SECTION VI

Improved Environmental Control

IMPROVED ENVIRONMENTAL CONTROL

II. STATUS OF TECHNOLOGY

A. Present Status

1. Demonstration of specific flue gas sulfur control techniques are underway. Demonstration of technical performance capabilities are highly advanced. The demonstration of long-term performance reliability is under study and new processes are in the bench scale and development stage.

Development of improved particulate control and identification of the hazardous pollutant problem have been initiated.

Major conversion technologies are in, or entering into, a pilot-scale development stage. Environmental problems associated with these conversion technologies are presently being identified and quantified.

Physical and chemical coal cleaning research and development is presently underway at laboratory scale. Design of a pilot-scale unit is underway with initiation of construction possible by February 1974.

Fluidized-bed combustion for environmentally acceptable utilization of high-sulfur refinery residue has been successfully operated in a pilot plant facility.

B. Barriers to Technology Implementation

1. Research is necessary to development of basic data that would result in: improved systems, reduced energy requirements, improved waste disposal, and waste and by-product utilization.

Basic specific research is required to provide fundamental knowledge on coal conversion and shale oil technology problems and on alternative methods for insuring the environmental integrity of large-scale facilities. Continued basic research is needed to examine and optimize the degree of environmental control and cost reductions achievable with coal cleaning (physical and chemical). Basic research is also required to identify major conversion process and scrubbing technology by-product recoveries and uses.

- 2. Development of specific processes related to flue gas control techniques will be required prior to implementation. Development of required conversion process controls will be needed whenever existing technology is inappropriate for use. The compatibility and optimal degree of control achievable in fuel conversion facilities with effluent treatment technologies will require development. Effort must be applied to develop the feasibility of integrated, large-scale continuous operation of coal cleaning technologies. Indicated directions from the basic waste/by-product scientific research must be developed through large-scale application on operating conversion systems. Technology for the recovery of energy from coal cleaning and refinery wastes and for the adequate reclamation of strip-mine areas must be developed to achieve highly efficient operation while minimizing environmental problems.
- 3. Implementation of fuel conversion technologies will be restricted ue to the limited number of sites capable of supplying the materials requirements of the technologies. Implementation of flue gas cleaning

will be limited both by problems associated with retrofit on existing facilities and by the costs of application to small-scale facilities.

C. On-Going RED Efforts to Overcome Barriers

- 1. Large funding levels in the multi-million dollar range are being expended in research, development and demonstration areas.

 The majority of funds (80-90%) is based on federal government operations or support.
- In demenstration or first commercial operations of processes,
 the federal/industry support is generally 50/50.
- 3. There has been continuous as well as major efforts to exchange information with foreign efforts. These efforts have varied from visits, formal meetings, and contractual arrangements to official agreements (e.g., protocol with U.S.S.R. in environmental areas) with foreign governments.

III. RATIONALE FOR FEDERAL INVOLVEMENT

A. Government funding of the pollution control area is required in view of the need for development, implementation, and enforcement of strong pollution control standards and of the requirement for a cohesive, well-directed R&D program to support environmental quality control. Private industry cannot be relied upon to develop the broad R&D program which is needed.

Increases in the cost of naturally clean fuels (oil and gas), restrictions upon fuel switching, and implementation of emission standards should produce a more favorable industrial attitude toward application of pollution control technologies.

The development of processes for conversion of coal to high-grade fuels or liquids requires and will continue to require increasingly larger financial support. Such levels of funding required for accelerated or even minimum programs appear to be beyond the capabilities of industry. To achieve these developments successfully in a near-term period, requires a multi-prong attack. Only federal support could achieve this goal.

B. Financial support by the federal government will be required to reduce research and development barriers due to lack of profit motive to industrial users and to technical expertise centered in federal agencies. Federal financial assistance will also be required to accelerate the implementation of the developed technology due to the higher risk involved and the capital required. This assistance

support could be in several forms: direct funding, low interest loans, tax reduction incentives or even a federally supported and operated industry.

IV. OBJECTIVES, CRITERIA

- A. The Pollution Control research area objective is to develop to commercial application technologies for environmentally acceptable domestic energy resource utilization and energy self-sufficiency.
- B. Criteria for setting priorities among programs should include:
 - 1. Public acceptance of program output
 - 2. Government cost/benefit
 - 3. Environmental acceptability
 - 4. Related cost/manpower requirements
 - 5. Resource extension
 - 6. Efficiency enhancement

V. ALTERNATIVE RED PROGRAMS

A. Schedule and Costs of RSD Program at Alternative Funding Levels

Pollution control-related energy RSD major milestone charts and
federal obligation summaries are attached as Form A and Form B,
respectively, for each of the program alternatives: _(a) accelerated/
orderly; (b) maximum (crash); and (c) minimum.

B. Criteria Employed by the Submanol in Constructing the Promosed R&D Program

- 1. N/A
- 2. The program was based upon:
 - a. Utilization of dirty fuels to supply cleam energy.
 - Increasing supplies of liquid and gaseous fuel (increasing freedom from foreign sources).
 - c. Reducing environmental degradation to a minimum.
 - d. Conservation of energy.

C. Relationship of Other R&D

- 1. No dependency upon other R&D areas is envisioned. The degree of implementation of conversion system control and enhancement is dependent upon continued conversion technology development and future application.
- 2. At the time of commercialization of technologies for pollution control the beneficial impact of program output will define and be defined by the degree of implementation of other technologies.

D. Acceptability of RGD Program

Very few problems are envisioned regarding acceptability of the pollution control area program outputs. Environmental impact statements will be required for all demonstration projects as well as for subsequent commercial applications.

E. Other Costs and Benefits

The achievement of expanded coal utilization will provide capabilities for more optimal programming of existing domestic fuel resources. Fuel switching (to oil) requirements could be avoided and fuel self-sufficiency attained.

Widespread technology application should produce economic benefits associated with new technology developments and expanded coal utilization.

Program failure will result in loss of approximately 50% of major capital expenditures.

Program termination will produce major user sector concern regarding program co-spensorship as well as problems in overall domestic fuel utilization impact and enhanced environmental quality attainment.

VI. IMPLEMENTATION PLAN

A. Direct Benefits

- 1. Implementation of the overall Environmental Control area R&D output will involve the extraction, refining and conversion, transportation, and central station conversion areas. Utility, industrial, and residential/commercial energy users would all comprise the ultimate technology utilization sectors. Supply sectors would encompass the pollution control equipment and construction industries.
- 2. The Pollution Control area technologies in the flue gas cleaning and fuel cleaning/conversion areas could ultimately impact upon the entire industrial, residential/commercial, and utility market. Flue gas environmental control capabilities could be achieved on 10-16* 10¹⁵ Btu by 1985 and 20-40* 10¹⁵ Btu by 2000. By the year 2000 synthetic gas from coal may provide 5.4-16.2* 10¹⁵ Btu/year. Also, yields of 2-6* 10¹⁵ Btu/year and 1.1-3.0* 10¹⁵ Btu/year of usable energy by 2000 could be obtained by fuel cleaning and shale oil industries, respectively. Ultimate application of Pollution Control area technologies will enable achievement of air quality criteria from fuel combustion and, thus, continued use of "dirty" domestic fuels.
- 3. Implementation of the Pollution Control area R&D will be a major factor in reducing U. S. dependence upon importation of fuels to supply domestic energy requirements. The utilization potential of coal and shale oil as a result of achievement of objectives will contribute to energy self-sufficiency. Process technology implementation will be independent of foreign resource or material supplies.

- 4. Program implementation will maximize usage of domestic energy supplies, thus precluding U. S. energy system vulnerability associated with strong dependence upon foreign fuel sources. Major security problems and accident impacts from technology implementation will not occur. Adequate environmental safeguard development will insure minimal risk associated with domestic energy supply.
- 5. The optional recovery elements of the Pollution Control R&D program will aid in increasing the efficiency of energy utilization from extracted demostic fuel resources. Development and refining of selective fuel cleaning technology will result in a maximum of useful fuel value recovery from coal. Strategies for central power station control and for conversion system control will be optimized to provide for the maximum possible net energy recovery.

