DOE/PC/90543--T7

COMMERCIAL-SCALE DEMONSTRATION OF THE LIQUID PHASE METHANOL (LPMEOH™) PROCESS

TECHNICAL PROGRESS REPORT NO. 8

For The Period

1 April to 30 June 1996

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OSTI

Prepared by

Air Products and Chemicals, Inc.
Allentown, Pennsylvania

and

Eastman Chemical Company
Kingsport, Tennessee

MASTER

for the
Air Products Liquid Phase Conversion Company, L.P.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Prepared for the United States Department of Energy
Pittsburgh Energy Technology Center
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Table of Contents

ACRONYMS AND DEFINITIONS

Acurex	-	Acurex Environmental Corporation
Air Products	-	Air Products and Chemicals, Inc.
AFDU	-	Alternative Fuels Development Unit - The "LaPorte PDU."
Balanced Gas	-	A syngas with a composition of hydrogen (H_2), carbon monoxide (CO), and carbon dioxide (CO_2) in stoichiometric balance for the production of methanol
Carbon Monoxide Gas	-	A syngas containing primarily carbon monoxide (CO); also called CO Gas
DME	-	dimethyl ether
DOE	-	United States Department of Energy
DOE-PETC	-	The DOE's Pittsburgh Energy Technology Center (Project Team)
DOE-HQ	-	The DOE's Headquarters - Clean Coal Technology (Project Team)
DTP	-	Demonstration Test Plan - The four year Operating Plan for Phase 3, Task 2 Operation
DVT	-	Design Verification Testing
Eastman	-	Eastman Chemical Company
EIV	-	Environmental Information Volume
EMP	-	Environmental Monitoring Plan
EPRI	-	Electric Power Research Institute
HAPs	-	Hazardous Air Pollutants
Hydrogen Gas	-	A syngas containing an excess of hydrogen (H_2) over the stoichiometric balance for the production of methanol; also called H_2 Gas
IGCC	-	Integrated Gasification Combined Cycle, a type of electric power generation plant
IGCC/OTM	-	An IGCC plant with a "Once-Thru Methanol" plant (the LPMEOH™ Process) added-on.
KSCFH	-	Thousand Standard Cubic Feet per Hour
LaPorte PDU	-	The DOE-owned experimental unit (PDU) located adjacent to Air Product's industrial gas facility at LaPorte, Texas, where the LPMEOH™ process was successfully piloted.
LPDME	-	Liquid Phase DME process, for the production of DME as a mixed coproduct with methanol
LPMEOH™	-	Liquid Phase Methanol (the technology to be demonstrated)
MTBE	-	methyl tertiary butyl ether
NEPA	-	National Environmental Policy Act
OSHA	-	Occupational Safety and Health Administration
Partnership	-	Air Products Liquid Phase Conversion Company, L.P.
PDU	-	Process Development Unit
PFD	-	Process Flow Diagram(s)
ppb	-	parts per billion
ppmv	-	parts per million, volume-basis
Project	-	Production of Methanol/DME Using the LPMEOH™ Process at an Integrated Coal Gasification Facility
psia	-	Pounds per Square Inch (Absolute)
psig	-	Pounds per Square Inch (gauge)
P&ID	-	Piping and Instrumentation Diagram(s)
SCFH	-	Standard Cubic Feet per Hour
Sl/hr-kg	-	Standard Liter(s) per Hour per Kilogram of Catalyst
Syngas	-	Abbreviation for Synthesis Gas
Synthesis Gas	-	A gas containing primarily hydrogen (H_2) and carbon monoxide (CO), or mixtures of H_2 and CO; intended for "synthesis" in a reactor to form methanol and/or other hydrocarbons (synthesis gas may also contain CO_2, water, and other gases)
Tie-in(s)	-	the interconnection(s) between the LPMEOH™ Process Demonstration Facility and the Eastman Facility
TPD	-	Ton(s) per Day
WBS	-	Work Breakdown Structure
wt	-	weight

Executive Summary

The Liquid Phase Methanol (LPMEOH™) Demonstration Project at Kingsport, Tennessee, is a $213.7 million cooperative agreement between the U.S. Department of Energy (DOE) and Air Products Liquid Phase Conversion Company, L. P. (the Partnership). The LPMEOH™ Process Demonstration Unit is being built at a site located at the Eastman Chemical Company (Eastman) complex in Kingsport.

On 4 October 1994, Air Products and Chemicals, Inc. (Air Products) and Eastman Chemical Company (Eastman) signed the agreements that would form the Partnership, secure the demonstration site, and provide the financial commitment and overall management for the project. These partnership agreements became effective on 15 March 1995, when DOE authorized the commencement of Budget Period No. 2 (Mod. A008 to the Cooperative Agreement). The Partnership has subcontracted with Air Products to provide the overall management of the project, and to act as the primary interface with DOE. As subcontractor to the Partnership, Air Products will also provide the engineering design, procurement, construction, and commissioning of the LPMEOH™ Process Demonstration Unit, and will provide the technical and engineering supervision needed to conduct the operational testing program required as part of the project. As subcontractor to Air Products, Eastman will be responsible for operation of the LPMEOH™ Process Demonstration Unit, and for the interconnection and supply of synthesis gas (syngas), utilities, product storage, and other needed services.

The project involves the construction of an 80,000 gallon per day (260 tons per day (TPD)) methanol unit utilizing coal-derived synthesis gas from Eastman's integrated coal gasification facility. The new equipment consists of synthesis gas feed preparation and compression facilities, the liquid phase reactor and auxiliaries, product distillation facilities, and utilities.

The technology to be demonstrated is the product of a cooperative development effort by Air Products and DOE in a program that started in 1981. Developed to enhance electric power generation using integrated gasification combined cycle (IGCC) technology, the LPMEOH™ process is ideally suited for directly processing gases produced by modern-day coal gasifiers. Originally tested at a small (10 TPD), DOE-owned experimental unit in LaPorte, Texas, the technology provides several improvements essential for the economic coproduction of methanol and electricity directly from gasified coal. This liquid phase process suspends fine catalyst particles in an inert liquid, forming a slurry. The slurry dissipates the heat of the chemical reaction away from the catalyst surface, protecting the catalyst and allowing the methanol synthesis reaction to proceed at higher rates.

At the Eastman complex, the technology is being integrated with existing coal-gasifiers. A carefully developed test plan will allow operations at Eastman to simulate electricity demand load-following in coal-based IGCC facilities. The operations will also demonstrate the enhanced stability and heat dissipation of the conversion process, its reliable on/off operation, and its ability to produce methanol as a clean liquid fuel without additional upgrading. An off-site product testing program will be conducted to demonstrate the

suitability of the methanol product as a transportation fuel and as a fuel for stationary applications for small modular electric power generators for distributed power.

The four-year operating test phase will demonstrate the commercial application of the LPMEOH™ process, to allow utilities to manufacture and sell two products: electricity and methanol. A typical commercial-scale IGCC coproduction facility, for example, could be expected to generate 200 to 350 MW of electricity, and to also manufacture 45,000 to 300,000 gallons per day of methanol (150 to 1000 TPD). A successful demonstration at Kingsport will show the ability of a local resource (coal) to be converted in a reliable (storable) and environmentally preferable way to provide the clean energy needs of local communities for electric power and transportation.

This project may also demonstrate the production of dimethyl ether (DME) as a mixed coproduct with methanol if laboratory and pilot-scale research and market verification studies show promising results. If implemented, the DME would be produced during the last six months of the four-year demonstration period. DME has several commercial uses. In a storable blend with methanol, the mixture can be used as a peaking fuel in gasification-based electric power generating facilities, or as a diesel engine fuel. Blends of methanol and DME can be used as chemical feedstocks for synthesizing chemicals, including new oxygenated fuel additives.

The project was reinitiated in October of 1993, when DOE approved a site change to the Kingsport location. DOE conditionally approved the Continuation Application to Budget Period No. 2 (Design and Construction) in March, and formally approved it on 1 June 1995 (Mod M009). After approval, the project initiated Design - Phase 1 - activities; and initiated Construction - Phase 2 - activities in October of 1995. The project required review under the National Environmental Policy Act (NEPA) to move to the construction phase. DOE prepared an Environmental Assessment (DOE/EA-1029), and subsequently a Finding of No Significant Impact (FONSI) was issued on 30 June 1995. The demonstration unit is scheduled to be mechanically complete in December of 1996.

Construction work for the LPMEOH™ demonstration unit began in October of 1995. The foundation and underground work was completed in January. The erection of the pipe rack steel and equipment items has begun, and piping installation in the pipe rack area began in April. The fabrication of the reactor was completed, and the reactor was delivered to the site on 24 June 1996. It is to be erected early in July.

A meeting was held in April of 1996 to review the current draft of the Environmental Monitoring Plan (EMP) and of the Demonstration Test Plan (DTP). The meeting resolved the reporting basis for Phase 3 - Operations. Revised EMP and DTP drafts were submitted, comments received, and the final draft of each is expected to be released in July.

Procurement of the process equipment is complete and the equipment is at the construction site. Construction work is well underway. All of the equipment has been installed, with the exception of items to be located on the elevated floors of the process building. Mechanical completion is forecast for 2 December 1996 (vs. an earlier forecast date of 8 November).

Commissioning work is expected to start in October, with plant start-up in early January (vs. late November in the earlier forecast). A cost forecast for Phase 1 and 2 will be completed in mid-July. Seventy one percent (71%) of the $36 million in funds authorized for the Kingsport portion of the LPMEOH™ Process Demonstration Project through Budget Period No. 2 have been expended (as invoiced) as of 30 June 1996.

A. Introduction

The Liquid Phase Methanol (LPMEOH™) demonstration project at Kingsport, Tennessee is a $213.7 million cooperative agreement between the U.S. Department of Energy (DOE) and Air Products Liquid Phase Conversion Company, L. P. (the Partnership). A demonstration unit producing 80,000 gallons per day (260 TPD) of methanol is being designed and constructed at a site located at the Eastman Chemical Company (Eastman) complex in Kingsport, Tennessee. The Partnership will own and operate the facility for the four-year demonstration facility operational period.

This project is sponsored under the DOE's Clean Coal Technology Program, and its primary objective is to "demonstrate the production of methanol using the LPMEOH™ Process in conjunction with an integrated coal gasification facility." The project will also demonstrate the suitability of the methanol produced for use as a chemical feedstock or as a low-sulfur dioxide, low-nitrogen oxides alternative fuel in stationary and transportation applications. The project may also demonstrate the production of dimethyl ether (DME) as a mixed coproduct with methanol, if laboratory- and pilot-scale research and market verification studies show promising results. If implemented, the DME would be produced during the last six months of the four-year demonstration period.

The LPMEOH™ process is the product of a cooperative development effort by Air Products and the DOE in a program that started in 1981. It was successfully piloted at a 10-TPD rate in the DOE-owned experimental unit at Air Products' LaPorte, Texas, site. This demonstration project is the culmination of that extensive cooperative development effort.

B. Project Description

Existing Site

The demonstration unit, which will occupy an area of 0.6 acre, is being integrated into the existing 4,000-acre Eastman complex located in Kingsport, Tennessee. The Eastman complex employs approximately 12,000 people. In 1983 Eastman constructed a coal gasification facility utilizing Texaco technology. The synthesis gas generated by this gasification facility is used to produce carbon monoxide and methanol. Both of these products are used to produce methyl acetate and ultimately cellulose acetate and acetic acid. The availability of this highly reliable coal gasification facility was the major factor in selecting this location for the LPMEOH™ Process Demonstration. Three different feed gas streams (hydrogen gas, carbon monoxide gas, and balanced gas) will be diverted from existing operations to the LPMEOH™ demonstration unit, thus providing the range of coal-derived synthesis gas ratios (hydrogen to carbon monoxide) needed to meet the technical objectives of the demonstration project.

For descriptive purposes and for design and construction scheduling, the project has been divided into four major process areas with their associated equipment:

- *Reaction Area* - Synthesis gas preparation and methanol synthesis reaction equipment.
- *Purification Area* - Product separation and purification equipment.
- *Catalyst Preparation Area* - Catalyst and slurry preparation and disposal equipment.
- *Storage/Utility Area* - Methanol product, slurry and oil storage equipment.

The physical appearance of this facility closely resembles the adjacent Eastman process plants, including process equipment in steel structures.

Reaction Area

The reaction area includes feed gas compression and catalyst guard beds, the reactor, a steam drum, separators, heat exchangers, and pumps. The equipment is supported by a matrix of structural steel. The most salient feature is the reactor, since with supports, it is approximately 84-feet tall.

Purification Area

The purification area features two distillation columns with supports; one is approximately 82-feet tall, and the other 97-feet tall. These vessels resemble the columns of the surrounding process areas. In addition to the columns, this area includes the associated reboilers, condensers, air coolers, separators, and pumps.

Catalyst Preparation Area

The catalyst preparation area consists of a building with a roof and partial walls, in which the catalyst preparation vessels, slurry handling equipment, and spent slurry disposal equipment are housed. In addition, a hot oil utility system is included in the area.

Storage/Utility Area

The storage/utility area includes two diked lot-tanks for methanol, two tanks for oil storage, a slurry holdup tank, a trailer loading/unloading area, and an underground oil/water separator.

C. Process Description

The LPMEOH™ demonstration unit is being integrated with Eastman's coal gasification facility. A simplified process flow diagram is included in Appendix A. Synthesis gas is introduced into the slurry reactor, which contains a slurry of liquid mineral oil with suspended solid particles of catalyst. The synthesis gas dissolves through the mineral oil, contacts the catalyst, and reacts to form methanol. The heat of reaction is absorbed by the slurry and is removed from the slurry by steam coils. The methanol vapor leaves the reactor, is condensed to a liquid, sent to the distillation columns for removal of higher alcohols, water, and other impurities, and is then stored in the day tanks for sampling before being sent to Eastman's methanol storage. Most of the unreacted synthesis gas is recycled back to the reactor with the synthesis gas recycle compressor, improving cycle efficiency. The methanol will be used for downstream feedstocks and in off-site fuel testing to determine its suitability as a transportation fuel and as a fuel for stationary applications in the power industry.

D. Project Status

The project status is reported by task, against the goals established by the Project Evaluation Plan for Budget Period No. 2 (see Appendix B). The status, and the major accomplishments during this period, are as follows:

Task 1.2 Permitting

For this task the Project Evaluation Plan for Budget Period No. 2 establishes these goals:

- Issue the final Environmental Information Volume (EIV) to support the DOE's Environmental Assessment/Finding of No Significant Impact.

  - The NEPA review was completed 30 June 1995 with the issuance of an Environmental Assessment (DOE/EA-1029), and a Finding of No Significant Impact (FONSI). The draft final EIV was submitted on 31 Jan 1996. Comments were received and a revised draft was issued in May of 1996. Comments have been received, and the final EIV will be issued next quarter.

- Obtain permits necessary for construction and operation.

  - The construction permits have been obtained. The approved Air Permit from the State of Tennessee allows for plant operation to begin. A final application for the plant operation must be filed 60 days after start-up.

Task 1.3 Design Engineering

For this task the Project Evaluation Plan for Budget Period No. 2 establishes these goals:

- Prepare the Environmental Monitoring Plan (EMP).

  - A meeting to review the current drafts of the Environmental Monitoring Plan (EMP) and of the Demonstration Test Plan (DTP) was held on April 25th in Pittsburgh. Participants from Air Products, Eastman, and DOE's Pittsburgh Energy Technology Center (PETC) attended. The meeting notes (2 pages) and some meeting handouts, (Table A and Figures 3-1 and 3-2) are included in Appendix C. The meeting resolved the reporting basis for monitoring and reporting the LPMEOH™ Process Demonstration Unit operations. Table A summarizes the process stream numbers, stream descriptions, and the EMP and DTP reporting basis. Figure 3-1 shows the integration of existing (Eastman Gasification/Chemical Complex) facilities with the LPMEOH™ demonstration unit, and Figure 3-2 the main process streams of the LPMEOH™ demonstration unit.

- Following up on the review meeting, an updated draft of the Environmental Monitoring Plan (EMP) was issued in May of 1996. This update incorporated the agreed basis from the review meeting.

- Comments on this updated draft of the EMP have now been received from the DOE, and the final draft is expected to be released in July.

- Complete the design engineering necessary for construction and commissioning. This includes Piping and Instrumentation Diagrams, Design Hazard Reviews, and the conduct of design reviews.

  - Design Engineering progressed to being 98% complete as of the end of June of 1996. Detailed design of the demonstration unit is essentially complete, with only a few items left to be resolved. The largest remaining effort is to complete the programming of the Honeywell Digital Control System (DCS). This work is being done by Eastman and is approximately 60% complete.

  - During this quarter, Piping Design completed details on the vent piping and small bore piping and added recent P&ID changes to the drawings. The pipe pressure test procedures are being prepared for issue to the field.

  - Instrument and Electrical Design group is completing their design. The last of the instrument panels and the analyzer building are being fabricated in the vendor's shop in Florida.

  - The detail design and fabrication of the safety relief Vent Stack was awarded to John Zink Company. This is a 230-foot tall stack to vent and disperse gases released from any of the process safety relief valves.

  - A bid package for final Grading and Paving was issued to contractors. This package includes road bed installation, concrete paving under the pipe racks and final site stoning. A bid package for Painting will be prepared in August.

  - Testing of synthesis gas at Kingsport for poisons was initiated during this quarter. The following summarizes the synthesis gas test activities:

    - Construction of the Alternative Fuels Field Test Laboratory was completed in April. A test run at Air Products facilities in Allentown was successfully completed. Methanol yield and catalyst behavior during the 250-hour test run was normal, after an initial break-in period with high carbonyls. The Field Test Laboratory was then prepared and shipped to Kingsport.

- The Alternative Fuels Field Test Laboratory was set up at the Kingsport site with no trouble. Testing of the suitability of the process stream for the LPMEOH™ process began in May. Thus far, the gas quality presents no problems. The catalyst aging is as expected from previous laboratory experience. The unit has been performing excellently.

- No unexpected poisons have been detected in the feed gas. The following table summarizes the results from the 678-hour test run:

Component	**Specification (ppmv)**	**Measured Concentration (ppmv)**
Arsenic, as AsH_3	0.01	0.027
Halogens (Chloride & Fluoride)	0.01	~0
Hydrogen Chloride	0.01	<1
Iron Carbonyl	0.01	<0.01
Nickel Carbonyl	0.01	≤0.001
Ammonia	10	<0.023
Hydrogen Cyanide	0.01	<1
Acetonitrile	none defined	<0.05
Hydrogen Sulfide (post Eastman guardbed)	0.03*	0.035±0.024
Carbonyl Sulfide	0.03*	<0.5

*[Note that the 30 ppb specification for hydrogen sulfide and carbonyl sulfide is an arbitrary division between the two compounds; the true specification is 60 ppb *total sulfur*.]

The state-of-the-art gas chromatograph equipment revealed the presence of 7-15 ppm carbonyl sulfide (COS) in the Eastman feed gas. This level of COS is below the design specification, but is higher than had been measured previously. Low concentrations of nickel and iron carbonyls have been identified and are thought to be artifacts of tying in the new lines for the trailer. A Topical Report on the catalyst poisons testing at Kingsport will be published.

Task 1.4 Off-Site Testing (Definition and Design)

The Project Evaluation Plan for Budget Period No. 2 establishes the following goal for this task:

- Prepare the fuel-use demonstration plan for Phase 3, Task 4 Off-Site Product Use Demonstration. This off-site test plan will be incorporated into an updated, overall (fuel and chemical) product-use test plan (in Phase 1, Task 5).

Discussion

The fuel-use test plan, developed in 1992 to support the demonstration at the original Cool Water Gasification Facility site in 1992, has become outdated. Since the site change to Eastman, the original fuel-use test plan under-represents new utility dispersed electric power developments, and possibly new mobile transport engine developments. The updated fuel-use test plan will attempt for broader market applications and for commercial fuels comparisons. The objective of the fuel-use test plan update will be to demonstrate commercial (e.g., economic) market applications (municipal, industrial and electric utility) replacing or supplementing (gasoline, diesel, natural gas) commercial fuels, based on expected (1998 to 2018) U. S. energy market needs when the technology is to be commercialized.

A limited quantity (up to 400,000 gallons) of the methanol product as produced from the demonstration unit will be made available for fuel-use tests. Fuel-use tests will be targeted for an approximate 18 to 30-month period, commencing in the second year of demonstration unit operation. The methanol product from the demonstration unit will be available in Kingsport, Tennessee. Air Products, Acurex Environmental Corporation (Acurex), and the DOE will develop the final fuel-use test plan.

- Air Products and DOE-PETC representatives held an exploratory meeting with a representative of DOE-Energy Efficiency and Renewable Energy, Office of Transportation Technologies, for Fuel Cell R&D. A brief overview of the Clean Coal Technology Program and of the goals and objectives of the LPMEOH™ Project was presented. The availability of product methanol for fuel testing in the 1998 to 2000 time-frame was outlined. A list of EE's fuel cell program contractors and contacts will be provided, for followup discussions. The fuel test plan outline as handed out at the meeting, and a followup summary letter, are included in Appendix D.

Task 1.5 Planning and Administration

Task 1.5.1 Product-Use Test Plan

The Project Evaluation Plan for Budget Period No. 2 establishes the following goal for this task:

- Update the (fuel and chemical) product-use test plan to better meet the technical objectives of the project and serve the needs of commercial markets.

  - Air Products and Eastman have updated plans for the on-site product-use demonstrations. The schedule for on-site product use tests was established for August to October of 1997. Methanol product from the LPMEOH™ Process Demonstration Unit will be used as a chemical feedstock. Eastman will perform fitness-for-use tests on the methanol product for use as a chemical feedstock and provide a summary of the results.

Task 1.5.2 Commercialization Studies

The Project Evaluation Plan for Budget Period No. 2 establishes the following goal for this task:

- Complete economic studies of important commercial aspects of the LPMEOH™ process to enhance IGCC electric power generation. These studies will be used to provide input to the LPMEOH™ Process Demonstration Unit operating test plan (Phase 2, Task 3).

  - Completion of the high priority process design work for Task 1.3 (Design Engineering) has allowed significant progress on Task 1.5.2 to be made during this quarter. The Process Economics Study - Outline was issued, and is included in Appendix E. This outline, and some initial results, were reviewed at the 6 June 1996 project review meeting (see Task 1.5.4 report). The outline addresses several needs for this Task 1.5.2 Commercialization Study:

    a) to meet the Cooperative Agreement's technical objectives requirement for comparison with Gas Phase Methanol technology. This preliminary assessment will help set demonstration operating goals, and identify the important market opportunities for the Liquid Phase technology.
    b) to provide process design guidance for commercial plant designs,
    c) to provide input to the demonstration test plan (Task 2.3).
    d) to provide input to the Off-site Testing (Task 1.4) fuel-use test plan update.

  Part One - "Coproduction" of the Process Economics Study is expected to be issued by 30 July 1996. The Demonstration Test Plan final draft has been updated to include all the important aspects that have been identified by this study.

Task 1.5.3 DME Design Verification Testing

The Project Evaluation Plan for Budget Period No. 2 establishes the following goal for this task:

- Perform initial Design Verification Testing (DVT) for the production of dimethyl ether (DME) as a mixed coproduct with methanol. This activity includes laboratory R&D and market economic studies.

