DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT

OVERVIEW

FUSION ENERGY

Fusion offers the promise of a safe, environmentally benign and affordable source of energy. Widespread uncertainty about the safety, environmental compatibility, total cost, availability, adaptability and/or public acceptance of all current major sources of energy dictates continuation of a world-wide effort to develop fusion. A fusion power plant would contain only a small inventory of fuel or high-level radioactive waste, thus eliminating the possibility of a severe, uncontrolled reaction. Operation of a fusion reactor would produce no combustion products. The deuterium fuel required for fusion is plentiful and could be readily obtained from sea water. Manufacture of tritium, which is also required in a fusion reactor, would be accomplished in the reactor itself, thus reducing both the risk and cost involved in transporting the radioactive fuel to the site. A vigorous development program is required to demonstrate the technical feasibility of fusion energy.

The Fusion Policy Advisory Committee (FPAC) conducted an in-depth review of the fusion program in 1990. The Committee concluded that there are compelling reasons for the U.S. to initiate a goal-oriented fusion energy program, including both magnetic and inertial approaches, and that the program is technically ready to proceed with its next major steps. FPAC recommended participation in the International Thermonuclear Experimental Reactor (ITER) Engineering Design Activities (EDA) and construction of a Burning Plasma Experiment (BPX) based on the previously proposed Compact Ignition Tokamak, beginning in FY 1992. In addition, they recommended proceeding expeditiously with deuterium-tritium experiments in the Tokamak Fusion Test Reactor (TFTR), modest increases in the base program, and increased emphasis on low activation materials and nuclear technology.

These conclusions have led to establishment of a policy to proceed with a goal-oriented program for the development of fusion energy as an important part of a comprehensive, balanced National Energy Strategy. Although the scientific investigation of the fusion process will continue to be an integral part of the program, it is now appropriate to establish specific energy-related objectives leading to a practical source of fusion power. The primary long-term goals of this policy are to have an operating demonstration power plant by about 2025 and an operating commercial power plant by about 2040.

The strategy for obtaining the long-term goals for a demonstration plant and a commercial power plant is to support two separate and distinct approaches to fusion energy development: magnetic fusion energy and inertial fusion energy. The pursuit of both options will reduce the technological risk associated with the difficult task of developing fusion energy. The strategy in each case is to gain scientific understanding of the complex processes involved in ignited and burning plasmas and to use this understanding to develop fusion technology in an engineering test facility. The final step toward commercialization would be the construction of a demonstration power plant. The overall program must ultimately include the study and development of the most effective confinement systems, materials, and technology to ensure the eventual economic success of fusion. An important element in carrying out this entire strategy is to take full advantage of international collaboration while maintaining a sound domestic program. In addition, inertial fusion energy will require continued scientific development in the Defense Programs Inertial Confinement Fusion activity. Carrying out the fusion energy program will involve national laboratories, universities, and industrial research centers as well as an increasing involvement of the private sector as an integral part of the program.

Implementation of this new policy began with Congressional approval of the Department's reprogramming in FY 1991. However, fiscal constraints, in FY 1991 and beyond, have made it impossible to implement all of FPAC's recommendations. These fiscal constraints have required the program to prematurely narrow its focus to the tokamak concept, including tokamak improvement activities, and to eliminate major alternate magnetic confinement program elements. At least five experimental programs have been closed in FY 1991 and 1992. The Confinement Physics Research Facility reversed field pinch under construction at Los Alamos National Laboratory (LANL) has been canceled. The Advanced Toroidal Facility stellarator at Oak Ridge National Laboratory (ORNL) is being mothballed. The recently dedicated Large S Experiment at Spectra Technology and the Field Reversed Experiment - C compact torus at LANL have been shut down. Restart of the Princeton Beta Experiment advanced tokamak at Princeton Plasma Physics Laboratory (PPPL) did not take place in FY 1991 as originally planned, but was instead delayed to FY 1992. In addition, with continued constraints in FY 1992, it will be necessary to prematurely shut down the Microwave Tokamak Experiment at LLNL in late FY 1992.

Considering the worsening budget deficit and the continuing budget caps, difficult decisions are required. A special panel of the Secretary of Energy Advisory Board (SEAB) was constituted in September, 1991 to consider the Department's Energy Research projects and recommend scientific priorities across a number of fields. The SEAB panel advised against proceeding with the Burning Plasma Experiment (BPX) because of funding limitations. The newly constituted standing advisory committee, the Fusion Energy Advisory Committee (FEAC), then reviewed fusion plans in the context of no more than modest real growth of fusion funding. The FEAC also concluded that it was not appropriate to proceed with BPX under the budget constraints. Considering fiscal constraints and the views of its advisory committees, the Department has decided not to proceed with BPX. This decision places greatly increased emphasis on the role of ITER in exploring the behavior of tokamak plasma dominated by the self heating of alpha particles from the fusion reaction.

Key elements of the program in FY 1993 are initiation of D-T experiments in TFTR, ITER design and related research and development, supporting experiments to improve the tokamak reactor concept, and fusion technology development. The TFTR will operate for the first time using D-T as a fuel. These experiments are expected to produce significant amounts of fusion power allowing us to study plasma properties at about 50-70% of breakeven conditions. ITER's objective is to demonstrate the scientific and technological feasibility of fusion. The first phase of ITER, by about 2010, will demonstrate extended fusion burn. This will test alpha heating physics, major superconducting magnet systems, fueling and ash removal concepts, and handling of unprecedented heat and neutron fluxes. It is imperative that ITER succeed at extended burn so that testing of fusion technology, including tritium breeding and energy conversion in blanket modules, can proceed within the overall ITER program. A commercial tokamak reactor would benefit greatly from an increase in the plasma power density, a reduction in the magnetic field intensity and associated mechanical stresses, and increases in the tokamak self-generated, or bootstrap, current. New regimes of tokamak operation that can have the desired features are being explored to the extent possible in present experiments.

In order to address the scientific issues associated with such tokamak concept improvements, the U.S. fusion program is developing plans for an experimental facility, less costly than BPX, which will complement other world-wide facilities. The planning for this facility will be conducted on an urgent basis during FY 1992 in order to maintain the energy mission defined for fusion in the National Energy Strategy.

Status of Magnetic Fusion:

As a result of concerted efforts throughout the industrialized world, a broad consensus now exists on how ignition and burn of a magnetically confined fusion plasma can be achieved, and significant progress has been made toward this goal. To date, the most effective way to magnetically confine plasma is in a toroidal, or doughnut-shaped, device. The leading toroidal confinement concept is the tokamak. Tokamak performance, in terms of fusion power production, has improved more than a factor of a million over the past 15 years. Recent results indicate that the Tokamak Fusion Test Reactor (TFTR) in the U.S. and the Joint European Torus (JET) in the European Community are very close to breakeven plasma conditions, wherein the energy produced using the appropriate fuel would equal the energy applied to heat the fuel. In addition, JET recently produced nearly 2 MW of fusion power by using a 13% tritium mixture in a deuterium plasma. This corresponds to about 10% of breakeven.

The successful achievement of the goals in magnetic fusion requires a program aimed at the resolution of key physics and technology issues. The key physics issues and objectives include:

CONFINEMENT: To increase understanding of the phenomena which dominate energy transport in the plasma.

POWER HANDLING AND PARTICLE EXHAUST: To determine ways for reducing the power load on the most exposed components and to develop improved means of controlling impurities and exhausting particles.

NON-INDUCTIVE CURRENT DRIVE: To develop methods for driving tokamak plasma current efficiently.

ALPHA PARTICLE HEATING: To understand how burning plasmas behave under conditions of dominant self-heating by the alpha particles produced in fusion reactions.

OPERATIONAL LIMITS: To better understand the operational limits on plasma pressure, current, and density.

The key technology issues that would enhance magnetic fusion's economic and environmental characteristics include:

BLANKETS: To develop blankets suitable for tritium fuel production, energy extraction and radiation protection.

HEATING AND FUELING SYSTEMS: To develop the plasma heating and fueling technology for a fusion reactor.

LARGE, HIGH-FIELD SUPERCONDUCTING MAGNETS: To develop magnets of the size, field, current, and reliability required for reactor-sized devices.

MATERIALS: To develop structural, plasma-facing, and blanket materials, including low-activation materials.

REMOTE HANDLING AND MAINTENANCE METHODS: To develop adequate remote handling and maintenance methods.

SAFETY AND ENVIRONMENT: To minimize the environmental and safety consequences of any accidents and to establish acceptable waste disposal procedures.

Status of Inertial Fusion:

Inertial fusion for energy applications is based on compression of a small fuel capsule to high density using intense, uniform, radiation pressure. According to validated physics models, the compression will heat the central core of the capsule after which rapid nuclear fusion reactions ignite the deuterium-tritium fuel. The heat from reaction-produced alpha particles will propagate through the surrounding high density fuel resulting in burn of most of the fuel and release of energetic neutrons. Net system energy gain should be possible when the ratio of fusion energy released to input driver energy is greater than 100.

The Inertial Fusion Energy program assumes that ignition and high-gain burn of a deuterium-tritium pellet can be demonstrated in the laboratory within DOE's Defense Program activities. Experiments, within Defense Programs, currently provide confidence that an upgrade of the NOVA facility will be capable of demonstrating ignition in the laboratory. For energy applications, there are additional critical problem areas that must be successfully addressed by the IFE program:

1. The development of efficient, high-power drivers that can be operated at useful repetition rates of several times per second.

2. The design of pellets that can be cheaply produced, efficiently driven, and stably imploded, and that yield high gain.

3. Design of reactor chambers that contain the micro-explosion products and adequately protect the driver.

The FPAC and National Academy of Science (NAS) reports have indicated that a heavy ion beam is the driver of choice to meet energy requirements. Light ions and improved gas lasers (such as the krypton fluoride laser) were viewed by FPAC as appropriate, and potentially viable, back-up candidates for energy applications. However, budget constraints preclude specific, energy-program development of these back-up options.

