

(No more than 12 characters and spaces for name of contractor, use standard abbreviation for state, up to 16 characters and spaces for county.)

Site where work will be performed	State:	County:
NAME OF CONTRACTOR:		
Site where work will be performed	State:	County:
NAME OF CONTRACTOR:		
Site where work will be performed	State:	County:
NAME OF CONTRACTOR:		
Site where work will be performed	State:	County:
NAME OF CONTRACTOR:		
Site where work will be performed	State:	County:

5. BRIEF DESCRIPTION OF PROPOSAL

(No more than 34 lines of text and no more than 79 characters and spaces per line)

Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.

Four (4) 100,000 BPD Plants are proposed employing (1) Direct hydrogenation, (2) Carbonization with hydrogenation and utilization of all char, (3) Extraction/hydrogenation, (4) Gasification with Fischer Tropsch or related synthesis. These processes may be in various combinations.

6. JUSTIFICATION (Use a separate sheet(s). See Item 6. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978	1979
a. MANPOWER (in man years)	(1) Scientific	300	300	300	200	200
	(2) Technici	300	300	300	300	300
	(3) Support	600	600	600	600	600
	(4) Other Const		200	1000	2000	1500
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)		minor	minor	coal 1.0x10 ⁶ tons/yr.	coal 10.0x10 ⁶ tpy water 20,000 acre ft.	coal 50.0x10 ⁶ water 50,000 ac.
c. LAND AREA REQUIRED (in acres)	(1) Govt-owned					
	(2) Govt-leased	2560	2560			
	(3) Privately-owned			Same as 1975-1976		
	(4) Other			No additional area required		
d. OTHER RESOURCES NEEDED (Specify item and unit of measure below. Show quantity of each in columns at right.)						

(1)

(1)

3

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

Level of Effort

- MAXIMUM
 ORDERLY
 MINIMUM

IDENTIFICATION NUMBER

05-04-21-03-12-78-

G. JUSTIFICATION - State the specific energy problem or objective, and specify how the proposal will contribute to the solution of the problem or attainment of the objective. Include reasons for selecting the recommended approach over other alternatives. Also include the benefits expected to be derived from meeting the objectives or solving the problems for which the project is proposed. Outline the risks/uncertainties (R/U), plans to minimize R/U, and basis for proceeding in face of R/U. Quantitative data should be used to the fullest extent.

The objective of this subprogram is the development of a viable industry for conversion of coal to a clean burning liquid fuel. Such a fuel can be used for generation of electric power relieving pressure on use of oil and gas. With additional treatment, the liquids can be further refined to motor fuel. All processes produce other energy by-products such as pipeline gas, LPG's, electric power and may produce a clean burning solid as well. Each of the products will contribute to the reduction of pressure on oil and gas.

Production of a clean burning liquid fuel should have a high priority because of the broad energy market that can be served by such a product. Cleaner air is an important secondary benefit.

This subprogram is based on technology that has been carried through small scale equipment and is supported by on-going pilot plant projects. The primary risk is scale-up which means that plant outputs cannot be guaranteed but product quality can. The primary barrier to commercial acceptance is industrial fear of the risk of the investment in commercial plants. By assuming the major risk, the government will insure the maximum rate of commercial adoption of these processes.

Rapid commercialization of clean burning liquids from coal holds promise for independence on middle east oil and could lead to national energy self-sufficiency. The program should be supported by industry at the 50/50 basis.

DEVELOPMENT FACT SHEET (Continued)

Level of Effort

- MAXIMUM
 ORDINARY
 MINIMUM

IDENTIFICATION NUMBER

05-04-21-03-12-78-03-01

specific energy problem or objective, and specify how the proposal will contribute to the solution of the problem. Include reasons for selecting the recommended approach over other alternatives. Also include the benefits resulting from the objectives or solving the problems for which the project is proposed. Outline the risks/uncertainties and basis for proceeding in face of R/U. Quantitative data should be used to the fullest extent.

One of the major objectives of this subprogram is the development of a viable industry for conversion of coal to a clean burning liquid fuel. Such a fuel can be used for generation of electric power relieving pressure on use of oil and gas. With additional processing the liquids can be further refined to motor fuel. All processes produce valuable by-products such as pipeline gas, LPG's, electric power and may produce other solid products as well. Each of the products will contribute to the relief of dependence on oil and gas.

The development of a clean burning liquid fuel should have a high priority because of the large market that can be served by such a product. Cleaner air is an equally important secondary benefit.

The program is based on technology that has been carried through small scale demonstration and is supported by on-going pilot plant projects. The primary risk involves the fact that plant outputs cannot be guaranteed but product quality is a secondary barrier to commercial acceptance is industrial fear of the magnitude of investment in commercial plants. By assuming the major risk, the government should support the maximum rate of commercial adoption of these processes.

The commercialization of clean burning liquids from coal holds promise for decreasing dependence on middle east oil and could lead to national energy self-sufficiency. This program should be supported by industry at the 50/50 basis.

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

MODULE (include major facilities and major equipment. Indicate dates by Fiscal Year and Quarter).

a. DEVELOPMENT MILESTONES (number each consecutively)

(Limit Title of Milestone to 60 characters and spaces)

b. DATES

Start		Complete	
FY	Q	FY	Q
75	1	77	2
76	1	78	4
78	2	79	2
79	3		
75	3	77	4
76	3	79	1
78	3	79	3
79	4		
76	1	78	1
77	1	79	4
79	3	80	3
80	3		
75	1	76	2
75	1	77	1
76	1	78	1
74	3	75	4
74	2	78	4

Design Plant #1
 Construct Plant #1
 Test Operate Plant #1
 Production Plant # 1

Plant #2: Design
 Construct
 Test Operate
 Production

Plants #'s 3 and 4: Design
 Construct
 Test Operate
 Production

Supporting Pilot Plant Program
 Operating Data: Process #1
 Process #2
 Process #3

Engr. Studies
 Combination Plants
 Cost Estimates

(Continue to next column)

- Level of Effort:
- MAXIMUM
 - ORDERLY
 - MINIMUM

IDENTIFICATION NUMBER

05-04-21-03-12-78-03-01

a. DEVELOPMENT MILESTONES (continued)

(Limit Title of Milestone to 60 characters and spaces)

b. Effort	
Start	End
FY	Q

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (continued)

B. SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

Requirement	(1)		(2)		(3)		(4)	
	FY 1974 (Non-Add)		FY 1975		FY 1976		FY 1977	
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays
a. OPERATING (See p. for detail) Total Operating Requirements (from Detail Sheet)	151	101	215	215	265	265	225	225
b. CONSTRUCTION (See p. for detail) Total Construction Requirements (from Detail Sheet)			125	75	650	450	1250	1150
c. EQUIPMENT (See p. for detail) Total Equipment Requirements (from Detail Sheet)			0.3	0.3	0.4	0.4	0.2	0.2
d. GRAND TOTAL—OBLIGATIONS								
e. GRAND TOTAL—OUTLAYS								

NOTE: If cooperative programs are proposed, indicate the amount by year of both private and Federal government funding. A brief description of responsibilities should be separately provided in the above format.

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER
05-01-21-03-12-78-03-01

(4) 1977	(5) FY 1978		(6) FY 1979		(7) Subtotal FY 1975-79		(8) Balance To Complete		(9) Total Expendings FY 1974 (Col. 7 & 8)	
	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.
225	220	220	220	220						
1150	625	750	350	475	3000	2950	---	50		
0.2	0.1	0.1	---	---	1.0	1.0				

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

1. DETAIL OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

2. OPERATING

ITEM	(1)		(2)		(3)		C
	FY 1974 (Non-Add)		FY 1975		FY 1976		
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	
TOTAL (Carry forward to summary sheet) >	151	101	215	215	265	265	2
Name of Performing Organization: OCR (Contractors)	150	100	200	200	250	250	2
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION							
Name of Performing Organization: Bu Mines	1.0	1.0	10	10	15	15	1
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION							
Name of Performing Organization: Bu Standards			5	5	10	10	10
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION							
Name of Performing Organization:							
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION							

(Continue on

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER

05-04-21-03-12-78-03-01

(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) SUBTOTAL FY 1975-79		(8) BALANCE TO COMPLETE		(9) TOTAL EXCLUDING FY 1975-79	
Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
25	225	220	220	220	220						
00	200	200	200	200	200						
5	15	15	15	10	10						
0	10	5	5	5	5						

2

ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

B. DETAILS OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

B. CONSTRUCTION Total Funds are Shown - Industry Participation not Specified

ITEM	(1)		(2)		(3)		Ot	
	FY 1974 (Non-Add)		FY 1975		FY 1976			
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays		
TOTAL (Carry forward to summary sheet)			125	75	650	450	120	
Title of project, Location (State and County) and Total Estimated Cost (TEC) for each item consecutively. Every project lasting one or more years or more should be separately identified with a brief statement if it is required.	Item No. ()							
TITLE OF PROJECT (Not to exceed 30 characters and spaces.) Clean Burning Liquid Fuel	()							
State	County	TEC (in millions)						
		750.0		75	50	300	250	350
Statements: Process Plant #1 is a commercial scale Carbonization Plant with hydrogenation and char gasification. Plant products are a clean burning liquid and pipeline gas.								
TITLE OF PROJECT (Not to exceed 30 characters and spaces.) Clean Burning Liquid Fuel	()							
State	County	TEC (in millions)						
		750.0		50	25	200	100	400
Statements: Process Plant #2 is a direct hydrogenation plant producing a boiler fuel fraction and a motor fuel fraction. By-product chemicals may be recovered.								
TITLE OF PROJECT (Not to exceed 30 characters and spaces.) Clean Burning Liquid Fuel	()							
State	County	TEC (in millions)						
		\$1,500.0		—	→	150	100	500
Statements: Process plants #3 and #4 are multiple product plants based on SRC, extraction and hydrogenation.								

(Continue on S)

Level of Effort:
 MAXIMUM
 ORDERLY
 MINIMUM

IDENTIFICATION NUMBER

05-04-21-03-12-78-03-01

(5) FY 1978		(6) FY 1979		(7) SUBTOTAL FY 1975-79		(8) BALANCE TO COMPLETE		(9) TOTAL EXCLUDING FY 1975-79	
Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
625	750	350	475	3,000	2,950	—	50		
25	50			750	750				
100	200	—	75	750	750				
500	500	350	400	1500	1450	—	50		

2

ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

DETAIL OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

EQUIPMENT

ITEM <i>(Each item not to exceed 60 characters and spaces)</i>	(1)		(2)		(3)		(4)	
	FY 1974 (Non-Add)		FY 1975		FY 1976		FY 1977	
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays
(Each item not to exceed 60 characters and spaces) TOTAL (Carry forward to summary sheet) ▶	.300	.300	.300	.300	.400	.400	.200	.200
CCR (Contractors)	.100	.100	.200	.200	.300	.300	.100	.100
Bu Mines (Govt Lab)	.200	.200	.100	.100	.100	.100	.100	.100

(Continue on Separate Sheet)

Level of Effort:

MAXIMUM

ORDERLY

MINIMUM

IDENTIFICATION NUMBER

05-04-21-03-12-78-03-01

(5) FY 1978		(6) FY 1979		(7) SUBTOTAL FY 1975-79		(8) BALANCE TO COMPLETE		(9) TOTAL EXCLUDING FY 1974 Cons. 7 & 8	
Ob's.	Outlays	Ob's.	Outlays	Ob's.	Outlays	Ob's.	Outlays	Ob's.	Outlays
100	.100	---	---	1.	1.				
---	---	---	---	.600	.600				
100	.100	---	---	.500	.500				

2

ENERGY RESEARCH & DEVELOPMENT
 FACT SHEET

Level of Effort
 MAXIMUM
 MODERATE
 MINIMUM

1. IDENTIFICATION NUMBER
 05-03-21-03-12-82-03-C

2. a. PROGRAM	Coal Processing		
b. SUBPROGRAM	Clean Mining Methods		
3. a. PROGRAM AGENCY	Interior		
b. SUBUNIT	OCR		
4. CONTRACTOR AND SITE	NAME OF CONTRACTOR: Various 25-35		
<i>(No more than 12 characters and spaces for name of contractor, use standard abbreviation for state up to 16 characters and spaces for county.)</i>	Site where work will be performed	State:	County:
	NAME OF CONTRACTOR:		
	Site where work will be performed	State:	County:
	NAME OF CONTRACTOR:		
	Site where work will be performed	State:	County:
NAME OF CONTRACTOR:			
NAME OF CONTRACTOR:			
Site where work will be performed	State:	County:	

5. BRIEF DESCRIPTION OF PROPOSAL	<p><i>(No more than 24 lines of text and no more than 70 characters and spaces per line)</i></p> <p>Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.</p>
	<p>Current coal research projects will be accelerated. Pilot plant projects will be completed and the data used to design a modular demonstration plant for proving results at a commercial scale. The modular plant is expected to be about 10% of the size of a commercial. Design to be based on and include pilot plant results.</p>

6. JUSTIFICATION (Use a separate sheet(s). See Item 6. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978	1979
a. MANPOWER <i>(in man years)</i>	(1) Scientific	100	100	100	100	100
	(2) Technical	200	200	200	200	200
	(3) Support	300	300	300	300	300
	(4) Other Const.	---	100	500	200	---
b. RAW MATERIALS <i>(List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)</i>		minor	minor	coal 50,000 tpy	coal 1.0x10 ⁶ tpy	coal 1.0x10 ⁶
c. LAND AREA REQUIRED <i>(in acres)</i>	(1) Government			640		
	(2) Government					
	(3) Privately-owned					Same areas as 1977
	(4) Other					No additional area needed
d. OTHER RESOURCES NEEDED						

W&A

Level of Effort

- MAJOR
- OTHER
- MINOR

1. IDENTIFICATION NUMBER

05-04-21-03-12-82-0-01

CONTRACT NUMBER

Long Mining Leases

interior

CR

NO OF CONTRACTORS Various 25-35

Where work will be formed

State: County:

NAME OF CONTRACTOR

Where work will be formed

State: County:

NAME OF CONTRACTOR

Where work will be formed

State: County:

NAME OF CONTRACTOR

Where work will be formed

State: County:

NAME OF CONTRACTOR

Where work will be formed

State: County:

Current coal research projects will be accelerated. Pilot plant projects will be completed and the data used to design a modular concentration plant for proving results at a commercial scale. The modular plant is expected to be about 10% of the size of a commercial. Design to be based on and include pilot plant results.

2

(4). See Item 6. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

1975	1976	1977	1978	1979
100	100	100	100	100
200	200	200	200	200
300	300	300	300	300
—	100	500	200	—
minor	minor	coal 50,000 tpy	coal 1.0x10 ⁶ tpy	coal 1.0x10 ⁶ tpy
		640	←————→	
			Same areas as	1977
			No additional	area needed

BLANK PAGE

use standard abbreviation for state up to 16 characters and spaces for county.

NAME OF CONTRACTOR:

Site where work will be performed State: _____ County: _____

NAME OF CONTRACTOR:

Site where work will be performed State: _____ County: _____

NAME OF CONTRACTOR:

Site where work will be performed State: _____ County: _____

NAME OF CONTRACTOR:

Site where work will be performed State: _____ County: _____

5. BRIEF DESCRIPTION OF PROPOSAL

(No more than 24 lines of text and no more than 70 characters and spaces per line)

Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.

Current coal research projects will be accelerated. Pilot plant projects will be completed and the data used to design a modular demonstration plant for proving results at a commercial scale. The modular plant is expected to be about 10% of the size of a commercial. Design to be based on and include pilot plant results.