  - The first DVT decision milestone, on whether to continue with DME DVT, is targeted for 1 December 1996. DVT is required to provide additional data for engineering design and demonstration decision-making. The essential steps required for decision-making are: a) confirm catalyst activity and stability in the laboratory, b) develop engineering data in the laboratory, and c) confirm market(s), including fuels and chemical feedstocks. Action during this quarter included:

Market Economic Studies

- A feasibility study of DME for use as a Domestic Liquid Fuel for methanol/LPG replacement (e.g., China, Pacific Rim) is being undertaken.

- The feasibility of DME as a chemical feedstock for chemicals and/or fuels is being investigated.

Laboratory R&D

Initially, synthesis of DME concurrently with methanol in the same reactor was viewed as a way of overcoming the synthesis gas conversion limitations imposed by equilibrium in the LPMEOH™ process. Higher synthesis gas conversion would provide improved design flexibility for the coproduction of power and liquid fuels from an IGCC facility. The liquid phase DME (LPDME) process concept seemed ideally suited for the slurry-based liquid phase technology, since the second reaction (methanol to DME) could be accomplished by adding a second catalyst with dehydration activity to the methanol-producing reactor. Initial research work determined that two catalysts, a methanol catalyst and an alumina-based dehydration catalyst, could be physically mixed in different proportions to control the yield of DME and of methanol in the mixed product. Proof-of-concept runs, in the laboratory and at the Alternative Fuels Development Unit, confirmed that a higher synthesis gas conversion could be obtained when a mixture of DME and methanol is produced in the liquid phase reactor.

Subsequent catalyst activity-maintenance experiments have shown the catalyst system utilized in the proof-of concept runs experienced relatively fast deactivation compared to the LPMEOH™ process catalyst system. Further studies of the LPDME catalyst deactivation phenomenon were, therefore, initially undertaken under the DOE's Liquid Fuels Program (Contract No. DE-FC22-95PC93052), and are being continued under this Task 1.5 through Fiscal Year 1996. This LPDME catalyst deactivation research has determined that an interaction between the methanol catalyst and the dehydration catalyst is the cause of the loss of activity. Parallel research efforts--a) to determine the nature of the interaction; and b) to test new dehydration catalysts--are being undertaken. In late 1995, the stability of the LPDME catalyst system was greatly improved, to near that of the LPMEOH™ catalyst system, when a new aluminum-based (AB) dehydration catalyst was developed. During the last quarter, work concentrated on developing the promising new AP series of dehydration catalysts.

Summary of Activity and Results during the Current Quarter

- A dual-catalyst containing a new aluminum-based dehydration catalyst showed good activity and stability. This system has an activity approaching that of the standard catalyst system.

- A second trial of the new LPDME dual catalyst system showed the same excellent stability and high activity as reported last quarter. Increasing the reaction temperature led to an increase in dehydration activity, but gave rather high deactivation rates. Additional work on catalyst development is needed, but with the repetition of last month's results, we are confident in the observation that a catalyst with greatly increased life has been identified.

- Another two aluminum-based catalyst samples, 04 and 05, exhibited good activity, stability, and no negative effect on the methanol catalyst in standard LPDME runs. The methanol equivalent productivity of the dual catalyst system was as high as 94% of the initial productivity of the dual catalyst system containing alumina. Life testing of the best of these samples (05) showed a higher rate of decrease in methanol catalyst activity after 600 hours on stream. While the activity of this catalyst system is much higher than that of the standard system and even this high aging rate is less than that of the standard system, this increase in the rate of deactivation must be investigated and understood.

- A strong dependence of the performance of aluminum-based catalysts on preparation method was continued to be observed. Areas being investigated include the catalyst material, the concentration of starting solution, final pH during precipitation, washing schemes, and the ramp rate during calcination. For example, doubling the concentration of substrate in the preparation of samples 04 and 05 lead to a catalyst with considerably reduced stability compared with the previous preparation. Successful catalyst scaleup depends upon understanding these sensitivities.

- Based on the promising results from the Laboratory R & D to date, Air Products is planning to perform a test run at the LaPorte AFDU for the fourth quarter of Fiscal Year 1997. Air Products must yet confirm that the final DME catalyst composition for the LaPorte run indeed has the productivity and stability characteristics that warrant such a run.

Task 1.5.4 Administration and Reporting

A project review meeting was held at Kingsport on 5-6 June 1996. Attendees from Air Products, Eastman, and DOE-PETC participated. The meeting notes, agenda, and extracts of the meeting handouts are included in Appendix F. The construction site was visited. Major steel was being erected; and piping and electrical work were progressing in specific plant areas. The overall project status was reviewed. Detailed design is 95 % complete. The reactor was shipped and arrived in Kingsport on 24 June 1996. The process building structural steel began arriving on-site on 28 May 1996. Steel and reactor delivery are on the critical path. Once the remainder of the steel is received on-site, construction staffing is expected to peak in July through September, as the balance of the construction is being completed. (See also Task 2.3, for more detailed discussion of the commissioning schedule and planned turnover of the demonstration unit for operations). A cost forecast for Phase 1 and 2 will be completed in mid-July, after the reactor has been erected and the insulation bids have been received (after the remaining cost and schedule variables have been defined).

A meeting was held in Washington, DC on 28 June 1996, with DOE-HQ, DOE-PETC, Eastman, and Air Products participation. The purpose was to review the status of the LPMEOH™ Project and finalize plans for submission, review, and approval of the Continuation Application for Budget Period No. 3. The agenda and meeting handouts are included in Appendix G. The Project Evaluation Plan status summary sheets (handout pages 4 and 5) show that work at the Demonstration Unit has made good progress through the Design and Construction Phases. The Continuation Application is to be submitted in August, for review and approval in September.

The Milestone Schedule Status and the Cost Management Report, through June 30, 1996 are included in Appendix H. The demonstration unit is scheduled to be mechanically complete on or about 2 December 1996. Plant commissioning (check out) work is to start in October, and should be completed by December 1996. Start-up would begin after Christmas, in early January. The cost forecast for Task 1.3 Design Engineering and Task 1.5 Planning has been increased since the prior quarter. Now that the reactor has been installed, a detailed forecast will be prepared in July, after the last major construction bid (insulation) is received. The structural steel erection schedule's impact on the remaining piping, instrument and electrical work will be included in this detailed forecast.

Seventy-one percent (71%) of the $36 million of funds authorized for the Kingsport portion of the LPMEOH™ Process Demonstration Project through Budget Period No. 2 have been expended, as invoiced through 30 June 1996.

The monthly reports for April, May and June were submitted. These reports include the Milestone Schedule Status Report, the Project Summary Report, and the Cost Management Report.

Task 2.1 Procurement

The Project Evaluation Plan for Budget Period No. 2 establishes the following goal for this task:

- Complete the bidding and procurement for all equipment and Air Products-supplied construction materials.

  - The purchase and detailed mechanical design of the C-120 Vent Stack was finalized. The stack was purchased from John Zinc of Tulsa, OK. This unit should be ready to ship to the site by mid-August.

  Remaining amounts of manual valves, pipe spring hangers, and instrumentation were placed on order this quarter. All major equipment and most of the bulk materials (prefab piping, valves, instrumentation, and electrical) have been received on-site. The first and second levels of prefabricated structural steel for the reactor and distillation area bays were received on site in late May and in June. The third tier of steel for the reactor bay will be on-site in July, and the Catalyst Building steel will be on-site by mid-August.

Reactor Status

The reactor fabrication was completed at Joseph Oat Corporation in Camden, NJ. The internal exchanger was inserted into the vessel in early April. This operation took one week to complete because of the length, weight and limited access to the front end of the bundle once it was started in the vessel. The boiler feed water inlet and outlet nozzles were welded in place after insertion of the bundle. The top head was welded in place and the weld area heat treated. Joseph Oat found an acceptable subcontractor to punch the sparger holes to meet Air Products' tolerance requirements. The reactor shipped via special rail car on 14 June, arrived in Kingsport on 24 June, and was expected to be installed on its supports on 2 July 1996.

Task 2.2 Construction

The Project Evaluation Plan for Budget Period No. 2 establishes the following goal for this task:

- Provide construction management for contractor coordination and compliance with design, construction, and quality control standards.

  - Air Products added a lead Electrical Superintendent to the site construction management staff in April. His main area of concentration will be working with the Instrument and Electrical contractor who started construction work on 9 May 1996.

- Erect the major equipment and structural steel. Install the large bore piping, electrical, and insulation such that instrument checkout and equipment commissioning work can be completed during the 60-day Continuation Application approval period.

  - The Mechanical contractor moved on site in April. Piping work began in the areas east of the process building, plus the setting of miscellaneous equipment items. Approximately 47% of the large bore (greater than 2.5") piping is installed and 24% of the small bore piping is installed. Overall, as of 30 June 1996, the Mechanical Contractor is 33% complete versus a scheduled 36% complete.

  The reactor arrived on site 24 June 1996. It was off loaded from the railcar, transported to the site on the weekend and erected into position on 2 July 1996.

The first level of steel in the Distillation and Reactor areas were erected in June. The second level of steel for the Reactor bay arrived on site in June. The equipment in the Distillation area, including the two distillation columns have been set and piping to these items have begun.

The Instrument and Electrical (I & E) Contractor moved on-site in May. The cable trays and field junction boxes east of the reactor structure have been installed. The I & E Contractor has begun pulling cable from the Motor Control Center (MCC) Building to the field junction boxes. The electrical equipment has been installed in the MCC Building. The I & E Contractor is 15% complete as of the end of June.

The latest photographs (through 2 July 1996) of the construction site are in Appendix I. All equipment has been installed with the exception of items to be located on elevated floors. Erection of structural steel can now proceed since the reactor has been installed. Overall construction work for all contractors is approximately 41% complete as of 30 June 1996.

- Complete mechanical construction so that checkout and commissioning can be started in Budget Period No. 3.

Since the prior reporting period, the overall construction schedule has slipped slightly. The Summary Schedule for Phase 1 and 2 is included in Appendix K. The completion date for the steel and equipment erection task has moved from 15 July to 22 August. The completion date for mechanical construction has not changed, however, as a result of input from the mechanical contractor (who is also performing the steel and equipment erection). The delay in steel delivery will impact the instrument and electrical contractor; that completion date has slipped from 8 November to 2 December. This becomes the date for Mechanical Completion. With these revised dates, the completion of plant commissioning has moved from 27 November to 23 December 1996 and start-up would begin after Christmas. Air Products construction management will work with the contractors to maintain this schedule.

Task 2.3 Training and Commissioning

The Project Evaluation Plan for Budget Period No. 2 establishes the following goals for this task:

- Prepare a four-year test plan for Phase 3, Task 2 - Operation.

- A meeting to review the Environmental Monitoring Plan (EMP) and the Demonstration Test Plan (DTP) was held on April 25th. Participants from Air

Products, Eastman, and DOE-PETC attended. The meeting notes (2 pages), and some of the handouts (Table A and Figures 3-1 and 3-2) are included in Appendix C. The meeting resolved the reporting basis for monitoring and reporting the LPMEOH™ Process Demonstration Facility operations. Table A summarizes the process streams, stream descriptions, and the EMP and DTP reporting basis. Figure 3-1 shows the integration of existing (Eastman Gasification/Chemical Complex) facilities with the LPMEOH™ demonstration unit, and Figure 3-2 shows the main process streams of the LPMEOH™ demonstration unit.

- Following up on the review meeting, an updated draft of the Demonstration Test Plan (DTP) was issued 23 May 1996. Table 5-1 - Operation Test Plan (4 pages from the DTP) is included in Appendix J. This update incorporates comments from the review meeting, as well as input from the Process Economics Study (Phase 1, Task 5). The updated plan indicates that product for fuel testing (Phase 3, Task 4), should not be expected before May of 1998. This will impact the fuel-test planning for Task 1.4 Off-Site Testing.

- Comments on the updated (23 May 1996) draft of the DTP have been received from the DOE, and the Final DTP is expected to be released in early July.

- Prepare the operating manual and initiate the operator training program.

  - The Commissioning and Start-up Schedule has been developed and issued for review. The May 16, 1996 update (3 pages) is included in Appendix K. This schedule shows that the main checkout work starts in October; but that some commissioning (instrument air header), precommissioning (calibration, cleaning) and other work will start in July, after the reactor is erected.

  - The Schedule for Eastman Operations Support is also included in Appendix K. The Standard Operating Procedure (manual) development is continuing and is about 60% complete. A rough draft of the procedure should be finished by late August. A second operator will be assigned to the project on August 1st to begin development of the Lesson Plans to be used in operator training. Training classes are scheduled for late October with one crew per week. The Functional Checkout procedure is also being developed and is about 50% complete. Piping systems should start becoming available for physical check out in late August.

  - The overall Phase 1-2 Summary Schedule is also included in Appendix K. The overall schedule was reviewed during the 5-6 June 1996 Project Review meeting (See Task 1.5.4 - Project Meeting Notes in Appendix F). The target date for turnover of the demonstration unit from construction to operations for 'final' commissioning and startup is 2 December 1996.

Task 2.4 Off-Site Testing (Procurement and Construction)

The Project Evaluation Plan for Budget Period No. 2 establishes the following goal for this task:

- Prepare the final off-site product-use test plan.

  - The off-site product-use test plan update is being reported under the Phase 1, Task 4 Off-Site Testing work. No procurement or construction work is planned for this task during Budget Period No. 2.

Task 2.5 Planning and Administration

The Project Evaluation Plan for Budget Period No. 2 establishes the following goals for this task:

- Prepare annually an updated (Partnership) plan for the remaining activities. The first annual plan will update the remaining Phase 1 and Phase 2 activities, and the second will include an updated Phase 3 Operating Plan.

  - The first update of the Partnership Annual Operating Plan was prepared and submitted (See Quarterly Technical Progress Report No. 5). The goals and objectives for the Fiscal Year (FY)-96 annual plan are; to continue the Phase 1 and Phase 2 tasks required by the Statement of Work. The major objectives for FY-96 annual plan are:

    - the LPMEOH™ process demonstration unit will be ready for commissioning and startup in the 4th quarter of calendar year 1996.

    - the Project Evaluation Report for Budget Period No. 2 is to be completed and submitted to the DOE along with the Continuation Application for Budget Period No. 3.

- Submit all Project status, milestone schedule, and cost management reports as required by the Cooperative Agreement.

  - The DOE reporting tasks are currently being performed and reported under Task 1.5.

E. Planned Activities for the Next Quarter - July through September of 1996.

- Continue shipment of bulk materials to the site.
- Continue erection of equipment and structural steel.
- Issue and award the Insulation and Fireproofing Construction bid package and start work.
- Complete cost forecast for Phase 1 and 2.
- Issue the Final Environmental Information Volume (EIV), the Final Demonstration Test Plan, and the Final Environmental Monitoring Plan.
- Hold a Project Review/Update meeting at the site in September.
- Complete Part One of the Process Economics Study; on co-production of methanol with IGCC power.
- Issue an updated fuel-use test program plan.
- Submit the Continuation Application for Budget Period No. 3, including supporting documentation.
- Modify the Cooperative Agreement to authorize the start of Phase 3 activities; so that when the LPMEOH™ Process Demonstration Unit is mechanically complete there will be no delay in beginning commissioning and startup.

F. Summary

Construction work for the LPMEOH™ process demonstration facility began in October of 1995. The foundation and underground work was completed in January. Installation of steel for the pipe rack area is essentially complete. The reactor has been erected. The Steel and Equipment Erection Contractor is 45% complete. The Mechanical Contractor is 36% complete and the I & E Contractor is 15% complete. Overall construction is 41% complete. A cost forecast for Phase 1 and 2 will be completed in mid-July.

DOE's comments on the Draft Final Environmental Monitoring Plan (EMP) Demonstration Test Plan (DTP), and EIV were received. The Final EMP, DTP, and EIV are being prepared for issue in July.

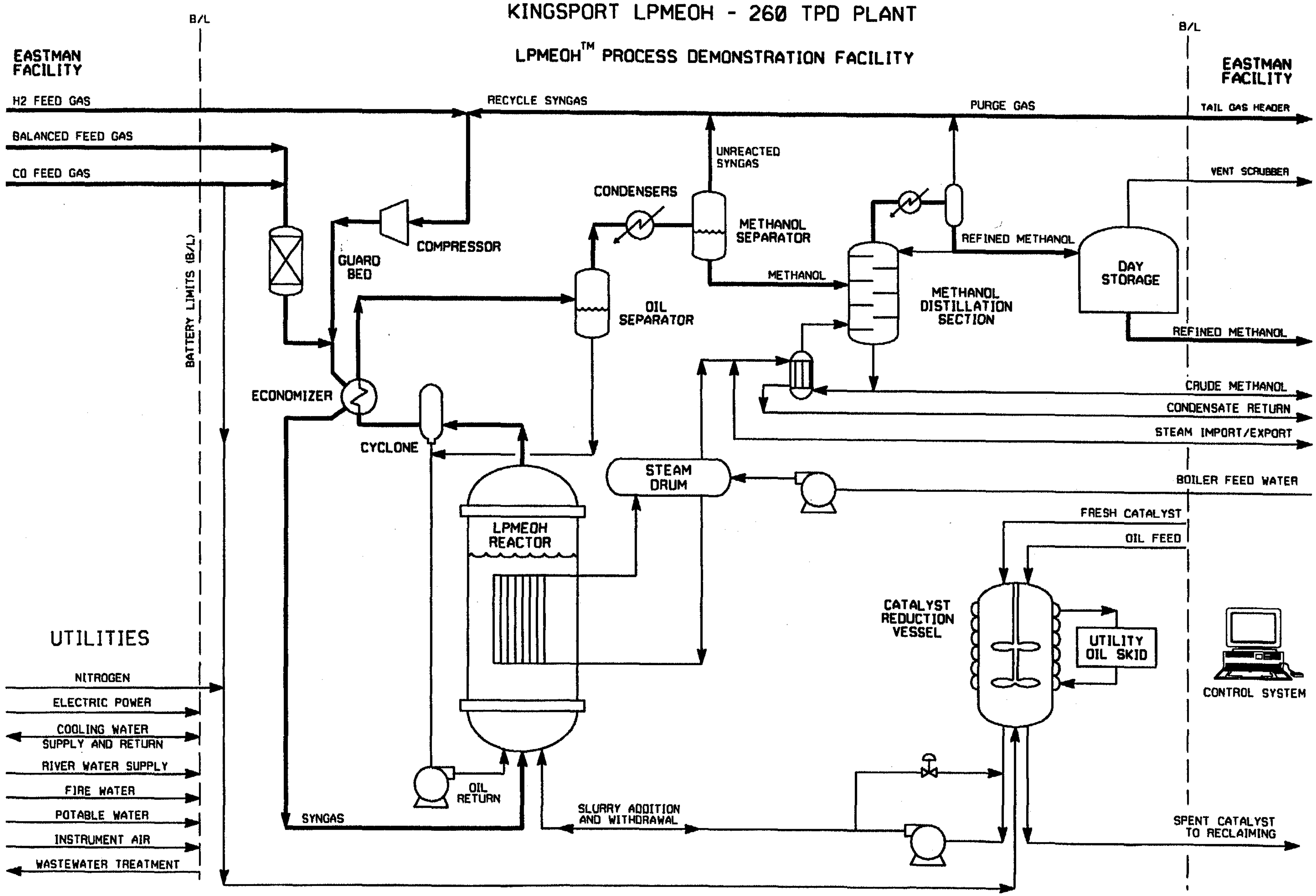
Procurement of process equipment is complete and construction work is well underway. Mechanical completion is forecasted for 2 December (vs. the earlier forecast of 8 November). Commissioning work is expected to start in mid-October, with plant start-up in early January (vs. late November in the earlier forecast). Seventy-one percent (71%) of the $36 million in funds authorized for the Kingsport portion of the LPMEOH™ Process Demonstration Project through Budget Period No. 2 have been expended (as invoiced) as of 30 June 1996.

APPENDICES

APPENDIX A - SIMPLIFIED PROCESS FLOW DIAGRAM
1 PAGE

SIMPLIFIED PROCESS DIAGRAM
KINGSPORT LPMEOH - 260 TPD PLANT

LPMEOH™ PROCESS DEMONSTRATION FACILITY



APPENDIX B - PROJECT EVALUATION PLAN FOR BUDGET PERIOD NO. 2
4 PAGES

COMMERCIAL-SCALE DEMONSTRATION OF THE LIQUID PHASE METHANOL (LPMEOH™) PROCESS COOPERATIVE AGREEMENT NO. DE-FC22-92PC90543

PROJECT EVALUATION PLAN FOR BUDGET PERIOD NO. 2

The work to be performed during Budget Period No. 2 consists of Phase 1 Design and Phase 2 Construction of the LPMEOH™ Process Demonstration Facility at Eastman Chemical Company's integrated coal gasification facility located in Kingsport, TN. Completion of these Budget Period No. 2 activities will essentially ready the LPMEOH™ Process Demonstration Facility for commissioning, startup, and operation to begin in the final Budget Period No. 3. The Statement of Work for the Project subdivides these Phase 1 and Phase 2 activities into Tasks. This Project Evaluation Plan for Budget Period No. 2 will meet the following criteria aligned by the Statement of Work tasks:

1. **Phase 1 - Task 2 - Permitting**

    - Issue the final Environmental Information Volume to support the U.S. Department of Energy's (DOE's) Environmental Assessment/Finding of No Significant Impact.

    - Obtain permits necessary for construction and operation.

2. **Phase 1 - Task 3 - Design Engineering**

    - Complete the design engineering necessary for construction and commissioning. This includes Piping and Instrumentation Diagrams, Design Hazard Reviews, and conducting design reviews.

    - Prepare the Environmental Monitoring Plan.

3. **Phase 1- Task 4 - Off-site Testing (Definition and Design)**

- Prepare the fuel-use demonstration plan for Phase III, Task 4 Off-site Product Use Demonstration. This off-site test plan will be incorporated into the overall product-use test plan (in Phase 1, Task 5).

4. **Phase 1 - Task 5 - Planning, Administration and DME Verification Testing**

- Update the (fuel and chemical) product-use test plan, that will better meet the technical objectives of the Project and serve the needs of commercial markets.

- Complete economic studies of the important commercial aspects of the LPMEOH™ Process to enhance Integrated Gasification Combined Cycle (IGCC) electric power generation. These studies will be performed by Air Products and Chemicals, Inc. and the Electric Power Research Institute, and used to provide input to the LPMEOH™ Process Demonstration Facility operating test plan (Phase 2, Task 5).

- Perform initial Design Verification Testing for the production of dimethyl ether (DME) as a mixed coproduct with methanol. This activity includes laboratory R&D and market economic studies.

- Submit all Project status, milestone schedule, and cost management reports as required by the Cooperative Agreement.

5. **Phase 2 - Task 1 - Procurement**

- Complete the bidding and procurement for all equipment and Air Products supplied construction materials.

6. **Phase 2 - Task 2- Construction**

- Complete mechanical construction so that checkout and commissioning can be started in Budget Period No. 3.

- Erect the major equipment and structural steel. Install the large bore piping, electrical, and insulation such that instrument checkout and equipment commissioning work can be completed during the 60-day Continuation Application approval period.

