DOE/MA-0274
Volume 2 of 4

Congressional Budget Request

Energy Supply Research and Development
Nuclear Waste Fund

Volume 2

FY 1988

U.S. Department of Energy
Assistant Secretary,
Management and Administration
Office of the Controller

January 1987

DEPARTMENT OF ENERGY

FISCAL YEAR 1988 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATIONS

BUDGET AUTHORITY IN THOUSANDS OF DOLLARS

	FY 1986 Actual BA	FY 1987 Estimate BA	FY 1988 Request BA
Appropriations Before The Energy and Water Development Subcommittees:			
Energy Supply Research and Development	$ 1,701,351	$ 1,254,131	$ 1,914,710
Uranium Enrichment	1,549,015	1,210,400	1,070,000
General Science and Research	659,059	719,517	814,498
Atomic Energy Defense Activities ..	7,292,405	7,481,852	8,050,000
Departmental Administration	235,676	139,509	166,133
Alaska Power Administration	3,245	2,881	3,026
Bonneville Power Administration ...	404,329	327,659	205,800
Southeastern Power Administration .	---	19,647	27,400
Southeastern - Continuing Fund	4,028	---	---
Southwestern Power Administration .	29,180	25,337	16,648
Western Area Power Administration .	195,842	240,309	295,515
Western Area Power Emergency Fund .	147	225	---
Federal Energy Regulatory Commission	45,107	-3,465	-900
Nuclear Waste Fund	499,037	499,000	500,000
Geothermal Resources Development Fund	69	72	72
Subtotal, Appropriations Before the Energy and Water Development Subcommittees	$12,618,490	$11,917,074	$13,062,902

DEPARTMENT OF ENERGY

FISCAL YEAR 1988 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATIONS

BUDGET AUTHORITY IN THOUSANDS OF DOLLAR

	FY 1986 Actual BA	FY 1987 Estimate BA	FY 1988 Request BA
Appropriations Before Interior and Related Agencies Subcommittees:			
Alternative Fuels Production	$ 2,775	$ ---	$ ---
Clean Coal Technology	---	---	50,000
Fossil Energy Research and Development	309,389	251,402	168,900
Naval Petroleum and Oil Shale Reserves	13,002	122,177	159,700
Energy Conservation	426,187	149,679	86,090
Energy Regulation	23,423	23,400	21,680
Emergency Preparedness	5,750	6,044	6,206
Strategic Petroleum Reserve	107,533	147,433	270,181
Energy Information Activities	57,724	60,301	61,599
Subtotal, Interior and Related Agencies Subcommittees	945,783	760,436	824,356
Subtotal, Energy and Water Development Subcommittees	12,618,490	11,917,074	13,062,902
Subtotal, Department of Energy	13,564,273	12,677,510	13,887,258
Permanent - Indefinite Appropriations:			
Payments to States	629	705	727
Total, Department of Energy	$13,564,902	$12,678,215	$13,887,985

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL STAFFING REQUEST
TOTAL WORK FORCE

	FY1986 FTE USAGE	FY1987 -FY86	FY1987 CONGR REQ	FY1988 -FY87	FY1988 CONGR REQ
ENERGY & WATER SUBCOMMITTEE					
HEADQUARTERS	4,663	170	4,833	47	4,880
FIELD	9,393	62	9,455	-4	9,451
SUBCOMMITTEE TOTAL	14,056	232	14,288	43	14,331
INTERIOR SUBCOMMITTEE					
HEADQUARTERS	1,254	-13	1,241	-104	1,137
FIELD	883	5	888	-143	745
SUBCOMMITTEE TOTAL	2,137	-8	2,129	-247	1,882
GRAND TOTAL	16,193	224	16,417	-204	16,213
ADJUSTMENT		-317	-317	54	-263
ADJUSTED TOTAL	16,193	-93	16,100	-150	15,950

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL STAFFING REQUEST
TOTAL WORK FORCE

	FY1986 FTE USAGE	FY1987 -FY86	FY1987 CONGR REQ	FY1988 -FY87	FY1988 CONGR REQ
10:ENERGY SUPPLY RESEARCH AND DEV	918	8	926	0	926
HEADQUARTERS	635	4	639	0	639
FIELD	283	4	287	0	287
15:URANIUM ENRICHMENT	65	2	67	0	67
HEADQUARTERS	54	2	56	0	56
FIELD	11	0	11	0	11
20:GENERAL SCIENCE AND RESEARCH	38	1	39	0	39
HEADQUARTERS	38	1	39	0	39
25:ATOMIC ENERGY DEFENSE ACTIVITI	2,718	142	2,860	30	2,890
HEADQUARTERS	491	52	543	19	562
FIELD	2,227	90	2,317	11	2,328
30:DEPARTMENTAL ADMINISTRATION	3,273	77	3,350	20	3,370
HEADQUARTERS	1,693	46	1,739	5	1,744
FIELD	1,580	31	1,611	15	1,626
34:ALASKA POWER ADMINISTRATION	36	2	38	-3	35
FIELD	36	2	38	-3	35
36:BONNEVILLE POWER ADMIN	3,491	-61	3,430	-50	3,380
FIELD	3,491	-61	3,430	-50	3,380
38:SOUTHEASTERN POWER ADMIN	38	2	40	0	40
FIELD	38	2	40	0	40
42:SOUTHWESTERN POWER ADMIN	193	-7	186	0	186
FIELD	193	-7	186	0	186
46:WAPA - POWER MARKETING	1,176	-16	1,160	0	1,160
FIELD	1,176	-16	1,160	0	1,160
50:WAPA - COLORADO RIVER BASIN	219	0	219	0	219
FIELD	219	0	219	0	219
52:FEDERAL ENERGY REGULATORY COMM	1,597	62	1,659	0	1,659
HEADQUARTERS	1,597	62	1,659	0	1,659
54:NUCLEAR WASTE FUND	291	20	311	46	357
HEADQUARTERS	154	3	157	23	180
FIELD	137	17	154	23	177
56:GEOTHERMAL RESOURCES DEV FUND	1	0	1	0	1
HEADQUARTERS	1	0	1	0	1
65:FOSSIL ENERGY RESEARCH AND DEV	706	-3	703	-113	590
HEADQUARTERS	141	-3	138	0	138
FIELD	565	0	565	-113	452
70:NAVAL PETROL & OIL SHALE RES	99	-4	95	0	95
HEADQUARTERS	20	2	22	0	22
FIELD	79	-6	73	0	73
75:ENERGY CONSERVATION	322	30	352	-109	243
HEADQUARTERS	201	26	227	-84	143
FIELD	121	4	125	-25	100
80:EMERGENCY PREPAREDNESS	64	7	71	0	71
HEADQUARTERS	64	7	71	0	71
81:ECONOMIC REGULATION	348	-53	295	-20	275
HEADQUARTERS	348	-53	295	-20	275
85:STRATEGIC PETROLEUM RESERVE	152	-5	147	-5	142
HEADQUARTERS	34	-12	22	0	22
FIELD	118	7	125	-5	120
90:ENERGY INFORMATION ACTIVITIES	446	20	466	0	466
HEADQUARTERS	446	20	466	0	466
94:ADVANCES FOR CO-OP WORK	2	0	2	0	2
FIELD	2	0	2	0	2
GRAND TOTAL	16,193	224	16,417	-204	16,213
ADJUSTMENT		-317	-317	54	-263
ADJUSTED TOTAL	16,193	-93	16,100	-150	15,950

ENERGY SUPPLY, RESEARCH AND DEVELOPMENT ACTIVITIES

(Including Transfer of Funds)

For expenses of the Department of Energy activities including the purchase, construction and acquisition of plant and capital equipment and other expenses incidental thereto necessary for energy supply, research and development activities, and other activities in carrying out the purposes of the Department of Energy Organization Act (Public Law 95-91), including the acquisition or condemnation of any real property or any facility or for plant or facility acquisition, construction, or expansion; purchase of passenger motor vehicles (not to exceed [18] 21 for replacement only), [$1,347,048,000,] $1,909,710,000, to remain available until expended; [in addition $684,158,000 shall be derived by transfer from Uranium Supply and Enrichment Activities provided in prior years and shall be available until expended; and of which $84,100,000 which shall be available only for the Center for New Industrial Materials; the Center for New Industrial Materials; the Center for Nuclear Imaging Research; the Energy Research Complex; Saint Christopher's Hospital for Children - Energy Demonstration Project; Center for Excellence in Education - Energy Utilization Performance Project; the Institute of Nuclear Medicine; the Advanced Science Center; the Center for Science and Engineering; and funds provided for byproducts utilization activities shall be available only for the following regional projects: Florida Department of Agriculture and Consumer Services; Hawaii Department of Planning and Economic Development; Iowa State University; Oklahoma, Red-Ark Develoment Authority; Washington, Port of Pasco; State of Alaska.] (Energy and Water Development Appropriations Act, 1987 as included in Public Laws 99-500 and 99-591, section 101(e),) and in addition, as authorities by section 201 of Public Law 95-238 and notwithstanding 31 U.S.C. 3302, revenues received as user fees for use of the Liquified Gaseous Fuels Spill Test Facility in Fiscal Year 1988 shall be retained and used to provide toxic and flammable spill test facilities and activities.

Explanation of Change

Deletes Language contained in Public Laws 99-500 and 99-591 which had specific application to fiscal year 1987.

Proposed Language provides fees from non-Federal users of the Liquified Gaseous Fuels Spill Test Facility in Nevada to be received into the account as reimbursable expenses to be retained and used to operate, manage and maintain the facility.

DEPARTMENT OF ENERGY

FISCAL YEAR 1988 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATION BY MAJOR ACTIVITY

ENERGY SUPPLY RESEARCH AND DEVELOPMENT

BUDGET AUTHORITY IN THOUSANDS OF DOLLARS

	FY 1986 Actual	FY 1987 Estimate	FY 1988 Request
Solar Energy	$ 143,464	$ 123,532	$ 71,175
Cooperative Venture R&D Pools	---	---	5,000
Geothermal	26,495	20,830	15,935
Hydropower	481	450	---
Electric Energy Systems	11,387	11,276	6,500
Energy Storage Systems	17,142	16,589	7,500
Nuclear Energy R&D	372,037	327,474	334,170
Remedial Action & Waste Technology .	229,915	276,870	251,500
Civilian Waste R&D	15,991	6,500	5,000
Environmental, Safety and Health ...	44,004	62,014	70,000
Biological and Environmental Research	178,000	193,992	217,500
Liquified Gaseous Spill Test Facility	1,732	2,000	500
Magnetic Fusion	361,480	345,313	345,600
Basic Energy Sciences	419,850	525,450	479,075
Energy Research Analysis	2,567	2,000	3,700

DEPARTMENT OF ENERGY

FISCAL YEAR 1988 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF ESTIMATES BY APPROPRIATION BY MAJOR ACTIVITY

ENERGY SUPPLY RESEARCH AND DEVELOPMENT (CONTINUED)

BUDGET AUTHORITY IN THOUSANDS OF DOLLARS

	FY 1986 Actual	FY 1987 Estimate	FY 1988 Request
University Research Instrumentation.	6,176	5,000	5,000
University Research Support	10,168	15,775	13,400
Advisory and Oversight Program Direction	2,674	2,490	3,200
Multi-Program Laboratories Facilities Support	39,908	56,695	56,600
Small Business Innovation Research Program	29,137	---	---
In-House Energy Management	11,715	16,500	18,880
Strategic Facilities Utilization Program	---	---	2,175
Technical Information and Management	12,407	14,698	14,000
Policy and Management	3,497	3,874	4,300
Subtotal, Energy Supply R&D ...	1,940,227	2,029,322	1,930,710
Less Use of Prior Year Balances and Other Adjustment	-238,876	-775,191	-16,000
Total, Energy Supply R&D............	$1,701,351	$1,254,131	$1,914,710

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT

OVERVIEW

Magnetic Fusion Energy

The goal of this program is to establish the scientific and technological base required for achieving magnetic fusion energy. The program is being conducted according to the Magnetic Fusion Program Plan (MFPP), which was developed in 1985. This Plan took into consideration the constraints on Federal spending, the uncertainty of energy supply, the excellent technical progress in fusion research, the program's ability to train creative scientists and engineers, the contributions of fusion to basic research in the fields of plasma physics and atomic physics, and the important role of this program in technology transfer to U.S. industry. The Plan also recognized the importance of the fusion program--a complex scientific effort directed at a practical application. This plan has been accepted by both the Congress and the technical community.

In this plan, the target for completion of magnetic fusion development is determined by the present technical, economic, and political uncertainties of energy supply. Given timescales for the resolution of these uncertainties, it follows that the scientific and technological base for fusion should be essentially available by the turn of the century.

