimum energy usage without compromising design objectives. The program was used to determine the Residential Building Energy Performance Standards (BEPS). Objectives to be reached by 1982 are to: (1) simplify the computer program for the user, (2) form an interface with other Building Energy Analysis programs in the country and (3) initiate the next generation of the BEA Computer Program.

#### Building Energy Performance Standards

Levine

This program provides information and analysis supporting DOE's development of energy performance standards for residential and commercial buildings and mobile homes. The objectives are to (1) develop and apply analytical techniques to assess energy and economic impacts, the performance, and cost effectiveness of alternative conservation measures, (2) develop and apply a framework for deriving alternative sets of performance standards, and (3) develop alternative strategies for implementing energy-efficiency standards. Program extensions include analyses of life-cycle costs of commercial buildings, development of improved modeling of energy use in residential buildings, and analysis of the behavior of the marketplace in adopting energy conservation measures.

The major milestones of the program will be (1) a reproposal of the Building Energy Performance Standards, expected in 1981, (2) a final rule for the program (1981 or 1982), (3) a final rule for the implementation of the standards (1981 or 1982), and (4) a major update of the standards

(expected in 1986). We anticipate purchasing a VAX 11/780 computer and peripheral equipment costing approximately \$400,000. Significant subcontracts are included to provide high-level support in economic analysis not presently available at LBL.

Appliance Standards (EC 02) (FY-80 \$0.4 M)

Appliance Efficiency Standards\*

Levine

The objective of this research is to provide a sound basis for assessing the energy and economic impacts of alternative energy-efficiency standards for appliances.

Analysis and Technology Transfer (EC 06) (FY-80 \$0.3 M)

Home Energy Conservation

Schipper

Develop methods for measuring changes in U.S. residential energy use, at a highly disaggregated level, particularly for space heating, and assess the progress achieved in residential energy conservation.

Community College Energy Conservation

York

This project is targeted on the 1,230 community college campuses in the U.S., encouraging them to record their energy use while implementing energy conservation measures so that the resulting energy savings can be calculated.

TRANSPORTATION ENERGY CONSERVATION (EE) (FY-80 \$0.3 M)

Vehicle Propulsion Research and Development (EE 01)

Lean-Engine Combustion Technology

Sawyer

A single pulse compression-expansion apparatus, shock tube and constant volume combustion vessel are being used to study wall and bulk quenching, flame propagation, heat transfer and vortex roll-up processes. (Part of Combustion program.)

Catalyzed Combustion

Robbin

Surface-catalyzed combustion in a heated wall laminar boundary layer is being studied experimentally and computationally with the aim of understanding the interactions between surface and gas phase reaction as a function of surface type, fuel and temperature. (Part of Combustion program.)



MULTI-PROGRAMS (EG) (FY-80 \$0.2 M)

Appropriate Technology (EG 02)

Appropriate Energy Technology

Case

The Appropriate Energy Technology project assists DOE in the Region 9 program for Small Scale Technology Grants, and is conducting evaluations of the energy-savings potential of the program on a regional and national basis.



A/S Fossil Energy

CURRENT EFFORT

## A/S Fossil Energy

## CURRENT EFFORT

## COAL (AA)

Advanced Research and Technology (AA 15) (FY-80 \$0.2 M)Coal Liquefaction (AA 25) (FY-80 \$0.3 M)

Heinemann

Chemical and catalytic reactions in the hydrogenation and liquefaction of coal, changes in the surface and bulk structure of coal, effects of catalyst-support interaction on the synthesis of hydrocarbons from synthesis gas; (2) use of double quantum NMR and magic-angle sample spinning to follow the evolution of deuterium introduced at some stage in coal processing technology; (3) study of isotopically labeled coal processing intermediates and products from other DOE projects; (4) determination of the behavior of commercially available alloys and coatings in simulated, above ground, and underground oil-shale retorts; (5) development of physical and chemical understanding of oxygen-platinum-ligand interactions necessary for selection of alloying components of platinum for oxygen reduction catalysis.

Heat Engines and Heat Recovery (AA 55) (FY-80 \$0.1 M)Nitinol Engine Development

Wahlig

The Nitinol Engine project is investigating the feasibility of applying the thermal activated shape-memory phenomenon in certain alloys (particularly the nickel-titanium compound 55-nitinol) in thermal-to-mechanical energy conversion at low temperatures and modest temperature differences.

Mining Research and Development (AA 75) (FY-80 \$0.3 M)Chemical Transport Studies

Fox

The purpose of this program is to develop basic chemical data necessary to simulate the transport of chemical wastes in the vicinity of an in-situ oil shale, coal, or tar sands burn.

Hydrologic and Water Quality Effects of Coal Mining

Fox

This program is investigating waste-disposal and water-related impacts of coal mining. Magnitudes of impacts will be assessed and conceptual mine designs analyzed, and recommendations made on methods to comply economically with the requirements of PL 95-87. The results of these studies will be used to formulate control technologies and management strategies to mitigate environmental impacts.

Efficient Mine Ventilation

Hood

This program is aimed at development of computer and physical models that assist in optimizing coal-mine ventilation systems and airflow-control techniques.

PETROLEUM (AC) (FY-80 \$0.4 M)

Enhanced Oil Recovery (AC 15)Chemical Improvement of Oil Mobility

Somerton

Laboratory experiments are being undertaken to develop chemical processes that lower facial tension and improve mobility, with the goal of enhancing the recovery of both light and heavy oils from underground systems.

Oil Shale (AC 20)Environmental Effects and Controls - Oil Shale

Fox

The purpose of this program is to identify and investigate environmental impacts of surface and in-situ oil shale retorting and to develop control technologies and strategies to mitigate these impacts. The program is presently focusing on abandonment of in-situ retorts and characterization of in-situ processes. The retort abandonment program, jointly sponsored by EV and FE, is described under HA 01. The purpose of the characterization program is to identify and quantify major, minor, and trace elements, organic and organometallic compounds, and mineral phases in oil shales and their byproducts.

A/S Fossil Energy

NEW WORK

## A/S Fossil Energy

## NEW WORK

Process Chemical Parameters in Aqueous Sulfur Dioxide  
Removal by Lime/Limestone Scrubbers

Lynn, Connick

Enhanced coal utilization depends on better and more efficient methods for removing sulfur before, during or after combustion. This project is aimed at improving understanding of the chemical behavior of sulfur in all oxidation states, but it will be directed primarily toward oxidation state IV, including sulfur dioxide, bisulfite, disulfite, and sulfite. The experimental program will concentrate on identifying species in reaction mixtures, observing the influence of heavy metals, selenium and sulfur oxy-acid catalysts on equilibria and kinetics. The results will be translated into predictive models to provide information needed by engineers designing new energy systems.

Protective Coatings for Combustion Environments

Various

The proposed program will determine how compositional, structural and processing factors influence the ability of metallic and ceramic protective coatings on structural metals to develop and maintain surface barrier scales that can resist oxidation, hot corrosion, erosion and thermal shock in the environments of low grade petroleum, hybrid and synthetic fuel combustion products. Experience with components in gas turbine engines operating on clean fuels, with relatively mild levels of contaminants, has shown the importance of using protective coatings to supplement the limited surface stability of the high strength alloy substrates. As the use of lower grade fuels increases, the life extension of gas turbine components by coatings will become more important. Early and limited experience with diesel engines operating at higher combustion temperatures and with lower grade fuels has suggested that their metallic components will also benefit from protective coatings, because accelerated surface degradation is likely to occur as diesel efficiencies are increased.

High Temperature Catalysis

Heinemann

In the past, catalytic reactions have not been carried out above temperatures of about 600°C because thermal reactions are fast enough at these temperatures to mask catalytic effects. With availability of ultrafast heating and quenching devices, it is now possible to determine whether greater selectivities to desired products are possible in applying catalysis to reactions at temperatures in the range 600-1000°C. Examples of possible reactions are coal-steam interaction, catalytic cracking of heavy hydrocarbons and tars, and dehydrogenations for olefin production.

Catalyst Development for Hydrocracking  
of Preasphaltenes

Vermeulen

Preasphaltenes, which are major primary products in coal liquefaction, are high in organic nitrogen, have high molecular weights (1000-5000), and melt above 400°C. Although soluble, they are not distillable and are relatively unreactive. Further conversion is frequently accompanied by char production. However, their hydrocracking can be enhanced by catalytically active trace materials, including coal minerals. This project seeks to develop economic and effective catalysts for preasphaltene conversion.

The approach will be to undertake a search for economic catalysts supplementing and extending similar efforts elsewhere. A major possibility to be investigated is the use of individually dispersed, precipitated solids (e.g., ferrous sulfide) prepared just prior to use. Also to be studied are organic-soluble organometallic compounds (e.g., stabilized metal carbonyls) and finely divided solids (e.g., pyrite).

The investigation will utilize preasphaltenes obtained by extraction of oils and asphaltenes from solvent-refined coal. In addition, appropriate model compounds, possessing salient characteristics of preasphaltenes (e.g., quinoline), will be studied.

Coal Liquefaction by Homogeneous Catalysts

Grens

This program is investigating the conversion of coal to liquid products, at temperatures below onset of coal pyrolysis, through the use of homogeneous catalysts such as zinc chloride melts, in combination with coal-derivable solvent media. (Continuing project, transferring from KC 03).

Oxydesulfurization of Coal in Acidic Iron Sulfate

Vermeulen

Chemical cleaning is potentially attractive to render high-sulfur coal usable as a boiler fuel. Most desulfurization processes require a large input of water and chemicals, and pose substantial waste-disposal problems. This project seeks to carry out the cleaning under reaction conditions that will permit the recovery of iron (as oxide or sulfate) and sulfuric acid in marketable form. In a subsidiary problem, impregnation with alkalis that will serve as SO<sub>2</sub> scavengers during combustion will be studied as a function of coal suitability and choice of alkaline treating agent. (Continuing project: Funded by DOE in FY-79, and LBL in FY-80.)





A/S Resource Applications

CURRENT EFFORT

## A/S Resource Applications

## CURRENT EFFORT

GEOHERMAL (AM) (FY-80 \$6.9 M)

Geopressured Resources (AM 05) (FY-80 \$0.4 M)

Geopressured Reservoir Development

Witherspoon

Under DOE/GRI cooperative sponsorship, this project is developing numerical codes, physical models, resource evaluation tools and data analysis techniques to evaluate the physical/chemical characteristics, energy resource potential and environmental aspects of geopressured hydrothermal aquifers.

Geothermal Technology Development (AM 10) (FY-80 \$5.2 M)

Energy Utilization

Fulton

This work involves computer analysis of energy-conversion processes, development of economic direct-contact heat exchangers, determination of basic work-fluid properties for binary cycle evaluations, field testing of heat-exchange and conversion processes, and assessment of other emerging conversion technologies.

Exploration

Goldstein

This project involves development of improved geophysical instruments, field techniques, interpretation methodologies and exploration strategies for more economic and reliable assessment and delineation of hydrothermal reservoirs.

Reservoir Engineering

Witherspoon

The purpose of this effort is to conduct research and develop technologies in reservoir modeling and well testing to predict the magnitude, longevity and production/injection response of hydrothermal reservoirs. Projects include code development, downhole tool development, field testing and analysis of reservoirs under active exploitation.

Hydrothermal Energy Resources (AM 15) (FY-80 \$1.3 M)

Goldstein

This is a research and technical assistance effort focused on predicting, measuring and evaluating possible environmental responses to reservoir exploitation schemes, such as seismicity and subsidence. Activities include fundamental research, computer modeling, tool development and field experiments in collaboration with investigators from the public and private sectors.

Hawaii Integrated Assessment

Siri

This research assesses the technical, economic and institutional feasibility and consequences of a transition from reliance on imported petroleum to dependence on a mix of renewable and geothermal energy in Hawaii. (Also funded under AM 15 and AN 35 in FY-80. No further funding against AM 05 expected; AM 15 and AN 35 will continue.)

GEOTHERMAL-HYDROTHERMAL (CM) (FY-80 \$0.1 M)

Planning and Analysis (CM 10)Geothermal Progress, Monitoring, and Support

Yen

Analysis is carried out of public policies and innovation associated with the commercialization of new geothermal energy resources in the United States and in less developed countries.

Private Sector Development (CM 20)National Geothermal Information

Lederer

This project involves information monitoring and research to assess the continuing development of geothermal resources, provide public domain data bases, and improve the generation and utilization of bibliographic and numeric/fact data systems.

**A/S Resource Applications**

**NEW WORK**

## A/S Resource Applications

## NEW WORK

Geothermal Technology Development

Lippmann

The U.S.-Mexico collaborative case study of the Cerro Prieto geothermal field has been successfully progressing for three years. Based on recent DOE discussions with the Comision Federal de Electricidad (CFE), it is planned to extend these cooperative investigations (starting in FY-81) to the Los Azufres field in the vicinity of Mexico City.