- Provide construction management for contractor coordination and compliance with design, construction, and quality control standards.

7. **Phase 2 - Task 3 - Training and Commissioning**

- Prepare a four (4)-year test plan for Phase 3, Task 2-Operation.

- Prepare the operating manual and initiate the operator training program.

8. **Phase 2 - Task 4 - Off-Site Testing (Procurement and Construction)**

- Prepare the final off-site product-use test plan.

9. **Phase 2 - Task 5 - Planning and Administration**

- Prepare annually an updated plan for the remaining activities. The first annual plan will update the remaining Phase I and Phase II tasks. The second annual plan will include an updated Phase III Operating Plan, identifying specific goals and milestones for the first twelve months of operation, and a general plan for the remaining years to achieve the Project's market penetration objectives.

- Submit all Project status, milestone schedule, and cost management reports as required by the Cooperative Agreement.

Completion of the above work activities will essentially ready the LPMEOH™ Process Demonstration Facility for commissioning, startup, and operation to begin in the final Budget Period No. 3. These criteria will be the basis of the Project Evaluation Report which shall be submitted to the DOE for approval along with the Project Continuation Application, at least 60 days before the end of Budget Period No. 2. Construction of the Facility will be essentially completed during the 60-day approval period for the Continuation Application.

At the time that the Project Evaluation Report for Budget Period No. 2 is submitted with the Continuation Application; Air Products will also prepare an update on the expected technical and economic performance of the mature unit. This update will demonstrate the commercial potential of the LPMEOH™ process technology to enhance IGCC electric power generation with coproduct methanol. This IGCC enhancement is expected to reduce the cost of electricity for retrofit, repowering, replacement, and new applications for electric power generation from coal.

WRB/jjs/Proeva.

APPENDIX C - TASK 1.3 - EMP AND DTP REVIEW MEETING
6 PAGES

NOTES FROM MEETING

AIR PRODUCTS

DISTRIBUTION (NAME/ORGANIZATION) *Unable to attend. **Chairman	COPIED FOR INFORMATION ONLY
W. R. Brown* E. C. Heydorn* K. M. Khonsari*(PETC) R. M. Kornosky* (PETC) W. J. O'Dowd* (PETC) B. T. Street* (EMN)	D. Drown L. Paulonis (EMN) V. Stein

FROM	ORGANIZATION	EXTENSION	TODAY'S DATE
F. S. Frenduto FSF ✓	Project Engineering	17857	30 April, 1996

DATE OF MEETING	WEEKDAY	TIME STARTED	TIME ENDED	LOCATION
4/25/96	Thursday	8:30 a.m.	3:00 p.m.	DOE-PETC

SUBJECT AND/OR PURPOSE
Review of Kingsport Environmental Monitoring Plan (EMP) and Demonstration Test Plan (DTP)

ITEM NO.	RESPONSIBLE PERSON (INITIALS)	TARGET DATE	DISCUSSION
			Regarding EMP
1.	FSF		Provide latest available schedule in EMP Appendix.
2.			Discussed pros and cons of combining Test Series Reports and EMRs and decided to keep them separate.
3.	WRB/FSF/ ECH		Make stream numbers consistent on EMP and DTP documents. Change text accordingly.
4.	WRB/FSF/ ECH/BTS		Decided to provide a separate Test Series Report for the material balance information promised on the Eastman gasification and gas cleanup areas (see attached update to WRB's cross reference table on stream numbers and reporting).
5.	FSF/BTS		Bob Kornosky provided spreadsheets (attached) showing the kind of information PETC would like for the typical gas, liquid, and solid streams APCI/EMN will modify Table 7-1 of the EMP to include this kind of information.
6.	FSF		Add internal points shown on the DTP (109, 120, 149, and 204) to the EMP diagrams and Table 7-1.
7.	FSF/BTS		Include note that if there are future changes in the law that require additional compliance monitoring, these new requirements will be included in the EMRs.
8.	FSF		There are two tables labeled 5-2. Fix as necessary.

NOTES FROM MEETING
CONTINUATION

AIR PRODUCTS

ITEM NO.	RESPONSIBLE PERSON (INITIALS)	TARGET DATE	DISCUSSION
			<u>Regarding the DTP</u>
9.	EH		PETC expressed concern that our longest runs will be on balanced gas and not on CO rich gas which we see as our commercial implementation. Ed Heydorn explained that CO availability at EMN was one reason for not having long runs in CO rich gas; he explained that the balanced gas would better demonstrate higher volumetric productivity and heat transfer. We were asked to provide a better discussion on the CO limitations at the EMN site.
10.			Discussed temperature lagging, returning to base line conditions and the commercial advantages of having a demonstration of a mixed (two vendors) catalyst system.
11.	EH		Need to redefine "standard conditions".
12.	EH		Need better definition of "balanced gas".
13.	EH		Review feed gas terms and make them consistent.
14.	EH/VS		Provide sample calculations in first Topical Report so PETC will not have to calculate plant physical parameters (e.g., reactor cross sections, reactor volume, etc).
15.	WRB		In Section 2.1 we say "imports are shrinking". Make appropriate change.
16.	EH		Change column in Table 5-1 to read cumulative elapsed time.
			<u>Others</u>
17.	FSF		Presented brief update of project status (see attached).
18.			Discussed definition of mechanical completion. Provided commissioning and startup schedule (see attached). Schedule shows commissioning to occur in stages and starting on 1 October 1996. Synthesis gas will be brought into the plant for the first time on 27 December 1996.

TABLE A (&B)
(Combined)

REVISED STREAM #'S - AND REPORTING - CHECK LIST
ENVIRONMENTAL MONITORING PLAN (EMP)
AND
DEMONSTRATION TEST PLAN (DTP)

STREAM #		STREAM DESCRIPTION	REPORTED as part of:		DISCUSSION/ COMMENTS
New # for both Plans	Old (EMP) # for Ref.	STREAM DESCRIPTION	EMP	DTP	
					Ref. Table 6-1 in DTP, for mass/energy balance data.
30	11	Balanced Gas to LPMEOH Facility	s	✔	Topical Reports (Syngas In)
10	12	CO Gas to LPMEOH Facility	s	✔	Topical Reports (Syngas In)
20	13	H2 Gas to LPMEOH Facility	s	✔	Topical Reports (Syngas In)
242	14	Crude (Grade) Methanol to Lurgi (methanol) Unit	s	✔	Topical Reports (Methanol Product Out)
216	27	Refined (Grade) Methanol	s	✔	Topical Reports (Methanol Product Out)
148	19	Main (Plant) Purge	s	✔	Topical Reports (Unreacted Syngas Out)
149	-	Recycle Gas		✔	Topical Reports (Internal material balance point)
109	-	Reactor Feed Gas		✔	Topical Reports (Internal material balance point)
120	-	Reactor Section Effluent (Syngas/Methanol) Gas		✔	Topical Reports (Internal material balance point)
204	-	Methanol to Distillation		✔	Topical Reports (Internal material balance point)
			s		s = summaries in EMRs too; see Article 7.4, EMP.
-	16	Stabilizer Reflux Drum (C-11) Non-condensables		-	
-	17	Stabilizer Feed Drum (C-12) Non-condensables		-	
-	18	Rectifier Reflux Drum (C-21) Non-condensables		-	
19	-	*Distillation Fuel Gas (Sum of the above 3 streams)*		✔	*Ref. Table 6-1 in DTP, for mass/energy balance data.*
29	20	Reduction Gas Vent (intermittent flow)	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)
21	21	Methanol Storage Tank (D-20 and D-21) Vent (interm	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)
22	22	Methanol Drain Tank (D-25) Vent (intermittent flow)	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)
23	23	Bypass (intermittent)	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)
24	24	Compressor (process side) Seal Gas	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)
25	25	Guard Bed Regeneration (intermittent flow)	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)
26	37	Analytical Sample Vents	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)
27	26	Total Flow to Boilers: (Sum of 19+29+23; +24+25+26) (New #'s; Fig 7-2))	✔	a	Ref. Article 7.3 in EMP (Compliance Monitoring) a = Environmental impact summaries will be included in Topical Report(s); see Art. 6.4 in DTP.

TABLE A (&B)
(Combined)

REVISED STREAM #'S - AND REPORTING - CHECK LIST
ENVIRONMENTAL MONITORING PLAN (EMP)
AND
DEMONSTRATION TEST PLAN (DTP)

STREAM #		STREAM DESCRIPTION	REPORTED as part of:		DISCUSSION/ COMMENTS
New # for both Plans	Old (EMP) # for Ref.	STREAM DESCRIPTION	EMP	DTP	
1	1	Fresh Coal to Gasifier		✔	Test Series Report (Publicly Available Gasifier Data)
2	2	Oxygen Feed to Gasifier		✔	Test Series Report (Publicly Available Gasifier Data)
3	3	Water Feed to Gasifier		✔	Test Series Report (Publicly Available Gasifier Data)
4	4	Waste Water from Gasifier		✔	Test Series Report (Publicly Available Gasifier Data)
5	5	Clean Balanced (Synthesis) Gas from Gasification		✔	Test Series Report (Publicly Available Gasifier Data)
6	6	Sulfur Recovered from Gasification		✔	Test Series Report (Publicly Available Gasifier Data)
7	7	Carbon Dioxide Produced from Gasifier		✔	Test Series Report (Publicly Available Gasifier Data)
8	8	Slag Generated from Gasifier		✔	Test Series Report (Publicly Available Gasifier Data)
9	10	Balanced (Syngas) from Existing Guard Bed		✔	Test Series Report (Publicly Available Guard Bed Data)
28	15	Wastewater and Alcohols to WWTS	✔	a	Environmental Report (Publicly Available (Distillation) Data)
37	30	Waste Oil	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)
31	31	Spent Catalyst	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)
32	32	Guard Bed Adsorbent to Incinerator	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)
33	33	Compressor and Pump Lubricants to Energy Recove	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)
34	34	Equipment Leak (fugitive emissions)	✔	a	Ref. Article 7.3 in EMP (Compliance Monitoring)
35	35	Miscellaneous Vents to the Atmosphere	✔	a	Ref. Article 7.3 in EMP (Deviations reported)
36	36	Vents through 29C-120 Vent Scrubber	✔	a	Ref. Article 7.4 in EMP (Supplemental Monitoring)

a = Environmental impact summaries will be included in Topical Report(s); see Art. 6.4 in DTP.

INTEGRATION OF EXISTING FACILITIES WITH LPMEOH™ FACILITY

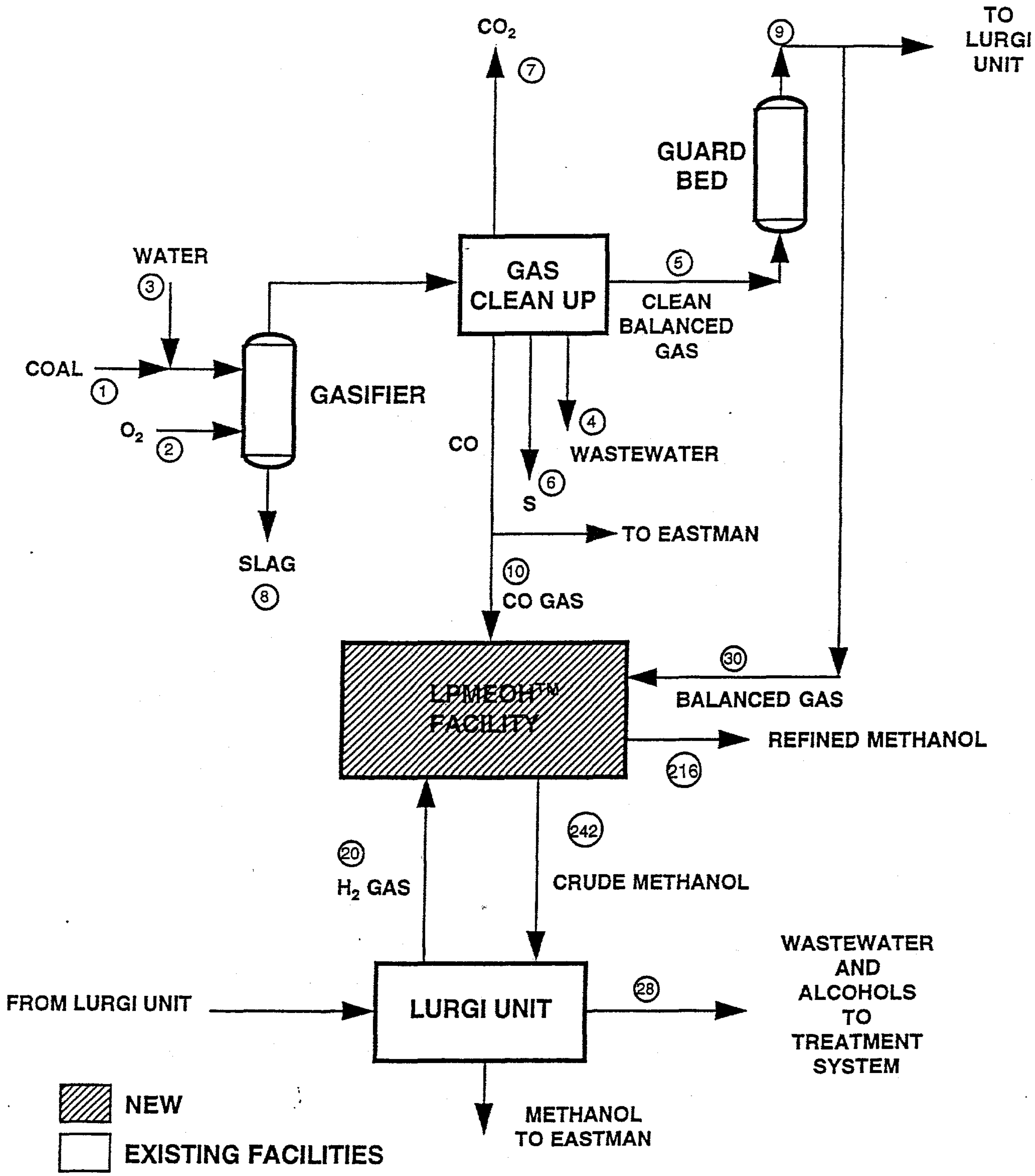


FIGURE 3-1

"LPMEOH™ FACILITY"
SIMPLIFIED PROCESS FLOW DIAGRAM

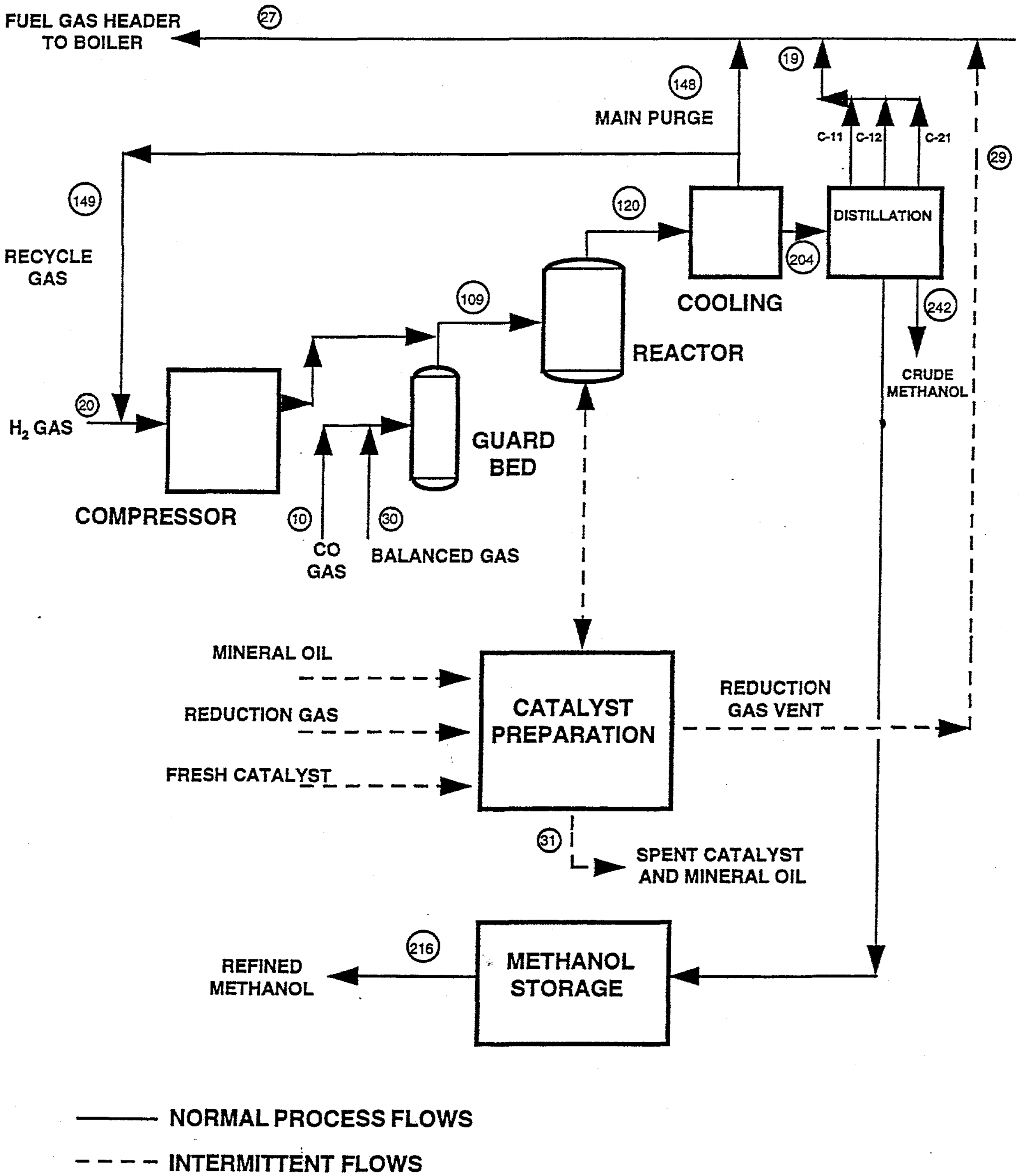


FIGURE 3-2

APPENDIX D - TASK 1.4 - FUEL-USE TEST PLAN MEETING
5 PAGES

Methanol
Fuel-Use and Product-Use Testing
Liquid Phase Methanol (LPMEOH™) Demonstration Project

(DOE Cooperative Agreement No. DE-FC22-92PC90543)

Fuel-Use Testing and Product-Use Testing Plans

Air Products intends to make available limited quantities (up to 400,000 gallons) of the methanol product as produced from the LPMEOH™ demonstration facility, for fuel-use (or product-use) testing demonstrations. Fuel-use tests will be targeted for an approximate 18 month period starting in May 1998. The objective of these fuel-use (product-use) tests is to demonstrate the suitability of the methanol, as produced, for use in applications which would enhance the commercial acceptance of the LPMEOH™ process technology.

For example; methanol product testing might be conducted to demonstrate how a centrally located clean coal electric power plant with methanol coproduct could provide energy services to local communities. Off-site testing will be conducted for small modular power generators, small modular H2 generators, and in mobile transportation applications. Testing will illustrate the advantages of a clean-burning substitute fuel for buses, van pools, and for distributed hydrogen or electric power needs. Air Products (and it's Subcontractor, Acurex Environmental Corp.) will develop the final fuel-use test plan. The draft plan needs to be prepared by August 1996.

Fuel-Use Tests

The actual fuel-use tests will be conducted under the above DOE Cooperative Agreement. As initial guidance for parties interested in performing fuel-use tests, the following is provided:

A. Methanol for fuel-use test will be available ex-works from the LPMEOH™ facility at Kingsport, Tennessee, at below-market pricing.

B. DOE cost share would be available to the participant for a portion of the cost of conducting the tests (including transportation of the methanol, equipment preparation, operation, maintenance and test result reporting).

C. Acurex will be the primary subcontractor to Air Products for *(most of)* the fuel-use tests.

More details about the DOE Cooperative Agreement's requirements for these fuel-use tests will be provided to interested parties.

Background

The DOE Cooperative Agreement is signed. Construction of the LPMEOH™ demonstration facility, located at Eastman Chemical Company's site in Kingsport, Tennessee, is underway.

1. Premium Methanol Fuel Applications

- At 40 cents per gallon, methanol as a fuel ($6.00 per mmBtu) will not compete with oil in most applications ($20/bbl crude = $3.30/mmBtu; $24/bbl diesel = $4.00 /mmBtu). However, methanol coproduced at a central IGCC power station, may be a valuable premium fuel for two evolving developments: as an economical Hydrogen source for small fuel cells, and as an environmentally advantaged fuel for dispersed electric power.

- "Central clean coal technology processing plants, making coproducts of electricity and methanol; to meet the needs of local communities for dispersed power and transportation fuel" - meets the DOE Clean Coal Technology Program's objectives. Serving (initially) small local fuel markets also builds on LP's (the LPMEOHTM process) strengths; good economics at small methanol plant sizes, fuel grade product distillation savings, and a freight advantage in local markets vis a vis large off-shore remote gas methanol. Baseload methanol coproduction studies show that (40) cent per gallon methanol can be provided from an abundant, non-inflationary local fuel source.. *We need to show when (at what oil price) we can compete, and to arrange fuel tests to confirm the dispersed energy environmental advantage.*

1.1. Hydrogen Source for Fuel Cells

- Hydrogen fuel cells, being developed for transportation applications, can achieve 65% system efficiency, as compared to 45% for diesel IC engines and 32% for gasoline IC engines. Methanol is a storable, transportable liquid fuel which can be reformed under mild conditions to provide H2. For small H2 applications, *and at low utilization factors,* methanol reforming is a more economical source of hydrogen than : a) natural gas reforming, b) distillate (oil) reforming; and is cheaper than LH2.

1.1.1. Fuel Cells for Transportation

1.1.2. Fuel Cells for Stationary Power

(See also dispersed power below).

1.1.3. Small Hydrogen Applications

Small pressurized methanol reformers for transportation applications may be suitable for adapting to meet the needs of small commercial hydrogen gas requirements.

