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

TECHNICAL PROGRESS REPORT NO. 7

For The Period

1 January to 31 March 1996

Prepared by

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and

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Kingsport, Tennessee

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

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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
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 signed the agreements that would form the Partnership, secure the demonstration site, and provide the financial commitment and overall project 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, utilities, product storage, and other needed services.

The project involves the construction of an 80,000 gallons 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 3,200 gallons per day, 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-use 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). Since then the project has been in Design - Phase 1 - activities; and also moved into 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 November of 1996.

Construction work for the LPMEOH™ plant 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 should begin in April. The fabrication of the reactor continues, and is being expedited. The reactor ship date has slipped to 3 May 1996.

DOE's comments on the draft Environmental Monitoring Plan (EMP) and on the draft Demonstration Test Plan (DTP) were received. Revised EMP and DTP drafts were prepared, and a meeting to review and finalize both is planned for April.

Procurement of process equipment is essentially complete and construction work is well underway. Mechanical completion has slipped two weeks due to late reactor and structural steel delivery dates. Commissioning work is expected to start in mid-October, with plant start-up in late December. Fifty-two percent (52%) 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 31 March 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 of methanol (260 TPD) 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, will be 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 reactionequipment.
- *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 will include feed gas compression and catalyst guard beds, the reactor, a steam drum, separators, heat exchangers, and pumps. The equipment will be supported by a matrix of structural steel. The most salient feature is the reactor, since with supports, it will be 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 will be 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 Finding of Significant Impact (FONSI). The draft final EIV was submitted on 31 Jan 1996.

- Obtain permits necessary for construction and operation.

  - The construction permits have been obtained.

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).

  - The initial draft EMP was submitted on 9 October 1995. DOE's comments were received, and revised draft EMP was issued 27 February 1995. A meeting with DOE is scheduled on 25 April to review the EMP, and also the Demonstration Test Plan (see Task 2.3), since both plans are interrelated.

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

  - Process Engineering work focused on:
    - Completing Design of C-120 Vent Scrubber
    - Piping Design Reviews
    - Documentation of Vent Header Design

  - Engineering work is focused on:
    - Starting work on Pressure Testing definition
    - Working on Distributed Control System logic and documentation.

· Writing Specification for Instruments
· Continuing Work on Distributed Control System (DCS) logic and documentation.

- Design Work is focused on:
  · Completing the Mechanical Bid Package
  · Completing the Electrical Bid Package
  · Completing the Bid Package for Miscellaneous Buildings

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 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 market applications for the "as produced" methanol as a replacement fuel and as a fuel supplement. Fuel economics will be evaluated for the "as produced" methanol for use in municipal, industrial and utility applications and as fuel supplements for gasoline, diesel, and natural gas. These fuel evaluations will be based on the U.S. energy market needs projected during the 1998 to 2018 time period when the LPMEOH™ technology is expected 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.

- The draft amendment to the 21 December 1992, contract between Air Products and Acurex Environmental Corporation (Acurex) was issued for consideration and approval. The amendment will incorporate the current Statement of Work and Milestone Schedule for the request.

- Air Products' Program Manager attended a seminar on fuel cell developments. Of

particular interest was a presentation by DOE's Manager, Fuel Cell Systems R&D, Office of Transportation Technologies. Methanol is being considered in some of the longer-term developments for transportation vehicles. Methanol would be used as the on-board storable fuel, which would be reformed to provide the hydrogen for the fuel cell/electric powered vehicle. A fuel test plan outline was drafted, based on the concept of methanol coproduced at centrally located IGCC power plants providing liquid transportation fuel for local markets. The draft of this fuel test plan outline is included in Appendix C.

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 will update plans for the on-site product-use demonstrations. The schedule for on-site product-use tests was established for August to October of 1997. Product-use test plan details will be developed later in 1996, in parallel with the operating test plan (Phase 2, Task 3); and in combination with the off-site fuel-use test plan (Phase 1, Task 4).

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).

  - During this quarter, the work on process economic studies was generally of lower priority than Task 1.3 Design Engineering. However, some work on this Task 1.5.2 was accomplished during the quarter:

    a) Initiated process design work of the Product Purification Options for three alternative grades of product: Chemical, MTBE, and Fuel.

    b) Completed work on a methanol production matrix for a given (e.g. Kingsport) liquid phase reactor volume. The results are included in Appendix D. These show

that a given reactor size is capable of a wide range methanol production rates (100 TPD to 600 TPD for the Kingsport reactor size), dependent upon four inter-related process design variables. These design variables are i) reactor pressure, ii) inlet superficial velocity, iii) recycle ratio; and iv) percent Btu conversion. These interesting results of the Kingsport reactor's capability will be utilized in the next quarter to prepare the outline of the Process Economics Study.

c) Reviewed the methanol production matrix and determined that percent Btu conversion for the Texaco-type synthesis gas was limited. This conclusion has led to the inclusion of other design parameters in the Process Economics Study, such as feed gas composition and water addition to the reactor feed gas. A comparison with gas phase reactor technology, which requires treatment of the reactor feed gas with shift and carbon dioxide (CO_2) removal equipment, will also be explored.

d) Plans and resource commitments for Task 1.5.2 Commercialization Studies work in the next quarter were made.