A/S Defense Programs

CURRENT EFFORT



## A/S Defense Programs

## CURRENT EFFORT

INERTIAL CONFINEMENT FUSION (GA) (FY-80 \$1.7 M)

Program Resources (GA 01)Heavy Ion Fusion

Keefe

The goal of the Heavy Ion Fusion program is to prove the feasibility of the heavy-ion induction linac as the driver for an inertial confinement fusion system. A test bed, consisting of a scaled-up version of the present cesium-ion source and drift-tube injector structure, plus 47 induction modules, will be built to demonstrate containment of high-mass, high-current, low-charge-state beams and to investigate the stability and control of the beam bunches. This construction effort will call upon the substantial engineering expertise at LBL; it will also require new technology development in core materials, spark gaps, timing, etc. for the fabrication of pulsed power devices. The baseline heavy-ion fusion research on other ion-source options, system studies, ion-ion cross section measurements and underlying theory, will continue in support of LBL's test bed development and the efforts of the other laboratories (Argonne, Livermore and Los Alamos) participating in the national heavy-ion fusion program.

The test bed is planned to be operational in FY-84 or -85. However, preliminary experiments can be conducted on the test bed beginning in FY-82, as construction progresses. The University of California Richmond Field Station site permits expansion of the test bed for upgraded operation relevant to the design of the next demonstration stage.



Administrator, Energy Information Administration

CURRENT EFFORT

## Administrator, Energy Information Administration

## CURRENT EFFORT

## ENERGY APPLIED ANALYSIS (TA) (FY-80 \$0.1 M)

Energy Applied Analysis Program (TA 01)International Conservation Analysis

Schipper

Research goals are to determine past and present changes in residential energy use in major OECD countries; identify areas where technical and policy means to achieve energy savings exist; and improve DOE's ability to forecast future world demand for oil and other fuels.

Evaluation of EIA Energy Projections

Sathaye

This work provides critical reviews of energy supply/demand projections for Federal Region 9 and assesses projections formulated by EIA as part of its annual report to Congress; it also provides support with input of critical information for Federal Region 9 including energy forecasts derived from state and industry plans, and projections and analysis of economic and other factors affecting energy supply and demand.

Validation of the RDFOR Model

Siri

This project focuses on an assessment of the Hirst (ORNL) and other models by examination of the equations of the models, the precision with which numerous model parameters can be estimated, and predictive performance of selected models.

Administrator, Energy Information Administration

NEW WORK

## Administrator, Energy Information Administration

## NEW WORK

Data Management Research (TB 01)

Quong

Requirements for energy information systems, as described in the Congressional mandate for a National Energy Information System (NEIS) and an Energy Emergency Management Information System (EEMIS), are the basis for research in distributed data management, focusing on the evaluation of available data management systems and the development of a small prototype NEIS in the framework of the laboratory's Socio-Economic Environmental Demographic Information System (SEEDIS).

A/S Nuclear Energy

CURRENT EFFORT

## A/S Nuclear Energy

## CURRENT EFFORT

## CONVERTER (AG)

Advanced Laser Isotope  
Separation Technology (AG 05) (FY-80 \$0.3 M)

Lee, Moore

This project pursues an investigation of the dynamics of physical and chemical processes involved in various isotope separation schemes, and development of a new efficient isotope separation method based on a combination of the molecular beam method and laser technology.



Other DOE Contractors

## Solar Energy Research Institute (SERI)

## CURRENT EFFORT

Bioconversion of Cellulose and Production of Ethanol

Wilke/Blanch

Process-development studies are carried out on the conversion of cellulose (whole trees and agriculture residues) to sugars and the subsequent fermentation of these sugars to ethanol with simultaneous recovery and concentration of the alcohols.

Ammonia Transport Studies

Packer

This project seeks to determine how recycling of H<sub>2</sub> gas is involved in the generation of electrochemical gradients and reducing power in N<sub>2</sub>-fixing bacterial species, in order to enhance their bioproductivity.

Photoacoustic Characterization

Amer

This is an investigation of the optical and electronic properties of amorphous silicon.

Solar Electric Power Evaluation

Kahn

This project is designed to advance state-of-the-art techniques for power system reliability evaluation using analytic methods which will increase computational efficiency and improve conceptual transparency.

U.S.-Saudi Arabian Solar Cooling Program (SOLERAS)

Wahlig

The LBL role in the joint U.S.-Saudi Arabian Solar Cooling program (SOLERAS) is to insure its integration with the U.S. national cooling program, for which LBL has primary technical support responsibility.

## Oak Ridge National Laboratory (ORNL)

## CURRENT EFFORT

BEPS Economic Analysis

Levine

The objective of the program is to develop and apply techniques to:  
(1) understand market behavior in adopting energy conservation in the presence and absence of specific government policies; (2) assess economic impacts of energy conservation policies on electric utilities; and  
(3) extend methods for evaluating the costs and benefits of energy conservation programs.

Thermal Wall Performance

Edlin

This project is developing an in-situ measurement procedure and the necessary apparatus for characterizing the dynamic thermal performance of building-envelope systems, (walls, ceilings, floors), in terms of specific parameters, in the current building stock, including retrofitted walls.

## Sandia Laboratories

## CURRENT EFFORT

Fire Tests for Cable Penetrations

Williamson

Fire tests and criteria are being developed for fire protection of cable penetrations that are critically important for nuclear reactor safety. (Part of Combustion program.)

## Laramie Energy Technology Center

## CURRENT EFFORT

Atomic Absorption Instrument

Fox

This program is to characterize raw and spent oil shale cores from various field sites and to interpret the data in geochemical and environmental framework.

## Morgantown Energy Technology Center

## CURRENT EFFORT

Combustion Staging

Brown

This research is directed toward innovating and characterizing methods of staging combustion for several fuel types such that an optimum reduction in pollutants is achieved. (Part of Combustion program.)

Reagent Additive Effects in Scrubber Chemistry

Lynn

The chemistry of the reactions of iron chelates in aqueous solution with  $\text{SO}_2$  and  $\text{NO}$  will be studied to determine the usefulness of such chelates in flu gas scrubbers.

## NEW WORK

Solution Thermodynamics of Sulfites and Sulfite Oxidation Mechanisms

Brewer, Connick

This project is concerned with the development of satisfactory wet scrubbing processes for the removal of sulfur dioxide from flue gases of coal-fired power plants. Thermodynamic and kinetic properties will be determined for the aqueous species and various solid phases that can form in the oxidation of bisulfite ion by oxygen. The reaction is believed to proceed by a chain mechanism and therefore is sensitive to a wide variety of catalysts and inhibitors. The rate law will be determined for a variety of conditions, including those encountered in flue-gas desulfurization processes.

Pittsburgh Energy Technology Center  
~~Battelle Northwest~~

## NEW WORK

Coal Liquefaction

Heinemann

A study is underway to determine the causes for differences in behavior between fixed and fluid bed Fischer-Tropsch reactors on the one hand and slurry-type reactors on the other. The former require  $H_2/CO$  ratios of 2:1 to avoid coking, the latter can tolerate a 0.7:1 ratio. Temperature control, gas transport limitations and solvent effects are being investigated.

## Battelle/Office of Nuclear Waste Isolation

## CURRENT EFFORT

Swedish-American Cooperative Project

Witherspoon

A comprehensive program of theory, laboratory, and field experiments, and data analysis is evaluating the technical merits of using crystalline rock masses for nuclear-waste repositories. Research activities address geotechnical issues in rock-mechanics, fracture hydrology and chemical transport areas.

Ultra-Large Core Testing

Watkins

Through the maintenance and operation of dedicated test facilities, experiments are done on very large rock cores to investigate such areas as representative sample sizes, fluid flow through discrete fractures and the hydrological character of rocks under thermal and mechanical loading.

Hydrology of Fractured Rock

Wilson

This program encompasses theoretical, modeling and field-technique development studies focused on the determination of the hydrological environment in deep fractured rock masses.

Thermodynamic Properties of Actinides

Edelstein

This project involves laboratory determinations of basic thermodynamic properties of the actinide elements in aqueous solutions typical of a repository environment.

Radionuclide Migration

Various

Fundamental studies are carried out in the areas of waste-rock-water interactions, modeling of radionuclide migration, and development of instrumentation to measure repository leakage.





II. Scientific and Technical Activities (Continued)

WORK FOR OTHERS

Other Federal Agencies

## WORK FOR OTHERS

## Other Federal Agencies

## Nuclear Regulatory Commission (NRC)

## CURRENT EFFORT

Geotechnical Research Addressing Repository Licensing Cohen

Fundamental and applied research is conducted on geotechnical issues of concern in developing the regulatory process for underground nuclear waste repositories.

## Department of Defense (DOD)

## CURRENT EFFORT

U. S. ArmyComparative Effects of Low-Level Ionizing and  
Non-Ionizing Radiation Damage to Vertebrate  
Photoreceptors

Raybourn

This is a study of the biological effects and potential hazards to the retina of both laser light and accelerated heavy ions.

Army Corps of Engineers - System of Information  
Retrieval and Analysis for Planners

Gey

SIRAP is a component of the Socio-Economic Environmental Demographic Information System (SEEDIS, see Department of Labor) focusing on the development of detailed small area profiles and other analytical capabilities of particular use to civil works planners.

## Environmental Protection Agency (EPA)

## CURRENT EFFORT

Air Pollutants

White

This is a study of the possible carcinogenicity of two airborne contaminants from fossil-fuel combustion, nitric oxide and sulfur dioxide.

Cancer, Induction, Mechanism

Fabrikant

Studies are carried out of the relationships among dose, tumor incidence, tumor size, and time in carcinogenesis, and implications of these for the understanding of the process of cancer induction.

Plan for a Research and Information Center  
for the Analysis and Interpretation of  
Data from Short-Term Tests

McCann

This establishes an analyzed data base of short-term tests for carcinogenicity and mutagenicity of environmental chemicals, and develops and analyzes the methodology of human risk assessment.

Analytical Techniques for Oil Shale Retorting

Fox

This program is developing instrumentation to make real-time, continuous measurements of As, Se, Cd, and Hg in oil-shale offgasses, in order to characterize emission patterns from laboratory and field retorts.

Mobile Laboratory

Clem

A mobile water quality monitoring van is being developed for use by EPA to measure 20 water quality parameters in potable water.

Field Studies in MAP 3S

Novakov

The objective of this program is the experimental study of two processes which may contribute to the formation of "acid rain:" oxidation of SO<sub>2</sub> by water droplets containing NO<sub>x</sub>, and oxidation of SO<sub>2</sub> in water droplets containing soot particles.

Alternatives for Small Communities

Berman

The purpose of this research is to examine the potential for using nonconventional technologies in small, rural communities and as mitigation strategies in rapidly growing, energy-impacted boom towns that are experiencing a surge in demand for municipal services. (Also funded by Dept. of State.)

### X-ray Fluorescence Analysis of Samples

This is a continuing program of elemental analysis of samples collected by the Environmental Protection Agency, including quality control studies of the data.

### Aerosol Instrument Development

This includes development and engineering of field instruments for sampling and analysis of environmental pollutants.

### Carbon Fibers in Air

This is an investigation of measurement techniques appropriate for on-line monitoring of carbon fibers released from combustion of composite materials in the atmosphere.

## NEW WORK

### Analysis and Screening of Carcinogenic and Mutagenic Agents

McCann

Work is currently underway on broad statistical analyses of the validity and inter-test consistency of short-term screening tests of carcinogenicity and mutagenicity. This work will be significantly expanded, as some of the more narrowly directed investigations on particular pollutants and specific biological targets reach completion.

### Effects of Pollutants on Freshwater Lakes

Harte

The purpose of this research, to be jointly funded by EPA and the Electric Power Research Institute (EPRI), is to enhance ability to determine ecological effects of toxic substances in freshwater lakes. Two major objectives are (1) to complete a series of studies pursued since 1977 on understanding and improving the design and operation of laboratory freshwater lake microcosms as a tool for assessment of toxic substance effects, and (2) to develop and evaluate a relatively simple standard procedure for predicting the likely effects of toxic substances on decomposition processes in freshwater lakes. These two objectives are expected to be reached by the end of FY-83.

## National Space and Aeronautics Administration (NASA)

## CURRENT EFFORT

Neutron Production by Heavy Ions

Schimmerling

Experiments are underway to measure the production of neutrons by high-energy heavy ions traversing targets of air and tissue constituents, as well as to study of shielding design materials.

Carcinogenesis and Life Span Studies

Ainsworth

This study seeks information for predictive modeling of the excess risks of carcinogenesis and other deleterious late effects from space-related radiation.

Surface Tension Phenomena

Concus

Mathematical, computational and experimental studies of capillary free-surface phenomena under zero-gravity and low-gravity conditions are performed, focusing on in-space experimentation.

## National Bureau of Standards (NBS)

## CURRENT EFFORT

Fire Modeling

Pagni

This project examines fire hazard assessment from a fundamental viewpoint with the purpose of establishing new and more accurate material test standards for insuring life safety from unwanted fire. (Part of Combustion program.)