1.2. Dispersed Power

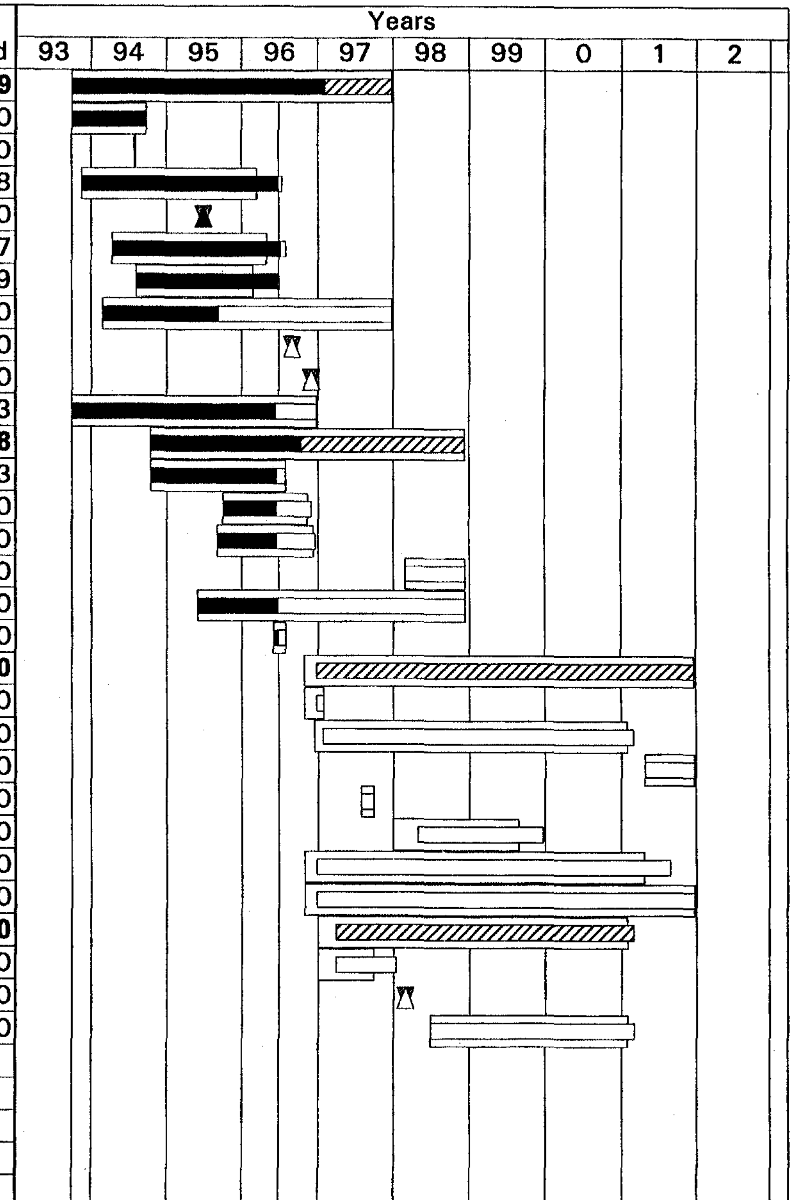
- Dispersed power is getting a lot of favorable publicity. . The world wide package (0.2 MW to 10 MW) power plant market is large. A variety of technologies (combustion turbine, internal combustion engine, fuel cell) are being packaged to provide power and heat locally, at the use point. Environmental and Economic advantages include Methanol for Fuel Cells = clean stationary local power; no need for natural gas pipelines; no new high voltage power lines.

1.3. Dimethyl Ether as an Enhancement to Methanol in Premium Fuel Applications

Can coproduced mixtures of methanol and dimethyl ether improve upon methanol, in the above?

MILESTONE SCHEDULE STATUS REPORT
LIQUID PHASE METHANOL DEMONSTRATION
DE-FC22-92PC90543

Task Name	Duration	Start	End	% Comp	% Sched
PHASE 1: DESIGN	**51.20 m**	**Oct/01/93**	**Dec/30/97**	**97**	**79**
PROJECT DEFINITION(TASK1)	12.04 m	Oct/01/93	Sep/30/94	100	100
CONTINUATION APPLICATION(B.P.#2)	9.00 d	Aug/02/94	Aug/10/94	100	100
PERMITTING(TASK 2)	32.07 m	Nov/17/93	Jul/15/96	98	98
NEPA FONSI APPROVAL	0.00 d	Jun/30/95	Jun/30/95	100	100
DESIGN ENGINEERING(TASK 3)	27.71 m	Apr/15/94	Aug/01/96	98	97
VENDOR ENGINEERING	22.83 m	Aug/10/94	Jul/01/96	99	99
OFF-SITE TESTING(TASK 4)	46.35 m	Feb/25/94	Dec/30/97	10	40
UPDATED FUEL TEST PLAN APPROVAL	0.00 d	Aug/31/96	Aug/31/96	0	0
DECISION TO CONTINUE DME TESTING	0.00 d	Dec/01/96	Dec/01/96	0	0
PLANNING, ADMIN & DME DVT(TASK 5)	39.16 m	Oct/01/93	Dec/30/96	95	83
PHASE 2: CONSTRUCTION	**50.18 m**	**Oct/17/94**	**Dec/15/98**	**60**	**48**
PROCUREMENT(TASK1)	21.61 m	Oct/17/94	Aug/01/96	98	93
CONSTRUCTION(TASK 2)	14.12 m	Oct/02/95	Dec/02/96	41	60
TRAINING & COMMISSIONING(TASK 3)	15.70 m	Sep/05/95	Dec/23/96	25	60
OFF-SITE TESTING(TASK 4)	9.57 m	Mar/01/98	Dec/15/98	0	0
PLANNING & ADMINISTRATION(TASK 5)	42.69 m	Jun/01/95	Dec/15/98	30	30
CONTINUATION APPLICATION(B.P.#3)	2.08 m	May/31/96	Aug/01/96	40	40
PHASE 3: OPERATION	**60.31 m**	**Dec/27/96**	**Dec/28/01**	**0**	**0**
START-UP(TASK 1)	1.22 m	Dec/27/96	Feb/01/97	0	0
METHANOL OPERATION(TASK 2.1)	49.52 m	Jan/26/97	Mar/06/01	0	0
DISMANTLE PLANT(TASK 2.3)	7.98 m	May/01/01	Dec/28/01	0	0
ON-SITE PRODUCT USE DEMO(TASK 3)	2.08 m	Aug/01/97	Oct/02/97	0	0
OFF-SITE PRODUCT USE DEMO(TASK 4)	20.02 m	May/01/98	Dec/28/99	0	0
DATA ANALYSIS/REPORTS(TASK 5)	56.35 m	Dec/27/96	Aug/30/01	0	0
PLANNING & ADMINISTRATIVE(TASK 6)	60.31 m	Dec/27/96	Dec/28/01	0	0
PROVISIONAL DME IMPLEMENTATION	**47.41 m**	**Apr/01/97**	**Mar/07/01**	**0**	**0**
DME DVT(PDU TESTS)(TASK 3.6)	9.57 m	Apr/01/97	Jan/15/98	0	0
DECISION TO IMPLEMENT	0.00 d	Mar/01/98	Mar/01/98	0	0
DESIGN, MODIFY & OPERATE(TASK 3.2.2)	32.36 m	Jul/01/98	Mar/07/01	0	0



Printed: Jun/27/96
Page 1

Milestone △ Summary

Department of Energy
Pittsburgh Energy Technology Center
P.O. Box 10940
Pittsburgh, Pennsylvania 15236-0940

July 2, 1996

MEMORANDUM FOR: JoAnn Milliken, Ph.D., EE-321

FROM: Robert M. Kornosky, CT-10 Robert M Kornosky

SUBJECT: Liquid Phase Methanol Demonstration Project Fuel-Use Testing

Thank you for taking the time to meet with the Liquid Phase Methanol (LPMEOH™) Project Team on Friday, June 28, 1996. Representatives from Air Products and Chemicals, Inc., Eastman Chemical Company, and the Department comprise the LPMEOH™ Project Team. The objective of the LPMEOH™ Project is to demonstrate the production of methanol from coal-derived synthesis gas and to determine the suitability of the "as-produced" methanol for use as an alternative fuel and as a chemical feedstock. Construction of the 80,000 gallon-per-day LPMEOH™ demonstration unit at the Eastman Chemical complex in Kingsport, Tennessee, is expected to be completed late this year, with operations scheduled to begin early in 1997. During the 1998 to 2000 time-frame, about 400,000 gallons of the "as-produced" methanol will be available for fuel-use testing. Under a subcontract to Acurex Environmental Corporation, the project will allocate a total of up to $ 2 million for fuel-use testing.

As we discussed, the LPMEOH™ Project was selected in 1989 under the Department's Clean Coal Technology (CCT) Program. The CCT Program is a jointly funded government-industry effort to select the most promising advanced coal-based technologies and, over the next decade, move them into the commercial marketplace through demonstration. These demonstrations are conducted at a scale large enough to generate the data from design, construction, and operation that is necessary for the private sector to judge commercial potential and to make informed and confident decisions on commercial readiness.

The goal of the program is to make available to the U.S. energy marketplace, particularly the industrial and utility sectors, a number of advanced, more efficient, and environmentally responsive coal technologies. These technologies will reduce and/or eliminate the economic and environmental impediments that limit the full consideration of coal as a future energy resource. The program is being implemented through a series of five competitive solicitations which are now completed. Federal funding of $2.75 billion was committed for the five rounds of the program. When the private sector cost share is included, total funding approaches $7 billion.

These projects are conducted under jointly funded cooperative agreements -- not contracts -- between government and industry. The industrial partner in each project contributes at least 50% of the total cost -- in many cases, more -- and the patent rights for inventions developed during the demonstration are normally granted to the participant. Numerous non-federal organizations, including state, utility, and industrial research groups, provide important co-funding and other support for these CCT projects. A complete description of the CCT Program and each project can be found in the attached copy of "Clean Coal Technology Demonstration Program -- Program Update 1995."

Again, thank you for meeting with the LPMEOH™ Project Team and exploring the possibilities of integrating our methanol fuel-use testing with the Office of Transportation Technologies' fuel cell and alternative fuels programs. If have any questions regarding the LPMEOH™ Project or the CCT Program, please do not hesitate to contact me at (412) 892-4521.

Attachment

cc w/o attachment:
W.R. Mundorf, AD-24
D.B. Archer, FE-221
W.R. Brown, Air Products

APPENDIX E - TASK 1.5.2 - PROCESS ECONOMICS STUDY - OUTLINE
4 PAGES

Process Economics Study - Outline
LPM as an add-on to IGCC for Coproduction

Part One - Coproduction

1. Introduction

1.1. LPM Process Design Options.

- Develop plant design options for the LPM process, for design variables such as: a) feed gas pressure, b) feed gas compositions, and c) % syngas conversion.

2. LP Methanol Process advantage versus Gas Phase Methanol.

2.1. Syngas Conversion Cost for Methanol Production from CO-Rich syngas. (LP vs. GP).

- For the various LPM process design options (from 1.1) develop plant capital and conversion costs for a 500 t/d LPM plant, derived from the Kingsport Project costs and design basis,

- Summarize in a series of graphs, conversion costs, in cents per gallon over the range of syngas conversion from 15% (LP - Once-thru) to 94% (GP), for baseload annual coproduction operation. This will show LP's advantage at lower conversions; highlight process design or development
  - **2.1.1. 1000 psi, 5 ppm S, syngas; 500 t/d Plant size**
  - **2.1.2. 500 psi, 5 ppm S, syngas; 500 t/d Plant size**
  - **2.1.3. Impact of Plant Size on Conversion Costs**
    - Summarize in a graph, conversion cost versus plant size, for 2.1.1 and 2.1.2 above. *Include plant size impact on product distribution (freight) cost, assuming that local markets are served. Freight cost will increase with plant size, as the distribution radius increases.*

2.2. Methanol Product Purification Cost. (LP Vs GP).

- Develop capital and operating costs for product purification design alternatives. Summarize LP's advantage (in cents per gallon), especially for MTBE and Fuel Grade from CO-rich gas at low conversions, Vs GP process.
  - **2.2.1. MTBE Grade; Over the above range of syngas conversion**
  - **2.2.2. Fuel Grade**
  - **2.2.3. Chem. Grade**

2.3. Feedgas (Syngas) Composition Variations: (Impact on LP vs. GP).

- Higher Sulfur content in the feedgas will have a negative cost impact on LP at low syngas conversion, relative to GP at high conversions. Conversely, higher feedgas inert content will have a negative relative cost impact on GP.
  - **2.3.1. Sulfur content variation; over the above range of syngas conversion**
  - **2.3.2. Inert gas content variation; over the above range of syngas conversion**

2.4. Syngas ~~Utilization~~ Usage (Btu per Gallon) - (Impact on LP vs. GP).

- Summarize differences in syngas ~~utilization~~ usage (Btu per gallon of methanol), and in mass flow loss to the combustion turbine (kwh production loss per gallon of methanol); for the cases in 2.1 above.

Process Economics Study - Outline
LPM as an add-on to IGCC for Coproduction

Part One - Coproduction (Cont'd.)

2.5. Summary of Cost Advantage(s) - (LP Vs GP).

- Summarize the cost impact (cents per gallon) of the above design variables and syngas utilization differences. Show the impact of methanol plant size on the conversion costs. *Also (separately show) the impact of 90%, 80%, and 70% annual load utilization for use with Section 5. "Intermediate Load Coproduction and Stored Energy" of this Economics Study.*

- Recommend areas for process design value engineering work; and areas for demonstration at Kingsport.

3. Coproduction - Impact on Electric Power Cost -

3.1. Baseload Coproduction with Methanol Sales

3.1.1. 2 T/D methanol per MW (20% conversion)
3.1.2. 4 T/D methanol per MW (33% conversion)
3.1.3. 8 T/D methanol per MW (50% conversion)

For baseload coproduction, the gasifier must be sized for both the power and methanol products.. A matrix of power plant and methanol plant sizes of interest, is show in the following tables.

- For a given gasifier size (base is about 2160 x 10^6 Btu/hr. in this example); the methanol plant size and power plant size would change:

Methanol to Power Size	Power Plant Size	Methanol Plant Size	Syngas Conversion	Gasifier Size
0 T/D per MW	300 MW	0 T/D	0 %	Base
2 T/D per MW	250 MW	500 T/D	20%	Base
4 T/D per MW	200 MW	800 T/D	33%	Base
8 T/D per MW	150 MW	1200 T/D	50%	Base

- For a given baseload power plant size; the gasifier and methanol plant size is adjusted:

Methanol to Power Size	Power Plant Size	Methanol Plant Size	Syngas Conversion	Gasifier Size
0 T/D per MW	150 MW	0 T/D	0 %	0.50 x Base
2 T/D per MW	150 MW	300 T/D	20%	0.625 x Base
4 T/D per MW	150 MW	600 T/D	33%	0.75 x Base
8 T/D per MW	150 MW	1200 T/D	50%	1.00 x Base

- The impact of coproduction on electric costs should be shown in graphs of electricity cost Vs. methanol net back price, for both of these matrix tables..

End of Part One.

Process Economics Study - Outline
LPM as an add-on to IGCC for Coproduction

Part Two - Coproduction for Intermediate Electric Load Following.

4. Intermediate Load Coproduction and Stored Energy.

4.1. Syngas Value.

4.1.1.Syngas value as a function of (time of day) Power Value.

- Our earlier load following work indicates that an LPM coproduction add-on optimizes for intermediate peak-load power in the 1000 to 2500 hr./yr. range. This means the methanol plant operates during "off--peak" power in the 7760 (88% utilization) to 6260 (71% utilization) hr./yr. range (8760 hr./yr. = 100% = total hr./yr.), with up to 200 annual daily stop/start operations for the daily on/off peaks.
  - *Time of day example: A given Lambda Curve might provide data at 2000 and 1500 peak hr./yr. such as: a)* 2.7 cent off-peak power (6760 hr.) plus 6.6 cent intermediate-peak power (2000 hr.) equals 3.6 cent baseload power (8760 hr.). b). 2.9 cent off-peak (7260 hr.) plus 7.0 cents intermediate-peak power (1500 hr.) equals 3.6 cent baseload power (8760 hr.). Time of day syngas values can be derived, based on the alternative value of using syngas for power (in CC or CT power plants).

4.1.1.1. Syngas value as function of seasonal opportunity fuels/feeds.

- *Natural gas may be available seasonally, for use in the CC power plant, allowing syngas to be used for conversion in an LPM add-on. Other feeds?*

4.1.2.Syngas value as function of cost to produce incremental quantity..

- ***Defer this for later study.*** We should await other CCT project (e.g. Tampa, Wabash River) projections of future IG facility fuel gas (syngas) costs, and/or electric power costs.

4.2. Intermediate Load Coproduction - for Methanol Sales.

- ***Defer this for later study.*** For all intermediate load coproduction cases, redundant investment to utilize syngas on/off-peak is required; so that when the methanol plant shuts down during peak power periods, all of the syngas can be converted to electric power. There are many intermediate load coproduction power plant design choices; a) CC power plant turned down, or b) CC power plant baseload with CT power plant for peak; which may be combined with many methanol plant choices of size/% conversion. To do these studies properly, we need to have good time of day power values (also called Lambda Curves) as well as the Section 2. (above) Methanol Plant design choices completed.

Methanol may also be used as backup fuel for enhanced power plant availability,.

4.3. Intermediate Load Stored Energy Production, with Methanol Fuel for Peak Power Production.

- ***Defer this for later study.*** The design optimization for this is quite complex. The IGCC/OTM plant design has an additional variable: the peaking power plant size and hours of operation is an independent variable. We may be able to use the \ ; study with a published paper as goal. An alternative study option is to compare ourselves (IGCC/OTM) to the various published EPRI (IG-Cash, et. al.) studies, which have some favorable Lambda Curves examples for energy storage.

4.4. Intermediate Load Stored Energy Production, with Methanol for Dispersed Energy.

- Methanol transported to remote **existing** or new power plants on the Utilities grid system.

End of Part Two.

Process Economics Study - Outline
LPM as an add-on to IGCC for Coproduction

Part Three - Methanol Fuel Applications

5. Premium Methanol Fuel Applications

- At 40 cents per gallon, methanol as a fuel ($6.00 per mmBtu) will not compete with oil in most applications ($20/bbl crude = $3.30/mmBtu; $24/bbl diesel = $4.00 /mmBtu). However, methanol coproduced at a central IGCC power station, may be a valuable premium fuel for two evolving developments: as an economical Hydrogen source for small fuel cells, and as an environmentally advantaged fuel for dispersed electric power.

- "Central clean coal technology processing plants, making coproducts of electricity and methanol; to meet the needs of local communities for dispersed power and transportation fuel" - meets the DOE Clean Coal Technology Program's objectives. Serving (initially) small local fuel markets also builds on LP's (the LPMEOH™ process) strengths; good economics at small methanol plant sizes, fuel grade product distillation savings, and a freight advantage in local markets vis a vis large off-shore remote gas methanol. Baseload methanol coproduction studies show that (40) cent per gallon methanol can be provided from an abundant, non-inflationary local fuel source.. *We need to show when (at what oil price) we can compete, and to arrange fuel tests to confirm the dispersed energy environmental advantage.*

5.1. Hydrogen Source for Fuel Cells

- Hydrogen fuel cells, being developed for transportation applications, can achieve 65% system efficiency, as compared to 45% for diesel IC engines and 32% for gasoline IC engines. Methanol is a storable, transportable liquid fuel which can be reformed under mild conditions to provide H2. For small H2 applications, *and at low utilization factors,* methanol reforming is a more economical source of hydrogen than : a) natural gas reforming, b) distillate (oil) reforming; and is cheaper than LH_2.

5.1.1.Fuel Cells for Transportation

5.1.2.Fuel Cells for Stationary Power

(See also dispersed power below).

5.1.3. Industrial Applications - Small Hydrogen Plants

Small pressurized methanol reformers for transportation applications may be suitable for adapting to meet the needs of small commercial hydrogen gas requirements.

5.2. Dispersed Power

- Dispersed power is getting a lot of favorable publicity. . The world wide package (0.2 MW to 10 MW) power plant market is large. A variety of technologies (combustion turbine, internal combustion engine, fuel cell) are being packaged to provide power and heat locally, at the use point. Environmental and Economic advantages include Methanol for Fuel Cells = clean stationary local power; no need for natural gas pipelines; no new high voltage power lines.

5.3. Dimethyl Ether as an Enhancement to Methanol in Premium Fuel Applications

Can coproduced mixtures of methanol and dimethyl ether improve upon methanol, in the above?

<u>**End of Part Three.**</u>

APPENDIX F - TASK 1.5.4 - PROJECT REVIEW MEETING (June 5/6)
12 PAGES

AIR PRODUCTS

NOTES FROM MEETING

DISTRIBUTION (NAME/ORGANIZATION) *Unable to attend. **Chairman

William C. Jones - EMN
Bill Brown - APCI*
Ed Heydorn - APCI
Van Eric Stein - APCI
Laurie Paulonis - EMN*
Barry Street - EMN*
Dave Drown - APCI*
Bob Moore - APCI
Bob Kornosky - DOE*
Bill O'Dowd - DOE*

* with attachments

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Frank Frenduto - APCI
Tom Dahl - APCI
Dan Canning - APCI
Barry Halper - APCI
Bernie Toseland - APCI

FROM	ORGANIZATION	EXTENSION	TODAY'S DATE
Bill Brown WRB 6/20/96	APCI LPMEOH Prog. Mgr.	17584	19 June, 1996

DATE OF MEETING	WEEKDAY	TIME STARTED	TIME ENDED	LOCATION
June 5, 1996	Wednesday	3:00 pm	5:30 pm	Eastman (EMN), Kingsport Building 310, Room 112 and Construction Site
June 6, 1996	Thursday	8:30 am	1:00 pm	

SUBJECT AND/OR PURPOSE

Project Review Meeting with DOE, Eastman, and Air Products

ITEM NO.	RESPONSIBLE PERSON (INITIALS)	TARGET DATE	DISCUSSION
1	DPD	7/18	• The meeting (Agenda attached) started at 3:00 p.m., Wednesday, June 5 with a review of project design, procurement, construction cost and schedule by Dave Drown. (see attachment 1-1 thru 1-11) The reactor is now expected to ship the week of June 10 (in fact, 14 June!) and to be on-site in late June. Dec. 2nd is the anticipated completion of construction, with turn-over of the site to operations for commissioning and start-up (Dec. 27th). The overall project cost (Phases 1, 2, and 3) is on target. A cost forecast (DPD) for Phase 1 and 2 is to be completed in mid-July; after the reactor has been erected and the insulation bids are received (e.g., the major remaining cost and schedule variables are done). • The attendee's adjourned to the LPMEOH plant site to review construction progress. Major steel was being erected; and piping and electrical work being done in specific plant areas. Steel and reactor delivery are on the critical path. Good progress is being made with peak construction staffing (about 100) anticipated from July through September. • The meeting reconvened on Thursday, June 6, with a review of the training, commissioning and start-up plans (ECH/BTS). Attachment 2-1 shows the overall Eastman operations support plan and schedule. Operator training will start in mid-October for 1 week/crew by 4 crews. Water batching checks will start Dec. 2nd; which will mark the transition of the site from construction control to operations control. Catalyst reduction (9 Batches of about 1 Ton each) will start in early January; with methanol production in late January.

