APPENDIX D

PANEL MEETING REPORTS

An important element of the methodology used in conducting this assessment of coal liquefaction research needs was holding two formal meetings of the entire expert panel. The initial two-day meeting at the beginning of the project was held to conduct a preliminary evaluation of R&D needs assessment. The second full panel meeting was held to finalize the recommendations of the study. The panel meetings, which were run by the principal investigator, were structured to give the experts the primary role in making R&D recommendations and guiding study efforts.

This appendix contains brief reports of the activities of the two panel meetings, which were held as follows:

First Panel Meeting:	Pittsburgh, PA January 5-6, 1988
Second Panel Meeting:	McLean, VA July 13-14, 1988

D.1 REPORT ON FIRST PANEL MEETING

D.1.1 Overview

The twelve-man expert panel selected for the Assessment of Coal Liquefaction Research Needs project held its first meeting, at the Hotel Sheraton South Hills in Pittsburgh, on January 5-6, 1988. This meeting was followed by a one-day site visit to the Pittsburgh Energy Technology Center (PETC), where DOE personnel reviewed in-house research on coal liquefaction.

The two-day meeting and the PETC site visit were attended by all twelve panel members. A number of people from DOE Headquarters, PETC, and METC attended the meeting as ex-officio members, and several SAIC staff participated in the meeting to assist the panel's discussion. A complete list of attendees is as follows:

Panel Members

Dr. Francis Burke
Dr. K. C. Chao
Dr. Burtron Davis
Dr. Martin Gorbaty
Dr. Kamil Klier
Dr. Carl W. Kruse
Dr. John Larsen
Dr. Robert Lumpkin
Dr. Michael E. McIlwain
Mr. Norman Stewart
Dr. Irving Wender

Ex-Officio Members

Dr. George Jordy, DOE
Dr. Gilbert S. Jackson, DOE
Dr. Paul C. Scott, DOE
Dr. Robert Hamilton, DOE
Dr. Lloyd Lorenzi, PETC
Dr. Malvina Farcasiu, PETC
Dr. Madhav Ghate, METC

SAIC

Dr. Edward Wan
Dr. Harvey Schindler
Dr. Malcolm Fraser
Dr. Isaac Kwarteng
Mr. William R. King

The meeting was broken down into four sessions. The first session was a general meeting of all attendees. After introductions and introductory remarks, presentations were made to review project objectives and the development status of the three main coal liquefaction

technology areas--direct liquefaction (H. Schindler), indirect liquefaction (K. Klier) and pyrolysis (C. Kruse).

Following the technology status reviews, the panel was divided into three subpanels--one for each technology area. Simultaneous sessions of the three subpanels were held to discuss research recommendations and to try to develop preliminary rankings of the ideas.

After presentations of research priorities by the subpanels to the full panel, plans for future information-gathering, suggested ranking criteria, and potential site visits were discussed.

The third day of the meeting was devoted to a site visit to PETC.

D.1.2 Meeting Accomplishments

A comprehensive meeting agenda was planned in advance in detail to try to accomplish certain objectives. Some of these objectives were met while others were completed via follow-up actions such as mailings and phone calls.

During the initial general discussion, the background, objectives, and expected product of the assessment were reviewed so that all panel members would have a common understanding of them. An emphasis was placed in several presentations on the need to set research priorities. The technology status and the potential new developments of the three liquefaction technology areas were reviewed.

Over one hundred research recommendations were generated and discussed by the subpanels. A preliminary ranking procedure was proposed and used for selecting 30 to 40 of the more important recommendations. A final ranking procedure was not agreed upon at the meeting because panel members had different opinions regarding evaluation criteria selection and a weighting procedure.

The information and the supporting rationale developed for these research recommendations were necessarily incomplete, to be expanded later to serve as the basis for the final ranking.

Sites for visits were discussed. The second panel meeting was scheduled for June 15-17 in McLean, Virginia.