B. Proposed Schoole for Implementation

- 1. Pollution control technology developments will initiate commercial market penetration in 1980 and progress as expanded fuel demands and public demands for environmental control necessitate.
- 2. The rate of technology implementation will be restricted by the availability of capital and the lack of trained manpower to undertake technology application. The ability of vendors to supply needed control equipment and control equipment guarantees will also be an implementation constraint.

- 3. The national energy system would be favorably affected through the expanded use of the vast domestic coal reserves which would be attained from achievement of program objectives.
- 4. Geographical/siting requirements will be major consideration in the application of fuel conversion technologies. The economics of retrofit applications will limit the degree of implementation of flue gas cleaning technologies.
- 5. The application potential of Pollution Control area technologies will be most favorably realized through optimum process economics. This will occur through enhanced by-product recovery and utilization and/or disposal techniques.

C. Economic Impact

Assuming a raw coal energy cost of \$0.35/10⁶ Btu, the clean fuel product from fuel cleaning (physical and chemical) will cost \$0.55-\$0.65/10⁶ Btu. Technology for the environmentally sound recovery of oil from shale will produce fuel at a cost of \$1.00-\$1.50/10⁶ Btu. Major product fuels from coal liquefaction and coal gasification technologies are expected to cost \$0.75-\$0.80/10⁶ Btu and \$1.00-\$1.30/10⁶ Btu, respectively.

On the basis of a delivered electrical energy cost of \$2.00/10⁶ Btu (6.75 mills/kwhr) from conventional coal-fired power plants the final energy cost with the addition of flue gas cleanup would amount to \$2.35-\$2.80/10⁶ Btu (7.95-9.55 mills/kwhr). This electrical energy will of course be completely clean at the point of use and has a high "end use value."

VII. IMPACTS OF IMPLEMENTATION

A. Natural Resources Required

In addition to the quantities of energy which have been estimated to be attainable from technology implementation, flue gas cleaning and fuel cleaning (chemical + physical) are each expected to consume approximately 65 of the clean energy which they produce. Approximately 15%-25% of the fuel resources fed to coal-to-gas and coal-to-liquid conversion systems will be required to meet process fuel requirements.

B. Compatibility with Existing Energy System

The major fuel conversion and fuel cleaning technology developments should be compatible with existing fuel combustion facilities with little, if any, modifications required.

C. Environmental Impacts of Implementation

The technologies being developed in the Environmental Control R&D area will reduce atmospheric emissions from fuel combustion to levels which comply with environmental regulations. The impact of liquid, solid, and thermal effluents from developed technologies will be reduced to acceptable levels through development and implementation of the required control measures.

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Waste Disposal and By-Products (continued) Lime-Sludge Waste Utilization	Ini	intion			Lab. Es Comple	i ed
		Lab. I Comp	operi. Eng.	Develop. pleted		Demo. Plan Complete
Waste By-Product from Gasification		/	2		*****	
	First App	ommercial ication			Cota;	lote
Fly-Ash Strip Mining Reclamation					Z	i
•		Eng. Der Complet	led Plan		•	Çomplete
Use of Sulfur as Asphalt Substituto		2		` .		(1981)
High Sulfur Combustor Demonstration			C.	Develop mpleted 		Demó. lant Comp. Standard Comp. (1982)
• :	٠,					

.PROGRAM NAME: Improved Environmental Control

PROGRAM ALTERNATIVE: Accolerated

PEDERAL OBLICATIONS \$x10⁶

D DOCUME DECEMBE			*****						
PROGRAM RIUMENT :	1975 -	1976	1977	1978	1979	1980-1989			 +
Particulate Control Technology			}	}					
Fine Particulate/Electrical Power Generation 5	3.600	4,850	3,500	3,500	3.500			 	
'Pine Particulate/Industrial & Commercial Sources *	2.300	2.500	2.7667	2.7667	2.766,7				
Hatardous & Other Pollutant Control Feebnology	٠								
Gaseous Toxic Emission Control	1.850	3.000	0,6185	0.6185	0.6185	·			
Operational Control/BO and Trace Emissions	0.460	0.810	1.070	1.070	1.070				
									1
* Federal obligations as:	ame at lea:	t 50% das	onstrati	יוו סם-לוויי	ling by I	he nrivo	e socto	••	
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			'				•		
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	• i	THE PARTY AND ADDRESS OF THE PARTY ASSESSMENT ASSESSMEN	Accelerated
PROGRAM NAME:		PROGRAM ALTERNATIVE:	
12:34:144.1 113:4 1111			

FEDERAL OBLIGATIONS

	FEDERAL ONLIGATIONS						
ROGRAM ELEMENT	1975	1976	\$x10 ⁰ 1977	1978	1979	1980-1989	1990
y Control Technology	•				,	,	
1 & 10 MW Pilot Plant	2,025	1.935	1,135				
Alkaline Ash # .	1.1	0.6	1.25	1.25			
Lime/Limestone *	3.0	1.5					
<u>Oz Grahadlentarohorapje</u>						·	
Citrate *	1.0	8.0	1.5	1.5	,		
Armonia-Bisulfate	0.6	0.6	0.25	1			
Integrated Cat-Ox#	10.0		0.3	0.3	0.3		
Metal Oxides *	0.43	1.41	1.3	1,3			
Advanced Systems *	5.75	3,25					
Industrial Boiler®	0.85	0.5	0.167	0.167	0.167		
Wellman-Lord/ Allied * .	4.5	8.7	,5				
uel Cleaning				ļ			1.
Chemical Treatment of Coal*	2.581	4,15	2.0	2.0	2.0		
Physical & Chemical Removale of Sulfur	1.0	1.0	1.0	1.0	1.0		
High Gradient Magnetic Separation	0,25	0.65	2.0				

PROCRAM NAME:					PROGRAM A	LTERNATIVE:	Accelerated .
PROGRAM ELEMENT	1975	FE	DERAL OBLI \$X10 ⁶ 1977		197 9	1980-1989	1990
Fuel Conversion and							
Process Control					!		•
Development and Demonstration of Control Components	6.1	10.1	4,334	4.334	4.334		
Development and Demonstration for Shale Oil Control	1.45	2.5	3.899	3,899	3,899		
Control of Fine Particulates from Fuel Extraction Processing Plants	1.25	1.0	1,433	1.433	1.453	2.0	
Hecovery of Petroleum Refining Hydrocarbon Losses [®]	2.45	2.2	0.717	0,717	0.717		
Utilization and Disposal of Conversion Plant Wastes	0.5	0.5					
Improved gas-solid-liquid Separation	2.9	2,85	1.983	1.983	1.983		
•			·		ļ		
•							}
					· ·		
* Foderal obligations as:	ume at lea	t 50% dem	matratio	ı co-fund	ine hy th	o private se	ector.
• •							
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FORM B

PROGRAM NAME:

PROGRAM ALTERNATIVE: Accelerated

FEDERAL OBLIGATIONS

5 11/1 (21/1 A 1 A - 60 P B) A 1904 (200	•	\$×10 ⁶						
PROGRAM ELEMENT	1975	1976	1977	1978	1979	1980-1939	1990	
aste Disposal and By-Products					*	,		
Disposal of High Sulfur Refinery Naste by CAFB*	3.25	1.25	0.5	0.5	0.5			
Alternate Reductants From Regen. Flue Gas Cleaning Systems	0.7	0.2		•	/ .** /			
Use of sulfur as / Asphalt Substitute#	0.5	0.5	0.667	0.667	0.667			
High Sulfur Combustor Demonstration ²¹	6.4	8.3	4.0	4.0	4.0			
Lium sludge Waste Utilization	0.163	0.18	0.22	0.22		•		
Maste By-Product from Gasification*	1.5	.2.0	2.599	2.599	2.599	2.599 (1980)		
.Fly-Ash Strip Mining Reclamation	1.0	1.5	1.333	1,333	1.333			
					٠.			
	- assume at lea	t 50% dem	nstratio	co~fund	ing hy tr	private secto	r.	
		ŀ			٠.	•		