6. JUSTIFICATION (Use a separate sheet(s). See Item 6. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978	1979
a. MANPOWER (in man years)	(1) Scientific	100	100	100	100	100
	(2) Technical	200	200	200	200	200
	(3) Support	300	300	300	300	300
	(4) Other	---	100	500	200	---
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)		minor	minor	coal 50,000 tpy	coal 1.0x10 ⁶ tpy	coal 1.0x10 ⁶ tpy
c. LAND AREA REQUIRED (in acres)	(1) Gov-owned					
	(2) Gov-leased			640		
	(3) Privately-owned					
	(4) Other				Same areas as 1977	No additional area needed
d. OTHER RESOURCES NEEDED (Specify item and unit of measure below. Show quantity of each in columns at right.)						
(1)	(1)					

3

ENERGY RESEARCH AND DEVELOPMENT PROJECTS (Continued)

- MAXIMUM
- ORDINARY
- MINIMUM

IDENTIFICATION NUMBER
05-04-21-03-12-82-03-01

6. JUSTIFICATION- State the specific energy problem or objective, and specify how the proposed will contribute to the solution of the problem or attainment of the objective. Include reasons for selecting the recommended approach over other alternatives. Also include the benefits expected to be derived from meeting the objectives, or solving the problems for which the project is prepared. Outline the risks/uncertainties (R/U), plans to minimize R/U, and how to proceed in face of R/U. Quantitative data should be used to the fullest extent.

Same as maximum

AND DEVELOPMENT FACILITY (Continued)

LEVEL OF

- MAXIMUM
- MODERATELY
- MINIMUM

IDENTIFICATION NUMBER

05-04-21-03-12-82-03-01

Describe the specific energy problem or objective, and specify how the proposal will contribute to the solution of the problem or objective. Include reasons for selecting the recommended approach over other alternatives. Also include the benefits from meeting the objectives or solving the problems for which the project is proposed. Outline the risks/uncertainties, the R/U, and basis for proceeding in face of R/U. Quantitative data should be used to the fullest extent.

maximum

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

SCHEDULE *Include major facilities and major equipment. Indicate dates by Fiscal Year and Quarter.*

a. **DEVELOPMENT MILESTONES** *(number each consecutively)*

(Limit Title of Milestone to 60 characters and spaces)

b. DATES

	Start		Complete	
	FY	Q	FY	Q
Pilot Plant Data:				
(1) Direct Hydrogenation	75	3	78	4
(2) Carbonization w/Hydro & Char Utilization	72	2	74	3
(3) Extraction/Hydro	75	4	78	1

(Continue to next column)

- Level of Effort:
- MAXIMUM
 - ORDERLY
 - MINIMUM

IDENTIFICATION NUMBER

05-04-21-03-12-82-03-01

a. DEVELOPMENT MILESTONES (continued)

(Limit Title of Milestone to 60 characters and spaces)

b. DATES

Start of Completion

FY : C FY : C

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

9. SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

Requirement	(1)		(2)		(3)		(4)	
	FY 1974 (Non-Add)		FY 1975		FY 1976		FY 1977	
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Out
a. OPERATING (See p. for detail) Total Operating Requirements (from Detail Sheet)								
b. CONSTRUCTION (See p. for detail) Total Construction Requirements (from Detail Sheet)								
c. EQUIPMENT (See p. for detail) Total Equipment Requirements (from Detail Sheet)								
d. GRAND TOTAL—OBLIGATIONS	45		150		200		200	
e. GRAND TOTAL—OUTLAYS		30		100		200		20

NOTE: If cooperative programs are proposed, indicate the amount by year of both private and Federal government funding. A brief description of the activities should be separately provided in the above format.

ENERGY RESEARCH & DEVELOPMENT
FACT SHEET

Level of Effort:
 MAXIMUM
 ORDINARY
 MINIMUM

1. IDENTIFICATION NUMBER

05-04-21-03-12-85-03

2. a. PROGRAM	Coal Processing		
b. SUBPROGRAM	Clean Burning Liquids		
3. a. FUNDING AGENCY	Interior		
b. SUBJECT	OCR		
4. CONTRACTOR AND SITE	NAME OF CONTRACTOR: Various 15-25		
<i>(No more than 42 characters and spaces for name of contractor, use standard abbreviation for state, up to 16 characters and spaces for county.)</i>	Site where work will be performed	State:	County:
	NAME OF CONTRACTOR:		
	Site where work will be performed	State:	County:
	NAME OF CONTRACTOR:		
	Site where work will be performed	State:	County:
	NAME OF CONTRACTOR:		
	Site where work will be performed	State:	County:
	NAME OF CONTRACTOR:		

5. BRIEF DESCRIPTION OF PROPOSAL	<p><i>(No more than 24 lines of text and no more than 70 characters and spaces per line)</i></p> <p>Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.</p> <p>The existing program for clean burning liquids will continue at current minimum. Pace will not be accelerated. Pilot plants will be operated and those under construction will be completed and operated. Resulting pilot plant data will be used to design a larger demonstration plant capable of proving a number of processes and process alternatives. The plant will have a capacity of about 10% of a commercial plant.</p>
----------------------------------	---

6. JUSTIFICATION (Use a separate sheet(s). See Item 6. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978
a. MANPOWER <i>(in man years)</i>	(1) Scientific	100	100	50	50
	(2) Technical	200	200	150	150
	(3) Support	300	300	300	200
	(4) Other	none	none	0	0
b. RAW MATERIALS <i>(List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)</i>		11	1	N	0
c. LAND AREA REQUIRED <i>(in acres)</i>	(1) Govt-owned				
	(2) Govt-leased				
	(3) Privately-owned				
	(4) Other				
d. OTHER RESOURCES NEEDED					

DEVELOPMENT
ACT

Level of Effort:
 MAXIMUM
 ORDERLY
 MINIMUM

1. IDENTIFICATION NUMBER
 15-04-21-03-12-85-03-61

	COAL PROGRAMS		
	Clean Burning Liquids		
ICY	Interior		
	OCR		
ITE	NAME OF CONTRACTOR: Various 15-25		
Site and location:	Site where work will be performed	State:	County:
State:	NAME OF CONTRACTOR:		
State:	Site where work will be performed	State:	County:
	NAME OF CONTRACTOR:		
	Site where work will be performed	State:	County:
	NAME OF CONTRACTOR:		
	Site where work will be performed	State:	County:
	NAME OF CONTRACTOR:		
	Site where work will be performed	State:	County:

OF

of total
tractors

of space
to
be
required

The existing program for clean burning liquids will continue at the current minimum. Pace will not be accelerated. Pilot plants will be operated and those under construction will be completed and expanded. Resulting pilot plant data will be used to design a modular demonstration plant capable of proving a number of processes and process alternates. The plant will have a capacity of about 10% of a commercial plant.

2

(separate sheet(s). See Item 6. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS					
YEAR	1975	1976	1977	1978	1979
Manpower	100	100	50	50	50
Material	200	200	150	150	150
Equipment	300	300	300	200	200
Other	none	none	0	0	0
of one of units of unit of	N	I	N	O	R
owned					
leased					
financed					
needed					

BLANK PAGE

Use standard abbreviation for state, up to 16 characters and spaces for county.

NAME OF CONTRACTOR:		
Site where work will be performed	State:	County:
NAME OF CONTRACTOR:		
Site where work will be performed	State:	County:
NAME OF CONTRACTOR:		
Site where work will be performed	State:	County:
NAME OF CONTRACTOR:		
Site where work will be performed	State:	County:

5. BRIEF DESCRIPTION OF PROPOSAL

(No more than 24 lines of text and no more than 70 characters and spaces per line)
 Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.

The existing program for clean burning liquids will continue at the current minimum. Pace will not be accelerated. Pilot plants will be operated and those under construction will be completed and operated. Resulting pilot plant data will be used to design a modular demonstration plant capable of proving a number of processes and process alternates. The plant will have a capacity of about 10% of a commercial plant.

6. JUSTIFICATION (Use a separate sheet(s). See Item 6, on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978	1979
a. MANPOWER (in man years)	(1) Scientific	100	100	50	50	50
	(2) Technical	200	200	150	150	150
	(3) Support	300	300	300	200	200
	(4) Other	none	none	0	0	0
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)		M	I	N	O	R
c. LAND AREA REQUIRED (in acres)	(1) Govt-owned					
	(2) Govt-leased					
	(3) Privately-owned					
	(4) Other					
d. OTHER RESOURCES NEEDED (Specify item and unit of measure below. Show quantity of each in columns at right.)	(1)	3				

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

Level of Effort

- MAXIMUM
- ORDINARY
- MINIMUM

IDENTIFICATION NUMBER

05-04-21-03-12-85-

6. JUSTIFICATION: State the specific energy problem or objective, and specify how the proposal will contribute to the solution of the problem or attainment of the objective. Include reasons for selecting the recommended approach over other alternatives. Also include the benefits expected to be derived from meeting the objective, or solving the problems for which the project is proposed. Outline the risks/uncertainties (R/U), plans to minimize R/U, and bases for proceeding in face of R/U. Quantitative data should be used to the fullest extent.

Same as maximum

DEVELOPMENT FACT SHEET (Continued)

Level of Effort

- MAXIMUM
- ORDINARY
- MINIMUM

IDENTIFICATION NUMBER

05-04-21-03-12-85-03-01

state the energy problem or objective, and specify how the proposal will contribute to the solution of the problem. Include reasons for selecting the recommended approach over other alternatives. Also include the benefits of meeting the objectives or solving the problems for which the project is proposed. Outline the risks/uncertainties and basis for proceeding in face of R/U. Quantitative data should be used to the fullest extent.

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

SCHEDULE (Includes major facilities and major equipment. Indicate dates by Fiscal Year and Quarter).

a. DEVELOPMENT MILESTONES (number each consecutively)

(Limit Title of Milestone to 60 characters and spaces)

b. DATES

Start		Complete	
FY	Q	FY	Q
Completion of Construction of Pilot Plants			
		75	1
		78	1
		75	1
Completion of Pilot Plant DATA			
		77	3
		80	4
		79	4
Module Demonstration Plant			
		76	4
		78	4
		81	2
		80	4
		83	1
		75	4
		80	1
		80	2
		82	4
		82	2
		83	4
		76	4
		80	4
		81	1
		83	3
		83	1
		84	4

(Continue to next column)

Level of Effort:
 MAXIMUM
 ORDERLY
 MINIMUM

IDENTIFICATION NUMBER
05-04-21-03-12-05-03-01

a. DEVELOPMENT MILESTONES (continued)

(Limit Title of Milestone to 60 characters and spaces)

b. DATES
Start: Comp:
FY | Q FY | Q

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

9. SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

Requirement	(1)		(2)		(3)		(4)	
	FY 1974 (Non-Add)		FY 1975		FY 1976		FY 1977	
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outl
a. OPERATING (See p. for detail) Total Operating Requirements (from Detail Sheet)								
b. CONSTRUCTION (See p. for detail) Total Construction Requirements (from Detail Sheet)								
c. EQUIPMENT (See p. for detail) Total Equipment Requirements (from Detail Sheet)								
d. GRAND TOTAL—OBLIGATIONS	45		75		100		75	
e. GRAND TOTAL—OUTLAYS		30		50		100		75

NOTE: If cooperative programs are proposed, indicate the amount by year of both private and Federal government funding. A brief de:

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER
05-04-21-03-12-85-03-01

s	(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) Subtotal FY 1975-79		(8) Balance To Complete		(9) Total Excluding FY 1974 (Col. 7 & 8)	
	Ob's.	Outlays	Ob's.	Outlays	Ob's.	Outlays	Ob's.	Outlays	Ob's.	Outlays	Ob's.	Outlays
	75		75		50		375		1,000		1375	
		75		75		75		375		1,000		1375

2

<p>4. CONTRACTOR AND SITE</p> <p>(No more than 12 characters and spaces for contractor; no more than 12 characters and spaces for county.)</p> <p>To be selected by competitive procurement. Potential contractors are partially listed.</p>	<p>NAME OF CONTRACTOR: Esso Research & Engineering</p> <p>State where work will be performed: I- State: New Jersey County: Hudson</p>
	<p>NAME OF CONTRACTOR: Esso Research & Engineering</p> <p>State where work will be performed: I- State: California County: Contra Costa</p>
	<p>NAME OF CONTRACTOR: Babcock & Wilcox</p> <p>State where work will be performed: I- State: Ohio County: Summit</p>
	<p>NAME OF CONTRACTOR: Combustion Engineering</p> <p>State where work will be performed: I- State: Connecticut County: Hartford</p>
	<p>NAME OF CONTRACTOR: International Flame Research Foundation</p> <p>State where work will be performed: I- State: Holland County: Michigan</p>

5. BRIEF DESCRIPTION OF PROPOSAL

(No more than 24 lines of text and no more than 70 characters and spaces per line)

Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed:

Development and Demonstration of Modified Combustion Technology and Industrial Applications: Modify the combustion process utility boilers to provide more efficient utilization of fuel waste fuels, and simultaneously reduce air pollutant emissions. Techniques will be developed for firing coal and heavy oil, reduced emissions so cleaner fuels can be used with smaller. Technology for efficient, low-pollution combustion of derived fuels (e.g. low BTU gas) will be developed. Development of Modified Combustion Control Technology for Gas Turbines: Develop and demonstrate dry control methods for NO_x from stationary gas turbines. This R&D will be toward maximizing system efficiency. Fuels to be considered: light and heavy oil, natural gas, low-BTU gas, and candidate fuels. Develop and Demonstrate Modified Combustion Technology for Industrial Process Furnaces: Develop and demonstrate control methods for combustion related and toxic pollutant emissions industrial process furnaces. This R&D effort will also be toward improved efficiency in the use of fuels and feedstocks. Combustion of Reformed Fuels: Demonstrate a 1 MW combustion system for low NO_x emissions comprising a reformer of clean sulfur) liquid and gaseous fossil fuels in combination with combustion designed for lean operation.

6. JUSTIFICATION (Use separate sheets). See Item 6. on Instruction Sheet.

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978
a. MANPOWER	(1) Scientific	25	33	45	54
	(2) Technical	14	17	23	28
	(3) Support	23	62	85	62
	(4) Other	6	6	6	6
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)	TONS OF COAL	254,000	50,400	193,200	192,000
	BBLS OF OIL	1,200,000	170,400	732,000	729,600
	ft ³ nat. gas	420,000,000	14,400,000	7,200,000	--
	ft ³ low BTU gas		36,000,000	72,000,000	1,290,000,000
c. LAND AREA REQUIRED	(1) Govt-owned				
	(2) Govt-owned				

Coal & Oil Processing Combustion
 Improved Combustion Processes, Part 1. Combustion Modification (NO_x other
 EPA Office of Coal Research DOE

NAME OF CONTRACTOR	Esso Research & Engineering
Site where work will be performed	State: New Jersey County: Essex
NAME OF CONTRACTOR	INCO
Site where work will be performed	State: California County: Contra Costa
NAME OF CONTRACTOR	SAATCHI & SAATCHI
Site where work will be performed	State: Ohio County: Summit
NAME OF CONTRACTOR	Combustion Engineering
Site where work will be performed	State: Connecticut County: Fairfield
NAME OF CONTRACTOR	INTERNATIONAL FIRE RESEARCH FOUNDATION
Site where work will be performed	State: Holland County: Rotterdam

Development and Demonstration of Modified Combustion Technology for Utility and Industrial Boilers: Modify the combustion process in utility boilers to provide more efficient utilization of fossil and waste fuels, and simultaneously reduce air pollutant emissions. Techniques will be developed for firing coal and heavy oil with reduced emissions so cleaner fuels can be used with smaller equipment. Technology for efficient, low-pollution combustion of coal-derived fuels (e.g. low BTU gas) will be developed. **Development and Demonstration of Modified Combustion Control Technology for Utility Gas Turbines:** Develop and demonstrate any control methods for control of NO_x from stationary gas turbines. This R&D will be directed toward maximizing system efficiency. Fuels to be considered include light and heavy oil, natural gas, low-BTU gas, and candidate future fuels. **Development and Demonstration of Modified Combustion Technology for Industrial Process Furnaces:** Develop and demonstrate control methods for combustion related and toxic pollutant emissions from industrial process furnaces. This R&D effort will also be directed toward improved efficiency in the use of fuels and feedstock. **Low NO_x Combustion of Reformed Fuels:** Demonstrate a 1 MW combustion system for low NO_x emissions comprising a reformer of clean (low sulfur) liquid and gaseous fossil fuels in combination with a combustion designed for lean operation.

state sheet(s). See Item 6. on Instruction Sheet.)