The strategy for providing this scientific and technological base is twofold: (1) maintenance of a strong, domestic R&D program to adequately cover the necessary range of fusion science and technology issues, and (2) use of international collaboration to advance the program in a timely way.

International collaboration is an important facet of the activities associated with the development of fusion energy. The fusion program has a long history of scientific exchange and cooperation. The Economic Summit process has provided a mechanism for systematically developing a coordinated fusion program among the summit nations. A great deal of progress toward this goal has been made through the Economic Summit members Fusion Working Group (FWG). In particular, the FWG deliberations have resulted in the identification of the common mid-term goal of these major fusion research programs, namely, an Engineering Test Reactor (ETR). Most recently, the Reagan/Gorbachev Summits have stimulated the interests of all parties in prospect of collaborating to achieve this common goal.

The Geneva Summit statement advocated the widest practicable development of international cooperation to attain the beneficial use of fusion energy. This intent was reinforced at the Reykjavik meeting and resulted in a specific U.S. proposal. The proposal was that the European Community, Japan, the United States, and the Union of the Soviet

Socialist Republics join together to develop a common ETR conceptual design report (CDR)and to perform the R&D supporting the design.

The activity proposed by the United States would prepare any nation or group of nations for subsequent decisions on construction of an ETR. This budget request contains sufficient funding to support the U.S. share of the necessary design work and supporting research and development. The design work will be carried out in a coordinated fashion by comparable design teams working in each nation. The supporting R&D work will be carried out by the parties within their national programs or under existing bilateral and multilateral agreements.

The initiation of an international ETR activity is particularly timely in light of the progress achieved this year in the world's large tokamak experiments. In particular, the Tokamak Fusion Test Reactor (TFTR) at the Princeton Plasma Physics Laboratory has set significant new records by reaching reactor level ion temperatures of 250 million degrees and, in separate experiments, plasma confinement within a factor of two of that required for an ETR. These record achievements are the consequence of the progress made over the past years in solving many smaller, but no less important problems of fusion research. This budget request supports the continuation of a wide range of research that is essential, both for producing continued advances such as the recent TFTR results, as well as for attaining the capability to proceed in the future with more ambitious steps such as the ETR.

Although magnetic fusion research and development is addressing a wide range of detailed scientific and technological problems, the work described in this budget request can be summarized in terms of the four key technical issues defined in the U.S. fusion program plan. These issues have also been agreed to by the Economic Summit members FWG as the focus for planning future research facilities.

The first of these issues concerns magnetic confinement systems. The particular geometry of the magnetic field used to confine a fusion plasma will have a profound influence on the eventual economics of a fusion device. Although significant progress continues to be made in understanding the confinement physics process, we do not have enough scientific knowledge at this time to design a fusion reactor that is suitable for commercial application. Therefore, a variety of confinement systems must continue to be investigated at the scientific level. Research on this key issue is on the international scene being closely coordinated to maintain the broadest scientific coverage at minimum cost. This budget request supports the United States' share of research in developing the tokamak, in participating in both an international Stellarator and a Reversed Field Pinch program, and performing smaller scale basic research in this area.

The second key technical issue concerns the properties of burning plasmas. Understanding the properties of burning plasmas is required to complete the scientific base. This step requires a new experimental device that is capable of achieving ignition and plasma burn for the first time. No such experiment currently exists or is under construction in the world. The United States is in the best technical position to proceed with such an experiment.

As part of joint international planning to avoid duplication of costly facilities, the European Community and Japan have supported the United States' proposal to undertake a Compact Ignition Tokamak (CIT) experiment to provide critical information to support operation of their planned engineering test facilities, Next European Tokamak (NET) and Fusion Energy Reactor (FER) or the equivalent international ETR. We expect modest participation from other countries on such an ignition experiment once a commitment to proceed is made. This budget submission contains funding for architect/engineering (A/E) design and R&D support for the CIT project.

The proposed schedule for CIT is determined by both domestic and international program considerations. A timely U.S. CIT will provide vital information on how to operate an ETR in the ignited mode, saving several years of costly exploratory research on the reactor itself. Europe and Japan have made it clear that our ignition experiment should provide this information in the early 1990's to maintain the orderly progress of their programs.

In order to complete the CIT by the early 1990's, and to make the best use of existing domestic plant and personnel resources, the TFTR facility at the Princeton Plasma Physics Laboratory (PPPL) will be used for the CIT. The TFTR experiment will shut down after completion of its scientific program, and the Princeton staff will operate CIT. This budget proposal positions the U.S. to build on experimental progress to date, to use past U.S. investments in facilities and personnel to proceed with its own next step and to support international fusion progress in a major and cost effective way.

The third key issue concerns the nuclear technology of fusion systems. This issue requires advances in engineering sciences, as well as the application of the results of basic fusion material research. This issue will be resolved only when blankets are tested in a nuclear environment, such as in an ETR. As noted above, this budget supports the design and supporting R&D for such an ETR, as well as basic technology research that underlies the development of blankets for the future.

The fourth key issue concerns materials for fusion systems. Since materials play a central role in determining the environmental characteristics of a fusion reactor, they are one of the keys to realizing the benefits of fusion. Achievement of the program goal requires the development of new materials to enhance the economic and environmental potential of fusion, as well as the facilities required for testing these materials. Although of lower near term priority than the preceding issues, the research needed here requires a long time to complete and must be carried out as part of a complete fusion effort. The proposed FY 1988 budget supports the core domestic program which supports work in this area. This includes U.S. participation in a world-wide materials development effort now under discussion within the International Energy Agency (IEA).

In summary, this budget provides for a U.S. fusion program focused on the key technical issues and interwoven tightly with other world fusion programs through international collaboration. The result is a cost-effective path to the development of fusion energy.

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

LEAD TABLE

Magnetic Fusion Energy

	FY 1986 Actual	FY 1987 Appropriation	FY 1988 Base	FY 1988 Request	% Change from FY 1987 Approp.
Confinement Systems..........	$188,661	$186,500 c/	$186,500	$170,920	-8
Applied Plasma Physics.......	69,692	73,500 c/	73,500	73,075	-1
Development and Technology...	57,641	50,510	50,510	55,915	+11
Planning and Projects........	946	4,653	4,653	4,520	-3
Program Direction............	3,608	3,940	4,035	4,600	+17
Capital Equipment............	28,279	18,010	18,010	19,670	+9
Construction.................	12,653	8,200	8,200	16,900	+106
Total.......................	361,480	345,313	345,408	345,600	0
Operating Expenses.........	(320,548)	(319,103)	(319,198)	(309,030)	-3
Capital Equipment..........	(28,279)	(18,010)	(18,010)	(19,670)	+9
Construction...............	(12,653)	(8,200)	(8,200)	(16,900)	+106
Total Program..............	($361,480) a/b/	($345,313)	($345,408)	($345,600)	0
Staffing (FTEs)............	62	62	62	62	

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

a/ Total has been reduced by $3,989,000 which has been transferred to SBIR program.
b/ Total has been reduced by $14,358,000 in accordance with P.L. 99-177, the Balanced Budget and Emergency Deficit Control Act of 1985 (Gramm/Rudman/Hollings).
c/ Includes proposed reprogramming request of $2.8 million from Confinement Systems to Applied Plasma Physics to carry out Congressional guidance contained in FY 1987 appropriation request.

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

SUMMARY OF CHANGES

Magnetic Fusion Energy

FY 1987 Appropriation enacted..	$345,313
Adjustments - FY 1987 Pay raise plus one additional day..	+95
FY 1988 Base...	345.408
Operating Expenses	
- The overall operating budget has been decreased about 3% in about 6% in real terms, requiring some experiments to be stretched out and the objectives to be further focused on only the *highest priority* issues. *The most significant area of decrease is in Mirror Confinement Systems* where the TARA experiment will be terminated and close out cost on MFTF-B are completed.........	-10,168
Capital Equipment	
- Funding is increased in the Toroidal Confinement Systems area to provide support for the experimental programs and to partially restore it to the FY 1986 level of support...............	+1,660
Construction	
- This increase is associated with initiation of construction effort on the Compact Ignition Tokamak at the Princeton Plasma Physics Laboratory and the General Plant Projects...............	+8,700
FY 1988 Congressional Budget Request..	$345,600

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

MAGNETIC FUSION ENERGY

I. Preface: Confinement Systems

The Confinement Systems subprogram supports experimental research on controlling and heating the plasmas required for a magnetic fusion energy source. This research is conducted primarily on toroidal configurations which have been proven most effective in providing the necessary plasma parameters. This work involves developing a data base needed to resolve scientific issues, preparing for a burning plasma experiment and working on identifying an optimum confinement system. The approach used is to build upon theory, modeling, and previous experimental results and to fabricate new devices with specific goals that help complete the data base. The primary technical issues being addressed by this research are energy confinement, plasma stability, heating, current drive and impurity and particle control.

Energy confinement relates to understanding plasma behavior so that plasma can be confined long enough for significant fusion reactions to occur. The plasma also must be heated to high termperatures for the fusion reaction to occur. Auxiliary heating methods, such as neutral beam heating and radiofrequency (rf) wave heating, are being evaluated experimentally in a high power environment. As the temperature and density of the plasma increase, pressure increases and the output of fusion power increases. Plasma stability is characterized by the parameter beta which indicates the maximum plasma pressure which can be confined in a given magnetic field. Since higher magnetic fields require larger, more costly magnets, it is desirable to maximize beta. Research is being done to determine the optimum value of beta for stable operation to ensure that the magnetic fields are used as efficiently as possible.

The current drive issue addresses the operation of devices in a steady state mode as opposed to a pulsed mode. The primary advantage to a steady state mode is that it will reduce component fatigue problems and machine size. Planned experiments will attempt to drive continuous currents in tokamaks with rf. The final issue is impurity and particle control. Impurities cool the plasma and cause it to shrink and become unstable. Thus, impurities must be controlled throughout the period of operation. A major source of these impurities is particles hitting the vessel walls. 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. The other half of this issue is fueling to replenish the reacting ions. Current experiments indicate that fueling by injection of frozen pellets will work satisfactorily.

Research is being conducted on several toroidal devices to prepare for addressing the burning plasma issue. The confinement of high temperature plasmas will be studied in the Tokamak Fusion Test Reactor (TFTR) device at Princeton Plasma Physics Laboratory (PPPL). Experiments on the beta issue will be carried out on the Doublet-III-D device at GA Technologies. The objective of the Alcator C Modification facility at the Massachusetts Institute of Technology (MIT) is to study rf heating current drive and current ramp up in a high field, high density plasma. International collaboration will be relied on to carry out research on a number of related plasma issues in foreign facilities including Textor and ASDEX in West Germany, Tore Supra in France, Joint European Torus (JET) in Europe, and JT-60 in Japan.

A concentrated U.S. analysis effort has been underway to establish the physics bases for achieving ignition and burn, using the experimental data base from these U.S. and foreign experiments. Achievement of ignition has always been a major objective of magnetic fusion research. We have now reached the point where experimental progress justifies proceeding with an ignition experiment. This budget proposes a construction project to build such an ignition device, the Compact Ignition Tokamak (CIT), at PPPL.

Work on identifying an optimum toroidal confinement system will be conducted on several advanced toroidal machines including the Princeton Beta Experiment (PBX) at PPPL and the Advanced Toroidal Facility (ATF) at the Oak Ridge National Laboratory (ORNL). PBX will study the feasibility of very high beta tokamak operation with a bean shaped plasma. ATF, a flexible stellarator device, will be used to investigate whether an external helical coil configuration can be used to improve tokamak performance. These devices will also explore regimes that are theoretically predicted to produce much higher betas than present tokamaks.

Upgrades and modifications to existing devices are supported by major device fabrication (MDF) projects. These projects increase the inherent capability of the devices in a cost effective way as progress is made towards understanding the relevant physics issues.

In the Mirror Systems subprogram, a modest research effort is conducted investigating the linear approach to confining plasmas. The tandem mirror is presently the main approach used in linear systems. These systems are intrinsically steady-state and provide a good vehicle for plasma physics studies in conditions comparable to divertor and edge plasmas in toroidal devices. Physics issues that need to be addressed include heating, and understanding of confinement.

The primary facilities available for mirror research include the axisymmetric tandem mirror TARA device at MIT and Phaedrus at the University of Wisconsin. The Mirror Fusion Test Facility-B, which was recently completed at LLNL, is currently being maintained in a standby condition.

