

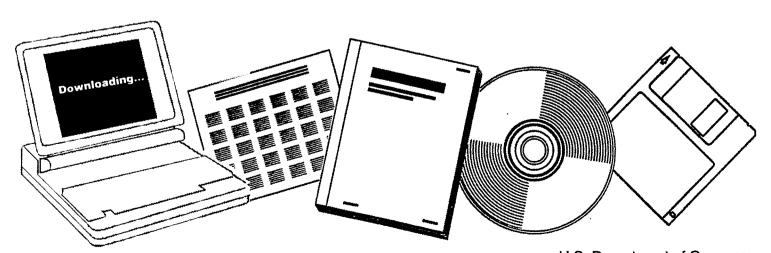
FE248013



SCALE-UP REQUIREMENTS OF THE EXXON CATALYTIC COAL GASIFICATION PROCESS.
MONTHLY REPORT, NOVEMBER 1--NOVEMBER 30, 1977

EXXON RESEARCH AND ENGINEERING CO., FLORHAM PARK, N.J

MAY 1978



U.S. Department of Commerce **National Technical Information Service**

One Source. One Search. One Solution.





Providing Permanent, Easy Access to U.S. Government Information

National Technical Information Service is the nation's largest repository and disseminator of government-initiated scientific, technical, engineering, and related business information. The NTIS collection includes almost 3,000,000 information products in a variety of formats: electronic download, online access, CD-ROM, magnetic tape, diskette, multimedia, microfiche and paper.





Search the NTIS Database from 1990 forward

NTIS has upgraded its bibliographic database system and has made all entries since 1990 searchable on **www.ntis.gov.** You now have access to information on more than 600,000 government research information products from this web site.

Link to Full Text Documents at Government Web Sites

Because many Government agencies have their most recent reports available on their own web site, we have added links directly to these reports. When available, you will see a link on the right side of the bibliographic screen.

Download Publications (1997 - Present)

NTIS can now provides the full text of reports as downloadable PDF files. This means that when an agency stops maintaining a report on the web, NTIS will offer a downloadable version. There is a nominal fee for each download for most publications.

For more information visit our website:

www.ntis.gov



FE-2480-13 Dist. Category UC-90

SCALE-UP REQUIREMENTS OF THE EXXON CATALYTIC COAL GASIFICATION PROCESS

Monthly Report for the Period

November 1 - November 30, 1977

S. J. Cohen - Project Manager

Exxon Research and Engineering Company P. O. Box 101 Florham Park, New Jersey 07932

May, 1978

PREPARED FOR THE UNITED STATES DEPARTMENT OF ENERGY

Under Contract No. EX-76-C-01-2480

-NOTICE-

NOTICE

This report was prepared as an account of work appearanced by the United States Government. Neither the United States Incernment of Emergy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or admines any legal liability or responsibility for the accumery, completeness or usefulness of any information, appearants, product or process disclosed, or represents that its use would not infinize privately owned distin. infrings privately owned rights.

REPRODUCED BY NATIONAL TECHNICAL INFORMATION SERVICE U. S. DEPARTMENT OF COMMERCE SPRINGFIELD, VA. 22161

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States DOE, nor any of their employees, nor any of their contractors, subcontractors, or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.

ABSTRACT

A study design and cost estimate have been completed for a major revamp of the Synthane Coal gasification pilot plant which would allow it to be operated as a catalytic coal gasification (CCG) large pilot plant. The study design was based upon modifying the Synthane Unit so that it would duplicate as closely as possible the size and capabilities of the grass roots large pilot plant (LPP) for CCG.

As in the grass roots case (described in previous monthly summaries) the revamped gasifier is 3.5' I.D. and can feed up to 92 T/D of Illinois No. 6 coal (as received). The size was set to permit scaleup to a pioneer commercial plant with acceptable risk (no demonstration plant). Also, as in the grass roots case, synthesis gas and catalyst are recycled to the gasifier to permit integrated operation of all key process steps.