Thermal Radiation

Tien

Radiation, the dominant mode of heat transfer in structural fires, is studied in fundamental detail with the goal of predicting the quantity and character of flame radiation. (Part of Combustion program.)

## NEW WORK

Intra-Laboratory Evaluation of a StandardRoom Fire Test

Williamson

The objective of this research in fire growth is to develop experimental methods to evaluate the fire-growth characteristics of materials. (Part of Combustion program.)



## National Oceanic and Atmospheric Administration (NOAA)

## CURRENT EFFORT

Aerosol Particle Measurement

Novakov

This project involves characterization of the carbonaceous component of particulate material collected in the Arctic haze by determination of the nature of the absorbing species, quantification of the graphitic and total carbon content as a function of time of year, and comparison of the optical and chemical properties of the carbonaceous component of the Arctic haze with particulate matter collected in urban environments.

## National Institutes of Health (NIH)

## CURRENT EFFORT

Cancer Treatment with Heavy Charged Particles

Castro

This is an investigation of therapeutic application of heavy charged particles in the treatment of human cancers, in order to test the potential advantages of improved dose distribution and increased biological effect.

Cardiovascular Research

Budinger

In this program physicians, physicists, chemists, and biologists will be trained in techniques for cardiovascular research using advanced instrumentation, pharmaceuticals, and other analytical methods.

Heavy-Ion Radiation

Schimmerling

Measurement is being made of the physical characteristics of high-energy, heavy-ion beams as a function of absorbed depth. The results will be used to obtain the dose and beam quality of radiation fields used in biomedical research at the Bevalac.

Heavy-Ion Radiobiology Related to Oncology

Tobias

This is an investigation of the biological effects of accelerated heavy particles (e.g., carbon, neon, and argon ions), and the optimization of methods for applying these beams to the treatment of human cancer.

Heavy-Ion Radiation and Multicellular Spheroids

Alpen

Examination is made of the relative biological effectiveness of heavy-ion radiation on cell lines grown as multicellular spheroids.

Lipoprotein Methodology and Biomedical Applications

Lindgren

This is a development of lipoprotein methodology and biomedical applications particularly screening for heart disease risk.

Lipoprotein Methodology, Structure, and Function

Forte

This is a training program of postdoctoral fellows in lipoprotein methodologies and their biomedical applications.

Myocardium Infarct Sizing

Budinger

This research aims to define myocardial infarction and ischemia with increased accuracy and resolution using the positron-emitting isotope rubidium-82 and carbon-11 amino acids.

Rat Tumor, Heavy Ions

Curtis

This is an in-depth study of the radiation response of a rat rhabdomyosarcoma to heavy-ion beams, and comparison of tumor responses to irradiation by various charged particle beams. Its purpose is the selection of the most promising beam for clinical application.

Alkylating Carcinogens, Mutagenesis

Burki

A model system is being developed for studying the mutagenesis of alkylating carcinogens in asynchronous and synchronous mammalian cells in vitro.

DNA Complexes

Maestre

This is a study of the interaction of nucleic acids with the gene product protein 32 of T4 bacteriophage by methods to obtain information on the secondary and tertiary structure of the nucleic acids in the complex and the structure of the active protein sites.

DNA-Unwinding Protein

Hosoda

A study is being made of the primary and tertiary structure of DNA unwinding protein in relation to its functional activities.

Central Nervous System Toxicity

Raybourn

Determinations are being made of dose-response functions between certain toxic substances in the environment and the quantitative measures of central nervous system and synaptic network viability as monitored electrophysiologically. Investigation is also under way of cellular mechanisms underlying the toxic actions of these substances.

Erythropoietin Radioassay

Garcia

Labeled erythropoietin is being used in a search for specific erythropoietin-binding proteins in erythropoietic tissues, the aim of which is the development of a radioreceptor assay for erythropoietin.

Ligase and Other Enzymes in DNA Replication

Hosoda

This research is examining the roles of various T4 gene products, such as DNA-ligase, DNA polymerase and nucleases. Special emphasis is given to the product of gene 32(P32), a DNA-unwinding protein.

Megakaryocyte and Platelet Turnover

Ebbe

This research is an evaluation of megakaryocytopoiesis, kinetic properties of megakaryocyte precursor cells, and homeostatic control of platelet production.

Structure of Viruses

Maestre

Study is made of the structure of viruses, nucleoproteins, and chromosomes, with particular emphasis on the internal organization of their nucleic acids.

Tritium-Damaged Mammalian Cells in Vitro

Burki

Tritium-damaged mammalian cells are studied to obtain information on the basic mechanisms that lead to the inactivation of proliferative ability and mutagenesis of mammalian cells and to the induction of chromosome aberrations.

Biological Structure Analysis by Electron Microscopy

Glaeser

Methods of high-resolution structural analysis by electron microscopy are being applied to determine the three-dimensional structure of several cell membranes.

Effects of Benzo(a)pyrene on Human Epithelial Cells

Smith

This is a study of the effect of the chemical carcinogen benzo(a)pyrene on a series of human epithelial cell lines of normal and malignant origin.

Megakaryocyte Differentiation

Barker

The kinetics and ultrastructure of megakaryocyte maturation are being investigated under a number of experimental conditions, including humoral stimulation without concomitant alteration of circulating platelet levels; during and after hypoxia; and in vitro culture systems.

Dietary Effects on Serum High-Density Lipoproteins

Krauss

This is research on the effects of dietary fats, cholesterol, protein and complex carbohydrates on composition, physical properties, and morphology of high-density lipoproteins (HDL) and their distribution and concentration in plasma. Objectives are to relate these effects to initial levels of HDL, to changes in properties and distribution of other lipoprotein classes; and to determine the effects of an acute fat meal and changes in total energy flux on HDL and other lipoproteins.

Characterization of Human Mammary Cells

Stampfer

The aim of this research is development of conditions for in vitro culture of human mammary cells to facilitate use of this cell system in investigations of differentiation and carcinogenesis.

Hemopoietic Cellular Proliferation and its Regulation

Ebbe

In this program qualified individuals are being trained in the research aspects of hematopoiesis. Emphasis is on a one-to-one association of trainees with preceptors from the Biology and Medicine Division staff who have expertise in specific aspects of hematology research.

Biomedical Computerized Tomographic Scanner

Grunder

Research is underway on the construction of a computerized axial tomographic scanner with the capability of functioning in any geometric position; that is, the patient can be imaged in the standing, sitting, or horizontal position.

DNA Structure by Electron Diffraction and Microscopy

Downing

The objective of this research is the determination of the structure of duplex DNA by recently developed methods of electron microscopy and electron diffraction, independent of prior studies performed by x-ray diffraction.

Heavy-Ion Radiography and Cancer

Tobias/Farbrikant

This is an investigation and development of heavy-ion radiography as a safe, noninvasive, low-dose imaging process for application to the diagnosis and treatment of cancer in man.

Assymetry of the Inner Mitochondrial Membrane

Melhorn

Energy conversion and storage processes in biological and synthetic membranes are being studied with paramagnetic probes, with emphasis on surface potential measurements of mitochondrial membranes. .

## National Science Foundation (NSF)

## CURRENT EFFORT

Welding of Cryogenic Steels

Morris

Development is underway of improved weld filler metals for cryogenic steels to take full advantage of the significant cost benefits of ferritic cryogenic steels.

National Resource for Computation in Chemistry (NRCC)

The National Resource for Computation in Chemistry is jointly supported by DOE and NSF. See discussion under DOE Office of Energy Research.

Particle Data Group

The Particle Data Group of the Physics, Computer Science and Mathematics Division is jointly supported by DOE and NSF. See discussion under DOE Office of Energy Research.

## Department of Labor (DOL)

## CURRENT EFFORT

Socio-Economic Environmental Demographic Information  
System (SEEDIS/DCN)

Quong

Research and development in the areas of distributed information systems technology, data management, information display and analysis, and tools for policy analysis are collaboratively supported by DOE's Office of Energy Research and the Department of Labor Employment and Training Administration. The Socio-Economic Environmental Demographic Information System (SEEDIS) is comprised of a large integrated database and sophisticated analytical, modeling and display capabilities. The development of an experimental homogeneous network of minicomputers provides a basis for the extension of SEEDIS into the area of distributed information technology.

## Department of State

## CURRENT EFFORT

Agency for International Development (AID)Alternatives for Small Communities

Berman

The purpose of this research is to examine the potential for using nonconventional technologies in small, rural communities and as mitigation strategies in rapidly growing, energy-impacted boom towns that are experiencing a surge in demand for municipal services. (Also funded by EPA.)



## Veterans Administration (VA)

## CURRENT EFFORT

Solid State Ballast Project

Verderber

A qualification-demonstration of solid state fluorescent ballasts is being undertaken for the VA Office of Construction in a hospital environment, to determine the energy savings of this new product and to prove that no excess radio frequency interference emanates from these units.

II. Scientific and Technical Activities (Continued)

WORK FOR OTHERS

All Others

## WORK FOR OTHERS

All Others

State of California

## CURRENT EFFORT

Air Resources BoardPollutants from Ammonia Injection

Brown

This research is directed toward characterizing the selective reduction of NO by NH<sub>3</sub> in post-combustion environment for several experimental variables. (Part of Combustion program.)

California Energy CommissionCalifornia Energy System Assessment Model

Sathaye

The function of this program is (1) to develop methodology, primarily in the form of an interlinked computer model system and data base, to analyze alternative energy supply and use systems feasible for the state of California, and (2) application to the formulation of alternative energy futures and analysis of their economic and environmental impacts.

## Electric Power Research Institute (EPRI)

## CURRENT EFFORT

Air Pollution and Human Health

Merrill

Using the Populations at Risk to Environmental Pollution (PAREP) database, researchers will examine the validity of the use of regression techniques involving county-average values of mortality rates, air quality and socio-economic indicators.

Precipitation Strengthening of Austenitic Alloys

Morris

Improvement is sought of the fundamental understanding of precipitation reactions that contribute to the properties of austenitic alloys being developed for generator retaining rings and other potential applications.

Investigation of New Fuel Cell Electrolyte  
and Electrode Concepts

Ross

An advanced high temperature (120-190°C) electrolyte is being developed to substitute for the presently-used phosphoric acid.

Improved Beta-Alumina Electrolytes for Advanced  
Storage Batteries

De Jonghe

The aim of this work is determination of the mechanisms of slow degradation and rapid break-down in the polycrystalline beta-aluminas used in advanced sodium/sulfur batteries.

Effects of Pollutants on Freshwater Lakes

Harte

This project is to be jointly funded by EPA (see EPA new work).

## Electric Power Research Institute (EPRI)

## NEW WORK

Inhibitive Salts for Reducing High-Temperature  
Oxidation and Scale Spallation

Whittle

This is an investigation into the effect of addition of small amounts of reactive elements to heat-resistant alloys to produce marked improvements in their behavior under cyclic oxidation conditions. Surface coatings of active elements (Hf, Ca, Y, Zn, and Ti) will be applied by drying and heating, or by anodic deposition, to examine the feasibility of using surface coatings of stable oxides as a means of improving resistance to scale spallation and oxidation.

Phase Equilibrium of Fixed Bed Gasification Products  
and By-Products in Water

Prausnitz

Determination is made of fundamental physicochemical data required for optimal design of quench and cooling systems in coal gasification plants. Solubilities in aqueous-hydrocarbon systems are measured in the temperature range 25-250°C, of heavy hydrocarbons (and their nitrogen-, sulfur-, or oxygen-containing derivatives) as model compounds. Measurements are made with real, heavy organic residues as obtained from coal-gasification pilot plants. Solubility data will be correlated by use of a semi-empirical technique (UNIFAC) for estimating activity coefficients.

## Resources for the Future

## CURRENT EFFORT

Energy Use and Conservation in Kenya

Schipper

This project is assessing the present state of the end use of energy in Kenya, including the energy intensity of key modern energy uses. From these data and a forecast of economic growth, a qualitative forecast will be made of the possible impacts of energy conservation in a country like Kenya over the coming decade.

## Foreign Universities

### CURRENT EFFORT

#### Collaborative Research

A five-year collaborative research agreement between LBL and the Institute for Nuclear Study (University of Tokyo) became effective in 1979. This supports experimental studies of relativistic heavy ion collisions. GSI (Darmstadt) and the University of Marburg have recently increased their collaborative research efforts at LBL; particular interests include developing further use of the Bevalac streamer chamber and completion of the plastic ball facility.

## Miscellaneous

## CURRENT EFFORT

LBL Service Capabilities Available to OthersNeutron Activation Analysis

Asaro

High precision neutron activation measurement methods are developed and applied to interdisciplinary research studies.

Gas Chromatography/Mass Spectrometry

Newton

Using a gas chromatograph/mass spectrometer, organic and nitrogenous compounds from processing or combustion of energy technologies such as oil shale, coal liquefaction, coal slurries and biomass conversion are identified and quantified.

X-ray Fluorescence

Giauque

Trace element x-ray fluorescence analytic methods are applied (developed under DOE/OER funding) to specific energy-related problems.