The Heavy Ion Fusion Accelerator Research (HIFAR) program, formerly funded in the Basic Energy Sciences program, has provided the basis for a heavy ion driver. Multiple beams of heavy ions have been accelerated and amplified in a low-energy induction linac system demonstrating basic feasibility of a driver concept with potentially acceptable cost and beam quality. By employing low-mass ions, the next step called the Induction Linac Systems Experiments (ILSE) can achieve high speed ions and test concepts of beams merging, drift compression, and focussing within the stringent beam quality (spot size) requirements. The new Inertial Fusion Energy program will complete development of the ILSE conceptual design in FY 1993.

In FY 1990, two reactor concept studies were undertaken within the Office of Fusion Energy that will be completed in FY 1992. These studies, building on previous reactor studies carried out in Defense Programs, will provide a basis for addressing the reactor chamber and target capsule technology issues. Continued reactor studies and validating research and development may be undertaken within the new Inertial Fusion Energy Program after considering fiscal constraints and the timing for required results.

FY 1993 Budget Summary:

The FY 1993 Fusion Energy budget supports a focused effort to implement a goal-oriented program with magnetic and inertial fusion components. Both magnetic and inertial approaches will seek to develop capability for a demonstration power plant by about 2025 with a subsequent commercial power plant by about 2040.

The magnetic fusion effort is focused on the tokamak confinement concept and on an integrated international approach to demonstrate the scientific and technological feasibility of fusion power. The ITER will provide a focus for the world-wide effort on the tokamak concept, and funding is requested for the U.S. to participate as an equal partner in the Engineering Design Activities of ITER. This consists of the engineering design and technology development tasks required to validate the ITER design effort. To contribute to the success of ITER, the U.S. will begin to address alpha particle physics with deuterium-tritium experiments in TFTR in FY 1993. To address the physics of tokamak improvements, the U.S. will conduct the conceptual design and supporting R&D for an experimental device, the Tokamak Physics Experiment, of more modest cost than BPX. Theory and other tokamak experiments will be focused to support these major experiments. The Princeton Beta Experiment, the D III-D, and Alcator C-Mod will be operated to address key scientific issues of magnetic fusion energy, provide physics support to ITER and provide information to improve the tokamak concept. Technology development will be focused to validate ITER design and to support TFTR and other present and future fusion experiments. International cooperation will be a part of all aspects of the program. Because of budget constraints, the U.S. will rely on international cooperation for alternate concept development as well as to advance critical tokamak physics and technology.

An Inertial Fusion Energy (IFE) program, constrained to one driver concept and to budget-paced technology development, has been initiated. This program will rely on continuing development of target physics within Defense Programs. The heavy ion driver, successfully conceived through Defense Programs and Basic Energy Sciences activities, will be extended and tested. Where possible, within budgetary and classification constraints, international cooperation will be pursued to speed the overall progress in IFE.

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

LEAD TABLE

FUSION ENERGY

Activity	FY 1991 Enacted		FY 1992 Enacted		FY 1993 Base	FY 1993 Request	Program Change Request vs Base: Dollar	Program Change Request vs Base: Percent
Operating Expenses								
Confinement Systems....................	$150,913		$183,250		$183,250	$182,780	(470)	+ 0%
Applied Plasma Physics.................	62,887		61,750		61,750	62,450	700	+ 1%
Development & Technology............	46,554		56,650		56,650	67,550	10,900	+ 19%
Planning & Projects........................	1,012		4,250		4,250	4,800	550	+ 13%
Inertial Fusion Energy.....................	1,600		8,150		8,150	8,150	0	+ 0%
Program Direction..........................	5,617		7,500		8,800	8,800	0	+ 0%
Subtotal Operating Expenses..........	268,583		321,550		322,850	334,530	11,680	+ 4%
Capital Equipment............................	10,415		11,000		11,000	20,980	9,980	+ 91%
Construction....................................	7,581		4,550		4,550	4,200	(350)	- 8%
Total...	$286,579	a/b/	$337,100	c/	$338,400	$359,710	$21,310	+ 6%

a/ Total has been reduced by $3,130,000 which has been transferred to the SBIR program.
b/ Includes $2,523,000 for education programs funded in the Atomic Energy Defense Activities account.
c/ Reflects transfer of HIFAR from the Basic Energy Sciences program to the Fusion Energy program in FY 1992.

	FY 1991 Estimate	FY 1992 Appropriation	FY 1993 Base	FY 1993 Request	Program Change Request vs Base	
					Dollar	Percent
Operating Expenses..........................	($268,583)	($321,550)	($322,850)	($334,530)	($11,680)	+ 4%
Capital Equipment............................	(10,415)	(11,000)	(11,000)	(20,980)	(9,980)	+ 91%
Construction....................................	(7,581)	(4,550)	(4,550)	(4,200)	350	- 8%
Staffing (FTEs)						
Headquarters................................	65	61	61	61	-	-
Field Office..................................	0	22	22	22	-	-
Total..	65	83	83	83	-	-

Authorization: Section 209, P.L. 95-91 "Department of Energy Organization Act" Section 209

SUMMARY OF CHANGES

Fusion Energy

FY 1992 Enacted Appropriation.. $ 337,100

Comparability Adjustments
FY 1993 Base Adjustment
Program Direction - Increased Personnel Costs........................ $ 1,300

FY 1993 Base.. $ 338,400

FY 1993 Major Program Changes

Confinement Systems.. + 1,010
Supports continued operation of DIII-D, Alcator C-Mod and Princeton Beta Experiment-M, maintaining the schedule for D-T experiments in TFTR and conceptual design, and supporting R&D for a new experimental device for tokamak improvements. The Microwave Tokamak Experiment is shutdown in FY 1992 and does not operate in FY 1993.

Applied Plasma Physics.. + 700
Theory, diagnostic development, small university experiments and operation of the National Energy Research Supercomputer Center are funded essentially at the FY 1992 level.

Development and Technology.. + 19,400
This increase provides for the support of U.S. share of the ITER Engineering Design Activity including the engineering design and technology development tasks required to validate the ITER design effort.

Planning and Projects.. + 200
Maintains essentially the FY 1992 level for General Plant Projects and SBIR obligations and completion of the Fire and Safety Improvement project at the Princeton Plasma Physics Laboratory.

Inertial Fusion Energy..	+ 0
Funding maintained at the FY 1992 level provides for pursuit of one driver concept.	
FY 1993 OMB Budget Request..	$ 359,710

KEY ACTIVITY SUMMARY

FUSION ENERGY

I. Preface: Magnetic Fusion Energy - Confinement Systems

The Confinement Systems subprogram supports the recommendations of the Department's National Energy Strategy by carrying out research on resolving the key scientific issues of magnetic fusion, preparing for deuterium-tritium (D-T) fusion experiments in the Tokamak Fusion Test Reactor (TFTR), planning for major facilities to improve the tokamak concept, and conducting physics R&D for the International Thermonuclear Experimental Reactor (ITER). These issues are investigated through experimental research on producing, controlling, and heating plasmas to the conditions required for fusion energy production. Current research efforts are devoted to developing a sufficient understanding of plasmas confined in toroidal configurations to permit the design of efficient fusion energy sources. The basic approach is to use theory, previous experimental results and modeling of these results to define further experiments on existing devices and to guide the design of new devices to complete the scientific data base. The primary scientific issues being addressed by this research are energy confinement, plasma heating, equilibrium and stability, power handling and particle control, current drive, and alpha particle physics.

Energy confinement is perhaps the most important physics issue affecting the performance of future fusion research devices, such as ITER. In a fusion reactor, the plasma must be heated to a temperature of about 100,000,000 degrees Celsius to initiate the fusion reactions, and then the thermal energy of the plasma must be sufficiently well confined that the heat from the fusion-produced alpha particles sustains the plasma temperature. Research on the topics of energy confinement and plasma heating involves developing and using auxiliary heating methods, such as neutral beam heating and/or radio-frequency (RF) wave heating, to heat a plasma to high temperatures; then sophisticated diagnostics and operational techniques are used to characterize, understand, and determine how to reduce energy transport in a high-temperature plasma. A focused effort on energy confinement research in support of future experiments, such as ITER, is carried out in close cooperation with experimental and theory groups supported by the Applied Plasma Physics subprogram.

In a practical fusion power reactor, the temperature and density of the plasma (i.e. the plasma pressure) must be high enough to produce sufficient fusion power density to make an economical reactor. The confining magnetic field must apply a pressure about 10 times larger than the plasma pressure for stable containment of the plasma. Since practical magnets have technological limits on the pressure they can exert, research on equilibrium and stability concentrates on alternate plasma shapes and operating modes that theory predicts can increase the ratio of plasma pressure to the confining magnetic field pressure (the ratio is referred to as beta). Research to date has shown that D-shaped plasmas can achieve sufficient beta for ITER. This work also includes attempts at obtaining a predicted second regime of stability, which allows even higher beta values than can be obtained in the present operating mode.

Research in power handling and particle control methods for impurity control and fueling is essential for the operation of next generation devices, such as ITER. In a fusion device, impurities must be continuously controlled, because they can dilute the deuterium-tritium fuel, cool the plasma, and/or cause the plasma to contract and become unstable. A major source of these impurities is influx of the particles dislodged from surfaces in contact with the plasma. Studies are being conducted to ensure that the plasma is kept as clean as possible by treating surfaces or selecting materials to reduce the generation of impurities and by isolating the impurities that are generated. Another particle control issue concerns methods of fueling to replace the fuel ions in the plasma that are consumed by the fusion reactions or are transported out of the plasma. Current experiments are studying fueling the plasma by injection of high-velocity frozen hydrogen or deuterium pellets.

The current drive physics issue addresses the future operation of fusion devices in a continuous, or steady-state, mode as opposed to the present short pulses. The primary advantage of steady-state operation in a reactor is that it will reduce the problems of thermal and mechanical fatigue of components. Planned experiments include attempts to drive continuous currents in tokamaks with radio-frequency waves and with current-carrying elements inserted at the plasma edge. These experiments are designed to support ITER, which will require current drive in its technology-testing phase.