PROGRAM NAME: Improved Environm	ental Control				PROGRAM A	LTERNATIVE	: <u>Crash</u>	
	•	F	EDERAL OBLY					
PROGRAM ELEMENT	1975	1976		1978	1979	1930-1939		,
erticulate Control Technology					{			
Fine Particulate/Electrical Power Generation*	10.140	4.200	4.200	4,200				
Fine Particulate/Industrial & Commercial Sources #	4.162	4.162	3.320	3.320	,			
azardous & Other Pollutant Control lecturatory								
Gaseous Toxic Emission Control *	2.850	1.542	1.542	1.542	}			
Operational Control/HO _X and Trace Emissions #	1.067	1.284	1,284	1.284				
•							•	
* Fedoral obligations as	sumo at le	st 50% d	monstrat	on co-fi	nding by	the priv	ite sect	or.
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ENERGY RED PROGRAM BUDGET SUMMARY

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PROGRAM NAME:	PROGRAM ALTERNATIVE:	Crash

FEDERAL OBLIGATIONS

PROGRAM ELEMENT	\$XI0 _Q						
- nothing bearing	1975	1976	1977	1978	1979	1980-1989	1990
SO, Control Technology	·						
1 A 10 MM Pilot Plant	2,025	1.935	1.135				
Alkaline Ash "	1.265	2.128	1.438				
Lime/Limestone#	3,0	1.5					
80x Control-Maganerable							
Citrate ^a	, 1,15	9.2	3.45	} .			•
Austonia-Bisulfate	0.6	0.6	0.25				1.
Integrated Cat-Ox#	11.5	0,345	0.345	0.345			
Metal Oxides *	2.116	1.495	1.495				ĺ
Advanced Systems*	5,75	3,25	ţ		ļ		(
Industrial Boiler*	0.978	0.767	0.384				
Wellman-Lord/ Allied * '	8.7	0.5	1				
Fuel Cleaning	•						
Chemical Treatment of Coal #	7 .7 4 .	2.3	2.3	2.3			İ
Physical & Chemical Removal of Sulfur	1.0	1.0	1.0	1.0	1.0		
·High Gradient Magnetic Separation	1.035	2,3					
* Federal obligations assume	at least	0% demons	tration o	o-funding	by the	rivate s ctor	

PROGRAM NAME:					PROGRAM AL	TERNATIVE:	Cra	sh .
		FE	DERAL OBLI \$x10 ⁶			•		
P ROGRAM ELEMENT	1975	1976	1977	1978	1979	1980-198	59	1990 -
Fuel Conversion and Process Control								
Development and Demonstration of Control Components	9.15	20.2	13.002	13.002	13.002			
Devalopment and Demonstration for Shale Oil Control	4.35	7.5	11.697	11.697	11.697	,		
Control of Fine Particulates from Fuel Extraction Processing Plants	2.587	1,648	1.648	1.648	2.3	·		
Recovery of Petroleum Refining Hydrocarbon Losses*	5.348	0.825	0.825	0,825				
Utilization and Disposal of Conversion Plant Wastes	0.5	0.5						
Improved gas-solid-liquid Separation	3,0	5.0	5.0		·			
	•							
* Federal obligations as	ume at lea	t 50% den	onstratic	ı co-fun	ing by the	privat	sector	•
•				•			•	
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ENERGY RED PROGRAM BUDGET SUMMARY

FORM B

PROGRAM NAME:	PROGRAM ALTERNATIVE:	Crash

PEDEPAL OBLIGATIONS

PROGRAM ELEMENT	\$x10 ⁶						
	1975	1976	1977	1978	1979	1980-1989	1000
Waste Disposal and By-Products							
Disposal of High Sulfur Refinery Waste by CAFB *	3.738	2.013	1.15				
Alternate Reductants From Regen. Flue Gas Cleaning Systems	0.7	0.2			, ,	,	
Use of sulfur as Asphalt Substitute [#]	1.15	0.767	0.767	0.767			
High Sulfur Combustor Demonstration *	16.905	4.6	4.6	4.6			
Line sludge Waste Utilization	0.163	0.18	0.22	0.22			
Waste By-Product from Gasification*	4,025	2.989	2.989	2,989	2.989		
• .Fly-Ash Strip Mining Reclamation	2.0	3.0	2.666	2,666	2.666		
	·				-		
						,	
		•	,				} :
	s ume at len	st 50% der	onstrati	n co-fun	ing by the	e privat; secto	or.
• .		•					

PROGRAM NAME: Improved Environmental Control

PROGRAM ALTERNATIVE: Minimum

FEDERAL OBLIGATIONS

Daniel Firms	\$x10 ⁶							,
PROGRAM ELEMENT	1975	1976	1977	1978	1979	1980-1989	 -	
Particulate Control Technology								
Fine Particulate/Electrical Power Generation*	2.500	2.975	2.975	3.500	3.500	3,500		·
Fine Particulate/Industrial & Commercial Sources #	2.000	2.000	2.000	2.000	2.000.	2.000		÷
Pazardous & Other Pollutant Control Technology								
Gascous Toxic Emission Control*	1.500	2.000	.750	.750	.750	.750		
Operational Control/NO _X and Trace Emissions*	.460	.500	.500	1.000	1.000	1,000		
•								•
* Federal obligations ass	ume at leas	t 50% den	onstratic	n c0-fun	ing by	he privo	e secto	·•
•			•					
	·		·					
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ENERGY RED PROGRAM BUDGET SUMMARY

FORM B

PROGRAM NAME:					PROGRAM	alternative	: Mini	nitira	
• •		FL	EDERAL OBL	IGATIONS					
PROGRAM ELEMENT			\$X10 ⁸	5					
P ROOKO ELEMENT	1975	1976	1977	1978	1979	1980-1989			
SOy Control Technology		•	}				·		`
1 & 10 im Pilot Plant	0.849	0.849	0,849	0,849	0.849	0.849			
Alkaline Ash st	0.7	0.7	0.7	0.7	0.7	0.7			
Lime/Limestone *	3.0	1.5							
SO, Control-magenerable									
Citrate *	0.5	2.0	4.0	2.5	2.5	0.5.			
Ammonia-Bisulfate	0.363	0.363	0.363	0.363					
Integrated Cat-Ox*	1.0	3.0	3.0	.3.0	0.3	0.6			
Metal Oxides*	0.74	0.74	0.74	0.74	0.74	0.74			i .
Advanced Systems [#]	2.25	2.25	2.25	2,25					1
Industrial Boiler*	0.425	0.25	0.167	0.167	0.167				}
. Wellman-Lord/ Allied *	4,5	8.7	0.5						1
Fuel Cicaning	<u> </u>				Í			•	
Chemical Treatment of Coal*	1,819	1.819	1.819	1.819	1.819	3.638			
Physical & Chemical Removal of Sulfur	0.5	0.5	0.5	0.5	0.5				
High Gradient Magnetic Separation	0,125	0.325	.25				•		
	}		,].					
* Federal obligations as	ume at lo	st 50% de	aonstrat:	on co-fu	ding by	the priv:	te sect	or.	

