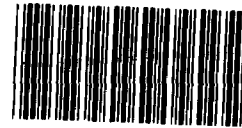


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UNITED STATES GENERAL ACCOUNTING OFFICE  
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STATEMENT OF  
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ENERGY AND MINERALS DIVISION  
BEFORE THE  
CALIFORNIA ENERGY COMMISSION  
ON  
[COAL LIQUEFACTION]



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Mr. Commissioner and Members of the Commission:

We welcome the opportunity to contribute to your hearings on synthetic fuels by presenting our views on coal liquefaction. These views are based on our August 12, 1980, report to the Congress, "Liquefying Coal for Future Energy Needs."

As you know, on June 30, 1980, the President signed into law the Energy Security Act, which establishes a Synthetic Fuels Corporation. The Corporation is authorized to provide financial incentives for the development of 500,000 barrels a day by 1987 and 2 million barrels a day by 1992 of substitutes for imported oil from domestic sources. One substitute which will be expected to contribute to these goals is coal liquefaction.

Coal liquefaction is the conversion of coal to a clean-burning, low-sulfur-content fuel. This technology can augment petroleum-derived products such as gasoline and boiler fuels and consequently help meet a requirement for large supplies of liquid fuel.

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This morning I would like to (1) discuss the status of the two basic types of coal liquefaction, (2) briefly review the Department of Energy's (DOE's) efforts in developing these processes, and (3) present our observations on their potential contribution to the Nation's goals for alternative domestic fuels to replace imported oil.

#### PERSPECTIVE

There are two basic types of coal liquefaction--direct and indirect. Direct liquefaction produces liquids through the interaction of coal and hydrogen at high temperature and pressure. Indirect liquefaction involves the gasification of coal to a synthesis gas and then production of a liquid from that gas by introducing a catalyst.

Direct liquefaction processes are currently in the research, development, and demonstration (RD&D) stage and are expected to yield a high percentage of boiler fuels which can be used by industry and utilities. In contrast, indirect processes are commercially available and generally produce a high percentage of light products such as gasoline.

Although indirect processes are commercially available, no commercial liquefaction plants are operating or under construction in the United States today. South Africa is the only nation with a commercial coal liquefaction plant in operation. This plant uses an indirect liquefaction process and is subsidized by the South African government.

FOUR DIRECT LIQUEFACTION  
PROCESSES UNDER DEVELOPMENT

With that background, I would now like to discuss the four direct liquefaction processes which are currently in the RD&D stage. [The Department of Energy and private industry are developing four direct liquefaction processes]-- two variations of Solvent Refined Coal (SRC), H-Coal, and Exxon Donor Solvent. Two small Solvent Refined Coal pilot plants are operating and conceptual design of two demonstration plants has been completed. Also, H-Coal and Exxon Donor Solvent pilot plants have recently begun operating.

[The direct processes have only operated on a small scale to date.] DOE and industry officials involved told us that [there are many major issues to be resolved, but they foresee no insurmountable technical or environmental constraints to a commercial industry, assuming successful operation of the plants.] Some of the major issues include:

- o Scale-up--[Larger test facilities are needed to adequately address the operability and reliability of a commercial-scale plant.] For example, a sponsor of the SRC-I process told us that reactor vessels for SRC-I must be scaled up from 2 feet in diameter in the current test facilities to 17 feet in the demonstration plant. An official of the Electric Power Research Institute stated that because

chemical changes could occur when a process is scaled up, larger-scale facilities must be operated to demonstrate a sustained rate of operation at the larger scale.

- o Liquid/solid separation--Reliability on a commercial scale of equipment which removes undissolved coal from the liquid products is a major concern. SRC-I and H-Coal have had little success with a filtration process. As a consequence, testing and large-scale operation in the pilot and demonstration plants of new processes developed by Kerr-McGee and U.S. Filter Company are planned.
- o Product upgrading--Direct liquefaction products are still hydrogen deficient and must be upgraded before they can replace petroleum-derived products ranging from boiler fuels to gasoline. However, the tests that have been performed to date have shown some promise. For example, a December 1979 study by Mobil Research and Development Corporation stated that both SRC-I and SRC-II can be upgraded to higher-grade boiler fuels by means of standard refining techniques.
- o Worker protection and public health--Some products of direct liquefaction are known or suspected to be carcinogenic and mutagenic and contain toxic elements. As a result, DOE stated in its coal

liquefaction Environmental Development Plan that coal liquefaction may pose some potential hazards to worker health and the environment. The plan added that although the potential hazards are still being researched and catalogued, it appears that the risks will be similar to those in the production, transportation, and end-use of other commercial material.

- o Siting--Factors to be considered include air quality, water availability and quality, community development, fish and wildlife, vegetation disruption, optimization of use of Federal lands, global carbon dioxide concentrations, waste disposal requirements, and product safety impacts. A June 1980 DOE report addressed these factors and concluded that, assuming application of the most effective environmental control technologies and management practices, development of synthetic liquids facilities on an accelerated basis appears feasible. This would require careful environmental planning, but no major exclusionary constraint is expected. However, DOE emphasized that its report did not determine specific sites for locating technologies.
- o Management of solid waste--Limited data exist concerning the nature of solid wastes from coal

liquefaction facilities.] Thus, DOE and the Environmental Protection Agency are continuing to identify those waste materials that can be classified as carcinogenic, mutagenic, and toxic. The Environmental Protection Agency intends to promulgate regulations covering those materials. A primary concern to industry is that regulations for handling process wastes are not yet in place. Industry officials told us that they are anxious for the regulations to be finalized since the cost associated with meeting the regulations could have a substantial impact on the economics of the technology.)