NOTES FROM MEETING
CONTINUATION

AIR PRODUCTS

ITEM NO.	RESPONSIBLE PERSON (INITIALS)	TARGET DATE	DISCUSSION
2 3	RMK/WJO'D ECH	6/14 6/28	• The Demonstration Test Plan, and the status of the syngas (trailer) tests were reviewed. The latest draft of the DTP looks to be in good shape. The syngas tests indicate catalyst life should be good. The DOE owes comments (Item No. 2) and Ed Heydorn (Item No. 3) a revised final draft of the DTP.
4 5	WRB WRB	6/28 8/28	• The DOE Reports are shaping up. Quarterly's in the format and form of #4 will be submitted by the end of June (Item No. 4). The Project Management Plan should be updated for Phase 3 (Item No. 5).
6	RBM	7/30	• Other Phase 1, Task 5 tasks were reviewed. An outline of the Process Economics Study (Attachment 3-1 thru 3-4) was reviewed, and Bob Moore reviewed his progress to date on Section 1 and 2.1. An initial release of Part One of the Study will be issued by the end of July. Page 3-4 of the attachment outlines premium methanol fuel applications (Fuel Cells, Dispersed Power) which will be the target for off-site fuel use demonstrations (Phase 3, Task 4) in 1998-99. The DME milestone decision plan and status of Design Verification Testing (Attachments 4-1 and 4-2) was reviewed. The Laboratory R & D verification has had positive results to date; and market verification is underway. Plans for a LaPorte PDU run in 1997 are being made, in anticipation of a positive decision in Dec. 1996.
7	WRB	7/30	• Plans for the Continuation Application and for a June 19 (subsequently changed to June 28th) meeting at DOE-HQ were discussed. The only issue is whether to seek Budget Period #3 approval by 30 Sept, or whether to extend B.P. #2 to 30 Nov and delay approval. The Continuation Application will be submitted July 30, if timely 30 Sept approval is opted for.
8	ALL	Sept. 4-5	• The next project review meeting will be held (noon to noon) on Sept 4 and 5 (Wed. - Thurs.) in Kingsport. **Please Note!**

FORM 3684 (REV. 5/89)
MN006 - wrb

Meeting Notes

MEETING NOTICE

AIR PRODUCTS

☐ Check if this meeting was scheduled through Schedule+

PLEASE NOTE: Security badges required for visitors in all buildings and employees in R&D buildings.

DISTRIBUTION (NAME/ORGANIZATION) (If unable to attend, contact originator)		COPIED FOR INFORMATION ONLY
William C. Jones - EMN	Barry Street - EMN *	Frank Frenduto - APCI
Bill Brown - APCI*	Dave Drown - APCI *	Tom Dahl - APCI
Ed Heydorn - APCI	Bob Moore - APCI	Dan Canning - APCI
Van Eric Stein - APCI	Bob Kornosky - DOE *	Barry Halper - APCI
Lauri Paulonis - EMN*	Bill O'Dowd - DOE*	Bernie Toseland - APCI
~~Andy Wang - APCI~~	* with attachments	

FROM	ORGANIZATION	EXTENSION	TODAY'S DATE
Bill Brown WRB 5/24	APCI LPMEOH Prog. Mgr.	17584	24 May 1996

DATE OF MEETING	WEEKDAY	TIME FROM	TIME TO	LOCATION
June 5, 1996	Wednesday	3:00 pm	5:30 pm	Eastman (EMN), Kingsport, Building 310, Room 112 and Construction Site
June 6, 1996	Thursday	8:30 am	1:00 pm	

SUBJECT AND/OR PURPOSE

Project Review Meeting with DOE, Eastman, and Air Products

DESIRED RESULTS/OUTCOMES

Review Budget Period #2 status; and prepare for Continuation Application for Budget Period #3.

REFERENCE MATERIAL/OTHER

AGENDA

A. Tour Site 3:00 PM - Wednesday June 5.

Plant construction site tour and Syngas Poisons Trailer tour. *(DOE arriving on 1:30 PM flights; they will meet us, or we them, about 3:00)*

B. End of (work) Day - 5:30 PM?

Dinner (?) & early to bed!

C. Status Updates; on B.P. #2 Tasks: 8:30 am - Thursday, June 6.

1. Design, Procurement, Construction (Schedule/Cost F/C) Status — DPD
2. Training, Commissioning & Startup Plan/Schedule — BTS/ECH/VES/DPD
3. Four year Demonstration Test Plan for Phase 3, Task 2 - Operations — ECH
4. DOE Reports
   a. Due for B.P. #2 (EMP, Quarterlies #5,6,7,8; etc.) — WRB/DPD
   b. Phase 3 Reports/Reporting Plan — ECH/VES
5. Phase I, Task 5 Tasks - Status
   a. Fuel-use test plan update — WRB
   b. DME DVT Status/Milestone Plan — ECH/WRB
   c. Process Economic Study - Outline and 1.1 & 2.1 (partial) — Outline - UP? — WRB/RBM
6. Syngas (Trailer) Testing update. — VES ~~AWW~~
7. Plans for: a) June 19th meeting at HQ — (all)
   b) Next Project Meeting — 4-5 Sept., Noon : Noon
   c) Continuation Application Draft

(The DOE have return flights; leaving about 2:00 PM on 6 June.)

FORM 3683 (REV. 2/91)

WKB
DOE Meeting
June 5-6
1996
@ Kingsport

KINGSPORT LPMEOH DEMONSTRATION PROJECT
JUNE 6, 1996 DOE STATUS OVERVIEW

DESIGN

95% COMPLETE DETAIL DESIGN
INSTRUMENT AND ELECTRICAL PACKAGE ISSUED

PROCUREMENT

REACTOR TO SHIP BY RAIL THIS WEEK — probably ~~6/10~~ June 10th week now Rail Car repairs!
C-120 VENT STACK AWARDED TO JOHN ZINC
89% OF PREFAB PIPE ON SITE
PROCESS BUILDING STRUCTURAL STEEL BEGAN ARRIVING ON SITE 5/28/96

CONSTRUCTION

30% COMPLETE OVERALL ON CONSTRUCTION
INSTRUMENT/ ELECTRICAL WORK STARTED

COST FORECAST

PHASE 1& 2 -POST MOD 3 - $36.5 MM

SCHEDULE

PLANT MECHANICALLY COMPLETE 12/02/96
BEGAN CARBONYL BURNOUT 12/27/96

LPMEOH PROJECT

DESIGN STATUS - 5 JUNE 1996

PROCESS ENGINEERING
- Complete except for startup and operations issues.

P&ID
- Rev 2 "As Designed" released end of May.

PROCESS CONTROLS
- Hardware---carbonyl analyzer remains to be purchased
- EMN now has all data necessary for programming the DCS
- Reviewing Logic Diagrams prepared by EMN
- Working on identifying Commissioning activities and schedule
- Working on identifying IT needs for APCI on-site personnel and tie-ins to TTown.

VALVES AND MATERIALS
- Working on Pressure Test Flowsheet .

PIPING/LAYOUT
- Will send Bulletin #5 to Mechanical Contractors today
- Preparing documents for Insulation Bid Package
- Final piping dimensions to C-120 Vent Stack to be completed

CIVIL STRUCTURAL
- Reviewing Catalyst Building drawings from Steel Detailer(this is the final package from the Detailer)
- Completing a few drawings for Fireproofing of Structural Steel
- Foundation for C-120 to be completed
- Preparing Final Grading & Paving drawings

EQUIPMENT ENGINEERING
- Essentially complete except for C-120 vendor prints

ELECTRICAL/INSTRUMENT DESIGN
- Completed Rev. 0 (released for construction) package.
- Awarded Analyzer Bldg. Design to ICS; expect mid August delivery
- Loop Diagrams promised for July

REMAINING BID PACKAGES
- Insulation- Out for Bids June 12, Award by end of July.
- Painting- Out for Bids in July, Award in August.
- Final Grading & Paving-Out for Bids in August, Award in September

LPMEOH PROJECT

STATUS OF FIELD MATERIALS - 5 JUNE 1996

PROCESS BUILDING STRUCTURAL STEEL

- All First Tier of Steel is on-site.
- Steel for second Tier and main stair tower is in fabrication.
- Third Tier will be released for fabrication by 5 June.
- Catalyst Building Steel will be released for Fabrication by 12 June.

PREFAB PIPE

- 630 Spools total - 561 Spools on-site(89%)
  - 24 spools delayed until 8/25
  - Awaiting delivery of balance- no impact on schedule

MANUAL VALVES

- Approximately 95% of all valves are on site

INSTRUMENTS

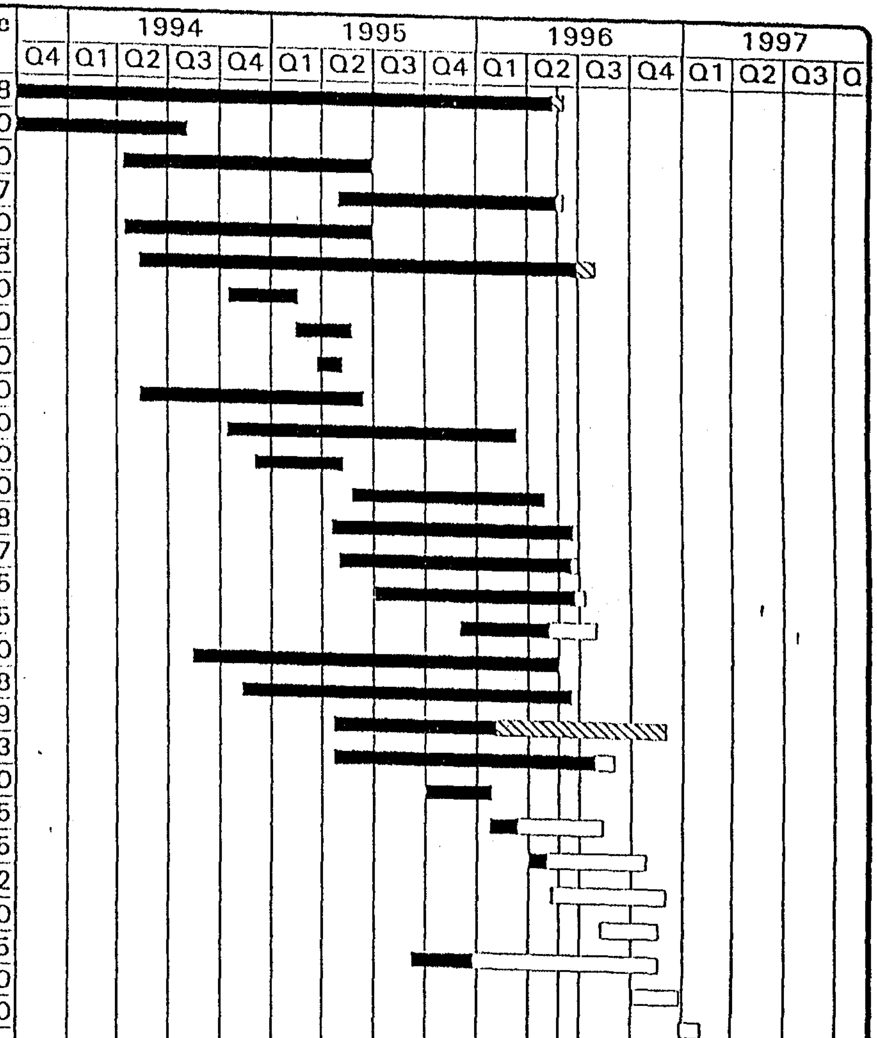
- All Flow Elements are on site.
- All control valves are on-site.
- Analyzer building scheduled to ship in mid August.
- DCS on-site and being programmed by EMN
- Instrument Panels still in vendor shops.

ELECTRICAL MATERIALS

- All Bulk Materials(cable, cable trays, lighting fixtures, terminal boxes)are on-site

LPMEOH DEMONSTRATION PROJECT
PHASE 1-2 SUMMARY SCHEDULE

Task Name	Start	End	Perce Com
PROCESS DESIGN	Oct/01/93	Jun/03/96	98
PFD/HEAT & MAT'L BALANCE	Oct/01/93	Aug/05/94	100
PROCESS EQUIPMENT SPECS	Apr/13/94	Jun/30/95	100
REVIEW DETAIL DESIGN	May/01/95	Jun/03/96	97
NEPA FONSI REVIEW	Apr/15/94	Jun/30/95	100
DETAILED DESIGN	May/11/94	Jul/29/96	96
P&ID'S, REV. PC	Oct/17/94	Feb/17/95	100
OPERABILITY/HAZARDS REVIEWS	Feb/13/95	May/24/95	100
P&ID'S, REV. P1	Mar/23/95	May/08/95	100
PROCESS EQUIP. MECH. SPECS	May/11/94	Jun/13/95	100
EQUIPMENT VENDOR PRINTS	Oct/14/94	Mar/12/96	100
EQUIPMENT ARRANGEMENTS	Dec/01/94	May/08/95	100
INSTRUMENT SPECS	May/22/95	Apr/29/96	100
CIVIL/STRUCTURAL DESIGN	Apr/17/95	Jun/28/96	98
PIPING DESIGN	May/01/95	Jun/28/96	97
INSTRUMENT/ELECTRICAL DESIGN	Jul/03/95	Jul/10/96	95
DCS PROGRAMMING	Dec/01/95	Jul/29/96	65
EQUIPMENT PROCUREMENT	Aug/12/94	May/23/96	100
REACTOR DELIVERY	Nov/08/94	Jun/27/96	98
CONSTUCTION	Apr/21/95	Nov/29/96	49
EASTMAN OSBL WORK	Apr/21/95	Aug/30/96	93
CIVIL/UNDERGROUND	Oct/02/95	Jan/26/96	100
STEEL & EQUIPMENT ERECTION	Jan/22/96	Aug/09/96	25
MECHANICAL	Apr/01/96	Oct/25/96	15
INSTRUMENT/ELECTRICAL	May/09/96	Nov/29/96	2
INSULATION & FIRE PROOFING	Aug/05/96	Nov/15/96	0
PROCEDURES/TRAINING	Sep/05/95	Nov/15/96	25
CHECK-OUT/COMMISSIONING	Oct/01/96	Dec/24/96	0
START-UP	Dec/26/96	Jan/31/97	0



Printed: May/24/96
Page 1

Milestone △ Summary Fixed Delay - - - -

Dec 2 = EMN sub
no "Const" sub. | for commissioning.

1-5

W8T 6/6/96 Handout to DOE Proj. Rev. Mtg (Barry Street)

SCHEDULE FOR EASTMAN OPERATIONS SUPPORT
LIQUID PHASE METHANOL PROJECT(6/6/96)

DATE	ACTIVITY	STAFFING
May	SOP Std Op Procedure	1 Eng., 1 Opr.
June	SOP	1 Eng., 1 Opr.
July 1	SOP, Checklists, Lesson plans	1 Eng., 1 Opr.
July 29	Lesson plans, piping PCO (Physical Check Out)	2 Eng., 1 Opr.
August 12	FCO procedure, Piping PCO (Functional Check Out)	2 Eng., 1 Opr.
September 3	FCO procedure, Piping PCO	2 Eng., 2 Opr.
September 23	FCO procedure, Piping PCO, Continuity checks	2 Eng., 2 Opr., 2-3 E & I
September 30	PCO, Continuity checks, Pre-Training	2 Eng., 4 Opr., 2-3 E & I
October 14	PCO, Loop Checks, operator training*	2 Eng., 4 Opr., 4-6 E & I
December 2	Start water checks - FCO Days only	2 Eng., 4 Opr., 4-6 E & I
December 11	Final FCO ESD/Interlock test	2 Eng., 4 Opr., 2-3 E & I
Dec.27	Carbonyl burnout, Hot tests - FCO	1 Eng/shift, 2 - 3 Opr/shift, 1/2 to 1 E&I/shift
Jan. 6	Catalyst Reduction Batches	1 Eng/shift, 3 Opr/shift
Jan. 26	Ready for plant startup	1 Eng/shift, 3 Opr/shift

*Operator training will consists of 4 operators/crew in training for 1 week/crew or 4 weeks total.

Attach 2-1

Process Economics Study - Outline
LPM as an add-on to IGCC for Coproduction

Part One - Coproduction

1. Introduction

1.1. LPM Process Design Options.

- Develop plant design options for the LPM process, for design variables such as: a) feed gas pressure, b) feed gas compositions, and c) % syngas conversion.

2. LP Methanol Process advantage versus Gas Phase Methanol.

2.1. Syngas Conversion Cost for Methanol Production from CO-Rich syngas. (LP vs. GP).

- For the various LPM process design options (from 1.1) develop plant capital and conversion costs for a 500 t/d LPM plant, derived from the Kingsport Project costs and design basis,

- Summarize in a series of graphs, conversion costs, in cents per gallon over the range of syngas conversion from 15% (LP - Once-thru) to 94% (GP), for baseload annual coproduction operation. This will show LP's advantage at lower conversions; highlight process design or development

  2.1.1. 1000 psi, 5 ppm S, syngas; 500 t/d Plant size
  2.1.2. 500 psi, 5 ppm S, syngas; 500 t/d Plant size
  2.1.3. Impact of Plant Size on Conversion Costs

  - Summarize in a graph, conversion cost versus plant size, for 2.1.1 and 2.1.2 above. *Include plant size impact on product distribution (freight) cost, assuming that local markets are served. Freight cost will increase with plant size, as the distribution radius increases.*

2.2. Methanol Product Purification Cost. (LP Vs GP).

- Develop capital and operating costs for product purification design alternatives. Summarize LP's advantage (in cents per gallon), especially for MTBE and Fuel Grade from CO-rich gas at low conversions, Vs GP process.

  2.2.1. MTBE Grade; Over the above range of syngas conversion
  2.2.2. Fuel Grade
  2.2.3. Chem. Grade

2.3. Feedgas (Syngas) Composition Variations: (Impact on LP vs. GP).

- Higher Sulfur content in the feedgas will have a negative cost impact on LP at low syngas conversion, relative to GP at high conversions. Conversely, higher feedgas inert content will have a negative relative cost impact on GP.

  2.3.1. Sulfur content variation; over the above range of syngas conversion
  2.3.2. Inert gas content variation; over the above range of syngas conversion

2.4. Syngas ~~Utilization~~ Usage (Btu per Gallon) - (Impact on LP vs. GP).

- Summarize differences in syngas ~~utilization~~ usage (Btu per gallon of methanol), and in mass flow loss to the combustion turbine (kwh production loss per gallon of methanol); for the cases in 2.1 above.

Attach 3 - 1

Part One - Coproduction (Cont'd.)

2.5. Summary of Cost Advantage(s) - (LP Vs GP).

- Summarize the cost impact (cents per gallon) of the above design variables and syngas utilization differences. Show the impact of methanol plant size on the conversion costs. *Also (separately show) the impact of 90%, 80%, and 70% annual load utilization for use with Section 5. "Intermediate Load Coproduction and Stored Energy" of this Economics Study.*

- Recommend areas for process design value engineering work; and areas for demonstration at Kingsport.

3. Coproduction - Impact on Electric Power Cost -

3.1. Baseload Coproduction with Methanol Sales

3.1.1. 2 T/D methanol per MW (20% conversion)
3.1.2. 4 T/D methanol per MW (33% conversion)
3.1.3. 8 T/D methanol per MW (50% conversion)

For baseload coproduction, the gasifier must be sized for both the power and methanol products.. A matrix of power plant and methanol plant sizes of interest, is show in the following tables.

- For a given gasifier size (base is about 2160 x 10^6 Btu/hr. in this example); the methanol plant size and power plant size would change:

Methanol to Power Size	Power Plant Size	Methanol Plant Size	Syngas Conversion	Gasifier Size
0 T/D per MW	300 MW	0 T/D	0 %	Base
2 T/D per MW	250 MW	500 T/D	20%	Base
4 T/D per MW	200 MW	800 T/D	33%	Base
8 T/D per MW	150 MW	1200 T/D	50%	Base

- For a given baseload power plant size; the gasifier and methanol plant size is adjusted:

Methanol to Power Size	Power Plant Size	Methanol Plant Size	Syngas Conversion	Gasifier Size
0 T/D per MW	150 MW	0 T/D	0 %	0.50 x Base
2 T/D per MW	150 MW	300 T/D	20%	0.625 x Base
4 T/D per MW	150 MW	600 T/D	33%	0.75 x Base
8 T/D per MW	150 MW	1200 T/D	50%	1.00 x Base

- The impact of coproduction on electric costs should be shown in graphs of electricity cost Vs. methanol net back price, for both of these matrix tables. .

End of Part One.

Process Economics Study - Outline
LPM as an add-on to IGCC for Coproduction

Part Two - Coproduction for Intermediate Electric Load Following.

4. Intermediate Load Coproduction and Stored Energy.

4.1. Syngas Value.

4.1.1. Syngas value as a function of (time of day) Power Value.

- Our earlier load following work indicates that an LPM coproduction add-on optimizes for intermediate peak-load power in the 1000 to 2500 hr./yr. range. This means the methanol plant operates during "off--peak" power in the 7760 (88% utilization) to 6260 (71% utilization) hr./yr. range (8760 hr./yr. = 100% = total hr./yr.), with up to 200 annual daily stop/start operations for the daily on/off peaks.
  - *Time of day example: A given Lambda Curve might provide data at 2000 and 1500 peak hr./yr. such as: a)* 2.7 cent off-peak power (6760 hr.) plus 6.6 cent intermediate-peak power (2000 hr.) equals 3.6 cent baseload power (8760 hr.). b). 2.9 cent off-peak (7260 hr.) plus 7.0 cents intermediate-peak power (1500 hr.) equals 3.6 cent baseload power (8760 hr.). Time of day syngas values can be derived, based on the alternative value of using syngas for power (in CC or CT power plants).

4.1.1.1. Syngas value as function of seasonal opportunity fuels/feeds.

- *Natural gas may be available seasonally, for use in the CC power plant, allowing syngas to be used for conversion in an LPM add-on. Other feeds?*

4.1.2. Syngas value as function of cost to produce incremental quantity..

- ***Defer this for later study.*** We should await other CCT project (e.g. Tampa, Wabash River) projections of future IG facility fuel gas (syngas) costs, and/or electric power costs.

4.2. Intermediate Load Coproduction - for Methanol Sales.

- ***Defer this for later study.*** For all intermediate load coproduction cases, redundant investment to utilize syngas on/off-peak is required; so that when the methanol plant shuts down during peak power periods, all of the syngas can be converted to electric power. There are many intermediate load coproduction power plant design choices; a) CC power plant turned down, or b) CC power plant baseload with CT power plant for peak; which may be combined with many methanol plant choices of size/% conversion. To do these studies properly, we need to have good time of day power values (also called Lambda Curves) as well as the Section 2. (above) Methanol Plant design choices completed.

Methanol may also be used as backup fuel for enhanced power plant availability,.

4.3. Intermediate Load Stored Energy Production, with Methanol Fuel for Peak Power Production.

- ***Defer this for later study.*** The design optimization for this is quite complex. The IGCC/OTM plant design has an additional variable: the peaking power plant size and hours of operation is an independent variable. We may be able to use the ( ) study with a published paper as goal. An alternative study option is to compare ourselves (IGCC/OTM) to the various published EPRI (IG-Cash, et. al.) studies, which have some favorable Lambda Curves examples for energy storage.

4.4. Intermediate Load Stored Energy Production, with Methanol for Dispersed Energy.

- Methanol transported to remote **existing** or new power plants on the Utilities grid system.

End of Part Two.

Part Three - Methanol Fuel Applications

5. Premium Methanol Fuel Applications

- At 40 cents per gallon, methanol as a fuel ($6.00 per mmBtu) will not compete with oil in most applications ($20/bbl crude = $3.30/mmBtu; $24/bbl diesel = $4.00 /mmBtu). However, methanol coproduced at a central IGCC power station, may be a valuable premium fuel for two evolving developments: as an economical Hydrogen source for small fuel cells, and as an environmentally advantaged fuel for dispersed electric power.