		FI	DERAL OBLI	GATIONS				
•		* *	\$X106					
ROGRAM ELEMENT	1975	1976	1977	1978	1979	1980-1989		
ol Conversion and Process Control					,			
Development and Demonstration of Control Components	1.0	3.0	2,0	2.0	2.0	19,2		
Development and Demonstration for Shale Gil Control	. 0.29	0.5	0.78	0.78	0.78	12.517		
Control of Fine Particulates from Fuel Extraction Processing Plants	0.625	0.5	0.717	0.717	0.717	1.0		
Recovery of Petroleum Refining Hydrocarbon Losses	0.45	2.0	2.2	.717	.717	.717		
Utilization and Disposal of Conversion Plant Wastes	0.25	0.25	0.25	0.25				
Improved gas-solid-liquid Separation	0.725	0.713	0.496	0.496	0.496			
•								
* Federal obligations as	umo at len	:t 50% de	onstrati	on co-fui	ding by	he priv	te sector	•
						,		

ENERGY RED PROGRAM BUDGET SUMMARY

FORM B

PROGRAM NAME:	PROGRAM ALTERNATIVE:	Minlata

FELERAL OBLIGATIONS

	*	1.12	THEO TENTE						
PROGRAM ELEMENT	1975	1976	\$X10 ⁶ 1977	1978	1979	1980-1989			•
	1773	1970	1277	1://0		1200-1505			
laste Disposal and Ly-Products									
Disposal of High Sulfur Refinery Waste by CAFB*	1.0	2.0	1.25	0.25	0.25	0.5			
Alternate Reductants From Regen. Flue Gas Cleaning Systems	0.35	0.2		•	•		:		
Use of sulfur as Asphalt Substitute*	0.429	0.429	0.429	0.429	0.429	0.858	!		
High Sulfur Combustor Demonstration *		1.0	3,0	4.4	6.3	12.0			
Limo sludge Waste Utilization	0.157	0.157	0.157	0.157	0.157				
Maste By-Product from Gasification*	1,985	1,985	1.985	1.985	1.985	3.97			
.Fly-Ash Strip Mining Reclamation	0,5	0.75	0.666	0.666	0.666		•		
•							ļ		1
•									
•	·		·.	j			-		
* Federal obligations	a sume at le	st 50% a	monstrut	on co-ft	nding by	the private	e scc	or.	
•									
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SECTION VII

Support Research to Achieve Coal and Shale Processing and Combustion Program Objectives

Program: Coal & Shale Processing and Corbustion

Sub-program: Supporting Research to Achieve Coal and Shale Processing and Combustion Program Objective

II. Status of the Technology

- A. Present Status of the Technology
 - 1. Equipment, materials and processes for simple coal gasifiers, for example, fixed bed Lurgi gasifiers, and first generation oil shale plants are in the development stage. None of these are currently in commercial use in the U.S. Research on fluid bed coal gasifiers and various coal liquification processes is being actively pursued in the U.S., supported primarily by the U.S. Department of Interior with some support from private sources. Currently supporting research is funded at a very low level.
- B. Barriers to Implementation of the Technology
 - 1. Research Barriers

First generation plants producing gas and oil from coal and shale could at high cost be made to operate now. Improvement of the reliability of the components and development of first and second generation plants requires research on materials which are more resistant to erosive wear and corrosive environment, better catalysts, easier production of hydrogen and better data on processes and materials.

2. Development Ferriers

Present equipment, such as valves, operate sufficiently well

to provide the possibility of operation of first generation plants. However, reliability and economy of operation could be greatly improved by a planned program in component development and process development.

3. Implementation Barriers

The building of commercial units requires that cost of present processes be on a level that can be supported by normal market operations, with possible guarantees supplied by the government. The effect of the technology development subprogram might play a significant role in reducing costs and thus in increasing the potential for actual creation of a commercial industry.

C. Ongoing R&D Efforts to Overcome Barriers

- Present level planned for FY 74 is \$12% funded by the U.S. government.
- 2. Private funding is restricted mainly to pilot plant development rather than technology development and supporting research.
- Foreign results on Lurgi gasifiers may be of marginal use but the main effort must come from U.S.

III. Pationale for Federal Involvement

A. Federal involvement is warranted because the national interest requires that the U.S. not become dependent on foreign sources

of gas and oil. Both national defense strategy and economic balance of payments considerations are important here. Market forces at present allow individual companies more profit from importing gas and oil than by domestic production from coal and oil shale, so Federal involvement is needed.

- B. Because of the broad application to many processing schemes of the research of this sub-program, industry will probably look to the government to support this area.
- C. Attitude of industry toward applied research will not be greatly altered by external factors. Levels are relatively low.
- D. Manpower training programs might be useful. If part of the work on this sub-program were carried out at universities, a manpower training aspect would be inherently included.

IV. Objectives, Criteria, and Priorities

A. The supporting research sub-program is divided into six areas.

For further details see Item 6 of energy research and development fact sheet for this sub-program. The objectives are:

1. Equipment Development

To develop, independent of pilot and demonstration plants, new reliable coal injection systems for high pressure, char and ash withdrawal systems, solids monitoring instruments, valves and other key components required for coal processing.

2. Materials

To develop methods for service life prediction, test methods

for materials and improved materials for coal processing equipment

3. Data compilations, handbooks and analyses

To advance the development of coal processing by developing a technical, design and economic information data base.

4. Catalysis and Chemical Kinetics

To develop improved catalysts for methanation, coal gasification and liquefaction and to develop the chemical kinetics necessary for the development of improved coal processing systems.

5. Process Development

To advance the development of coal processing by research on the unit operations of coal processing (i.e., fluidized bed technology) and by developing new processes for producing hydrocarbons from coal.

6. Hydrogen Production

To develop low-cost on-site processes for producing hydrogen-rich gases from non-petroloum sources for near and midterm coal and oil shale processing.

B. The program on coal and shale processing and development contains a number of expensive development projects such as pilot plants and demonstration plants. To support these plant development sub-programs, a technology development and supporting research sub-program equal in cost to 10% of the total program cost is

justified according to the consensus of opinion of consultants interviewed by the sub-panel.

V. A.1.a

Milestones

It is doubtful that meaningful milestones can be developed for the bulk of the projects in the supporting category. It is, therefore, suggested that in place of milestones, decision points be established for continued funding. Major criteria would be the progress that has been made and the likelihood of the ultimate success in applying the technology. The suggested decision point for all categories is July 1977 (beginning of FY 78).

At the end of the five year period, only those programs should be carried forward which hold promise of contributing to the development of second and third generation coal processing.

V. A.2

(a) Cost and I	Budcet Proje	ctions (Mill	ions)	
Accelerated/Orderly Program	FY 75	FY 76	(Avg.) FY 77-79	Total
Equipment Development Materials Data Compilation	\$3.4 6.8	\$5.8 7. 7	\$7.9 8.4	\$37.9 39.7
Handbooks and Analys Catalysis and Chemic		3.5	4.2	18.8
Kinetics	13.3	17.2	22.4	97.9

Cost and Pudget Projections (Millions) (cont.)

Accelerated/Orderly Program	FY 7 5	FY 76	(Avg.) FY 77-79	Total
Process Development Hydrogun Production Total*	20.8 4.0 \$55	26.8 8.2 \$70	28.4 8.5 \$80	132.8 37.7 \$365
*Rounded				
Maximum Program Total	\$110	\$140	\$160	\$730
Minimum Program Total	\$12	\$12	\$12	\$60

- (b) Megligible contribution from the public sector is anticipated.
- (c) See (a) above.

V. A.3

- (a) No new major manpower needs are envisioned. Overall 250 new professionals would be involved and 500 new nonprofessional supporting staff would be required.
- (b) No major new facilities would be required. A number of small scale test facilities would be required, none requiring significant new construction.

4. Management Plan

(a) The research will be performed at a number of different government, industrial and university laboratories having existing competence. An appropriate organization should be charged with overall coordination of the program with the

major organizations funding the development work. Industrial liasion should be established for individual programs.

V. B. Criteria Employed in Constructing the Proposed R&D Program

- 1. Alternative Funding Approaches Considered: Industry could fund all research and development work including supporting research. Considering the economic structure of private profit making companies, it is improbable that this research would be carried out on the scale necessary to develop a coal processing industry in an accelerated orderly manner.
- 2. There are many technological options available, none of which have been developed to the point where a single option can be selected. Therefore, the recommended program supports those considered to be technically sound and furthering the objective of improved coal processing.
- C. 1. In general, the program is not starting from a zero technological base. Many of the technologies have been applied in other areas (i.e., fluidized bed technology) and it will be extremely beneficial to apply this expertise to coal technology.
 - Attempts to solve major technological problems in pilot and demonstration plants are extremely expensive. Every effort should be made to minimize the costs of development by having

parallel efforts independent of the pilot and demonstration plants.