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 project milestone schedule shows that the first decision point, 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

No further work will be done, until Labratory R&D confirmation of a stable liquid phase DME (LPDME) catalyst system is obtained.

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 electric power and liquid fuels from an IGCC facility. The

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 DOE Contract No. DE-FC22-95PC93052, and are being continued under Task 1.5.3. 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. During the last quarter, work concentrated on the screening of LPDME catalysts. Most catalysts exhibited poorer stability than the standard dual catalyst system. Efforts were also made to understand the nature of the detrimental interaction between the methanol synthesis and dehydration catalysts under LPDME conditions. The quarterly report, prepared for Contract DE-FC22-95PC93052 for the period October - December 1995, is included in Appendix E for reference, and is summarized in the following:

Summary of Laboratory Activity and Results

- Stability of the DME catalyst system was greatly improved to near that of a LPMEOH™ catalyst system when a laboratory prepared alumina based dehydration catalyst was used. The productivity of this catalyst system is 30% higher than a normal LPMEOH™ system, but is still lower than the initial productivity of a standard LPDME catalyst so that the DME selectivity is rather low. The data show once again that there is a chance for a modification of the alumina to lead to long life.

- The new aluminum-based dehydration catalyst showed good stability in an LPDME run. The activity was low and the methanol catalyst deactivated. However, the results are interesting enough so that additional runs are planned. The ratio of Lewis to Bronsted acid sites can be changed for this catalyst so that it is an interesting probe catalyst for determination of the deactivation mechanism.

- In continued testing of candidate dehydration catalysts, mesoporous silica alumina (MCM-41) and hydrotalcite ($MgOAl_2O_3$) were tested. Neither were suitable dehydration catalysts. The hydrotalcite exhibited no dehydration activity while catalyst system using MCM-41 exhibited poor stability.

- Changing solvents may lead to a greater degree of dispersion of the two catalysts and thus a decrease in the interaction which causes deactivation. The use of

perfluoropolyether (FOMBLIN Y HVAC) resulted in very poor catalyst life probably due to decomposition of the solvent.

- Two single component, dual functional catalysts which were obtained from BASF were tested. Copper oxide (CuO) on alumina gave high selectivity to DME at low rates with about the same stability as the standard DME catalyst system. Copper oxide (CuO) on magnesium silicate had low activity and showed little dehydration activity so that the main product was methanol.

- The use of a lanthanum oxide modified BASF methanol catalyst with the standard dehydration catalyst did not exhibit improved stability.

Task 1.5.4 Administration and Reporting

A project review meeting was held in Air Products' offices in Allentown, PA, on March 4th, and a trip was made to Joseph Oat Corporation in Camden, NJ, on March 5th, to observe the LPMEOH™ reactor fabrication. Attendees from Air Products and DOE participated. The meeting notes, agenda, and some of the meeting handouts are included in Appendix F. The project status was reviewed. Detailed design is 85% complete. The general mechanical construction package is out for bid, and the instrument and electrical construction bid package was released March 25th. Construction on steel and equipment erection has started (see photo in Appendix F). The Environmental Monitoring and Demonstration Test Plans were reviewed, and plans were made for a review meeting with DOE in April. A visit to Air Products Research Lab in Iron Run was made, where the DME catalyst life testing research is being done. The status of the DME laboratory Research (Task 1.5.3) was reviewed. The Alternate Fuels Field Development Unit (AFFDU) trailer, which is being prepared for a synthesis gas catalyst poisons study at Kingsport in May 1996, was also visited.

The Milestone Schedule Status and the Cost Management reports, through March 31, 1996, are inlcuded in Appendix G. The demonstration unit is scheduled to be mechanically complete in November of 1996. Fifty-two percent (52%) 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 31 March 1996.

The monthly reports for January, February, and March 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.

- All Equipment except for the C-120 Vent Scrubber have been purchased.

Reactor Status

- The reactor fabrication continues at Joseph Oat Corporation in Camden, NJ. Some time was lost during this quarter due to required weld repairs on a few of the shell circumferential welds. Oat also encountered problems using an orbital welder to weld the two sections of the internal heat exchanger tubes in the middle. The weld procedure was revised to achieve an acceptable weld. Air Products assigned a full time inspector at Joseph Oats' shop to expedite the order and insure that good quality is maintained.

  The vessel shell and heads were post weld heat treated at the beginning of March prior to inspection of the internal heat exchanger.

  The DOE joined Air Products for a progress review meeting at Joseph Oat's shop on 5 March. The reactor ship date has slipped to 3 May 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 Mechanical Superintendent to the site construction management staff in late January. His main area of concentration will be working with the Structural Steel Erector who started construction work on 29 January 1996 and then the Mechanical Contractor.