F

7. MAJOR RESOURCE REQUIREMENTS

YEAR	1975	1976	1977	1978	1979
Personnel	25	33	45	54	31
Materials	14	17	23	28	16
Equipment	23	62	65	62	20
Travel	6	6	6	6	3
Costs of coal	24,000	50,400	193,200	192,000	
Costs of oil	1,200,000	170,400	732,000	729,600	2,000,000
Costs of natural gas	1,200,000	14,400,000	7,200,000	--	
Cost of low BTU gas		36,000,000	72,000,000	1,220,000,000	

2

BLANK PAGE

county. To be selected by competitive procurement. Potential contractors are partially listed.

performed	California Orange	
NAME OF CONTRACTOR	Dabcock & Wilcox	
Site where work will be performed	1- State: OHIO	County: Summit
NAME OF CONTRACTOR	Combustion Engineering	
Site where work will be performed	1- State: Connecticut	County: Hartford
NAME OF CONTRACTOR	International Flame Research Foundation	
Site where work will be performed	1- State: Holland	County: In. Dijen

5. BRIEF DESCRIPTION OF PROPOSAL

(No more than 24 lines of text and no more than 70 characters and spaces per line)

Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed:

Development and Demonstration of Modified Combustion Technology for Utility and Industrial Boilers: Modify the combustion process in utility boilers to provide more efficient utilization of fossil and waste fuels, and simultaneously reduce air pollutant emissions. Techniques will be developed for firing coal and heavy oil with reduced emissions so cleaner fuels can be used with smaller equipment. Technology for efficient, low-pollution combustion of coal-derived fuels (e.g. low Btu gas) will be developed. Development and Demonstration of Modified Combustion Control Technology for Utility Gas Turbines: Develop and demonstrate dry control methods for control of NO_x from stationary gas turbines. This R&D will be directed toward maximizing system efficiency. Fuels to be considered include light and heavy oil, natural gas, low-BTU gas, and candidate future fuels. Develop and Demonstrate Modified Combustion Technology for Industrial Process Furnaces: Develop and demonstrate control methods for combustion related and toxic pollutant emissions from industrial process furnaces. This R&D effort will also be directed toward improved efficiency in the use of fuels and feedstock. Low NO_x Combustion of Reformed Fuels: Demonstrate a 1 MW combustion system for low NO_x emissions comprising a reformer of clean (low sulfur) liquid and gaseous fossil fuels in combination with a combustion designed for lean operation.

6. JUSTIFICATION (Use a separate sheet). See Item 6. on Instruction Sheet.

F

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978	1979
a. MANPOWER (in man years)	(1) Scientific	26	33	45	54	31
	(2) Technical	14	17	23	28	16
	(3) Support	23	62	85	62	20
	(4) Other	6	6	6	6	3
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)	TONS OF COAL	24,000	50,400	193,200	192,000	
	BBLS OF OIL	1,200,000	170,400	732,000	729,600	2,000,000
	FT ³ NAT. GAS	140,000,000	14,400,000	7,200,000	--	
	FT ³ LOW BTU GAS		36,000,000	72,000,000	1,290,000,000	
c. LAND AREA REQUIRED (in acres)	(1) Govt-owned					
	(2) Govt-owned					
	(3) Privately-owned					
	(4) Other					
d. OTHER RESOURCES NEEDED (Specify item and unit of measure below. Show quantity of each in columns at right.)	(1)	(1) 3				

RESEARCH
 DESIGN
 DEMONSTRATION

PROJECT NUMBER

05-02-05-05-12-

- G. **JUSTIFICATION:** State the specific energy problem or problems, and specify how the proposed work contributes to the solution of the problem. List all sources of the problem. Indicate the need for solving the problem. List all other alternative solutions. Also include the benefits expected to be derived from meeting the objectives of solving the problem. List all the risks or uncertainties. Outline the risks/uncertainties (R/U), plan to minimize R/U, and basis for proceeding in face of R/U. Quantitative data should be used to the fullest extent.

Utility and Industrial Boilers: Combined NO_x emissions from these source categories account for 68% of the total NO_x emitted from stationary sources. At the proposed level of effort, modified combustion technology can be developed and demonstrated in FY 77. Successful completion of this program would permit continuous operation with combustion modifications to achieve 60 to 70% reductions in NO_x and related emissions with maximum unit efficiency. It is expected that modified combustion technology for these equipment classes would result in savings of 2×10^{14} BTU of energy in 1990. The only uncertainties or risks are related to operating problems such as slagging and fireside corrosion. These problems will be addressed and reconciled concurrently as combustion modification techniques are developed. Such unknowns would only affect the degree to which combustion modifications could be applied.

Utility Gas Turbines: The installed capacity of gas turbines is doubling every eight years. The increasing popularity of the combined cycle plant with efficiencies higher than conventional steam plants makes this concept highly attractive from the standpoint of energy conservation. The New Source Performance Standards for stationary gas turbines will necessitate steam or water injection to control NO_x . This technique, the current state-of-the-art, is wasteful of water and degrades thermal efficiency. Modified combustion control technology could increase fuel efficiency by 14% for gas turbines and 37% for combined cycle plants. By replacing "wet" control methods, potential savings of consumptive use of demineralized water could range between 13.5×10^9 and 108×10^9 gallons annually. At the proposed level of effort, development and demonstration of advanced combustion technology could be accomplished in FY 79. No risks or uncertainties are foreseen. Comprehensive screening of candidate systems will be conducted concurrently with economic evaluations to determine an optimum design.

Industrial Process Furnaces: Emission studies and total fuel/energy use by industrial process furnaces have established the need for a program directed at reducing pollution and increasing fuel efficiency. At the proposed level of effort, modified combustion technology can be developed and demonstrated in FY 78. Successful completion will establish the emission and energy conservation results of combustion control. The quantities of energy used by industry annually (20×10^{15} BTU's currently and projected to reach 40×10^{15} BTU's by 1990) make this an important project for improvement in energy utilization. This project has the potential for saving 1×10^{15} BTU/year by 1980 and 1990. Beyond that, there is the potential for saving up to 2×10^{15} BTU/year. Modified combustion technology should provide substantial control of combustion related pollutants. However, the diversity of other pollutants from these processes may make flue gas cleaning an additional requirement.

Low NO_x Combustion of Reformed Fuels: Formation of NO_x can be limited by maintaining combustion temperatures below 3000°F . This can be accomplished by burning fuels with an excess of air. Conventional fossil fuels have a narrow range of flammability and lean combustion is often limited. Hydrogen, e.g. from reformed fuels, has a wide flammability range and together with leaning will permit relatively low temperature low NO_x combustion. At the proposed level of effort, development and demonstration of an economic and efficient fuel reforming and combustion process can be accomplished by mid FY 78. Successful completion of this program could provide advanced low NO_x combustion processes for a variety of industrial applications. The major uncertainty is optimizing the reformer to provide high thermal efficiency. It is expected, however, that this optimization would evolve in pilot scale experiments.

NO. 1000
%
U
U

05-02-05-05-12-75-56-01

... specify the energy problem or objective, and specify how the proposed will contribute to the solution of the problem. ... Also include the benefits, ... Outline the risks/uncertainties ...

Industrial Boilers: Combined NO_x emissions from these source categories of the total NO_x emitted from stationary sources. At the proposed level ... modified combustion technology can be developed and demonstrated in FY 77. ...

It is expected that modified combustion technology for these equipment result in savings of 2 X 10¹⁴ BTU of energy in 1980. The only uncertainties related to operating problems such as slagging and fireside corrosion. These addressed and reconciled concurrently as combustion modification technology developed. Such unknowns would only affect the degree to which combustion could be applied.

Gas Turbines: The installed capacity of gas turbines is doubling every eight years increasing popularity of the combined cycle plant with efficiencies higher than steam plants makes this concept highly attractive from the standpoint of energy conservation. The New Source Performance Standards for stationary gas turbines require steam or water injection to control NO_x. This technique, the current practice, is wasteful of water and degrades thermal efficiency. Modified combustion technology could increase fuel efficiency by 14% for gas turbines and combined cycle plants. By replacing "wet" control methods, potential savings in use of demineralized water could range between 13.5 X 10⁹ and 108 X 10⁹ gallons. At the proposed level of effort, development and demonstration of combustion technology could be accomplished in FY 79. No risks or uncertainties Comprehensive screening of candidate systems will be conducted concurrent with valuations to determine an optimum design.

Process Furnaces: Emission studies and total fuel/energy use by industrial processes have established the need for a program directed at reducing pollution and fuel efficiency. At the proposed level of effort, modified combustion technology can be developed and demonstrated in FY 78. Successful completion will result in emission and energy conservation results of combustion control. The large amount of energy used by industry annually (20 X 10¹⁵ BTU's currently and projected 30 X 10¹⁵ BTU's by 1990) make this an important project for improvement in energy conservation. This project has the potential for saving 1 X 10¹⁵ BTU/year between 1975 and 1990. Beyond that, there is the potential for saving up to 2 X 10¹⁵ BTU/year. Combustion technology should provide substantial control of combustion emissions. However, the diversity of other pollutants from these processes requires cleaning an additional requirement.

Use of Reformed Fuels: Formation of NO_x can be limited by maintaining combustion temperatures below 3000°F. This can be accomplished by burning fuels with high flame temperatures. Conventional fossil fuels have a narrow range of flammability and flame temperature is often limited. Hydrogen, e.g. from reformed fuels, has a wide flammability range and together with leaning will permit relatively low temperature, low NO_x formation. At the proposed level of effort, development and demonstration of an efficient fuel reforming and combustion process can be accomplished by successful completion of this program could provide advanced low NO_x combustion processes for a variety of industrial applications. The major uncertainty is the reformer to provide high thermal efficiency. It is expected, however, that reformer technology would evolve in pilot scale experiments.

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

NOTE: Include major facilities and major equipment. Indicate dates by Fiscal Year and Quarter.

a. DEVELOPMENT MILESTONES (number each consecutively)

(Limit Title of Milestone to 60 characters and spaces)

b. DATES

	Start		Complete	
	FY	Q	FY	Q
<u>Utility & Industrial Boilers</u>				
1. Engineering Development: Burner Scale-up for Fossil Fuels	74	1	75	2
2. Pilot Plant: Tests Performed on Single Burner Systems	75	1	76	2
3. Demonstration Plant: 160 MW Utility Boiler; 150 MM BTU/hr Industrial Boiler	76	1	77	3
<u>Utility Gas Turbines</u>				
1. Fabrication of Prototype Mini-scale Combustors	75	1	76	1
2. Verification Testing/Emissions Data Analysis of Prototype	75	4	76	4
3. Optimization and Construction of Pilot Scale Prototype	76	3	77	2
4. Pilot Plant: 15 MW Simple Cycle Turbine	77	1	78	1
5. Demonstration Plant: 50-75 MW Combined Cycle Plant	77	4	79	3
<u>Industrial Process Furnaces</u>				
1. Lab Experimentation to Identify Control Methods	75	1	76	1
2. Engineering Development of Modified Combustion Technology	75	4	76	4
3. Pilot and Demonstration Plants on Representative Equipment	76	1	78	3
<u>Low NO_x Combustion of Reformed Fuels</u>				
1. Evaluation of Bench Model	75	1	76	1
2. Separate Reformer/Combustor Tests	76	1	77	1
3. Combined Reformer/Combustor Tests	76	4	78	2

(Continue to next column)

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER
05-02-05-05-12-75-56-01

a. DEVELOPMENT MILESTONES (continued)
(Limit Title of Milestone to 60 characters and spaces)

b. DATE:
Start Complete
FY Q FY Q

TES	
Complete	
FY	Q
75	2
76	2
77	3
76	1
76	4
77	2
78	1
79	3
76	1
76	4
78	3
76	1
77	1
78	2

2

(Continue on separate sheet)

Page of

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

B SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

Following sheets

Combustion Modifications R. D & D Projects	(1)		(2)		(3)		
	FY 1974 (Non-Add)		FY 1975		FY 1976		Obis
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	
a. Utility and Industrial Boilers			8.6		12.7		4.8
b. Gas Turbines			0.8		1.2		1.2
c. Industrial Process Furnaces			0.5		1.0		2.5
d. Reformed Fuels			0.8		1.4		0.7
e. GRAND TOTAL—OUTLAYS			10.7		16.3		9.2

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER

05-02-55-05-12-75-56-01

(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) Subtotal FY 1975-79		(8) Balance To Complete		(9) Total Excluding FY 1974 (Cat. 7 & 8)	
Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
4.8		1.7		0		27.8		-		27.8	
1.2		2.1		1.5		6.8		-		6.8	
2.5		2.5		0		6.5		-		6.5	
0.7		0.8		0		3.7		-		3.7	
9.2		7.1		1.5		44.8		-		44.8	

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

B. SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

Requirement	(1)		(2)		(3)		(4)
	FY 1974 (Non-Add)		FY 1975		FY 1976		FY 1
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.
a. OPERATING (See p. for detail) Total Operating Requirements (from Detail Sheet)			7.60	7.60	11.91	11.91	6.44
b. CONSTRUCTION (See p. for detail) Total Construction Requirements (from Detail Sheet)			1.27	1.27	1.94	1.94	0.96
c. EQUIPMENT (See p. for detail) Total Equipment Requirements (from Detail Sheet)			1.83	1.83	2.45	2.45	1.80
d. GRAND TOTAL—OBLIGATIONS			10.7		16.3		9.2
e. GRAND TOTAL—OUTLAYS				10.7		16.3	

1. If a program is proposed, indicate the amount by year of both private and Federal government funding. A brief

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION
05-02-55-05-12-75-56-01

(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) Subtotal FY 1975-79		(8) From To C - 1975		(9) From To C - 1975	
Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays
6.44	6.44	4.81	4.81	0.93	0.93	31.69	31.69	-	-	31.69	31.69
0.96	0.96	0.64	0.64	0.11	0.11	3.58	3.58	-	-	3.58	3.58
1.80	1.80	1.65	1.65	0.46	0.46	8.19	8.19	-	-	8.19	8.19
9.2		7.1		1.5		44.8		0		44.8	
	9.2		7.1		1.5		44.8		0		44.8

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

RESEARCH AND DEVELOPMENT REQUIREMENTS - Federal Government Only (in millions of dollars)

ITEM	(1)		(2)		(3)	
	FY 1974 (Non-Fed)		FY 1975		FY 1976	
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
TOTAL (Comp forward to summary sheet)			7.60	7.60	11.91	11.91
Electricity and Industrial Boilers						
MANPOWER			4.02	4.02	7.37	7.37
MATERIALS			1.20	1.20	1.00	1.00
MAJOR PROCUREMENTS						
ALL OTHER			0.20	0.20	0.40	0.40
TOTAL FOR THIS PERFORMING ORGANIZATION			5.42	5.42	8.77	8.77
Gas Turbines						
MANPOWER			0.50	0.50	0.70	0.70
MATERIALS			0.38	0.38	0.30	0.30
MAJOR PROCUREMENTS						
ALL OTHER			0.10	0.10	0.10	0.10
TOTAL FOR THIS PERFORMING ORGANIZATION			0.98	0.98	1.10	1.10
Industrial Process Furnaces						
MANPOWER			0.22	0.22	0.58	0.58
MATERIALS			0.15	0.15	0.20	0.20
MAJOR PROCUREMENTS						
ALL OTHER			0.05	0.05	0.05	0.05
TOTAL FOR THIS PERFORMING ORGANIZATION			0.42	0.42	0.83	0.83
Coal and Oil-Fired Fuels						
MANPOWER			0.38	0.38	0.61	0.61
MATERIALS			0.30	0.30	0.30	0.30
MAJOR PROCUREMENTS						
ALL OTHER			0.10	0.10	0.10	0.10
TOTAL FOR THIS PERFORMING ORGANIZATION			0.78	0.78	1.21	1.21

(Cont.)