The following table summarizes the operating expense funding for the Confinement Systems subprogram:

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Toroidal Systems				
Tokamak Fusion Test Reactor.....	$ 67,029	$ 72,190	$ 71,600	- 1
Base Toroidal Research..........	46,995	40,051	38,560	- 4
Advanced Toroidal Research......	13,010	27,001	32,860	+11
Major Device Fabrication........	14,778	16,128	11,040	-19
Compact Ignition Tokamak........	600	9,960	8,000	-20
Subtotal, Toroidal Systems....	142,412	165,330	162,060	- 2
Mirror Systems....................	46,249	21,170	8,860	-58
Total, Confinement Systems.....	$188,661	$186,500	$170,920	- 8

II. B. Major Laboratory and Facility Funding

	FY 1986	FY 1987	FY 1988	% Change
GA Technologies....................	$ 31,049	$ 29,785	$ 28,500	- 4
Lawrence Livermore National Lab...	40,308	27,340	15,600	-43
Massachusetts Institute of Tech...	16,594	17,640	14,535	-18
Oak Ridge National Laboratory.....	17,688	21,017	21,795	+ 4
Princeton Plasma Physics Lab......	76,367	81,920	86,125	+ 5
Total..........................	$182,006	$177,702	$166,555	- 4

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Tokamak Fusion Test Reactor	Operate TFTR at full design parameters and conduct heating experiments using four neutral beam heating lines capable of providing 15-20 MW of heating power. These experiments are designed to	Continue experiments in hydrogen and deuterium plasma at higher power levels with long pulse neutral beams to achieve equivalent breakeven conditions. (This condition exists when the fusion power	Continue experiments to study the physics of high temperature, high density plasmas and to determine optimum conditions for subsequent breakeven experiments in deuterium-tritium plasmas.

Program Activity	FY 1986	FY 1987	FY 1988
Tokamak Fusion Test Feactor (Cont'd)	investigate energy confinement scaling in high temperature plasmas. Recently, temperatures of 200 million degrees Celcius were achieved with confinement conditions approaching those required for breakeven.	output would be equal to the auxiliary heating input in an equivalent deuterium-tritium plasma.) Develop the understanding of plasma behavior at breakeven conditions that is required to prepare for an ignition experiment.	
	Install pellet injector to carry out fueling experiments and determine their effects on energy and particle confinement.	Continue preparations for subsequent operations in deuterium-tritium plasmas in order to provide the first studies of the effects of alpha particles on a plasma's confinement and stability.	Begin final commissioning of all systems for D-T operation, including the tritium handling systems, HVAC, maintenance manipulator, and radiation shielding.
	Begin modification of neutral beam system to extend pulse length from 0.5 seconds to 2 seconds.	Complete modification of neutral beam systems and begin to transfer 6 MW ICRF heating system from Princeton Large Torus (PLT) to TFTR.	Add an additional 3-4 MW of ICRF heating power.
Tokamak Fusion Test Reactor	($67,029)	($72,190)	($71,600)
Base Toroidal	Initiate experiments on the recently upgraded Doublet-III-D device to study energy confinement and beta limits in shaped plasmas with divertor and limiter configurations.	Complete initial evaluation in Doublet-III of high beta operation and its effect on energy confinement. A team of Japanese scientists will participate.	Carry out detailed experiments on D-III-D to gain an understanding of energy confinement time and beta limits using long pulse neutral beams and electron cyclotron heating (ECH) systems.
	Complete the experimental programs in Alcator C and the Princeton Large Torus on RF heating and current drive. Conduct design studies of a modification of the Alcator C facility to provide a state-of-the-art, high magnetic field tokamak.	Provide physics support for fabrication of the Alcator C Modification project.	Continue physics support for the project and begin diagnostic fabrication and planning for the Alcator C Modification experimental program.
	Conduct programs of international collaboration on TEXTOR and ASDEX in West Germany, JET in England, and TORE SUPRA in France to supplement information gained from operation of our own experiments.	Establish increased international collaboration in the areas of plasma fueling, particle control, rf heating, and steady-state operation. Activities include installation of a pumped limiter on TEXTOR, fabrication of a pumped limiter and pellet injector for TORE	Using international collaboration, and employing the hardware fabricated and installed during prior years, carry out joint experiments on fueling, impurity control, heating, and their effect on plasma performance.

Program Activity	FY 1986	FY 1987	FY 1988
Base Toroidal (Cont'd)		SUPRA, installation of a pellet injector on JET, and continued investigation of impurity control techniques of ASDEX.	
Base Toroidal	($46,995)	($40,051)	($38,560)
Advanced Toroidal	Complete preparations for operation of the Advanced Toroidal Facility. The initial set of diagnostics will be installed to study confinement in a stellarator type device.	Initiate experimental operations on ATF to determine the maximum beta that can be obtained in a steady-state toroidal configuration provided by the external helical coils used for confining the plasma.	Complete installation of second phase of diagnostics, a pellet injector, and a pumped limiter on ATF to investigate high-beta, steady-state operation. Continue investigation of beta limits and energy confinement using RF heating systems.
	Begin work on diagnostic modifications and planning of the research program for the Princeton Beta Experiment Modification (PBX-M).	Initiate experiments on PBX-M to explore beta limits using indented plasma shapes.	Conduct experiments on optimizing energy confinement and understanding beta limits on PBX Mod and to assess the need for control of current profiles.
	No activity.	Conduct modeling studies on using divertors for controlling impurities and pellet injectors for fueling the plasma in compact, high field ignition devices.	Continue limited studies of an advanced toroidally connected mirror and toroidal devices such as the spherical torus or the elongated torus.
Advanced Toroidal	($13,010)	($27,001)	($32,860)
Major Device Fabrication	Fabrication and installation of major systems will be completed on the Advanced Toroidal Facility.	Complete system testing and final assembly of ATF.	No activity.
	Complete fabrication, installation, and systems testing of the new vacuum vessel on the Doublet-III device to extend the operating capability of this device.	No activity.	No activity.
	Begin procurement of hardware to extend the pulse length of the neutral beam system on Doublet-III-D.	Complete procurement of long pulse neutral beam sources and up-grade of the neutral beam system on Doublet III.	No activity.
	Begin modification of the PBX device to permit a greater indentation in the plasma and to improve the divertor configuration.	Complete modification of the PBX device.	No activity.

Program Activity	FY 1986	FY 1987	FY 1988
Major Device Fabrication (Cont'd)	No activity.	Complete design studies and initiate fabrication for a small high field tokamak (Alcator C-Mod) with elongated seal and divertor.	Continue fabrication of the Alcator C-Mod tokamak at MIT in preparation for FY 1989 start of operation.
	No activity.	Complete design and begin installation of an existing tokamak device at LLNL to test the use of a free electron laser (FEL) as a more cost effective and efficient means of improved plasma heating and current drive.	Complete installation of an existing tokamak device at LLNL to test the use of a free electron laser (FEL) as a more cost effective and efficient means of improved plasma heating and current device.
Major Device Fabrication	($14,778)	($16,128)	($11,040)
Compact Ignition Tokamak	Funding of conceptual design studies supported under Development and Technology subprogram.	Provide physics analysis and begin R&D activities in support of conceptual design studies for a compact ignition tokamak as a successor to the TFTR experiment.	Continue physics analyses, design scoping studies, and R&D activities in support of a compact, high-field ignition tokamak to be initiated in FY 1988 at PPPL.
Compact Ignition Tokamak	($600)	($9,960)	($8,000)
Mirror Systems	Complete construction and testing of MFTF-B facility at LLNL, including magnets, cryogenic systems, test neutral beams, and ECH power supply. Continue preparation of documentation and prepare for mothballing the facility.	Begin closeout of major MFTF-B contracts, complete documentation, and maintain all systems in working condition.	Complete closeout of contracts and maintain MFTF-B in a mothballed state.
	Continue operation of TMX-U at LLNL with new diagnostics to better understand hot electrons, end losses, and radial transport.	Complete experiments on thermal barrier filling rate in TMX-U during the first quarter of the year.	No activity.
	Bring the TARA facility at MIT into full operation with ICRF, ECH, and neutral beams. Carry out preliminary experiments on thermal barrier operation with external anchors.	Operate TARA to complete experiments on thermal barriers and to obtain information on axisymmetric confinement.	Complete studies of axisymmetric confinement. Begin transfer of physics team to support toroidal experiments.

III. Confinement Systems (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Mirror Systems (Cont'd)	Continue RF experiments on the Phaedrus mirror device at University of Wisconsin and collaborative experiments on mirror devices in Japan.	Continue RF research experiments on the Phaedrus device and collaborative experiments on mirror devices in Japan.	Continue RF research experiments on the Phaedrus device and collaborative experiments on mirror devices in Japan.
Mirror Systems	($46,249)	($21,170)	($8,860)
Total Confinement Systems	($188,661)	($186,500)	($170,920)

I. Preface: Applied Plasma Physics

The Applied Plasma Physics subprogram has a major role in the magnetic confinement and burning plasma issues. It provides support and supplements research performed in the Confinement Systems subprogram by providing information on new techniques and new concepts and by understanding vital basic data necessary to conduct larger scale fusion experiments. Activities include research on advanced fusion concepts, theoretical and experimental physics support and large-scale computing capability.

In Advanced Fusion Concepts, several potentially attractive alternate confinement concepts with varying magnetic configurations are investigated which offer innovative improvements over tokamaks, mirrors, and stellarators. Concepts currently being evaluated include Reversed Field Pinch (RFP's), Field Reverse Configurations (FRC's), and Spheromaks. Reversed Field Pinch devices require no auxiliary heating and offers efficient use of magnetic fields. Compact Toroids (FRC's and spheromaks) have simple magnetic fields, make efficient use of confinement magnetic fields, and offer natural systems for impurity control. The work is aimed at addressing the critical technical issue of developing an optimum confinement concept. Major facilities currently available or under fabrication include the reversed field pinch devices (ZT-40 and Confinement Physics Research Facility at LANL), field reversed configuration devices at Spectra Technology and LANL, spheromak devices at PPPL and the University of Maryland.

Plasma processes that determine the success of magnetic confinement are complex. Understanding these processes and developing specialized plasma heating and control techniques are required for extrapolation to optimum magnetic confinement and burning plasma performance. The Fusion Plasma Theory and Experimental Plasma Research branches supply basic tools for understanding plasma phenomena and for the development of new ideas.

Theory supports development of models and mathematical techniques to describe and predict the behavior of magnetically confined plasma. General models are developed to extract physics features common to different confinement geometries and to develop predictive capability for parameter ranges not yet explored. Theories and models are developed to interpret results from confinement experiments, using both analytical and numerical techniques. This work is supported 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. Diagnostic techniques required for measuring plasma properties are developed and tested. Atomic data necessary for understanding plasma behavior are obtained. New ideas currently receiving first tests are directed to 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 activities at national laboratories and industry as well.

The national magnetic fusion energy computing network provides network access to state of the art computational hardware (CRAY 1 and CRAY 2 computers). The facility provides support for the development of models and codes of 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, GA Technologies, PPPL, and ORNL, together with direct line or remote access by smaller users through the user service centers.

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

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Advanced Fusion Concepts				
Research Operations............	$ 14,893	$ 12,811	$ 9,265	-28
Major Device Fabrication........	3,970	10,500	13,790	+31
Supporting Studies..............	459	541	450	-17
Subtotal, Advanced Fusion Concepts......................	19,322	23,852	23,505	- 1
Fusion Plasma Theory..............	$ 19,229	$ 18,168	$ 18,135	0
Experimental Plasma Research......	14,696	13,083	13,350	+ 2
National MFE Computer Network.....	16,445	18,397	18,085	- 2
Total, Applied Plasma Physics...	$ 69,692	$ 73,500	$ 73,075	- 1

II. B. Major Laboratory and Facility Funding

	FY 1986	FY 1987	FY 1988	% Change
Univ. of California at L.A........	$ 2,862	$ 2,585	$ 2,530	- 2
GA Technologies, Inc...............	2,681	2,550	2,285	-10
Lawrence Livermore National Lab...	17,968	18,374	18,360	0
Los Alamos National Laboratory....	13,706	16,943	17,505	+ 3
Massachusetts Institute of Tech...	2,818	2,380	1,995	-16
Oak Ridge National Laboratory.....	3,864	3,865	3,700	- 4
Princeton Plasma Physics Lab......	6,260	5,910	3,300	-44
Spectra Technology................	1,980	3,120	4,150	+33
Univ. of Texas.....................	5,235	5,450	5,100	- 6
Univ. of Wisconsin.................	1,800	1,790	1,975	+10
Total..........................	$59,174	$62,967	$60,900	

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Advanced Fusion Concepts - Research Operations	Continued studies of critical issues of the reversed field pinch concept; operated ZT-40 facility, ZT-P, and OHTE at GA Technologies; established pellet injection re-fueling and operated with hot ions in ZT-40; established stability conditions for next generation devices in modified OHTE. Continued fabrication of Wisconsin reversed field pinch device.	Provide R&D support for fabrication of the Confinement Physics Research Facility (CPRF) using ZT-40 and ZT-P devices. Evaluate results of stability studies in RFP at GA Technologies. Refine density control in ZT-40. Assemble and test Wisconsin reversed field pinch device.	Provide R&D support in ZT-P for fabrication of CPRF. Study RFP plasma conditions at University of Wisconsin.

