DEPARTMENT OF ENERGY
FY 1992 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 vigorous development program is required over the next several decades to confirm the safety and environmental promise of fusion.

The Department has recently concluded an in-depth review of the fusion program by the Fusion Policy Advisory Committee (FPAC) to determine what is an appropriate, practical, and enduring fusion policy. The Committee concluded that there are compelling reasons for the U.S. to initiate a goal-oriented fusion energy program, 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, for the national program, a Burning Plasma Experiment based on the previously proposed Compact Ignition Tokamak, beginning in FY 1992. In addition, their plan recommended resources for 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. Based on the expert evaluation of the technical progress attained by fusion research to date, the fusion program is ready to make the transition to a goal-oriented energy development program. 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.

Implementation of this new policy will begin with approval of the Department's proposed reprogramming in FY 1991. However, fiscal constraints, in FY 1991 and beyond, have made it impossible to implement even FPAC's recommended fusion policy with support not available even for a minimum budget case recommendation. These constraints have required the program to prematurely narrow its focus on the tokamak concept, including tokamak improvement activities, and to cut back on the alternate confinement program elements. At least five experimental programs will be closed in FY 1991. The Confinement Physics Research Facility reversed field pinch under construction at Los Alamos National Laboratory (LANL) will be canceled. The Advanced Toroidal Facility stellarator at Oak Ridge

National Laboratory (ORNL), the recently dedicated Large S Experiment at Spectra Technology, the Field Reversed Experiment - C compact torus at LANL. The Princeton Beta Experiment advanced tokamak at Princeton Plasma Physics Laboratory (PPPL) will be closed in FY 1991 and restarted in FY 1992. The Department proposed reprogramming for FY 1991 would allow minimum support for an energy preparation program by maintaining the options for ITER Engineering Design Activities (EDA) participation and design and R&D for a Burning Plasma Experiment, although no construction authorization is being sought in FY 1992.

The Burning Plasma Experiment is an evolution of the Compact Ignition Tokamak with a slightly larger size tokamak, higher plasma current and greater heating capability resulting in a more conservative approach. The purpose of the Burning Plasma Experiment is to investigate the physics of self-heated fusion plasmas and to demonstrate the production of 100 - 500 MW of fusion power. In the process, the Burning Plasma Experiment will investigate the confinement physics, operational limits, and alpha particle physics of self-heated fusion plasmas. In addition, it will demonstrate many of the heating, fueling, and plasma handling techniques necessary to produce reactor-level fusion plasmas. The Burning Plasma Experiment could operate several years before the ITER and provide valuable information on burning plasmas prior to ITER operation. The purpose of the ITER is to demonstrate the scientific and technological feasibility of fusion power. Therefore, ITER will demonstrate not only plasma ignition but also extended burn, with steady-state operation as a goal. This will provide the physics data base needed for a demonstration tokamak power reactor, demonstrate many of the reactor technologies needed for fusion power, and provide a test bed for high heat flux and nuclear components.

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 strategy is to take full advantage of international collaboration while maintaining a sound domestic program. In addition, Inertial Fusion Energy will require continued development of knowledge being produced 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.

<u>Status of Magnetic Fusion</u>:

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.

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 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 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 fuel production (tritium), 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 all the environmental and safety consequences of any accidents and to establish acceptable waste disposal procedures.

The following list is provided to highlight some of the significant progress in both underlying physics and enabling technology that has been accomplished in magnetic fusion:

Physics

1. Improvements in the key tokamak fusion power parameter (product of density, energy confinement time and temperature) have resulted in an increase of fusion power production by a factor of a million over the past 15 years, and only an additional factor of about seven is required in these parameters to reach the ignition condition.

2. The experimental ratio of the plasma pressure to the pressure of the confining magnetic fields has reached 11% in Doublet III-D (DIII-D). These results are considered adequate for an economic reactor.

3. An international experimental data base has been used to summarize and accurately predict confinement in tokamaks.

4. Quantitative results and physics insights have been obtained on the processes that transport energy out of toroidal plasma. New and improved diagnostics have been developed and are being applied to existing experiments to obtain and study important "high confinement" operating modes on tokamaks.

5. The prospects for steady-state current drive in a tokamak reactor have been greatly enhanced by the demonstration of plasma current driven totally by neutral beams on DIII-D and on TFTR, and by the confirmation on TFTR of the theoretically predicted bootstrap current that increases current drive efficiency. In the recent ARIES advanced reactor design, the bootstrap effect is predicted to produce 75% of the plasma current, reducing the amount of externally required current drive power four-fold and leading to a more economic reactor design.

6. Princeton Beta Experiment-Modified (PBX-M), Versator, DIII-D, and TFTR, have produced plasma conditions near a regime of higher plasma pressure that could dramatically improve the tokamak reactor concept.

7. Confinement and heating properties of dense tokamak plasmas at high magnetic fields have been measured in Alcator C which supports the design basis for cost-effective, high-field, burning plasma experiments.

Technology

8. Radio frequency heating has been developed at Oak Ridge National Laboratory (ORNL) (ion cyclotron heating) and Lawrence Livermore National Laboratory (LLNL) (electron cyclotron heating) allowing high-power, localized heating of a tokamak. These developments support the design of the Burning Plasma Experiment and ITER devices.

9. The implementation of wall coating techniques and limiters have reduced plasma impurity content and increased the performance of TFTR and DIII-D. Advanced divertors to control particle and energy flow have been designed by UCLA, General Atomics and Princeton for DIII-D and PBX-M.

10. Pneumatic pellet injectors developed at ORNL enabled TFTR to achieve record n-tau.

11. The Tritium System Test Assembly at Los Alamos National Laboratory (LANL) has achieved an excellent safety record through seventy-two months of tritium operations, and has processed tritium at the rate of over 1 kg per day throughput.

12. Experiments at ORNL, in collaboration with Japan, have shown the effects of neutron irradiation on the properties of austenitic stainless steels in the ITER temperature range.

13. Scale model superconducting coils with magnetic field strength in the 9-10T reactor relevant range have been tested successfully in a tokamak configuration.

14. Significant contributions have been made to the U.S. science and technology base in supercomputers, gyrotrons, superconducting magnets, and atomic physics.

15. The International Thermonuclear Experimental Reactor (ITER) Conceptual Design Activities have been successfully completed and are a model of international collaboration on a large scientific project.

Status of Inertial Fusion:

Inertial fusion for energy applications will proceed by compressing a small fuel capsule to high density using pressure from uniform irradiation by short-wavelength light or ion beams as drivers. According to validated physics models, the compression will heat the central core of the capsule in 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 energy gain, defined as the ratio of fusion energy released to input driver energy, should be possible with a ratio up to about 100.

The energy application of inertial fusion assumes that ignition and burn of a deuterium-tritium pellet can be demonstrated in the laboratory within DOE's Defense Program activities. Indirect-drive, laboratory experiments, in which laser energy is delivered to the target through an intermediary radiant enclosure, have achieved required capsule compression ratios. Inherently more efficient, direct drive targets have been imploded to densities several hundred times that of liquid hydrogen. Experiments using a tiny fraction of the energy from a fission device underground have allowed demonstration of excellent performance, putting to rest fundamental questions about basic feasibility of achieving high gain. This combined progress, extended with existing laser facilities, gives confidence that an upgrade of the NOVA facility at Livermore to about 2MJ of energy will be capable of demonstrating ignition in the laboratory.