Semiconductor Detector System Development  
and Fabrication

The unique abilities and facilities of LBL in this area are used by laboratories of DOE and other agencies as a resource for providing specialized research systems.





### III. Site and Facilities Development

#### OVERVIEW

The LBL Site Development Plan is consistent with the LBL Institutional Plan for FY-81/86 and incorporates the following elements:

1. Recognition of physical and environmental constraints to site expansion into new building sites.
2. The orderly redevelopment of the oldest (original) area of the Laboratory in the vicinity of the 184-Inch Cyclotron including:
  - Demolition of existing sub-standard and inefficient buildings.
  - Construction of new buildings with specialized laboratories needed to carry out the Laboratory's broadened missions in goal-oriented basic and applied research related to DOE missions.
  - Rehabilitation of selected laboratory and high bay buildings for new uses.
  - Removal of the 184-Inch Cyclotron and the conversion of space made available for use at crane-covered high bay research area.
  - Relocation of existing service and administrative functions from buildings that are to be demolished in order to continue redevelopment of the original site of the Laboratory. These functions will be housed in a new Safety, Supply and Materials Handling Complex.
3. Move administrative and technical off-site services back on site and reconsolidate programmatic and research-support activities now in trailers or widely scattered off-site locations.

The specific projects required to carry out the LBL Institutional Plan are itemized under Construction below.

## CONSTRUCTION

### Funded Projects

#### Program Special Facilities

High Intensity Uranium Beam (FY-78) TEC \$6.85 M. This project, presently in progress, entails modifications to the SuperHILAC and the Bevalac to permit acceleration of intense beams of all ions, including uranium, at both of these national facilities. At the SuperHILAC, a new high-mass injector will be added, while at the Bevatron, a new ultra-high vacuum chamber will be inserted within the main ring. The last two magnets in the transfer line between the two machines will also be replaced.

#### Program Justified GPF

Chemical and Materials Sciences Laboratory (FY-80) 4200 GSF/TEC \$4.3 M. This laboratory will house the Atomic Resolution Microscope (ARM), a major scientific instrument which will be utilized in the development of materials for advanced energy systems. The project will fulfill the need for application of atomic resolution microscopy to problem areas associated with free surfaces and internal interfaces in energy related materials. The building will provide 4200 gross square feet of high bay space in a three-story tower with a vibration isolation support system for the ARM in a location adjacent to the existing High Voltage Electron Microscope at Building 72.

Biomedical Laboratory II (FY-80) TEC \$5.5 M (non-DOE \$). This building, of approximately 24,000 gross square feet, is being built by the UC Regents to accommodate research activities being moved from the present UC Campus site to a location adjacent to the Biology and Medicine Division's biomedical laboratory and LBL. The new facility will be occupied by the Research Medicine group which is now scattered in a number of buildings but involves close interrelationships between instrument techniques and development, the development of animals and human studies, and mathematical analysis.

#### Multiprogram GPF

Energy Monitoring and Control System (FY-80) TEC \$1.1 M. This system will provide continuous surveillance and control of LBL's energy consumption and plant operations. A central processor and control console will monitor and supervise remote data collecting and multiplexing panels or microprocessors, and will provide overall automatic and/or manual adjustments to plant operations as needed to maximize utilization, and minimize cost and energy consumption.

### Budgeted Projects

#### Program Justified GPF

Biomedical Laboratory Building 74 Addition (FY-81) TEC \$1.5 M. This proposal is for the modification of the existing LBL Biomedical Laboratory to provide additional space for the programs of the Biology and Medicine Division. The modification will provide for staff and animal colony needs

related to new programs, and will permit the relocation of some existing programs from older buildings not designed for biomedical research.

### Proposed Projects

#### Program Special Facilities

Nuclear Science Accelerator-VENUS (FY-8X) (ER) TEC unknown at present. Studies of a versatile heavy ion facility for the 1980's and beyond have been underway at LBL for several years. Substantial R&D efforts will begin in FY-81 to -82.

#### Program Justified GPF

Building 3 Enlargement and Modification (FY-83) TEC \$5.0 M. The addition of 16,000 gross square feet to the Laboratory of Chemical Biodynamics (Bldg. 3) will provide space needed to accommodate planned growth into new areas of solar energy research. The present space is fully occupied with ongoing research programs in molecular biology and photobiology. However, the existing building has neither space nor laboratory characteristics appropriate to the growth areas of photochemistry and photophysics.

Chemical and Materials Sciences Laboratory II (FY-83) (ER) TEC \$11.9 M. The Chemical and Materials Sciences Laboratory II would contain approximately 42,000 gross square feet for laboratories vitally needed for research in catalysis, photoelectron spectroscopy, conversion of coal, organometallic chemistry, chemistry and materials production technology, metal clusters, and application of atomic microscopy. This project facilitates use of the Atomic Resolution Electron Microscope, whose purchase and housing were the main elements of the initial (FY-80) construction of the Chemical and Materials Sciences Laboratory, as a national center for high resolution electron microscopy.

Cell Culture Laboratory II (FY-84) (EV) TEC \$2.5 M. Cell Culture Laboratory II is the second increment of a specialized facility to carry out research in cell biology. At the present time the work in Cell Culture Laboratory I is supported by laboratory and office space in remote buildings. This new facility would permit consolidation.

Plant Tissue Culture Laboratory (FY-85) (EV) TEC \$2.5 M. A facility is required to house plant-cell tissue-culture research devoted to development of strains of Euphorbia for possible production of hydrocarbons and sugars as energy sources. A building of 4000 gross square feet is proposed. Present research has indicated yields that are attractive in terms of production of chemical feedstocks and susceptible to great improvements through selection of genetic plant material. While such development can take place by seed selection and cloning for plants reproduced by cuttings, it is expected that development can be greatly accelerated through the use of plant-cell tissue-culture techniques. Not only would acceleration be possible, but modification of yield and product itself by genetic engineering could ultimately be achieved.

### Multiprogram GPF

Energy Research Laboratory I (FY-82) TEC \$23.5 M. The Laboratory's highest planning priority is to provide specialized laboratory space and to permit consolidation of existing energy-related activities in a central location. A new building, Energy Research Laboratory I (ERL I), 65,000 gross square feet, would fill this need by providing required special laboratories and heavy experimental space. This will create an environment that would promote daily contact among investigators in interdependent fields of research who are now scattered on and off the site in locations up to five miles apart. ERL I is LBL's number one priority for construction of a general purpose facility.

Safety Supply and Materials Handling Complex (FY-82) TEC \$13.7 M. This project with 98,000 gross square feet would house supply administration, purchasing, central stores, reclamation and salvage, bulk stock, records and mailroom. Also included is a Safety Services Addition to Building 75 consisting of an office/laboratory structure to house department administration, industrial safety, equipment development and safety coordination.

Building 6 Rehabilitation (FY-83) TEC \$5.6 M. The project involves removing the 184-Inch Cyclotron and rehabilitating the building for use for high priority R&D programs. This will create heavy duty, high-bay crane covered research space. In addition, high voltage power, low conductivity water and other utilities are available. The rehabilitated space would be utilized for large scale experimental magnetic fusion devices, prototype pilot plants and other programs.

Support Service Buildings (FY-84) TEC \$16.6 M. This building would provide 50,000 gross square feet of office space for engineering and research support. Activities that would be located in this building are presently scattered throughout the Laboratory. Consolidation of these activities would free other space on the hill and would permit return of off-site administrative and technical groups. Many trailers and temporary buildings would be removed.

Energy Research Laboratory II (FY-86) TEC \$34.5 M. This laboratory will be similar in concept of Energy Research Laboratory I proposed for FY-82, and would be used for continuing and consolidating programs in energy technology research.

## ADP REQUIREMENTS

In addition to providing computational support to LBL programs, the LBL Computer Center serves as a remote computing facility for many other DOE sites and contractors, and (on a noninterference basis) for other federal agencies. Spurred by PEP, NRCC, and the new energy technology programs, LBL's demand for computing will more than double by 1984. This increase, together with only a constant level of other DOE and DOE-related work, would saturate the current configuration.

The ADP Long Range Plan contains detailed projections of computing requirements, itemized by program, together with LBL's proposed solution to present difficulties with interactive computing. The major elements of the ADP Plan are (1) incremental replacement of the obsolescent equipment over a relatively long period (1978-1984), (2) shift to a more flexible, distributed configuration than is now employed, based upon a high-speed bus (the Hyperchannel) used for intermachine communication, (3) use of highly price-competitive IBM plug-compatible peripherals wherever possible, and (4) the replacement of two cumbersome front-end machines with a larger number (4-6) of smaller and more flexible front ends.

The Computer Center resource requirements include no major items of equipment, but a selection of smaller items is necessary (including mass storage, disks, front-end computers, network equipment, and miscellaneous peripherals), amounting to an aggregate of \$3.5 M in General Purpose Capital Equipment/ADP money, spread over the years FY-81 to -84.

LBL's overall strategy to eliminate the deficiencies and accomplish the goals mentioned above is based upon the establishment of an inter-connected set of functionally independent nodes, capable in the aggregate of supporting both these functions currently supported by the 6000's and those new functions (such as data base applications and BDP) not now adequately supported. The sole exception is staging for the 7600, which is expected to remain with the smaller 6000 machine (unless an inexpensive compatible substitute should become available).

The ADP Plan is basically an incremental approach to replacing obsolete ADP equipment on a functional basis while at the same time providing for the changing Laboratory computing requirements. The Plan has the added advantage of permitting flexibility during a period when computer technology is undergoing rapid development.



APPENDIX

Table E. Summary by Assistant Secretary

Table H. A/S Office Summary

ENERGY RESEARCH

ENVIRONMENT

CONSERVATION AND SOLAR ENERGY

FOSSIL ENERGY

RESOURCE APPLICATIONS

DEFENSE PROGRAMS

MISCELLANEOUS

Table J. Resources for New Initiatives

Table K. Major Construction Projects: Summary

Table L. Major Construction Projects: Proposed Projects--Description

Table M. Major Construction Projects: Proposed Construction--  
Resource Requirements

Table N. General Plant Projects

Table P. WPAS Cross References



Table E. Summary by Assistant Secretary

Table E. Summary by Assistant Secretary

(\$ in millions)

Assistant Secretary	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
<b>Energy Research</b>														
Operating	44.8	45.0	51.6	46.5	66.0	58.7	63.8	62.6	64.6	64.0	65.0	64.6	65.1	64.8
Other Procurement	6.5	6.5	6.4	6.4	8.0	8.0	8.6	8.6	8.7	8.7	8.7	8.7	8.8	8.8
Total Operating	51.3	51.5	58.0	52.9	74.0	66.7	72.4	71.2	73.3	72.7	73.7	73.3	73.9	73.6
Equipment	8.7		8.6		10.8		14.1		12.3		12.3		11.3	
Construction	7.6		2.9		3.9		4.5		4.9		5.5		6.1	
Total	67.6	51.5	69.5	52.9	88.7	66.7	91.0	71.2	90.5	72.7	91.5	73.3	91.3	73.6
<b>Environment</b>														
Operating	11.3	11.3	12.0	11.6	15.0	14.1	15.0	15.0	15.3	15.2	15.4	15.4	15.4	15.4
Subcontract	0.2	0.2	0.2	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Procurement	1.5	1.5	1.8	1.8	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Total Operating	13.0	13.0	14.0	13.6	17.5	16.6	17.2	17.2	17.5	17.4	17.6	17.6	17.6	17.6
Equipment	1.5		1.6		2.6		2.9		3.4		2.8		2.8	
Construction	0.0		1.5		2.0		1.3		3.7		0.0		0.0	
Total	14.5	13.0	17.1	13.6	22.1	16.6	21.4	17.2	24.6	17.4	20.4	17.6	20.4	17.6
<b>Conservation and Solar Energy</b>														
Operating	12.1	11.6	14.7	12.5	14.4	13.9	14.3	14.3	14.1	14.1	14.0	14.1	14.0	14.0
Subcontract	6.2	5.0	6.9	6.1	8.5	8.1	8.2	8.1	8.2	8.1	8.2	8.1	8.2	8.1
Other Procurement	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total Operating	18.6	16.9	21.9	18.9	23.2	22.3	22.8	22.7	22.6	22.5	22.5	22.5	22.5	22.4
Equipment	0.9		1.2		1.2		1.3		1.3		1.3		1.3	
Total	19.5	16.9	23.1	18.9	24.4	22.3	24.1	22.7	23.9	22.5	23.8	22.5	23.8	22.4
<b>Fossil Energy</b>														
Total Operating	1.3	1.4	3.7	2.8	3.7	3.5	3.9	3.8	3.3	3.2	3.4	3.3	3.4	3.3
Equipment	0.2		0.3		0.3		0.2		0.2		0.2		0.2	
Total	1.5	1.4	4.0	2.8	4.0	3.5	4.1	3.8	3.5	3.2	3.6	3.3	3.6	3.3
<b>Resource Applications</b>														
Operating	1.7	2.8	4.7	3.6	5.4	5.0	5.1	5.1	4.8	4.8	4.3	4.3	4.3	4.2
Subcontract	3.3	3.7	3.2	2.5	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Other Procurement	0.5	0.5	0.4	0.4	0.5	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5
Total Operating	5.5	7.0	8.3	6.5	8.5	8.0	8.2	8.2	7.8	7.8	7.3	7.3	7.3	7.2
Equipment	0.2		0.1		0.1		0.2		0.2		0.2		0.2	
Total	5.7	7.0	8.4	6.5	8.6	8.0	8.4	8.2	8.0	7.8	7.5	7.3	7.5	7.2