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NO.

05-02-55-05-12-75-55-01

Is.	(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) SUBTOTAL FY 1975-79		(8) BALANCE TO COMPLETE		(9) TOTAL FY 1975-79	
	Outlays	Cbfs.	Outlays	Cbfs.	Outlays	Cbfs.	Outlays	Cbfs.	Outlays	Cbfs.	Outlays	Cbfs.
.44	6.46	4.81	4.81	0.93	0.93	37.59	37.59	-	-	37.59	37.59	
.53	2.53	0.72	0.72	-	-	14.64	14.64			14.64	14.64	
.60	0.60	0.60	0.60	-	-	3.40	3.40			3.40	3.40	
.20	0.20	0.30	0.30	-	-	1.10	1.10			1.10	1.10	
.33	3.33	1.62	1.62	-	-	19.14	19.14			19.14	19.14	
.63	0.63	0.89	0.89	0.78	0.78	3.50	3.50			3.50	3.50	
.20	0.20	0.20	0.20	0.10	0.10	1.18	1.18			1.18	1.18	
.10	0.10	0.20	0.20	0.05	0.05	0.55	0.55			0.55	0.55	
.93	0.93	1.29	1.29	0.93	0.93	5.23	5.23			5.23	5.23	
.32	1.32	1.05	1.05	-	-	3.18	3.18			3.18	3.18	
.20	0.20	0.23	0.20	-	-	0.75	0.75			0.75	0.75	
.10	0.10	0.10	0.10	-	-	0.30	0.30			0.30	0.30	
.62	1.62	1.36	1.36	-	-	4.23	4.23			4.23	4.23	
.36	0.36	0.34	0.34	-	-	1.89	1.89			1.89	1.89	
.10	0.10	0.10	0.10	-	-	0.80	0.80			0.80	0.80	
.10	0.10	0.10	0.10	-	-	0.40	0.40			0.40	0.40	
.56	0.56	0.54	0.54	-	-	3.09	3.09			3.09	3.09	

2

ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

TOTAL OF FUNDING REQUIREMENTS—Federal Government Only (In millions of dollars)

CONSTRUCTION

ITEM:	(1) FY 1974 (Non-Aid)		(2) FY 1975		(3) FY 1976	
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays
TOTAL (Carry forward to summary sheet)			1.27	1.27	1.94	1.94
Amount, Location (State and County) and Total Estimated Cost of each item (except for items identified with a brief description of the project in the summary sheet).						
() Industrial Boilers State: _____ County: _____ TEC (in millions)			1.10	1.10	1.64	1.64
() Small Boilers State: _____ County: _____ TEC (in millions)			0.05	0.05	0.09	0.09
() Industrial Process Furnaces State: _____ County: _____ TEC (in millions)			0.04	0.04	0.08	0.08

(Continued)

Level of Effort:

- MAXIMUM
- MODERATE
- MINIMUM

IDENTIFICATION:

05-02-85-05-12-75-55-02

(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) SUSTOTAL FY 1976-79		(8) BALANCE TO COMMITTEE			
Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays				
1.96	0.96	0.64	0.64	0.11	0.11	4.92	4.92	0	0	4.92	4.92
1.62	0.62	0.22	0.22	-	-	3.58	3.58	-	-	3.58	3.58
1.09	0.09	0.16	0.16	0.11	0.11	0.51	0.51	-	-	0.51	0.51
0.19	0.19	0.19	0.19	-	-	0.50	0.50	-	-	0.50	0.51

2

ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

DETAILS OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

CONVERSION

ITEM	(1) FY 1974 (Non-Add)		(2) FY 1975		(3) FY 1976		Ob
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	
TOTAL (Carry forward to summary sheet)							
Referred Fuels			0.07	0.07	0.13	0.13	0.0
FEDERAL PROJECT (Not to exceed 50 characters and spaces.) County: _____ TEC (in millions): _____							
FEDERAL PROJECT (Not to exceed 50 characters and spaces.) County: _____ TEC (in millions): _____							
FEDERAL PROJECT (Not to exceed 50 characters and spaces.) County: _____ TEC (in millions): _____							

(Continue on Se

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION

05-02-55-05-12-75-56-01

(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) SUBTOTAL FY 1977-79		8. FUND BALANCE COMMITMENT			
Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	C. 1. 1977-79		C. 2. 1977-79	
06	0.06	0.07	0.07	-	-	0.33	0.33	-	-	0.33	0.33

2

ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

ALL OF FUNDING REQUIREMENTS - Federal Government Only (In millions of dollars)

DEPARTMENT

ITEM <i>(Each item not to exceed 60 characters and spaces)</i>	(1) FY 1974 (Non-Add)		(2) FY 1975		(3) FY 1976		(4) FY 1977	
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
	TOTAL (Carry forward to summary sheet) >			1.83	1.83	2.45	2.45	1.80
Research and development, including operation, maintenance, and repair of equipment, and purchase of equipment, and purchase of materials or more.								
Utility and industrial boilers			1.24	1.24	1.43	1.43	0.69	0.69
Refrigeration			0.24	0.24	0.37	0.37	0.37	0.37
Thermal process furnaces			0.10	0.10	0.21	0.21	0.52	0.52
Heat exchangers			0.25	0.25	0.44	0.44	0.22	0.22

(Continued on Separate Sheet)

Level of Effort:

- MAXIMUM
- ORDINARY
- MINIMUM

IDENTIFICATION NO.

05-02-55-05-12-75-56-01

(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) SUB-TOTAL FY 1975-79		DATA SET TO COMPLETE		TOTAL FY 1975	
Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
1.80	1.80	1.65	1.65	0.46	0.46	8.19	8.19			8.19	8.19
0.69	0.69	0.24	0.24	-	-	3.50	3.60			3.60	3.60
0.37	0.37	0.64	0.64	0.46	0.46	2.08	2.08			2.08	2.08
0.52	0.52	0.52	0.52	-	-	1.35	1.35			1.35	1.35
0.22	0.22	0.25	0.25	-	-	1.16	1.16			1.16	1.16

2

ENERGY EVALUATION & DEVELOPMENT
FACT SHEET

Level of Effort:
 MANPOWER
 MATERIALS
 EQUIPMENT

1. IDENTIFICATION NO.
05-02-55-05-12-75

2. a. PROGRAM	Coal & Shale Processing Combustion
b. SUBPROGRAM	Improved Combustion Processes-Part 1-Combustion Modification (A)
3. a. PROJECT AGENCY	EPA
b. SUBUNIT	
4. CONTRACTOR AND SITE <i>(No more than 12 characters and spaces for name of contractor. Use standard abbreviation for state up to 14 characters and spaces for county.)</i> To be selected by competitive procurement. Potential contractors are partial listed.	NAME OF CONTRACTOR: Esso Research & Engineering Site where work will be performed: State: New Jersey County: Union
	NAME OF CONTRACTOR: KVS Engineering Site where work will be performed: State: California County: Orange
	NAME OF CONTRACTOR: Babcock & Wilcox Site where work will be performed: State: Ohio County: Summit
	NAME OF CONTRACTOR: Combustion Engineering Site where work will be performed: State: Connecticut County: Hartford
	NAME OF CONTRACTOR: International Flame Research Foundation Site where work will be performed: State: Holland County: Idmuiden
5. BRIEF DESCRIPTION OF PROPOSAL <i>(No more than 24 lines of text and no more than 70 characters and spaces per line)</i> Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.	Development and Demonstration of Modified Combustion Technology <u>Utility and Industrial Boilers:</u> Modify the combustion process utility boilers to provide more efficient utilization of fossil waste fuels, and simultaneously reduce air pollutant emissions. Techniques will be developed for firing coal and heavy oil with reduced emissions so cleaner fuels can be used with smaller equipment. Technology for efficient, low-pollution combustion of coal derived fuels (e.g. low Btu gas) will be developed. <u>Demonstration of Modified Combustion Control Technology for Utility Gas Turbines:</u> Develop and demonstrate dry control methods for control of NO _x from stationary gas turbines. This R&D will be directed toward maximizing system efficiency. Fuels to be considered include light and heavy oil, natural gas, low-BTU gas, and candidate fuel fuels. <u>Develop and Demonstrate Modified Combustion Technology Industrial Process Furnaces:</u> Develop and demonstrate control methods for combustion related and toxic pollutant emissions from industrial process furnaces. This R&D effort will also be directed toward improved efficiency in the use of fuels and feedstock. <u>NO_x Combustion of Reformed Fuels:</u> Demonstrate a 1 MW combustion system for low NO _x emissions comprising a reformer of clean (low sulfur) liquid and gaseous fossil fuels in combination with a combustion designed for lean operation.

6. JUSTIFICATION (Use a separate sheet). See Item 6. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978	
a. MANPOWER <i>(in man years)</i>	(1) Scientific	17	21	29	35	
	(2) Technical	9	11	15	18	
	(3) Support	15	40	55	40	
	(4) Other	4	4	4	4	
b. RAW MATERIALS <i>(List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns of right.)</i>	tons of coal	720,000	42,000	161,000	160,000	
	bbbls of oil	1,000,000	142,000	610,000	608,000	2,0
	10 ⁶ cu ft of nat. gas	60,000,000	12,000,000	6,000,000	-	
	10 ⁶ cu ft of low btu gas	--	30,000,000	60,000,000	1,080,000,000	17,500
c. LAND AREA REQUIRED <i>(in acres)</i>	(1) Govt-owned					
	(2) Govt-leased					
	(3) Privately-owned					
	(4) Other					

RESEARCH & DEVELOPMENT
PROJECT SHEET

Level of Effort
 MAXIMUM
 MODERATE
 MINIMUM

1. IDENTIFICATION NUMBER
05-02-55-05-12-75-56-01

AGENCY: Coal & Shale Processing Combustion
Improved Combustion Processes-Part 1-Combustion modification (NO_x, SO_x)
EPA

CHARACTERISTICS AND FUNCTION FOR STATE AND AGENCIES	NAME OF CONTRACTOR	STATE	COUNTY
Contracted by a procurement agency for partial	Esso Research & Engineering	New Jersey	Union
	KVS Engineering	California	Orange
	Babcock & Wilcox	Ohio	Summit
	Combustion Engineering	Connecticut	Hartford
	International Flame Research Foundation	Holland	Idmuiden

TITLE OF PROJECT: Development and Demonstration of Modified Combustion Technology for Utility and Industrial Boilers: Modify the combustion process in utility boilers to provide more efficient utilization of fossil and waste fuels, and simultaneously reduce air pollutant emissions. Techniques will be developed for firing coal and heavy oil with reduced emissions so cleaner fuels can be used with smaller equipment. Technology for efficient, low-pollution combustion of coal-derived fuels (e.g. low Btu gas) will be developed. Development and Demonstration of Modified Combustion Control Technology for Utility Gas Turbines: Develop and demonstrate dry control methods for control of NO_x from stationary gas turbines. This R&D will be directed toward maximizing system efficiency. Fuels to be considered include light and heavy oil, natural gas, low-BTU gas, and candidate future fuels. Develop and Demonstrate Modified Combustion Technology for Industrial Process Furnaces: Develop and demonstrate control methods for combustion related and toxic pollutant emissions from industrial process furnaces. This R&D effort will also be directed toward improved efficiency in the use of fuels and feedstock. Low NO_x Combustion of Reformed Fuels: Demonstrate a 1 MW combustion system for low NO_x emissions comprising a reformer of clean (low sulfur) liquid and gaseous fossil fuels in combination with a combustion designed for lean operation.

2

Use a separate sheet(s). See Item 6. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

CAL YEAR	1975	1976	1977	1978	1979
Scientific	17	21	29	35	31
Technical	9	11	15	18	16
Support	15	40	55	40	20
Other	4	4	4	4	3
tons of coal	720,000	42,000	161,000	160,000	-
bbbls of oil	1,000,000	142,000	610,000	608,000	2,000,000
100,000,000 Btu of nat. gas	12,000,000	6,000,000	-	-	-
100,000,000 Btu of low btu gas	30,000,000	60,000,000	1,080,000,000	17,500,000,000	-
Personnel					
Equipment					
Materials					
Other					
RESOURCES NEEDED					

BLANK PAGE

up to 24 characters and spaces for county.
 To be selected by competitive procurement. Potential contractors are partially listed.

Site where work will be performed	State: California	County: Orange
NAME OF CONTRACTOR: Babcock & Wilcox	State: Ohio	County: Summit
NAME OF CONTRACTOR: Combustion Engineering	State: Connecticut	County: Hartford
NAME OF CONTRACTOR: International Flame Research Foundation	State: Holland	County: IJmuiden

5. BRIEF DESCRIPTION OF PROPOSAL
 (No more than 24 lines of text and no more than 70 characters and spaces per line)
 Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.

Development and Demonstration of Modified Combustion Technology and Industrial Boilers: Modify the combustion process utility boilers to provide more efficient utilization of fossil waste fuels, and simultaneously reduce air pollutant emission. Techniques will be developed for firing coal and heavy oil with reduced emissions so cleaner fuels can be used with smaller investment. Technology for efficient, low-pollution combustion of derived fuels (e.g. low Btu gas) will be developed. Development of Modified Combustion Control Technology for Gas Turbines: Develop and demonstrate dry control methods for control of NO_x from stationary gas turbines. This R&D will be toward maximizing system efficiency. Fuels to be considered light and heavy oil, natural gas, low-BTU gas, and candidate fuels. Develop and Demonstrate Modified Combustion Technology Industrial Process Furnaces: Develop and demonstrate control methods for combustion related and toxic pollutant emissions industrial process furnaces. This R&D effort will also be directed toward improved efficiency in the use of fuels and feedstock. NO_x Combustion of Reformed Fuels: Demonstrate a 1 MW combustion system for low NO_x emissions comprising a reformer of clean sulfur) liquid and gaseous fossil fuels in combination with combustion designed for lean operation.