- "Central clean coal technology processing plants, making coproducts of electricity and methanol; to meet the needs of local communities for dispersed power and transportation fuel" - meets the DOE Clean Coal Technology Program's objectives. Serving (initially) small local fuel markets also builds on LP's (the LPMEOH™ process) strengths; good economics at small methanol plant sizes, fuel grade product distillation savings, and a freight advantage in local markets vis a vis large off-shore remote gas methanol. Baseload methanol coproduction studies show that (40) cent per gallon methanol can be provided from an abundant, non-inflationary local fuel source.. *We need to show when (at what oil price) we can compete, and to arrange fuel tests to confirm the dispersed energy environmental advantage.*

5.1. Hydrogen Source for Fuel Cells

- Hydrogen fuel cells, being developed for transportation applications, can achieve 65% system efficiency, as compared to 45% for diesel IC engines and 32% for gasoline IC engines. Methanol is a storable, transportable liquid fuel which can be reformed under mild conditions to provide H2. For small H2 applications, *and at low utilization factors,* methanol reforming is a more economical source of hydrogen than : a) natural gas reforming, b) distillate (oil) reforming; and is cheaper than LH_2.

5.1.1. Fuel Cells for Transportation

5.1.2. Fuel Cells for Stationary Power

(See also dispersed power below).

5.1.3. Industrial Applications - Small Hydrogen Plants

Small pressurized methanol reformers for transportation applications may be suitable for adapting to meet the needs of small commercial hydrogen gas requirements.

5.2. Dispersed Power

- Dispersed power is getting a lot of favorable publicity. . The world wide package (0.2 MW to 10 MW) power plant market is large. A variety of technologies (combustion turbine, internal combustion engine, fuel cell) are being packaged to provide power and heat locally, at the use point. Environmental and Economic advantages include Methanol for Fuel Cells = clean stationary local power; no need for natural gas pipelines; no new high voltage power lines.

5.3. Dimethyl Ether as an Enhancement to Methanol in Premium Fuel Applications

Can coproduced mixtures of methanol and dimethyl ether improve upon methanol, in the above?

<u>End of Part Three.</u>

APPENDIX G - TASK 1.5.4 - PROJECT REVIEW MEETING (June 28th)
14 PAGES

WRB
for 6/28

Agenda For 28 June 1996

LPMEOH™ Project Review Meeting
@ DOE - HQ

Start 10:15

			Start Time
•	Introductions	All	10:15 ✓
•	Phase 1, 2, and 3 - Overview Agreements, Cost Plan, Statement of Work - Still Valid*	WRB	10:30
•	Phase 1 and 2 - Project Status (Pictures, Schedule, PETC/EMN/APCI relationships)	DPD	10:45 1035 ✓
•	Phase 3 - Plans	WRB	11:00
•	Commercialization	WRB	
•	Issues = None	WRB	
•	Continuation Application Approved By 30 September		11:30 11:20
	• DOE Review/Approval Processes	DOE (HQ-PETC)	
	• Timing Required For Approval:	DOE (HQ-PETC)	
	• Expectations/Recommendations	WRB/All	
•	Conclusion/Wrap-up		12:00

Attendee's: Air Products - Barry Halper, Dave Drown, Bill Brown, Eastman - Bill Jones, DOE/PETC - Bob Kornosky and Bill Mundorf DOE/HQ - Lowell Miller, George Lynch, Doug Archer

* Conclusion: Costs, Plan, Scope have not changed, except 90-day front-end slip.

Agenda3 - wrb
6/25/96

Phase 1, 2 and 3 Overview - (WRB)

Ref Clean Coal Today Article

+ "Success Factors"

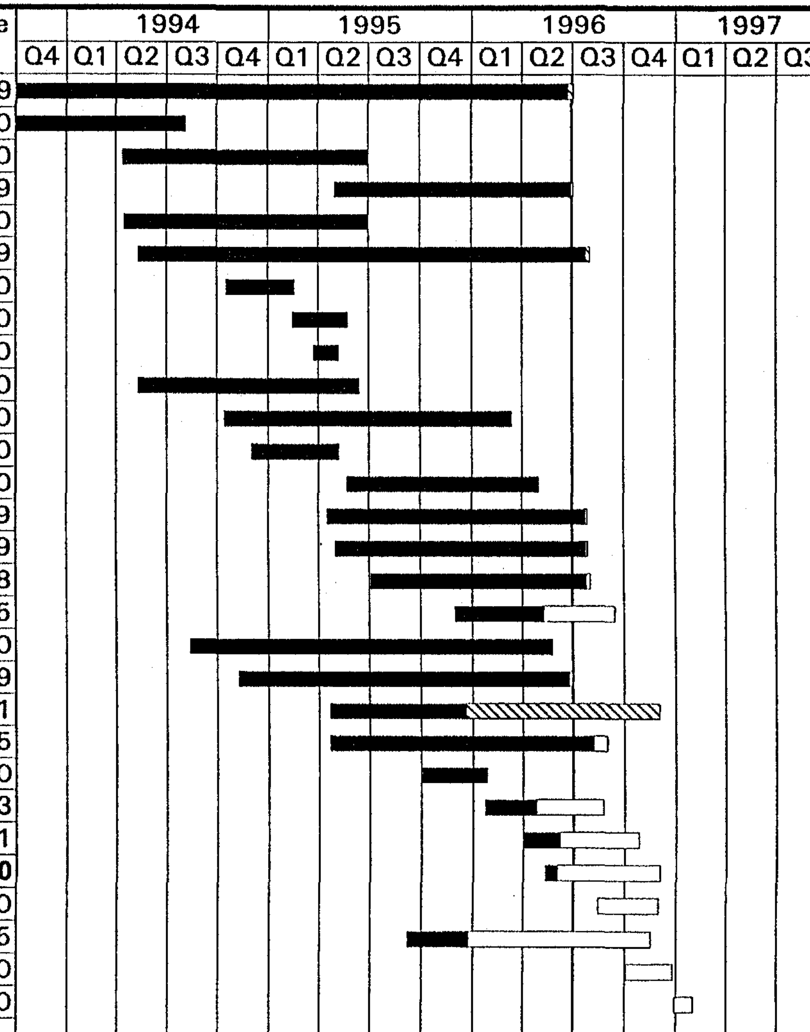
- **Agreements, Commitments - Still Valid**
- **Cost Plan - Still Valid**
  - Oct. '94 vs June '96 Plan - Same total and end date.
  - (About a 2 to 3 month slip in Phase 2 and Phase 3 Start).
- **Phase 3 Statement of Work - Still Valid**
  - Environmental Monitoring Plan - Done
  - Demonstration Test Plan - Done 37 Tests ✓ Good DOE input Catalyst Temperature Control Life
  - DME is still an option -
    - Dec. '96 Decision Milestone still valid.

Phase 1 and 2 - Project Status (DPD)

- **Design and Procurement -**
  - Done
- **Construction Status (Pictures)**
  - Mechanical Completion = Dec. 2
- **Schedule**
  - Reactor at site, All Major Construction bids - Done (by July 15)
  - Remaining uncertainties are small
  - Construction Productivity - Normal
  - Training, Commissioning and Startup Plans- Done
- **Participant Relationships - Good**
  - DOE-PETC + Eastman + Air Products
  - "Success Factors" - Mid-term Report Card = A!

LPMEOH DEMONSTRATION PROJECT
PHASE 1-2 SUMMARY SCHEDULE

Task Name	Start	End	Perce Com
PROCESS DESIGN	Oct/01/93	Jul/01/96	99
PFD/HEAT & MAT'L BALANCE	Oct/01/93	Aug/05/94	100
PROCESS EQUIPMENT SPECS	Apr/13/94	Jun/30/95	100
REVIEW DETAIL DESIGN	May/01/95	Jul/01/96	99
NEPA FONSI REVIEW	Apr/15/94	Jun/30/95	100
DETAILED DESIGN	May/11/94	Jul/31/96	99
P&ID'S, REV. PC	Oct/17/94	Feb/17/95	100
OPERABILITY/HAZARDS REVIEWS	Feb/13/95	May/24/95	100
P&ID'S, REV. P1	Mar/23/95	May/08/95	100
PROCESS EQUIP. MECH. SPECS	May/11/94	Jun/13/95	100
EQUIPMENT VENDOR PRINTS	Oct/14/94	Mar/12/96	100
EQUIPMENT ARRANGEMENTS	Dec/01/94	May/08/95	100
INSTRUMENT SPECS	May/22/95	Apr/29/96	100
CIVIL/STRUCTURAL DESIGN	Apr/17/95	Jul/26/96	99
PIPING DESIGN	May/01/95	Jul/26/96	99
INSTRUMENT/ELECTRICAL DESIGN	Jul/03/95	Jul/31/96	98
DCS PROGRAMMING	Dec/01/95	Sep/13/96	55
EQUIPMENT PROCUREMENT	Aug/12/94	May/23/96	100
REACTOR DELIVERY	Nov/08/94	Jun/28/96	99
CONSTUCTION	Apr/21/95	Dec/02/96	41
EASTMAN OSBL WORK	Apr/21/95	Aug/30/96	95
CIVIL/UNDERGROUND	Oct/02/95	Jan/26/96	100
STEEL & EQUIPMENT ERECTION	Jan/22/96	Aug/22/96	43
MECHANICAL	Apr/01/96	Oct/25/96	31
INSTRUMENT/ELECTRICAL	**May/09/96**	**Dec/02/96**	**10**
INSULATION & FIRE PROOFING	Aug/12/96	Nov/29/96	0
PROCEDURES/TRAINING	Sep/05/95	Nov/15/96	25
CHECK-OUT/COMMISSIONING	Oct/01/96	Dec/24/96	0
START-UP	Dec/27/96	Jan/31/97	0



Printed: Jun/27/96
Page 1

Milestone △ Summary
Fixed Delay ----

Phase 3 - Plans (WRB)

- **Operations take over of plant - Dec. 2, 1996** Commissioning
- **Catalyst Reduction and Startup - January 1997** of operation
- **Demonstration/Operational Testing - 1997 - 2000**
- **Off-site Fuel Testing - 1998 - 1999** May
- **DME Implementation Decision - March 1998**
  - Interim Decision for LaPorte PDU Testing - Dec. 1996.
- **Final Report(s) - Dec. 28, 2001**

PROJECT EVALUATION PLAN FOR BUDGET PERIOD NO. 2

Status

Show PEP

A. PHASE 1 DESIGN AND PHASE 2 CONSTRUCTION OF THE LPMEOH PROCESS DEMONSTRATION FACILITY

PHASE/TASK	Status	Comments
1.2 Permitting		
x Issue Final EIV	Done	Final being released, for printing.
x Obtain Construction and Operation Permits	Done	
1.3 Design Engineering		
x Complete the design engineering	Done	(98% Complete)
x Prepare the Environmental Monitoring Plan	Done	Final being issued
2.1 Procurement		
x Procure all equipment and materials	Done	
2.2 Construction		
x Complete mechanical construction; so that checkout and commissioning can be started in Budget Period No. 3.	Forecast: 12/2/96	About 41% complete, as of 6/21/96.
x (ready for checkout, etc.)	(")	
x (manage construction)	(")	
2.3 Training and Commissioning		
x Prepare four year test plan for Phase 3, Task 2-Operation.	Done	Final comments received, will release 7/3/96.
x Prepare operating manual, initiate operator training.	On-schedule.	Operator training in October.
1.5 & 2.5 Administration		
x Submit all Project status, etc. reports as required by the Cooperative Agreement.	x	Monthlies Done - Quarterlies catching up.
x Prepare annually an updated plan for remaining activities.	One Done On Schedule	The second plan provides the basis for the B.P. No. 3 Cost Plan.

Completion of the above work activities will essentially ready the LPMEOH Process Demonstration Facility for commissioning, startup, and operation to begin in the final Budget Period No. 3.

PROJECT EVALUATION PLAN
FOR
BUDGET PERIOD NO. 2
Status

B. Other Planning, Administration and DME Verification Testing tasks.

PHASE/TASK	Status	Comments
1.4 & 2.4 Off-site Testing.		
x Prepare the fuel-use plan for Phase 3, Task 4: Off-site product tests.	Underway	The task 2.3 Demo Test Plan, now indicates mid 1998 thru 1999 test time frame. Fuel cell and dispersed power applications are being targeted.
1.5 Planning, Administration and DME Verification Testing.		
x Update product-use plan.	Underway	*Part of 1.4, above.*
x Complete economic studies of commercial aspects. Provide input to op. test plan.	Underway	Outline issued. First draft about 7/30. Input to op. test plan has been provided.
x Perform Testing for Dimethyl Ether (DME)	On Schedule	For Dec. 1996 Decision.
x Laboratory R & D. DVT / (Design Verification Testing)	"	Promising results.
x Market Economic DVT	"	" "

"At the time the Project Evaluation Report for Budget Period No. 2 is submitted with the Continuation Application; Air Products will also prepare an update on the expected technical and economic performance of the mature unit. This update will demonstrate the commercial potential to enhance IGCC electric power generation with coproduct methanol. This IGCC enhancement is expected to reduce the cost of electricity for retrofit, repowering, replacement, and new application for electric power generation from coal."

PROJECT EVALUATION PLAN
FOR
BUDGET PERIOD NO. 2
Status

Recommendations
for Budget Period No. 3 Submittal.

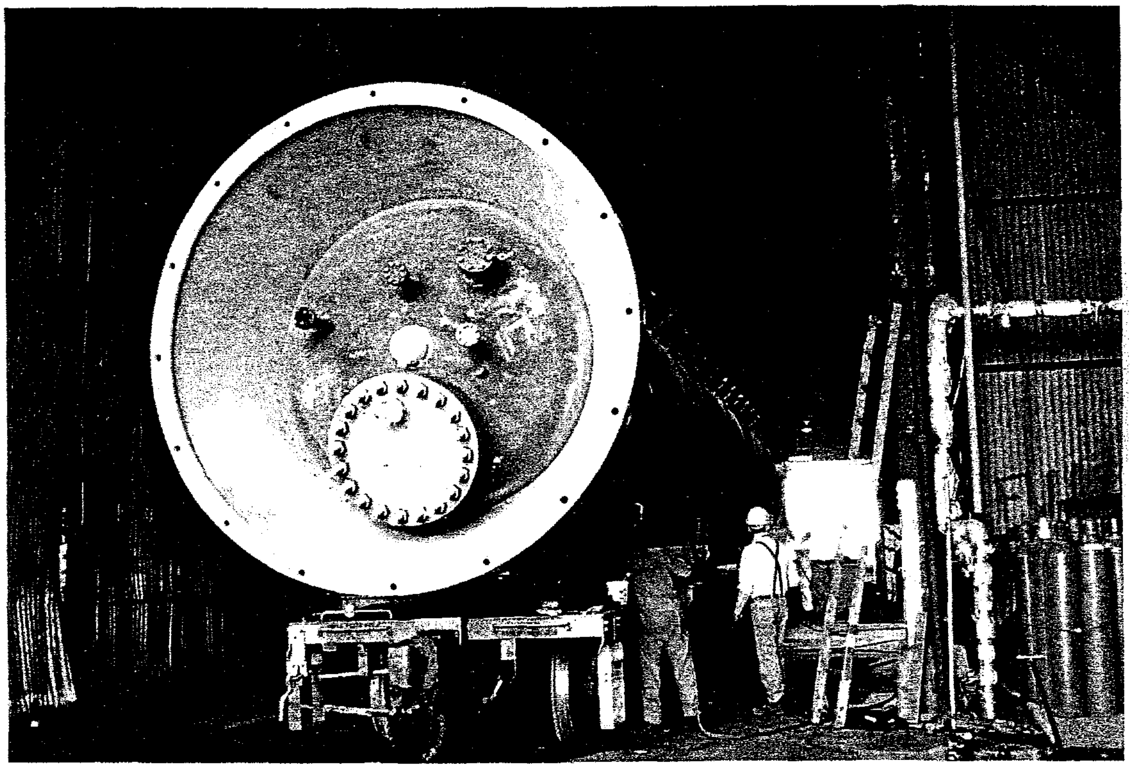
1. Submit Continuation Application for Budget Period No. 3, in time for 30 Sept. 1996 approval.

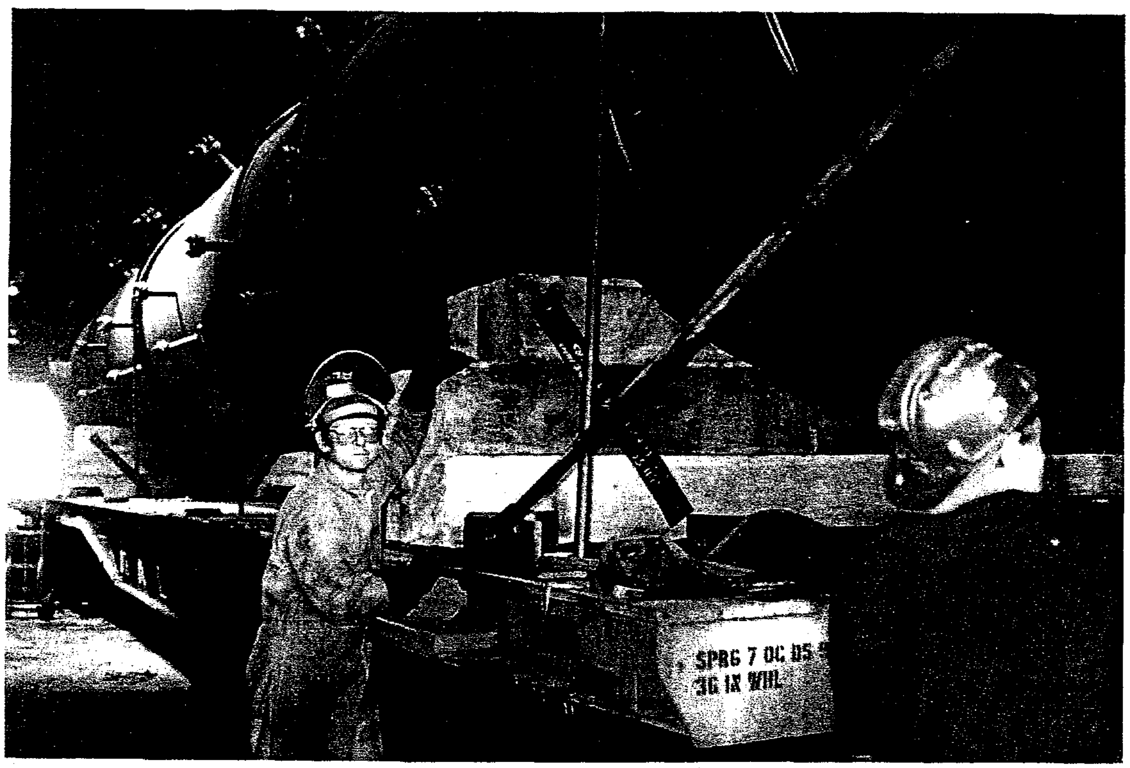
2. Consider contingent approval, such as the following:

   "DOE funds may not be expended by the Participant on tasks under Phase 3: Operation unless and until the Contracting Officer notifies the Participant in writing that the Contracting Officer"s Technical Representative has verified that construction of the Liquid Phase Methanol Demonstration Facility has been mechanically completed."

3. The Participant should submit the Continuation Application documentation by Aug 1 (date).

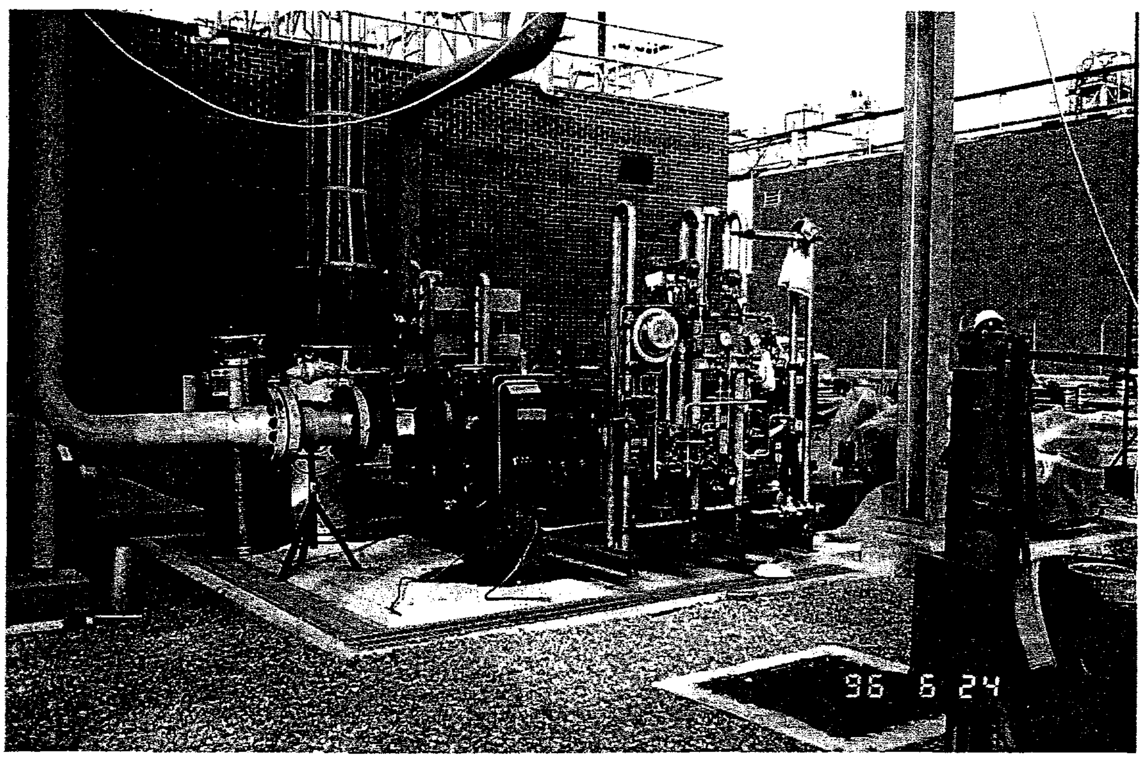
KINGSPORT LPMEOH DEMONSTRATION PROJECT





REACTOR LEFT JOSEPH OAT'S SHOP, CAMDEN, NJ 6/14/96

KINGSPORT LPMEOH DEMONSTRATION PROJECT



6/24/96

1) Reactor At Kingsport
2) Recycle Compressor

KINGSPORT LPMEOH DEMONSTRATION PROJECT
6/4/96 STATUS

Outline 6/27 for notes (HQLP.Doc)

COMMERCIALIZATION

IGCC Coproduction with Liquid Phase Technology

Bill Brown - Air Products - 6/28/96.

Why Liquid Phase Technology for Coproduction?

- **Liquid Phase "Once-Through" Methanol from coal is economic.**
    - Gas Phase Technology is not.
    - "All-Methanol" is not.
- **Coproduced liquids from coal (versus from off-shore gas) is economic.**
- **Liquid Phase Technology makes coproduction viable.**

(Ref. a.)

Why Coproduction?

- **Reduce Electric Power Costs**
    - When power demand is cyclical
    - When methanol valued at > 50 to 60 cents/gallon
- **Hasten IGCC Penetration**
    - With Environmental Benefits
- **Cost effectively serve moderate size regional markets**
    - Energy and Chemical markets;
    - with locally produced goods.
- **Reduce Oil imports**

(Ref. b.)

IGCC Coproduction with Liquid Phase Technology

When, in U.S.?