V. D. Acceptability of Program

There are no acceptability problems for the program other than those associated with the general program of coal conversion.

E. Other Costs and Benefits of the PSD Program

- 1. The program focuses upon coal conversion process. Some of the technologies have the potential for transference to oil shale processing. The production of hydrogen rich gases will have a direct bearing upon shale-oil hydrogenation.
- Failure to develop reliable key components of equipment independent of plant operations results in large expenditures at the plant level.
- 3. Orderly termination costs would be small.

I and VII. Implementation Plan to Pollow Completion of Successful RED Phases of Implementation

These sections are not applicable to the coal and oil shale supporting research program. All of the factors involved are discussed in other sub-program elements of the coal and oil shale processing report.

SUBPANEL 5

COAL AND SHALE PROCESSING AND COMBUSTION

APPENDIX C

BUDGET FACT SHEETS

	C varia i 105-03-20-03-12-
2. a. Proportati	Coal & Oil Simle Processin:
h. SWA'rebeites	Pipeline Godity Gas From God1
3. a. Physic Light ACENCY	Department of the Interior
b. DUBLETAT	Office of Coal desearch - Dureau of Mines
4. CONTRACTOR AND SITE	MAME OF COMTRACTOR: Office of Coal Besearch - Institute of Cas
(No more than 42), har, every and	Site and remark with the State Illinoin County: Chicago
	NAME OF CONTRACTOR: Office of Contracts and Conselidated Contracts will be StateS. Dailography:
	NAME OF CONTRACTOR: Dureau of Mines, Lummus, Rust Engineering
	Site where work will be State: PA. County: Allegheny .
	NAME OF COMTRACTOR Office of Coal Research-Dituminous Coal Re
-	Site where work will be State County: Homer City
	MAME OF CONTRACTOR: Par. Mines. Datelle Mem Inst., Chem System
	Site where work will be State: County:

5. BRIEF DESCRIPTION OF PROPOSAL

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

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

The research area concerns the production of pipeline gas from coal. The objectives are to: a) develop the te necessary for the establishment of a commercial coal to pi quality gas industry with due regard to environmental cons b) accelerate demonstration at a commercial scale by const and operating one or more coal to pipeline gas plants.

The work involves the acceleration of the present Off Research - American Gas Association program and the Bureau program to produce high Dtu gas from coal. The proposed p for operation of four pilot plants (Hygas, CO2-Acceptor, S Bigas; each producting 1 to 2 million scf/day). Two of th plants are operating (Hygas and CO2-Acceptor) and two will operating by early 1975. A program for a stirred-fixed be plant is also planned. The maximum program involves the i design and construction of three commercial (250 million c plants. Construction would begin July 1, 1975. This woul place of the demonstration plant program as described in t accelerated/orderly program. This program would also be 1 junction with industry.

R&D on new gasification processes and supporting rese equipment/materials development will be carried out concur with the construction of the commercial plants.

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

		7. 51.	AJOR RESOURCE REC	DUIREMENTS	<u>F</u>	
RESOURCE T	FISCAL YEAR	1975	1976	1977	1978	
a. MANPOWER	(1) Scientific	50	1600	30	25	╁
(in mon yeers)	(2) Technical	130	4500	50	75	T
	(3) Support				T	1
	(4) Other	30	1600	20	20	Τ
(list malerials and units of measure below, such as tons of coal, burnels of all. Rilarrams of uranium, etc. Show amount of each in columns at right.)		and 3,000 acr Each commercia	tion plant will c-ft of water.	l consume abou	5,000 tpd of -20,000 tpd of	
c. LAND AREA REQUIRED (in seres)	(2) Governessed	Pilot plant <u>wi</u> Comercial foc coal mine whi	ility will rec	uire about 200	-acres includi	E.g
d. OTHER RESC (Specify item)	DURCES NEEDED					T

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:05-03-00-03-10-0X-3::-##

(1) maaritus Coal & Oil Shale Processin: Pipeline Quality Gas From Coal Department of the Interior Office of Conl desearch - Eureau of Mines NAME OF CONTRACTOR: Office of Coal Research - Institute of Cas Technology Site where work will be - Stated Illinois County: Chicago and MAME OF CONTRACTOR: Office of Coal Research-Consolidated Coal-Stearns? She where work ead be > States Daito county: NAME OF CONTRACTOR: Pareau of Mines, Lummus, Rust Engineering Di State: Site where work and be County: Allegheny

NAME OF CONTRACTOR Caffice of Coal Research Bituminous Coal Research State: County: Homer City

NAME OF CONTRACTOR: Pur Mines, Marelle Mem Inst . Chem Systems

State: Site where work will be performed

The research area concerns the production of pipeline quality gas from coal. The objectives are to: a) develop the technology necessary for the establishment of a commercial coal to pipeline quality gas industry with due regard to environmental consideration, b) accelerate demonstration at a commercial scale by constructing and operating one or more coal to pipeline gas plants.

The work involves the acceleration of the present Office of Coal-Research - American Gas Association program and the Bureau of Mines program to produce high Btu gas from coal. The proposed plan calls for operation of four pilot plants (Hygas, CO2-Acceptor, Synthene, Bigas; each producting 1 to 2 million scf/day). Two of the pilot plants are operating (Hygas and CO2-Acceptor) and two will be operating by early 1975. A program for a stirred-fixed bed pilot plant is also planned. The maximum program involves the immediate design and construction of three commercial (250 million of/day) plants. Construction would begin July 1, 1975. This would be in place of the demonstration plant program as described in the accelerated/orderly program. This program would also be in conjunction with industry.

R&D on new gasification processes and supporting research on equipment/materials development will be carried out concurrently with the construction of the commercial plants.

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

7. MAJOR RESOURCE REQUIREMENTS F							
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Current descriptions of natural gas cannot meet demand and both pipel. gas (Canada) and liquid natural gas, LNG, (Algeria) are being imported. Import. dicted to rise sharply of a the next 10-15 years as a result of a continuing into the demand for natural gas, but imports will fall far short of the demand. Large imports are undesirable both from a political/military standpoint and because of contribution to the balance of trade deficit.

Although the U.S. domestic supplies of petroleum and natural gas cannot me supply, U.S. reserves of goal are immense with a projected lifetime of 400-600 present consumption rates. The proposed plan is designed to help alleviate the shortages of natural gas by developing a commercial process for the production line quality gas at reasonable cost.

The proposed plan involves the acceleration of the present OCR-AGA program present Dureau of Mines program for the production of high Btu-gas as well as r programs for development of new gasification processes. In addition, the plan a program of supporting research and development (submitted and outlined in a s sub-program proposal) for equipment/materials research and development and for a studies of gasification chemistry.

This plan includes the operation of the Hyges process pilot plant and the Acceptor process pilot plant and completion of the construction and operation of plants for the Synthene process and for the Bi-Cas process. In addition other will be supported. This includes but is not limited to: construction and opera a pilot plant to test the Durcau of Mines Hydrane process, development of the B Memorial Institute's Self-Agglomerating Ash process, Chem Systems Liquid Phase I process and Bituminous Coal Research's Combined Shift and Methanation Process.

In addition to all of the above projects, the maximum rate program include, diate design and construction of 3 250 million of/day commercial plants. The programs, therefore, would be occurring concurrently with commercial plant constant operation. Construction of the commercial plants would begin July 1, 1975.

Because the connectial plants will be built and operated before the beneficible plant operation can be obtained, the technical risks and uncertainties will over those encountered in the accelerated/orderly program.