\* 10% escalation factor

Table E. Summary by Assistant Secretary (continued)

(\$ in millions)

Assistant Secretary	FY 1980		FY 1981		FY 1982 <sup>*</sup>		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
<b>Defense Programs</b>														
Operating	1.5	1.6	2.9	2.1	8.1	6.5	13.4	11.6	10.9	11.1	4.9	6.5	6.5	6.5
Other Procurement	0.1	0.1	0.2	0.2	0.5	0.5	0.8	0.8	0.8	0.8	0.5	0.5	0.5	0.5
Total Operating	1.6	1.7	3.1	2.3	8.6	7.0	14.2	12.4	11.7	11.9	5.4	7.0	7.0	7.0
Equipment	0.1		0.3		0.2		0.3		0.3		0.3		0.3	
Total	1.7	1.7	3.4	2.3	8.8	7.0	14.5	12.4	12.0	11.9	5.7	7.0	7.3	7.0
<b>Miscellaneous Programs</b>														
Operating	0.8	0.8	1.2	1.0	1.4	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Subcontract	0.2	0.2	0.1	0.1										
Total Operating	1.0	1.0	1.3	1.1	1.4	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Equipment	0.0		0.1		0.1		0.1		0.1		0.1		0.1	
Construction	1.1		0.0		0.0		0.0		0.0		0.0		0.0	
Total	2.1	1.0	1.4	1.1	1.5	1.2	1.2	1.1	1.2	1.1	1.2	1.1	1.2	1.1
<b>Other DOE</b>														
Operating	12.4	12.4	9.4	9.4	10.3	10.3	9.7	9.7	9.3	9.3	7.2	7.2	6.3	6.3
Subcontract	0.5	0.5	0.3	0.3	0.6	0.6	0.6	0.6	0.7	0.7	0.3	0.3	0.1	0.1
Other Procurement	1.0	1.0	1.1	1.1	1.2	1.2	1.1	1.1	1.1	1.1	0.8	0.8	0.7	0.7
Total Operating	13.9	13.9	10.8	10.8	12.1	12.1	11.4	11.4	11.1	11.1	8.3	8.3	7.1	7.1
Equipment	0.9		0.8		0.7		0.6		0.6		0.5		0.5	
Total	14.8	13.9	11.6	10.8	12.8	12.1	12.0	11.4	11.7	11.1	8.8	8.3	7.6	7.1
<b>Total DOE</b>														
Operating	85.9	86.9	100.2	89.5	124.3	113.2	126.2	123.2	123.3	122.8	115.2	116.5	116.0	115.6
Subcontract	10.4	9.6	10.7	9.2	12.0	11.5	11.4	11.2	11.5	11.3	11.1	10.9	10.9	10.7
Other Procurement	9.9	9.9	10.2	10.2	12.7	12.7	13.6	13.6	13.6	13.6	13.0	13.0	13.0	13.0
Total Operating	106.2	106.4	121.1	108.9	149.0	137.4	151.2	148.0	148.4	147.7	139.3	140.4	139.9	139.3
Equipment	12.5		13.0		16.0		19.7		18.4		17.7		16.7	
Construction	8.7		4.4		5.9		5.8		8.6		5.5		6.1	
Gen. Purpose Facilities					10.8		28.4		11.9		8.3		6.0	
Total	127.4		138.5		181.7		205.1		187.3		170.8		168.7	
<b>Other than DOE</b>														
NRC	0.7	0.4	0.9	0.9	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
DOD	1.6	1.5	1.4	1.4	1.3	1.3	0.9	0.9	0.6	0.6	0.3	0.3	0.3	0.3
Other Federal	12.7	12.3	13.1	12.1	13.3	12.3	13.3	12.7	13.2	13.0	13.5	13.3	13.6	13.4
All Others	3.8	3.8	3.1	3.1	2.9	2.9	2.2	2.2	1.2	1.2	1.1	1.1	1.0	1.0
Total other than DOE	18.8	18.0	18.5	17.5	19.0	18.0	18.4	17.8	17.0	16.8	16.9	16.7	16.9	16.7
<b>Total Laboratory Funding</b>	146.2	124.4	157.0	126.4	200.7	155.4	223.5	165.8	204.3	164.5	187.7	157.1	185.6	156.0

\* 10% escalation factor

Table H. A/S Office Summary

Table H. A/S Office Summary

## ENERGY RESEARCH

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AT 05 10														
Advanced Fusion Concepts														
New Work	0.0	0.0	0.9	0.7	1.9	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Direct FTE**		1		9		20		20		20		20		20
AT 05 20														
Fusion Plasma Theory														
Curr. Eff./Operating	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
New Work	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
Total Operating	0.1	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Direct FTE		3		4		5		5		5		5		5
AT 05 30														
Experimental Plasma Research														
Curr. Eff./Operating	0.2	0.4	0.8	0.5	0.9	0.7	0.9	0.7	0.9	0.7	0.9	0.7	0.9	0.7
Direct FTE		5		6		7		7		7		7		7
AT 10 10														
Tokamak/Doublet III														
Curr. Eff./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
Direct FTE		7		0		0		0		0		0		0
AT 15 10														
Development/Magnetic Systems														
Curr. Eff./Operating	0.2	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct FTE		1		2		2		2		2		2		2

\* 10% escalation factor

\*\* FTE figures are manpower given as Full Time Equivalents.

Table H. A/S Office Summary

ENERGY RESEARCH (continued)

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AT 15 20														
Plasma Engineering														
Curr. Eff./Operating	0.0	0.0	4.2	3.0	7.4	6.2	6.2	6.2	6.2	6.2	6.1	6.1	6.2	6.2
Curr. Eff./Other Procure.	0.0	0.0	0.5	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Total Operating	0.0	0.0	4.7	3.5	8.3	7.1	7.1	7.1	7.1	7.1	7.0	7.0	7.1	7.1
Direct FTE	0		55		100		100		100		100		100	
AT 20 10														
TFTR														
Curr. Eff./Operating	4.1	4.1	0.0		0.0		0.0		0.0		0.0		0.0	
Curr. Eff./Other Procure.	0.6	0.6	0.0		0.0		0.0		0.0		0.0		0.0	
Total Operating	4.7	4.7	0.0		0.0		0.0		0.0		0.0		0.0	
Direct FTE	61		0		0		0		0		0		0	
AT Total														
Curr. Eff./Operating	4.9	5.2	5.5	3.8	8.8	7.3	7.5	7.3	7.5	7.3	7.4	7.2	7.5	7.3
Curr. Eff./Other Procure.	0.6	0.6	0.5	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
New Work	0.0	0.0	1.0	0.8	2.0	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Total Operating	5.5	5.8	7.0	5.1	11.7	9.9	10.1	9.9	10.1	9.9	10.0	9.8	10.1	9.9
Equipment	0.1		0.4		1.0		1.0		1.0		1.0		1.0	
Direct FTE	78		76		134		134		134		134		134	

\* 10% escalation factor

Table H. A/S Office Summary

## ENERGY RESEARCH (continued)

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
KA 01 01														
High Energy Physics Research														
Curr. Eff./Operating	5.8	5.8	7.0	6.2	7.6	6.5	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Curr. Eff./Other Procure.	0.9	0.9	0.9	0.9	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Total Operating	6.7	6.7	7.9	7.1	8.6	7.5	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Direct FTE	120		115		115		125		125		125		125	
KA 02 02														
HEP Experimental Facilities Operations														
Curr. Eff./Operating	0.7	0.7	0.8	0.6	1.1	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Direct FTE	8		7		9		11		11		11		11	
KA 03 01														
Accelerator R&D														
Curr. Eff./Operating	2.1	2.1	2.4	2.1	3.6	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Curr. Eff./Other Procure.	0.3	0.3	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total Operating	2.4	2.4	2.7	2.4	4.1	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Direct FTE	38		35		48		48		48		48		48	
KA 03 02														
HEP Experimental Facilities R&D														
Curr. Eff./Operating	1.6	1.6	1.7	1.6	2.2	1.9	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Curr. Eff./Other Procure.	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
Total Operating	1.8	1.8	1.9	1.8	2.5	2.2	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Direct FTE	21		19		23		25		25		25		25	
KA Total														
Curr. Eff./Operating	10.2	10.2	11.9	10.5	14.5	12.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
Curr. Eff./Other Procure.	1.4	1.4	1.4	1.4	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Total Operating	11.6	11.6	13.3	11.9	16.3	14.2	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Equipment	5.0		2.9		4.2		6.6		4.6		4.6		3.6	
Equipment FTE	104		62		63		93		86		83		83	
Total Direct FTE	291		238		258		302		295		292		292	

\*10% escalation factor

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LBL

Table H. A/S Office Summary

## ENERGY RESEARCH (continued)

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
<b>KB 01 01</b>														
Medium Energy Nuclear Physics														
Curr. Eff./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
New Work	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total Operating	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct FTE	2		2		2		2		2		2		2	
<b>KB 02 01</b>														
Heavy Ion Nuclear Physics Research														
Curr. Eff./Operating	4.5	4.4	5.2	4.7	6.7	5.6	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Curr. Eff./Other Procure.	0.7	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Total Operating	5.2	5.1	5.9	5.4	7.5	6.4	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Direct FTE	77		73		81		88		88		88		88	
<b>KB 02 02</b>														
Heavy Ion Nuclear Physics Operations														
Curr. Eff./Operating	9.8	9.8	10.9	10.5	13.8	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
Curr. Eff./Other Procure.	1.6	1.6	1.6	1.6	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total Operating	11.4	11.4	12.5	12.1	15.8	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7
Direct FTE	208		200		220		220		220		220		220	
<b>KB 03</b>														
Nuclear Theory														
Curr. Eff./Operating	0.6	0.6	0.7	0.7	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Direct FTE	11		11		12		12		12		12		12	
<b>KB Total</b>														
Curr. Eff./Operating	15.1	15.0	16.8	15.9	21.4	19.1	19.6	19.6	19.6	19.6	19.6	19.6	19.6	19.6
Curr. Eff./Other Procure.	2.3	2.3	2.3	2.3	2.8	2.8	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
New Work	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total Operating	17.4	17.3	19.3	18.4	24.4	22.1	22.7	22.7	22.7	22.7	22.7	22.7	22.7	22.7
Equipment	2.4		4.0		4.0		4.0		4.0		4.0		4.0	
Construction	3.3		2.9		3.9		4.5		4.9		5.5		6.1	
Plant and Equipment FTE	98		89		48		48		48		53		53	
Total Direct FTE	396		375		363		370		370		375		375	

\* 10% escalation factor



Table H. A/S Office Summary

## ENERGY RESEARCH (continued)

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
KC 01 01														
Low Energy Nuclear Sciences														
Curr. Eff./Operating	2.1	2.1	2.3	2.1	2.9	2.4	2.7	2.7	2.8	2.8	2.9	2.9	2.9	2.9
Curr. Eff./Other Procure.	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5
New Work	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total Operating	2.4	2.4	2.7	2.5	3.5	3.0	3.3	3.3	3.4	3.4	3.5	3.5	3.6	3.6
Direct FTE	32		32		34		37		38		39		40	
KC 02														
Materials Sciences														
Curr. Eff./Operating	4.7	4.7	5.4	5.1	5.7	5.7	7.0	6.5	6.9	6.8	7.1	7.0	7.0	7.0
Curr. Eff./Other Procure.	0.8	0.8	0.9	0.9	0.9	0.9	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
New Work	0.0	0.0	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total Operating	5.5	5.5	6.6	6.3	7.0	7.0	8.5	8.0	8.4	8.3	8.6	8.5	8.5	8.5
Direct FTE	68		70		72		85		88		90		90	
KC 03														
Chemical Sciences														
Curr. Eff./Operating	4.9	4.9	4.4	4.4	5.6	5.3	6.9	6.4	7.5	7.2	7.5	7.4	7.5	7.4
Curr. Eff./Other Procure.	0.8	0.8	0.7	0.7	0.8	0.8	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1
Total Operating	5.7	5.7	5.1	5.1	6.4	6.1	7.9	7.4	8.6	8.3	8.6	8.5	8.6	8.5
Direct FTE	61		50		56		70		78		80		80	
KC 04														
Engr. Math. Geosciences														
Curr. Eff./Operating	1.9	1.9	2.3	2.2	2.9	2.7	2.8	2.8	2.9	2.9	3.0	3.0	3.1	3.1
Curr. Eff./Other Procure.	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total Operating	2.2	2.2	2.6	2.5	3.3	3.1	3.2	3.2	3.3	3.3	3.4	3.4	3.5	3.5
Direct FTE	31		32		26		38		39		40		41	
KC 06														
Bio. Energy Conversion and Conservation														
Curr. Eff./Operating	0.7	0.7	1.1	0.8	1.3	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.5	1.5
Direct FTE	9		10		14		15		16		17		17	