6. JUSTIFICATION (Use a separate sheet(s). See Item 5. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS		1975	1976	1977	1978	
a. MANPOWER (in man years)	(1) Scientific	17	21	29	35	
	(2) Technical	9	11	15	18	
	(3) Support	15	40	55	40	
	(4) Other	4	4	4	4	
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)	tons of coal	720,000	42,000	161,000	160,000	
	bbbls of oil	1,000,000	142,000	610,000	608,000	2,
	cu ft of nat. gas	150,000,000	12,000,000	6,000,000	-	
	cu ft of low btu gas	--	30,000,000	60,000,000	1,080,000,000	17,50
c. LAND AREA REQUIRED (in acres)	(1) Govt-owned					
	(2) Govt-leased					
	(3) Privately-owned					
	(4) Other					
d. OTHER RESOURCES NEEDED (Specify item and unit of measure below. Show quantity of each in columns at right.)	(1)					

3

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

Level of Effort

- MAXIMUM
- MODERATE
- MINIMUM

IDENTIF

05-02-1

6. JUSTIFICATION - State the specific energy problem or objective, and specify how the proposal will contribute to the solution or attainment of the objective. Include reasons for selecting the recommended approach over other alternatives. Also include the expected benefits from meeting the objectives or solving the problems for which the project is proposed. Outline the risks, IR/UR, plans to minimize R/U, and basis for proceeding in face of R/U. Quantitative data should be used to the fullest extent.

Utility and Industrial Boilers: Combined NO_x emissions from these source can account for 60% of the total NO_x emitted from stationary sources. At the proposed level of effort, modified combustion technology can be developed and demonstrated. Successful completion of this program would permit continuous operation with modifications to achieve 60 to 70% reductions in NO_x and related emissions w unit efficiency. It is expected that modified combustion technology for the classes would result in savings of 2 X 10¹⁴ BTU of energy in 1990. The only risks are related to operating problems such as slagging and fireside corrosion problems will be addressed, and reconciled concurrently as combustion modifications are developed. Such unknowns would only affect the degree to which modifications could be applied.

Utility Gas Turbines: The installed capacity of gas turbines is doubling every 5 years. The increasing popularity of the combined cycle plant with efficient than conventional steam plants makes this concept highly attractive from the point of energy conservation. The New Source Performance Standards for stationary sources will necessitate steam or water injection to control NO_x. This technique, a state-of-the-art, is wasteful of water and degrades thermal efficiency. Modified combustion control technology could increase fuel efficiency by 14% for gas turbines and 37% for combined cycle plants. By replacing "wet" control methods, potential of consumptive use of demineralized water could range between 13.5 X 10⁹ and 100 X 10⁹ gallons annually. At the proposed level of effort, development and demonstration of advanced combustion technology could be accomplished in FY 81. No risks or uncertainties are foreseen. Comprehensive screening of candidate systems will be conducted with economic evaluations to determine an optimum design.

Industrial Process Furnaces: Emission studies and total fuel/energy use by process furnaces have established the need for a program directed at reducing NO_x and increasing fuel efficiency. At the proposed level of effort, modified combustion technology can be developed and demonstrated in FY 79. Successful completion will establish the emission and energy conservation results of combustion control technology. Quantities of energy used by industry annually (20 X 10¹⁵ BTU's currently and 40 X 10¹⁵ BTU's by 1990) make this an important project for improving energy utilization. This project has the potential for saving 1 X 10¹⁵ BTU in 1980 and 1990. Beyond that, there is the potential for saving up to 2 X 10¹⁵ BTU. Modified combustion technology should provide substantial control of combustion related pollutants. However, the diversity of other pollutants from these sources may make flue gas cleaning an additional requirement.

Low NO_x Combustion of Reformed Fuels: Formation of NO_x can be limited by maintaining combustion temperatures below 3000°F. This can be accomplished by burning with an excess of air. Conventional fossil fuels have a narrow range of flammability. Lean combustion is often limited. Hydrogen, e.g. from reformed fuels, has a wide flammability range and together with leaning will permit relatively low temperature low NO_x combustion. At the proposed level of effort, development and demonstration of an economic and efficient fuel reforming and combustion process can be accomplished in FY 78. Successful completion of this program could provide advanced low NO_x combustion processes for a variety of industrial applications. The major uncertainty is optimizing the reformer to provide high thermal efficiency. It is expected that this optimization would evolve in pilot scale experiments.

Level of Effort

- MAXIMUM
- MODERATELY
- MINIMUM

IDENTIFICATION NUMBER

05-02-85-05-12-75-56-01

Describe the energy problem or objective, and specify how the proposed action contributes to the solution of the problem. Include alternatives for achieving the response and the practicality of other alternatives. Also include the benefits resulting from the objectives of solving the problem for which the project is prepared. Outline the risks/uncertainties of proceeding in face of R.U. Quantitative data should be used to the fullest extent.

Stationary Boilers: Combined NO_x emissions from these source categories are 10% of the total NO_x emitted from stationary sources. At the proposed level of effort, advanced combustion technology can be developed and demonstrated in FY 78. Demonstration of this program would permit continuous operation with combustion technology that can achieve 60 to 70% reductions in NO_x and related emissions with maximum efficiency. It is expected that modified combustion technology for these equipment will result in savings of 2×10^{14} BTU of energy in 1990. The only uncertainties are related to operating problems such as slagging and fireside corrosion. These will be addressed and reconciled concurrently as combustion modification technology is developed. Such unknowns would only affect the degree to which combustion technology could be applied.

Gas Turbines: The installed capacity of gas turbines is doubling every eight years. The increasing popularity of the combined cycle plant with efficiencies higher than steam plants makes this concept highly attractive from the standpoint of energy conservation. The New Source Performance Standards for stationary gas turbines require the use of steam or water injection to control NO_x . This technique, the current practice, is wasteful of water and degrades thermal efficiency. Modified combustion technology could increase fuel efficiency by 14% for gas turbines and combined cycle plants. By replacing "wet" control methods, potential savings of 10% of demineralized water could range between 13.5×10^9 and 108×10^9 gallons per year.

At the proposed level of effort, development and demonstration of advanced combustion technology could be accomplished in FY 81. No risks or uncertainties are associated with comprehensive screening of candidate systems will be conducted concurrent with development and demonstration to determine an optimum design.

Industrial Furnaces: Emission studies and total fuel/energy use by industrial sources have established the need for a program directed at reducing pollution and increasing energy efficiency. At the proposed level of effort, modified combustion technology can be developed and demonstrated in FY 79. Successful completion will result in energy conservation results of combustion control. The large amount of energy used by industry annually (20×10^{15} BTU's currently and projected 30×10^{15} BTU's by 1990) make this an important project for improvement in energy conservation. This project has the potential for saving 1×10^{15} BTU/year between 1980 and 1990. Beyond that, there is the potential for saving up to 2×10^{15} BTU/year. Demonstration of advanced combustion technology should provide substantial control of combustion emissions. However, the diversity of other pollutants from these processes may require additional cleaning an additional requirement.

Control of Reformed Fuels: Formation of NO_x can be limited by maintaining combustion temperatures below 3000°F. This can be accomplished by burning fuels with low nitrogen content.

Conventional fossil fuels have a narrow range of flammability and energy content often limited. Hydrogen, e.g. from reformed fuels, has a wide flammability range and together with leaner fuels permit relatively low temperature, high efficiency combustion. At the proposed level of effort, development and demonstration of advanced efficient fuel reforming and combustion process can be accomplished by late 1980. Completion of this program could provide advanced low NO_x combustion technology for a variety of industrial applications. The major uncertainty is the difficulty of reformer to provide high thermal efficiency. It is expected, however, that demonstration would evolve in pilot scale experiments.

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

Table includes major facilities and major equipment. Indicate dates by Fiscal Year and Quarter.

a. DEVELOPMENT MILESTONES (number each consecutively)

(Limit Title of Milestone to 60 characters and spaces)

b. DATES

Start		Complete	
FY	Q	FY	Q
<u>Utility Industrial Boilers</u>			
74	1	75	2
75	2	76	3
76	3	78	3
<u>Utility Gas Turbines</u>			
75	1	76	2
76	2	77	3
77	3	78	3
78	3	79	3
79	3	81	3
<u>Industrial Process Furnaces</u>			
75	1	76	2
76	2	77	3
77	3	79	3
<u>Low NO_x Combustion of Reformed Fuels</u>			
75	1	76	3
76	3	77	3
77	3	78	4

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

2. SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (In millions of dollars)

Combustion Modifications R, D & D Projects	(1)		(2)		(3)	
	FY 1974 (Non-Add)		FY 1975		FY 1975	
	obls	outlays	obls	outlays	obls	outlays
Utility and Industry Boilers			3.2		7.0	1.
Gas Turbines			0.8		0.8	0
Industrial Process Furnaces			0.3		0.6	1
Reformed Fuels			0.8		1.4	0
GRAND TOTAL-OUTLAYS			5.1		9.8	2

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER
05-02-55-05-12-75-56-01

(4) FY 1977	(5) FY 1978		(6) FY 1979		(7) Subtotal FY 1975-79	(8) Balance To Complete	(9) Total Effort FY 1975-79
outlays	obls	outlays	obls	outlays	obls	outlays	obls
	1.9		1.9		15.9	-	1.59
	1.4		1.0		4.8	-	4.8
	1.3		1.3		5.1	-	5.1
	0.5		-		3.2	-	3.2
	5.1		4.2		29.0	-	29.0

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

B. SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

Requirement	(1) FY 1974 (Non-Add)		(2) FY 1975		(3) FY 1976		FY Obls.
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	
a. OPERATING (See p. for detail) Total Operating Requirements (from Detail Sheet)			3.10	3.10	4.29	4.29	3.45
b. CONSTRUCTION (See p. for detail) Total Construction Requirements (from Detail Sheet)			0.55	0.55	2.56	2.56	0.47
c. EQUIPMENT (See p. for detail) Total Equipment Requirements (from Detail Sheet)			1.45	1.45	2.95	2.95	0.90
d. GRAND TOTAL—OBLIGATIONS			5.10		9.80		4.80
e. GRAND TOTAL—OUTLAYS				5.10		9.80	

When appropriate, the amount by year of both private and Federal government funding. A tab

(d)

Level of Effort:
 MAXIMUM
 ORDERLY
 MINIMUM

IDENTIFICATION:
 05-02-55-05-12-75-56-07

(3) FY 1976		(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) Subtotal FY 1976-79		8: 9: 10: 11:		12: 13:	
Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
4.29	4.29	3.43	3.43	3.45	3.45	3.12	3.12	17.09	17.09	0	0	17.09	17.
2.56	2.56	0.47	0.47	0.52	0.62	0.27	0.27	4.47	4.47	0	0	4.47	4.
2.95	2.95	0.90	0.90	1.03	1.03	0.81	0.81	7.14	7.14	0	0	7.14	7.
9.80		4.80		5.10		4.20		29.0		0		29.0	
	9.80		4.80		5.10		4.20		29.0		0		29.

of government funding. A brief description of the Cooperative program and the rationale for the division of...

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

PENDING REQUIREMENTS-Federal Government Only (in millions of dollars)

ITEM	(1)		(2)		(3)	
	FY 1974 (Non-AID)		FY 1975		FY 1976	
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays
TOTAL (same format as summary sheet)			3.10	3.10	4.29	4.29
Gas Turbines						
City and Industrial Boilers						
MANPOWER			1.13	1.13	2.17	2.17
MATERIALS			0.60	0.60	0.52	0.52
MAJOR PROCUREMENTS						
ALL OTHER			0.10	0.10	0.20	0.20
TOTAL FOR THIS PERFORMING ORGANIZATION			1.83	1.83	2.89	2.89
Gas Turbines						
Gas Turbines						
MANPOWER			0.28	0.28	0.25	0.25
MATERIALS			0.25	0.25	0.15	0.15
MAJOR PROCUREMENTS						
ALL OTHER			0.05	0.05	0.05	0.05
TOTAL FOR THIS PERFORMING ORGANIZATION			0.58	0.58	0.45	0.45
Industrial Process Furnaces						
Industrial Process Furnaces						
MANPOWER			0.11	0.11	0.19	0.19
MATERIALS			0.08	0.08	0.10	0.10
MAJOR PROCUREMENTS						
ALL OTHER			0.02	0.02	0.02	0.02
TOTAL FOR THIS PERFORMING ORGANIZATION			0.21	0.21	0.31	0.31
Other Organizations						
Reformed Fuels						
MANPOWER			0.28	0.28	0.44	0.44
MATERIALS			0.15	0.15	0.15	0.15
MAJOR PROCUREMENTS						
ALL OTHER			0.05	0.05	0.05	0.05
TOTAL FOR THIS PERFORMING ORGANIZATION			0.48	0.48	0.64	0.64

(Continued)

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NO. 1

05-02-55-05-12-75-55-0

(3) 1976	(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) SUBTOTAL FY 1975-79		(8) BALANCE TO COMPLETE		TOTAL		
	Outlays	Obfs.	Outlays	Obfs.	Outlays	Obfs.	Outlays	Obfs.	Outlays	C. s.	C. s.	C. s.	C. s.
3	4.20	3.43	3.43	3.45	3.45	3.12	2.12	17.39	17.39	0	0	17.39	17.39
7	2.17	1.05	1.06	0.95	0.95	1.47	1.47	6.78	6.78	-	-	6.78	6.78
12	0.52	0.30	0.30	0.30	0.30	0.15	0.15	1.87	1.87	-	-	1.87	1.87
10	0.20	0.10	0.10	0.15	0.15	0.15	0.15	0.70	0.70	-	-	0.70	0.70
9	2.89	1.46	1.46	1.40	1.40	1.77	1.77	9.35	9.35	-	-	9.35	9.35
5	0.25	0.45	0.45	0.70	0.70	0.50	0.50	2.18	2.18	-	-	2.18	2.18
5	0.15	0.10	0.10	0.10	0.10	0.05	0.05	0.65	0.65	-	-	0.65	0.65
5	0.05	0.05	0.05	0.10	0.10	0.05	0.05	0.30	0.30	-	-	0.30	0.30
5	0.45	0.60	0.60	0.90	0.90	0.60	0.60	3.13	3.13	-	-	3.13	3.13
9	0.19	0.81	0.81	0.65	0.65	0.65	0.65	2.41	2.41	-	-	2.41	2.41
0	0.10	0.10	0.10	0.10	0.10	0.05	0.05	0.43	0.43	-	-	0.43	0.43
12	0.02	0.05	0.05	0.05	0.05	0.05	0.05	0.19	0.19	-	-	0.19	0.19
11	0.31	0.96	0.96	0.80	0.80	0.75	0.75	3.03	3.03	-	-	3.03	3.03
14	0.44	0.31	0.31	0.25	0.25	-	-	1.28	1.28	-	-	1.28	1.28
5	0.15	0.05	0.05	0.05	0.05	-	-	0.40	0.40	-	-	0.40	0.40
05	0.05	0.05	0.05	0.05	0.05	-	-	0.20	0.20	-	-	0.20	0.20
54	0.64	0.41	0.41	0.35	0.35	-	-	1.28	1.28	-	-	1.28	1.28

(Continue on Separate Sheet)

Page of

2

ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

STATE OF FUNDING REQUIREMENTS—Federal Government Only (In millions of dollars)

CONSTRUCTION

ITEM	(1) FY 1974 (Non-Fed)		(2) FY 1975		(3) FY 1976	
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
TOTAL (Carry forward to summary sheet)			0.55	0.55	2.56	2.56
(Project, Location (State and County) and Total Estimated Cost of each item consecutively). Every project costing one million or more shall be separately identified with a brief description of the project.						
(Project (Not to exceed 100 characters and spaces.) Utility and Industrial Boilers	Item No.		0.50	0.50	2.40	2.40
(State) County TEC (in millions)						
(Project (Not to exceed 100 characters and spaces.) Industrial Process Furnaces			-	-	-	-
(State) County TEC (in millions)				✓		

(Cont.)