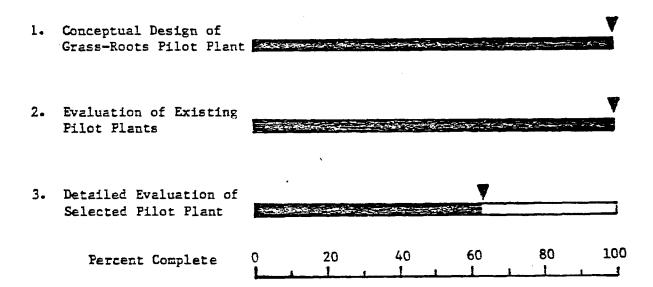
The investment required to modify the Synthane LPP for CCG operation is estimated to be 150 M\$. As reported in the September monthly summary the cost for constructing a grass roots LPP at a Gulf Coast location is 130 M\$. The higher cost to modify the Synthane Unit results primarily from the high labor costs for a revamp and the higher labor costs for the Pittsburgh area relative to the Gulf Coast. The cost of operating the revamped Synthane LPP is estimated to be 80 M\$. This is about 10% higher than for the grass roots case.

SUMMARY OF PROGRESS THROUGH NOVEMBER, 1977

FOR THE STUDY OF SCALE-UP REQUIREMENTS

OF THE EXXON CATALYTIC COAL GASIFICATION PROCESS

Technical Reporting Category



Legend

Shaded area = percentage of activity actually completed

V= percentage of activity scheduled for completion

DISCUSSION

- STUDY DESIGN FOR GRASS ROOTS LARGE PILOT PLANT (Reporting Category 1)

 No work scheduled in this category.
- SELECTION OF PREFERRED EXISTING LARGE PILOT PLANT (Reporting Category 2)

 No work scheduled in this category.

MODIFICATION OF THE SYNTHANE PILOT PLANT - (Reporting Category 3)

A study design and cost estimate have been completed for a major revamp of the Synthane Coal gasification pilot plant which would allow it to be operated as a Catalytic Coal Gasification (CCG) large pilot plant. The study design was based upon modifying the Synthane unit so that it would duplicate as closely as possible the size and capabilities of the grass roots large pilot plant (LPP) for CCG.

As in the grass roots case (described in previous monthly summaries) the revamped gasifier is 3.5' I.D. and can feed up to 92 T/D of Illinois No. 6 coal (as received). The size was set to permit scaleup to a pioneer commercial plant with acceptable risk (no demonstration plant). Also as in the grass roots case synthesis gas and catalyst are recycled to the gasifier to permit integrated operation of all key process steps. However, due to site related limitations, certain features of the grass roots case could not be included in the Synthane revamp. These include a spare coal preparation train and the ability to feed coal at the design rate of 92 T/D when operating with once—through synthesis gas.

The investment required to modify the Synthane Unit for CCG operation is estimated to be 150 MS. An investment breakdown is presented in Table 1. The cost for constructing a grass roots LPP at a Gulf Coast location is 130 M\$, as previously reported.

The investment for the Synthane revamp includes escalation to an April 1, 1983 startup. The escalation basis is presented in Table 2. The schedule for the revamp is presented in Figure 1. As in the grass roots case, this is based on obtaining LPP design data from a Process Development Unit (PDU) which begins operating in early 1979. The revamp schedule assumes prudent overlap with the PDU and any delay in PDU operations would delay the LPP schedule. The project execution time for the revamp is approximately four months longer than for a grass roots pilot plant. The incremental time reflects delays for removal and relocation of existing equipment. Construction time also has to be spread out because of the high manning levels and limitations on the number of field labor personnel that can be effectively utilized on the congested site.

The investment for the Synthane revamp is compared in Table 3 with the investment for the grass roots LPP on a Gulf Coast location. To further illustrate the difference between the two cases, the investment for the Gulf Coast grass roots facilities was adjusted to a Pittsburgh location basis. As shown in Table 3, on this basis the grass roots investment is 150 M\$. It should be emphasized that this estimating approach reflects only the difference in labor conditions. It does not reflect other differences such as climate, terrain and specific site factors, and therefore, is not a true estimate of the cost of building a grass-roots LPP in the Pittsburgh area.