For energy applications, there are additional critical problem areas that must be successfully addressed:

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

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

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 heavy ions are 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 Basic Energy Sciences program in Heavy Ion Fusion Accelerator Research (HIFAR) 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 carbon ions, a low-cost next step called the Induction Linac Systems Experiment (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 support preparation for the ILSE experiments.

Two reactor concept studies were undertaken within the Office of Fusion Energy beginning in FY 1990. These studies, building on previous reactor concept evolution carried out in Defense Programs, will provide a basis for addressing the reactor and pellet technology issues. Continued reactor studies and validating research and development will be undertaken within the new Inertial Fusion Energy Program.

FY 1992 Budget Summary:

The FY 1992 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 has been redirected to concentrate on the tokamak 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 the U.S. will enter negotiations to participate as an equal partner in the Engineering Design Activities of ITER. To contribute to the success of ITER and to maintain a strong domestic program, the U.S. will prepare to carry out deuterium-tritium experiments in TFTR and provide R&D in support of the engineering design of a Burning Plasma Experiment (BPX). The BPX will be based on a more conservative approach to the previously proposed Compact Ignition Tokamak, and international participation will be sought. Other tokamak experiments, theory and modelling, and innovation in plasma control and heating will be focused to support these major experiments. The Princeton Beta Experiment, which is planned for restart, will provide physics support to BPX and ITER and will also serve as the focus for the U.S. effort to improve the tokamak concept. Technology development will be focused to validate ITER design and to support TFTR and BPX. International cooperation will be a part of all aspects of the program. Because of budget constraints, the U.S. will not continue major alternate concepts experiments and will rely on international cooperation for alternate concept development as well as to advance some critical tokamak physics and technology.

An Inertial Fusion Energy (IFE) program, constrained to one driver concept and to budget-paced technology development, will be initiated. This program will rely on continuing development of target physics and ignition characteristics within Defense Programs. The heavy ion driver, successfully conceived through Defense Programs and Basic Energy Sciences activities, will be extended and tested. Technology research and development will be based on reactor studies and will rely on progress within the world-wide magnetic fusion program for common elements such as low-activation materials and breeding blankets. Where possible within budgetary and classification constraints, international cooperation will be pursued to speed the overall progress in IFE.

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ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

LEAD TABLE

Fusion Energy

Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Base	FY 1992 Request	Program Change Request vs Base: Dollar	Program Change Request vs Base: Percent
Operating Expenses						
Confinement Systems..........	$160,170	$150,915	$150,915	$183,250	$+ 32,335	+ 21
Applied Plasma Physics.......	71,609	62,888	62,888	61,750	- 1,138	- 2
Development and Technology...	46,269	46,555	46,555	56,650	+ 10,095	+ 22
Planning and Projects........	653	4,142	4,142	4,250	+ 108	+ 3
Inertial Fusion Energy.......	1,150	1,600	6,930	8,150	+ 1,220	+ 18
Program Direction............	4,930	5,461	7,500	7,500	+ 0	+ 0
Subtotal Operating Expenses..	284,781	271,561	278,930	321,550	+ 42,620	+ 15
Capital Equipment............	13,330	10,415	11,061	11,000	- 61	- 1
Construction.................	18,595	7,581	7,581 b/c/	4,550	- 3,031	- 40
Total....................	$316,706 a/	$289,557 b/c/	$297,572 d/	$337,100	+ 39,528	+ 13
Less Proposed Reprogramming...		- 16,000	- 16,000			
Total FY 1991 Enacted....		$273,557	$281,572			

a/ Total has been reduced by $3,553,000 which has been transferred to the SBIR program.
b/ Assumes proposed reprogramming request of $16.0 million is approved.
c/ Includes $2,523,000 for education programs funded in the Atomic Energy Defense Activities account.
d/ Reflects transfer of HIFAR from the Basic Energy Sciences program to the Fusion Energy program in FY 1992.

Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Base	FY 1992 Request	Program Change Request vs Base	
					Dollar	Percent
Operating Expenses............	(284,781)	(271,561)	(278,930)	(321,550)	+ 42,620	+ 15
Capital Equipment.............	(13,330)	(10,415)	(11,061)	(11,000)	- 61	- 1
Construction..................	(18,595)	(7,581)	(7,581)	(4,550)	- 3,031	- 40
Staffing (FTEs)						
Headquarters................	61	64	61	61	--	--
Field.......................	0	0	16	16	--	--
Total...................	61	64	77	77	--	--

Authorization: Section 209, P.L. 95-91

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(dollars in thousands)

SUMMARY OF CHANGES

Fusion Energy

FY 1991 Enacted Appropriation	$ 289,557
Comparability Adjustments	
- Heavy Ion Fusion Accelerator Research - transfer Heavy Ion Accelerator Physics from the Basic Energy Sciences	+ 5,976
- Program Direction - provides for the transfer of 16 field office FTE's that support magnetic fusion energy research from the Departmental Administration appropriation	+ 1,370
FY 1992 Base Adjustments	
Pay cost increase	+ 669
FY 1992 Major Program Changes	
Confinement Systems	+ 31,000
This increase provides for R&D, prototype fabrication, and design for the BPX project, preparations of the TFTR device for deuterium-tritium experiments in late 1993, and experimental physics support for BPX/ITER.	
Applied Plasma Physics	- 6,691
This decrease results from the termination of the Confinement Physics Research Facility construction project and research on significant alternate concept experiments.	
Development and Technology	+ 11,200
A decrease in the base technology efforts is off-set by an increase in ITER project support on those tasks that require the longest lead time and are most critical to the success of ITER.	

Planning and Projects.. + 2,610
This increase is primarily associated with the initiation of the Fire and Safety Improvement Projects at PPPL.

Inertial Fusion Energy.. + 1,409
An increase is provided for Heavy Ion Beam research.

FY 1992 Congressional Budget Request.. $ 337,100

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ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

FUSION ENERGY

I. Preface: Magnetic Fusion Energy - Confinement Systems

The Confinement Systems subprogram supports the recommendations of the Department's Fusion Policy Advisory Committee by carrying out research on resolving the key scientific issues of magnetic fusion, preparing for the world's first deuterium-tritium (D-T) fusion experiments in the Tokamak Fusion Test Reactor (TFTR), planning for a Burning Plasma Experiment (BPX), based on the Compact Ignition Tokamak design, studying alpha particle heating, 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. This research involves developing a sufficient understanding of plasmas confined in toroidal configurations to permit the design of efficient fusion energy sources. The 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, such as BPX, 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, non-inductive current drive, and alpha particle physics.

Energy confinement is an important issue affecting the fusion performance of future fusion research devices such as the planned BPX and the 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 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. An earlier redirection of the Confinement Systems subprogram in FY 1989 focused resources on energy confinement research in support of future experiments such as BPX and ITER, and this emphasis will continue in FY 1992. This work is carried out in close cooperation with experimental groups 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. A magnetic field pressure about 10 times larger than the plasma pressure is required for stable confinement of the plasma. Since practical magnetic field pressures are limited, research on equilibrium and stability concentrates on alternate plasma shapes and operating modes that theory predicts can maximize 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 BPX and 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.