MAXIMUM
 GROSSLY
 MINIMUM

05-02-55-05-12-75-85-01

(4) FY 1977	(5) FY 1978		(6) FY 1979		(7) SUBTOTAL FY 1976-79		(8) TOTAL		(9) TOTAL		
	Outlays	Cals.	Outlays	Cals.	Outlays	Cals.	Outlays	Cals.	Outlays	Cals.	
7	0.47	0.62	0.62	0.27	0.27	4.47	4.47	-	-	4.47	4.47
2	0.12	0.12	0.12	0.12	0.12	3.26	3.26	-	-	3.26	3.26
15	0.15	0.30	0.30	-	-	0.45	0.45	-	-	0.45	0.45
15	0.15	0.15	0.15	0.15	0.15	0.45	0.45	-	-	0.45	0.45

(Repeat Sheet)

ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

TABLE OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

CONSTRUCTION

ITEM	(1) FY 1974 (Non-Aid)		(2) FY 1975		(3) FY 1976		C
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	
TOTAL (Carry forward to summary sheet)							
PROJECT (State and County) and Total Estimated Cost (Not to exceed 30 characters and spaces). Every project costing one million dollars or more should be separately identified with a brief description of the project. (Not to exceed 30 characters and spaces.)							
Item No. ()							
FY 1975	-	-	0.05	0.05	0.15	0.16	0.
County	TEC (in millions)						
PROJECT (Not to exceed 30 characters and spaces.)							
Item No. ()							
County	TEC (in millions)						
PROJECT (Not to exceed 30 characters and spaces.)							
Item No. ()							
County	TEC (in millions)						

(Continue on S)

Level of Effort:

- MAXIMUM
- OTHERLY
- MINIMUM

05-02-55-05-12-75-56-01

76 Outlay:	(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) SUBTOTAL FY 1978-79		BALANCE TO COMPLETE			
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
0.16	0.05	0.05	0.05	0.05	-	-	0.31	0.31	-	-	0.31	0.31

(Continue on Separate Sheet)

ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

TABLE OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

ELEMENT

ITEM <i>(Only item not to exceed 60 characters and spaces)</i>	(1) FY 1974 (Non-Add)		(2) FY 1975		(3) FY 1976		
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.
TOTAL (Carry forward to summary sheet) ▶			1.45	1.45	2.95	2.95	0.9
City and industrial boilers			0.85	0.85	2.25	2.25	0.0
Turbines	-	-	0.25	0.25	0.30	0.30	0.0
Serial process furnaces	-	-	0.10	0.10	-	-	0.0
Hot fuels	-	-	0.25	0.25	0.40	0.40	0.0

(Continued)

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION

05-02-55-05-12-75-56-01

No.	(4) FY 1977	(5) FY 1978		(6) FY 1979		(7) SUBTOTAL FY 1977-79		BALANCE TO CARRY OVER		Total	Total
	Outlays	Obfr.	Outlays	Obfr.	Outlays	Obfr.	Outlays	Obfr.	Outlays		
90	0.90	1.03	1.03	0.81	0.81	7.14	7.14	0	0	7.14	7.14
08	0.08	0.08	0.08	0.08	0.08	3.34	3.34	-	-	3.34	3.34
35	0.35	0.45	0.45	0.38	0.38	1.73	1.73	-	-	1.73	1.83
32	0.32	0.35	0.35	0.35	0.35	1.12	1.12	-	-	1.12	1.22
15	0.15	0.15	0.15	-	-	0.95	0.95	-	-	0.95	0.95

on Separate Sheet

4. TITLE OF PROJECT
5. FEDERAL AGENCY
6. FUNDING AGENCY
7. FUNDING AGENCY ADDRESS
 (No more than 12 characters and spaces for name of contractor, and no more than 77 characters and spaces for address and county.)
 To be selected by competitive procurement. Potential contractors are partially listed.

8. NAME OF CONTRACTOR
9. STATE
10. COUNTY
11. CITY
12. ZIP CODE
13. NAME OF CONTRACTOR
14. STATE
15. COUNTY
16. CITY
17. ZIP CODE
18. NAME OF CONTRACTOR
19. STATE
20. COUNTY
21. CITY
22. ZIP CODE
23. NAME OF CONTRACTOR
24. STATE
25. COUNTY
26. CITY
27. ZIP CODE

5. BRIEF DESCRIPTION OF PROPOSAL
 (No more than 25 lines of text and no more than 77 characters and spaces per line.)
 Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.

Coal and Shale Processing; Combustion ...
Improved Combustion Processes - Part 1 - Combustion Modific
LPA

NAME OF CONTRACTOR Esso Research & Engineering
STATE New Jersey
COUNTY Union
CITY Linden
ZIP CODE 07036

NAME OF CONTRACTOR W.S. Engineering
STATE California
COUNTY Orange
CITY Fullerton
ZIP CODE 92630

NAME OF CONTRACTOR Hubcock & Wilcox
STATE Ohio
COUNTY Summit
CITY Akron
ZIP CODE 44316

NAME OF CONTRACTOR Combustion Engineering
STATE Connecticut
COUNTY Hartford
CITY Hartford
ZIP CODE 06105

NAME OF CONTRACTOR International Flame Research Foundation
STATE Maryland
COUNTY Prince Georges
CITY Landover
ZIP CODE 20785

Developer and Demonstration of Modified Combustion Technol.
Utility and Industrial Boilers: Modify the combustion process of utility boilers to provide more efficient utilization of fossil waste fuels, and simultaneously reduce air pollutant emissions. Techniques will be developed for firing coal and heavy oil with reduced emissions so cleaner fuels can be used with smaller equipment. Technology for efficient, low-pollution combustion of derived fuels (e.g. low Btu gas) will be developed. **Developer and Demonstration of Modified Combustion Control Technology for Gas Turbines:** Develop and demonstrate dry control methods for control of NO_x from stationary gas turbines. This R&D will be toward maximizing system efficiency. Fuels to be considered: light and heavy oil, natural gas, low-BTU gas, and candidate fuels. **Develop and Demonstrate Modified Combustion Technology Industrial Process Furnaces:** Develop and demonstrate control methods for combustion related and toxic pollutant emissions industrial process furnaces. This R&D effort will also be directed toward improved efficiency in the use of fuels and feedstock. **NO_x Combustion of Reformed Fuels:** Demonstrate a 1 MW combustion system for low NO_x emissions comprising a reformer of clean (sulfur) liquid and gaseous fossil fuels in combination with combustion designed for lean operation.

6. JUSTIFICATION (Use a separate sheet(s). See Item 5. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978
a. MANPOWER (in man years)	(1) Scientific	15	18	25	30
	(2) Technical	8	10	13	16
	(3) Support	13	35	43	35
	(4) Other	3	3	3	3
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)	tons of coal	622,000	36,000	139,200	138,300
	hbls of oil	864,000	122,700	527,300	525,000
	ft ³ of nat gas	303,000,000	10,400,000	5,200,000	=
	ft ³ low Btu gas	-----	25,900,000	52,000,000	933,600,000
c. LAND AREA REQUIRED (in acres)	(1) Government				15
	(2) Government				
	(3) Privately-owned				

Coal and Shale Processing Contribution
 Improved Combustion Processes - Part 1 - Combustion Modification (No. 1)
 EPA

NAME OF CONTRIBUTOR	Esso Research & Engineering	
State where work will be performed	New Jersey	County: Union
NAME OF CONTRIBUTOR	EPA Engineering	
State where work will be performed	California	County: Orange
NAME OF CONTRIBUTOR	RUBCOCK & WILCOX	
State where work will be performed	Illinois	County: Schuyler
NAME OF CONTRIBUTOR	Combustion Engineering	
State where work will be performed	Connecticut	County: Hartford
NAME OF CONTRIBUTOR	International Flame Research Foundation	
State where work will be performed	Holland	County: Zeeland

2

Development and Demonstration of Modified Combustion Technology for Utility and Industrial Furnaces: Modify the combustion process in utility boilers to provide more efficient utilization of fossil and waste fuels, and simultaneously reduce air pollutant emissions. Techniques will be developed for firing coal and heavy oil with reduced emissions so cleaner fuels can be used with smaller equipment. Technology for efficient, low-pollution combustion of coal-derived fuels (e.g. low Btu gas) will be developed. Development and Demonstration of Modified Combustion Control Technology for Utility Gas Turbines: Develop and demonstrate dry control methods for control of NO_x from stationary gas turbines. This R&D will be directed toward maximizing system efficiency. Fuels to be considered include light and heavy oil, natural gas, low-BTU gas, and candidate future fuels. Develop and Demonstrate Modified Combustion Technology for Industrial Process Furnaces: Develop and demonstrate control methods for combustion related and toxic pollutant emissions from industrial process furnaces. This R&D effort will also be directed toward improved efficiency in the use of fuels and feedstock. Low NO_x Combustion of Reformed Fuels: Demonstrate a 1 MW combustion system for low NO_x emissions comprising a reformer of clean (low sulfur) liquid and gaseous fossil fuels in combination with a combustion designed for lean operation.

(rate sheets). See Item 6. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

ARY	1975	1976	1977	1978	1979
	15	18	25	30	27
	8	10	13	16	14
	13	35	48	35	17
	3	3	3	3	3
tons of coal	622,000	36,000	139,200	138,300	--
hbls of oil	864,000	122,700	527,300	525,600	1,730,000
ft ³ of nat gas	303,000,000	10,490,000	5,200,000	==	
ft ³ low Btu gas		25,900,000	52,000,000	933,600,000	15,000,000,000

BLANK PAGE

NAME OF CONTRACTOR
CONTRACTORS ARE
PARTIALLY LISTED.

NAME OF CONTRACTOR: Combustion Engineering	Site where work will be performed: Connecticut	County: Hartford
NAME OF CONTRACTOR: International Flame Research Foundation	Site where work will be performed: CT	County: Middle

5. BRIEF DESCRIPTION OF PROPOSAL

(No more than 25 lines of text and no more than 77 characters and spaces per line)

Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.

Development and Demonstration of Modified Combustion Technology for Utility and Industrial Boilers: Modify the combustion process in utility boilers to provide more efficient utilization of fossil and waste fuels, and simultaneously reduce air pollutant emissions. Techniques will be developed for firing coal and heavy oil with reduced emissions so cleaner fuels can be used with smaller equipment. Technology for efficient, low-pollution combustion of coal-derived fuels (e.g. low Btu gas) will be developed. Development and Demonstration of Modified Combustion Control Technology for Utility Gas Turbines: Develop and demonstrate dry control methods for control of NO_x from stationary gas turbines. This R&D will be directed toward maximizing system efficiency. Fuels to be considered include light and heavy oil, natural gas, low-BTU gas, and candidate future fuels. Develop and Demonstrate Modified Combustion Technology for Industrial Process Furnaces: Develop and demonstrate control methods for combustion related and toxic pollutant emissions from industrial process furnaces. This R&D effort will also be directed toward improved efficiency in the use of fuels and feedstock. Low NO_x Combustion of Reformed Fuels: Demonstrate a 1 MW combustion system for low NO_x emissions comprising a reformer of clean (low sulfur) liquid and gaseous fossil fuels in combination with a combustion designed for lean operation.

6. JUSTIFICATION (Use a separate sheet). See Item 6. on Instruction Sheet.

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978	1979
a. MANPOWER (in man years)	(1) Scientific	15	18	25	30	27
	(2) Technical	8	10	13	16	14
	(3) Support	13	35	46	35	17
	(4) Other	3	3	3	3	3
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)	tons of coal	622,000	36,000	139,200	138,300	
	bbls of oil	864,000	122,700	527,300	525,600	1,700
	ft ³ of nat gas	303,000,000	10,400,000	5,200,000	==	
	ft ³ low Btu gas	-----	25,900,000	52,000,000	933,600,000	15,000
c. LAND AREA REQUIRED (in acres)	(1) Government					
	(2) Cost-owned					
	(3) Privately-owned					
	(4) Other					
d. OTHER RESOURCES NEEDED (Specify item and unit of measure below. Show quantity of each in column at right.)	(1)		3			

ENVIRONMENTAL REPORT (continued)

1. Introduction
2. Objectives
3. Methodology
4. Results

NO. 1000-200-12-75-56-01

05-02-75-05-12-75-56-01

The overall problem of air quality and specifically the particulate matter contribute to the solution of the problem. This report will analyze the economic costs of each of the alternatives. Also include the benefits of the alternatives for solving the problem. Evaluate the project in perspective. Outline the risks/uncertainties of the project and the cost of it. Consultative data should be used to the fullest extent.

Oil Boilers: Combined NO_x emissions from these source categories are the total NO_x emitted from stationary sources. At the proposed level of combustion technology can be developed and demonstrated by mid FY 79. Completion of this program would permit continuous operation with combustion efficiency 60 to 70% reductions in NO_x and related emissions with maximum savings. It is expected that modified combustion technology for these equipment will result in savings of 2×10^{14} BTU of energy in 1990. The only uncertainties are related to operating problems such as slagging and fireside corrosion. These will be addressed and reconciled concurrently as combustion modification technology is applied. Such unknowns would only affect the degree to which combustion technology can be applied.

Gas Turbines: The installed capacity of gas turbines is doubling every eight years. The increasing popularity of the combined cycle plant with efficiencies higher than steam plants makes this concept highly attractive from the standpoint of energy production. The New Source Performance Standards for stationary gas turbines require the use of water injection to control NO_x. This technique, the current standard, is wasteful of water and degrades thermal efficiency. Modified combustion technology could increase fuel efficiency by 14% for gas turbines and related plants. By replacing "wet" control methods, potential savings of demineralized water could range between 13.5×10^9 and 108×10^9 gallons at the proposed level of effort, development and demonstration of technology could be accomplished by FY 83. No risks or uncertainties are anticipated. Comprehensive screening of candidate systems will be conducted concurrent with development to determine an optimum design.

Furnaces: Emission studies and total fuel/energy use by industrial processes have established the need for a program directed at reducing pollution and increasing efficiency. At the proposed level of effort, modified combustion technology can be developed and demonstrated by mid FY 80. Successful completion will result in energy conservation results of combustion control. The large amount of fuel used by industry annually (20×10^{15} BTU's currently and projected 30×10^{15} BTU's by 1990) make this an important project for improvement in energy efficiency and that, there is the potential for saving up to 2×10^{15} BTU/year. Advanced combustion technology should provide substantial control of combustion products.

However, the diversity of other pollutants from these processes may require an additional requirement.

Use of Reformed Fuels: Formation of NO_x can be limited by maintaining combustion temperatures below 3000°F. This can be accomplished by burning fuels with low flame temperatures. Conventional fossil fuels have a narrow range of flammability and often limited. Hydrogen, e.g. from reformed fuels, has a wide flammability range and together with leanings will permit relatively low temperature, high efficiency combustion. At the proposed level of effort, development and demonstration of advanced fuel reforming and combustion process can be accomplished by completion of this program could provide advanced low NO_x combustion technology for industrial applications. The major uncertainty is the ability of the process to provide high thermal efficiency. It is expected, however, that the technology would evolve in pilot scale experiments.