Alpha particle physics, the major burning plasma physics issue, concerns the effect of these fusion-produced energetic helium nuclei on the confined plasma. The impact of alpha particle heating on energy confinement and plasma stability are subjects of critical importance to assessing the energy potential of magnetic fusion. Work on this issue will begin to be addressed in TFTR during its period of deuterium-tritium operation and studied in detail in ITER.

Research is being conducted on several toroidal magnetic confinement devices to investigate the scientific issues discussed above and to prepare for performing burning plasma physics experiments on ITER. Because of fiscal constraints on the overall fusion program, work on design and R&D for a Burning Plasma Experiment (BPX) which was directed at the alpha partical physics issue is being proposed for termination in the FY 1992 reprogramming. The confinement of high-temperature plasmas will be emphasized in the TFTR at the Princeton Plasma Physics Laboratory (PPPL). Experiments on confinement, beta limits, power and particle control, and current drive will be carried out on the DIII-D tokamak at General Atomics (GA). The Alcator C-MOD facility at the Massachusetts Institute of Technology (MIT), will study radio-frequency heating, energy confinement, and fueling in a high-field, high-density plasma. At the Lawrence Livermore National Laboratory (LLNL), the Microwave Tokamak Experiment (MTX) aimed at tokamak heating with a free electron laser will be completed in May 1992. This represents the completion of a collaborative program with the Japanese and no subsequent operations are planned.

A national effort built around the BPX design team is beginning to develop the design for a device, at lower cost than BPX, optimized to address the scientific issues associated with improving the post-ITER tokamak reactor concept.

Work on identifying an optimum toroidal confinement system will also be supported at a more modest level. The Princeton Beta Experiment (PBX) at PPPL, which is designed to study confinement and the second regime of stability with improved capabilities to control the current and pressure profiles, will resume operating in FY 1992 and continue into FY 1993. The Advanced Toroidal Facility (ATF) at the Oak Ridge National Laboratory (ORNL), an alternate concept with inherent advantages for steady-state operation, will be placed on standby in FY 1992-1993 because of budget limitations.

In response to a reduced number of major operating experiments, on-site and off-site national collaboration on the remaining facilities is being encouraged to take advantage of the experience, skills, and resources of fusion teams at widely spread national laboratories and universities. At the same time, international collaboration will be used to carry out research on a number of related plasma physics issues on foreign facilities including: TEXTOR and ASDEX-Upgrade in Germany, TORE SUPRA in France, the Joint European Torus (JET) in England, and JFT-2M and JT-60-Upgrade in Japan.

This budget includes $1,600,000 in FY 1992 and FY 1993 in support of education activities. The following table summarizes the operating expense funding for the Confinement Systems subprogram:

II. A. Summary Table: Magnetic Fusion Energy - Confinement Systems

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Tokamak Fusion Test Reactor	$ 58,626	$ 78,025	$ 78,770	+ 1
Base Toroidal	60,639	66,418	68,010	+ 2
Advanced Toroidal	12,502	11,807	16,000	+ 36
Major Device Fabrication	1,190	0	0	0
Burning Plasma Experiment (BPX)	17,956	27,000	0	-100
Tokamak Physics Experiment	0	0	20,000	>999
Total, Magnetic Fusion Energy - Confinement Systems	$ 150,913	$ 183,250	$ 182,780	0

II. B. Major Laboratory and Facility Funding

General Atomics	$ 30,242	$ 31,980	$ 32,780	+ 3
Lawrence Livermore National Laboratory	$ 11,500	$ 6,700	$ 4,500	- 33
Massachusetts Institute of Technology	$ 13,731	$ 14,600	$ 15,000	+ 3
Oak Ridge National Laboratory	$ 10,257	$ 9,575	$ 9,325	- 3
Princeton Plasma Physics Laboratory	$ 82,703	$ 113,694	$ 96,728	- 15

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1991	FY 1992	FY 1993
Magnetic Fusion Energy - Confinement Systems			
Tokamak Fusion Test Reactor	Additional improvements to the transport diagnostics were installed to develop an improved understanding of transport in tokamaks in order to increase the confidence in extrapolating from present tokamaks to ITER. Installation of the second phase of the radio frequency limiters was completed to allow full power operation with both ICRF and neutral beams. Most of the work on the upgrade of the ICRF system was completed and the system will be available in early FY 1992. Only limited experiments were carried out due to budget restrictions.	With the completion of the ICRF heating system upgrade and the limiter upgrades, the research program will focus on determining optimum scenarios for deuterium-tritium operation using combined neutral beam and ICRF heating. Preparation for D-T operation will intensify. The preparations include: commissioning the tritium handling and safety systems, testing the tritium systems with small amounts of tritium, installing new diagnostics to monitor the fusion-produced alpha particles, setting up local shielding, and preparing the neutral beams and vacuum systems for tritium operation. Scientists from ORNL will begin collaboration on TFTR heating and fueling experiments.	Refer to narrative description below.
		However, upon approval of the proposed FY 1992 reprogramming request, the Tokamak Fusion Test Reactor program would include the following modification to the above for TFTR: An additional $3.4 million provides for increased ITER support by carrying out, on a timely basis, TFTR experiments burning deuterium-tritium fuel, providing for increased overhead burden resulting from the phase out of BPX project activities and increased costs resulting from required safety and environmental improvements.	TFTR will be shut down for most of the fiscal year to complete the modifications required for D-T operation. Major modifications include: installation of shielding for diagnostics, final commissioning of the tritium systems, installation of tritium monitors and safety equipment, modification of the neutral beam systems to operate with tritium, and final adjustment of new diagnostics to monitor the alpha particles produced by the D-T fusion reactions. First operations with the modified systems will occur in July 1993. D-T experiments will take place following a thorough review of procedures and safety systems.
	$ 58,626	$ 78,025	$ 78,770

Program Activity	FY 1991	FY 1992	FY 1993
Base Toroidal	Energy confinement and high beta programs were continued in DIII-D, and divertor physics and biasing experiments in support of BPX and ITER began. Installation of a 2MW 110GHz electron cyclotron frequency heating (ECH) system continued. Initial results from fast wave current drive experiments were evaluated.	The energy confinement and high beta program with control of plasma current and pressure profile will be continued on DIII-D at higher ECH and ICRF power. Divertor pumping experiments will begin. Preliminary results will be obtained on non-inductive current drive at moderate beta. Profile control experiments will be performed in support of the ITER program. Scientists from ORNL will expand their collaboration on the DIII-D program.	Refer to narrative description below.
		However, upon approval of the proposed FY 1992 reprogramming request, the following modifications would be made to the above for DIII-D: The utilization of the DIII-D would be increased by adding about six to eight weeks of run time to the machine's operating schedule plus additional staff to support collaborative activities with other laboratories.	AT DIII-D, the ICRF power increase to 4 MW will be completed and the implementation of a higher power 110 GHz ECH system will be initiated. Experiments on fast wave current drive with a pumped divertor will be initiated in support of the ITER R&D program. High beta experiments with good confinement will continue with further improvements in current profile control. ORNL collaboration will continue and the LLNL collaboration will expand.
	MIT completed installation of the major components and began operation of Alcator C-MOD, a high field, shaped, and diverted tokamak. In addition, MIT continued work on the development of advanced diagnostics for C-MOD.	Alcator C-MOD will complete the ohmic heating phase of operation and begin ICRF heating experiments at the 2MW level. Later in the year, the second ICRF antenna will be installed, in preparation for heating experiments at the 4MW level. MIT will begin upgrading the ICRF components to an 8MW system in support of high power ICRF experiments.	At Alcator C-Mod, ICRF heating experiments will be conducted at the 4-6 MW level and evaluation of confinement in high density, high magnetic field regimes will be carried out. In particular, the H-mode threshold with open and closed divertors will be determined. Wall conditioning studies and impurity transport studies will continue. Studies of high elongation and the effects of strong heating on equilibrium and stability will begin. Upgrades to 8MW will continue with operation planned for FY 1994.

III. Magnetic Fusion Energy - Confinement Systems (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Base Toroidal (Cont'd)	The 140 GHz gyrotron was tested as a driver for the free electron laser (FEL) on MTX. The accelerator system of the FEL was rebuilt and the improved "wiggler" was installed.	LLNL will conduct single pulse and multi-pulse microwave heating and confinement experiments in a high density plasma using the FEL. MTX will be closed out in May 1992 at the end of the Japanese collaboration.	No activity. Scientific staff redirected to support research on DIII-D.
	Collaborative experiments on edge physics, particle control, fueling, heating, current drive, and confinement experiments were carried out on foreign tokamaks including TEXTOR, ASDEX-U, JET, and TORE SUPRA.	Collaborative experiments on edge physics, particle control, fueling, heating, current drive, and confinement will be continued on TEXTOR, ASDEX-U, JET, and TORE SUPRA, all in Europe.	Refer to narrative description below.
		However, upon approval of the proposed FY 1992 reprogramming request, the following modifications would be made: Additional funds will provide for physics analyses and physics R&D coordination in support of ITER EDA.	Collaborative experiments on edge physics, particle control, fueling, heating, current drive, and confinement will be continued on TEXTOR, ASDEX-U, JET, and TORE SUPRA in support of ITER. Physics Analyses and Physics R&D coordination in support of ITER will be continued.
	$ 60,639	$ 66,418	$ 68,010
Advanced Toroidal	The ATF experiments were conducted with electron cyclotron heating to complete transport studies.	The ATF program is being shutdown due to budget limitations. Some of the physics staff will work on supporting DIII-D, TFTR and PBX-M.	Refer to narrative description below.
		However, upon approval of the proposed FY 1992 reprogramming request, the following additions would be made to ATF activity: modest repairs to the coil set would be made to prepare the machine for possible future operation.	ATF shutdown continues. Collaborative activities on DIII-D, TFTR, and PBX-M will continue.
	The PBX-M experimental program was postponed for another year of modest upgrades. No operations were conducted due to budget constraints.	The PBX-M experimental program will resume development of the physics of lower hybrid current drive and IBW heating; transport studies and divertor operation will be conducted using unique plasma shaping capability of PBX-M.	Refer to narrative description below.