The programs in power handling and particle control are important in developing impurity control and power handling methods, which are crucial for the operation of next generation devices such as BPX and 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 the vacuum vessel walls and the limiters or divertor tiles by interaction with the plasma. Studies are being conducted to ensure that the plasma is kept as clean as possible by reducing 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. Current experiments are studying injection of frozen hydrogen or deuterium pellets. Finally, the study of edge physics and edge particle control is important because the edge plasma can have a significant effect on the confinement properties of the rest of the plasma.

The non-inductive current drive issue addresses operation of devices in a steady-state mode as opposed to the present pulsed mode. The primary advantage of steady-state operation in a reactor is that it will reduce the problem of thermal and mechanical fatigue of components. Planned experiments include attempts to drive continuous currents in tokamaks with radio-frequency waves and with edge currents. These experiments are designed to support ITER, which will require non-inductive current drive in its technology phase.

Alpha particle physics, the major burning plasma physics issue, concerns the effect of these fusion produced plasma energetic helium nuclei on the confined plasma. The impact of alpha particle heating on the plasma 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 will be addressed in detail in BPX, and extended to long pulse in ITER.

Research is being conducted on several toroidal devices to investigate the scientific issues discussed above and to prepare for performing burning plasma physics experiments on BPX and ITER. The confinement of high temperature plasmas will be studied in the TFTR at the Princeton Plasma Physics Laboratory (PPPL). Experiments on confinement, beta limits, 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 begin operation to study radio-frequency heating, energy confinement, and fueling in a high-field, high-density plasma. The former Alcator-C tokamak has been moved to Lawrence Livermore National Laboratory (LLNL) and renamed the Microwave Tokamak Experiment (MTX). During FY 1991, LLNL will carry out limited experiments on the feasibility of using pulsed, high power microwaves from a free electron laser (FEL) as a heating technique for tokamak devices and then close out MTX in early FY 1992 because of budget limitations. International collaboration will be utilized to carry out research on a number of related plasma physics issues on foreign facilities including: TEXTOR and ASDEX in Germany, Tore Supra in France, the Joint European Torus (JET) in England, and JFT-2M and JT-60 in Japan.

Work on identifying an optimum toroidal confinement system will also be supported at a reduced 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 be shut down in FY 1991 but will resume operating in FY 1992. The Advanced Toroidal Facility (ATF) at the Oak Ridge National Laboratory (ORNL), an alternate concept with inherent advantages for steady-state operation, will be closed out in FY 1991 because of budget limitations.

A national effort led by PPPL has been underway for the past few years to design and carry out R&D on the proposed BPX, formally the Compact Ignition Tokamak (CIT), with the objective of investigating the physics of burning plasmas. The CIT project was intensively reviewed during 1990 and both the mission of the experiment and the engineering design of the device have been modified. Achievement of plasma self-heating by the fusion-produced alpha particle has always been an essential objective of magnetic fusion research. The successful operation of BPX will demonstrate the scientific feasibility of plasma self heating, provide key support to the initiative to establish a four-party program (ITER), and maintain the rate of scientific progress in the U.S. fusion program. This budget continues the work on the design and R&D for a burning plasma experiment.

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 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Tokamak Fusion Test Reactor	$ 60,518	$ 59,300	$ 75,300	+ 27
Base Toroidal	59,817	62,025	65,200	+ 5
Advanced Toroidal	15,623	12,500	12,750	+ 2
Major Device Fabrication	3,410	390	0	-100
Burning Plasma Experiment (CIT)	17,325	16,700	30,000	+ 80
Tandem Mirror Operations	2,500	0	0	0
Changes in Inventory	977	0	0	0
Total, Magnetic Fusion Energy - Confinement Systems	$ 160,170	$ 150,915	$ 183,250	+ 21

II. B. Major Laboratory and Facility Funding

General Atomics	$ 31,625	$ 29,912	$ 32,205	+ 8
Lawrence Livermore National Laboratory	$ 13,409	$ 10,732	$ 4,650	- 57
Massachusetts Institute of Technology	$ 13,374	$ 16,925	$ 19,200	+ 13
Oak Ridge National Laboratory	$ 15,344	$ 12,569	$ 12,775	+ 2
Princeton Plasma Physics Laboratory	$ 83,159	$ 73,535	$ 96,920	+ 32

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Magnetic Fusion Energy - Confinement Systems			
Tokamak Fusion Test Reactor	An initial set of transport diagnostics was added, and numerous comparisons were made among the fluctuation levels, measured transport values, and relevant transport theories. The inner limiter was upgraded with the installation of carbon-carbon composite tiles, and this has allowed operation with up to 32MW heating power without large influxes of carbon impurities. The neutral beam and ICRF heating systems were used at their full power capabilities to prepare for equivalent breakeven experiments in deuterium plasmas. Present results project to performance in the breakeven regime in deuterium-tritium (D-T) plasmas. Work began on the upgrade of the ICRF system power from 7MW to 12.5MW.	Additional improvements to the transport diagnostics will be installed to develop an improved understanding of transport in tokamaks in order to increase the confidence in extrapolating from present tokamaks to BPX and ITER. Most of the work on the upgrade of the ICRF system will be completed and the system will be available in early FY 1992. The RF limiters will be upgraded to handle the additional power. Experiments will be limited 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 D-T operation using combined neutral beam and ICRF heating. Preparation for D-T operation will intensify in order to be ready for D-T experiments beginning in late 1993. The preparations include: commissioning the tritium handling and safety systems, installing limited remote maintenance equipment, setting up local shielding, installing a diagnostic to study the alpha particles produced by the fusion reactions, and preparing the neutral beams and vacuum systems for tritium operation. Scientists from ORNL will begin collaboration on TFTR experiments.
	$ 60,518	$ 59,300	$ 75,300
Base Toroidal	DIII-D continued energy confinement and high beta programs with optimized profile/shape control. A plasma beta value of 11% was achieved, which exceeds the BPX and ITER requirements. H-mode discharges with good confinement were sustained for 10 sec long pulses, and extensive information was obtained on the physics of H-mode plasmas. Programs on rf heating included completion of the Ion Bernstein Wave heating and the initiation of fast wave current drive experiments. A first prototype of the antenna for the 110GHz electron cyclotron heating (ECH) system was installed for current drive experiments. The advanced divertor	Energy confinement and high beta program will be continued in DIII-D, and divertor physics and biasing experiments in support of BPX and ITER R&D needs will begin. Installation of a 2MW 110GHz electron cyclotron frequency heating system will continue. Initial results from fast wave current drive experiments will be evaluated. Experimental operations will be limited due to budget restrictions.	Energy confinement and high beta program with plasma current and pressure profile control will be continued on DIII-D. Divertor pumping experiments will begin. Preliminary results will be obtained on non-inductive current drive at moderate beta. Experimental operations will be increased to 26 weeks with increased ECH and ICRF power. Profile control experiments will be performed in support of the steady-state tokamak program. Scientists from ORNL will expand their collaboration on the DIII-D program.