Non-technical uncertainties will exist for the maximum program as for the programs. These include: prices of foreign petroleum, Federal, State, and loc strip-mine regulations, source of large amounts of capital needed for gasificat: plants and Federal Power Commission action on pricing of synthetic natural gas coal.

⁵ JUSTIFICATION—State the specific energy problem or objective, and specify how the proposal will contribute to the solution of the proposal automorphism of the constitution of the solution of the proposal of the constitution of the constitution of the solution of the proposal of the proposal. Outline the resistance this IB/UI, place to minimize B/U, and basis for proceeding in face of B/U. Quantitative data should be used to the fullest extent.

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IDENTIFICATION NUMBER

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e the specific energy problem or objective, and specify how the proposal will contribute to the solution of the problem sective. To clock to except for selecting the recommended approach over other alternatives. Also include the bandits from according the objective controllers to contains for which the propert is proposed. Outline the risks/uncertainties e H/U, and basis for proceeding in face of R/U. Quantitative data should be used to the fellest extent,

desestic supplies of natural gas cannot meet demand and both pipeline natural and liquid natural gas, LNG, (Algeria) are being imported. Imports are pree sharply over the next 10-15 years as a result of a continuing increase in r natural gas, but imports will fall far short of the demand. Large scale ndesirable both from a political/military standpoint and because of the to the balance of trade deficit.

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quiactions, source of large amounts of capital needed for gasification Maral Power Commission action on pricing of synthetic natural gas from

ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

1850ULE Anclude major facilities and major equipment. Indicate dates by Fiscal Year and s	worter).

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a. DEVELORMENT MILESTONES (number each consecutively)	<u></u>	b. D.	ATES		
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legin design of 3 commercial (250 million of/day) plants	75	1	76	1	;
ligin operation of Synthane pilot plans	75	1	76	4	1
Eagin eperation of Bi-Gas pilot plant	75	3	76	4	
Degin construction of commercial plants	76	1	78	3	1
Design pilot plant for movel gasification processes	77	3	78	3	
Operate pilot plant for novel processes	78	3	80	3	•
Operate commercial plants	78	3	Con	in	in
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IDENTIFICATION NUMBER MULLIXAM ORDERLY □ MINIMUM b DATES b. DATES a. DEVELOPMENT MILESTONES (continued) Start Start Complete (Limit Title of Milestone to 60 characters and spaces) FY C 0 la <u>;</u> 1 76 1 5 5 6 7 1 76 4 4 3 76 1 3 78 3 78 3 80 3 3 3 3 3 Continuing Page ٥f

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ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

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

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* Include three commercial-scale plants at \$275 million each with industry contributir

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: MUMIXAM 2 IDENTIFICATION NUMBER ORDERLY ■ MINIMUM .· (5) (4) (7) (8) (9) (6) Total Exercising FY 1974 (Cc. T E E) Subtotal Eplance To FY 1977 FY 1978 FY 1979 FY 1975-79 Complete Chis. Outlays Cals. | Outlays Outlays Cutlays Obis. Cutlays - Obis. Obis. Obls. : Outlays 909.7

rry contributing \$125 million each



ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

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

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Level of Effort: IDENTIFICATION NUMBER MAXIMUM ORDERLY 05-03-20-03-12-70-5 ☐ MINIMUM (4) (5) (6) **(7)** (8) BALANCE TO COMPLETE TOTALES FY 1974 - SUBTOTAL FY 1975-79 FY 1977 FY 1978 FY 1979 Outlays Obis. Outlays Obis. Outlays Obis. Obis. Outlays Outlays Obls.

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ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

- 9. DETAIL OF FUNDING REQUIREMENTS- Federal Government Only (in millions of dollars)
 - b. CONSTRUCTION

b. Ch. STREETION				[1]	(2)	(3)		
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ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

- 9. DETAIL OF FUNDING REQUIREMENTS-Federal Government Only (in millions of dollars)
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2. v. PHOGHAM	Conl & Oil Shale Processing
ь, виниральна	Pipeline Quality Gas From Coal
3. a. Projectant Agency	Department of the interior
h, 60900114	Office of Coul Research-Dereau of Mines
4. CONTRACTOR ADDICTE	NAME OF CONTRACTOR Office of Coal Research-Institute of Gas Tech.
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use standard addinguation for state, up to 16 characters and spaces for county.	NAME OF CONTRACTOR: OFF Coal Research-Consol Coal-Stearns & Roge State of the Work will be State Dakoth County:
•	NAME OF CONTRACTOR: Burgau of Mines, Lummus, Rust Engineering
	State value a veork with the State: PA. County. Allogheny
	NAME OF CONTRACTOR Office of Coal Research-Bituminous Coal Resear

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Site where work will be

Site where work will be State:

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5. BRIEF DESCRIPTION OF PROPOSAL

> (No more than 24 lines of text) and no more than To pherocless. and spaces per time)

Briefly outline nature and scape. of work to be underfucing including any new facilities which may have to be acquired or constructed.

The research area concerns the production of pipeline qua gas from coal. The objectives are to: a) develop the technolo necessary for the establishment of a commercial coal to pipeli quality gas industry with due regard to environmental consider b) accelerate demonstration at a commercial scale by construct and operating one or more coal to pipeline gas plants.

NAME OF CONTRACTOR: Bur Mines, Batelle Mem. Inst., Chen Systems

County.

Pomer City

The work involves the acceleration of the present Office Coal Research - American Gas Asso. program and the Bureau of Σ program to produce high Dtu gas from coal. The proposed plan for operation of four pilot plants (Hygas, CO2-Acceptor, Synthe Biggs; each producing 1 to 2 million scf/day), followed by the construction and operation of two demonstration plants (50-150 lion of/day, also in conjunction with industry). The demonstr plants will be spaced about two years apart. The second demon stration plant will provide facilities for testing newer devel ments and processes. The demonstration program will be follow by design and construction of commercial-scale plants (250 mil cf/day).

R&D on new gasification processes and supporting research equipment/materials development will be carried out concurrent with the pilot plant/demonstration plant program.

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

	·	7, M	AJOR RESOURCE RE	EQUIREMENTS		_
RESOURCE V	FISCAL YEAR	1975	1976	1977	1978	1
a. MANPOWER	(1) Scientific	50	400	30	400	30
(in mon years)	(2) Taginnical (130	1300	50	1300	40
	(3) Support					:
	(4) Other	30	300	20	300	20
measure below, such as tons of coal, betterby of oil, Rilagrams of uranium, etc. Show emount of cach in columns at right,)		Each commerc	cre-ft of wat ial plent wil 0,000 acre-ft	ll consume 15,	000-20,000 tpd ce =8. Schedule	of coal
e. LAND AREA REQUIRED (in ocres)	(1) Gost-owned (2) Gost-leaved (3) Prescriptorated (4) Other	_C::::::::::::::::::::::::::::::::::::	hill require toility will hich leads the	about 20 acre require about to plant	200-acres inc	Luding
6. OTHER RESO	URCES NEEDED					

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1, IDENTIFICATION NUMBER V05-03-20-03-12-03-20-55-01

	Coal & Oil Shale Processing	
	Fineline Quality Gas From Coal	•
	Department of the Interior	
	Office of Coal Research-Purgan	of Mines
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arrid	Side of the work will be . States Count in the said	y: Chicana
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	Site where work wall be State: PA Count performed	y: Allecheny
- [NAME OF CONTRACTOR: Office of Coal R	esearch-Bituminous Coal Research
	Site where work will be State: FA Count	
	NAME OF CONTRACTOR: Bur Mires, Bate	lle Mem. Inst., Chem Systems
	Site where work will be State: Count performed	
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The research area concerns the production of pipeline quality gas from coal. The objectives are to: a) develop the technology necessary for the establishment of a commercial coal to pipeline quality gas industry with due regard to environmental consideration, b) accelerate demonstration at a commercial scale by constructing and operating one or more coal to pipeline gas plants.

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R&D on new gasification processes and supporting research on equipment/materials development will be carried out concurrently with the pilot plant/demonstration plant program.