Program Activity	FY 1991	FY 1992	FY 1993
Advanced Toroidal (Cont'd)		However, upon approval of the proposed FY 1992 reprogramming request, the following modifications would be made to PBX-M: Additional lower hybrid heating would be installed on PBX-M.	The experimental program will focus on current profile control and its uses as a tool to achieve second regime stability through different operating modes. Fluctuations and transport studies will continue and ICRF power will be upgraded to 4 MW. New ideas for modest scale tokamak improvements will be explored on a continuing basis, both as potential modifications to existing experiments and as possible new devices to investigate specific physics issues.
	$ 12,502	$ 11,807	$ 16,000
Major Device Fabrication	Final testing of all major systems of Alcator C-Mod was completed and initial operation began in late FY 1991.	No activities.	No activities.
	$ 1,190	$ 0	$ 0
Burning Plasma Experiment (BPX)	The conceptual design of the BPX tokamak was completed. R&D on materials and fabrication methods for components was continued.	Continue preliminary design of device and complete final design of certain key system prototypes. Initiate fabrication of prototypes for major tokamak components. Complete environment review process and initiate Preliminary Safety Analysis Report (PSAR). Continue supporting R&D on materials, remote maintenance, and manufacturing processes to be used in tokamak fabrication and assembly.	No activities.
		However, upon approval of the proposed FY 1992 reprogramming request, the following modifications would be made to the Burning Plasma Experiment/ Toroidal Improvement program: The Burning Plasma Experiment project effort will be closed out. Scoping studies leading to a new experimental device that can support ITER and	No activities.

III. Magnetic Fusion Energy - Confinement Systems (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Burning Plasma Experiment (BPX) (Cont'd)		improve the Tokamak concept will be conducted.	
	$ 17,956	$ 27,000	$ 0
Tokamak Physics Experiment	No activity.	However, upon approval of the proposed FY 1992 reprogramming request, the following modifications would be made to the Burning Plasma Experiment/ Toroidal Improvement program: The Burning Plasma Experiment project effort will be closed out. Scoping studies leading to a new experimental device that can address tokamak concept improvements will be conducted.	Redirection of staff continues to a smaller Tokamak Physics Experiment (TPX). Conceptual design and R&D in support of the selected advanced Tokamak Physics Experiment will be accomplished.
	$ 0	$ 0	$ 20,000
Magnetic Fusion Energy - Confinement Systems	$ 150,913	$ 183,250	$ 182,780

KEY ACTIVITY SUMMARY

FUSION ENERGY

I. Preface: Magnetic Fusion Energy - Applied Plasma Physics

The Applied Plasma Physics subprogram develops physics understanding and innovative techniques to allow for improved plasma confinement and achievement of program goals in ITER and in reactor design. Complex plasma behavior determines the physical size, magnetic field and current of the tokamak device required for net energy release. Applied Plasma Physics conducts research on basic magnetic confinement physics and supports and supplements research performed in the Confinement Systems subprogram by developing and implementing new diagnostics, and by developing plasma heating, and control concepts and basic data necessary to design and conduct reactor scale fusion experiments. Activities include: theoretical and experimental physics, analysis and design supporting major devices, and large-scale computing. In 1989, a tokamak transport initiative was begun to improve understanding of how energy and particles are lost from the plasma by mechanisms that transport them across confining magnetic fields. A significant portion of the Applied Plasma Physics activity has been focussed on this issue.

Theory is responsible for the development of models that describe and predict the behavior of magnetically confined plasma. In FY 1993, emphasis will be given to applying the developing understanding of transport to predicting specific behavior in operating and planned tokamaks. An example of specific behavior is a transition from poor confinement to improved confinement that occurs in most tokamaks under selected conditions and that is needed for burning plasmas. Theory will use the developing model of why this transition occurs to predict specific amounts of heating power and applied fields that will cause this transition in particular tokamaks. Increased attention will be given to additional issues of importance to ITER, including containment and thermalization of fast alpha particles produced in fusion burning, control of small scale instabilities, current drive, impurity control, and design of improved auxiliary heating. In addition, general models of plasma behavior will be developed from physics features common to different confinement geometries. Theory work uses both analytical and numerical techniques and is located at universities, national laboratories and industrial research centers.

The Experimental Plasma Research activity provides experimental techniques, basic data, and fundamental physics information required to operate and interpret present major confinement experiments. In FY 1993, at selected tokamaks, recently installed diagnostics will be applied that can measure properties associated with energy and particle transport. Also, new diagnostic techniques will be developed for burning plasma. The TEXT tokamak at University of Texas, Austin will be operated with new electron cyclotron heating and divertors in order to compare transport of particles and energy in various tokamak operation modes. Atomic data necessary for understanding plasma behavior will be obtained and compiled in cooperation with the International Atomic Energy Agency with direct emphasis on ITER needs. Innovation to seek improved, reactor-relevant features will continue. New ideas currently receiving first tests are directed toward improved heating and current drive, better particle and energy control, and plasma stability at higher betas. Most of this work is at universities, with some at national laboratories and industrial centers as well.

The Energy Sciences computing network provides access to state-of-the-art computational hardware (CRAY 2 computers) for the MFE program. The network and computing facilities support the development of models and codes, plasma theory, management and interpretation of experimental results, and the design of large scale fusion experiments. The network infrastructure links the computers at LLNL and five user service centers at LLNL, LANL, General Atomics, PPPL, and ORNL. International data links and telephone line access by smaller users are also provided. In FY 1993, improved computer network access will be used to more effectively couple the Cray computers with local, research-site computers that manage and display computed results.

This budget includes $700,000 in FY 1992 and FY 1993 in support of education activities. The following table summarizes the operating expenses funding for the Applied Plasma Physics subprogram:

II. A. Summary Table: Magnetic Fusion Energy - Applied Plasma Physics

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Advanced Fusion Concepts	$ 9,552	$ 0	$ 0	0
Fusion Plasma Theory	19,325	19,038	19,600	+ 3
Experimental Plasma Research	21,499	26,307	26,645	+ 1
MFE Computing	12,511	16,405	16,205	- 1
Total, Magnetic Fusion Energy - Applied Plasma Physics	$ 62,887	$ 61,750	$ 62,450	+ 1

II. B. Major Laboratory and Facility Funding

General Atomics	$ 2,777	$ 3,025	$ 2,795	- 8
Lawrence Livermore National Laboratory	$ 10,155	$ 15,310	$ 15,695	+ 3
Los Alamos National Laboratory	$ 7,374	$ 2,498	$ 2,300	- 8
Massachusetts Institute of Technology	$ 3,093	$ 2,935	$ 3,150	+ 7
Oak Ridge National Laboratory	$ 4,326	$ 4,365	$ 4,420	+ 1
Princeton Plasma Physics Laboratory	$ 4,045	$ 3,425	$ 3,550	+ 4
University of California - Los Angeles	$ 2,970	$ 3,075	$ 3,124	+ 2
University of Texas	$ 7,795	$ 7,820	$ 7,550	- 3
University of Wisconsin	$ 5,430	$ 5,585	$ 5,920	+ 6

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1991	FY 1992	FY 1993
Magnetic Fusion Energy - Applied Plasma Physics			
Advanced Fusion Concepts	Discontinue and close the Confinement Physics Research Facility (CPRF) construction project and phase out related support activity.	No activity.	No activity.
	Employ improved diagnostics on Madison Symmetric Torus (MST) and correlate fluctuations with Reversed Field Pinch (RFP) and tokamak confinement. Move activity into the Experimental Plasma Research sub-category.	No activity. See Experimental Plasma Research.	No activity. See Experimental Plasma Research.
	Close out Large S Experiment (LSX) and prepare program summary documentation and technical papers.	No activity.	No activity.
	Phase out experiments on Spheromak at the University of California at Berkeley and at the University of Maryland while completing student research. Move the activity into Experimental Plasma Research sub-category.	No activity. See Experimental Plasma Research.	No activity. See Experimental Plasma Research.
	$ 9,552	$ 0	$ 0
Fusion Plasma Theory	Increase emphasis on developing improved understanding of transport and confinement in toroidal devices. Develop new techniques for experimental data evaluation and analysis.	Maintain emphasis on improved understanding of transport in toroidal devices. Develop new techniques for data analysis and for visualization of toroidal plasma models. Resolve issues on stabilization of small scale instabilities for burning plasmas.	Maintain emphasis on improved understanding of transport in toroidal devices. Deploy and evaluate the impact of new techniques for data analysis and for visualization of toroidal plasma models. Develop models for stabilization of small scale instabilities for burning plasmas.

III. Magnetic Fusion Energy - Applied Plasma Physics (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Fusion Plasma Theory (Cont'd)	Continue theory development in support of BPX and ITER. Special emphasis will be placed on resistive MHD (current ramp-up), RF heating (ECH and ICRF), alpha particle theory, and modeling of alpha particle detection techniques.	Continue theory development in support of ITER with emphasis on alpha particle theory, and RF heating effects.	Continue theory development in support of ITER with emphasis on alpha particle stability and transport. Develop realistic models for RF heating and profile control. Provide models for transport of heat and particles in magnetic divertors.
	Phase out theoretical support for alternate concepts while maintaining theory contact with foreign alternate concept programs. Continue theoretical analysis of transport and confinement properties of alternate concept devices and apply insights gained from alternate concept theory to tokamak devices. Prepare technical summary papers on alternate concepts.	Maintain theory contact with foreign alternate concept programs and apply alternate concept insight to tokamak improvement ideas.	Maintain theory contact with foreign alternate concept programs and apply alternate concept insight to tokamak improvement ideas.
	$ 19,325	$ 19,038	$ 19,600
Experimental Plasma Research	Conduct helicity injection experiments in low aspect ratio system. Investigate physics of compact toroid injection into medium sized tokamak.	Evaluate ion method of helicity injection current drive. Decide on construction of multi-pulse compact toroid injector. Complete work on alternate concept devices and apply ideas to tokamak improvement. Carry out studies of the spherical tokamak concept.	Evaluate RF method of helicity injection current drive. Construct laboratory scale multi-pulse compact toroid injection. Continue studies of low aspect ratio (spherical) and high aspect ratio tokamaks. Operate low aspect ratio tokamaks at PPPL and University of Washington.
	Prepare TEXT upgrade to study correlation between edge electric field, fluctuations and transitions between various confinement modes using beam probe and related diagnostics.	Study transport mechanisms associated with various confinement modes using heavy ion beam probe and related diagnostics on TEXT in electron cyclotron heated plasmas.	Study transport mechanisms associated with various confinement modes using heavy ion beam probe and related diagnostics on TEXT in electron cyclotron heated plasmas.
	Install proof-of-principle alpha particle diagnostic system on a major machine for evaluation.	Conduct proof-of-principle tests for alpha particle diagnostic systems. Enhance efforts to adapt advanced diagnostics to burning plasmas.	Continue proof-of-principle tests for alpha particle diagnostic systems. Enhance efforts to adapt advanced diagnostics to burning plasmas, focusing on harsh radiation and temperature environment.