Program Activity	FY 1990	FY 1991	FY 1992
Base Toroidal (Cont'd)	baffle system for density control and edge modification was installed and initial results were obtained.		
	MIT continued to install the major components, diagnostics, data acquisition systems, and control system of Alcator C-Mod, a compact, high-field tokamak designed to study ICRF heating of high density plasmas in support of a BPX.	MIT will finish installation of the major components and begin operation of Alcator C-MOD, a high field, shaped, and diverted tokamak. They will conduct experiments with ohmic heating and pellet fueling. The ICRF heating experiments will begin at the 2MW level and will be extended to 4MW in 1992. They will also continue development of advanced diagnostics and advanced toroidal modes of operation for C-MOD.	Alcator C-MOD will finish the ohmic heating phase of operation and the ohmic limits will be evaluated. The second ICRF antenna will be installed, 2MW of source power will be brought up and full performance ICRF experiments will begin. MIT will begin upgrading the ICRF components to an 8MW, variable frequency system in support of high power ICRF experiments planned for BPX.
	On MTX a deuterium pellet injector was installed and used to produce high density target plasmas for future heating experiments. A 0.5MW, 140GHz gyrotron was recently installed for separate heating experiments and to provide an input for the FEL. Diagnostics provided by Japan were installed as part of the collaborative program on MTX.	The 140 Ghz gyrotron will be tested as a driver for the FEL. The accelerator system of the FEL will be rebuilt and the improved "wiggler" will be installed. The FEL will be used to conduct experiments on single-pulse microwave absorption and heating in high density plasmas. Then MTX will begin shut down at the end of the year.	Close out of the MTX experiment will be completed.
	International collaboration was continued for joint experiments on fueling, edge physics and particle control, heating and energy confinement on TEXTOR, ASDEX, JET, and Tore Supra, and JFT-2M. LH current drive experiments in ASDEX were completed; fueling and size scaling experiments continued on JET; as well as the pumped limiter experiments on TEXTOR and Tore Supra. The divertor biasing experiments on JFT-2M were completed.	Collaborative experiments on edge physics, particle control, fueling, heating, current drive, and confinement experiments will be continued 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.
	$ 59,817	$ 62,025	$ 65,200

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

Program Activity	FY 1990	FY 1991	FY 1992
Advanced Toroidal	An investigation of confinement characterization and improvement on ATF was continued, including work on low collisionality transport (bootstrap current and trapped electron modes) and edge fluctuation induced transport. These studies have contributed to the understanding of confinement physics in toroidal devices. Discharges with 20sec long pulses were produced.	The ATF program will be shutdown. Funding is provided for close out costs.	No activities.
	The PBX-M experimental operation was halted for the year in order to install the 1MW lower hybrid current drive and 2MW Ion Bernstein Wave (IBW) heating equipment. These projects were essentially completed by the end of the year.	The experimental program will be halted for another year of modest upgrades. No operations are planned due to budget constraints.	The experimental program will resume development 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.
	$ 15,623	$ 12,500	$ 12,750
Major Device Fabrication	Fabrication of all major systems for Alcator C-MOD at MIT is completed.	Final testing of all major systems of Alcator C-Mod will be carried out and initial operation will begin in mid FY 1991.	No activities.
	$ 3,410	$ 390	$ 0
Burning Plasma Experiment (CIT)	Carried out conceptual design optimization and a re-assessment of project technical objectives and design requirements. Accomplished R&D on materials to be used in magnets, vacuum vessel and other tokamak components.	Complete conceptual design and initiate preliminary design of tokamak. Continue R&D on materials and fabrication methods for tokamak components. Initiate procurements for fabrication of prototype tokamak components.	Complete preliminary design of device and final design of necessary prototypes. Initiate fabrication of manufacturing prototypes for the tokamak. Complete the NEPA review and safety evaluation required for start of construction in FY1993. Continue supporting technology R&D on materials and manufacturing processes to be used in tokamak manufacturing and assembly.
	$ 17,325	$ 16,700	$ 30,000

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

Program Activity	FY 1990	FY 1991	FY 1992
Tandem Mirror Operations	The mirror program will be completed with the final close-out of MFTF-B contracts.	No activities.	No activities.
	$ 2,500	$ 0	$ 0
Changes in Inventory	Support of spare parts primarily for TFTR.		
	$ 977	$ 0	$ 0
Magnetic Fusion Energy - Confinement Systems	$ 160,170	$ 150,915	$ 183,250

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

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 ignition and reactor design. 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 Advanced Fusion Concepts, there will be no activity in fiscal year 1992. During fiscal year 1991, selected research tasks that are of exploratory and broad scientific value and that can contribute to tokamak understanding will be integrated with other similar activity in the Experimental Plasma Research sub-category. The remaining Advanced Fusion Concept activity and in particular the two experiments at Los Alamos National Laboratory and one at Spectra Technology in Seattle will be phased out during fiscal year 1991.

Plasma processes that determine the success of magnetic confinement are complex. The Fusion Plasma Theory and Experimental Plasma Research elements supply basic tools for understanding these plasma processes and in FY 1992 emphasis will be on applying these tools to current tokamaks and predicting performance of BPX and ITER.

Theory is responsible for the development of concepts and models that describe and predict the behavior of magnetically confined plasma. In FY 1992 emphasis will be given to modelling and understanding of processes controlling transport of energy and particles in toroidal plasma and especially in ITER. Increased attention will be given to issues of importance to the Burning Plasma Experiment and ITER, particularly containment and thermalization of fast alpha particles produced in fusion burning as well as control of small scale instability (sawtooth), 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. This work uses both analytical and numerical techniques and is located at universities, national laboratories and industrial contractors.

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 1992, at selected tokamaks, recently installed diagnostics will be applied that can measure properties associated with energy and particle transport. Also, new diagnostic techniques required for measuring plasma properties will be developed and tested with particular attention to advanced diagnostic concepts 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 including ideas that were previously explored and developed under Advanced Fusion Concepts. 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 facilities provide support for the development of models and codes, for plasma theory, for management and interpretation of experimental results, and for design of large scale fusion experiments. The network consists of the computers at LLNL and five user service centers at LLNL, LANL, General Atomics, PPPL, and ORNL, together with international data links and telephone line access by smaller users. In FY 1992 improved computer network access will be used to more effectively manipulate output from the Cray computers.

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

The following table summarizes the operating funding for the Applied Plasma Physics subprogram.