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	7. M	AJOR RESOURCE RE	QUIREMENTS		
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	130	1300	50	1300	40
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•	NAME OF CONTRACTOR: Bureau of Mines, Lummus, Rust Engineering
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	NAME OF CONTRACTOR: Bur Mines, Batelle Mem Inst., Chem Systems
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5. GRIEF 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 uncerturen, including any new facilities which may have to be acquired or constructed..."

The research area concerns the production of pipeline quality gas from coal. The objectives are to: a) develop the technology necessary for the establishment of a commercial coal to pipeline quality gas industry with due regard to environmental considerat: b) accelerate demonstration at a commercial scale by construction and operating one or more coal to pipeline gas plants.

The work involves the acceleration of the present Office of Coal Research - American Gas Asso. program and the Bureau of Min program to produce high Btu gas from coal. The proposed plan ca for operation of four pilot plants (hygas, CO2-Acceptor, Synthan Bigas; each producing 1 to 2 million scf/day), followed by the construction and operation of two demonstration plants (50-150 m lion cf/day, also in conjunction with industry). The demonstrat plants will be spaced about two years apart. The second demonstration plant will provide facilities for testing newer developments and processes. The demonstration program will be followed by design and construction of commercial-scale plants (250 milli cf/day).

R&D on new gasification processes and supporting research c equipment/materials development will be carried out concurrently with the pilot plant/demonstration plant program.

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

	•	7. MA	AJOR RESOURCE REC	DUIREMENTS		
RESOURCE	FISCAL YEAR	1975	1976	1977	1978	1975
a. MANPOWER	(1) Scientific	50	400	30	400	30
(in man years)	(2) Technical	130	1300	50	1300	40
	(3) Support					<u> </u>
	(4) Other	30	300	20	300	20
coal, barrels of	and units of , such as tons of oil, Kilograms of Show emount of	Each demonst and 3,000 a Each commerc	re-ft of wate tal plant will	ill consume a	of coal cout 5,000 tpd 00-20,000 tpd o e #8. Schedule)	 coal
c. LAND AREA REOUIRED (in acres)	(1) Govt-leased (2) Govt-leased (3) Powerely-tweed (4) Other	Compercial f.	vill require a cility will r lich feeds the	equire_about_	200-acres inclu	ding
d. OTHER RESO (Specify item a messare below of each in colu (1)	nd unit of Since quantity	(1)	·			

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	MINIMUM	05-03-20-03-12

6. JUSTIFICATION- State the steadic energy problem or objective, and specify how the proposal will contribute to the solution of the proof attributed the objective. Include reasons for selecting the recommended approach over other attemptives. Also include the benefit expected to be defined from the etting the objectives or solving the problems for which the project is proposed. Outline the risks/uncertain (R/U), pinks to minimize R/U, and basis for proceeding in face of R/U. Quantitative data should be used to the fullest extent.

Current domestic supplies of natural gas cannot meet demand and both pipeline gas (Canada) and liquid natural gas, LNG, (Algeria) are being imported. Imports a dicted to rise sharply over the next 10-15 years as a result of a continuing incretthe demand for natural gas, but imports will fall far short of the demand. Further large scale imports are undesirable both from a political/military standpoint and of the contribution of the unfavorable balance of trade.

Although the U.S. domestic supplies of petroleum and natural gas cannot meet supply, U.S. reserves of coal are immense with a projected lifetime of 400-600 yes present consumption rates. The proposed plan is designed to help alleviate the coshortages of natural gas by developing a commercial process for the production of line quality i.e., high Btu gas from coal at reasonable cost.

The proposed plan involves the acceleration of the present OCR-AGA program a present Europa of Mines program for the production of high-Etu gas from coal as w research programs for development of new gasification processes. In addition, th includes a program of supporting research and development (submitted and outlined separate sub-program proposal) for equipment/materials research and development a basic studies of gasification chemistry.

This plan includes the operation of the Hygas process pilot plant and the CO Acceptor process pilot plant, completion of the construction and operation of pil plants for the Synthane process, for the Bi-Gas process and for a stirred-fixed t gasifier and the construction and operation of two 50-150 million of/day demonstr plants. In addition other research will be supported. This includes but is not to: construction and operation of a pilot plant to test the Bureau of Mines Hydr process, development of a) Batelle Memorial Institute's Self-Agglomerating Ash pr b) Chem Systems Liquid Phase Methanation process, and c) Bituminous Coal Research Combined Shift and Methanation Process.

This approach was selected because it provides a flexible research program (to examine the merits of a number of promising processes before a demonstration | is constructed. It is aimed at developing a process to produce a product gas at lowest price with the least amount of harm to the ecology. Other processes which considered were ultimately decided to be too complicated or too costly.

It is expected that as a result of the proposed program, full scale (250 mi cf/d) gasification plants will be operating by 1980. Present estimates point to trillion cf/year of synthetic natural gas from coal by 1985 and 3 trillion cf/ye 1990.

Risks and uncertainties have been minimized by a comprehensive pilot plant to establish and solve technical problems before the demonstration plant stage. ing research will be carried out concurrent with the pilot program to aid in the of technical problems and to further improve the processes.

Non-technical uncertainties consist of: prices of foreign petroleum, Feder and local strip-mine regulations, source of large amounts of capital needed for cation plants and Federal Power Commission action on pricing of synthetic natura from coal.

CH /	ND	DEVEL	OPMENT.	FACT	SHEET	(Continued)
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State the specific energy problem or objective, and specify how the proposal will contribute to the solution of the problem is objective. Include reasons for selecting the recommended approach over other alternatives. Also include the benefits well from receiting the objectives or solving the problems for which the project is proposal. Outline the reasonneertainties namize R/U, and boars for proceeding in face of R/U. Quantitative data should be used to the fullest extent.

domestic supplies of natural gas cannot meet demand and both pipeline natural and liquid natural gas, LNG, (Algeria) are being imported. Imports are pre-e-sharply over the next 10-15 years as a result of a continuing increase in or natural gas, but imports will fall far short of the demand. Furthermore, imports are undesirable both from a political/military standpoint and because bution of the unfavorable balance of trade.

the U.S. domestic supplies of petroleum and natural gas cannot meet the reserves of coal are immense with a projected lifetime of 400-600 years at imption rates. The proposed plan is designed to help alleviate the critical natural gas by developing a commercial process for the production of pipelie, high btu gas from coal at reasonable cost.

nosed plan involves the acceleration of the present OCR-AGA program and the most Mines program for the production of high-Btm gas from coal as well as grams for development of new gasification processes. In addition, the plan rogram of supporting research and development (submitted and outlined in a program proposal) for equipment/materials research and development and for of gasification chemistry.

in includes the operation of the Hygas process pilot plant and the CO2tess pilot plant, completion of the construction and operation of pilot te Synthane process, for the Bi-Gas process and for a stirred-fixed bed the construction and operation of two 50-150 million of/day demonstration ddition other research will be supported. This includes but is not limited tion and operation of a pilot plant to test the Bureau of Mines Hydrane lopment of a) Batelle Memorial Institute's Self-Agglomerating Ash process, tms Liquid Phase Methanation process, and c) Bituminous Coal Research's t and Methanation Process.

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d uncertainties have been minimized by a comprehensive pilot plant program and solve technical problems before the demonstration plant stage. Support-will be carried out concurrent with the pilot program to aid in the solution problems and to further improve the processes.

nical uncertainties consist of: prices of foreign petroleum, Federal, State, ip-mine regulations, source of large amounts of capital needed for gasifiand Federal Power Commission action on pricing of synthetic natural gas

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ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

AEDULE (Include major Accilities and major equipment, Indicate dates by Fiscal Year and Quarter).

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ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

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

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		1974 -64d)	FY	1975	FY	1976	FY
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^{*} Includes \$200 million for demonstration plant.

^{**} It is assumed that industry will build and operate the commercial plant.