\* 10% escalation factor

Table H. A/S Office Summary

## ENERGY RESEARCH (continued)

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
<b>KC Total</b>														
Curr. Eff./Operating	14.3	14.3	15.5	14.6	18.4	17.3	20.7	19.7	21.5	21.1	22.0	21.8	22.0	21.9
Curr. Eff./Other Procure.	2.2	2.2	2.2	2.2	2.5	2.5	2.9	2.9	3.0	3.0	3.0	3.0	3.1	3.1
New Work	0.0	0.0	0.4	0.4	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Total Operating	16.5	16.5	18.1	17.2	21.5	20.4	24.2	23.2	25.1	24.7	25.6	25.4	25.7	25.6
Equipment	1.2		1.3		1.6		2.5		2.7		2.7		2.7	
Construction	4.3		0.0		0.0		0.0		0.0		0.0		0.0	
Direct FTE	201		194		202		245		259		266		268	
<b>KD 03</b>														
Tech. Assess./Solar Powered Satellite														
Curr. Eff./Operating	0.2	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 FTE	2		2		0		0		0		0		0	
<b>LB 06</b>														
University Lab Co-Op Program														
Curr. Eff./Operating	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Direct FTE	7		10		10		10		10		10		10	
<b>Total A/S for Energy Research</b>														
Curr. Eff./Operating	44.8	45.0	50.0	45.1	63.2	56.2	61.3	60.1	62.1	61.5	62.5	62.1	62.6	62.3
Curr. Eff./Other Procure.	6.5	6.5	6.4	6.4	8.0	8.0	8.6	8.6	8.7	8.7	8.7	8.7	8.8	8.8
New Work		0.0	1.6	1.4	2.8	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Total Operating	51.3	51.5	58.0	52.9	74.0	66.7	72.4	71.2	73.3	72.7	73.7	73.3	73.9	73.6
Equipment	8.7		8.6		10.8		14.1		12.3		12.3		11.3	
Construction	7.6		2.9		3.9		4.5		4.9		5.5		6.1	
Direct FTE	975		895		967		1061		1068		1077		1079	
Total Funding	67.6	51.5	69.5	52.9	88.7	66.7	91.0	71.2	90.5	72.7	91.5	73.3	91.3	73.6

\*10% escalation factor

Table H. A/S Office Summary

## ENVIRONMENT

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
HA 01 03														
Environmental/Technology Impacts														
Curr. Eff./Operating	1.0	1.0	0.9	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Curr. Eff./Other Procure.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total Operating	1.1	1.1	1.0	0.9	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Direct FTE	15		12		13		13		13		13		13	
HA 01 07														
Environmental/Safety Engineering														
Curr. Eff./Operating	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Direct FTE	5		5		5		5		5		5		5	
HA 02 01														
Biomed./Human Health Studies														
Curr. Eff./Operating	1.1	1.1	1.2	1.2	1.4	1.3	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Curr. Eff./Subcontract	0.2	0.2	0.2	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Curr. Eff./Other Procure.	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
Total Operating	1.5	1.5	1.6	1.6	2.0	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Direct FTE	20		20		22		24		24		24		24	
HA 02 02														
Biomed./Health Effects Research														
Curr. Eff./Operating	1.7	1.7	1.8	1.8	2.3	2.1	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Curr. Eff./Other Procure.	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
New Work	0.0	0.0	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total Operating	1.9	1.9	2.4	2.3	2.9	2.7	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Direct FTE	29		32		36		38		38		38		38	

\* 10% escalation factor

Table H. A/S Office Summary

ENVIRONMENT (continued)

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
HA 02 03														
Biomed./Environmental Studies														
Curr. Eff./Operating	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Direct FTE		3		3		3		3		3		3		3
HA 02 04														
Biomed./Physical Tech. Studies														
Curr. Eff./Operating	1.6	1.6	1.7	1.7	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Curr. Eff./Other Procure.	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total Operating	1.8	1.8	2.0	2.0	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Direct FTE		30		30		31		31		31		31		31
HA 02 05														
Biomed./CO <sub>2</sub> and Climate Research														
New Work	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Direct FTE		0		0		2		2		2		2		2
HA Total														
Curr. Eff./Operating	6.0	6.0	6.2	6.1	7.5	7.1	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
Curr. Eff./Subcontract	0.2	0.2	0.2	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Curr. Eff./Other Procure.	0.7	0.7	0.9	0.9	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
New Work	0	0	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total Operating	6.9	6.9	7.6	7.4	9.2	8.8	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1
Equipment	1.2		1.2		1.6		1.6		1.6		1.6		1.6	
Direct FTE		102		102		112		116		116		116		116

\*10% escalation factor

Table H. A/S Office Summary

## ENVIRONMENT (continued)

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
<b>HB 01</b>														
<b>General Life Sciences</b>														
Curr. Eff./Operating	1.2	1.2	1.3	1.2	2.0	1.8	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.0
Curr. Eff./Other Procure.	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total Operating	1.3	1.3	1.5	1.4	2.3	2.1	2.2	2.2	2.3	2.3	2.3	2.3	2.3	2.3
Direct FTE	18		18		23		24		26		27		27	
<b>HB 02</b>														
<b>Biomedical Applications</b>														
Curr. Eff./Operating	4.1	4.1	4.2	4.1	5.2	4.9	5.1	5.1	5.3	5.2	5.4	5.4	5.4	5.4
Curr. Eff./Other Procure.	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Total Operating	4.8	4.8	4.9	4.8	6.0	5.7	5.9	5.9	6.1	6.0	6.2	6.2	6.2	6.2
Direct FTE	45		44		50		52		54		55		55	
<b>HB Total</b>														
Curr. Eff./Operating	5.3	5.3	5.5	5.3	7.2	6.7	7.0	7.0	7.3	7.2	7.4	7.4	7.4	7.4
Curr. Eff./Other Procure.	0.8	0.8	0.9	0.9	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Total Operating	6.1	6.1	6.4	6.2	8.3	7.8	8.1	8.1	8.4	8.3	8.5	8.5	8.5	8.5
Equipment	0.3		0.4		1.1		1.3		1.8		1.2		1.2	
Equipment FTE	3		3		3		3		3		3		3	
Direct FTE	66		65		76		79		83		85		85	
<b>Total A/S for Environment</b>														
Curr. Eff./Operating	11.3	11.3	11.7	11.4	14.7	13.8	14.7	14.7	15.0	14.9	15.1	15.1	15.1	15.1
Curr. Eff./Subcontract	0.2	0.2	0.2	0.2	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Curr. Eff./Other Procure.	1.5	1.5	1.8	1.8	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
New Work	0.0	0.0	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total Operating	13.0	13.0	14.0	13.6	17.5	16.6	17.2	17.2	17.5	17.4	17.6	17.6	17.6	17.6
Equipment	1.5		1.6		2.6		2.9		3.4		2.8		2.8	
Construction	0.0		1.5		2.0		1.3		3.7		0.0		0.0	
Direct FTE	168		167		188		195		199		201		201	
Total Funding	14.5	13.0	17.1	13.6	22.1	16.6	21.4	17.2	24.6	17.4	20.4	17.6	20.4	17.6

\*10% escalation factor

Table H. A/S Office Summary

## CONSERVATION AND SOLAR ENERGY

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AL 05														
Energy Storage Systems/Battery														
Curr. Eff./Operating	1.0	0.8	1.0	0.8	1.4	1.3	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Curr. Eff./Subcontract	2.2	1.9	2.2	1.9	3.8	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Total Operating	3.2	2.7	3.2	2.7	5.2	4.9	5.1	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Equipment	0.2		0.1		0.1		0.2		0.2		0.2		0.2	
Direct FTE		10		12		14		14		14		14		14
AN 05 05														
Solar/Biomass/Technology Devel.														
Curr. Eff./Operating	0.2	0.4	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 FTE		2		0		0		0		0		0		0
AN 05 15														
Biomass/Conversion Systems														
Curr. Eff./Operating	0.9	0.8	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Direct FTE		7		3		3		3		3		3		3
AN 05 20														
Biomass/R&D														
Curr. Eff./Operating	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Direct FTE		3		3		4		4		4		4		4

\* 10% escalation factor

Table H. A/S Office Summary  
 CONSERVATION AND SOLAR ENERGY (continued)

(\$ in millions)

	FY 1980		FY 1981		FY 1982 <sup>*</sup>		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AN 10														
Solar/Ocean														
Curr. Eff./Operating	0.7	0.7	0.9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Curr. Eff./Subcontract	0.6	0.6	0.9	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Curr. Eff./Other Procure.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total Operating	1.4	1.4	1.9	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Direct FTE	14		14		14		14		14		14		14	
AN 15 00														
Solar/Photovoltaics														
Curr. Eff./Operating	0.0	0.0	0.0	0.0	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Direct FTE	1		0		4		4		4		4		4	
AN 35														
Solar/Thermal Power														
Curr. Eff./Operating	0.1	0.1	0.0	0.0	0.3	0.2	0.2	0.2	0.1	0.1	0.0	0.1	0.0	0.0
Direct FTE	1		0		3		2		1		1		0	
AN Total														
Curr. Eff./Operating	2.2	2.3	1.6	1.3	2.1	1.9	1.9	1.9	1.8	1.8	1.7	1.8	1.7	1.7
Curr. Eff./Subcontract	0.6	0.6	0.9	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Curr. Eff./Other Procure.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total Operating	2.9	3.0	2.6	2.0	2.8	2.6	2.6	2.6	2.5	2.5	2.4	2.5	2.4	2.4
Equipment	0.0		0.1		0.1		0.1		0.1		0.1		0.1	
Direct FTE	28		20		28		27		26		26		25	

\* 10% escalation factor

Table H. A/S Office Summary  
 CONSERVATION AND SOLAR ENERGY (continued)  
 (\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
EA 01														
Solar Applications/Systems Dev.														
Curr. Eff./Operating	2.3	2.3	3.3	2.5	2.9	2.8	3.0	2.9	3.0	2.9	3.0	2.9	3.0	2.9
Curr. Eff./Other Procure.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total Operating	2.4	2.4	3.4	2.6	3.0	2.9	3.1	2.9	3.1	3.0	3.1	3.0	3.1	3.0
Direct FTE	30		30		32		32		32		32		32	
EA 02 01														
Solar Demonstration Buildings														
Curr. Eff./Operating	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct FTE	2		2		0		0		0		0		0	
EA 05														
Solar Commercialization														
Curr. Eff./Operating	0.1	0.1	0.2	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct FTE	1		1		1		1		1		1		1	
EA Total														
Curr. Eff./Operating	2.5	2.5	3.5	2.7	3.1	2.9	3.2	3.1	3.2	3.1	3.2	3.1	3.2	3.1
Curr. Eff./Other Procure.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total Operating	2.6	2.6	3.6	2.8	3.2	3.0	3.3	3.2	3.3	3.2	3.3	3.2	3.3	3.2
Direct FTE	33		33		33		33		33		33		33	

\* 10% escalation factor



Table H. A/S Office Summary  
 CONSERVATION AND SOLAR ENERGY (continued)  
 (\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
EC 01 01														
Residential, Commercial Buildings														
Curr. Eff./Operating	2.8	2.4	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3
Curr. Eff./Subcontract	1.0	0.7	0.9	0.9	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
New Work	0.3	0.2	1.1	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total Operating	4.1	3.3	6.3	6.0	6.3	6.2	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
Direct FTE	42		60		61		62		63		63		63	
EC 01 02														
Performance Standards														
Curr. Eff./Operating	0.8	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 FTE	11		0		0		0		0		0		0	
EC 02 01														
Consumer Products Efficiency														
Curr. Eff./Operating	0.1	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Direct FTE	2		2		2		2		2		2		2	