The direct cost for the revamp is 41.5 M\$ on a 1077 basis. A breakdown of the direct cost components for each section of the plant is presented in Table 4. This compares to a direct cost of 47.0 M\$ for the grass roots LPP at a Gulf Coast location and to 48.5 MS for the grass roots facilities on a Pittsburgh estimating basis. Most of the savings are for materials and result from reuse of the coal feed and acid gas removal facilities, pipeways, and the control room. Smaller material savings were made in the areas of coal receipt, storage and preparation. Subcontracts which are principally for refactory lining of vessels and furnaces, installation of solids handling equipment, buildings, and site preparation were 8 M\$ in all three cases. Direct labor charges, on the other hand, were higher for the Synthane revamp: 15.3 M\$, versus 12.3 - 14.7 M\$ for the grass roots cases. This is due to increased labor manhours resulting from the need to relocate or remove equipment, and lower labor productivity at a revamp site. In addition both Pittsburgh location cases reflect a higher general labor cost than for the U.S. Gulf Coast. A section by section breakdown of the combined costs for direct material and labor and subcontracts is presented along with comparable information for the grassroots case in Table 5.

The savings in direct cost for the revamp is offset by increased indirect costs relative to the grass roots case. For example, the indirect costs for the revamp are 44.6 M\$ compared to 40.4 M\$ for the grass roots facilities on a Pittsburgh estimating basis and 35.5 M\$ for a Gulf Coast basis. The increased indirect costs for the revamp are a result of the inefficiencies associated with a revamp project and differences in the productivity and payroll burden between the Gulf Coast and the Pittsburgh area.

As shown in Table 3, the escalation for the revamp is 34.2 M\$ versus 32.9 M\$ for Pittsburgh grass roots estimate and 23.2 M\$ for the Gulf Coast grass roots case. The reason for the large difference between the Gulf Coast and Pittsburgh locations is a difference in labor escalation. The Gulf Coast grass roots case is based on the use of open-shop hiring, and under the terms of Davis-Bacon Act, a higher initial wage rate which is not subject to escalation after contract award. The revamp is based on a union shop with wage rate escalation over the course of the contract.

Estimated costs for 2 1/2 years of operation of the revamped Synthane unit are 80 M\$. A year-by-year breakdown of the operating cost components is presented in Table 6, and information on the estimating basis is presented in Table 7. Overall, the operating cost for the Synthane revamp is approximately 10% higher than for the Gulf Coast, grass-roots CCG pilot plant. Principle cost increases are for fuel (17.4 vs. 11.0 M\$) and maintenance (31.7 vs. 25.4 M\$). There is a saving of 5.6 M\$ in property taxes and land leasing costs for using the existing DOE property at Synthane.

The high cost for fuel at Synthane is the result of choosing LNG for feed to the synthesis gas generator (steam reformer). This choice was

made because pipeline natural gas was not available and the pipeline quality propane that is available, is not suitable without considerable treatment. Adding reating facilities would have increased investment and utilities requirements, and created equipment layout problems. The increased maintenance cost is attributable to the higher construction craft labor cost in the Pittsburgh area.

TABLE 1
INVESTMENT SUMMARY FOR
SYNTHANE REVAMP

Cost Breakdown	<u>k\$</u>
Material Labor Subcontracts	18,300 15,200 8,000
Total Direct Costs (1077)	41,500
Payroll Burdens Field Labor Overheads Vendor'Representatives Loss on Surplus Insurance Engineering Fees: Engineering, Construction & Royalty	7,200 20,600 300 200 200 11,700
Total Indirect Costs (1077) Total Prime Contract (1077)	44,600 86,100
Project Management Services Escalation	4,000 24,200
	124,300
Project Contingency (20%) Revamp Contingency	24,900 2,700
Total Erected Cost	151,900
CALL	150 M\$

k = Thousand
M = Million

TABLE 2

BASIS FOR COST ESCALATION ESTIMATE - SYNTHANE REVAMP

Escalation Rates	Annual Percentage					
Base Point-1077	Material	Labor	Engineering			
lst year	1	8	9			
2nd year	8	8	9			
3rd year	8	7	7			
4th year	5	7	7			
5th year	5	7	7			
6th year		7				
Centroid	July 1981	Aug. 1982	July 1981			
Time from Base Point (yrs.)	4.25	5.33	4.25			
Cumulative escalation effect, perce	nt 25	47	39			