- **IGCC Forecast is Large**
  - 150,000 MWe in 20 years
  - Additions, Replacements
  - Repowering old Steam Plants
  - Natural Gas (CC plant) Conversions
- **But, has slipped a Decade**
  - Since our 1989 CCT-3 proposal

(Ref. c.)

Impact

- **IGCC Forecast for U.S.:**
  - 150,000 MWe in initial two decades.
- **Methanol Plant Sizes; for IGCC coproduction:**
  - @ 250 MWe (2T/D per MWe); 150,000 Gal. per Day
  - @ 250 MWe (4T/D per MWe); 300,000 Gal. per Day
  - @ 500 MWe (4T/D per MWe); 600,000 Gal. per Day
  - For Reference:
    - Kingsport Demo is 80,000 Gal. per Day; with higher hopes.
    - Off-shore world scale is 750,000 Gal. per Day.

World Meth Capacity ~ 75,000 T/D 22,000,000 Gal/D

- **Two Decade Impact;** (at 3T/D per MWe; on 50% of IGCC)
  - Gallons of Methanol per Day: 67,500,000 = 220,000 T/D (3×'s worlds' use now)
  - Bbl per Day, Oil Equivalent: 800,000 (4.4% of oil use)
    - About 8 % of U. S. Oil Imports
  - At 6 T/D Methanol per MW ?!

(Ref. d.)

When, Elsewhere?

- **Refineries -**
  - Europe, Pacific Rim
- **Coal -**
  - India, China, Pacific Rim, East Europe, Australia

(Ref. e.)

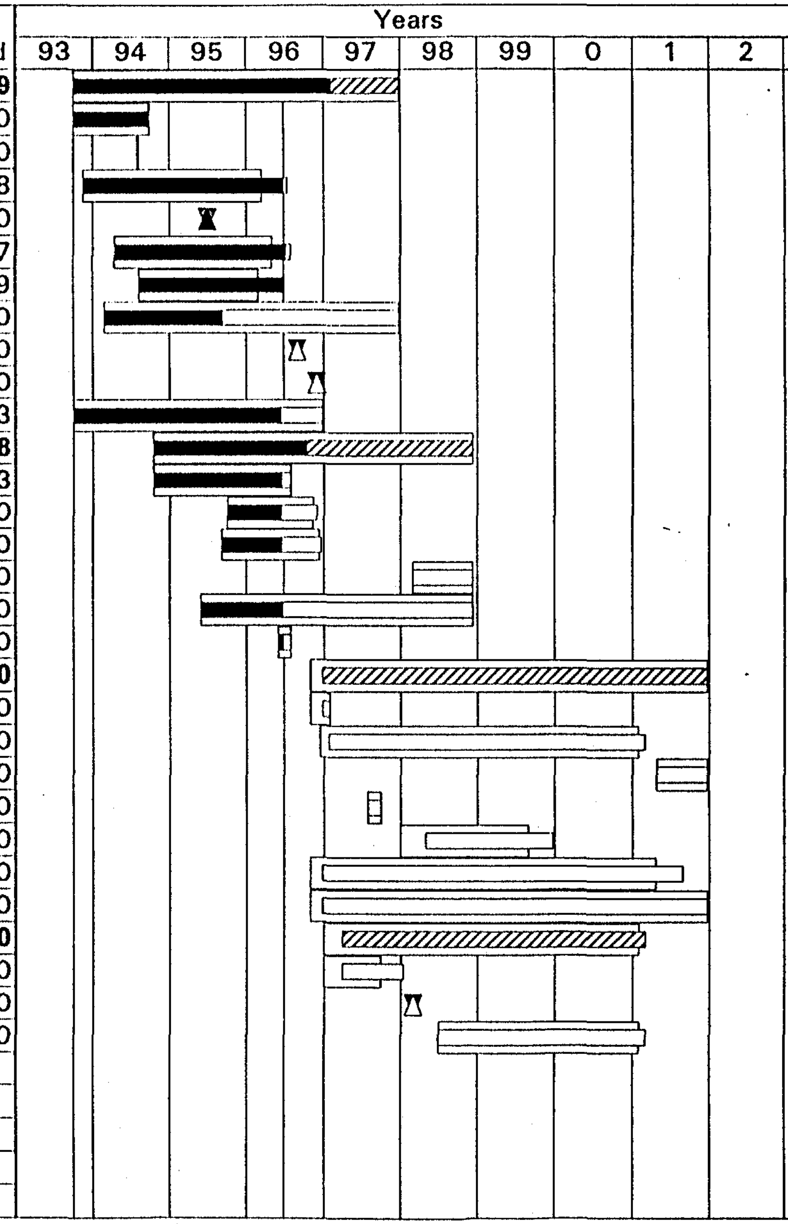
Conclusion

- **Big Impact Potential for Coproduction with IGCC**
- **Liquid Phase Technology can make coproduction happen.**
- **The Demonstration is essential for Commercialization**
- **Timing is just right.**
  - Ready when IGCC is ready.
  - First Decade(s) of 21st Century - .

APPENDIX H - MILESTONE SCHEDULE AND COST FORECAST
2 PAGES

MILESTONE SCHEDULE STATUS REPORT
LIQUID PHASE METHANOL DEMONSTRATION
DE-FC22-92PC90543

Task Name	Duration	Start	End	% Comp	% Sched
PHASE 1: DESIGN	**51.20 m**	**Oct/01/93**	**Dec/30/97**	**97**	**79**
PROJECT DEFINITION(TASK1)	12.04 m	Oct/01/93	Sep/30/94	100	100
CONTINUATION APPLICATION(B.P.#2)	9.00 d	Aug/02/94	Aug/10/94	100	100
PERMITTING(TASK 2)	32.07 m	Nov/17/93	Jul/15/96	98	98
NEPA FONSI APPROVAL	0.00 d	Jun/30/95	Jun/30/95	100	100
DESIGN ENGINEERING(TASK 3)	27.71 m	Apr/15/94	Aug/01/96	98	97
VENDOR ENGINEERING	22.83 m	Aug/10/94	Jul/01/96	99	99
OFF-SITE TESTING(TASK 4)	46.35 m	Feb/25/94	Dec/30/97	10	40
UPDATED FUEL TEST PLAN APPROVAL	0.00 d	Aug/31/96	Aug/31/96	0	0
DECISION TO CONTINUE DME TESTING	0.00 d	Dec/01/96	Dec/01/96	0	0
PLANNING, ADMIN & DME DVT(TASK 5)	39.16 m	Oct/01/93	Dec/30/96	95	83
PHASE 2: CONSTRUCTION	**50.18 m**	**Oct/17/94**	**Dec/15/98**	**60**	**48**
PROCUREMENT(TASK1)	21.61 m	Oct/17/94	Aug/01/96	98	93
CONSTRUCTION(TASK 2)	14.12 m	Oct/02/95	Dec/02/96	41	60
TRAINING & COMMISSIONING(TASK 3)	15.70 m	Sep/05/95	Dec/23/96	25	60
OFF-SITE TESTING(TASK 4)	9.57 m	Mar/01/98	Dec/15/98	0	0
PLANNING & ADMINISTRATION(TASK 5)	42.69 m	Jun/01/95	Dec/15/98	30	30
CONTINUATION APPLICATION(B.P.#3)	2.08 m	May/31/96	Aug/01/96	40	40
PHASE 3: OPERATION	**60.31 m**	**Dec/27/96**	**Dec/28/01**	**0**	**0**
START-UP(TASK 1)	1.22 m	Dec/27/96	Feb/01/97	0	0
METHANOL OPERATION(TASK 2.1)	49.52 m	Jan/26/97	Mar/06/01	0	0
DISMANTLE PLANT(TASK 2.3)	7.98 m	May/01/01	Dec/28/01	0	0
ON-SITE PRODUCT USE DEMO(TASK 3)	2.08 m	Aug/01/97	Oct/02/97	0	0
OFF-SITE PRODUCT USE DEMO(TASK 4)	20.02 m	May/01/98	Dec/28/99	0	0
DATA ANALYSIS/REPORTS(TASK 5)	56.35 m	Dec/27/96	Aug/30/01	0	0
PLANNING & ADMINISTRATIVE(TASK 6)	60.31 m	Dec/27/96	Dec/28/01	0	0
PROVISIONAL DME IMPLEMENTATION	**47.41 m**	**Apr/01/97**	**Mar/07/01**	**0**	**0**
DME DVT(PDU TESTS)(TASK 3.6)	9.57 m	Apr/01/97	Jan/15/98	0	0
DECISION TO IMPLEMENT	0.00 d	Mar/01/98	Mar/01/98	0	0
DESIGN, MODIFY & OPERATE(TASK 3.2.2)	32.36 m	Jul/01/98	Mar/07/01	0	0



Milestone △ Summary

DOE F 1332.9
(11-84)

U.S. DEPARTMENT OF ENERGY
COST MANAGEMENT REPORT

FORM APPROVED
OMB 1910-1400

1. TITLE
Liquid Phase Methanol Demonstration

2. REPORTING PERIOD
June 01, 1996 through June 30, 1996

3. IDENTIFICATION NUMBER
DE-FC22-92PC90543

2. PARTICIPANT NAME AND ADDRESS
Air Products Liquid Phase Conversion Co., L.P.
7201 Hamilton Boulevard
Allentown, PA 18195-4911

5. COST PLAN DATE
October 01, 1995

6. START DATE
January 1, 1990

7. COMPLETION DATE
December 31, 2001

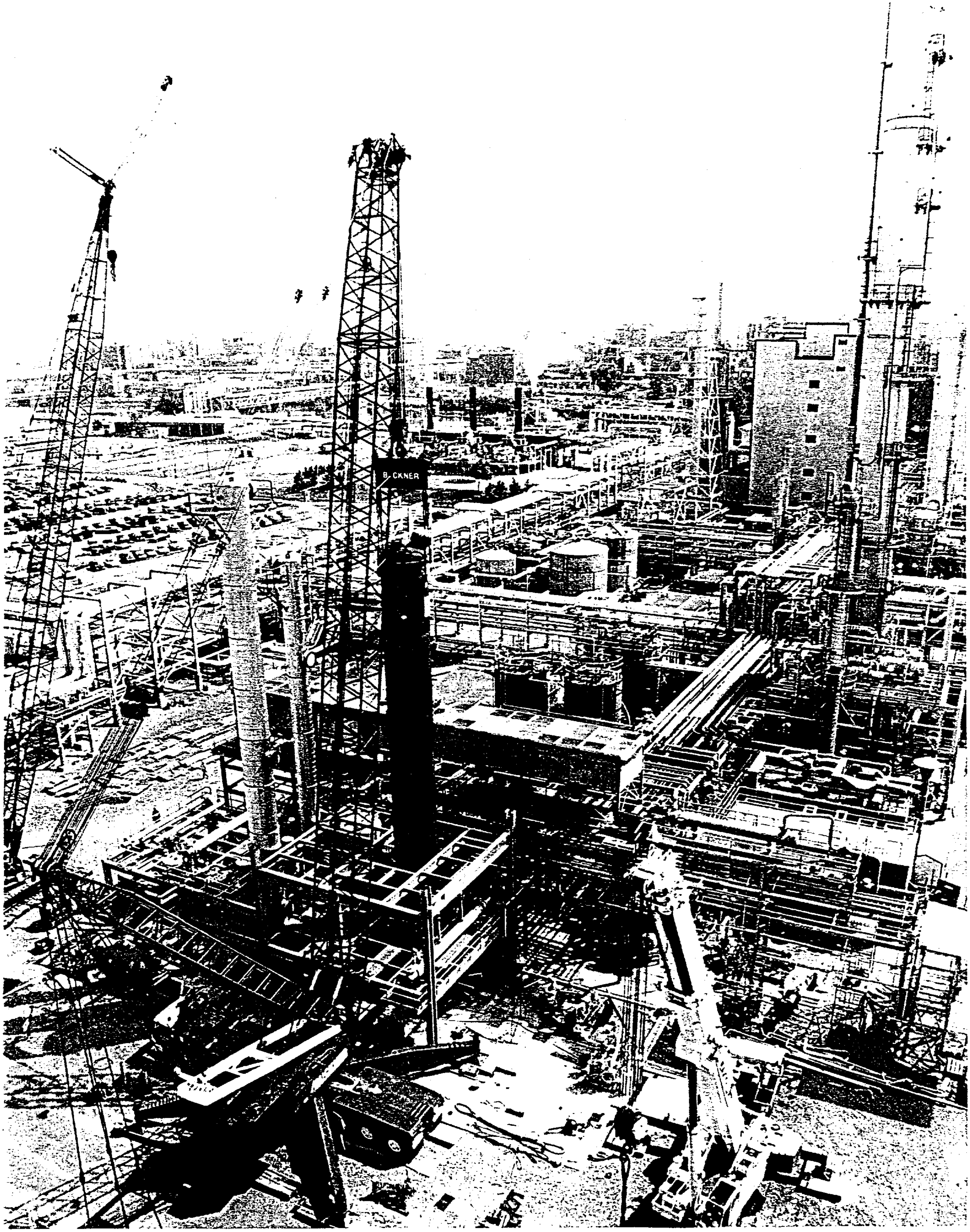
8. ELEMENT	9. REPORTING ELEMENT	10. ACCRUED COSTS Reporting Period a. Actual	b. Plan	Cumulative to Date c. Actual	d. Plan	11. ESTIMATED ACCRUED COSTS a. Subsequent Reporting Period	b. Balance of Fiscal Year	c. FY 1997 (1)	FY 1998 (2)	FY 1999 (3)	d. Subsequent FY's (4)	e. Total	12. Total Contract Value	13. Variance
	Prior to Mod 2	0	0	16,289	16,289	0	0					16,289	16,289	0
1.1.1	Project Definition	0	0	1,044	1,021	0	0	0	0	0	0	1,044	1,021	23
1.1.2	Permitting	2	0	237	246	0	0	0	0	0	0	237	246	(9)
1.1.3	Design Engr.	346	339	9,300	9,169	200	290	600	0	0	0	10,390	9,960	430
1.1.4	Off-site Testing	0	8	12	58	8	54	246	0	0	0	320	320	0
1.1.5	Planning, Admin, & DME Verif. Testing	147	43	2,403	1,766	61	60	0	0	0	0	2,524	1,892	632
1.2.1	Procurement	1,157	691	8,219	7,413	163	325	700	0	0	0	9,407	9,783	(376)
1.2.2	Construction	734	923	3,936	7,938	1,654	3,308	1,602	0	0	0	10,500	11,200	(700)
1.2.3	Train. & Commissioning	0	149	1	717	200	396	600	0	0	0	1,197	1,197	0
1.2.4	Off-Site Test - Proc. & Constr.	0	0	0	0	0	0	180	81	0	0	261	261	0
1.2.5	Planning & Admin	78	46	318	475	40	72	251	0	0	0	681	681	0
1.3.1	Startup	0	0	0	0	0	0	3,435	0	0	0	3,435	3,435	0
1.3.2	Operations													0
1.3.2.1	Methanol Operation	0	0	0	0	0	0	33,753	36,822	36,822	39,890	147,287	147,287	0
1.3.2.2	DME Design, Mod., Oper.	0	0	0	0	0	0	351	509	680	800	2,340	2,340	0
1.3.2.3	LPMEOH Dismantlement	0	0	0	0	0	0	0	0	0	425	425	425	0
1.3.3	On-Site Product Use Demo	0	0	0	0	0	0	0	0	2	2	4	4	0
1.3.4	Off-Site Product Use Demo	0	0	0	0	0	0	427	2,773	340	300	3,840	3,840	0
1.3.5	Data Analysis & Reports	0	0	0	0	0	0	385	380	500	661	1,926	1,926	0
1.3.6	Planning & Admin.	0	0	0	0	0	0	245	252	260	836	1,593	1,593	0
14. TOTAL		2,463	2,199	41,760	45,092	2,326	4,505	42,775	40,817	38,604	42,914	213,700	213,700	0

15. DOLLARS EXPRESSED IN:
Thousands

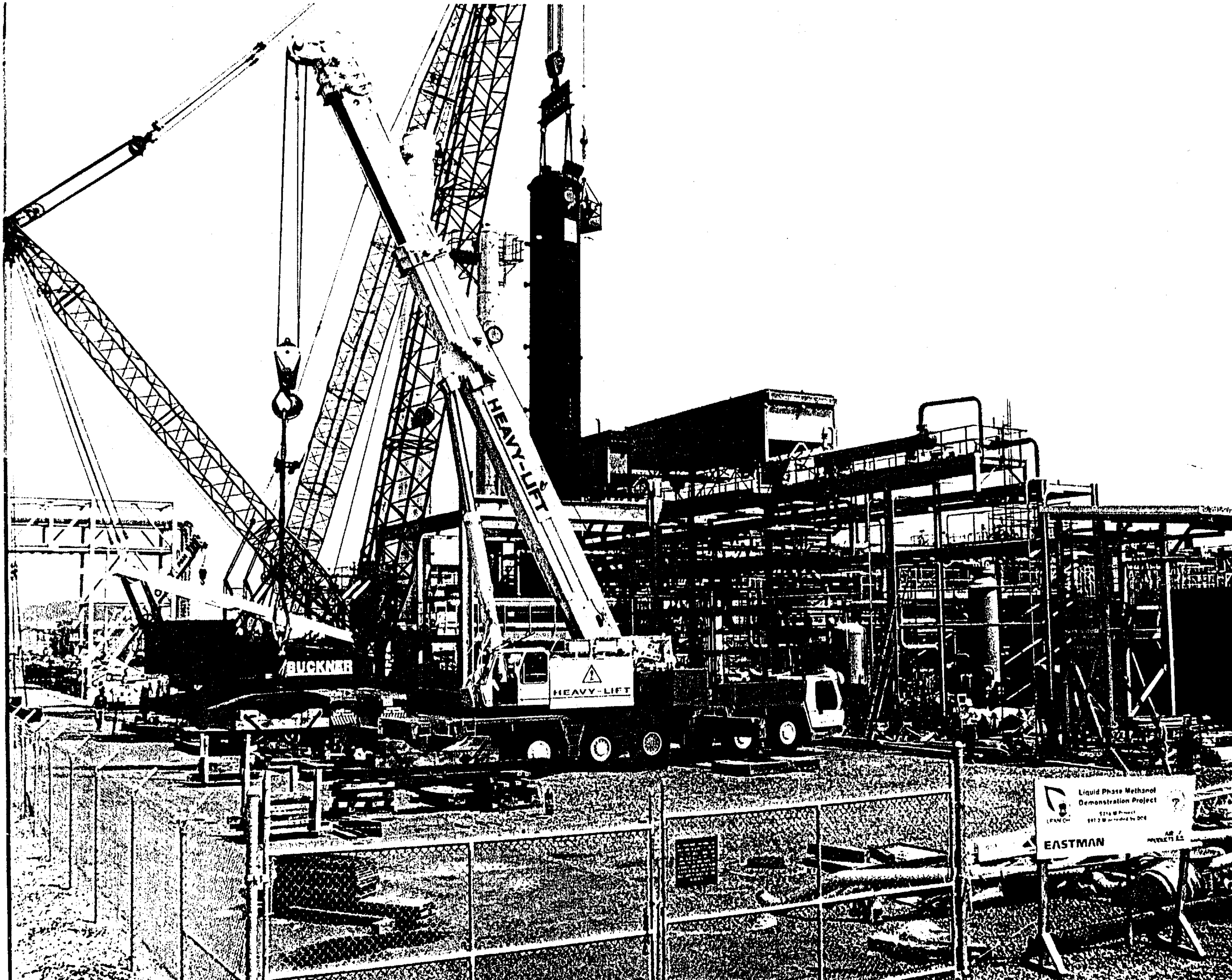
16. SIGNATURE OF PARTICIPANT'S PROJECT MANAGER AND DATE
D. P. Drown 7/2/96
DATE

17. SIGNATURE OF PARTICIPANT'S AUTHORIZED FINANCIAL REPRESENTATIVE AND DATE
Susan J. Kasnecz 7/29/96
S. J. Kasincz
DATE

APPENDIX I - TASK 2.2 - SITE CONSTRUCTION PHOTOS
2 PAGES



7/12/96


HEAVY-LIFT
BUCKNER
HEAVY-LIFT
Liquid Phase Methanol
Demonstration Project
EASTMAN

7/2/96.