\* 10% escalation factor

Table H. A/S Office Summary  
 CONSERVATION AND SOLAR ENERGY (continued)  
 (\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
EC 05														
Technology and Consumer Products														
Curr. Eff./Operating	1.6	1.4	1.8	1.5	1.5	1.5	1.5	1.6	1.5	1.6	1.5	1.6	1.5	1.6
Curr. Eff./Subcontract	2.4	1.8	2.9	2.7	3.0	2.9	3.0	2.9	3.0	2.9	3.0	2.9	3.0	2.9
Curr. Eff./Other Procure.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total Operating	4.1	3.3	4.8	4.3	4.6	4.5	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Direct FTE		22		22		22		22		22		22		22
EC 06 02														
Consumer Motivation														
Curr. Eff./Operating	0.4	0.3	0.2	0.2	0.2	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Direct FTE		3		3		2		1		0		0		0
EC Total														
Curr. Eff./Operating	5.7	5.3	6.7	6.3	6.3	6.3	6.1	6.3	6.1	6.2	6.1	6.2	6.1	6.2
Curr. Eff./Subcontract	3.4	2.5	3.8	3.6	4.1	3.9	4.0	3.9	4.0	3.9	4.0	3.9	4.0	3.9
Curr. Eff./Other Procure.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
New Work	0.3	0.2	1.1	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total Operating	9.5	8.1	11.7	10.8	11.4	11.2	11.2	11.3	11.2	11.2	11.2	11.2	11.2	11.2
Equipment	0.5		0.8		0.8		0.8		0.8		0.8		0.8	
Direct FTE		80		87		87		87		87		87		87

\* 10% escalation factor

Table H. A/S Office Summary  
 CONSERVATION AND SOLAR ENERGY (continued)  
 (\$ in millions)

LBL

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
EE 01 03														
Vehicle Systems														
Curr. Eff./Operating	0.2	0.2	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Direct FTE		1		2		2		2		2		2		2
EE 01 04														
Transportation/Engineering Support														
Curr. Eff./Operating	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	0.1
Direct FTE		1		1		1		1		1		1		1
EE Total														
Curr. Eff./Operating	0.2	0.3	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total Operating	0.2	0.3	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Direct FTE		2		3		3		3		3		3		3
EG 02														
Multi-Programs/Appropriate Tech.														
Curr. Eff./Operating	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2
Total Operating	0.2	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2
Direct FTE		3		3		3		3		3		3		3
Total A/S for Conservation and Solar Energy														
Curr. Eff./Operating	11.8	11.4	13.6	11.7	13.5	13.0	13.3	13.3	13.1	13.1	13.0	13.1	13.0	13.0
Curr. Eff./Subcontract	6.2	5.0	6.9	6.1	8.5	8.1	8.2	8.1	8.2	8.1	8.2	8.1	8.2	8.1
Curr. Eff./Other Procure.	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
New Work	0.3	0.2	1.1	0.8	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total Operating	18.6	16.9	21.9	18.9	23.2	22.3	22.8	22.7	22.6	22.5	22.5	22.5	22.5	22.4
Equipment	0.9		1.2		1.2		1.3		1.3		1.3		1.3	
Direct FTE		156		158		168		167		166		166		165

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\* 10% escalation factor

Table H. A/S Office Summary

## FOSSIL ENERGY

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AA 15 10														
Materials and Components														
Curr. Eff./Operating	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
New Work	0.0	0.0	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.2
Total Operating	0.1	0.1	0.5	0.3	0.5	0.4	0.5	0.4	0.5	0.4	0.5	0.4	0.5	0.4
Direct FTE		4		9		9		9		9		9		9
AA 15 15														
Advanced Research/Processes														
Curr. Eff./Operating	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct FTE		4		4		4		4		4		4		4
AA 25 15														
Liquefaction Third Generation														
Curr. Eff./Operating	0.3	0.3	0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
New Work	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
Total Operating	0.3	0.3	0.6	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Direct FTE		4		6		7		7		7		7		7
AA 45 10														
Fuel Cell Applied Research														
Curr. Eff./Operating	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct FTE		1		1		3		3		3		3		3
AA 55 15														
Heat Recovery Component Technology														
Curr. Eff./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
Direct FTE		1		0		0		0		0		0		0

\* 10% escalation factor

Table H. A/S Office Summary

## FOSSIL ENERGY (continued)

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AA 75 15														
Underground Coal Mining														
Curr. Eff./Operating	0.3	0.3	0.7	0.5	0.6	0.6	0.7	0.7		0.0		0.0		0.0
New Work	0.0	0.0	0.7	0.6	0.8	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.0
Total Operating	0.3	0.3	1.4	1.1	1.4	1.3	1.5	1.5	0.9	0.9	1.0	1.0	1.0	1.0
Direct FTE		3		9		11		14		9		10		10
AA 95														
University Coal Research														
New Work	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct FTE		0		2		3		3		3		3		3
AA Total														
Curr. Eff./Operating	0.9	1.0	1.7	1.2	1.7	1.7	1.8	1.8	1.1	1.1	1.1	1.1	1.1	1.1
New Work	0.0	0.0	1.2	1.0	1.3	1.1	1.4	1.3	1.5	1.4	1.6	1.5	1.6	1.5
Total Operating	0.9	1.0	2.9	2.2	3.0	2.8	3.2	3.1	2.6	2.5	2.7	2.6	2.7	2.6
Equipment	0.1		0.2		0.2		0.1		0.1		0.1		0.1	
Direct FTE		17		31		37		40		35		36		36
AC 20 05														
Oil Shale/In-Situ Conversion														
Curr. Eff./Operating	0.4	0.4	0.8	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Equipment	0.1		0.1		0.1		0.1		0.1		0.1		0.1	
Direct FTE		5		7		8		8		8		8		8
Total A/S for Fossil Energy														
Curr. Eff./Operating	1.3	1.4	2.5	1.8	2.4	2.4	2.5	2.5	1.8	1.8	1.8	1.8	1.8	1.8
New Work	0.0	0.0	1.2	1.0	1.3	1.1	1.4	1.3	1.5	1.4	1.6	1.5	1.6	1.5
Total Operating	1.3	1.4	3.7	2.8	3.7	3.5	3.9	3.8	3.3	3.2	3.4	3.3	3.4	3.3
Equipment	0.2		0.3		0.3		0.2		0.2		0.2		0.2	
Direct FTE		22		38		45		48		43		44		44
Total Funding	1.5	1.4	4.0	2.8	4.0	3.5	4.1	3.8	3.5	3.2	3.6	3.3	3.6	3.3

\*10% escalation factor

Table H. A/S Office Summary

RESOURCE APPLICATIONS

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AM 05 15														
Geopress./Engrg. Applications														
Curr. Eff./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
New Work	0.0	0.0	0.5	0.4	0.8	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Total Operating	0.1	0.1	0.5	0.4	0.8	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Direct FTE		1		5		7		8		8		8		8
AM 05 20														
Geopress./Environment Control														
Curr. Eff./Operating	0.0	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 FTE		3		0		0		0		0		0		0
AM 10 05														
Geotherm./Component Dev.														
Curr. Eff./Operating	1.1	1.9	2.7	1.9	2.8	2.7	2.6	2.6	2.8	2.7	2.8	2.7	2.8	2.7
Curr. Eff./Subcontract	2.8	2.8	2.1	1.6	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Curr. Eff./Other Procure.	0.5	0.5	0.4	0.4	0.5	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5
New Work	0.0	0.0	1.0	0.8	0.9	0.8	0.8	0.8	0.4	0.5	0.0	0.0	0.0	0.0
Total Operating	4.4	5.2	6.2	4.7	5.9	5.6	5.6	5.6	5.3	5.3	4.9	4.8	4.9	4.8
Direct FTE		39		39		39		39		37		33		33

\* 10% escalation factor

Table H. A/S Office Summary  
 RESOURCE APPLICATIONS (continued)  
 (\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AM 15 15														
Hydrotherm./Non Electric Demo.														
Curr. Eff./Operating	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct FTE		1		1		3		3		3		3		3
AM 15 20														
Hydrotherm./ Environ. Control														
Curr. Eff./Operating	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Curr. Eff./Subcontract	0.5	0.9	1.1	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Total Operating	0.8	1.2	1.3	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Direct FTE		9		7		7		7		7		7		7
AM Total														
Curr. Eff./Operating	1.6	2.7	3.0	2.2	3.3	3.2	3.1	3.1	3.3	3.2	3.3	3.2	3.3	3.2
Curr. Eff./Subcontract	3.3	3.7	3.2	2.5	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Curr. Eff./Other Procure.	0.5	0.5	0.4	0.4	0.5	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5
New Work	0.0	0.0	1.5	1.2	1.7	1.5	1.7	1.7	1.3	1.4	0.9	0.9	0.9	0.9
Total Operating	5.4	6.9	8.1	6.3	8.1	7.7	7.9	7.9	7.6	7.6	7.2	7.1	7.2	7.1
Equipment	0.2		0.1		0.1		0.2		0.2		0.2		0.2	
Direct FTE		53		52		56		57		55		51		51

\* 10% escalation factor

Table H. A/S Office Summary  
 RESOURCE APPLICATIONS (continued)  
 (\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
<b>CM 10</b>														
Geo-Hydro/Planning Analysis														
Curr. Eff./Operating	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
Direct FTE		1		0		1		1		1		1		1
<b>CM 20</b>														
Geo-Hydro/Private Sector Dev.														
New Work	0.0	0.0	0.2	0.2	0.3	0.2	0.2	0.2	0.1	0.1	0.0	0.1	0.0	0.0
Direct FTE		0		3		3		3		2		1		0
<b>CM Total</b>														
Curr. Eff./Operating	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
New Work	0.0	0.0	0.2	0.2	0.3	0.2	0.2	0.2	0.1	0.0	0.0	0.1	0.0	0.0
Total Operating	0.1	0.1	0.2	0.2	0.4	0.3	0.3	0.3	0.2	0.1	0.1	0.2	0.1	0.1
Direct FTE		1		3		4		4		3		2		1
<b>Total A/S Resource Applications</b>														
Curr. Eff./Operating	1.7	2.8	3.0	2.2	3.4	3.3	3.2	3.2	3.4	3.3	3.4	3.3	3.4	3.3
Curr. Eff./Subcontract	3.3	3.7	3.2	2.5	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Curr. Eff./Other Procure.	0.5	0.5	0.4	0.4	0.5	0.5	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5
New Work	0.0	0.0	1.7	1.4	2.0	1.7	1.9	1.9	1.4	1.5	0.9	1.0	0.9	0.9
Total Operating	5.5	7.0	8.3	6.5	8.5	8.0	8.2	8.2	7.8	7.8	7.3	7.3	7.3	7.2
Equipment	0.2		0.1		0.1		0.2		0.2		0.2		0.2	
Direct FTE		54		55		60		61		58		53		52
Total Funding	5.7	7.0	8.4	6.5	8.6	8.0	8.4	8.2	8.0	7.8	7.5	7.3	7.5	7.2

\* 10% escalation factor



Table H. A/S Office Summary

DEFENSE PROGRAMS

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
GA 01 02														
Inertial Confine./Adv. Drivers														
New Work	1.5	1.6	2.9	2.1	8.1	6.5	13.4	11.6	10.9	11.1	4.9	6.5	6.5	6.5
Other Procurement	0.1	0.1	0.2	0.2	0.5	0.5	0.8	0.8	0.8	0.8	0.5	0.5	0.5	0.5
Total Operating	1.6	1.7	3.1	2.3	8.6	7.0	14.2	12.4	11.7	11.9	5.4	7.0	7.0	7.0
Equipment	0.1		0.3		0.2		0.3		0.3		0.3		0.3	
Direct FTE		27		31		80		100		99		79		79

\* 10% escalation factor

Table H. A/S Office Summary

## MISCELLANEOUS

(\$ in millions)

	FY 1980		FY 1981		FY 1982*		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
AG 05 05														
Advanced Isotope Separation Tech.														
Curr. Eff./Operating	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Equipment	0.0		0.1		0.1		0.1		0.1		0.1		0.1	
Direct FTE		3		4		5		5		5		5		5
LA 04														
Technical Information Services														
Curr. Eff./Operating	0.3	0.3	0.4	0.3	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Direct FTE		7		5		8		8		8		8		8
SA														
Emergency/Preparedness/Plan														
New Work	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct FTE		0		3		3		3		3		3		3
TA 01														
Energy Applied Analysis														
Curr. Eff./Operating	0.1	0.1	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct FTE		1		2		2		0		0		0		0
TB 01														
Collect/Product/Dissemination														
Curr. Eff./Operating	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Direct FTE		1		1		1		0		0		0		0
WB														
In-House Energy Management														
Curr. Eff./Subcontract	0.2	0.2	0.1	0.1		0.0		0.0		0.0		0.0		0.0
Construction	1.1		0.0		0.0		0.0		0.0		0.0		0.0	
Direct FTE		0		0		0		0		0		0		0
Total Miscellaneous Programs														
Curr. Eff./Operating	0.8	0.8	1.0	0.8	1.2	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Curr. Eff./Subcontract	0.2	0.2	0.1	0.1										
New Work	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total Operating	1.0	1.0	1.3	1.1	1.4	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Equipment	0.0		0.1		0.1		0.1		0.1		0.1		0.1	
Construction	1.1		0.0		0.0		0.0		0.0		0.0		0.0	
Direct FTE		12		15		19		16		16		16		16

\*10% escalation factor

Table J. Resources for New Initiatives

Table J. Resources for New Initiatives

(\$ in millions)