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

NOTE: Include major facilities and major equipment. Indicate dates by Fiscal Year and Quarter.

a. DEVELOPMENT MILESTONES (number each consecutively)

(Limit Title of Milestone to 60 characters and spaces)

b. DATES

	Start		Complete	
	FY	Q	FY	Q
<u>Utility & Industrial Boilers</u>				
Engineering Development: Burner Scale-up for Fossil Fuels	74	1	75	4
Pilot Plant: Tests Performed on Single Burner Systems	75	4	77	3
Demonstration Plant: 150 MW Utility Boiler; 150 MW BTU/hr Industrial Boiler	77	3	79	3
<u>Utility Gas Turbines</u>				
Fabrication of Prototype Mini-scale Combustors	75	1	76	3
Verification Testing/Emissions Data Analysis of Prototype	76	3	77	4
Optimization and Construction of Pilot Scale Prototype	77	4	79	1
Pilot Plant: 15 MW Simple Cycle Turbine	79	1	80	3
Demonstration Plant: 50-75 MW Combined Cycle Plant	80	3	83	1
<u>Industrial Process Furnaces</u>				
Lab Experimentation to Identify Control Methods	75	1	76	3
Engineering Development of Modified Combustion Technology	75	3	78	1
Pilot and Demonstration Plants on Representative Equipment	78	1	80	3
<u>Utility Combustion of Reformed Fuels</u>				
Evaluation of Bench Model	75	1	76	4
Separate Reformer/Combustor Tests	76	4	78	2
Combined Reformer/Combustor Tests	78	2	80	1

Level of Effort:

MAXIMUM

ORDERLY

MINIMUM

IDENTIFICATION NUMBER:

05-02-55-05-12-75-56-01

a. DEVELOPMENT MILESTONES (continued)

(Limit Title of Milestone to 60 characters and spaces)

Date	C	Title	FY		
			Q	F	Q
4					
3					
3					
3					
4					
1					
3					
1					
3					
1					
3					
4					
2					
1					

(Continue on separate sheet)

Page 2

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

2. SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (In millions of dollars)

Combustion Modifications R, D & D Projects	(1)		(2)		(3)		Obi
	FY 1974 (Non-Add)		FY 1975		FY 1976		
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	
a. Utility and Industrial Boilers			2.9		6.3		1.
b. Gas Turbines			0.6		0.6		0.
c. Industrial Process Furnaces			0.3		0.5		1.
d. Reformed Fuels			0.6		1.1		0.
e. GRAND TOTAL—OUTLAYS			4.40		8.50		3..

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER
05-02-55-05-12-75-56-01

Days	(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) Subtotal FY 1975-79		(8) Balance To Complete		(9) Total Excluding FY 1974 (Col. 7 & 8)	
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
	1.7		1.8		1.8		14.5		1.3		15.8	
	0.6		1.1		0.8		3.7		1.1		4.8	
	1.3		1.0		1.0		4.1		1.1		5.2	
	0.3		0.4		0.8		3.2		-		3.2	
	3.90		4.30		4.40		25.5		3.50		29.0	

FACT SHEET

EX MANPOWER
ORDERLY
PROGRAM

IDENTIFICATION NUMBER
05-02-55-05-

2. a. TITLE: Coal & Shale Processing Combustion
Improved Combustion Processes Part 2 - Fluidized Bed C
b. PROGRAM:
3. a. FUNDING AGENCY: DOJ, EPA, NASA, AEC
b. SUBJECT:

4. CONTRACTOR AND SITE
(No more than 10 characters and spaces for name of contractor. Use standard abbreviation for state up to 16 characters and spaces for county.)

NAME OF CONTRACTOR	Westinghouse Electric Corp., Esso R&E Co.	
Site where work will be performed	State:	County:
NAME OF CONTRACTOR	Ponc, Evans and Robbins, other	
Site where work will be performed	State:	County:
NAME OF CONTRACTOR	Combustion Power Co., other	
Site where work will be performed	State:	County:
NAME OF CONTRACTOR	Argonne National Laboratory	
Site where work will be performed	State:	County:
NAME OF CONTRACTOR		
Site where work will be performed	State:	County:

5. BRIEF DESCRIPTION OF PROPOSAL
(No more than 24 lines of text and no more than 70 characters and spaces per line)
Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be required or constructed.

Description same as that indicated in companion form of level of effort, with the exceptions that: (1) the size full-scale demonstration plants will be higher (500-800); (2) demonstration of the three fluidized boiler variation completion of the model, should be completed by the end of . The savings in time over that projected in the "orderly" would be achieved by initiating design of the demonstration early in FY 1975, and by beginning construction of the demonstration soon after the design is completed.

6. JUSTIFICATION (Use a separate sheet(s). See Item 5. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR:	1975	1976	1977	1978
a. MANPOWER (in man years)	(1) Scientific	204	237	366	308
	(2) Technical	252	320	1059	922
	(3) Support				
	(4) Other				
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)	Coal-259,000 tons	Coal-332,000 tons	Coal-5,265,000 tons	Coal-5,280,000 tons	
	Limestone-9,000 tons	Limestone-12,000 tons	Limestone-301,000 tons	Limestone-235,000 tons	
c. LAND AREA REQUIRED (in acres)	(1) Specified				
	(2) Specified				

ORDERLY
PROGRAM

IDENTIFICATION NUMBER
05-02-55-05-12-71-10-01

Coal & Shale Processing Combustion
Improved Combustion Processes - Part 2 - Fluidized Bed Combustion
DOI, IPA, NASA, AEC

NAME OF CONTRACTOR: Westinghouse Electric Corp., Esso R&E Co., Other

Site where work will be performed: State: County:

NAME OF CONTRACTOR: Pope, Evans and Robbins, other

Site where work will be performed: State: County:

NAME OF CONTRACTOR: Combustion Power Co., other

Site where work will be performed: State: County:

NAME OF CONTRACTOR: Argonne National Laboratory

Site where work will be performed: State: County:

NAME OF CONTRACTOR:

Site where work will be performed: State: County:

Description same as that indicated in companion form for "orderly" level of effort, with the exceptions that: (1) the size range of the full-scale demonstration plants will be higher (500-800 MW); and (2) demonstration of the three fluidized boiler variations, and completion of the model, should be completed by the end of FY 1978. The savings in time over that projected in the "orderly" program would be achieved by initiating design of the demonstration plants early in FY 1975, and by beginning construction of the demo plants soon after the design is completed.

2

(See Item 5 on Instruction Sheet.)

F

7. MAJOR RESOURCE REQUIREMENTS

	1975	1976	1977	1978	1979
	204	237	366	308	
	252	320	1059	922	
	Coal-259,000 tons	Coal-332,000 tons	Coal-5,265,000 tons	Coal-5,250,000 tons	
	Limestone-9,000 tons	Limestone-12,000 tons	Limestone-301,000 tons	Limestone-235,000 tons	

BLANK PAGE

Site where work was performed	State:	County:
NAME OF CONTRACTOR:		
Site where work will be performed	State:	County:

5. BRIEF DESCRIPTION OF PROPOSAL

(No more than 24 lines of text and no more than 70 characters and spaces per line)

Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.

Description same as that indicated in companion form for "order level of effort, with the exceptions that: (1) the size range of full-scale demonstration plants will be higher (500-800 MW); and (2) demonstration of the three fluidized boiler variations, and completion of the model, should be completed by the end of FY 1978. The savings in time over that projected in the "orderly" program would be achieved by initiating design of the demonstration plant early in FY 1975, and by beginning construction of the demo plant soon after the design is complete.

6. JUSTIFICATION (Use a separate sheet(s). See Item 5. on Instruction Sheet.)

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR:	1975	1976	1977	1978	1979
a. MANPOWER (in man years)	(1) Scientific	204	237	366	308	
	(2) Technical	252	320	1059	922	
	(3) Support					
	(4) Other					
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)	Coal-259,000 tons	Coal-332,000 tons	Coal-5,265,000 tons	Coal-5,280,000 tons		
	Limestone-9,000 tons	Limestone-12,000 tons	Limestone-301,000 tons	Limestone-235,000 tons		
c. LAND AREA REQUIRED (in acres)	(1) Government-owned					
	(2) Concessions					
	(3) Privately-owned		1200			
	(4) Other					
d. OTHER RESOURCES NEEDED (Specify item and unit of measure below. Show quantity of each in columns at right.)	(1)					

3

MAXIMUM
 ORDERLY
 MINIMUM

05-02-55-05-12-75-5

6. JUSTIFICATION: Specify the reasons for the selection of the program to be implemented in the solution of the problem or attainment of the project and the reasons for selecting the program needed, compared with other alternatives. Also include the benefits expected to be derived from the program, the advantages and disadvantages of the program for which the project is proposed. Outline the risks/uncertainties (R/U), plans to minimize R/U, and steps for proceeding in face of R/U. Quantitative data should be used to the fullest extent.

Same as that indicated in the companion form for the "orderly" level of effort. The major justification for the "maximum" program over the "orderly" program is that the technology would become available at an earlier date, thus enabling a greater degree of implementation by 1955 or any given future year. The larger size of the envisioned pressurized fluidized boiler plant in the "maximum" program (600 MW instead of 300 MW) would also serve to expedite implementation. However, the "maximum" program would probably result in inefficiencies which would boost the total cost of the program.

MAXIMUM
 ORDERLY
 MINIMUM

05-02-55-05-12-75-56-01

...the electric energy program in the electric industry... the proposed... the reduction of the...
...indications for selecting... compared over other alternatives. Also include the reasons
...the objectives of... the program for which the project is proposed. Outline the risks/uncertainties
...R.U. and basis for proceeding in face of R.U. Quantitative data should be used to the fullest extent.

ated in the companion form for the "orderly" level of effort. The major
the "maximum" program over the "orderly" program is that the technology
lable at an earlier date, thus enabling a greater degree of implementation
in future year. The larger size of the envisioned pressurized fluidized
the "maximum" program (600 MW instead of 300 MW) would also serve to expedite
however, the "maximum" program would probably result in inefficiencies which
total cost of the program.

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

E. Include major facilities and major equipment. Indicate dates by Fiscal Year and Quarter.

D. DEVELOPMENT MILESTONES (number each consecutively)

(Limit Title of Milestone to 60 characters and spaces)

b. DATES

	Start		Complete	
	FY	Q	FY	Q
Complete 30 MW atmospheric plant	73	2	75	4
Complete 30 MW pressurized plant	75	1	77	2
Complete 50 MW adiabatic plant	75	1	77	2
Complete 600 MW pressurized plant	75	1	78	4
Complete 200 MW atmospheric plant	75	1	78	4
Complete 500 MW adiabatic plant	75	1	78	4
Complete upgraded mathematical model	75	1	78	4

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER

05-02-55-05-12-75-56-03

DATES

a. DEVELOPMENT MILESTONES (continued)

(Limit Title of Milestone to 60 characters and spaces)

b. DATE

Start Date
FY 10 FY 11

Complete	
0	2
	75 4
1	77 2
1	77 2
	78 4
	78 4
1	78 4
1	78 4

(Continue on separate sheet)

P 177 - 1

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

2. SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

Requirement	(1)		(2)		(3)	
	FY 1974 (Non-Acc)		FY 1975		FY 1976	
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays
Fluidized-Bed Combustion						
- pressurized			8.1		55.4	
- atmospheric			13.0		70.9	
- adiabatic			9.2		57.5	
- adiabatic			9.2		57.5	
- support			6.8		6.8	
			37.1		190.6	

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER
05-02-55-05-12-75-84-01

(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) Subtotal FY 1975-79		(8) Balance To Complete		(9) Total Excluding FY 1974 (CS) 7.8	
Obs.	Outlays	Obs.	Outlays	Obs.	Outlays	Obs.	Outlays	Obs.	Outlays	Obs.	Outlays
54.6		45.0				163.1		0		163.1	
76.5		76.5				236.9		0		236.9	
37.0		37.0				140.7		0		140.7	
37.0		37.0				140.7		0		140.7	
3.5		3.0				20.1		0		20.1	
171.6		161.5		0		560.8		0		560.8	

includes a brief description of the Cooperative programs and the rationale for the division of funding

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

B. SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

Requirement	(1)		(2)		(3)		(4)	
	FY 1974 (Non-Add)		FY 1975		FY 1976		FY 1977	
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays
a. OPERATING (See p. for detail) Total Operating Requirements (from Detail Sheet)			9.6	9.6	22.0	22.0	59.5	59.5
b. CONSTRUCTION (See p. for detail) Total Construction Requirements (from Detail Sheet)			27.5	27.5	168.6	168.6	112.1	112.1
c. EQUIPMENT (See p. for detail) Total Equipment Requirements (from Detail Sheet)								
d. GRAND TOTAL—OBLIGATIONS			37.1	37.1	190.6	190.6	171.6	171.6
e. GRAND TOTAL—OUTLAYS				37.1		190.6		190.6

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER
05-02-55-05-12-75-56-01

7 Items	(5) FY 1972		(6) FY 1979		(7) Subtotal FY 1975-72		(8) Balance To Complete		(9) Total Funds FY 1974-1979	
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
9.5	104.3	104.3			195.4	195.4	0	0	195.4	195.4
2.1	57.2	57.2			365.4	365.4	0	0	365.4	365.4
	161.5		0		560.8		0		560.8	
71.6		161.5		0		560.8		0		560.8

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

LEVEL OF FUNDING REQUIREMENTS - Federal Government: Only (in millions of dollars)

ORGANIZATION

ITEM	(1) FY 1974 (Non-Add)		(2) FY 1975		(3) FY 1976		Obls.
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	
TOTAL (Carry forward to summary sheet)			9.6	9.6	22.0	22.0	59.5
of Performing Organization: Pope, Evans & Robbins, & Other							
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION			4.8	4.8	3.6	3.6	3.4
of Performing Organization: Contractor to be selected							
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION							9.0
of Performing Organization: Contractor to be selected							
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION	-	-	3.6	3.6	3.6	3.6	
of Performing Organization: Contractor to be selected							
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION	-	-	-	-	-	-	20.0

(Continue on S)

Level of Effort:
 MAXIMUM
 ORDERLY
 MINIMUM

IDENTIFICATION NUMBER
 05-02-55-05-12-75-56-01

Line	(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) SUBTOTAL FY 1975-79		(8) BALANCE TO COMPLETE		(9) TOTAL EXPENDITURE FY 1975-79	
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays
0	59.5	59.5	104.3	104.3			195.4	195.4	0	0	195.4	195.4
3	3.4	3.4	3.4	3.4			15.2	15.2	0	0	15.2	15.2
	9.0	9.0					9.0	9.0	0	0	9.0	9.0
5							7.2	7.2	0	0	7.2	7.2
-	20.0	20.0	40.0	40.0			60.0	60.0	0	0	60.0	60.0

(Continue on Separate Sheet)

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

TABLE OF FUNDING REQUIREMENTS - Federal Government Only (In millions of dollars)

OPERATING

ITEM	(1)		(2)		(3)		
	FY 1974 (Non-Add)		FY 1975		FY 1976		
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.
TOTAL (Carry forward to summary sheet)							
of Performing Organization: Contractor to be selected							
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION	-	-	-	-	-	-	-
of Performing Organization: Contractor to be selected							
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION	-	-	-	-	10.2	10.2	2
of Performing Organization:							
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION	-	-	1.2	1.2	4.6	4.6	2
of Performing Organization:							
MANPOWER							
MATERIALS							
MAJOR PROCUREMENTS							
ALL OTHER							
TOTAL FOR THIS PERFORMING ORGANIZATION							

(Continued)

Level of Effort:
 MAXIMUM
 ORDERLY
 MINIMUM

IDENTIFICATION NUMBER
 05-02-55-05-12-75-53-01

(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) SUBTOTAL FY 1975-79		(8) BALANCE TO COMPLETE		(9) TOTAL FY 1975-79	
Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays
-	-	33.8	33.8			33.8	33.8	0	0	33.8	33.
22.5	22.5	22.5	22.5			55.2	55.2	0	0	55.2	55.
4.6	4.6	4.6	4.6			15.0	15.0	0	0	15.0	15.