III. Magnetic Fusion Energy - Applied Plasma Physics (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Experimental Plasma Research (Cont'd)	Continue basic physics experiments in small stellarators and tokamaks with emphasis on understanding confinement.	Continue basic experiments in small stellarators and tokamaks with emphasis on understanding plasma potentials and current controls.	Continue basic experiments in small stellarators, reversed field pinch's and tokamaks with emphasis on tokamak improvements.
	Carry out edge physics and fluctuation measurements related to transport on major tokamaks.	Continue edge physics and core fluctuation measurements related to transport on major tokamaks using newly developed diagnostics.	Continue edge physics and core fluctuation measurements related to transport on major tokamaks using advanced diagnostics and collaborations.
	Begin excitation measurements for multiply charged ions using energy loss system. Continue electron-ion collision studies.	Continue excitation and ionization measurements for impurity ions. Extend atomic data compilation, under international guidelines, to support design of ITER edge plasma control techniques.	Extend excitation and ionization measurements for impurity ions, including ITER specific applications. Extend atomic data compilation, under international guidelines, to support design of ITER edge plasma control techniques.
	$ 21,499	$ 26,307	$ 26,645
MFE Computing	In cooperation with Energy Sciences Advanced Computing (ESAC), operate the National Energy Research Supercomputing Center (NERSC) with one Cray X-MP, one Cray 2, and one Class VII computer. Release Serial 1 Cray-2 late in FY 1991: retain the newer Cray-2.	In cooperation with ESAC program, operate the NERSC with one Cray X-MP, one Cray 2, and one Class VII computer. Use a proportionate share of time on these computers throughout activities of the Office of Fusion Energy.	In cooperation with ESAC program, operate the NERSC with one Cray X-MP - one Cray 2, and one Class VII computer. Use a proportionate share of time on these computers throughout activities of the Office of Fusion Energy.
	Upgrades of Energy Sciences Network (ESNET) to conform to the National Research and Education Network Standards will continue to be implemented; funding will be shared among ER programs that benefit from ESNET. This subprogram's share is $493,000.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences program.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences program.
	$ 12,511	$ 16,405	$ 16,205

III. Magnetic Fusion Energy - Applied Plasma Physics (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Magnetic Fusion Energy - Applied Plasma Physics	$ 62,887	$ 61,750	$ 62,450

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

FUSION ENERGY

I. Preface: Magnetic Fusion Energy - Development and Technology

The Development and Technology subprogram provides for: the design, and prototype development for the International Thermonuclear Experimental Reactor (ITER); the development of the technologies needed for TFTR and other present and future fusion experiments; and the design and analysis of fusion systems. The work is divided into four main technical areas: ITER, Plasma Technologies, Fusion Technologies, and Fusion Systems Analysis.

The Secretary of Energy's Fusion Policy Advisory Committee recommended in the Fall of 1990 that the U.S. participate as an equal partner in the ITER Engineering Design Activities (EDA). The overall objectives of ITER are to demonstrate the scientific and technological feasibility of fusion power, to demonstrate controlled ignition and extended burn, and to validate design concepts and qualify engineering components for a fusion reactor. The ITER EDA consists of the engineering design of the ITER device and the physics and technology development tasks required to validate and confirm the ITER design. The Development and Technology subprogram includes funding for the ITER design and technology development. The physics R&D for ITER is provided for in the Confinement Systems subprogram, and theory is covered in the Applied Plasma Physics subprogram. One of the goals of the EDA effort is to involve U.S. industrial firms so that they will be able to compete for contracts to fabricate components and systems for the ITER device, in the event that it is decided at a later date to construct ITER, or other future fusion devices. U.S. industrial firms will provide expertise in systems design and integration, scale-model component development and specific technology development tasks. The ITER technology development tasks to be accomplished by the U.S. in FY 1993 will be negotiated with the ITER Project Director.

The Plasma Technologies activity develops the technologies needed to form, confine, heat and sustain a reacting fusion plasma. These technologies include magnetic systems, plasma heating systems, fueling systems and plasma materials interactions. The principal focus of this development is ITER, although development in support of existing and near term devices is also addressed. The principal activity in the magnetic systems program is to develop reliable high field pulsed and steady state superconducting magnets that provide the magnetic field conditions required to confine a plasma. ITER requires significant development and demonstration of the technology of large, high field superconducting magnets. The heating program focuses on developing the technologies required to heat the plasma ions and electrons to reactive conditions and to sustain a steady-state plasma current needed for long-term confinement of the plasma. It encompasses negative ion neutral beams and electromagnetic wave heating methods using electron cyclotron heating (ECH) and ion cyclotron heating (ICH) techniques. The plasma fueling program develops high speed deuterium and tritium pellet injectors to not only maintain the proper amount of plasma fuel, but to tailor the plasma density profiles for optimum performance. Use of developed heating and fueling systems directly supports the key technical issues of improving magnetic confinement and burning plasma systems and has enabled the production of record plasma conditions in fusion devices. Plasma materials interaction (PMI) research is continuing with low and high atomic number (Z) materials that would provide the capability to withstand higher heat flux and plasma erosion on the first wall and divertor. PMI research focuses on examining erosion and redeposition in present tokamaks, as well as tritium retention and release. Several of these U.S. technologies provide the basis for many existing international collaborative programs. Projected experiments in higher density and higher temperature plasmas will necessitate continued development of higher power, longer pulse length, and higher frequency electromagnetic wave sources, transmission components, improved fueling devices, and plasma facing materials.

The Fusion Technologies activity focuses on the technology elements of fusion devices related to materials development and long-term waste issues, safety features, environmental considerations, device reliability, tritium breeding/processing, and power extraction. These elements are important for both future fusion power reactors and ongoing fusion experiments and are listed by FPAC as key technology issues. The tasks that address these elements are blankets and nuclear data, materials development and irradiation, scoping studies of a high energy neutron irradiation facility as recommended by FPAC, and environment and safety. Ongoing tasks under blankets and nuclear data include examination and design of the blanket and shields for ITER, cooperative International Energy Agency (IEA) and U.S./Japan work on blanket engineering and Tritium Systems Test

Assembly (TSTA) experimental tritium processing research. Materials development and irradiation supports examinations of proposed ITER structural materials, low activation materials and divertor materials. In addition, there is ongoing research for future fusion structural materials in cooperation with Japan, with the European Community, and with the Russian Federation. Environment and safety research emphasizes the operation of all the fusion reactor components in a safe and environmentally acceptable way. Emphasis today is being placed on studying the hazards associated with fusion radioactive products and is primarily focused on ITER.

Fusion Systems Analysis conducts studies using analytical and computational tools as well as data from the ongoing fusion program to model future fusion systems to identify issues and to provide future program directions. The ARIES study of future tokamak power reactors will be completed in early FY 1992. Follow-on studies that would provide information on program issues are being considered, and will include DEMO reactor conceptual designs.

Some of the significant facilities utilized in the Development and Technology subprogram include: the FENIX Test Facility at the Lawrence Livermore National Laboratory (LLNL) for testing of superconducting magnets; the Plasma Materials Test Facility at Sandia National Laboratories; the RF Test Facility at Oak Ridge National Laboratory (ORNL); the neutral beam test facilities at Lawrence Berkeley Laboratory (LBL); and a megawatt gyrotron test facility at VARIAN. The Tritium Systems Test Assembly (TSTA) at Los Alamos National Laboratory (LANL) and the fusion materials work in the High Flux Isotopes Reactor (HFIR) at Oak Ridge National Laboratory (ORNL) and in the Fast Flux Test Facility (FFTF) at Richland are also supported under collaborative agreements with Japan.

This budget includes $12,300,000 in FY 1992 and $14,400,000 in FY 1993 in support of materials research activities. The following table summarizes the operating expense funding for the Development & Technology subprogram:

II. A. Summary Table: Magnetic Fusion Energy - Development and Technology

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
ITER	$ 16,654	$ 39,150	$ 48,050	+ 23
Plasma Technologies	13,490	6,250	6,300	+ 1
Fusion Technologies	13,995	8,900	10,860	+ 22
Fusion Systems Studies	2,415	2,350	2,340	0
Total, Magnetic Fusion Energy - Development and Technology	$ 46,554	$ 56,650	$ 67,550	+ 19

II. B. Major Laboratory and Facility Funding

Argonne National Laboratory (East)	$ 3,768	$ 4,135	$ 5,593	+ 35
Lawrence Livermore National Laboratory	$ 9,634	$ 7,630	$ 5,895	- 23
Los Alamos National Laboratory	$ 2,800	$ 3,115	$ 3,725	+ 20
Massachusetts Institute of Technology	$ 2,678	$ 4,280	$ 4,420	+ 3
Oak Ridge National Laboratory	$ 9,732	$ 10,360	$ 8,440	- 19
Pacific Northwest Laboratory	$ 3,375	$ 3,449	$ 4,260	+ 24
Sandia National Laboratories	$ 3,945	$ 4,990	$ 2,660	- 47
University of California - Los Angeles	$ 2,835	$ 2,955	$ 3,880	+ 31