TABLE 3

TOTAL ERECTED COST COMPARISON
SYNTHANE REVAMP VERSUS GRASS ROOTS

Project Type	Revamp	Grass Roots			
Location	Bruceton, PA	Gulf Const	Pittsburgh		
Direct Costs, M\$					
Material	18.3	27.0	26.0 (1)		
Labor	15.2	12.3	14.7		
Subcontracts	8.0	7.7	7.8		
Direct Cost Total (1977)	41.5	47.0	48.5		
Indirects	44.6	35.5	40.4		
Project Management	4.0	3.8	4.1		
Escalation	34.2	23.2	32.9		
Total Cost Excluding Contingency	124.3	109.5	125.9		
Project Contingency	24.9	21.9	25.2		
Revamp Contingency	2.7	hand December of the Control of the	-		
Total Erected Cost	151.9	131.4	151.1		
CALL	150	130	150		

Note:

(1) Lower material cost shown is to reflect sales tax differences between Pennsylvania and Texas.

TABLE 4

DIRECT COST SUMMARY - SYNTHANE REVAMP

	107 Material kS	7 Bruceton, Labor kMH	Pa Subcontract k\$
Onsites			
• Catalyst Recovery	1,830	130	
 Gasification 	2,700	180	500
• Product Gas Cleanup	920	60	
• Acid Gas Removal	270	20	
• Methane Recovery	3,150	105	
• Steam Reforming	690	50	940
• Preheat Furnace	250	20	890
• Common Facilities	430	60	390
• Onsite Dismantling		65	
Total Onsites	10,240	690	2,720
Offsites			
• Cual Receipt & Preparation	770	60.	50
• Waste Treating	1,260	140	110
e Electrical	340	20	190
• Safety	430	35	
• Site Preparation	140	55	1,310
• Layout	180	40	50
Buildings	10	5	1,410
• Fotable, Industrial, & Firewater	280	30	160
• LNG, LPG, & Fuel Oil	510	40	20
 Cooling Water 	360	35	80
• CO ₂ & Inert Gas	370	65	
Boilers & Steam Distribution	2,420	170	1,790
• Compressed Air	520	50	
• Chemical Handling	190	15	60
 Catalyst Handling 	280	_20	50
Total Offsites	8,060	780	5,280
Total Onsites & Offsites	18,300	1,470	8,000

TABLE 5

DIRECT COST BREAKDOWN GRASS ROOTS VERSUS SYNTHANE REVAMP

1077 Costs, k\$ (3)

<u>Facilities</u>	Grass-Roots (Gulf Coast)	Synthane Revamo	Comments on Revamp
Onsites			
Coal Feed	1,595	***	Existing can be used at Synthane
Gasification	4,870	5,690	2 times labor for major revamp
Sterm Reformer	2,415	2,320	Synthane units must handle
Preheat Furnace	1,270	1,415	<pre>f dual fuels</pre>
Product Gas Cleanup	1,465	1,750	2 times labor for major revamp
Acid Gas Removal	2,655	545	New absorber
Methane Recovery	4,015	4, 6 00	Duplicate of Grass Roots
Catalyst Recovery	2,650	3,625	Duplicate of Grass Roots
Common Facilities	2,215	1,650	Substantially less material
Unused Equipment Dismantlin	g	900	Primarily methanation
Total Onsites	23,150	22,495	
Offsites		·	
Cozi Receipt & Storage	3,185		Existing at Synthane
Coal Preparation	4,850	1,650	Only one train
Catalyst Handling	520	605	Duplicate of Grass Roots
Utilities (1)		• •	•
Interconnecting Lines (1)	3,580		
Steam & BFW (1)	825	6,560	Relocation & major expansion
CO2 and Inert Gas (2)	10	1,270	Relocation
Compressed Air	1,010	1,210	Relocation & expansion
Fuel Systems (2)	250	1,085	Pipeline NG not available
Gooling Water	735	925	Relocation & major expansion
Fire Protection '	490	855	Includes all water systems
Chemicals Handling	320	- 455	Relocation & expansion
Electrical	1,450	805	Expansion & upgrading
Waste Water Treating	3,320	3,305	Smaller - some existing reased
Safety	510	915	Expansion
Buildings	1,610	1,490	Relocation
Leyout	2,085	780	Expansion/compact
Site Preparation	1,080	2,210	Hilly terrain at Bruceton
Total Offsites	25,830	24,120	
Total Direct Costs	48.980	46,615	

Notes:

- Steam, nitrogen and fuel gas are supplied to the pilot plant and fuel gas product and acid gas streams are returned to the refinery.
- For the grass roots case, costs listed are for distribution lines within **(2)** the pilot plant boundaries.
- Direct costs in this table include payroll burden on direct labor (2.0 M\$ for grass-roots case and 5.1 MS for Synthane case). Thus, the total direct cost for Synthene presented here is 5.1 MS higher than the direct cost present in Table 1, where payroll burden for direct labor and field supervision is shown as a separate item.