D.1.3 Subpanel Meetings

After the initial general meeting of the panel members and other attendees, the meeting was divided into meetings of three subpanels organized by technology area: direct liquefaction, indirect liquefaction, and pyrolysis. Panel members and the others were assigned to one of the subpanels, although moving from one subpanel to another was encouraged, depending on the person's interests and the topics being discussed.

The subpanel meetings were devoted to several types of discussions:

- Problem areas
- Research recommendations
- Technology status
- Recommendation evaluation.

Much of the discussion in each subpanel was of a general and freewheeling nature with little specific information becoming available as conclusions.

The most important specific information generated within each subpanel meeting was an initial list of research recommendations--topic areas as well as specific projects. This initial list in each of the three technology areas was a preliminary list which was pruned, condensed, added to, and organized during the course of the project.

This initial list of research recommendations for each technology area was discussed and the ideas evaluated within each subpanel. Ranking methodologies discussed in the general meeting were then applied to a sample of the recommendations to illustrate the use of a ranking procedure to develop research priorities.

The results of the deliberations of each subpanel were then summarized and reviewed by the entire panel in another general meeting.

D.2 REPORT ON SECOND PANEL MEETING

D.2.1. Overview

The twelve-man expert panel for the assessment of Coal Liquefaction Research Needs held its second full meeting at facilities at the SAIC main building in McLean, Virginia on July 13-14, 1988. This two-day meeting was attended by all twelve panel members and Dr. Gilbert Jackson from DOE. SAIC staff (Dr. Edward Wan and Dr. Malcolm Fraser) also participated in the meeting to assist the panel's discussions.

As background to the prioritization effort, which was the main concern of the meeting, the initial discussion was concerned with a review of the background to the project, the project objectives, and the emphasis of the DOE coal liquefaction programs. Following these introductory discussions, the main work of the meeting was concerned with discussing, ranking, and prioritizing the research recommendations generated and collected during the site visits. Rankings and prioritization were finally determined by compiling lists of what the panel members thought were the most important research needs and projects in each technology area.

In direct liquefaction, out of a total of 19 general research categories, 13 were mentioned by panel members as being important enough to be ranked and prioritized. In addition, 42 specific recommendations for research projects were rated. In general, the panel emphasized the need for fundamental work to discover new approaches with more potential than existing processes.

Coprocessing was considered to be part of direct liquefaction, but recommendations specific to this technology area were considered separately by the panel. The result was that four recommendations were rated by the panel in this area.

The panel members did not rank specific recommendations in bioliquefaction but rather endorsed the list of recommendations in this area with an indication of the relative importance of the general research needs.

The future of pyrolysis was discussed by the panel. In particular, there is a need for novel approaches, to increase the amount of liquid produced and to decrease the amount of co-product char or to utilize all of the char within the process. The categories of recommended research (4) and the specific projects rated (8) all emphasized fundamental work and the relatively new process of catalytic hydropyrolysis rather than further development of other existing processes.

In indirect liquefaction the panel made some changes in the list of recommendations, combining some and adding new ones. A total of six general research needs were rated, as well as nine specific recommendations, in both areas of syngas to hydrocarbons and syngas to oxygenates.

With respect to direct conversion of methane, the sixth and last technology area discussed, the panel discussed whether this technology should properly be considered a part of coal liquefaction. The panel's conclusion was that the development of this technology will be driven by resources other than the availability of methane from coal. The information and the recommendations gathered by the panel will be included in the report, but the recommendations will not be ranked or prioritized.

After the technology areas were discussed and the research recommendations ranked and prioritized, the outline of the final report was discussed, and the list of possible contributors of the technology status sections was reviewed. The panel members then discussed the selection of a peer review committee. A number of possible reviewers were proposed by panel members.

The schedule for the preparation of the final report was reviewed. The schedules of the panel members were also reviewed for their availability for the remainder of the project.

D.2.2 Discussion of Individual Technology Areas

D.2.2.1 Direct Liquefaction

This technology has undergone significant process modifications in recent years, but the cost of the liquid product is still considerably higher than that for petroleum liquids. The 76 research recommendations that had been generated in this technology area spanned all steps of direct liquefaction from break-up of coal bonds to refining of coal liquids. The emphasis was on obtaining a greater understanding of liquefaction chemistry, from which new processes may be developed.