- 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.

  - Site preparation work was completed at the end of 1995. This included initial grading and covering with gravel, soil fill and compaction on the north side of the job site, and installation of the storm sewers. The foundation and underground work was completed on schedule at the end of January 1996. This included installation of all major structural steel and equipment foundations, installation of tank farm dikes, process area slabs, underground drain lines, the oil-water separator and underground electrical grounding.

  - On-site fabrication of the large product methanol lot tanks started in November 1995 and was completed in December prior to erecting on their foundations in March 1996.

- Erection of the Pipe Rack area structural steel and equipment items east of the process building started 29 January. This work was awarded to Spartan Constructors of Atlanta, GA. There is approximately 47 tons of steel to erect east of the process structure. The process building steel is scheduled to begin arriving on site in May, therefore, construction work will concentrate on the east half of the plant. This contract was 22% complete as of the end of March.

- The reactor and the process building structural steel deliveries have slipped to the end of May. This will delay completion of construction for a major section of the demonstation unit.

- Prefabricated large bore piping was sent out for bidding at the end of November 1995. This work was awarded to Connex of Troutville, VA in mid-December. Initial release of piping spools drawings to Connex began on 5 January 1996. The large bore piping should be delivered to the job site to support construction.

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

  - The Mechanical Completion date has slipped two weeks to the end of November 1996. This is due to the late reactor and structural steel delivery dates. Air Products is investigating ways to expedite delivery of these items and minimize their impact. The revised estimated start-up date is 27 December 1996.

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 second draft of the Demonstration Test Plan (DTP) for Phase 3, Task 2 Operation was issued for review and comment on 29 March. A copy of the cover letter and of Table 5-1 - Operation Test Plan (4 pages) is included in Appendix H. A meeting with DOE is scheduled for 25 April to review the DTP, and also the Environmental Monitoring Plan, since both plans are interrelated. The final draft of the DTP is due to be submitted in August of 1996.

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

  - Eastman began preparing a rough draft of the LPMEOH™ Standard Operating Procedures and developed a plan for the start-up team. The operator training program outline was also being prepared and the schedule for the start of operator

training was tentatively set for October of 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 (Definition and Design).

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 goal and objective for the fiscal year 1996 annual plan is to continue the Phase 1 and Phase 2 tasks required by the Statement of Work. The major objectives for fiscal year 1996 are:

    - the LPMEOH™ demonstration unit will be ready for commissioning and start-up 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 1.5.4 - Administration and Reporting.

E. Planned Activities for the Next Quarter

- Complete the detailed engineering design and procurement.
- Continue shipment of equipment to the site. Expedite reactor fabrication, ship reactor by rail, off-load and transport the reactor to the site.

- Continue erection of equipment and structural steel.
- Issue and award the Instrument and Electrical Construction bid package and start work.
- Issue revised drafts of the Demonstration Test Plan and of the Environmental Monitoring Plan. Conduct a review meeting of both plans in late April with DOE. Issue final drafts of both plans.
- Hold a Project Review/Update meeting at the site in June.
- Complete Part One of the Process Economics Study; on co-production of methanol with IGCC power.
- Issue updated fuel-use test program plan.

F. Summary

Construction work for the LPMEOH™ demonstration unit began in October of 1995. The foundation and underground work was completed in January of 1996. The erection of the pipe rack steel and equipment items has begun, and piping installation in the pipe rack area should begin in April.

The fabrication of the reactor continues, and is being expedited. The reactor ship date has slipped to 3 May 1996.

A draft amendment to the off-site product-use testing subcontract between Acurex Environmental Corporation and Air Products has been prepared. The amendment incorporates the current Statement of Work and milestone schedule for the project.

DOE's comments on the draft Environmental Monitoring Plan (EMP) and on the draft Demonstration Test Plan (DTP) were received. Revised EMP and DTP drafts were prepared, and a meeting to review and finalize both is planned for April with DOE.

Procurement of process equipment is essentially complete and construction work is well underway. Mechanical completion has slipped two weeks due to late reactor and structural steel delivery dates. Commissioning work is expected to start in mid-October, with plant start-up in late December of 1996. Fifty-two percent (52%) 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 31 March 1996.

APPENDICES

APPENDIX A - SIMPLIFIED PROCESS FLOW DIAGRAM

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

APPENDIX C - TASK 1.4 - FUEL TEST PLAN UPDATE OBJECTIVES

APPENDIX D - TASK 1.5.2 - METHANOL PRODUCTION MATRIX

APPENDIX E - TASK 1.5.3 - DME (DE-FC22-95PC93052) QUARTERLY REPORT

APPENDIX F - TASK 1.5.4 - PROJECT REVIEW MEETING

APPENDIX G - TASK 1.5.4 - MILESTONE SCHEDULE STATUS AND COST MANAGEMENT REPORTS

APPENDIX H - TASK 2.3 - DEMONSTRATION TEST PLAN