(Continue on Separate Sheet)

Page of

2

MAIN SHEET

IDENTIFICATION NO.
05-02-55-05-12-75

1. TITLE: Coal & Shale Processing Combustion

2. A. FUNDING AGENCY: Improved Combustion Processes - Part 2 - Fluidized Bed Combustion
B. SUBJECT: DOI, EPA, NASA, AEC

4. CONTRACTOR ADDRESS: (No more than 42 characters and spaces for name of contractor, no standard abbreviation for state up to 16 characters and spaces for county.)

NAME OF CONTRACTOR: Westinghouse Electric Corp., Esso R&E Co., et	State:	County:
NAME OF CONTRACTOR: Pope, Evans and Robbins, other	State:	County:
NAME OF CONTRACTOR: Combustion Power Co., other	State:	County:
NAME OF CONTRACTOR: Argonne National Laboratory	State:	County:
NAME OF CONTRACTOR:	State:	County:

5. BRIEF DESCRIPTION OF PROPOSAL: (No more than 24 lines of text and no more than 70 characters and spaces per line.)
Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.

Three variations of the fluidized-bed combustion process will be developed and demonstrated on the full scale. These variations include: (1) the pressurized boiler concept, in which the fluid bed contains heat transfer surface, and the hot, pressurized gas are expanded through a gas turbine; (2) the atmospheric pressure concept; and (3) the adiabatic combustor concept, in which the bed is operated at elevated pressure without heat transfer surface, and hot, pressurized off-gases are expanded through a gas turbine with subsequent heat recovery/steam generation. A mathematical model describing the fluidized-bed combustion process will also be developed. Each of the three variations will be tested in a separate, intermediate sized plant (30-50 MW) and in a separate, full-scale demonstration plant (300-800 MW). All of these plants will be new. Demonstration of all three variations, and completion of the model should be completed by the end of FY 1980.

6. JUSTIFICATION (Use a separate sheet). See Item 5. on Instruction Sheet.

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978
a. MANPOWER (in man years)	(1) Scientific	85	97	144	149
	(2) Technical	97	122	409	399
	(3) Support				
	(4) Other				
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)	Coal-2500 tons	Coal-150,000 tons	Coal-200,000 tons	Coal-1,940,000 tons	Coal
	Limestone-400 tons	Limestone-5,000 tons	Limestone-8,000 tons	Limestone-100,000 tons	Lime 178
c. LAND AREA REQUIRED	(1) Government				
	(2) Other				

PROJECT TITLE: Coal & Shale Processing Combustion
 Improved Combustion Processes - Part 2 - Fluidized Bed Combustion
 AGENCY: DOE, EPA, NASA, AEC

CONTRACTOR: Westinghouse Electric Corp., Inso R&E Co., other
 Site where work will be performed: State: County:
 CONTRACTOR: Pope, Evans and Robbins, other
 Site where work will be performed: State: County:
 CONTRACTOR: Combustion Power Co., other
 Site where work will be performed: State: County:
 CONTRACTOR: Argonne National Laboratory
 Site where work will be performed: State: County:
 CONTRACTOR:
 Site where work will be performed: State: County:

DESCRIPTION OF PROJECT:
 Three variations of the fluidized-bed combustion process will be developed and demonstrated on the full scale. These variations include: (1) the pressurized boiler concept, in which the fluidized-bed contains heat transfer surface, and the hot, pressurized off-gases are expanded through a gas turbine; (2) the atmospheric pressure concept; and (3) the adiabatic combustor concept, in which the bed is operated at elevated pressure without heat transfer surface, and the hot, pressurized off-gases are expanded through a gas turbine with subsequent heat recovery/steam generation. A mathematical model describing the fluidized-bed combustion process will also be developed. Each of the three variations will be tested in a separate, intermediate sized plant (30-50 MW) and in a separate, full-scale demonstration plant (300-500 MW). All of these plants will be new. Demonstration of all three variations, and completion of the model should be completed by the end of FY 1980.

2

DN (Use a separate sheet). See Item 6. on Instruction Sheet.

F

7. MAJOR RESOURCE REQUIREMENTS

FISCAL YEAR ▶	1975	1976	1977	1978	1979
(1) Scientific	85	97	144	149	221
(2) Technical	97	122	409	399	357
(3) Support					
(4) Other					
ALS and units of (such as tons of oil, kilograms of flow amount of of right.)	Coal-2500 tons Limestone-400 tons	Coal-150,000 tons Limestone-5,000 tons	Coal-200,000 tons Limestone-8,000 tons	Coal-1,940,000 tons Limestone-100,000 tons	Coal-3,195,000 tons Limestone-178,000 tons
(1) Government					
(2) Government					
(3) Privately-owned			1,000		

BLANK PAGE

Site where work will be performed	State:	County:
NAME OF CONTRACTOR:		
Site where work will be performed	State:	County:

5. BRIEF DESCRIPTION OF PROPOSAL

(No more than 24 lines of text and no more than 70 characters and spaces per line)

Briefly outline nature and scope of work to be undertaken, including any new facilities which may have to be acquired or constructed.

Three variations of the fluidized-bed combustion process will be developed and demonstrated on the full scale. These variations include: (1) the pressurized boiler concept, in which the fluid bed contains heat transfer surface, and the hot, pressurized off-gases are expanded through a gas turbine; (2) the atmospheric pressure concept; and (3) the adiabatic combustor concept, in which the bed operated at elevated pressure without heat transfer surface, and hot, pressurized off-gases are expanded through a gas turbine with subsequent heat recovery/steam generation. A mathematical model describing the fluidized-bed combustion process will also be developed. Each of the three variations will be tested in a separate, inter-sized plant (30-50 MW) and in a separate, full-scale demonstration plant (300-600 MW). All of these plants will be new. Demonstration of all three variations, and completion of the model should be completed by the end of FY 1980.

6. JUSTIFICATION (Use a separate sheet(s). See Item 5. on Instruction Sheet.)

F

7. MAJOR RESOURCE REQUIREMENTS

RESOURCE	FISCAL YEAR	1975	1976	1977	1978	
a. MANPOWER (in man years)	(1) Scientific	85	97	144	149	2
	(2) Technical	97	122	409	399	3
	(3) Support					
	(4) Other					
b. RAW MATERIALS (List materials and units of measure below, such as tons of coal, barrels of oil, kilograms of uranium, etc. Show amount of each in columns at right.)	Coal-2500 tons	Coal-150,000 tons	Coal-200,000 tons	Coal-1,940,000 tons	Coal-3 tons	
	Limestone-400 tons	Limestone-5,000 tons	Limestone-8,000 tons	Limestone-100,000 tons	Limestone-178,000 tons	
c. LAND AREA REQUIRED (in acres)	(1) Government-owned					
	(2) State-owned					
	(3) Privately-owned			1,000		
	(4) Other					
d. OTHER RESOURCES NEEDED (Specify item and unit of measure below. Show quantity of each in columns at right.)	(1)					

3

- MAJOR
- MODERATE
- MINOR

6. JUSTIFICATION: State why the proposed program is necessary, why it will contribute to the solution of or attainment of the energy problem, and why it is a more desirable approach than other alternatives. Also include the expected rate of development from the start of the program to the date for which the project is projected. Outline the risks for (R/U), plans to minimize R/U, and steps for minimizing the R/U. Qualitative data should be used to the fullest extent.

The objective of the program is to develop technology for utilizing this vast stantial coal reserves for electric power production, with minimized environment and with reduced power costs. Successful development of the proposed variations fluidized-bed combustion process will achieve this objective, according to current projections.

(a) Environmental impact. Data from a variety of experimental fluidized combustion indicate over 90% reduction in SO₂ emissions with the addition of sorbent at a C of 2-3. Projections indicate that, with a system for regenerating the sorbent and sorbent makeup could be reduced to a Ca/S of perhaps 0.5. Limited data also indicate for systems operating at elevated pressure, emissions of NO_x may be reduced by 7 is felt that, by proper design, emissions of particulates and hydrocarbons will

(b) Economics. Economics estimates can vary between one estimator and another least partially to the use of different basis for preparation of the estimate. show an economic advantage for fluidized-bed boilers, in comparison with conventional One estimate is shown below:

	Conventional Boiler (stack gas cleaning)	Pressurized Fluid Bed	Atmospheric Fluid Bed
Capital cost, \$/kw (600 MW plant)	337	265-277	295-313
Power cost (mills/kwhr)	13.4	11.7-12.1	12.5-13.

M.A.=not available

Fluidized-bed combustion offers one promising means for achieving the objective reduced-cost power using the plentiful U.S. coal reserves.

It is projected that, once fluidized-bed combustion is successfully developed be applied to 0.2x10¹⁵ Btu (input) capacity by 1985, and 2.2x10¹⁵ Btu by 2000. of implementation could be greater if coal is called upon to provide a larger fraction U.S. power than is currently projected. This degree of implementation would result savings of \$0.2 billion in plant capital costs by 1985, and \$2.9 billion (cumulative 2000, compared to conventional boilers with stack gas cleaning. The reduction would be 0.7 million tons in 1985, and 7.2 million tons in 2000, compared to a conventional boiler. If the elevated-pressure systems result in an improvement thermal efficiency to 41%, a savings in coal utilization of up to 5 million tons could be achieved, compared to a 38% efficient system.

The major uncertainty in the program is the demonstration of the operability full-scale, integrated boiler systems. This uncertainty will be minimized by testing each process variation on an intermediate scale (30-50MW), and on a smaller scale. uncertainties include demonstration of sorbent regeneration and sulfur recovery tion is to be employed; and demonstration of high-temperature, high-pressure sulfur removal technology, for pressurized systems. The potential for the process, assuming these uncertainties, is adequate to justify proceeding with the program

- MAXIMUM
- MODERATE
- MINIMUM

05-02-55-05-12-75-56-02

...to the solution of the problem... Also include the benefits... Outline the risks/uncertainties... should be used to the fullest extent.

If the program is to develop technology for utilizing this nation's sub-
vers for electric power production, with minimized environmental impact
per costs. Successful development of the proposed variations of the
stion process will achieve this objective, according to current data and

al impact. Data from a variety of experimental fluidized combustors
eduction in SO₂ emissions with the addition of sorbent at a Ca/S mole ratio
s indicate that, with a system for regenerating the sorbent for reuse,
d be reduced to a Ca/S of perhaps 0.5. Limited data also indicate that,
ng at elevated pressure, emissions of NO_x may be reduced by 70-90%. In
oper design, emissions of particulates and hydrocarbons will also be low.

Economics estimates can vary between one estimator and another, due at
the use of different basis for preparation of the estimate. Most estimates
vantage for fluidized-bed boilers, in comparison with conventional boilers.
wn below:

	<u>Conventional Boiler (stack gas cleaning)</u>	<u>Pressurized Fluid Bed</u>	<u>Atmospheric Fluid Bed</u>	<u>Adiabatic Fluid Bed</u>
	337	265-277	295-313	320
(hr)	13.4	11.7-12.1	12.5-13.1	N.A.

N.A.=not available

combustion offers one promising means for achieving the objective of clean,
using the plentiful U.S. coal reserves.

that, once fluidized-bed combustion is successfully developed, it will
10¹³ Btu (input) capacity by 1985, and 2.2x10¹³ Btu by 2000. This degree
could be greater if coal is called upon to provide a larger fraction of
currently projected. This degree of implementation would result in a
lition in plant capital costs by 1985, and \$2.9 billion (cumulative) by
conventional boilers with stack gas cleaning. The reduction of SO₂ emission
on tons in 1985, and 7.2 million tons in 2000, compared to an uncontrolled
s. If the elevated-pressure systems result in an improvement in plant
to 41%, a savings in coal utilization of up to 5 million tons/yr in 2000
compared to a 38% efficient system.

ertainty in the program is the demonstration of the operability of the
ited boiler systems. This uncertainty will be minimized by first studying
tion on an intermediate scale (30-50MW), and on a smaller scale. Other
ide demonstration of sorbent regeneration and sulfur recovery, if regenera-
oyed; and demonstration of high-temperature, high-pressure particulate
for pressurized systems. The potential for the process, and for over-
tainties, is adequate to justify proceeding with the program.

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

3. *Include major facilities and major equipment. Indicate dates by Fiscal Year and Quarter.*

A. DEVELOPMENT MILESTONES (number each consecutively)

(Limit Title of Milestone to 60 characters and spaces)

	b. DATES			
	Start		Complete	
	FY	Q	FY	Q
Complete 0.6 MW pressurized plant	71	2	75	4
Complete 30 MW atmospheric plant	73	2	75	4
Complete 2 MW adiabatic plant	74	2	76	2
Complete 30 MW pressurized plant	75	1	78	2
Complete 50 MW adiabatic plant	76	1	78	2
Complete 300 MW pressurized plant	77	4	80	4
Complete 300 MW atmospheric plant	75	2	80	4
Complete 500 MW adiabatic plant	76	1	80	4
Complete upgraded mathematical model	75	1	80	4

Level of Effort:

MAXIMUM

ORDERLY

MINIMUM

IDENTIFICATION NUMBER
05-02-55-05-12-75-56-01

TES

3. DEVELOPMENT MILESTONES (continued)

(Limit Title of Milestone to 60 characters and spaces)

Complete	
FY	Q
75	4
75	4
76	2
78	2
78	2
80	4
80	4
80	4
80	4

DATE			
Start		Complete	
FY	Q	FY	Q

(Continue on separate sheet)

2

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (in millions of dollars)

R,D&D Area	(1)		(2)		(3)		(4)
	FY 1974 (Non-Add)		FY 1975		FY 1976		FY 1977
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.
Fluidized-Bed Combustion							
- pressurized				1.8		1.3	
- atmospheric				8.0		4.4	
- adiabatic				3.0		6.0	
- support				5.8		5.8	
				18.6		17.5	

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER
05-02-55-05-12-75-56-01

(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) Subtotal FY 1975-79		(8) Balance To Complete		(9) Total Expenses FY 1974 (Est.) 75-79	
Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
	12.2		26.4		20.4		62.1		20.0		82.1
	51.5		51.5		51.5		166.9		0		166.9
	6.1		5.2		3.7		24.0		75.0		99.0
	2.0		2.0		1.5		17.1		3.0		20.1
	71.8		85.1		77.1		270.1		98.0		368.1

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

B. SUMMARY OF FUNDING REQUIREMENTS—Federal Government Only (In millions of dollars)

Requirement	(1)		(2)		(3)		(4)
	FY 1974 (Non-Add)		FY 1975		FY 1976		FY 1977
	Obls.	Outlays	Obls.	Outlays	Obls.	Outlays	Obls.
a. OPERATING (See p. for detail) Total Operating Requirements (from Detail Sheet)			5.6	5.6	6.8	6.8	6.1
b. CONSTRUCTION (See p. for detail) Total Construction Requirements (from Detail Sheet)			13.0	13.0	10.7	10.7	65.7
c. EQUIPMENT (See p. for detail) Total Equipment Requirements (from Detail Sheet)							
d. GRAND TOTAL—OBLIGATIONS			18.6		17.5		71.8
e. GRAND TOTAL—OUTLAYS				18.6		17.5	

Level of Effort:

- MAXIMUM
- ORDERLY
- MINIMUM

IDENTIFICATION NUMBER
 05-02-55-05-12-75-56-01

Outlays	(4) FY 1977		(5) FY 1978		(6) FY 1979		(7) Subtotal FY 1975-79		(8) Balance To Complete		(9) Total Budget FY 1975-79	
	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays	Obis.	Outlays
.8	6.1	6.1	10.7	10.7	37.3	37.3	66.5	66.5	58.0	58.0	124.5	124.5
.7	65.7	65.7	74.4	74.4	39.8	39.8	203.6	203.6	40.0	40.0	243.6	243.6
	71.8		85.1		77.1		270.1		98.0		368.1	
.5		71.8		85.1		77.1		270.1		98.0		368.1