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1991	FY 1992	FY 1993
Magnetic Fusion Energy - Development and Technology			
ITER	In the magnet area, began testing ITER superconducting samples in FENIX facility as part of international collaboration with the EC.	In the magnet area, testing ITER superconducting samples in FENIX facility will continue. Design of ITER model coils will begin as will design of possible modifications to MFTF-B for use as magnet test facility.	In the magnet area, development and fabrication of ITER model coils and preparations for test of same will continue. Component testing in FENIX will be completed and supporting structural material tests will proceed on schedule.
	In the heating area, began development of negative ion source for ITER application.	In the heating area, development of negative ion source for ITER application will continue as will the development of an accelerator structure for the source.	In the heating area, development of a negative ion source and accelerator for ITER will proceed and preparation of testing facilities for same will continue. Development of gyrotron tubes will continue.
	In the fueling area, started the development of an ITER pellet injector.	In the fueling area, development of an ITER pellet injector will continue.	In the fueling area, development and fabrication of a high speed pellet injector to meet ITER needs will continue.
	In the area of plasma interactive materials, tests on high Z materials for ITER were initiated as were erosion and redeposition tests.	In the area of plasma interactive materials, tests on high Z materials for ITER will continue. Innovative divertor designs will be evaluated for ITER. ITER erosion and redeposition tests will continue.	In the area of plasma interactive materials, ITER divertor concepts will be studied and evaluated, tests will continue on high Z materials, erosion and redeposition tests will continue. International collaborations will be supported.
	The ITER neutron interactive materials task will contribute to the ITER data needed to validate selection of reference structural materials.	Critical questions on ITER reference materials will be experimentally investigated in irradiation and corrosion tests designed to explore ITER conditions.	Experimental evaluation of the ITER reference materials for first wall, blanket structure, divertor structure, heating, and diagnostic systems will address all critical questions and contribute to the design data base work needed for ITER.

III. Magnetic Fusion Energy - Development and Technology (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
ITER (Cont'd)	Continue validating research on critical issues for ITER driver blanket, including corrosion of structural materials, compatibility of solid breeder materials with beryllium and steel and neutron irradiation performance of blanket materials.	Focus activities to prepare for major initiatives in ITER driver blanket research, including non-nuclear facility for thermo-mechanical and thermal-hydraulic testing of blanket module prototypes and a blanket module for neutron irradiation in a Russian fission reactor.	Conduct full level of U.S. contributions toward ITER driver blanket R&D program, including completion of non-nuclear test facility for thermo-mechanical and thermal-hydraulic experiments with subscale blanket prototypes and fabrication of test module for insertion in a Russian nuclear fission reactor.
	No activity.	Operate TSTA to provide data for the ITER fuel cycle, design description and validation of the ITER methodology.	Operate TSTA to provide data for the ITER fuel cycle, design description and validation of the ITER methodology.
	No activity.	ITER environment and safety work will establish the basis for work to produce the safety and regulatory data base for the ITER design activity. Tritium, activation products, and magnetic safety issues are included.	The ITER funded environmental and safety work will support developing the regulatory-quality safety data base for ITER. Details of the design will be examined as they are developed with a focus of making the design safer.
	Complete the Conceptual Design Activities (CDA).	Begin engineering design for the ITER on a Four-Party basis. Work during 1992 includes engineering design and analysis; design of scalable superconducting magnet model.	Continue as full participant in the ITER Design for the EDA on a four-party basis by providing staff to the central team and providing design support for assigned design tasks within the U.S. Provide for industrial participation in the design process to utilize industrial expertise within the ITER process and to qualify industry to participate in ITER construction if that were to follow the EDA.
	Provide support to U.S. ITER home team and for establishment of ITER central team.	Provide support to U.S. ITER home team and for establishment of ITER central team. Establish a San Diego ITER Co-Center for design integration.	Provide support to U.S. ITER home team and for establishment of ITER central team. Operate the San Dieto ITER Co-Center.
	$ 16,654	$ 39,150	$ 48,050
Plasma Technologies	In the magnet area, completed tests of U.S. demonstration poloidal coil (DPC) in Japan.	No activity.	Superconducting wire characterization tests and magnet analysis will be conducted.

Program Activity	FY 1991	FY 1992	FY 1993
Plasma Technologies (Cont'd)	In the heating area, completed majority of 1 MW gyrotron test facility. Completed design and majority of fabrication and assembly of 1 MW gyrotron.	In the heating area, complete 1 MW gyrotron test facility. Complete test of 1 MW gyrotron. Begin tests of 280 GHz gyrotron.	In the heating area, development of 110 GHz gyrotron tubes will be completed and design of 280 GHz tube will be started. ICRH antenna design and development work will proceed in support of existing and near term fusion devices.
	In the fueling area, maintain development efforts for BPX pellet injector.	In the fueling area, work on advanced fueling techniques will be supported.	Advanced high speed pellet injectors will be developed.
	In the plasma materials interaction area, TFTR and BPX support was continued as was support for international collaborations on TEXTOR, ASDEX, and TORE SUPRA.	In the plasma materials interaction area, TFTR support will continue as will support for international collaborations on TEXTOR, ASDEX, and TORE SUPRA.	In the plasma materials interaction area, effort will be focused to provide support for international collaborations.
	$ 13,490	$ 6,250	$ 6,300
Fusion Technologies	Continue international cooperation on reactor-relevant blanket research to develop technology base for ITER blanket testing program. Continue collaboration with Germany and USSR on liquid metal MHD experiments and, with Japan and Canada on solid breeder materials testing in fission reactors, and with Japan on experiments to measure blanket nuclear performance parameters. Continue joint operating of TSTA tritium processing facility with Japan and testing of JAERI fuel cleanup system.	Continue international cooperation on TSTA testing program.	Conduct international cooperation on blanket research only in areas of critical feasibility issues for reactor-relevant blankets. Conduct TSTA operations at a level needed to test high-leverage tritium processing system components.
	The environment and safety program continued experimental and analytical efforts in tritium, activation products, blankets, and magnet areas, focusing on key ITER safety issues.	In the environment and safety program, continue with experimental and analytical efforts in tritium, activation products, blankets, and magnet areas, focusing on key safety issues.	The base environment and safety program will be focused on activation products and their release. There will be some support for better safety, economic and environmental code development.

III. Magnetic Fusion Energy - Development and Technology (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Fusion Technologies (Cont'd)	Neutron interactive materials programs will continue to test materials in HFIR, FFTF and other fission reactors. Alloy development, fabrication, physical metallurgy, corrosion/compatibility and joining studies supplement the irradiation testing. Conventional and low-activation materials are included. Evaluation of ceramic matrix composite materials will begin. Collaborative work with Japan and IEA partners include irradiations and data base development.	Neutron interactive materials program continues to use available fission reactors and other materials evaluation technologies. Alloy modifications to improve properties will be evaluated. Collaborative programs with Japan and IEA partners maximize the limited program resources. Work on composite materials will answer initial feasibility questions. Revised guidelines for low activation materials will evolve through IEA participation.	Materials for first wall/blanket structures, for use in heating systems, for divertor structures, and for components of diagnostic systems will be under study using fission reactors and particle accelerators to evaluate irradiation resistance. Modifications of compositions and microstructures to improve properties and to enhance resistance to irradiation will continue to be evaluated. Materials that meet revised low activation criteria will be developed. Critical feasibility questions on use of silicon-carbon (SiC) composites will be investigated in limited experiments.
	No activity.	Fusion neutron source scoping studies will be initiated. These will explore accelerator-based approaches and determine critical issues for future evaluation.	Scoping studies begun in FY92 will be expanded to preliminary design studies of an accelerator-based neutron source large enough to meet international needs. Critical design issues related to accelerator components and target features will be explored.
	$ 13,995	$ 8,900	$ 10,860
Fusion Systems Studies	Continue ARIES studies of tokamak fusion power reactor.	Complete ARIES studies and initiate studies of non-steady-state tokamak power reactors and fusion power demonstration facilities.	Bring non-steady-state study to rapid conclusion and initiate DEMO design studies.
	$ 2,415	$ 2,350	$ 2,340
Magnetic Fusion Energy - Development and Technology	$ 46,554	$ 56,650	$ 67,550

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

FUSION ENERGY

I. Preface: Planning and Projects

II. A. Summary Table: Planning and Projects

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Planning and Projects...........................	$ 1,012	$ 4,250	$ 4,800	+ 13
Total, Planning and Projects	$ 1,012	$ 4,250	$ 4,800	+ 13

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1991	FY 1992	FY 1993
Planning and Projects	Continue program support activities.	Continue the program's legal obligation to support the SBIR program.	Continue the program's legal obligation to support the SBIR program.
	No activity.	No activity.	In an effort to manage administrative costs more closely, the PSO/Office Directors' share of FTE-dependent costs for space, supplies, and telecommunications are included in this budget and will be transferred during the execution year.
	$ 1,012	$ 4,250	$ 4,800
Planning and Projects	$ 1,012	$ 4,250	$ 4,800

KEY ACTIVITY SUMMARY

FUSION ENERGY

I. Preface: Inertial Fusion Energy

Recent successes in inertial confinement fusion tests have provided confidence that net energy release in the laboratory is possible through implosion, ignition, and burn of microcapsules of deuterium-tritium fuel. With this background and following the advice of the Fusion Policy Advisory Committee, The Department of Energy has established this new budget category, Inertial Fusion Energy (IFE), to develop the potential of inertial fusion as an energy source. The IFE activity will be managed within Energy Research as a separate component of the Office of Fusion Energy.

This new activity will rely on coordination with the Inertial Confinement Fusion (ICF) activity in Defense Programs and will extend the Heavy Ion usion Accelerator Research (HIFAR) that previously was undertaken elsewhere within Energy Research. ICF is under development as a component of nuclear weapons research because it can test basic concepts of fusion explosions. The same basic concepts have potential for commercial energy applications. The target implosion and ignition physics is central to the energy concept but will be developed under Defense Programs activities. The HIFAR activities, previously funded in the Basic Energy Sciences program, have been transferred to this new Inertial Fusion Energy subprogram within the Fusion Energy program in FY 1992.