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ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

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

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EMERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

E. DETAIL OF FUNDING REQUIREMENTS-Federal Government Only (in millions of dollars)

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ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

- . DETAIL OF FUNDING REQUIREMENTS-Federal Government Only (in millions of dollars)
 - E. EQUIPMENT

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b. SUMPHOGRAM	Pipelica Quali	ty Cas From Co	val	
3. a. PROPONENT AGENCY	Dennetment of	the Interior		
6. SUBURIT	Office of Coal	Research - Bu	reau of Mines	5
4. CONTHACTOR AND SITE	NAME OF CONTRACTO	R: Office of Co	al Research-l	Institute of Gas Tecl
(No more than 42 characters and spaces for name of contractor:	Strict repork will be performed	▶ Stardlinois	County: Chicago)
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5. BRIEF DESCRIPTION OF PROPOSAL

fNo 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 research area concerns the production of pipeline qu gas from coal. The objectives are to: a) develop the techno necessary for the establishement of a commercial coal to pipe quality gas industry with due regard to environmental conside b) accelerate demonstration at a commercial scale by construct and operating one or more coal to pipeline gas plants.

County:

The work involves the present Office of Coal Research -American Gas Association program and the Eureau of Mines prog to produce pipeline quality gas from coal. The program invol the continued operation of two pilot plants, 1-2 million cf/c (the Hygas process and the CO₂-Acceptor process) and the cont construction and operation of pilot plants for the Synthame : and the Bi-Gas process. A stirred fixed-bed pilot plant wil. be constructed and operated. The pilot plant program will be followed by the construction of a demonstration plant (50-150 million of/day) to test the best process or combination of processes. After the demonstration program, it is anticipat: that sufficient design information will be available for des: and construction of commercial (250 million cf/day) plants.

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

		7. 814	MOR RESOURCE REC	CUIREMENTS	<i>F</i>
RESOURCE	FISCAL YEAR	1975	1976	1977	1978
a. MANPOWER	(1) Scientific	60	400	40	25
(in man years)	(2) Technical	180	1300	120	75
	(3) Support				
	(4) Other	30	300	30	20
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1. IDENTIFICATION NUMBER

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6. JUSTIFICATION State the specific energy problem or objective, and specify how the proposal will contribute to the solution of the or attachment of the of a true. Include tensor, for solving the recommended approach over other alternatives. Also include the beexpected to be derived from meeting the objectives or solving the problems for which the project is proposed. Outline the risks/und (B/U), plans to mandate B/U, and true for proceeding in face of B/U. Openitative data should be used to the fullest extent.

Current domestic supplies of natural gas cannot meet demand and both piggs (Canada) and liquid natural gas, LNG, (Alberia) are being imported. Imported to rise sharply over the next 10-15 years as a result of a continuing the demand for natural gas, but imports will fall far short of the demand. I large scale imports are undesirable both from a political/military standpoint of the contribution to the balance of trade edficit.

Although the U.S. demestic supplies of petroleum and natural gas cannot supply, U.S. reserves of coal are immense with a projected lifetime of 400-60 present consumption rates. The proposed plan is designed to help alleviate t shortages of natural gas by developing a commercial process for the production quality gas at reasonable cost.

This proposed minimum plan consists of the present Office of Coal Resear Gas Association gasification program and the present Eureau of Mines gasifical Specifically, this involves the continued operation of two pilot plants (Hyge Acceptor process) and the construction and operation of an additional two (Sy Bi-Gas). One demonstration plant will be built and the present schedule call tion of a 250 million of/day commercial plant by 1981. This plan also include and development on a stirred fixed-bed reactor.

Parts of the accelerated/orderly program which will not be supported wit minimum program are: new gasification processes, the Hydrane pilot plant, the Agglomerating process pilot plant, combined shift and methanation and a secon stration plant. The minimum program will lag the accelerated/program by about

This program provides a flexible pilot program which will allow a choice process or a combination of processes for use in a commercial-scale demonstra. The ultimate benefits to be derived consist of a commercial pipeline gas from industry which will help alleviate the critical shortages of natural gas projected future. The present program is expected to result in 1.2 trillion of/year thetic natural gas from coal by 1985 and 3 trillion of/year by 1990.

The simultaneous operation of four pilot plants will aid in minimizing trisks and uncertainties. However, the lack of research on new processes and of a second demonstration plant will increase technical risks as compared wit accelerated/orderly program. Non-technical uncertainties will still exist. include: prices of foreign petroleum, Federal State and local strip-mine reg source of large amounts of capital needed for gasification plants and Federal Commission action on pricing of synthetic natural gas from coal.

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#### ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

 ${\tt SCMEDULE} \ \textit{Include major facilities and major equipment. Indicate dates by Fiscal Year and Quarter).}$ 

s. DEVELOPMENT MILESTONES (number each consecutively)	<u> </u>	b. D	ATES
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	<ul> <li>MINIMUM</li> <li>DEVELOPMENT MILESTONES (continued)</li> </ul>	05-03-20	li li	D-788
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#### ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

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

		1) 1974 Add)		2) 1975	1	3) . 1976	(4 FY	ı) 1977 -
Pequirement	Cbis.	Outleys	Obls.	Outlays	Obis.	Outlays	Obls.	Outlays
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								
e. GRAND TOTAL-OUTLAYS		27.3		29.0		219.5*		7.0

^{*} Include \$200 for demonstration plant

NOTE: If cooperative pregrams are proposed, indicate the amount by year of both private and Federal government funding. A brief description of the cooperative programmes for description of the chosen format.

Assumes that industry will construct and operate commercial plant

Level of Effort: ☐ MAXIMUM IDENTIFICATION NUMBER ORDFRLY **⊠** MINIMUM [4] (5) (7) (6) (8) (2) * Test Excuding | PY 1974 (Co., 7.6.0.) Subtotat Calance To FY 1978 FY 1977 FY 1979 FY 1975-79 Complete Ob's. | Gutlays Outlays Obls. Outlays Obls. | Outlays Obis. Cuttay: Obls. ; Outlays : 262.5 3.0** 7.0 4.0

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### ENERGY RESEARCH AND DEVELOPMENT FACT SHEET (Continued)

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

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#### ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

9. DETAIL OF FUNDING REQUIREMENTS - Federal Government Color for millions of dollars.

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#### ENERGY RESEARCH & DEVELOPMENT FACT SHEET (Continued)

TAIL OF FUNDING REQUIREMENTS-Federal Government Only (in millions of dollars).

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# FACT SHEET

Leader Dress

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# 5. BRISE DISCRIPTION OF PROPOSAL

(No more than 24 lines of text and no more than 10 characters and spaces per time)

Briefly dutline nature and score of work to be undertained, including any new facilities which may have to be acquired or constructed.

Four (4) 100,000 BPD Plants are proposed employing (1) Dire hydrogenation, (2) Carbonization with hydrogenation and util of all char, (3) Ditraction/hydrogenation, (4) Gasification Fischer Trosch or related synthesis. These processes may various combinations.

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

	7. MAJOR RESOURCE REQUIREMENTS					
RESOURCE V	FISCAL YEAR!>	1975	1976	1977	1978	
a. MANPONER (in man pects)	(1) Salabilite	300	300	300	200	
	(2) Technica	300	300	300	300	
	(3) Support	600	600	500	600	
	(4) Cother Compa		20ú	1000	2000	
b. RAW MATERIALS (List materials and units of massive below, such as ions of coal, barrels of oil, Knowans of merdium, etc. Show amount of each in columns at right.)		minor	minor	ccal 1.0x10 ⁶ tcns/yr.	coal 10.0x10 ⁶ tpy water 20,000 acre fit	
c. LAND AREA REQUIRED (in cores)	(I) Govicianed		<del>i</del>			
	(2) God-lessed	<u>256</u> 0	256C	<del></del>		
	(3) Francisco sound)		Ī	Same as 1977-1976		
	(4) Gitter			No additional area required		
d. OTHER RESC	URCES NEEDED					

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Same as 1975-1976 No additional area required

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