III. Applied Plasma Physics (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Research Operations (Cont'd)	Continued critical studies of the field reversed configuration and spheromak concept in FRX-C and the S-1 devices and started tests in the spheromak at the University of Maryland. Supporting studies carried on at University of Washington.	Study heating in Maryland spheromak and confinement in S-1. Study FRC properties in FRX-C.	Study energy confinement in Maryland spheromak. Add compression heating to FRX-C.
Research Operations	($14,893)	($12,811)	($9,265)
Advanced Fusion Concepts - Major Device Fabrication	Began fabrication of the Confinement Physics Research Facility (CPRF), a replacement of the ZT-40 device at LANL, and a new Field Reversed Configuration device (LSX) at Spectra Technology.	Continue fabrication of the CPRF reversed field pinch device and the LSX project.	Continue fabrication of the CPRF reversed field pinch device and the LSX project at the planned levels. These projects will allow experiments to be conducted in an expanded parameter range and resolve critical physics issues.
Major Device Fabrication	($ 3,970)	($10,500)	($13,790)
Advanced Fusion Concepts - Supporting Studies	Conducted heliac experiment at University of Washington and dense Z pinch experiment at the Naval Research Laboratory.	Continue work on heliac and dense Z pinch. Modify heliac to simulate toroidal effects.	Evaluate high current dense Z pinch results.
Supporting Studies	($459)	($541)	($450)
Total Advanced Fusion Concepts	($19,322)	($23,852)	($23,505)
Fusion Plasma Theory	Continued theoretical support of experiments at laboratories and universities in areas related to toroidal, mirror and alternate concepts, as well as generic theory and atomic physics theory.	Reduce overall level of theory study at universities and laboratories to a critical mass level required to interact with major experiments.	Provide theoretical support of the experimental program. Increase emphasis on TFTR, ATF, and D-III-D related physics and provide specific guidance from these to CIT.

Program Activity	FY 1986	FY 1987	FY 1988
Fusion Plasma Theory (Cont'd)	Studied heating confinement and transport processes to improve toroidal systems performance.	Predict and interpret the effects of auxiliary heating and fueling on plasma stability and confinement.	Increase support of the national plasma transport working group to produce comparison of existing transport models. Continue support of auxiliary heating and fueling theory. Apply new methods for following individual particles in major codes to study plasma transport.
	Refined theoretical models to support improved understanding of high-current, high-density alternate concepts.	Continue theory support of alternate concepts.	Continue to support alternate concept theory. Place special emphasis on transferring physics results to toroidal devices.
	Refined theoretical models to support ignition issue.	Increase effort on the modeling of burning plasmas with emphasis on alpha particle modeling. Increase effort on unresolved problems of plasma behavior that are particularly important to CIT.	Expand MHD theory to study current penetration and initial stages of tokamak discharges leading to ignition.
	Supported theoretical studies of mirror issues.	Reduce direct mirror theory efforts. Continue support of active mirror experiments and increase theory effort to transfer mirror plasma physics results to toroidal applications.	No activity.
Fusion Plasma Theory	($19,229)	($18,168)	($18,135)
Experimental Plasma Research	Pursued basic research on plasma properties affecting stability and transport of particle and energy on several university plasma devices and on the TEXT research tokamak. Demonstrated control of tokamak edge temperature using external coils to provide local mixing of magnetic field lines.	Continue research on basic plasma properties and operate TEXT. Implement electron cyclotron heating (ECH) on TEXT to extend basic studies on transport and disruption control.	Investigate current drive, ECH-disruptions, particle control, and stability physics issues and innovations.
	Began tests of innovative techniques to improve tokamaks including current drive, plasma disruption control by use of ECH and stability of the plasma at high beta.	Continue innovative tests of plasma confinement, heating, and current drive initiated in FY 1986.	Assess innovative tests initiated in FY 1986 and select new directions as appropriate.

III. Applied Plasma Physics (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Experimental Plasma Research (Cont'd)	Developed and tested new diagnostic devices for detailed measurement of key plasma properties. Used lithium beam combined with laser beam in TEXT to determine that plasma current is more peaked on axis than expected in tokamaks.	Test and implement diagnostics developed to measure spatial and temporal variations of plasma properties in confinement experiments. Develop new ideas to measure nuclear reaction products within plasma.	Initiate development of diagnostic devices to detect nuclear reaction products within an ignited plasma.
	Developed and disseminated atomic physics data needed to understand plasma behavior. Used new ion source to produce fundamental data on electron-ion collisions needed to interpret diagnostic observations and energy flow in hot plasma.	Concentrate atomic physics on resonances in electronic collisions. Work with international partners through IAEA to establish atomic data base for fusion.	Continue support of fusion-specific atomic physics research and international data compilation efforts.
Experimental Plasma Research	($14,696)	($13,083)	($13,350)
MFE Computer Network	Provided access to supercomputers for fusion researchers via a nationwide satellite network with two CRAY 1 and one CRAY 2 supercomputer at the National Magnetic Fusion Energy Computer Center at LLNL. CRAY 2 is a Class VII supercomputer which advances the state of the art of the computational physics and assists in three-dimensional models. CDC-7600 removed to save maintenance costs.	Continue to provide access to supercomputers for fusion researchers via the satellite network. Begin upgrades of central file storage and network structure. Provide Computer Aided Design (CAD) system to major fusion contractors. Increase funding to User Service Centers so that local users can use analysis equipment required to support the experimental program.	Provide access to supercomputers for fusion research via a nationwide satellite network with two CRAY 1 and one CRAY 2 supercomputers at the National Magnetic Fusion Energy Computer Center at LLNL. Manage program with Energy Science Advanced Computation. Continue upgrades of central file storage and network structure to adequately support users.
MFE Computer Network	($16,445)	($18,397)	($18,085)
Total Applied Plasma Physics	($69,692)	($73,500)	($73,075)

I. Preface: Development and Technology

The Development and Technology subprogram provides for the development of the technologies needed for present and future fusion experiments and for design and analysis of fusion systems. The work is divided into three main areas: Plasma Technologies (which includes magnets, heating, and pellet fueling devices), Fusion Technologies (which includes tritium production and handling, nuclear analyses, materials, and environment and safety), and Fusion Systems Design (which carries out design studies).

Plasma Technologies covers the development of those technologies that are needed to obtain and sustain the conditions that are necessary to produce a reacting fusion plasma. These technologies include magnetic systems, plasma heating systems, and plasma fueling systems. The principal activity in magnetic systems is to develop the large superconducting magnets that are necessary to provide the magnetic field conditions required to confine the deuterium and tritium plasma associated electrons. The heating program focuses on the technologies required to heat the plasma ions and electrons, to reactive conditions and encompasses neutral particle beams, and several electromagnetic wave heating approaches. The plasma fueling systems efforts develop high speed deuterium and tritium pellet injectors to maintain the proper amount of plasma fuel. Use of the developed heating and fueling systems has enabled the production of record plasma conditions in fusion devices and this U.S. technology is in much demand internationally. 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.

Fusion Technologies covers technology issues that are concerned with the effect on systems in contact with the plasma and the effects of neutrons produced by the plasma. This program element includes development of heat extraction/blanket components, nuclear analysis methods, tritium production, tritium processing and control systems, materials, and environment and safety issues. The materials program element is developing materials to limit the degradation due to the bombardment of neutrons inside the fusion reactor, and materials that are capable of functioning as first wall materials, and materials that will reduce the need for long term waste disposal. Technologies needed for various blanket concepts are being investigated to perform their multiple functions of heat extraction, tritium production, and radiation shielding. Activities in tritium processing and controls systems will address the requirements for reliably processing, containing, and cleaning of tritium generated in blankets. Environment and safety issues are studied to develop an understanding of potential environmental and safety concerns in a fusion system.

Fusion Systems Analysis determines parameters of major fusion experiments and performance of possible fusion power systems. These studies help the program determine technical feasibility and costs, determine needs and objectives for R&D, and assess safety, environmental, and economic performance of future reactor concepts.

Some of the significant facilities utilized in the Development and Technology subprogram include the International Fusion Superconducting Magnet Test Facility at the Oak Ridge National Laboratory (ORNL) for testing of superconducting magnets; the plasma materials test facility at Sandia National Laboratory, and the RF test facility at ORNL.

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

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Plasma Technologies				
Magnetic Systems..................	$ 14,993	$ 10,575	$ 10,430	- 1
Heating and Fueling...............	7,396	8,905	12,105	+36
Subtotal, Plasma Technologies..	22,389	19,480	22,535	+16
Fusion Technologies				
Fusion Nuclear Technology........	5,909	5,988	6,945	+16
Environment and Safety............	1,493	1,521	1,675	+10
Fusion Materials..................	15,664	13,021	14,660	+13
Subtotal, Fusion Technologies..	23,066	20,530	23,280	+13
Fusion Systems Analysis............	12,186	10,500	10,100	- 4
Total, Development and Technology	$ 57,641	$ 50,510	$ 55,915	+11

II. B. Major Laboratory and Facility Funding

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Argonne National Laboratory.......	$ 3,389	$ 3,418	$ 3,715	+ 9
Hanford Eng. Dev. Lab.............	1,936	2,090	2,817	+35
Lawrence Livermore National Lab...	5,448	6,305	5,655	-10
Los Alamos National Laboratory....	2,787	2,827	3,087	+ 9
Oak Ridge National Laboratory.....	24,747	20,190	14,290	-29
Sandia National Laboratory........	3,047	3,290	3,563	+ 8
Total............................	$41,354	$38,120	$33,127	

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Plasma Technologies - Magnetics	Six large superconducting magnet coils provided by Euratom, Japan, Switzerland, and the U.S. were installed in the large coil test facility and testing was initiated.	The International Large Coil Tests are expected to be completed.	Analysis of Large Coil Test results will be completed.
	Development work on high field magnets for use in future fusion devices was carried out.	Development of superconductors and structural materials for high field and pulsed magnets for ETR will continue as well as a supporting materials database for CIT copper magnets.	Completion and delivery of a pulsed magnet for testing in a Japanese facility is scheduled. Effort on a multi-purpose coil to demonstrate high field superconductors will continue, as well as supporting effort for CIT copper magnets.
Magnetics	($14,993)	($10,575)	($10,430)
Plasma Technologies - Heating and Fueling	Development was completed on an improved positive ion neutral beam long pulse source for use on TFTR and Doublet III. Development of a 200 KW steady state gyrotron for use in an electron cyclotron heating system was successfully completed; development of high power launchers for ion cyclotron heating systems on TFTR, D-III, CIT, and TORE SUPRA; and the Radio Frequency Test Facility (RFTF) was placed in operation; development and fabrication of centrifugal and pneumatic pellet fuel injectors continued and a system was installed and operated on TFTR which resulted in record plasma conditions being achieved.	A high power compact launcher for the ICRF heating system will be tested in RFTF and installed on and operated on TFTR to demonstrate this new technology. Development emphasis will be placed on a 1 megawatt gyrotron and alternative approaches for electron cyclotron heating sources. Pellet fueling injector development will continue with emphasis on higher speeds, capability for continuous operation, and capability for tritium pellets.	Advanced high power ICRF launchers will continue under development and be tested on RFTF, D-IIID, and TORE SUPRA. Higher speed pellet injector development will continue and systems cooperatively provided to both U.S. and foreign machines. A tritium pellet injector will be tested on the Tritium System Test Assembly (TSTA). Advanced technology efforts will continue on high power electron heating sources and negative ion neutral beams. Additional efficient, cost effective international cooperative efforts will be sought.
Heating and Fueling	($7,396)	($8,905)	($12,105)