For commercial energy, a number of requirements must be met to deliver implosion driving energy to the target at high efficiency and high repetition rate. For net energy release, the ignition and burn of a microcapsule is required to produce about 100 times the energy required to implode the capsule. The implosion driving source must have energy efficiency of approximately 10% to allow net energy release from the system. For a reasonable energy source the implosion and energy gain should be repeated several times each second. The development of such implosion driver characteristics has been the objective of the HIFAR program which will be extended through proof-of-principle tests under this new IFE activity. The conceptual design of a new heavy ion test driver system called the Induction Linac Systems Experiments (ILSE) will be revised and completed in FY 1992. In FY 1993, the development of the injector for ILSE will be completed at Lawrence Berkeley Laboratory. ILSE is intended to allow testing, at low energy, of the production, amplification, merger, and transport of the required ion beams. An advantage for IFE is that the driver can be a robust, long-term component that is separate from the harsh reactor chamber environment.

The reactor concept presents significant technical challenges that will be addressed in a second component of the IFE program. Previous reactor studies, together with two studies currently underway within OFE, identify specific research and development issues that are long-lead elements in an energy program. These include: low-cost capsule fabrication, neutron absorbing and energy conversion blankets, high-strength and low-activation containment walls for the explosion environment, components to isolate the reactor chamber from the driver while admitting driver energy. Research and Development on these issues may be initiated in future years depending on the reactor studies to be completed in FY 1992, on fiscal constraints, and on collaboration with related research and development world-wide.

II. A. Summary Table: Inertial Fusion Energy

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Heavy Ion Beams	$ 0	$ 6,922	$ 7,650	+ 11
Reactor Technology	1,600	1,228	500	- 59
Total, Inertial Fusion Energy	$ 1,600	$ 8,150	$ 8,150	0

II. B. Major Laboratory and Facility Funding

Lawrence Berkeley National Laboratory	$ 0	$ 4,800	$ 3,800	- 21
Lawrence Livermore National Laboratory	$ 0	$ 300	$ 300	0

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1991	FY 1992	FY 1993
Inertial Fusion Energy			
Heavy Ion Beams	No activity.	Heavy Ion Accelerator Physics (previously funded in the Basic Energy Sciences program) will continue with emphasis on beam quality and merging techniques. Specific research and development and conceptual design will be undertaken for the Induction Linac Systems Experiment (ILSE).	Evaluate test results of pulse forming network and prototype accelerator cell. Conduct test of 2 MeV injection. Specific research and development will be undertaken for the Induction Linac Systems Experiments (ILSE).
	$ 0	$ 6,922	$ 7,650
Reactor Technology	Continue two design studies of IFE reactors.	Complete two conceptual design studies of IFE reactors. Use these results as a basis for extended reactor concept development and initiate research and development to validate these concepts in future years.	Initiate limited research and development to validate these concepts in future years.
	$ 1,600	$ 1,228	$ 500
Inertial Fusion Energy	$ 1,600	$ 8,150	$ 8,150

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

FUSION ENERGY

I. Preface: Program Direction

This subprogram provides the Federal staffing resources and associated funding needed to plan, direct, manage, and administer the highly scientific and technical research and development program in fusion energy. This program supports the energy mission contained in the National Energy Strategy. The Fusion Energy program is developing the magnetic and inertial approaches to attaining fusion energy as two separate and distinct programs. International collaboration and increasing industrial involvement are essential elements of the program strategy.

II. A. Summary Table: Program Direction

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Salaries and Expenses	$ 5,357	$ 7,140	$ 7,982	+ 12
Other	260	360	818	+127
Total, Program Direction	$ 5,617	$ 7,500	$ 8,800	+ 17

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1991	FY 1992	FY 1993
Program Direction			
Salaries and Expenses	Provided funds for salaries, benefits, and travel related to 65 full-time equivalents (FTEs) in the Office of Fusion Energy, the Office of Assessment and Support, and related program and management support staff.	Provide funds for salaries, benefits, and travel for 77 FTEs included in the FY 1992 budget. A revised request for six additional FTEs is discussed below.	Provide funds for salaries, benefits, and travel for 83 FTEs. Provide for an increase of 6 FTEs over the FY 1992 budget level as discussed below. These additional six FTEs are also required in FY 1992. Also provide for normal increased personnel costs resulting, for example, from a general pay raise and within-grade and merit increases.
	The Office of Fusion Energy performed staff activities which include: policy development; preparation of technical research and development plans; assessment of scientific needs and priorities; development and defense of budgets; review, evaluation, and funding of research proposals; monitoring, evaluation, and direction of laboratory work and allocation of resources; oversight of implementation of university and industrial research programs; oversight of construction and operation of scientific R&D facilities; and control of interagency and international liaison and negotiations. Proceeded with plans for development of a domestic fusion energy device as well as the ITER. Supported increased environment, safety, and health (ES&H) responsibilities as well as increased international collaboration. Supported the National Energy Strategy goal of securing future energy supplies.	Continue program management activities as in FY 1991. Strengthen ES&H capability to ensure compliance with applicable regulations and directives and to improve contractor oversight and accountability. Manage expanded programs in magnetic fusion energy and start of a new program involving Inertial Fusion Energy (IFE). Redirect BPX effort to a more modest Tokamak Physics Experiment to address tokamak improvements assuming the FY 1992 proposed reprogramming is approved. Continue physics experiments in support of the ITER design effort. Manage other ongoing program activities consistent with NES mission and Departmental initiatives, including increased emphasis on ES&H responsibilities. Continue international collaboration to avoid duplication of effort and advance the program in a timely way.	Continue program management activities as in 1992. Support expanded ITER and IFE activities. Continue to strengthen ES&H capability to ensure compliance with applicable regulations and directives as discussed in FY 1992. Manage ongoing programs in magnetic fusion energy including programs to improve the tokamak concept and ensure inertial fusion energy. Continue physics experiments in support of the ITER and support increased ITER activities. Continue experiments and establishment of ES&H criteria for ITER. Manage other ongoing program activities consistent with NES mission and Departmental priorities, including emphasis on ES&H responsibilities and improved contractor oversight. Increase international collaboration.
	Provided a portion of the total staffing requirement for the Office of Assessment and Support to implement ES&H oversight and support activities to ensure compliance with applicable ES&H regulations and directives.	No activity. Transferred to the Advisory and Oversight Program Direction account within the Energy Supply, R&D appropriation.	No activity.

III. Program Direction (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Salaries and Expenses (Cont'd)	Provided program and management support in the areas of budget and finance, personnel administration, acquisition and assistance, policy and coordination, and construction management support.	Provide program and management support as in FY 1991 with particular emphasis on strengthening line management control and accountability.	Continue to provide program and management support as in FY 1992.
	No activity.	Provide an increase of six FTEs over the FY 1992 budget to support magnetic fusion energy activities carried out by the Chicago Field Office, primarily at the Princeton Area Office. This Area Office is responsible for the operation of DOE's largest fusion laboratory, the Princeton Plasma Physics Laboratory, which operates the TFTR facility. Additional resources are required to implement the Tiger Team action plan, for strengthening ES&H oversight at the site and to strengthen overall contract management oversight.	Continue to support magnetic fusion energy activities carried out by the Chicago Field Office, primarily at the Princeton Area Office with six additional FTEs, which are also required and discussed in FY 1992, to support increased ES&H activities and contract management.
	No activity.	Support magnetic fusion energy activities at the San Francisco Field Office at the level included in the FY 1992 budget.	Continue to support magnetic fusion energy activities at the San Francisco Field Office at the level included in the FY 1992 budget.
	$ 5,357	$ 7,140	$ 7,982
Other	Provided funds for a variety of program support services such as printing and editing, and contractual support, for example, to assist with the environment, safety and health workload required by current regulations and directives and for timesharing on various information systems and communications networks.	Continue the variety of program support required in FY 1991. Also provide support for the employees at Chicago and San Francisco Field Offices who were reassigned to ER.	Continue the variety of program support required in FY 1992. Provide increased support to additional staff at the Princeton Area Office, including relocation costs.
	$ 260	$ 360	$ 818

III. Program Direction (Cont'd):

Program Activity	FY 1991	FY 1992	FY 1993
Program Direction	$ 5,617	$ 7,500	$ 8,800

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

FUSION ENERGY

I. Preface: Capital Equipment

The capital equipment request for FY 1993 of $20,980,000 supports the procurement of essential hardware to facilitate the conduct of the experimental program. This permits the effective utilization of devices and people. Much of this equipment is used to support the operation of the fusion experimental devices or to make measurements and gather technical data. Some of this equipment replaces existing obsolete equipment while other items of equipment are new items required to support the evolving scientific program. Listed below is a summary of the specific capital equipment needs by sub-program area.