At the start of the discussion, the panel agreed that research on coal structure and reactivity cross-cut several technologies and should not be confined to direct liquefaction. A comment was made that alternative chemistries were not adequately represented in the recommendations that had been compiled. This may be a result of the DOE solicitation procedure (see discussion in Section D.2.3).

The panel members were asked to each select their three top categories. Ratings were based on a score of five for first choice, three for second, and one for third. Twelve of the nineteen categories were selected by at least one panel member; coal structure, preconversion chemistry, hydrogen production, and catalysis were the most highly rated categories or research needs.

The panel members then picked the top 10 research recommendations (out of a total of 76). Ratings were based on a score of 10 for the first choice, down to one for the tenth choice. Forty-two recommendations were selected by at least one panel member. Fundamental research needs ranked higher than applied needs and followed the scoring trend pattern of the categories--research in coal structure,

preconversion chemistry, and catalysis received strong support. The single highest score, however, was for operation of a large-scale pilot plant. As originally proposed at the first panel meeting, this recommendation referred to a scale of 50-100 tons per day, but as currently worded, it could also mean the Wilsonville PDU.

D.2.2.2 Coprocessing

This technology is an outgrowth of direct liquefaction which has received strong support from DOE. Originally, coprocessing was included in this assessment under direct liquefaction. This may have limited the number of recommendations that specifically addressed the co-conversion of coal and petroleum.

The panel members were asked to select their top three research categories/recommendations. All 13 categories/recommendations received support from at least one panel member. Not surprisingly, one category (1.1) was the first choice of nine members. This category is the study of the chemistry of coal/oil reactions. Other research areas of importance were the study of hydrogen-donor chemistry in coprocessing, process studies, and development of catalysts specifically for coprocessing.

A recommendation that was not scored highly was 2.5.1-Design, construct, and test a small-scale, continuous-flow unit. However, the discussion during the second day indicated that some panel members had second thoughts, because without such a unit, new process concepts cannot be scaled up, unless the leap is made from laboratory to Wilsonville PDU.

D.2.2.3 Bioliquefaction

The panel found that bioliquefaction is in such an embryonic stage of development that little background information and data are available upon which to base research recommendations. The panel members did not rank specific project recommendations in this area but rather endorsed the list of recommendations, with an indication of the relative importance of the general research needs. In general, the type of

research needed should be termed "scoping studies," as it is too early to determine what the specific needs are in either fundamental or applied research.

D.2.2.4 Pyrolysis

Pyrolysis is the oldest of the liquefaction technologies, but it has received little attention recently because of the low yields of liquid that have been demonstrated in past process developments.

The consensus of the panel was that pyrolysis will not be a viable commercial technology unless the liquid yield is increased substantially, and this increase in liquid yield can be achieved only with a new approach. Therefore, none of the recommendations that seek to make improvements on current processes was scored highly.

The panel members were each asked to select the three top categories; ranking was based on a score of five for first, three for second, and one for third. Eight of the 11 categories received support from at least one panel member, but category 1.4 (study the chemistry and the mechanism of catalytic hydropyrolysis) was selected first by six panel members. This scoring may not have been an endorsement of this particular pyrolysis procedure, as much as a rejection of most of the other categories.

In the scoring of recommendations in which each panel member selected his top six, category 1.4 was again the clear choice, receiving first- or second-place scoring from 11 panel members. The second highest score was for the study of coal functional groups and their relationship to pyrolysis reactivity.

D.2.2.5 Indirect Liquefaction

The DOE research program in indirect liquefaction starts with syngas as the feedstock. Thus, indirect liquefaction in the coal liquefaction program is not directly concerned with the properties of coal or the technology of producing synthesis gas, but only with the conversion of

the syngas itself. This constraint limited the scope of the research needs to be considered for indirect liquefaction, and the list of recommendations proposed by the panel reflects this limitation. The DOE program of surface coal gasification does include coal gasification research for the production of syngas. (The reader is referred to the 1987 COGARN report for research needs for the production of syngas.)