Program Activity	FY 1986	FY 1987	FY 1988
Fusion Technologies - Fusion Nuclear Technology	The tritium system test assembly operated with its fuel cleanup and isotope separation system processing up to 35 grams of tritium. Phase I of the FINESSE study, initiated in 1984 to identify the experiments/facility requirements for fusion nuclear technology development was completed and currently provides a working methodology for planning in the U.S. and abroad. Phase I of the U.S./Japan Collaborative Program on fusion blankets for tritium production, which was initiated in late 1984, was completed. Phase II of the program was initiated in mid-1986.	Efforts continue on developing nuclear analysis methods needed to design and analyze fusion devices. Tritium production and tritium handling technology development efforts continue to gain a better understanding of the effects of the radioactive environment created by fusion devices. TSTA will test its systems with 50 grams of tritium. Phase II of U.S./Japan collaborative program on fusion neutronics will continue.	Continue developing nuclear analysis methods and data bases needed to design and analyze fusion devices. Complete Phase II of FINESSE study and bring study to a conclusion. Complete Phase II of U.S./Japan Collaborative Program on fusion neutronics and begin Phase III. Continue tritium production and handling development. TSTA will test its system with up to 100 grams of tritium.
Fusion Nuclear Technology	($5,909)	($5,988)	($6,945)
Fusion Technologies - Environment and Safety	The Idaho National Engineering Laboratory completed a series of tritium implantation tests with a low activation candidate first wall material (vanadium alloy) to determine the retention and permeation ratio of the material. Initiated a study to evaluate environmental, safety and economics aspects of fusion.	Develop a better understanding of environmental and safety concerns anticipated in present and future devices through studies. Complete Environment, Safety, and Economics tradeoff study. Complete lithium-lead and water interaction scoping experiments. Participate in international program for tritium release effects.	Develop a better understanding of environmental and safety concerns anticipated in present and future devices. Study ideas of how to make fusion inherently safe. Begin efforts on more integrated Environment, Safety, and Economics program.
Environment and Safety	($1,493)	($1,521)	($1,675)
Fusion Technologies - Fusion Materials	Tritium permeation measurements resulted in improved tritium inventory calculations for TFTR. Results from spectral irradiation testing in the Oak Ridge Reactor have confirmed theoretical predictions that the ratio of displacement to transmutation damage is critical to the response of fusion materials to neutron irradiation damage. Thermal fatigue studies on beryllium were completed for the Joint European Torus (JET). These studies	Continue evaluation of plasma-facing invessel materials; maintain plasma materials investigation in support of confinement system needs, in particular for CIT, ATF, and ETR and OFE international commitments for TORE SUPRA, ASDEX, and TEXTOR. RTNS-II and ORR shutdown and preparation initiated for materials test in FFTF.	Continue evaluation of plasma-facing invessel materials such as non-isotopic graphite works and composites. Expand neutron irradiation testing on invessel materials; maintain plasma materials investigation in support of OFE domestic and internatinal commitments. Prepare test equipment for irradiation in FFTF.

III. Development and Technology (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Fusion Materials (Cont'd)	resulted in substantial savings to the European Community in the cost of the JET beryllium limiters. Initial testing of reduced activation steels (Ferritic alloys) indicates that they may be successfully modified by elemental substitution to maintain radiation damage resistance.		
Fusion Materials	($15,664)	($13,021)	($14,660)
Fusion Systems Analysis	First designs of a compact copper tokamak for an ignition experiment were evaluated and a reference design was selected for conceptual design. Exploratory designs of a tandem mirror fusion power reactor were completed and a scoping study of a compact reversed field pinch power reactor was initiated. An advanced tokamak reactor that incorporates innovative features for an attractive reactor concept was analyzed.	Continue conceptual design of a compact ignition tokamak. Complete scoping study of a reversed field pinch power reactor. Initiate a study of an innovative engineering test reactor (ETR) to test nuclear technology as a possible international activity.	The major task is to participate in a cooperative international effort to design an Engineering Test Reactor (ETR) as proposed by the U.S. to the Economic Summit Nations and to the Soviet Union on October 30, 1986. Perform small-scale scoping studies of improved power reactor design features.
Fusion Systems Analysis	($12,186)	($10,500)	($10,100)
Total Development and Technology	($57,641)	($50,510)	($55,915)

I. Preface: Planning and Projects

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Planning and Projects..............	$ 946	$4,653	$4,520	-3

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Operating	Continue to support the program's legal obligation for the Small Business Innovative Research (SBIR) program and the non-fusion landlord responsibilities for inventories at ORNL.	Continue to support the program's legal obligation for the Small Business Innovative Research (SBIR) program and the non-fusion landlord responsibilities for inventories at ORNL.	Continue to support the program's legal obligation for the Small Business Innovative Research (SBIR) program and the non-fusion landlord responsibilities for inventories at ORNL.
Total Planning and Projects	($946)	($4,653)	($4,520)

I. Preface: Program Direction

This subprogram provides the Federal staffing resources and associated funding needed to plan, direct, and administer the highly scientific and technical research and development program in fusion energy.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Program Direction...............	$3,608	$3,940	$4,600	+17

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Salaries and Expenses	Provided funds for salaries, benefits, and travel for 62 full-time equivalents (FTE's) in the Office of Fusion Energy and related program and management support staff. Staff activities included: 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; implementation of university and industrial research programs, construction and operation of scientific	Provide for the increased personnel-related costs to continue the FY 1986 authorized level of 62 FTE's. Prior year unobligated funds will be used for the 1987 pay raise and the increased agency contributions to the new Federal Employees Retirement System. Staff effort will continue to be applied to maintenance of a strong, domestic R&D program to adequately cover the necessary range of fusion science and technology, with particular focus on the key technical issues and extensive use of international collaboration to advance the program in a timely way, especially through joint projects. Staff will evaluate results from the U.S. and abroad	Provide funds for salaries and related costs to continue 62 full-time equivalents. Provide for the normal increased personnel costs such as within-grade and merit increases, impact of the 1987 pay raise, and the increased agency contribution to the Federal Employees Retirement System as participation increases. Staff effort is required for effective overall program management and initiation of the Compact Ignition Tokamak Project, to focus on the program management and key technical issues required for CIT and for continued international collaboration. Strong program management oversight will be provided to support the world fusion

III. Program Direction (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Salaries and Expenses (Cont'd)	R&D facilities; interagency and international liaison negotiation; and related program and management support activities.	which should define the requirements for the design of a device to achieve ignition.	program in a major and cost effective way.
Salaries and Expenses	($3,583)	($3,840)	($4,500)
Other	Provided funds for program support such as printing and editing services, purchase of program-specific supplies and materials, and contract support such as personnel classification activities related to the recent Office of Fusion Energy reorganization. Obligations totaled $100, of which $75 comprised prior year unobligated carryover.	Provide for a variety of program support services similar to those in FY 1986. Also includes timesharing on various information systems and communications networks such as electronic mail and contractor support for technical writing, editing, assistance for advisory committees, and other services.	Continue the required level and variety of program support services and supplies at approximately the FY 1987 level.
Other	($25)	($100)	($100)
Total Program Direction	($3,608)	($3,940)	($4,600)

I. Preface: Capital Equipment

The capital equipment request of $19,670,000 supports the procurement of essential hardware to facilitate the conduct of the experimental program. This permits the effective utilization of devices and people. Listed below is a summary of the specific capital equipment needs by program area.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Confinement Systems................	$14,529	$ 7,800	$10,110	+ 30
Applied Plasma Physics............	5,619	4,500	3,260	- 28
Development and Technology........	4,330	1,890	2,480	+ 31
Planning and Projects.............	3,801	3,820	3,820	0
Total.........................	$28,279	$18,010	$19,670	+ 9

II. B. Major Laboratory and Facility Funding

Program Activity	FY 1986	FY 1987	FY 1988	% Change
G.A. Technologies, Inc............	$ 2,301	$ 1,775	$ 1,850	+ 4
Lawrence Livermore National Lab...	3,503	170	1,185	+ 597
Los Alamos National Laboratory....	3,896	3,280	2,725	- 17
Massachusetts Institute of Tech...	2,034	145	1,850	+1,175
Oak Ridge National Laboratory.....	8,575	6,770	6,735	- 1
Princeton Plasma Physics Laboratory	6,042	4,462	3,640	- 18
Total............................	$26,351	$16,602	$17,985	

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Confinement Systems	Provide equipment such as power supplies, diagnostic instruments, vacuum systems, data acquisition equipment and computer hardware purchased in support of the experimental devices. Begin fabrication of hardware for international collaborative programs including pellet injectors for JET and TORE SUPRA, and an ICRF antenna for TORE SUPRA.	Provide for toroidal program equipment needs in areas such as power supplies, diagnostic instrumentation, vacuum systems, data acquisition, and data analysis systems, and smaller miscellaneous test and analysis equipment required to support the experimental program. Examples of the large equipment items include an in-vacuum robotic maintenance manipulator, diagnostic instrumentation, shielding blocks, vacuum systems, and mass storage devices at TFTR; power system switches, data analysis acquisition and control hardware, diagnostic equipment, and cryogenic systems at Doublet-III-D; vacuum pumps and valves, data acquisition equiment, spectrometers, lasers, and infrared detectors at ATF; and electronic components, vacuum systems, and diagnostic hardware at PBX. Continue fabrication of hardware for international collaborative programs.	Continue purchase of power supplies and components for heating systems for ATF and D-III-D and for TF and PF coil operation of Alcator C-Mod. Continue support of vacuum equipment, analog to digital convertors and memory units for data acquisition systems, diagnostics, hardware, and cryogenic systems for ATF, D-III-D, PBX, and Alcator C-Mod. Complete installation of the maintenance manipulator in TFTR, begin procurement of an external maintenance manipulator for TFTR, and continue purchase of computer hardware and diagnostic equipment for TFTR. Complete fabrication of hardware for collaborative programs.
Confinement Systems	($14,529)	($7,800)	($10,110)
Applied Plasma Physics	Support provided for fabrication of the reversed field pinch device and for procurement of power supplies for this device.	Major portion of the equipment request is for acquisition of a power supply system for the CPRF including a motor-generator flywheel, power convertors, and space preparation.	Continue procurement and assembly of power handling system for CPRF project.

III. Capital Equipment (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Applied Plasma Physics (Cont'd)	Equipment provided for modification of devices for testing tokamak improvements, for diagnostic equipment under development and for support of atomic physics research.	Provide general laboratory and data acquisition equipment to support such areas as a new tokamak improvement test, diagnostic development, and TEXT operation.	Provide general laboratory and data acquisition equipment support for experimental research programs.
	Equipment provided to replace obsolete or unserviceable equipment in the computer network service centers.	Continue support of equipment needs at the computer network user service centers and NMFECC.	Continue support of equipment needs at the computer network user service centers and NMFECC.
Applied Plasma Physics	($5,619)	($4,500)	($3,260)
Development and Technology	In Plasma Technologies funds are used to complete the deuterium pellet injector for TFTR, critical spare part items for the International Fusion Superconducting Magnet Test Facility to prevent any extended down times, hardware to complete the 2 megawatt ICRH power module, support for the High Field Test Facility, and the RF Test Facility and general lab equipment for the base technology efforts. In Fusion Technologies general laboratory equipment items will be procured to support the research programs in materials, safety, and nuclear technology.	Equipment is needed to support the High Field Test Magnet Facility, the RF Test Facility, pellet injector development, and base technology effort in the Plasma Technology area: In Fusion Technology, equipment is needed to support research in materials, safety, and nuclear technology including the Plasma Surface Interaction Experiment, liquid metal test loop, Tritium Systems Test Assembly and radiation facilities at the Oak Ridge Reactor as well as modification to the High Flux Isotope Reactor and the Fast Flux Test Facility in the materials irradiation program.	Equipment is needed to support the High Field Test Magnet Facility, the RF Test Facility, pellet injector development, and base technology effort in the Plasma Technology area: In Fusion Technology, equipment is needed to support research in materials, safety, and nuclear technology including the Plasma Surface Interaction Experiment, liquid metal test loop, Tritium Systems Test Assembly and modifications to the High Flux Isotope Reactor and the Fast Flux Test Facility in the materials irradiation program.
Development and Technology	($4,330)	($1,890)	($2,480)
Planning and Projects	Continue to provide for the purchase of general purpose equipment to support non-fusion specific landlord responsibilities at ORNL.	Continue to provide for the purchase of general purpose equipment to support non-fusion specific landlord responsibilities at ORNL.	Continue to provide for the purchase of general purpose equipment to support non-fusion specific landlord responsibilities at ORNL.
Planning and Projects	($3,801)	($3,820)	($3,820)
Total Capital Equipment	($28,279)	($18,010)	($19,670)

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

Magnetic Fusion Energy

IV. A. Construction Project Summary

Project No.	Project Title	Total Prior Year Obligations	FY 1987 Appropriated	FY 1988 Request	Remaining Balance	TEC
88-R-902	Compact Ignition Tokamak	$ 0	$ 0	$ 8,000	$349,000	$357,000
88-R-901	General Plant Projects	0	0	8,900	0	8,900
Total Construction		0	0	16,900	349,000	365,900
Expense Funded Projects						
-	Confinement Physics Research Facility	3,420	8,600	10,820	25,560	48,400
-	Field Reversed Configuration	550	1,900	2,970	3,680	9,100
-	Alcator C Modification	0	4,500	4,900	8,000	17,400
-	Microwave Tokamak Experiment	0	2,460	6,140	0	8,600
Total Expense Funded Projects		$ 3,970	$ 17,460	$ 24,830	$ 37,240	$ 83,500

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Magnetic Fusion Energy

IV. B. Plant Funded Construction Project

1. Project title and location: 88-R-902 Compact Ignition Tokamak
Princeton Plasma Physics Laboratory

Project TEC: $357,000
Start Date: 1st Qtr. FY 1988
Completion Date: 4th Qtr. FY 1993

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1988	$ 8,000	$ 8,000	$ 8,000
1989	52,000	52,000	45,000
1990	75,000	75,000	68,000
1991	85,000	85,000	89,000
1992	75,000	75,000	75,000
1993	62,000	62,000	72,000

3. Narrative:

(a) This project will provide a compact, high-field, copper coil tokamak facility to generate critical, burning plasma data to allow for the successful operation of an integrated Engineering Test Reactor. Design, construction, fabrication, assembly, installation, and testing of the Compact Ignition Tokamak (CIT) involves the following work: (1) upgrade and reconfigure TFTR equipment and facilities systems to support the CIT project; (2) construct a compact tokamak device with copper toroidal and poloidal field coils cooled with liquid nitrogen; (3) build a shielded, tritium sealed test cell; and (4) provide support facilities, such as hot cells, and rf systems.