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

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Advanced Fusion Concepts	$ 12,226	$ 7,650	$ 0	-100
Fusion Plasma Theory	19,444	19,100	18,900	- 1
Experimental Plasma Research	24,375	21,115	26,545	+ 26
MFE Computing	15,564	15,023	16,305	+ 9
Total, Magnetic Fusion Energy - Applied Plasma Physics	$ 71,609	$ 62,888	$ 61,750	- 2

II. B. Major Laboratory and Facility Funding

General Atomics	$ 2,855	$ 2,625	$ 2,775	+ 6
Lawrence Berkeley National Laboratory	$ 15,631	$ 10,430	$ 15,395	+ 48
Los Alamos National Scientific Laboratory	$ 7,576	$ 4,080	$ 1,100	- 73
Massachusetts Institute of Technology	$ 2,628	$ 3,045	$ 3,025	- 1
Oak Ridge National Laboratory	$ 4,220	$ 4,010	$ 4,045	+ 1
Princeton Plasma Physics Laboratory	$ 4,794	$ 3,915	$ 3,800	- 3
University of California - Los Angeles	$ 3,312	$ 2,975	$ 3,175	+ 7
University of Texas	$ 8,557	$ 7,635	$ 7,670	0
University of Wisconsin	$ 5,125	$ 5,295	$ 5,675	+ 7

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Magnetic Fusion Energy - Applied Plasma Physics			
Advanced Fusion Concepts	Continue support of the confinement physics research facility (CPRF) construction project under the construction account including development of research diagnostics.	Discontinue and close the CPRF construction project and phase out related support activity.	No activity.
	Use new equilibrium control on Madison symmetric torus (MST), and improve confinement.	Employ improved diagnostics on MST and correlate fluctuations with RFP and tokamak confinement. Move activity into the Experimental Plasma Research sub-category.	No activity.
	Complete LSX MDF in July.	Close out LSX and prepare program summary documentation and technical papers.	No activity.
	Continue Maryland Spheromak heating experiments. Obtain record high temperatures in FRC at LANL. Study compression heating and transport.	Phase out experiments of 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.
	Support LSX diagnostic development at universities.	Discontinue and close out research activities on this effort.	No activity.
	$ 12,226	$ 7,650	$ 0
Fusion Plasma Theory	Continue to emphasize theory of transport processes controlling plasma confinement.	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 sawtooth stabilization for burning plasmas.

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

Program Activity	FY 1990	FY 1991	FY 1992
Fusion Plasma Theory (Cont'd)	Continue theory related to burning plasma experiment with emphasis on plasma heating by RF waves (ICRF and ECH) and by fast alphas generated within reacting plasma.	Continue theory development in support of burning plasma experiment 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 burning plasma experiment and ITER with emphasis on alpha particle theory, and RF heating effects.
	Provide predictions of behavior for new FRC plasmas and refine RFP theory to support Wisconsin experiment and future RFP device at LANL.	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 results to tokamak improvement ideas.
	$ 19,444	$ 19,100	$ 18,900
Experimental Plasma Research	Evaluate experiments on helicity injection current drive. Develop concepts for current profile control in tokamaks.	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.
	Install new coils, vacuum chamber, additional diagnostics, and additional ECH power at TEXT and initiate transport studies with various edge configurations.	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 beam probe and related diagnostics on TEXT in ECH heated plasmas.
	Develop proof-of-principle alpha diagnostic for installation on major tokamak.	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.

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

Program Activity	FY 1990	FY 1991	FY 1992
Experimental Plasma Research (Cont'd)	Continue basic physics experiments in small stellarators and tokamaks with emphasis on understanding confinement.	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.
	Study effect of fluctuations on transport in major tokamaks. Develop combined spectroscopy with neutral beam as a diagnostic for transport study.	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.
	Compile atomic data for application to plasma edge issues.	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.
	$ 24,375	$ 21,115	$ 26,545
MFE Computing	Participate with Energy Sciences Advanced Computation (ESAC) in operation of the National Energy Research Supercomputing Center (NERSC) which operates two Cray 2 and one Cray XM-P 22 as well as the nationwide Energy Sciences Network (ESNET) computer network, providing access to supercomputers and facilities at fusion laboratories. In addition, this activity provides partial support for local computing at major fusion sites.	In cooperation with ESAC, operate the 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.
	Implemented plans for the Energy Sciences Network (ESNET) project as identified in the Applied Mathematical Sciences subprogram of the Basic Energy Sciences program. This subprogram's share for the implementation of ESNET was $915,000.	Upgrades of 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.
	$ 15,534	$ 15,023	$ 16,305

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

Program Activity	FY 1990	FY 1991	FY 1992
Magnetic Fusion Energy - Applied Plasma Physics	$ 71,609	$ 62,888	$ 61,750

DEPARTMENT OF ENERGY
FY 1992 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 technology development for the International Thermonuclear Experimental Reactor (ITER); the development of the technologies needed for TFTR, Burning Plasma Experiment and other present and future fusion experiments; and the design and analysis of fusion systems. The work is divided into three main areas: Plasma Technologies, Fusion Technologies, and Fusion Systems Analysis including the design of ITER.

The Secretary of Energy's Fusion Policy Advisory Committee recommended that the U.S. participate as an equal partner in the ITER Engineering Design Activity (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 the technology development. One of the goals of the engineering design effort is to qualify U.S. industrial firms to compete with industrial firms of other nations for the contracts to fabricate components and systems of the ITER device in the event it is decided at a later date to construct ITER. U.S. industrial firms will be sought to provide expertise in large project management, systems design and integration, scale-model components and specific technology development tasks. The technology development tasks selected for emphasis in FY 1992 are those tasks that require the longest lead time and are the most critical to the success of ITER. These technology development tasks are carried out through the Plasma Technologies and Fusion Technologies activities as discussed below.

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, and plasma fueling systems. The principal focus of this development is ITER. 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 the plasma. The ITER superconducting magnets require 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. 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, and improved fueling devices.

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 blanket and nuclear data, materials development and irradiation (including the scoping studies of a high energy neutron irradiation facility as recommended by FPAC), plasma material interaction, and environment and safety. Ongoing tasks under blankets and nuclear data include examination and design of the breeding blanket for ITER, cooperative 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 as well as BPX materials issues. In addition, there is ongoing research for future fusion structural materials in cooperation with Japan, the International Energy Agency (IEA), and the USSR. Under

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

Plasma Materials Interaction (PMI) research is continuing for low and high atomic number (Z) materials that would provide the capability to withstand higher heat flux and plasma erosion for the first wall and divertor. PMI research focuses on examining erosion and redeposition in present tokamaks, as well as tritium retention and release. 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. Full support of ITER engineering design activities is provided. The ARIES study will be completed in early FY 1992. Several follow-on studies that would provide information on program issues are being considered.

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.

The following table summarizes the operating expense funding for the Development and Technology subprogram.

II. A. Summary Table: Development and Technology

Program Activity	FY 1990	FY 1991	FY 1992	% Change
Plasma Technologies				
Magnetic Systems	$ 5,606	$ 3,600	$ 7,700	+ 114
Heating and Fueling	9,202	8,900	7,650	- 14
Subtotal, Plasma Technologies	$ 14,808	$ 12,500	$ 15,350	+ 23
Fusion Technologies				
Fusion Nuclear Technology	$ 5,629	$ 5,570	$ 6,200	+ 11
Environmental & Safety	1,960	2,110	2,200	+ 4
Fusion Materials	13,222	14,675	15,300	+ 4
Subtotal, Fusion Technologies	$ 20,811	$ 22,355	$ 23,700	+ 6
Fusion Systems Analysis	10,650	11,700	17,600	+ 50
Total, Development and Technology	$ 46,269	$ 46,555	$ 56,650	+ 22