II. A. Summary Table: Capital Equipment

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
Confinement Systems	$ 5,985	$ 4,650	$ 6,130	+ 32
Applied Plasma Physics	585	550	550	0
Development and Technology	3,845	4,950	13,450	+172
Inertial Fusion Energy	0	850	850	0
Total, Capital Equipment	$ 10,415	$ 11,000	$ 20,980	+ 91

II. B. Major Laboratory and Facility Funding

General Atomics	$ 1,922	$ 1,500	$ 1,700	+ 13
Lawrence Livermore National Laboratory	$ 2,799	$ 2,450	$ 5,550	+127
Massachusetts Institute of Technology	$ 2,000	$ 2,000	$ 2,900	+ 45
Oak Ridge National Laboratory	$ 1,230	$ 1,900	$ 2,090	+ 10
Princeton Plasma Physics Laboratory	$ 1,108	$ 600	$ 2,030	+238

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1991	FY 1992	FY 1993
Capital Equipment			
Confinement Systems	Equipment funds provided to support experimental operations of existing devices. Continue maintenance and modest upgrades to data acquisition systems by replacing/upgrading output devices, analog to digital convertors, mass storage systems, etc., as needed primarily for DIII-D and TFTR.	Equipment funds provided to support experimental operations of existing devices. Continue maintenance and modest upgrades to data acquisition systems by replacing/upgrading diagnostics hardware, analog to digital convertors, mass storage systems, etc., as needed for C-Mod, DIII-D, PBX and TFTR.	Equipment funds provided to support experimental operations of existing devices. Continue maintenance and modest upgrades to data acquisition systems by replacing/upgrading diagnostics hardware, analog to digital convertors, mass storage systems, etc., as needed for C-Mod, DIII-D, PBX and TFTR.
	$ 5,985	$ 4,650	$ 6,130
Applied Plasma Physics	Provide general laboratory equipment for experimental research at national laboratories including computing equipment.	Provide general laboratory equipment for experimental research at national laboratories including computing equipment.	Provide general laboratory equipment for experimental research at national laboratories including computing equipment.
	$ 585	$ 550	$ 550
Development and Technology	Special and general purpose equipment is purchased to increase the efficiency and productivity of the research and development efforts and technology test facilities.	Special and general purpose equipment is purchased to continue the efficiency and productivity of the research and development efforts and technology test facilities.	Special and general purpose equipment is purchased to increase the efficiency and productivity of the research and development efforts and technology test facilities. The increase is required to procure the necessary hardware to support ITER R&D efforts on magnets, negative ion neutral beams, materials and blankets.
	$ 3,845	$ 4,950	$ 13,450
Inertial Fusion Energy	No activity.	Equipment funds are provided to support Heavy Ion Accelerator Physics Research.	Equipment funds are provided to support Heavy Ion Accelerator Physics Research.
	$ 0	$ 850	$ 850
Capital Equipment	$ 10,415	$ 11,000	$ 20,980

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

FUSION ENERGY

I. Preface: Construction

II. A. Summary Table: Construction

Program Activity	FY 1991 Enacted	FY 1992 Enacted	FY 1993 Request	% Change
General Plant Projects..........................	$ 2,063	$ 1,950	$ 2,000	+ 3
Confinement Physics Research Facility...........	5,518	0	0	0
Fire & Safety Protection Improvements...........	0	2,600	2,200	- 15
Total, Construction	$ 7,581	$ 4,550	$ 4,200	- 8

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

Program Activity	FY 1991	FY 1992	FY 1993
Construction			
General Plant Projects	Support projects to meet health, safety, and programmatic requirements and to provide miscellaneous modifications, additions, alterations, and non-major new construction items to meet programmatic goals.	Support projects to meet health, safety, and programmatic requirements and to provide miscellaneous modifications, additions, alterations, and non-major new construction items to meet programmatic goals.	Support projects to meet health, safety, and programmatic requirements and to provide miscellaneous modifications, additions, alterations, and non-major new construction items to meet programmatic goals.
	$ 2,063	$ 1,950	$ 2,000
Confinement Physics Research Facility	Project is terminated because of funding limitations. Funds are provided to satisfy contractual obligations and close-out costs.	No activity.	No activity.
	$ 5,518	$ 0	$ 0
Fire & Safety Protection Improvements	No activity.	Provides for initiation of a project to correct fire and safety deficiencies at the Princeton Plasma Physics Laboratory.	Provides for completion of a project to correct fire and safety deficiencies at the Princeton Plasma Physics Laboratory.
	$ 0	$ 2,600	$ 2,200
Construction	$ 7,581	$ 4,550	$ 4,200

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
OFFICE OF ENERGY RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

Fusion Energy

IV. Construction Project Summary

Total

Project No.	Project Title	Total Prior Year Obligations	FY 1992 Appropriated	FY 1993 Request	Unappropriated Balance	TEC
92-E-340	Fire & Safety Protection Improvements at Princeton Plasma Physics Laboratory	$ 0	$ 2,600	$ 2,200	$ 0	$ 4,800
GPE-900	General Plant Projects	0	1,950	2,000	0	2,000
Total Fusion Energy Construction		XXX	$ 4,550	$ 4,200	$ 0	$ XXX

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Fusion Energy

IV. B. Plant Funded Construction Project

1. Project title and location: 92-E-340 Fire and Safety Improvements
Princeton Plasma Physics Laboratory

Project TEC: $ 4,800
Start Date: 1st Qtr. FY 1992
Completion Date: 1st Qtr. FY 1994

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1992	2,600	2,600	1,000
1993	2,200	2,200	2,200
1994	0	0	1,600

3. Narrative:

(a) This project makes improvements to life safety and fire protection at the Princeton Plasma Physics Laboratory. It is divided into three main segments: Fire alarm system improvements, improvements for compliance with the Life Safety Code (LSC) and sprinklers and fire walls.

The alarm system segment itself consists of three parts: Part one provides for additional building alarm panels; part two provides a new fire alarm reporting and recording system for the entire complex and part three provides a 100 screen, full color graphics package that will automatically provide the Security Officer with all the necessary emergency information whenever an alarm is received.

The LSC segment of the project makes a variety of improvements for compliance with the LSC including three new external stairs and second exists from four areas.

The sprinkler/firewall portion of the project provides new sprinkler systems in seventeen buildings or areas, improvements to three additional sprinkler systems and improvements to the fire resistent capacity of certain walls and ceilings.

4. Total Project Funding (BA):

	Prior Years	FY 1992 Appropriated	FY 1993 Request
Construction...........	$ 0	$ 2,600	$ 2,200

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
OFFICE OF ENERGY RESEARCH
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Fusion Energy

IV. B. Plant Funded Construction Project

1. Project title and location: GPE-900 General Plant Projects
Various locations

Project TEC: $ 2,000
Start Date: 1st Qtr. FY 1993
Completion Date: 4th Qtr. FY 1994

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1993	$ 2,000	$ 2,000	$ 1,850

3. Narrative:

(a) This project supports many small alterations, additions, modifications, replacements, and non-major new construction items required annually to provide continuity of operation, improvement in economy, road and structure improvements, elimination of health and safety hazards, minor changes in operating methods, and protection of the Government's significant investment in facilities. Currently the estimated distribution for FY 1992 by laboratory is as follows:

Princeton Plasma Physics Laboratory..	2,000
Oak Ridge National Laboratory...	0
	$ 2,000

4. Total Project Funding (BA):

	Prior Years	FY 1991	FY 1992	FY 1993 Request	To Complete
Construction...........	$ 0	$ 2,063	$ 1,950	$ 2,000	$ 0

DEPARTMENT OF ENERGY
FY 1993 OMB BUDGET
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
FUSION ENERGY
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: General plant projects

2. Project No.: GPE-900

3a. Date A-E work initiated: 1st Qtr. FY 1993

3b. A-E Work (Title I & II) duration: Months vary per project

4a. Date physical construction starts: 2nd Qtr. FY 1993

4b. Date construction ends: 4th Qtr. FY 1994

5. Previous:--Construction cost estimate: None
--Total project cost: None

6. Current construction cost estimate: $ 2,000
TECC -- $ 2,000
TPC -- $ 2,000

7. Financial Schedule:

		Costs			
Fiscal Year	Obligations	FY 1991	FY 1992	FY 1993	After FY 1994
Prior Year Projects	XXXXXXXX	$ 3,137	$ 0	$ 0	$ 0
FY 1991 Projects	$ 2,063	321	1,742	0	0
FY 1992 Projects	1,950	0	1,800	150	0
FY 1993 Projects	2,000	0	0	1,850	150

8. Brief Physical Description of Project

These projects provide for the many miscellaneous alterations, additions, modifications, replacements, and non-major new construction items required annually to provide continuity of operation, improvement in economy, road and street improvements, elimination of health and safety hazards, minor changes in operating methods, and protection of the Government's significant investment in facilities at the present time. The continuing review of our requirements will result in some of the projects being changed in scope; it will also result in other projects being added to the list with the necessary postponements of some now listed, all depending on conditions or situations not apparent at this time.

The current estimated distribution of FY 1993 funds by location is as follows:

Princeton Plasma Physics Laboratory $ 2,000

1. Title and location of project: General plant projects 2. Project No.: GPE-900

9. Purpose, Justification of Need for, and Scope of Project

The following are tentative examples of the major items to be performed at PPPL:

Princeton Plasma Physics Laboratory*..		$ 2,000
Service Road and Parking Area Improvements............................	265	
Electric Power Modifications..	350	
Roof Replacement and Structural Reinforcement..........................	345	
Miscellaneous Building and Facility Repairs, Space Upgrades and Modifications...	250	
D-Site Transformer Yard Oil Sensors..	90	
Replace HVAC Units at C site..	450	
Miscellaneous Small Projects..	250	

These funds cover the Magnetic Fusion Energy program's specific modifications for modernization and safety improvements to existing facilities.

10. Details of Cost Estimate

Not available at this time.

11. Method of Performance

Design and engineering will be on the basis of negotiated subcontracts and construction work under fixed price subcontracts awarded on the basis of competitive bidding.

12. Funding Schedule of Project Funding and Other Related Funding Requirements

This item does not apply to general plant projects.

Since needs and priorities may change, other projects may be substituted for those listed, and some of these may be located on non-Government owned property.

* These projects will be constructed at the Princeton Plasma Physics Laboratory which is non-Government owned property.

1. Title and location of project: General plant projects 2. Project No.: GPE-900

13. Narrative Explanation of Total Project Funding and Other Related Funding Requirements

This item does not apply to general plant projects.

14. Incorporation of Fallout Shelters

Buildings to be constructed as a part of this project are not suitable for use as fallout shelters because of the predominantly light-weight prefabricated nature of the metal structures. Fallout shelters are available in existing structures.

15. Federal Compliance with Pollution Control Standards

There are no water or air pollutants associated with this project, and all measures necessary to assure that this facility will comply with Executive Order 12088 and state and local regulations have been taken.

16. Evaluation of Flood Hazards

These projects will be located in an area not subject to flooding determined in accordance with Executive Order 11988.

17. Environmental Impact

Projects will comply with provision of the National Environmental Policy Act, related to DOE orders and guidelines.

18. Accessibility for the Handicapped

Projects will be accessible to the handicapped in accordance with the Architect Barriers Act, P.L. 90-480, and implementing instructions in the Federal Property Management Regulations (41 CFR 101-91.6).