TABLE 6

OPERATING COST SUMMARY - SYNTHANE REVAMP

•	2nd Half			lst Helf			
	1980	1981	1982		1984	1985	
			k	\$			en 1
							Total
• Raw Materials						4.50	
- Coal (Illinois)	-	-	-	168	441	419	
- <u>Catalyst (K₂CO₃ Sol'n)</u> Total Raw Materials		-		<u>251</u> 419	<u>293</u> 734	593	1736
Intel Weak Weferters	U	U	U	417	134	202	1730
• Transportation							
- Coal	-	-	-	296	775	736	
- Catalyst			- 0	<u>22</u> 318	26 801	<u>15</u> 751	
Total Transportation	0	0	0	318	801	751	1870
• Salaries, Wages, Benefits, and Support Services							
balailes, wages, benefits, and Support Services	250	700	3500	7859	8219	4354	
Total S,W,B, and SS	259	709	3500 3500	7859	8219	4354	24,900
1744 2,11,2, 444 20		, 0,	2200	7055	0227	-35-	= / , , ,
• Administrative							
- Miscellaneous	$\frac{10}{10}$	80	155 155	<u> 185</u>	<u> 195</u>	98_	
Total Administrative	10	80	155	185	195	98	723
• Technical					•		
- Miscellaneous		-	25	200	200	100	
Total Technical	0	0	<u>25</u> 25	<u>200</u> 200	<u>200</u> 200	100	525
• Process Operations							
- Catalyst & Chemicals	-	-	-	186	312		
- Utilities		-	-	5449	7441		
- Process Services	-	-	10	34	35	35	
- Miscellaneous Total Process Operations	<u>-</u>		<u>20</u> 30	20 5689	20 7808	20 4798	18,325
Total Flocess operacions	0	U	30	7003	7808	4/30	10,323
• Mechanical							
- Labor	-	-	-	5639	5400	2374	
- Material	-	-	1000	6864	6572	2885	
- Miscellaneous	<u> </u>		200	300	300		
Total Mechanical		0	1200	12803	12272	5389	31664
GRAND TOTAL	269	789	4910	27473	30229	16073	79743

TABLE 7

OPERATING COST ESTIMATING BASIS - SYNTHAME REVAMP

Raw Materials

Coal

- Illinois No. 6 Bituminous
- 1980 price \$22.50/ST
- 15% contingency on annual requirements
- escalated at 6.6% per year

• Catalyst

- 47 wt% K2CO3 solution
- 1976 price \$152/ST
- 15% contingency on annual requirements
- escalated at 6.6% per year

Transportation

• Coal

- spot-shipment by rail from St. Louis to local supplier in Pittsburgh area
- truck shipment from local supplier to plant site
- 1977 rail shipping cost of \$22.40/ST
- 1977 truck shipping cost of \$10.25/ST
- escalated at 6.6% per year

e Catalyst

- truck shipment from Niagara Falls to Pittsburgh
- 1976 truck shipping cost of \$13.60/ST
- escalated at 6.6% per year

Salaries, Wages, Benefits, and Support Services

- Salaries, Wages, and Benefits
 - staff composed of 29 professionals and 70 technicians/operators during the $2\frac{1}{2}$ -year operating period
 - increasing portion of staff deployed onsite during the 2½-year engineering and construction period
 - salaries, wages, and benefits based on projected rates through 1982 and escalated at 6.6% per year through 1985

- Process and Technical Consultation
 - staff composed of 6 professionals during the 21/2-year operating
 - costs based on projected engineering billing rates
- Relocation Costs
 - relocate 13 professionals to and from Pittsburgh

Administrative

- Miscellaneous
 - office supplies
 - telephone service
 - plant security
 - travel