(b) The CIT experiment is intended to bridge the gap between the operation of TFTR and JET and the stable equilibrium burn projected for the Engineering Test Reactor. The objectives for this ignition experiment are that it achieve ignition and reveal the properties of burning plasma, that the cost of the machine be modest in relation to the cost of an ETR, and that it be operational in the early 1990's. Because of the experimental progress in fusion research, it is now possible to build a tokamak that will achieve this objective. The CIT incorporates new low cost design features as part of an upgrade to TFTR. This will be the first time in the world that a controlled fusion plasma will be ignited. The CIT facility will be used to study and optimize these fully ignited plasmas; identify generic plasma burn-control issues; and test burn control techniques and address associated issues such as tritium handling, remote maintenance, plasma-wall interactions, and radiation hardened diagnostics.

(c) The funding request of $8,000,000 provides for initiation of architect engineering services and procurement of selected long lead items. The use of the Princeton site minimizes the cost of the CIT by taking maximum advantage of existing TFTR facilities. The scheduled completion of experiments on TFTR is consistent with the CIT construction schedule.

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Magnetic Fusion Energy

IV. B. Plant Funded Construction Project

1. Project title and location: 88-R-901 General Plant Projects
Various locations

Project TEC: $8,900,000
Start Date: 1st Qtr. FY 1988
Completion Date: 4th Qtr. FY 1989

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1988	$ 8,900	$ 8,900	$ 3,411
After 1988	0	0	5,489

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 1988 by laboratory is as follows:

Los Alamos National Laboratory	$ 500,000
Lawrence Livermore National Laboratory	200,000
Princeton Plasma Physics Laboratory	1,000,000
Oak Ridge National Laboratory	7,200,000
	$8,900,000

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Magnetic Fusion Energy

IV. C. Operating Expense Funded Construction Project

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1. Project title and location: Confinement Physics Research Facility
Los Alamos National Laboratory

Project TEC: $48,400,000
Start Date: 3rd Qtr. FY 1986
Completion Date: 4th Qtr. FY 1992

2. Financial schedule:
(Budget Authority)

Prior Year	FY 1986 Actual	FY 1987 Appropriated	FY 1988 Request	To Complete
$ 0	$ 3,420	$ 8,600	$10,820	$25,560

3. Narrative

(a) The presently operating reversed field pinch (RFP) devices have achieved outstanding experimental results which surpass design specifications for the devices. It is now important to extend the plasma current capability in order to test energy confinement. As a result, a device will be fabricated which will have a 4 MA capability. This will bring to the fusion program an experimental capability to explore, in a multikilovolt collisionless regime, the physics properties of a toroidal confinement concept that has the theoretical potential, in a future device, of ohmic heating to ignition with low magnetic fields at the magnet coils.

(b) The device will consist of magnetic field coils, vacuum system, control system, and structural support systems. Related project funding will provide a power supply system from capital equipment funds and the required research and development support from operating expense funds.

(c) Initial operation of the device, with a capability of 2 megamperes of current, will occur at the beginning of FY 1991, and the device will be completed, with a capability of 4 MA of current, by the end of FY 1992.

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Magnetic Fusion Energy

IV. C. Operating Expense Funded Construction Project

1. Project title and location: Field Reversed Configuration
Spectra Technology

Project TEC: $ 9,100,000
Start Date: 4th Qtr. FY 1986
Completion Date: 4th Qtr. FY 1989

2. Financial schedule:
(Budget Authority)

Prior Year	FY 1986 Actual	FY 1987 Appropriated	FY 1988 Request	To Complete
$ 0	$ 550	$ 1,900	$ 2,970	$ 3,680

3. Narrative

(a) The field reversed configuration is a class of elongated toroidal plasma contained in a solenoidal magnetic field. Technical advances have made FRC's a potentially attractive confinement approach for achieving fusion power because of its high beta values.

(b) The objective of this project is to provide a device for FRC physics experiments to achieve conditions at which fusion-relevant confinement and stability can be tested. This objective is characterized by a parameter S--the average number of ion orbits between the center and edge of the plasma.

(c) Funds in FY 1988 will be used to continue fabrication and installation work.

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Magnetic Fusion Energy

IV. C. Operating Expense Funded Construction Project

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1. Project title and location: Alcator C Modification
Massachusetts Institute of Technology

Project TEC: $17,400,000
Start Date: 2nd Qtr. FY 1987
Completion Date: 2nd Qtr. FY 1990

2. Financial schedule:
(Budget Authority)

Prior Year	FY 1986 Actual	FY 1987 Appropriated	FY 1988 Request	To Complete
$ 0	$	$ 4,500	$ 4,900	$ 8,000

3. Narrative

(a) The Alcator C-Mod. project will provide a unique device, using existing support facilities, to conduct a valuable integrated test of recent improvements in tokamak physics design in the Compact Ignition Tokamak (CIT) range of operating parameters. This will allow us to develop operational techniques and control methods to produce high temperature, high density, well confined plasmas. Specific areas of physics investigation include ion cyclotron radiofrequency heating, plasma edge control, pellet fueling, impurity control, and current ramp-up.

(b) The major objective of Alcator C-Mod. is to provide unique and valuable information on transport in high density plasmas with intense ICRF heating.

(c) FY 1988 activities include fabrication and installation of hardware.

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Magnetic Fusion Energy

IV. C. Operating Expense Funded Construction Project

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1. Project title and location: Microwave Tokamak Experiment
Lawrence Livermore National Laboratory

Project TEC: $ 8,600,000
Start Date: 2nd Qtr. FY 1987
Completion Date: 4th Qtr. FY 1988

2. Financial schedule:
(Budget Authority)

Prior Year	FY 1986 Actual	FY 1987 Appropriated	FY 1988 Request	To Complete
$ 0	$ 0	$ 2,460	$ 6,140	$ 0

3. Narrative

(a) This facility will provide LLNL with the unique capability to test the applications of high power microwaves as a more efficient technique for heating plasmas in tokamak devices.

(b) This project provides for moving the existing tokamak device, Alcator C, from MIT to LLNL and connecting it to the existing large advanced free electron laser source. Additionally, it would be necessary to procure and install associated diagnostics and low power heating equipment.

(c) FY 1988 funding provides for completing the fabrication of this project.

DOE/MA-0274

Congressional Budget Request

Construction Project Data Sheets:
Energy Supply Research and Development
General Science
Uranium Enrichment
Naval Petroleum & Oil Shale Reserves

FY 1988

U.S. Department of Energy
Assistant Secretary,
Management and Administration
Office of the Controller
Washington, D.C. 20585

January 1987

Energy Supply Research and Development - Operating Expenses
Magnetic Fusion

(Tabular dollars in thousands. Narrative material in whole dollars.)

Confinement Physics Research Facility
Los Alamos National Laboratory (LANL)

Total Estimated Cost: $48,400,000
(For Design and Construction)

Confinement Physics Research Facility
Los Alamos National Laboratory

Total Estimated Cost: $48,400,000

(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1986 Actual		FY 1987 Estimate		FY 1988 Estimate		FY 1989 Estimate	
	B/A	B/O	B/A	B/O	B/A	B/O	B/A	B/O
Design and Construction								
Operating Expenses	$ 3,420	$ 2,413	$ 8,600	$ 8,400	$10,820	$10,620	$13,190	$14,597
Subtotal	3,420	2,413	8,600	8,400	10,820	10,620	13,190	14,597
Related Funding Requirement								
Research Operations	914	914	1,400	1,400	485	485	0	0
Capital Equipment	3,377	272	3,000	3,000	2,395	2,395	2,010	5,115
Subtotal	4,291	1,186	4,400	4,400	2,880	2,880	2,010	5,115
Total Project Cost	$ 7,711	$ 3,599	$13,000	$12,800	$13,700	$13,500	$15,200	$19,712

	FY 1990 Estimate		FY 1991 Estimate		FY 1992 Estimate		Total Project Funding
	B/A	B/O	B/A	B/O	B/A	B/O	B/A
Design and Construction							
Operating Expenses	$ 7,200	$ 7,200	$ 290	$ 290	$ 4,880	$ 4,880	$48,400
Subtotal	7,200	7,200	290	290	4,880	4,880	48,400
Related Funding Requirement							
Research Operations	0	0	0	0	0	0	2,799
Capital Equipment	4,500	4,500	6,019	6,019	0	0	21,301
Subtotal	4,500	4,500	6,019	6,019	0	0	24,100
Total Project Cost	$11,700	$11,700	$ 6,309	$ 6,309	$ 4,880	$ 4,880	$72,500

Confinement Physics Research Facility
Los Alamos National Laboratory

Total Estimated Cost: $48,400,000

(Tabular dollars in thousands. Narrative material in whole dollars.)

Description, Objective and Justification

The presently operating reversed field pinch (RFP) devices have achieved outstanding experimental results which surpass design specifications for the devices. For example, in ZT-40M, experimental duration has reached 25 milliseconds exceeding the design goal of 2 millisecond. The Magnetic Fusion Advisory Committee recommended proceeding with the physics exploration of the reversed field pinch concept. The importance of extending the plasma current capability to values in the megampere range in order to test energy confinement was emphasized. As a result, a device will be fabricated which will have a 4 MA capability. This will bring to the fusion program an experimental capability to explore, in a multikilovolt collisionless regime, the physics properties of a toroidal confinement concept that has the theoretical potential, in a future device, of ohmic heating to ignition with low magnetic fields at the magnet coils. These physics properties include particle and energy transport and MHD activity in a high-Beta, high-shear, low-q regime, including relaxation phenomena and the associated potential for steady-state current drive.

The device will consist of magnetic field coils, vacuum system, control system, and structural support systems. Related project funding will provide a power supply system from capital equipment funds and the required research and development support from operating expense funds. Initial operation of the device, with a capability of 2 megamperes of current, will occur at the beginning of FY 1991, and the device will be completed, with a capability of 4 MA of current, by the end of FY 1992. Technical goals will include the minimization of magnetic field errors and incorporation of particle control techniques including pellet injection, gas puffing, and plasma-wall interaction controls.

The funding profile shown will allow a design and construction schedule as follows.

(a) Schedule of Planned Activities

Activity	Start	Complete
Device Design	3Q FY 1986	4Q FY 1989
Procurement	3Q FY 1986	2Q FY 1992
Fabrication and Installation (2MA)	3Q FY 1986	4Q FY 1990
Plasma Operations (2MA Capability)	1Q FY 1991	1Q FY 1993; when 4 MA capability will exist
Fabrication and Installation (4MA)	3Q FY 1986	4Q FY 1992 (Project Complete)
Plasma Operations (4MA Capability)	1Q FY 1993	Indefinite; depends on research results

Total Estimated Cost: $48,400,000

(Tabular dollars in thousands. Narrative material in whole dollars.)

(b) Management and Contracting

The Los Alamos National Laboratory (LANL) has been assigned responsibility for this project. An objective of the RFP program is to involve other U.S. institutions that have skills needed for RFP development. To achieve this end, a competitive solicitation was attempted during FY 1986. This solicitation endeavored to attract parties interested in a significant cost shared joint participation in this project. Unfortunately, it was not possible to arrange such participation.

(c) Prior Year Achievements

System technical requirements and work breakdown structure were developed. Preliminary design occurred for all systems. Preparation of the project management plan was initiated. Procurement of the motor generator was initiated.

(d) Current Year Achievements

Project management plan will be finalized. Preliminary and final design will be completed for most systems. Procurements will be initiated for major components including coils, vacuum liner and shell.

(e) Reasons for Increases and Decreases

The design and construction cost estimate for the government share of the project has increased to $48,400,000 from the $32,300,000 submitted in the FY 1987 budget in which joint financial participation by other parties was assumed. Based upon results of a competitive solicitation process, it was not possible to arrange such participation and thus the revised cost reflects the full funding by the Government.