APPENDIX J - TASK 2.3 - DEMONSTRATION TEST PLAN
4 PAGES

TABLE 5-1 - DEMONSTRATION TEST PLAN

Test Run #	Test Run Description	Temp (Deg C)	Wt% Cat	H2/CO Ratio at Inlet	Space Velocity (Sl/hr-kg)	MeOH (tpd)	Fresh Feed Balanced (KSCFH)	Fresh Feed CO Gas (KSCFH)	Fresh Feed H2 Gas (KSCFH)	Recycle Gas (KSCFH)	Inlet Sup. Velocity (ft/sec)	Time Period (weeks)	Elapsed Time (incl. outages) (weeks)	Start of Test
Task 2.1.1 - Process Shakedown and Catalyst Aging:														
1.	Initial Shakedown; and	250	28	2.42	8,000	260	900	50	40	1,800	0.64	6	6	Feb-97
	Design Production Tests						(varies, to maintain syngas utilization.)							
2.	Gassed Slurry Level	Part of other tests										Ongoing		
3.	Reactor Feed: Texaco-	250	28	0.67	9,240	202	650	95 (*)	0	2,612 (*)	0.77	2	9	Mar-97
	Type Syngas													
4.	Early Testing @ High	250	28	2.54	10,300	TBD	1,200 (**)	50	40	2,520 (*)	0.88	2	12	Apr-97
	Superficial Velocity													
5.	Check @ Test 1	250	28	2.42	8,000	< 260	900	50	40	1,800	0.64	2	15	Apr-97
	Conditions													
6.	Catalyst Addition and	250	28 - 40	2.51	Dec. from	237	765	40	45	Max	0.79	18	41	May-97
	Aging	or less		2.30	8,000	260	900	50	40	(2,700)	TBD	6		to
	(Note: Kingsport Complex Outage during this test)													Nov-97
7.	Free-Drain Entrained/	250	28 - 40	2.51	Dec. from	237	765	40	45	Max	0.79	During		
	Condensed Oil to	or less			8,000							Test 6		
	Reactor													
8.	Operation @ Design	250	40	2.42	4,000	260	900	50	40	1,800	0.64	2	43	Nov-97
	Feed Gas Rates													
9.	Check for Limitation on	250	> 40	2.51	Varies	TBD	765	40	45	Max	0.79	6	50	Nov-97
	Catalyst Slurry Concentration									(2,700)				
10.	Catalyst Addition to	250	Target	2.49	3,320	256	765	40	45	2,605	0.79	12	68	Jan-98
	Reach Max Productivity	or less	45	2.29	3,500	293	900	50	40	2,520	0.81	2		
				TBD	TBD	TBD	1,110 (**)	50	40	2,520	0.86	2		

TABLE 5-1 - DEMONSTRATION TEST PLAN

Test Run #	Test Run Description	Temp (Deg C)	Wt% Cat	H2/CO Ratio at Inlet	Space Velocity (Sl/hr-kg)	MeOH (tpd)	Fresh Feed Balanced (KSCFH)	Fresh Feed CO Gas (KSCFH)	Fresh Feed H2 Gas (KSCFH)	Recycle Gas (KSCFH)	Inlet Sup. Velocity (ft/sec)	Time Period (weeks)	Elapsed Time (incl. outages) (weeks)	Start of Test
Task 2.1.2 - Process Operational Test Phase:														
	Note: At this time, need to produce some "typical" product methanol for off-site fuel tests. Also need to reassess the optimum operating conditions for the remaining tests (e.g. feed gas allocation for commercial design/optimal performance).													
11.	Catalyst Addition/ Withdrawal Test	250	Target 45	2.49	3,320	256	765	40	45	2,605	0.79	6	74	May-98
12.	Test 11 Conditions with No CO Make-up	250	Target 45	4.97	3,282	229	765	0	45	2,605	0.78	2	76	Jul-98
13.	Test 11 Conditions with No H2 Make-up	250	Target 45	1.98	3,277	252	765	40	0	2,605	0.78	2	79	Jul-98
14.	Test 11 Conditions with No H2 or CO Make-up	250	Target 45	5.03	3,238	232	765	0	0	2,605	0.77	2	81	Aug-98
15.	Repeat of Test 11 Conditions	250	Target 45	2.49	3,320	256	765	40	45	2,605	0.79	2	83	Aug-98
16.	Design Fresh Feed Operation Test	250	Target 45	2.29	3,500	293	900	50	40	2,520	0.81	2	86	Sep-98
17.	Testing @ High Superficial Velocity	250	Target 45	TBD	TBD	TBD	1,110 (**)	50	40	2,520	0.86	2	88	Sep-98
18.	Turndown and Ramping	250	Target 45	3.30	1,825	151	450	25	60	1,364	0.44	4	92	Oct-98
19.	Load-Following, Cyclone, & On/Off Tests		Target 45	Balanced, CO-Rich	To be Defined							6	99	Nov-98
20.	Reactor Feed: Texaco-Type Syngas	250	Target 45	0.69	2,870	207	650	85 (**)	0	2,195	0.67	4	103	Dec-98

TABLE 5-1 - DEMONSTRATION TEST PLAN

Test Run #	Test Run Description	Temp (Deg C)	Wt% Cat	H2/CO Ratio at Inlet	Space Velocity (Sl/hr-kg)	MeOH (tpd)	Fresh Feed Balanced (KSCFH)	Fresh Feed CO Gas (KSCFH)	Fresh Feed H2 Gas (KSCFH)	Recycle Gas (KSCFH)	Inlet Sup. Velocity (ft/sec)	Time Period (weeks)	Elapsed Time (incl. outages) (weeks)	Start of Test
21.	Reactor Feed: Destec-Type Syngas	250	Target 45	1.01	2,770	215	670	65 (***)	0	2,147	0.67	3	106	Jan-99
22.	Reactor Feed: BGL-Type Syngas	250	Target 45	0.52	2,165	137	485	200 (***)	0	1,568	0.43	3	109	Feb-99
23.	Repeat of Test 15 Conditions	250	Target 45	2.49	3,320	256	765	40	45	2,605	0.79	2	112	Mar-99
24.	Reactor Feed: Nat. Gas Reformer-Type Syngas	250	Target 45	4.98	1,978	197	765	0	30	1,264	0.48	3	115	Mar-99
25.	Reactor Feed: Shell-Type Syngas with Steam Injection and 1:1 Recycle	250	Target 45	0.53	1,471	101	238	400 (***)	50	842	0.35	3	118	Apr-99
26.	Repeat of Test 15 Conditions	250	Target 45	2.49	3,320	256	765	40	45	2,605	0.79	2	121	May-99
27.	Repeat of Test 16 Conditions	250	Target 45	2.29	3,500	293	900	50	40	2,520	0.81	2	123	May-99
28.	Reactor Operation @ 260 deg C	260	Target 45	2.51	3,320	248	765	40	45	2,605	0.79	2	125	May-99
29.	Repeat of Test 15 Conditions	250	Target 45	2.49	3,320	256	765	40	45	2,605	0.79	2	127	Jun-99
30.	Reactor Inspection - Then, Continue Operational Tests - with Alternative Catalyst):											4	131	Jun-99
31.	Plant Shakedown	240	TBD	2.42	TBD	260	900	50	40	Max(TBD)	TBD	6	137	Jul-99
32.	Reactor Feed: Texaco-Type Syngas	240	TBD	0.67	TBD	202	650	95 (*)	0	2,612 (*)	0.77	2	140	Aug-99

Test Run #	Test Run Description	Temp (Deg C)	Wt% Cat	H2/CO Ratio at Inlet	Space Velocity (Sl/hr-kg)	MeOH (tpd)	Fresh Feed Balanced (KSCFH)	Fresh Feed CO Gas (KSCFH)	Fresh Feed H2 Gas (KSCFH)	Recycle Gas (KSCFH)	Inlet Sup. Velocity (ft/sec)	Time Period (weeks)	Elapsed Time (incl. outages) (weeks)	Start of Test
33.	Catalyst Aging	240	TBD	2.50	TBD	237	765	40	45	2,605		16	162	Sep-99
				2.31	TBD	260	900	50	40	2,520	TBD	4		
34.	Catalyst Addition/	240 -	Target	Balanced	To be					Max(TBD)		6	168	Feb-00
	Withdrawal to Achieve	250	45		defined									
	Target Slurry Concentration													
35.	Reactor Feed: Texaco-	250	Target	0.69	2,870	207	650	85 (**)	0	2,195	0.67	4	173	Mar-00
	Type Syngas		45											
Task 2.1.3 - Extended Optimum Operation:														
36.	Stable Operation	250	Target	2.49	3320	256	765	40	45	2605	0.79	16	200	Apr-00
		250	45	2.29	3500,	293	900	50	40	2520	0.81	6		
		250		TBD	TBD	TBD	1,110 (**)	50	40	2520	0.86	2		
37.	DME Demo (Task 2.2)		Balanced and CO-Rich									TBD		Nov-00
	or													to
	Commercial Test Run (Task 2.1.3)		Target	2.49	3320	256	765	40	45	2605	0.79	8	208	Mar-01
			45											
					Syngas Outages (5%, including Kingsport complex outage during Test 6)							10		
		Planned LPMEOH Outages (including Reactor Inspection and Fresh Catalyst Charge in Test 28)										12		
							Unplanned LPMEOH Outages (10/yr @ 8 hrs.)					2		

Notes:

(*) - 700 HP motor on 29K-01 Compressor allows higher recycle gas flow than design basis.

(**) - 1200 KSCFH of Fresh Feed Syngas can be made available for testing (per Eastman debottlenecking of gasification area). Final decision on test will depend upon carbonyl concentrations in Balanced Gas and CO Gas, since 29C-40 Carbonyl Guard Bed will have to be bypassed. For this condition, test execution is subject to availability of CO Gas.

(***) - Subject to availability of CO Gas.

APPENDIX K - TASK 2.3 - COMMISSIONING AND STARTUP SCHEDULE
5 PAGES

and

PHASE 1-2 SUMMARY SCHEDULE

LPMEOH COMMISSIONING & STARTUP SCHEDULE

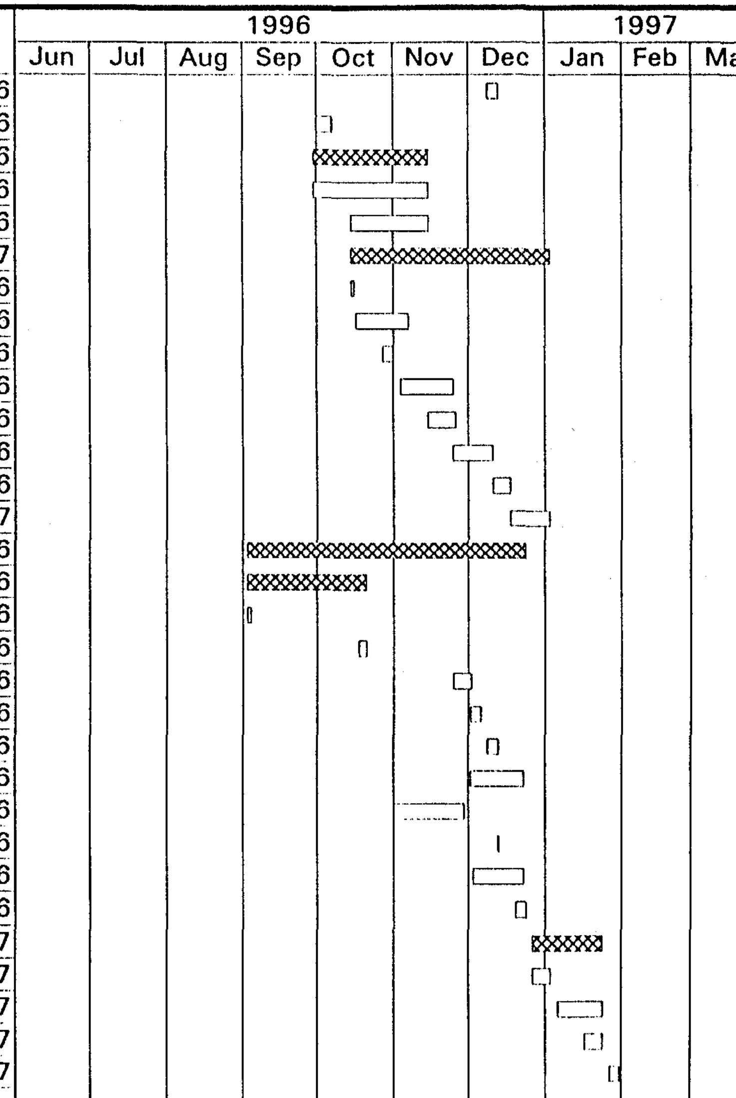
Task Name	Duration	Start	End
PRECOMMISSIONING WORK	21.00 w	Jul/01/96	Nov/29/96
PIPING PUNCH LISTING(EMN)	13.00 w	Aug/01/96	Nov/01/96
INSTRUMENTATION PUNCHLISTING(EMN)	4.60 w	Oct/15/96	Nov/15/96
LUBRICATION OF MACHINERY(APCI)	4.00 w	Jul/01/96	Jul/29/96
ALIGNMENT CHECKS(APCI)	2.00 w	Oct/01/96	Oct/15/96
ELECTRICAL PUNCHLISTING(EMN)	6.40 w	Oct/15/96	Nov/29/96
PASSIVATE REACTOR	8.40 w	Jun/27/96	Aug/26/96
SET REACTOR	0.40 w	Jun/27/96	Jun/28/96
FINISH CAT BLDG STEEL INSTALLATION	5.00 w	Jul/08/96	Aug/09/96
SET-UP EQUIPMENT FOR PASSIVATION	0.80 w	Aug/19/96	Aug/22/96
PASSIVATE REACTOR	0.40 w	Aug/23/96	Aug/26/96
INSTR. & ELECT. CONTINUITY CHECKS*	9.40 w	Sep/23/96	Nov/29/96
DCS WORK	15.60 w	Jul/01/96	Oct/21/96
TEMPORARY HVAC & FINISHED ROOF	3.80 w	Jul/01/96	Jul/26/96
CALIBRATE/TEST FM200 SYSTEM	0.40 w	Jul/22/96	Jul/23/96
INSTALL DATA HIGHWAY(EMN)	1.00 w	Jul/23/96	Jul/29/96
RELOCATE DCS CABINETS(EMN)	2.00 d	Jul/29/96	Jul/30/96
TERMINATE TO DCS	7.80 w	Jul/30/96	Sep/23/96
TEMPORARY POWER TO DCS	10.00 w	Aug/09/96	Oct/21/96
INSTRUMENT CALIBRATION	23.20 w	Jun/03/96	Nov/15/96
CHECK PSV'S SETTING(EMN)	8.60 w	Jun/03/96	Aug/01/96
TRANSMITTERS(EMN)	8.60 w	Jun/03/96	Aug/01/96
ABB ANALYZERS AT FACTORY	2.00 d	Jul/08/96	Jul/09/96
ANALYZER BLDG STUFF @ SHOP	2.00 d	Jul/22/96	Jul/23/96
LEVEL DIAPHRAM dP'S, CHECK FE'S	6.40 w	Oct/01/96	Nov/15/96
SKID INSTRUMENTS	6.40 w	Oct/01/96	Nov/15/96
NDG'S(T-01 & T-02)	2.00 w	Nov/01/96	Nov/15/96
AP-EMN JV OFFICE TRAILER SET-UP	24.00 w	Jun/24/96	Dec/13/96
ELECTRICAL & WATERHOOK-UP(EMN)	2.00 w	Jul/15/96	Jul/26/96
FURNITURE - ORDER & INSTALL	1.00 w	Aug/01/96	Aug/07/96
COMPUTER H/W - ORDER & INSTALL	10.80 w	Jun/24/96	Sep/09/96

Printed: May/16/96

Milestone △ Summary

LPMEOH COMMISSIONING & STARTUP SCHEDULE

Task Name	Duration	Start	End
CHECK-OUT TOTAL PLANT SYSTEM	1.00 w	Dec/09/96	Dec/13/96
CHECK-OUT APCI COMMUNICATION LIN	1.00 w	Oct/01/96	Oct/07/96
OPERATOR TRAINING	6.60 w	Sep/30/96	Nov/15/96
EMN TRAINING SESSIONS	6.60 w	Sep/30/96	Nov/15/96
APCI INVOLVEMENT	4.60 w	Oct/15/96	Nov/15/96
INSTRUMENT LOOP CHECKING**	10.85 w	Oct/15/96	Jan/03/97
ENERGIZE MCC	0.40 w	Oct/15/96	Oct/16/96
EAST OF COLUMN "C"	3.08 w	Oct/17/96	Nov/07/96
OTHER UTILITIES	1.00 w	Oct/28/96	Nov/01/96
DISTILLATION AREA	3.00 w	Nov/04/96	Nov/25/96
CATALYST PREP AREA	1.50 w	Nov/15/96	Nov/26/96
REACTOR AREA	2.25 w	Nov/25/96	Dec/11/96
FINAL FUNCTION TESTING	1.00 w	Dec/11/96	Dec/18/96
POUR CONDUIT SEAL OFFS	2.00 w	Dec/18/96	Jan/03/97
COMMISSIONING(PHASE 2)	15.60 w	Sep/03/96	Dec/24/96
COMMISSION INSTR. AIR HEADER	34.00 d	Sep/03/96	Oct/21/96
EAST OF COLUMN "C"	2.00 d	Sep/03/96	Sep/04/96
REMAINING PLANT AREAS	2.00 d	Oct/18/96	Oct/21/96
COMMISSION OTHER UTILITIES	1.00 w	Nov/25/96	Dec/02/96
LOAD CATALYST GUARD BED(EMN)	1.00 w	Dec/02/96	Dec/06/96
FILL D-30 WITH MINERAL OIL	1.00 w	Dec/09/96	Dec/13/96
WATER BATCHING	3.20 w	Dec/02/96	Dec/23/96
K-01 LUBE OIL FLUSH(EMN)	3.80 w	Nov/01/96	Nov/29/96
TURNOVER MCC & I/O BLDG.	1.00 d	Dec/13/96	Dec/13/96
ANALYZER CALIBRATION	3.00 w	Dec/03/96	Dec/23/96
TEST FIRE SPRINKLER DELUGE SYSTEM	3.00 d	Dec/20/96	Dec/24/96
PLANT START-UP(PHASE 3-TASK 1)	3.80 w	Dec/27/96	Jan/24/97
CARBONYL BURNOUT	1.00 w	Dec/27/96	Jan/03/97
REDUCE CATALYST BATCHES	2.80 w	Jan/06/97	Jan/24/97
START DISTILLATION	1.00 w	Jan/17/97	Jan/24/97
BEGIN PLANT OPERATION(TASK 2.1)	1.00 w	Jan/27/97	Jan/31/97



Printed: May/16/96
Page 2

Milestone △ Summary

LPMEOH COMMISSIONING & STARTUP SCHEDULE

Task Name	Duration	Start	End	1996 Jun	Jul	Aug	Sep	Oct	Nov	Dec	1997 Jan	Feb	Ma
* 340 manhour estimate	1.00 w	Jun/03/96	Jun/07/96										
** durations based on 3 men @50 hrs/w	1.00 w	Jun/03/96	Jun/07/96										

Milestone △ Summary

URB 1
6/6/96
Handout to DOE
Proj. Rev. Mtg
(Exam Sheet)

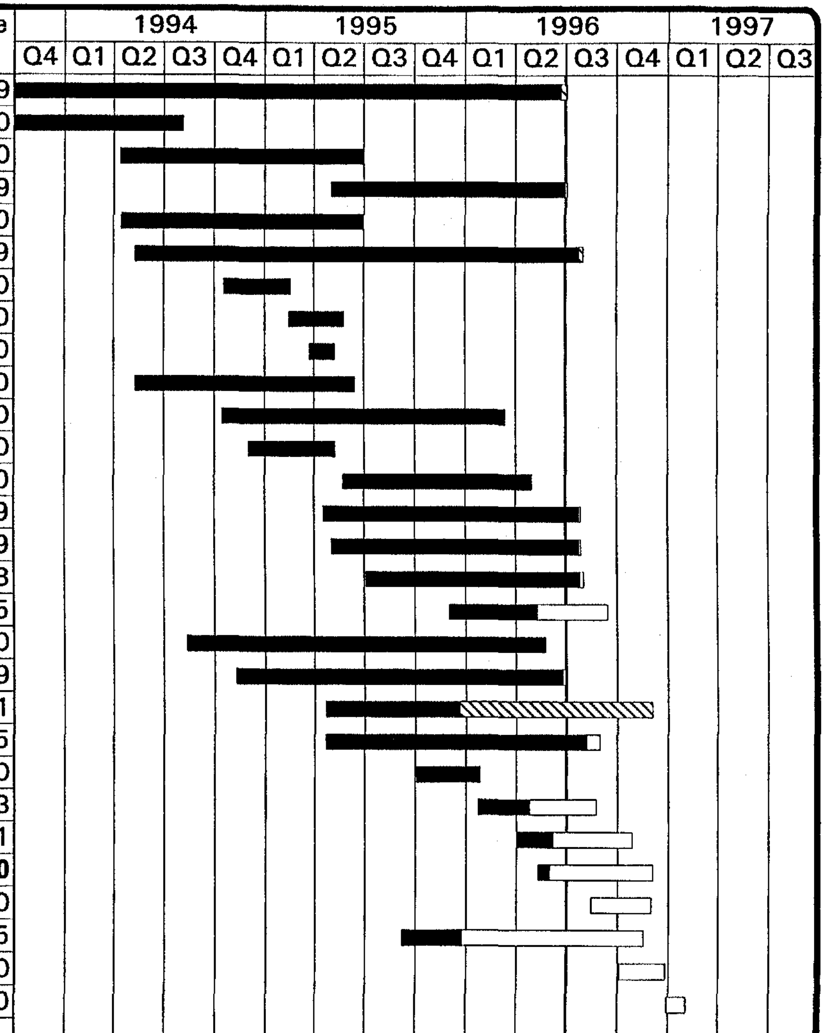
SCHEDULE FOR EASTMAN OPERATIONS SUPPORT
LIQUID PHASE METHANOL PROJECT(6/6/96)

DATE	ACTIVITY	STAFFING
May	SOP (Std Op Procedure)	1 Eng., 1 Opr.
June	SOP	1 Eng., 1 Opr.
July 1	SOP, Checklists, Lesson plans	1 Eng., 1 Opr.
July 29	Lesson plans, piping PCO (Physical Check Out)	2 Eng., 1 Opr.
August 12	FCO procedure, Piping PCO (Functional Check Out)	2 Eng., 1 Opr.
September 3	FCO procedure, Piping PCO	2 Eng., 2 Opr.
September 23	FCO procedure, Piping PCO, Continuity checks	2 Eng., 2 Opr., 2-3 E & I
September 30	PCO, Continuity checks, Pre-Training	2 Eng., 4 Opr., 2-3 E & I
October 14	PCO, Loop Checks, operator training*	2 Eng., 4 Opr., 4-6 E & I
December 2	Start water checks - FCO (Days only)	2 Eng., 4 Opr., 4-6 E & I
December 11	Final FCO ESD/Interlock test	2 Eng., 4 Opr., 2-3 E & I
Dec.27	Carbonyl burnout, Hot tests - FCO	1 Eng/shift, 2 - 3 Opr/shift, 1/2 to 1 E&I/shift
Jan. 6	Catalyst Reduction Batches	1 Eng/shift, 3 Opr/shift
Jan. 26	Ready for plant startup	1 Eng/shift, 3 Opr/shift

*Operator training will consists of 4 operators/crew in training for 1 week/crew or 4 weeks total.

LPMEOH DEMONSTRATION PROJECT
PHASE 1-2 SUMMARY SCHEDULE

Task Name	Start	End	Perce Com
PROCESS DESIGN	Oct/01/93	Jul/01/96	99
PFD/HEAT & MAT'L BALANCE	Oct/01/93	Aug/05/94	100
PROCESS EQUIPMENT SPECS	Apr/13/94	Jun/30/95	100
REVIEW DETAIL DESIGN	May/01/95	Jul/01/96	99
NEPA FONSI REVIEW	Apr/15/94	Jun/30/95	100
DETAILED DESIGN	May/11/94	Jul/31/96	99
P&ID'S, REV. PC	Oct/17/94	Feb/17/95	100
OPERABILITY/HAZARDS REVIEWS	Feb/13/95	May/24/95	100
P&ID'S, REV. P1	Mar/23/95	May/08/95	100
PROCESS EQUIP. MECH. SPECS	May/11/94	Jun/13/95	100
EQUIPMENT VENDOR PRINTS	Oct/14/94	Mar/12/96	100
EQUIPMENT ARRANGEMENTS	Dec/01/94	May/08/95	100
INSTRUMENT SPECS	May/22/95	Apr/29/96	100
CIVIL/STRUCTURAL DESIGN	Apr/17/95	Jul/26/96	99
PIPING DESIGN	May/01/95	Jul/26/96	99
INSTRUMENT/ELECTRICAL DESIGN	Jul/03/95	Jul/31/96	98
DCS PROGRAMMING	Dec/01/95	Sep/13/96	55
EQUIPMENT PROCUREMENT	Aug/12/94	May/23/96	100
REACTOR DELIVERY	Nov/08/94	Jun/28/96	99
CONSTUCTION	Apr/21/95	Dec/02/96	41
EASTMAN OSBL WORK	Apr/21/95	Aug/30/96	95
CIVIL/UNDERGROUND	Oct/02/95	Jan/26/96	100
STEEL & EQUIPMENT ERECTION	Jan/22/96	Aug/22/96	43
MECHANICAL	Apr/01/96	Oct/25/96	31
INSTRUMENT/ELECTRICAL	**May/09/96**	**Dec/02/96**	**10**
INSULATION & FIRE PROOFING	Aug/12/96	Nov/29/96	0
PROCEDURES/TRAINING	Sep/05/95	Nov/15/96	25
CHECK-OUT/COMMISSIONING	Oct/01/96	Dec/24/96	0
START-UP	Dec/27/96	Jan/31/97	0



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Page 1

Milestone △ Summary
Fixed Delay ----