Indirect liquefaction does include two distinct areas within the broad area of syngas reactions: conversion of syngas to hydrocarbons and conversion of syngas to oxygenates, such as alcohols or ethers. The types of research recommendations proposed and considered by the panel are a reflection of this status and the important concerns within this technology area.

The panel first recommended some changes in the list of recommendations. Two general categories were added, with two specific recommendations in each category, in the area of syngas to oxygenates. Some minor changes in the wording of some recommendations were also proposed.

The panel members were then asked to each pick their top three categories. Points were awarded to each category mentioned (five for a first place mention, three for a second place, and one for a third). The panel appeared to consider alcohol and ether syntheses to be more important than hydrocarbon (F-T) syntheses. Fundamental needs ranked higher than applied.

To rank specific recommendations the panel members were asked to each pick their top six. Most of the prioritized recommendations are in the fundamental area.

D.2.2.6 Direct Conversion of Methane

Direct conversion of methane is a technology which was not originally considered within the scope of this research needs assessment. This technology was first discussed at the site visit to PETC where

research is currently being conducted in this area. Additional presentations were made on this technology at the meetings at Naperville and Newtown Square.

This technology is considered by some to be of potential interest to the coal liquefaction community because it may be a useful way of dealing with the methane produced as a byproduct from coal gasification (depending on the type of gasifier, particularly Lurgi) or from Fischer-Tropsch synthesis reactions.

However, the panel discussed whether this technology should properly be included within the area of coal liquefaction. What would be the source of the methane, which should be derived from coal to be of interest to coal liquefaction researchers? It was suggested that a number of research recommendations in indirect liquefaction would lead process design and operation in the direction of minimizing the production of methane as a byproduct. It is improbable that anyone would purposely produce methane from coal as a feedstock for this technology; any methane produced from coal is expensive compared to alternative sources.

The consensus of the panel was to include consideration of this technology in the report, but as a separate technology in an appendix. The recommendations are to be submitted but will not be ranked and prioritized. Direct conversion of methane is not properly to be considered a part of coal liquefaction. There may be a great incentive to work in this area, but only because of the large amount of remote natural gas. Funding for research on direct conversion of methane should be sought from sources other than the budget for coal liquefaction.

D.2.3 Comments and Recommendations on DOE Programs and Policy

Part of the afternoon of the second day was devoted to a discussion of DOE programs and policy in the coal liquefaction area. From the

comments that were made in this discussion, several recommendations and concerns were voiced.

First, the panel recommended that open-ended solicitations are needed to ask for research proposals on fundamentally new chemistries to liquefy coal. It was also recommended that more funds be set aside to fund unsolicited proposals. The current system of putting all research funds into restricted RFPs channels research money in specific directions and has the unintended result of stifling new ideas which don't fit preconceived programs. New ideas are thought by the panel to be particularly important with respect to coal liquefaction because new approaches are needed.

Second, one panel member noted that DOE university programs are currently very small. Universities have no participation in larger programs. Academic participation should be solicited. He therefore recommended that all DOE-sponsored contracts with industrial contractors require a certain amount of participation (perhaps 20 percent as a minimum) by universities. For example, universities could do analyses and bench/autoclave tests.

The justification would be that universities could then attract and professionally train graduate students interested in industrial careers. This program would lead to an integrated and interdisciplinary approach to research. Guidance would be available for professors and graduate students, as well as industrial staff. The panel member suggested that this type of program is necessary because there is currently a lack of academic-industrial funding by the NSF.

As a related issue to this recommendation, it was noted by another panel member that organizations allied with universities and staffed with non-teaching researchers are for the most part shut out of programs, which are frequently directed at either university teaching professors or industrial organizations.

A third comment brought up the opinion that currently no mechanism exists for getting new ideas resulting from fundamental work into process development. Industrial organizations seem to be spending their effort on their old, known, or proprietary processes.