(f) Cost Estimate for Design and Construction (Cost estimate is preliminary)

Engineering and Design	$ 8,735
Procurement and Fabrication	24,530
Assembly and Installation	11,620
Contingency	3,515
Total	$48,400

Escalation is included at 5% per year.

Energy Supply Research and Development - Operating Expenses
Magnetic Fusion

(Tabular dollars in thousands. Narrative material in whole dollars.)

Field Reversed Configuration (FRC) Physics Experiment
Spectra Technology

Total Estimated Cost (TEC): $9,100,000
(For Design and Construction)

FRC Physics Experiment
Spectra Technology*

Total Estimated Cost (TEC): $9,100,000

(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1986 Actual		FY 1987 Estimate		FY 1988 Estimate		FY 1989 Estimate		Total Project Funding
	B/A	B/O	B/A	B/O	B/A	B/O	B/A	B/O	B/A
Fabrication									
Operating Expenses	$ 550	$ 254	$ 1,900	$ 1,376	$ 2,970	$ 3,167	$ 3,680	$ 4,303	$ 9,100
Subtotal	550	254	1,900	1,376	2,970	3,167	3,680	4,303	9,100
Related Funding Requirements									
Research Operations	550	0	1,100	1,551	1,030	833	920	1,216	3,600
Subtotal	550	0	1,100	1,551	1,030	833	920	1,216	3,600
Total Project	$ 1,100	$ 254	$ 3,000	$ 2,927	$ 4,000	$ 4,000	$ 4,600	$ 5,519	$12,700

Description, Objective and Justification:

The term field reversed configuration (FRC) refers to a special class of elongated toroidal plasma equilibria contained in a solenoidal magnetic field; the magnetic field is purely poloidal. Technological advances and increased understanding of FRC physics and formation processes have resulted in rendering the FRC a unique and promising approach to fusion power. Its promise arises from the extremely high beta values (of order unity) and its observed ruggedness.

The objective of this experiment is to achieve conditions at which fusion-relevant confinement and stability can be tested. This objective is characterized by a parameter S-the average number of ion orbits between the center and edge of the plasma. Present experiments operate at S of 2-3. Immediate extrapolation to the reactor-required S of 30 would be costly. However, theoretical predictions show that at S = 8 conditions are achieved similar to those encountered in a fusion plasma, and this value has been chosen as a cost effective near term goal.

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*This project will be constructed at Spectra Technology which is non-Government owned property.

Total Estimated Cost (TEC): $9,100,000

(Tabular dollars in thousands. Narrative material in whole dollars.)

Description, Objective and Justification (continued):

The hardware required to meet the experimental objectives are: large diameter plasma discharge tube, vacuum vessel and accompanying support structure, high voltage power supply banks, and ignition switches for capacitors. There will also be costs related to space preparation. The experiment will be designed to achieve a plasma condition of 54-cm-diam, 160-cm length, $2 \times 10^{15} cm^{-3}$ particle density, 300 eV temperature, energy confinement time of 1 millisecond, and fusion Lawson parameter of 2×10^{12} sec-cm^{-3}.

(a) Schedule of Planned Activities

Activity	Start	Completion
Device Design	4Q FY 1986	3Q FY 1987
Fabrication and Installation	2Q FY 1987	4Q FY 1989
Begin Operations	1Q FY 1990	Indefinite

(b) Management and Contracting

The technical requirements and experimental objectives have been established during a technical planning effort with experts in the field reversed configuration topical area. Outside reviews have supported the timing and confirmed the experimental objectives. The contractor is Spectra Technology, in Bellevue, Washington.

(c) Prior Year Achievements

A contract was negotiated and work started on July 18, 1986.

(d) Current Year Achievements

A preliminary design has been completed and reviewed, and a final design is to be completed and reviewed. Three RDAC's on power supplies, component testing, and plasma tube modules have been nearly completed. Construction work has started.

Total Estimated Cost (TEC): $9,100,000

(Tabular dollars in thousands. Narrative material in whole dollars.)

(e) Reasons for Increases and Decreases

Completion of a more detailed design and a programmatic lengthening of the construction schedule has led to a construction cost increase from the $8,000,000 shown in the FY 1987 Congressional budget to the $9,100,000 contained within. In addition, increased confidence in related R&D estimates results in a decrease in the related funding from $4,150,000 to $3,600,000.

(f) Cost Estimate (Cost estimate is preliminary).

Engineering and Design	$ 1,150
Procurement and Fabrication	4,700
Assembly and Installation	2,050
Contingency	1,200
Total	$ 9,100

Escalation is included at 3.5% per year.

DEPARTMENT OF ENERGY
1988 CONGRESSIONAL BUDGET REQUEST
OPERATING EXPENSE FUNDED PROJECT DATA SHEET
ENERGY RESEARCH

Energy Supply Research and Development - Operating Expenses
Magnetic Fusion

(Tabular dollars in thousands. Narrative material in whole dollars.)

Alcator C-Modification (C-MOD)
Massachusetts Institute of Technology

Total Estimated Cost: $17,400,000
(For Design and Construction)

Alcator C-Modification (C-MOD)
Massachusetts Institute of Technology*

Total Estimated Cost: $17,400,000

(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1986 Actual		FY 1987 Estimate		FY 1988 Estimate		FY 1989 Estimate		FY 1990 Estimate		Total Project Costs
	B/A	B/O	B/A	B/O	B/A	B/O	B/A	B/O	B/A	B/O	B/A
Fabrication											
Operating Expenses											
Design and Construction	$ 0	$ 0	$ 4,500	$ 4,500	$ 4,900	$ 4,900	$ 4,500	$ 4,500	$ 3,500	$ 3,500	$17,400
Subtotal	0	0	4,500	4,500	4,900	4,900	4,500	4,500	3,500	3,500	17,400
Related Funding Requirements											
Research Operations	0	0	3,665	3,665	4,500	4,500	3,235	3,235	600	600	12,000
Capital Equipment	0	0	0	0	1,700	1,700	3,000	3,000	0	0	4,700
	0	0	3,665	3,665	6,200	6,200	6,235	6,235	600	600	16,700
Total Project	$ 0	$ 0	$ 8,165	$ 8,165	$11,100	$11,100	$10,735	$10,735	$ 4,100	$ 4,100	$34,100

Description, Objective and Justification

The presently operating Alcator-C facility will be modified to Alcator C-MOD, a high-performance tokamak to optimize confinement in a high density, RF-heated plasma with the largest toroidal field operating range in the world. C-MOD will have a double-null divertor, and it will utilize 4-5 MW of ICRF power for auxiliary heating. $3.7M in capital equipment funds are to be used to replace power supplies transferred to LLNL for the Microwave Tokamak Experiment (MTX).

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*This project will be constructed at the Massachusetts Institute of Technology which is non-Government property.

Total Estimated Cost: $17,400,000

(Tabular dollars in thousands. Narrative material in whole dollars.)

Description, Objective and Justification (continued)

The major objective of Alcator C-MOD is to provide unique and valuable information on transport in high density plasmas with intense ICRF heating. With the high current capability of C-MOD, good confinement is expected. The improved access in C-MOD, together with most recent advances in divertor designs, will make it possible to investigate both the physics and engineering of high field tokamak operation.

During the initial phase of operation, the objective is to develop operational techniques and control methods to produce high-temperature, high-density, well confined plasmas using such tools as a baffled divertor and pellet fueling. Further in the area of particle control, C-Mod will develop operational techniques to improve confinement effects. C-Mod will address issues such as current ramp-up for discharge optimization.

(a) Schedule of Planned Activities

	Start	Complete
Design	1Q FY 1987	3Q FY 1987
Fabrication	2Q FY 1987	3Q FY 1988
Installation	1Q FY 1988	2Q FY 1990
Startup	1Q FY 1990	3Q FY 1990

(b) Management and Contracting

This project will be managed by the MIT Plasma Fusion Center under separate contract.

(c) Prior Year Achievements

N/A

(d) Current Year Achievements

Conceptual design will be completed. Technology R&D detail design and fabrication will be initiated.

Total Estimated Cost: $17,400,000

(Tabular dollars in thousands. Narrative material in whole dollars.)

(e) Reasons for Increases or Decreases

N/A

(f) Cost Estimate

Engineering and Design	$ 2,700
Hardware Fabrication and Installation	12,400
Contingency	2,300
Total	$17,400

Escalation at 5% per year.

DEPARTMENT OF ENERGY
1988 CONGRESSIONAL BUDGET REQUEST
OPERATING EXPENSE FUNDED PROJECT DATA SHEET
ENERGY RESEARCH

Energy Supply Research and Development - Operating Expenses
Magnetic Fusion

(Tabular dollars in thousands. Narrative material in whole dollars.)

Microwave Tokamak Experiment (MTX)
Lawrence Livermore National Laboratory (LLNL)

Total Estimated Cost: $8,600,000
(For Design and Construction)

Microwave Tokamak Experiment (MTX)
Lawrence Livermore National Laboratory (LLNL)

Total Estimated Cost: $8,600,000

(Tabular dollars in thousands. Narrative material in whole dollars.)

	Prior Year Obs.	FY 1987 Estimate B/A	FY 1987 Estimate B/O	FY 1988 Estimate B/A	FY 1988 Estimate B/O	Total Project Funding B/A
Fabrication						
Operating Expenses						
Design and Construction	$ 0	$ 2,460	$ 2,460	$ 6,140	$ 6,140	$ 8,600*
Subtotal	0	2,460	2,460	6,140	6,140	8,600
Related Funding Requirements						
Facility Operations	0	2,940	2,940	3,460	3,460	6,400
Capital Equipment	0	0	0	700	700	700
Subtotal	0	2,940	2,940	4,160	4,160	7,100
Total Project	$ 0	$ 5,400	$ 5,400	$10,300	$10,300	$15,700

*This amount is total construction cost not including MIT power supplies.

Description, Objective and Justification

Advances in high-power microwaves open up to some very interesting opportunities for plasma heating, current drive, and profile control. The technology, developed at LLNL, could have the same major impact on the fusion program that neutral-beam technology had in the 1970's. The salient features of the technology are that (1) the power is pulsed, but repetition rates of many kHz for long periods (or steady state) are possible; (2) frequencies from microwave to ultra violet can be produced; (3) average powers of several megawatts per device are theoretically possible; (4) pulse lengths are short (50 ns is typical), so windowless transmission is feasible without the worry of waveguide breakdown; and (5) costs of a few dollars per watt are estimated based on accelerator construction costs and theoretical estimates of efficiency.

Description, Objective and Justification (continued)

The three applications (heating, current drive and profile control) are based on ECH. This heating method could be superior to all others for compact high-density machines, both from a physics and a technology viewpoint. This is particularly true of deuterium-tritium devices. Efficiencies of current drive for this process are good. Combined with lower-hybrid current drive the efficiency could be enhanced. Also, to make a steady-state tokamak, the hybrid waves could be used for startup (here there are no alphas) while ECH waves would be used to sustain the current.

The funds requested here would install the Alcator, provide diagnostics to supplement those brought from MIT, and acquire the low-power-driver source (a pulsed gyrotron operating at 140 to 280 GHz). We propose using the 140 GHz sources developed by Varian, both in their present form and as modified for second harmonic output at 280 GHz.

(a) Schedule of Planned Activities

The following table presents the total program broken down by primary tasks.

Activity	Start	Complete
Design	2Q FY 1987	1Q FY 1988
Move Alcator C Components	2Q FY 1987	3Q FY 1987
Install Alcator C Components	4Q FY 1987	4Q FY 1988

(b) Management and Contracting

This project will be managed by the LLNL physics and engineering staff. All procurements will be done by approved UC/LLNL procurement rules. No participation is expected by industry. This project is of short duration, therefore, complicated project management procedures are not expected to be needed.

Microwave Tokamak Experiment (MTX)
Lawrence Livermore National Laboratory (LLNL)

Total Estimated Cost: $8,600,000

(Tabular dollars in thousands. Narrative material in whole dollars.)

(c) Prior Year Achievements

N/A

(d) Current Year Achievements

The Alcator C, its controls, diagnostics, and power supplies will be moved from MIT to LLNL and initial assembly will begin.

(e) Reasons for Increases and Decreases

N/A

(f) Cost Estimate

Engineering and Design	$ 1,813
Construction Costs	6,104
Contingency	683
Total	$ 8,600

Cost estimates are based on a preliminary design.