II. B. Major Laboratory and Facility Funding

	FY 1990	FY 1991	FY 1992	% Change
Argonne National Laboratory	$ 3,646	$ 3,400	$ 3,760	+ 11
University of California at Los Angeles	$ 2,875	$ 2,860	$ 3,010	+ 5
Lawrence Livermore National Laboratory	$ 10,031	$ 6,835	$ 3,535	- 48
Los Alamos National Laboratory	$ 2,760	$ 2,700	$ 3,130	+ 16
Massachusetts Institute of Technology	$ 2,985	$ 2,675	$ 4,775	+ 79
Oak Ridge National Laboratory	$ 8,692	$ 9,084	$ 7,140	- 21
Pacific Northwest Laboratory	$ 3,312	$ 3,270	$ 3,445	+ 5
Sandia National Laboratories	$ 4,107	$ 5,185	$ 3,835	- 26

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Magnetic Fusion Energy - Development and Technology			
Plasma Technologies	In the magnet area, technology development of superconducting, high field, radiation tolerant magnets for ITER was continued. U.S. demonstration poloidal coil (DPC) was installed in Japan for testing.	In the magnet area, complete tests of U.S. demonstration poloidal coil (DPC) in Japan. Begin testing DPC in FENIX. Maintain base technology program to develop superconductors and structural materials data at cryogenic temperatures for ITER. FENIX high field test facility supports international collaboration.	In the magnet area, maintain base technology program to develop improved superconductors and structural materials data at cryogenic temperatures for ITER. Magnet component testing continues in FENIX. Design of ITER model coil and test facility begins.
	In the heating area, completed development and test of 0.4MW gyrotron and confirmed major aspects of the design of 1MW gyrotron.	In the heating area, complete majority of 1MW gyrotron test facility. Complete design and majority of fabrication and assembly of 1MW gyrotron.	In the heating area, test small scale negative ion accelerator for ITER. Complete 1 MW gyrotron test facility and test 140GHz, 1MW steady-state gyrotron. Operate 280GHz, 1MW short pulsed gyrotron.
	In the fueling area, higher speed pellet injector approaches assessed and narrowed to one or two.	In the fueling area, maintain development efforts on higher speed fueling devices for BPX and ITER.	In the fueling area, proceed with development and fabrication of higher speed fueling devices for BPX. ITER development continues.
	$ 14,808	$ 12,500	$ 15,350
Fusion Technologies	In the plasma/materials interaction/high heat flux area, ITER, TFTR, and BPX support continued, as did support for international collaborations on TEXTOR, ASDEX, and Tore Supra. Innovative impurity control techniques and carbon-based and beryllium materials were investigated. The Tritium Plasma Experiment was upgraded to densities which are ITER-relevant. Work on low Z divertor materials, which are regeneratable through plasma spraying, were increased.	In the plasma/materials interaction/high heat flux area, ITER, TFTR, and BPX support will continue, as will support for international collaborations on TEXTOR, ASDEX, and Tore Supra. Innovative impurity control techniques will be pursued. Carbon-based and beryllium materials will be investigated. Work on low Z divertor materials, which are regeneratable through plasma spraying, will be increased.	In the plasma/materials interaction/high heat flux area, ITER, TFTR, and BPX support will continue, as will support for international collaborations on TEXTOR, ASDEX, and Tore Supra. Innovative impurity control and edge plasma manipulation techniques will be pursued. Carbon-carbon composites, beryllium, and high Z materials will be investigated. Real time in-situ erosion and redeposition experiments investigating normal and off-normal events will be increased.

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

Program Activity	FY 1990	FY 1991	FY 1992
Fusion Technologies (Cont'd)	In the neutron interactive materials area, irradiation testing in HFIR and FFTF were continued in cooperation with Japan and with IEA partners. Continued R&D in support of ITER and CIT including low activation materials, fracture behavior, and special purpose ceramics and diagnostic system materials.	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 will continue to be developed for CIT, ITER, and power reactors. Evaluation of ceramic matrix composite materials will begin. Collaborative work with Japan and IEA partners include irradiations, data base development, and evaluation of neutron source concepts.	Neutron interactive materials programs will continue to use available fission reactors and other materials evaluation technologies. Scoping studies of a 14 MeV neutron source will be started in FY 1992. 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 and expanded evaluations of neutron source concepts will evolve through IEA participation. Work will be initiated on ITER structural materials.
	In the nuclear analysis area, blanket and shield technology area, continued research on reactor relevant blanket issues with the particular objective of design of ITER blanket modules.	In the nuclear analysis area, blanket and shield technology area, continue international cooperation in blanket research including design of next step tests. Maintain ITER blanket support.	In the nuclear analysis area, blanket and shield technology area, continue international cooperation in blanket research including design of next step tests. Maintain ITER blanket support, especially supporting the tritium breeding blanket. Work will be initiated on ITER remote maintenance and containment structures.
	In the tritium processing area, continued joint operation of tritium systems test assembly (TSTA) and installed Japanese Atomic Energy Research Institute (JAERI's) Fuel Cleanup System into TSTA loop.	In the tritium processing area, continue joint operation of TSTA and initiate tritium testing of JAERI's Fuel Cleanup System.	In the tritium processing area, continue joint operation of TSTA and complete tritium testing of JAERI's Fuel Cleanup System. Participate in ITER validating R&D.
	In the environment and safety program, continued with experimental and analytical efforts in tritium, activation products, blankets, and magnet areas and completed Environmental, Safety, and Economic Aspects of Magnetic Fusion Energy (ESECOM) report.	In the environment and safety program, continue with 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 ITER safety issues.

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

Program Activity	FY 1990	FY 1991	FY 1992
Fusion Technologies (Cont'd)	$ 20,811	$ 22,355	$ 23,700
Fusion Systems Analysis	Continue ITER conceptual design study. Continue the ARIES effort as planned with completion in FY 1992. Initiate unclassified conceptual design of IFE (Inertial Fusion Energy) reactors.	Complete the International Thermonuclear Experimental (ITER) Reactor Conceptual Design Activities (CDA). Reach a U.S. Government position and conclude a Four-Party Agreement to implement the six years of ITER Engineering Design Activities (EDA). EDA work during FY 1991 includes conducting an international review of the ITER design and establishing a Central ITER Team at a Joint Work Site.	Fully implement design for the ITER EDA on a Four-Party basis. Work during 1992 includes engineering design and analysis; scalable superconducting magnet model design. Complete ARIES study and begin next study to identify programmatic elements.
	$ 10,650	$ 11,700	$ 17,600
Magnetic Fusion Energy - Development and Technology	$ 46,269	$ 46,555	$ 56,650

DEPARTMENT OF ENERGY
FY 1992 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 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Planning and Projects...........................	$ 653	$ 4,142	$ 4,250	+ 3
Total, Planning and Projects	$ 653	$ 4,142	$ 4,250	+ 3

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Planning and Projects	Continue support for non-fusion landlord responsibilities.	Continue the program's legal obligation to support the SBIR program.	Continue the program's legal obligation to support the SBIR program.
	$ 653	$ 4,142	$ 4,250
Planning and Projects	$ 653	$ 4,142	$ 4,250

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

FUSION ENERGY

I. Preface: Inertial Fusion Energy

As an energy source fusion has very favorable environmental, safety, and fuel availability potential. 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 establishes this new budget category, Inertial Fusion Energy (IFE), to develop the potential of inertial fusion as an energy source. The IFE activity will be within Energy Research as a separate component of the Office of Fusion Energy.