Technical

- Miscellaneous
 - laboratory technician salaries
 - supplies and services

Process Operations

- Catalysts and Chemicals
 - current costs obtained from Chemical Marketing Reporter
 - 15% contingency on annual requirements
 - escalation at 6.6% per year
- Utilities
 - electric power purchased from West Penn at prevailing rates potable water - industrial water - LNG

purchased from local supplier at prevailing rates

- LPG
- No. 2 fuel oil
- liquid CO2
- 15% contingency on annual requirements
- escalation at 6.6% per year
- Process Services
 - char disposal
 - fire fighting service

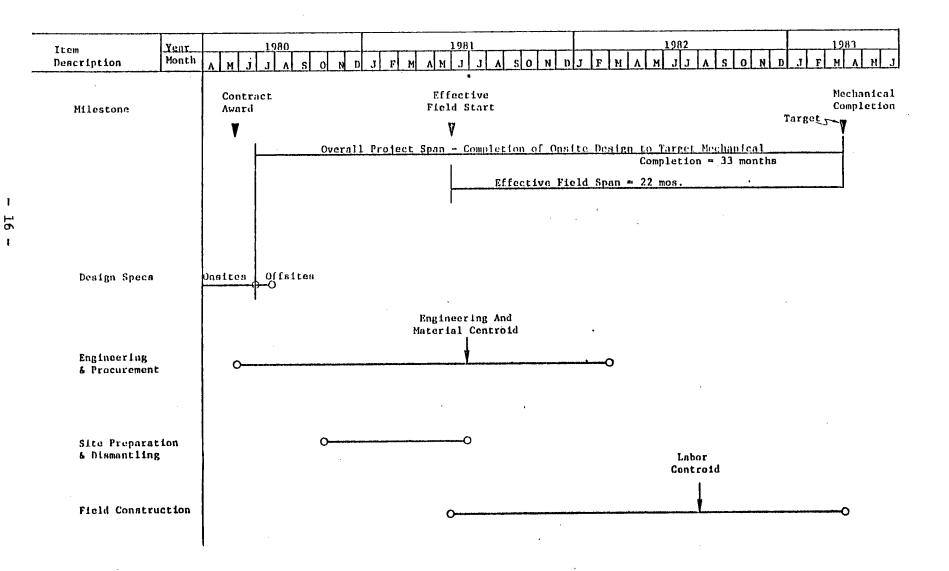
Miscellaneous

- radio system maintenance
- safety equipment
- tools
- supplies

Mechanical

- Contract Labor and Supervision
 - direct mechanical labor based on an average of 175 men during plant operating period
 - one supervisor required for every ten direct labor men
 - wage rates based on current data from Synthane
 - escalation at 6.6% per year
- Maintenance Material
 - based on 150% of direct labor costs
- Miscellaneous
 - equipment rentals
 - supplies

FIGURE 1
ENGINEERING AND CONSTRUCTION SCHEDULE - SYNTHANE REVAMP



SATISFACTION GUARANTEED

Please contact us for a replacement within 30 days if the item you receive NTIS strives to provide quality products, reliable service, and fast delivery (703)605-6050 Phone: 1-888-584-8332 s defective or if we have made an error in E-mail: info@ntis.gov

Reproduced by NTiS

National Technical Information Service Springfield, VA 22161

This report was printed specifically for your order from nearly 3 million titles available in our collection.

For economy and efficiency, NTIS does not maintain stock of its vast collection of technical reports. Rather, most documents are custom reproduced for each order. Documents that are not in electronic format are reproduced from master archival copies and are the best possible reproductions available.

Occasionally, older master materials may reproduce portions of documents that are not fully legible. If you have questions concerning this document or any order you have placed with NTIS, please call our Customer Service Department at (703) 605-6050.

About NTIS

NTIS collects scientific, technical, engineering, and related business information – then organizes, maintains, and disseminates that information in a variety of formats – including electronic download, online access, CD-ROM, magnetic tape, diskette, multimedia, microfiche and paper.

The NTIS collection of nearly 3 million titles includes reports describing research conducted or sponsored by federal agencies and their contractors; statistical and business information; U.S. military publications; multimedia training products; computer software and electronic databases developed by federal agencies; and technical reports prepared by research organizations worldwide.

For more information about NTIS, visit our Web site at http://www.ntis.gov.



Ensuring Permanent, Easy Access to U.S. Government Information Assets



U.S. DEPARTMENT OF COMMERCE Technology Administration National Technical Information Service Springfield, VA 22161 (703) 605-6000