(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Compact ignition tokamak (CIT) Princeton Plasma Physics Laboratory (PPPL)*

2. Project No.: 88-R-902

3. Date A-E work initiated: 1st Qtr. FY 1988

3a. Date physical construction starts: 3rd Qtr. FY 1988

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

5. Previous cost estimate: None
Date:

6. Current cost estimate: $357,000
Date: December 1986

7. Financial Schedule:

Fiscal Year	Authorization	Appropriation	Obligations	Costs
1988	$357,000	$ 8,000	$ 8,000	$ 8,000
1989	0	52,000	52,000	45,000
1990	0	75,000	75,000	68,000
1991	0	85,000	85,000	89,000
1992	0	75,000	75,000	75,000
1993	0	62,000	62,000	72,000
	$357,000	$357,000	$357,000	$357,000

8. Brief Physical Description of Project

The CIT project will provide for the reconfiguration of the Tokamak Fusion Test Reactor (TFTR) facilities into an ignition upgrade of the TFTR facility. The TFTR facilities include buildings, power supplies, motor generators, a tritium system, vacuum pumping systems, computer control systems, instrumentation systems, a

* This project will be located on non-Government owned land. The U.S. Government has leased this land from Princeton University for a 40 year period.

1. Title and location of project: Compact ignition tokamak (CIT)
Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 88-R-902

8. Brief Physical Description of Project (continued)

cryogenic system, a water cooling system, utilities, and diagnostics which are relevant to the CIT Project objective of achieving ignited plasma conditions in a tokamak configuration.

The elements of work required for the project are to:

- Upgrade and reconfigure TFTR equipment and facilities systems to support the CIT project; including power, tritium, water, utilities, vacuum, cryogenic, diagnostic, and computer control; as well as service facilities and buildings.
- Construct a compact tokamak device with copper toroidal and poloidal field coils cooled with liquid nitrogen.
- Build a shielded, tritium sealed test cell.
- Provide additional support facilities for CIT, such as hot cells and rf systems.

The construction project scope includes design, construction, fabrication, assembly, installation, and testing of the following:

- Tokamak device complete with support structure, vacuum vessel, vacuum pumping system, liquid nitrogen cooled copper coils, shielding, and fueling systems.
- Test cell to accommodate the tokamak device and its support systems, including a crane, radiation shielding, tritium sealing, and remote maintenance equipment.
- Liquid and gas nitrogen cooling system.
- Additional specialized support buildings.

1. Title and location of project: Compact ignition tokamak (CIT) Princeton Plasma Physics Laboratory (PPPL) 2. Project No.: 88-R-902

8. Brief Physical Description of Project (continued)

- o DC power supply system redirected from TFTR.
- o Tritium handling, delivery, and clean-up systems reconfigured from TFTR.
- o Instrumentation and control systems reconfigured from TFTR.
- o Existing TFTR plant and equipment and the existing laboratory infrastructure redirected and re-used, including AC power and cryogenic equipment, utility distribution systems, central plant facilities, service facilities such as roads and parking areas, and miscellaneous facilities including pump houses, cooling towers, storage areas, and waste handling facilities as appropriate.

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

The purpose of the U.S. Magnetic Fusion program is to build the scientific and technological base required to determine whether fusion can become a viable energy source for deployment in the 21st Century. A key science issue in establishing this fusion scientific base is understanding the properties of burning plasmas. Achievement of ignition and plasma burn has been an objective of the fusion program from its inception. This CIT project is designed to address this critical ignition and burn fusion science issue.

The U.S. fusion program is also characterized by a growing level of international collaboration. The CIT project supports the schedule and technical objectives of the U.S. national fusion program plan, as well as those of the international program and enables the United States to remain an important major participant and contributor to international fusion research.

The present generation of operating tokamaks are beginning to explore plasma confinement at near-reactor parameters. A consensus has developed among the leaders of the international fusion community that the fusion

1. Title and location of project: Compact ignition tokamak (CIT) Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 88-R-902

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

program would greatly benefit, and the Engineering Test Reactor (ETR) objectives would be served, if an ignited plasma could be produced and studied within the coming decade. CIT will bridge the gap between the transient, sub-ignited operation of TFTR and JET and the stable equilibrium burn projected for the ETR. The objectives, for this ignition experiment are that it achieve ignition and reveal the properties of burning plasma, that the cost of the machine be modest in relation to the cost of an ETR, and that it be operational in the early 1990's.

Because of experimental progress in fusion research, it is now possible to build a tokamak that will achieve this objective. Recent design studies have determined that this can be achieved in a compact, low-cost copper coil device. The CIT project incorporates this new, low-cost device as part of a TFTR facility upgrade. This will be the first time in the world that a controlled fusion plasma will be ignited, and therefore, CIT represents a major step in fusion research. Briefly, then the mission of CIT will be to realize, study, and optimize fully ignited plasma discharges. This data sheet proposes to provide this CIT facility which will:

- Conduct experiments and provide scientific information on the properties and behavior of burning plasma confined in a tokamak device.
- Address generic non-plasma issues such as tritium handling, remote handling, plasma-wall interactions, and radiation hardened diagnostics.

This compact, high-field, copper-coil tokamak configuration will enable low-cost ignition experimentation that will provide critical, burning-plasma data for successful future operation of an integrated Engineering Test Reactor. The use of the Princeton site minimizes the cost of the CIT by taking maximum advantage of existing TFTR facilities. The scheduled completion of experiments on TFTR is consistent with the CIT construction schedule at the TFTR site.

1. Title and location of project: Compact ignition tokamak (CIT) Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 88-R-902

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

The funding request of $8,000,000 in FY 1988 provides for initiation of Title I and II architect engineering services and for procurement of selected long-lead materials.

10. Details of Cost Estimate

	Item Cost	Total Cost
a. Engineering, Design and Inspection		$ 82,000
b. Construction Costs		197,000
(1) Improvements to land, including grading, drainage, roads, paving, area lighting and landscaping	$ 400	
(2) Buildings		
(a) New buildings to house CIT, approximately 60,000 square feet	24,300	
(3) Special facilities	166,000	
(4) Utilities including (mechanical) communications and electrical power	6,300	
Subtotal		279,000
c. Contingency at approximately 28% of above costs		78,000
Total Estimated Cost		$357,000

11. Method of Performance

The design, engineering, fabrication, and installation for CIT will be an effort involving the participation of several national laboratories, other DOE research centers, and possible international cooperation. A fusion program objective is for CIT to be a National project with broad U.S. fusion program involvement in order to make full use of the technical and scientific capabilities that exist throughout the U.S. program and to enable all program participants to benefit from the CIT technical and scientific challenges and progress.

The design of conventional facilities will be on the basis of a negotiated architect-engineer or construction management contract. The design of special facilities will be by PPPL, MIT, ANL, ORNL, INEL, LANL, LLNL, GAT, and the FEDC. These participants are necessary in order to ensure that the collective experience of the U.S. fusion community is properly utilized. PPPL will have responsibility for the design integration and configuration control. To the extent feasible, construction and procurement will be accomplished by industry under contracts awarded on a competitive basis.

1. Title and location of project: Compact ignition tokamak (CIT)
Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 88-R-902

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

	FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	Total
a. Total Project Funding							
1. Total Facility Costs	$ 8,000	$ 45,000	$ 68,000	$ 89,000	$ 75,000	$ 72,000	$357,000
2. Other Project Funding							
(a) Diagnostics	0	2,200	4,700	7,500	9,200	6,200	29,800
(b) R&D Necessary to Complete Construction	5,700	14,600	4,200	4,000	0	0	28,500
(c) Other Project Related Costs	2,300	2,500	4,700	6,200	7,900	5,600	29,200
Total Other Project Funding	8,000	19,300	13,600	17,700	17,100	11,800	87,500
Total Project Funding	16,000	64,300	81,600	106,700	92,100	83,800	444,500

b. Other Related Annual Costs

	Annual Estimates
1. Facility operating costs..	$45,000
2. Programmatic operating expenses directly related to the facility.....................	23,000
3. Capital equipment not related construction, but related to the programmatic effort in the facility..	4,500
Total Related Annual Costs..	$72,500

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

a. Total Project Funding

1. Total Facility Costs - Description is provided in Sections 8 and 9.

1. Title and location of project: Compact ignition tokamak (CIT)
Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 88-R-902

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

2. Other Project Funding

(a) Diagnostics

Diagnostics consists of new and modified experimental systems for evaluating plasma parameters and performance.

(b) R&D Necessary to Complete Construction

Technology development, prototyping and mockup testing to support the design and cost-effective fabrication of the magnets, vacuum vessel and first wall, remote maintenance, shielding, and instrumentation and control systems.

The project also depends upon the continued role of the fusion laboratories to support the technology research and development activities necessary to successfully complete CIT. Accordingly, continued adequate funding of the fusion base program is implied.

(c) Other Project Related Costs

These costs include spare parts, system software, supplemental staff support and preparation for operations.

b. Other Related Annual Costs

1. Facility Operating Costs

This facility is estimated to operate for a period of 7 years. The major elements comprising the annual operating costs will be personnel salaries, maintenance, spare parts, and utilities.

1. Title and location of project: Compact ignition tokamak (CIT) Princeton Plasma Physics Laboratory (PPPL)

2. Project No.: 88-R-902

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

2. Programmatic Operating Expenses Directly Related to the Facility

   The programmatic operating expenses directly related to the facility will be salaries for staff personnel (physicists and engineers) to carry out the experimental program.

3. Capital Equipment Not Related to Construction but Related to the Programmatic Effort in the Facility

   Capital equipment not related to construction but related to the programmatic effort.

DEPARTMENT OF ENERGY
1988 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
MAGNETIC FUSION
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: General plant projects

2. Project No.: 88-R-901

3. Date A-E work initiated: 1st Qtr. FY 1988

3a. Date physical construction starts: 2nd Qtr. FY 1988

4. Date construction ends: 4th Qtr. FY 1989

5. Previous cost estimate: None
Date:

6. Current cost estimate: $8,900
Date: December 1986

7. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1986	FY 1987	FY 1988	After FY 1988
Prior Year Projects	XXXXXXXX	$ 6,863	$ 4,677	$ 1,543	$ 0
FY 1986 Projects	$ 8,764	2,697	4,099	1,968	0
FY 1987 Projects	8,200	0	2,711	3,099	2,390
FY 1988 Projects	8,900	0	0	5,577	3,323
		$ 9,560	$ 11,487	$ 12,187	$ 5,713

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.: 88-R-901

8. Brief Physical Description of Project (continued)

The currently estimated distribution of FY 1988 funds by office is as follows:

1.	Los Alamos National Laboratory	$ 500
2.	Lawrence Livermore National Laboratory	200
3.	Princeton Plasma Physics Laboratory	1,000
4.	Oak Ridge National Laboratory	7,200
		$ 8,900

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

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

Los Alamos National Laboratory		$ 500
Control room building addition	150	
Cooling tower	200	
Miscellaneous small projects	150	
Lawrence Livermore National Laboratory		$ 200

Power source for NMFECC Network equipment.

Princeton Plasma Physics Laboratory*		$ 1,000
Safety and fire protection improvements, system modifications and alterations.	100	
Field coil power conversion (FCPC) office improvements	100	
TFTR Capacitor bank safety barriers	200	
Replace 10 PCB transformers	500	
Relocate TFTR diesel fuel line	30	
Miscellaneous small projects	70	

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

1. Title and location of project: General plant projects 2. Project No.: 88-R-901

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

Oak Ridge National Laboratory.. $ 7,200

These funds cover the Magnetic Fusion Energy program's responsibility to fund all of the generic general plant projects needs at this multipurpose laboratory.

Replacement of Ductwork, Phase II, Radiochemical Processing Pilot Plant....	$ 230
Replacement of HVAC System, Radioactive Containment Facility...............	600
Safeguards Upgrading, Thorium - Uranium Recycle Facility....................	350
Office and Laboratory Space..	630
Off-Site Tape Storage Facility...	340
Photography Lab Environmental Control Improvement..........................	190
Fire Training and Test Facility..	175
Sentry Post Replacement - Gate 3...	103
Sentry Post Replacement - Gate 1-E...	64
Sentry Post Replacement - Gate 19-B..	102
Coal Sample Preparation Facility...	65
Laundry Building Improvements..	60
Steam Plant Storage Building...	109
Manipulator Decontamination and Repair Facility............................	1,120
Central Mechanical Shops Air Conditioning..................................	175
Main Entrance Modifications..	265
Additional West End Parking..	160
Computer Science Research Facility...	1,100
Protein Engineering Laboratory...	220
New Facilities for Mobile Research Equipment...............................	100
Upgrade Electrical Supply, Fusion Energy Building..........................	400

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

1. Title and location of project: General plant projects | 2. Project No.: 86-R-[illegible]

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

Oak Ridge National Laboratory (continued)

Restoration of 480v Electrical System, Fusion Energy Building.............	500
Improvements for User Facilities..	60
Sound Proofing Instron Pump...	30
Sentry Post Replacement - Gate 20-B.......................................	52

10. Details of Cost Estimate

Not available at this time.

11. Method of Performance

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

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

This item does not apply to general plant projects.

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

This item does not apply to general plant projects.