This new activity will rely on coordination with the continuing development of Inertial Confinement Fusion (ICF) within the Defense Programs activities of DOE and will acquire and extend the Heavy Ion Fusion Accelerator Research (HIFAR) that has been undertaken 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 concepts but will be developed under Defense Programs activities. It is proposed to transfer the HIFAR activities previously funded in the Basic Energy Sciences program 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 allow delivery of 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 expected to produce about 100 times the energy required to implode the capsule. The implosion driving source must have energy efficiency considerably better than 1% to allow net energy release from the system. For a reasonable reactor 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. A new heavy ion test driver system called the Induction Linac Systems Experiment (ILSE) will be assembled at Lawrence Berkeley Laboratory to test, at low energy, the production, amplification, merger, and transport of the ion beams of the required type. 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 and chamber present 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 will be initiated in future years based on the reactor studies to be completed in FY 1992 and on collaboration with related research and development world-wide.

II. A. Summary Table: Inertial Fusion Energy

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Heavy Ion Beams................................	$ 0	$ 0	$ 6,850	>999
Reactor Technology.............................	1,150	1,600	1,300	- 19
Total, Inertial Fusion Energy	$ 1,150	$ 1,600	$ 8,150	+409

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Inertial Fusion Energy			
Heavy Ion Beams	No activity.	No activity.	TRANSFER: Heavy Ion Accelerator Physics will continue with emphasis on beam quality and merging techniques ($6,850,000). Specific research and development and final conceptual design will be undertaken for the Induction Linac Systems Experiment (ILSE).
	$ 0	$ 0	$ 6,850
Reactor Technology	Initiate unclassified design studies of ICF reactors.	Continue two design studies of IFE reactors. [The reactor design activity has been part of the Office of Fusion Energy, Development and Technology, Fusion Systems Analysis budget during FY 1990 and FY 1991.	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.
	$ 1,150	$ 1,600	$ 1,300
Inertial Fusion Energy	$ 1,150	$ 1,600	$ 8,150

DEPARTMENT OF ENERGY
FY 1992 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 national goal to provide an adequate supply of environmentally safe energy at reasonable cost and uses international collaboration as a major resource and to avoid needless duplication.

II. A. Summary Table: Program Direction

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Salaries and Expenses...........................	$ 4,425	$ 5,201	$ 7,140	+ 37
Other...	505	260	360	+ 38
Total, Program Direction	$ 4,930	$ 5,461	$ 7,500	+ 37

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Program Direction			
Salaries and Expenses	Provided funds for salaries, benefits, and travel for 61 full-time equivalents (FTEs) in the Office of Fusion Energy, the Office of Assessment and Support, and related program and management support staff. ($4,425)	Provide funds for salaries, benefits, and travel related to 64 FTEs included in the FY 1991 budget. ($5,201)	Provide funds for salaries, benefits, and travel for 77 FTEs. Provide for 16 additional FTEs transferred from the Departmental Administration appropriation, offset by transfer of three FTEs to other Energy Research programs. Also provide for normal increased personnel costs resulting, for example, from general pay raises and within-grade and merit increases. ($7,140)
	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. Continued extensive use of international collaboration to advance the program in a timely way, especially through joint projects, such as R&D and conducting the conceptual design for the ITER.	Continue program management as in FY 1990. Proceed with plans for development of a domestic fusion energy device as well as the ITER. Support increased environment, safety, and health (ES&H) responsibilities to ensure compliance with applicable regulations and directives, as well as increased international collaboration. Support the National Energy Strategy goal of securing future energy supplies.	Continue program management activities at the FY 1991 level of effort. Manage expanded programs in magnetic fusion energy and start of a new program involving Inertial Fusion Energy. Continue to focus on R&D and design to improve performance of a domestic device. Continue physics experiments in support of the Burning Plasma Experiment (BPX) and ITER. Manage other ongoing program activities to meet NES goals 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.

III. Program Direction (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Salaries and Expenses (Cont'd)	ER established the Office of Assessment and Support to provide environment, safety, and health (ES&H) oversight of ER field operations and support to line management in all areas of ES&H, and in safeguards and security, emergency preparedness, and quality assurance. Provided support for a wide variety of activities in these areas to ensure compliance with ES&H directives and regulations at fusion energy facilities. Designed risk acceptance, NEPA compliance, and ES&H appraisal programs, and initiated appraisals.	Continue to provide a portion of the total staffing requirement for the Office of Assessment and Support to implement oversight and support activities to ensure compliance with applicable ES&H regulations and directives.	TRANSFER: Two FTEs were transferred to the Advisory and Oversight Program Direction account within the Energy Supply, R&D appropriation.
	Provided program and management support in the areas of budget and finance, personnel administration, acquisition and assistance, policy and coordination, and construction management support.	Continue to provide program and management support at the FY 1990 level of effort.	TRANSFER: Continue to provide program and management support as in FY 1990 and FY 1991. However, one FTE was transferred to the Superconducting Super Collider Program Direction account in the General Science and Research appropriation. TRANSFER: Provide 14 FTEs to continue to support magnetic fusion energy activities carried out by the Chicago Operations 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. These resources were transferred from the Departmental Administration appropriation. TRANSFER: Provide two FTEs to continue to support magnetic fusion energy activities at the San Francisco Operations Office. These resources were transferred from the Departmental Administration appropriation.

III. Program Direction (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Salaries and Expenses (Cont'd)	$ 4,425	$ 5,201	$ 7,140
Other	Provided funds for a variety of program support services such as printing and editing, supplies, and materials. Also included 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 to provide the variety of program support required in FY 1990.	Continue the variety of program support required in FY 1991. Also provide support for the employees at Chicago and San Francisco Operations Offices who were reassigned to ER.
	$ 505	$ 260	$ 360
Program Direction	$ 4,930	$ 5,461	$ 7,500

DEPARTMENT OF ENERGY
FY 1992 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 1992 of $11,000,000 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 of equipment required to allow the science to advance. Listed below is a summary of the specific capital equipment needs by sub-program area.