	FY 1981		FY 1982 <sup>*</sup>		FY 1983		FY 1984		FY 1985		FY 1986	
	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO	BA	BO
<b>VENUS R&amp;D</b>												
Operating			1.3	1.0	1.7	1.5	2.1	2.0	2.7	2.5	2.5	2.5
Direct FTE			10		15		20		22		22	
<b>High Field Superconducting</b>												
Magnet Technology												
Operating	2.2	1.6	2.8	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Direct FTE	16		23		23		23		23		23	
<b>Fossil Energy Research</b>												
Coal Research Laboratory												
Operating	1.3	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Direct FTE	2		2		2		2		2		2	
Materials												
Operating	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Direct FTE	2		2		2		2		2		2	
Coal Liquefaction Catalysis												
Operating	0.4	0.3	0.6	0.5	0.6	0.6	0.8	0.7	0.7	0.7	0.7	0.7
Direct FTE	3		5		6		7		7		7	
Improved Instrumentation												
Operating	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Direct FTE	3		4		4		4		4		4	
<b>Neutral Beam Engrg. Test Facility</b>												
Equipment	3.5	2.7	2.5	2.5	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.2
Direct FTE	23		20		2		2		2		0	

\*10% escalation factor

**Table K. Major Construction Projects**

Table K. Major Construction Projects: Summary

(\$ in millions)

(Budget Authority BA)	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TEC
<u>Funded Construction</u>								
Program Special Facilities								
High Intensity Uranium Beam (ER)	0.5	0.3						6.8
Program Justified GPF								
Chemical & Materials Sciences Lab	4.3	0.0						4.3
Biomedical Lab I	*							*
Multiprogram GPF								
Energy Monitoring and Control System	<u>1.1</u>	—						<u>1.1</u>
<b>Total for Funded Construction</b>	<b>5.9</b>	<b>0.3</b>						<b>12.2</b>
<u>Budgeted Construction</u>								
Program Justified GPF								
Biomedical Lab 74 Addition (EV)	—	<u>1.5</u>						<u>1.5</u>
<b>Total Funded and Budgeted Construction</b>	<b>5.9</b>	<b>1.8</b>						<b>13.7</b>

\* Bldg. TEC = \$5.5 M to be funded from non-DOE sources; leased to LBL by the The Regents of the University of California.

Table L. Proposed Construction: Descriptions

Table L. Major Construction Projects: Proposed Projects - Descriptions

Priority	Responsible Program	Project Description	Justification	Status	(\$ in millions) TEC	Schedule 44 Submitted
<u>Program Special Facilities</u>						
	ER	VENUS Accelerator Storage Ring	Post SuperHILAC-Bevalac facility to serve nation's heavy ion physics needs in 1980's and beyond.	0	--*	198X
	ER	Chemical and Materials Sciences Lab II	This second addition to Building 62 is to provide laboratory space for investigators in basic and energy-related research in chemical and materials sciences, including support functions for ARM.	0	11.9	1981
<u>Program Justified GPF</u>						
	EV	Building 3 Modification	Provides laboratory facilities badly needed due to growth of scientific programs at Laboratory of Chemical Biodynamics.	0	5.0	1981
	EV	Cell Culture Lab II	Second increment of specialized laboratory to carry out research in cell biology. Permits consolidation of lab and office support facilities located in remote buildings.	0	2.5	1981
	EV	Plant Tissue Culture Laboratory	Facility to house plant cell tissue culture research for production of hydrocarbons and sugars as energy sources.	0	2.5	1981

\*Cost estimate will be determined after completion of PE&D.



Table L. Major Construction Projects: Proposed Projects - Descriptions (continued)

Priority	Responsible Program	Project Description	Justification	Status	(\$ in millions) TEC	Schedule 44 Submitted
<u>Multiprogram GPF</u>						
1	GPF	Energy Research Lab I	Provides wet and dry chem labs, high bay experimental areas, other special facilities, and office space for energy technology researchers.	1	23.5	1975
2	GPF	Safety, Supply and Materials Handling Complex	Consolidates scattered support personnel in transportation, safety and supply activities into centralized LBL location.	0	13.7	1980
	GPF	Bldg. 6 Rehabilitation	Removes 184-Inch Cyclotron to make crane covered, high bay, heavy duty experimental area available to high priority research.	0	5.6	1981
	GPF	Support Services Bldg.	Provides centralized, consolidated office space for engineering and research support activities presently scattered throughout the Laboratory.	0	16.6	1982
	GPF	Energy Research Lab II	Continues consolidation of energy technology researchers into a dedicated centralized location.	0	34.5	1984

**Table M. Proposed Construction: Resource Requirements**

Table M. Major Construction Projects: Proposed Construction - Resource Requirements

(\$ in millions)

(Budget Authority BA)		FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	TEC
<u>Priority</u>	<u>Title</u>								
	<u>Program Special Facilities</u>								
	VENUS Accelerator Storage Ring Project					*			*
	Chemical and Materials Sciences Lab II				11.9				11.9
	<u>Program Justified GPF</u>								
	Building 3 Enlargement				3.0	2.0			5.0
	Cell Culture Lab II				1.3	1.2			2.5
	Plant Tissue Culture Lab					2.5			2.5
	<u>Multiprogram GPF</u>								
1	Energy Research Lab I			4.0	19.5				23.5
2	Safety, Supply and Materials Handling Complex			6.8	6.9				13.7
	Building 6 Rehabilitation				2.0	3.6			5.6
	Support Services Building					8.3	8.3		16.6
	Energy Research Lab II							6.0	34.5
	<b>Total Proposed Construction</b>			10.8	44.6	17.6	8.3	6.0	117.8

\* Cost estimate will be determined after completion of PE&D.

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Table N. General Plant Projects

Table N. General Plant Projects

(\$ in millions)

(Budget Authority BA)	FY 1980	FY 1981	FY 1982 <sup>*</sup>	FY 1983	FY 1984	FY 1985	FY 1986
Total General Plant Project Requirements	2.3	2.1	2.9	3.3	3.6	4.1	4.5

\* Escalation at 12% per year used, FY-82 through FY-86.

Table P. WPAS Cross References

Table P. WPAS Cross References

A/S B&R CODE	CONTRACTOR'S WPAS NUMBER	TITLE	PREPARATION DATE
<u>A/S Energy Research</u>			
AT 05 10	XXXX, XXXX, XXXX	Advanced Fusion Concepts	4/80 all
AT 05 20	4570, XXXX	Fusion Plasma Theory	
AT 05 30	4571	Experimental Plasma Research	
AT 10 10	4958	Tokamak Systems Experiments	
AT 15 10	4097	Magnetic Systems	
AT 20 10	4959	Tokamak Fusion Test Reactor	
KA 01 01	4100	Research	
KA 02 02	4207	Experimental Facilities Operations	
KA 03 01	4540	Accelerator Research and Development	
KA 03 02	4200	Experimental Facilities Research and Development	
KB 01 01	4250, XXXX	Research	
KB 02 01	4610, 4611, 4614, 4616, 4617, 4618, 4619, 4622, 4625, 4630, 4633, 4635, 4640, 4642, 4643, 4644, 4648, 4649, 46XX	Research	
KB 02 02	4501, 4646	Operations	
KB 03	4605	Nuclear Theory	
KC 01 01	4610, 4611, 4615, 4619, 4620, 4630, 4646, 4648, 4649	Low Energy Nuclear Sciences	
KC 02 01	4053, 4054, 4061, 4051, 4057, 4064, 4059, 4055, 4056, 4058, 4060, XXXX, 4063, 4067	Metallurgy - Ceramics	
KC 02 02	4068, 4069, 4070, 4077, XXXX, 4065, 4066	Solid State Physics	

Table P. WPAS Cross References (continued)

A/S B&R CODE	CONTRACTOR'S WPAS NUMBER	TITLE	PREPARATION DATE
KC 02 03	4075, 4076, 4073, 4077, 4078, 4079, 4080, 4081	Materials Chemistry	4/80 all
KC 03 01	XXXX, 4495, 4768, 4014, 4016, 448X, 4991, 4769, 4005, 4008, 4009, 4010, 4012, 4015, 4023, 4024, 4025, XXXX, 4028	Fundamental Interactions	
KC 03 02	4761, 4763, 4006, 4001, 4002, 4004, 4007, 4017, 4018, 4019, 4021, 4003, 4767, 4020, 4765, 4022	Processes and Techniques	
KC 04 01	4762	Engineering Sciences	
KC 04 02	4291, 4292	Applied Mathematical Sciences	
KC 04 03	4685, 4683, 4684, 4980	Geosciences	
KC 06	4481, 4496, 4436, 4768	Biology Energy Conversion and Conservation	
KD 03	4428	Solar Powered Satellite	
LB 06	4773	University Laboratory Cooperative Program	
<u>A/S Environment</u>			
HA 01	4296, 4297	Overview and Assessment	
HA 01 03	2961, 3241, 3296, 1535 3211, 3212	Technology Impacts	
HA 01 07	(Hq. #) 800405, 800406, 800407, 800353, 800354, XXXXXX	Environmental and Safety Engineering	
HA 02	4199	Biomedical and Environmental Research	
HA 02 01	4789, 4408, 4799, 4464, 4435, 4463, 4434, 4458, 4409, 4426	Human Health Studies	



Table P. WPAS Cross References (continued)

A/S B&R CODE	CONTRACTOR'S WPAS NUMBER	TITLE	PREPARATION DATE
HA 02 02	4616, 4432, 4413, 44CC, 44EE, 4483, 4424, 44II, 44JJ, 44KK, 44MM, 44QQ, 4438, 4406, 4418, 4484, 4497, 448X, 4415, 4407, 4439, 44DD, 44GG, 44HH	Health Effects Research in Biomedical Systems	4/80 all
HA 02 03	4785	Environmental Studies	
HA 02 04	4782, 478C, 478B, 4422, 4963, 4962, 4786, 4964, 4798, 4961, 4786, 4965, XXXX, 44RR, XXXX, 478E, 4403, 4797, 478D	Physical and Technological Studies	
HA 02 05	478F	Carbon Dioxide and Climate Research	
HB 01	4492, 4494, 4419, 4423, 4791, 4498, 4493, 44FF, 44AA, 44BB	General Life Sciences	
HB 02 01	4456, 4453, 4452, 4454, 4455, 4457, 4410, 4405, 4404, 4462, 4450, 44NN	Medical Applications of Nuclear Technology	
<u>A/S Conservation and Solar Energy</u>			
AL	4740	Battery Storage	
AL 05 10	4032, 4034, 4035, 4037, 4038	Electrochemical Systems Support	
AN 05 15	4480, 4770	Conversion Systems	
AN 10	4686	Ocean	
AN 15 00	4751	Photovoltaics	
AN 35	(Hq. #) 366061	Solar Thermal Power	
EA 01	4752, 4753, 4755, 4757, 4758	Systems Development	
EA 02 01	4950	Buildings	

Table P. WPAS Cross References (continued)

A/S B&R CODE	CONTRACTOR'S WPAS NUMBER	TITLE	PREPARATION DATE
EA 05	4771	Commercialization	
EC 01 01 & 01 02	4721, 4725, 4728	Residential and Commercial Buildings	4/80 all
EC 02 01	4722	Consumer Products Efficiency	
EC 06 02	4720, 4724	Consumer Motivation and Systems Commercialization	
EE 01 03	4719	Vehicle Systems	
EE 01 04	4723	Engineering Support	
EG 02		Appropriate Technology	
<u>A/S Fossil Energy</u>			
AA 15 10	4047	Materials and Components	
AA 15 15	4761	Processes	
AA 25 15	4734, 4045, 4048, 4049	Third Generation Processes	
AA 45 10	4044	Fuel Cell Applied Research	
AA 55 15	4756	Heat Recovery Component Technology	
AA 75 15	4731	Underground Coal Mining	
AA 95	4772	University Coal Research	
AC 15 10	4680	Light Oil	
AC 20 05	4730	In-Situ Conversion	
<u>A/S Resource Applications</u>			
AM 05 10	4706	Resource Definition	
AM 05 15	XXXX, XXXX	Engineering Applications	
AM 05 20	4671	Environmental Control	
AM 10 05	4660, 4664, 4665, 4666, 4668, 4673, 4675, XXXX	Component Development	

Table P. WPAS Cross References (continued)

A/S B&R CODE	CONTRACTOR'S WPAS NUMBER	TITLE	PREPARATION DATE
AM 15 15	4674	Non-Electric Demonstrations	4/80 all
AM 15 20	4670, 4672	Environmental Control	
CM 10	4703	Planning and Analysis	
CM 20	(Hq. #) 8553	Private Sector Development	
<u>A/S Defense Programs</u>			
GA 01 02	4560	Advanced Drivers	
<u>A/S Nuclear Energy</u>			
	4041, 4042	Applications and Assessments of Advanced Technologies	
<u>A/S Energy Information Administration</u>			
LA 04	4981	Technical Information Support Services	
TA 01	4702, 4710, 4711	Energy Applied Analysis	
TB 01	4295, 4982, XXXX	Collection, Production and Dissemination Program	