Department and industry participants agree that further RD&D addressing these issues is needed for the direct liquefaction processes. As a result, it is unlikely that any commercial direct liquefaction plants will be operating in the 1980s.

### THREE INDIRECT LIQUEFACTION PROCESSES COMMERCIALY AVAILABLE

Turning now to the indirect processes, we found three processes commercially available--Fischer-Tropsch, methanol from coal, and Mobil Oil Corporation's M-Gas process.

Although these processes are available, DOE believes that further research, development, and demonstration can substantially improve them and that its commercialization

efforts will provide incentives for industry to use them.

The Department's RD&D work on indirect liquefaction focuses on the two major parts of the technology--production of synthesis gas and production of liquids from that gas. For example, the indirect processes currently operate only with western noncaking coals and DOE's gasification RD&D program is attempting to develop and demonstrate new gasifiers which can process eastern coals. The liquids production work will include the development of improved catalysts for two indirect processes and a variation of the M-Gas process in which the production of methanol is bypassed, so that gasoline is produced directly from coal.

#### Health and Environmental issues

Since no indirect liquefaction plants currently operate in the United States, there is uncertainty about their health and environmental impacts. DOE and industry officials promoting indirect liquefaction believe that the potential problems of direct liquefaction, such as disposal of hazardous wastes and carcinogenic and toxic material, may also apply to indirect processes. A DOE official stated that the Department is just beginning to define the environmental parameters of the indirect processes as well as the cost of environmental control technology.

Indirect liquefaction has an environmental advantage over direct liquefaction. During the gasification step

of indirect liquefaction, the synthesis gas produced is cleaned, thereby removing sulfur and nitrogen. Since direct liquefaction does not include a gasification step, these elements cannot be removed as effectively.

#### COMMERCIALIZATION EFFORTS

Department officials stated that even though the indirect processes are technically proven, the Department had done little to promote their commercialization because, in their opinion, (1) they are less efficient than the direct processes under development, (2) they are more costly than the direct processes, and (3) the commercially available gasifiers needed for the indirect processes can only operate on certain coals.

The estimated thermal efficiency of indirect liquefaction is 45 to 60 percent; for the direct processes it is 65 to 70 percent. DOE's estimate that the indirect processes will be more costly is based partly on lower efficiency estimates and also on the fact that a more complex plant is required to first gasify the coal and then liquefy it.

The degree of cost differential varies with each new report or study. For example, industry and congressional consultant reports issued from June through October 1979, using either 1978 or 1979 dollars, estimated the cost of direct liquefaction products ranging from \$20 to \$51 per barrel and the cost of indirect liquefaction products from \$30 to \$56 per barrel. These variations reflect



the cost uncertainties that will exist until commercial-size plants are operating.

Finally, as I mentioned earlier, the indirect liquefaction processes currently available do not use caking coals from the eastern United States. DOE is currently funding the design of two demonstration plants and plans to build, under a cooperative agreement with Texas Eastern, a commercial plant in the eastern United States.

Private industry is apparently willing to accept the shortcomings of the indirect processes and, if given financial assistance, is ready to build commercial-size plants. It wants financial incentives because these plants would be first-of-a-kind in the United States and therefore a high risk undertaking.

With the increasing need to develop alternate forms of energy from domestic sources, the United States is faced with a choice between building potentially less efficient, more costly indirect plants now or waiting for the direct processes to be developed. Indirect plants built now could contribute to supply while the direct processes are still under development. Also, information gained from designing, building, and operating commercial-size indirect liquefaction facilities would reduce the uncertainties involved with building future synthetic fuels plants. There is a danger, however, of getting overcommitted to an early, less efficient technology. Consequently, flexibility must be

maintained to adapt to new technologies as they become available.

The Congress has thus far appropriated \$19 billion for use by the newly established Synthetic Fuels Corporation. In the interim, before the Corporation is fully operating, the Department of Energy may use \$5.5 billion of the \$19 billion to begin offering financial incentives.

It is too early to tell how these incentives will affect coal liquefaction. The three indirect liquefaction processes discussed in our report would appear to be likely candidates for the \$5.5 billion program. Of the 110 projects selected for feasibility study and cooperative agreement funding to date, 9 were indirect coal liquefaction plants. No direct liquefaction plant proposals were awarded.

#### OBSERVATIONS

In summary, we believe that since the direct liquefaction processes have only operated in small test facilities, successful operations in larger-scale plants are needed to reduce technical, health, and environmental uncertainty before commercialization is viable. The successful operation of the recently constructed pilot plants and the planned demonstration plants should address this uncertainty. However, it is unlikely that any commercial direct liquefaction plants will be operating in the 1980s.

We also believe that if any portion of the national goals of 500,000 barrels a day by 1987 and 2 million barrels

a day by 1992 of crude oil equivalent is to be met with coal liquefaction, the bulk of the production is likely to come from the indirect processes.

That concludes my statement. We would be pleased to respond to questions.