II. A. Summary Table: Capital Equipment

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Confinement Systems	$ 6,535	$ 5,985	$ 4,650	- 22
Applied Plasma Physics	536	585	550	- 6
Development and Technology	3,038	3,845	4,950	+ 29
Planning and Projects	3,221	0	0	0
Inertial Fusion Energy	0	0	850	>999
Total, Capital Equipment	$ 13,330	$ 10,415	$ 11,000	+ 6

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Capital Equipment			
Confinement Systems	Complete purchase of main thyristor power supplies for Alcator C-MOD. Purchase instrumentation and data acquisition equipment to support transport research programs.	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.
	$ 6,535	$ 5,985	$ 4,650
Applied Plasma Physics	Provide general laboratory equipment for experimental research at national laboratories including plasma control and diagnostic equipment and equipment for alpha diagnostic devices.	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.
	$ 536	$ 585	$ 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 increase 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.
	$ 3,038	$ 3,845	$ 4,950
Planning and Projects	Purchase general purpose equipment to support non-fusion specific landlord responsibilities at ORNL to replace obsolete and worn equipment and to provide new state-of-the-art equipment.	TRANSFER: Landlord responsibilities at ORNL are reassigned to Environmental Research and Waste Management.	No activity.
	$ 3,221	$ 0	$ 0

III. Capital Equipment (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Inertial Fusion Energy			TRANSFER: Equipment funds are provided to support Heavy Ion Accelerator Physics Research.
	$ 0	$ 0	$ 850
Capital Equipment	$ 13,330	$ 10,415	$ 11,000

DEPARTMENT OF ENERGY
FY 1992 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 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
General Plant Projects...........................	$ 7,680	$ 2,063	$ 1,950	- 5
Confinement Physics Research Facility...........	10,915	5,518	0	-100
Fire & Safety Protection Improvements...........	0	0	2,600	>999
Total, Construction	$ 18,595	$ 7,581	$ 4,550	- 40

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
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 and support ORNL landlord requirements.	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.
	$ 7,680	$ 2,063	$ 1,950
Confinement Physics Research Facility	Proceed with fabrication of the coils and vessel/shell.	Project is terminated because of funding limitations. Funds are provided to satisfy contractual obligations and close-out costs.	No activity.
	$ 10,915	$ 5,518	$ 0
Fire & Safety Protection Improvements	No activity.	No activity.	Provides for initiation of a project to correct fire and safety deficiencies at the Princeton Plasma Physics Laboratory.
	$ 0	$ 0	$ 2,600
Construction	$ 18,595	$ 7,581	$ 4,550

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
OFFICE OF ENERGY RESEARCH
(dollars in thousands)

KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

Fusion Energy

IV. A. Construction Project Summary

Project No.	Project Title	Total Prior Year Obligations	FY 1991 Appropriated	FY 1992 Request	Unappropriated Balance	TEC
92-E-340	Fire and Safety Protection Improvements	$ 0	$ 0	$ 2,600	$ 2,200	$ 4,800
92-E-341	Burning Plasma Experiment	0	0	0	0	0
GPE-900	General Plant Projects	7,680	2,063	1,950	0	1,950
89-R-800	Confinement Physics Research Facility	52,499	5,518	0	0	N/A
Total, MFE Construction		XXX	$ 7,581	$ 4,550	$ 2,200	$ 6,750

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
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: 92-E-340 Fire and Safety Improvements
Princeton Plasma Physics Laboratory

Project TEC: $ 4,800
Start Date: 1st Qtr. FY 1992
Completion Date: 4th Qtr. FY 1993

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1992	2,600	2,600	1,000
1993	2,200	2,200	2,000
1994	0	0	1,800

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 Request	To Complete
Construction...........	$ 0	$ 2,600	$ 2,200

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
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: $ 1,950
Start Date: 1st Qtr. FY 1992
Completion Date: 4th Qtr. FY 1993

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1992	$ 1,950	$ 1,950	$ 1,950

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..	1,800
Oak Ridge National Laboratory...	150
	$ 1,950

4. Total Project Funding (BA):

	Prior Years	FY 1990	FY 1991	FY 1992 Request	To Complete
Construction...........	$ 0	$ 0	$ 0	$ 1,950	$ 0

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
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

3. Date A-E work initiated: 1st Qtr. FY 1992

3a. Date physical construction starts: 2nd Qtr. FY 1992

4. Date construction ends: 4th Qtr. FY 1993

5. Previous cost estimate: None
Date:

6. Current cost estimate: $1,950
Date: January 1991

7. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1990	Costs FY 1991	Costs FY 1992	Costs After FY 1992
Prior Year Projects	XXXXXXXX	$ 6,269	$ 0	$ 0	$ 0
FY 1990 Projects	$ 7,680	2,751	3,000	1,200	729
FY 1991 Projects	2,063	0	1,000	1,000	63
FY 1992 Projects	1,950	0	0	800	1,150
		$ 9,020	$ 4,000	$ 3,000	$ 1,942

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.

1. Title and location of project: General plant projects

2. Project No.: GPE-900

8. Brief Physical Description of Project (continued)

The current estimated distribution of FY 1992 funds by location is as follows:

1. Los Alamos National Laboratory	$ 0
2. Princeton Plasma Physics Laboratory	1,800
3. Oak Ridge National Laboratory	150
	$ 1,950

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

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

Princeton Plasma Physics Laboratory*		$ 1,800
Fire Safety Improvements	425	
Life Safety Code Compliance Modifications	150	
Roof Replacement and Structural Reinforcement	250	
Miscellaneous Building and Facility Repairs, Space Upgrades and Modifications	335	
TFTR Experimental Area HVAC System	120	
Replace Six HVAC Units - Central Computer Room	150	
Miscellaneous Small Projects	370	
Oak Ridge National Laboratory		$ 150

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

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

CONSTRUCTION PROJECT DATA SHEET

1. Title and location of project: Fire and Safety Protection Improvements at Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 92-E-340

9. Purpose, Justification of Need for, and Scope of Project (Continued)

Sprinkler Systems and Fire Walls

DOE fire protection policy as contained in DOE Order 5480.7 dated 11-16-87 requires automatic fire suppression whenever the potential fire loss exceeds $1 million. In an effort to achieve compliance with this policy, the laboratory has added sprinkler systems to several parts of the facility; however, this piecemeal approach is costly, inefficient and slow. This project would provide sprinkler protection throughout the remaining important unsprinklered portions of the laboratory in order to assure compliance with DOE Order 5480.7. Sprinkler protection is also used to achieve Life Safety Code exit distance compliance in one building.

DOE Order 5480.7 also requires the limitation of fire spread by physical means (e.g. geographic isolation, fire walls, firedoors, draft barriers). This part of the project will provide the work necessary to assure that effective fire walls exist in appropriate locations throughout the laboratory.

The effect of disapproval will be a higher risk of fire loss or personnel injury during a fire or other emergency at the laboratory.

10. Details of Cost Estimated[a/]

	Item Costs	Total Cost
a. Engineering, design, construction management and inspection at about 16.7% of construction cost, item b...........		$ 600
b. Land Costs..		0
(No land acquisition required; existing lands to be utilized for project)		
c. Construction costs..		3,600
(1) Fire Alarm System Replacement..................................	$1,000	
(2) Life Safety Code Compliance Improvements.......................	900	
(3) Sprinkler Systems and Fire Walls...............................	1,700	
d. Contingency at about 14.3% of above costs...........................		600
Total estimated cost...		$4,800[b/]

a/ The above estimates are based on conceptual design and feasibility studies which are 100% complete.

b/ All costs are stated in current year dollars consistent with the inflation factors promulgated by DOE (15% for FY 1992 and 21.5% for FY 1993).

CONSTRUCTION PROJECT DATA SHEET

1. Title and location of project: Fire and Safety Protection Improvements at Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 92-E-340

11. Method of Performance

The engineering, design and inspection shall be performed under a single, or series of, negotiated architect or engineer subcontracts.

Construction and equipment procurement for the project shall be accomplished by fixed price contracts awarded on the basis of competitive bidding.

Management of all contracts for engineering, design inspection, materials testing and construction shall be performed by PPPL to maximize the effective integrated performance of all participants involved in project development.

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

Not required.

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

Not required.