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MASTER

ENGINEERING SUPPORT SERVICES FOR THE DOE/GRI COAL GASIFICATION RESEARCH PROGRAM

QUARTERLY TECHNICAL PROGRESS REPORT

FOR THE PERIOD

October — December 1978

A. E. COVER

January 1979

Work Performed Under Contract
ET-78-C-01-2778

Pullman Kellogg
Three Greenway Plaza East
Houston, Texas 77046

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ABSTRACT

The objective of this contract is to provide engineering support services to the Department of Energy/Gas Research Institute in the high BTU coal gasification research program. The gasification research program is to determine the specific process and/or combination of component processing steps that offer the greatest economic potential for commercial application.

In the first quarter of this contract, Kellogg has assembled a task team and formulated plans for managing this program so that Kellogg can be quickly responsive to the needs of the Department of Energy/Gas Research Institute (DOE/GRI) and the program contractors. Kellogg has visited all of the Pilot Plants and Process Development Units (PDUs) which are presently involved in the DOE/GRI high-BTU coal gasification programs. Monitoring and evaluation activities have begun with recent tests at the Hygas and BI-GAS pilot plants and the Westinghouse PDU.

A metallurgist has been assigned to follow the activities of the Metal Properties Council in materials testing in the coal gasification environment.

Review of the C. F. Braun and Company (the previous engineering evaluation contractor for DOE/GRI) Final Report and supporting documents started during this quarter.

1.0 CONTRACT OBJECTIVE

The objective of this contract is to provide engineering support for the Department of Energy/Gas Research Institute (DOE/GRI) high-Btu coal gasification program. This support generally consists of assistance in:

- Developing or advancing each process to its maximum potential.
- Gathering, compiling, and presenting essential data necessary to delineate the advantages and disadvantages of each competing process.
- Determining and identifying the specific process and/or combination of component processing steps that offer the greatest economic potential for commercial application.
- Performing evaluation to determine the areas of development necessary to provide all technical data, including equipment and material specification, required for the design and construction of a commercial high-Btu coal gasification facility.
- Making recommendations and assisting in the compiling of sufficient data to complete conceptual commercial designs and prepare associated factored estimates.
- Evaluating progress reports for consistency, compliance with contract requirements, and adequacy in providing data necessary for process evaluation.

2.0 TASK 01 - ORIENTATION

2.1 C. F. Braun

R. N. McAdow, A. E. Cover and J. M. Gunderson met with R. Detman of C. F. Braun on 10 October to discuss the status of the project and Braun's method of carrying out the work. The following information was furnished:

- A draft copy of C.F. Braun's Final Report, No. FE-2240-101.
- A copy of Revision 2 of the Index of Reports, No. FE-2240-99.
- For monitoring work at the pilot plants, Braun found it advisable to assign a principal process investigator to each pilot plant. The process investigator monitored the pilot plant runs and prepared a trip report for each which reviewed the test run data, the results of the test and his observations during inspection of the equipment following the run.
- In addition, Braun's project manager and appropriate principal process investigator attended the GRI Project Advisors' meetings with each of the DOE/GRI contractors.
- Mr. Detman noted that the design work for the Factored Estimate for Eastern Coal was not done on the same basis as the design work for the Factored Estimates for Western Coal. A portion of the difference was the result of the local conditions in the two areas of the country, and the balance of the difference was the result of industry experience in the interval between the two studies.
- It was also noted that Braun personnel designed a vertical lift dryer for use in the BI-GAS pilot plant, but because of other problems at the plant, it had not been installed.

2.0 TASK 01 - ORIENTATION - Continued

2.2 DOE/GRI Operating Committee

R. N. McAdow, A. E. Cover and J. M. Gunderson met with the DOE/GRI Operating Committee on 17 October for indoctrination and to receive instructions on the initial task assignments. The following information was transmitted:

- Three pilot plants will remain in the joint DOE/GRI program and five process development units (PDUs) will be added to the joint program. Kellogg will be asked to monitor the eight projects. The projects and their status are:

  1) Hygas Pilot Plant - IGT, Chicago, Illinois
     DOE Project Manager: Steve Verikios
     IGT Contact: W. C. (Bill) Bair -(312) 542-7020

     The Hygas steam-oxygen pilot plant is starting up and will be in operation through 30 June 1979 to provide data to be used by Procon in designing a Hygas demonstration unit.

     The steam-iron hydrogen generator was shut down on 30 September 1978 and will be "moth balled". The final report is being written by IGT. Also, the liquid phase methanator has been shut down owing to a fire. It will not be restarted because of catalyst carry-over problems which will be investigated on the bench scale. Kellogg will have no responsibility for either of these units.

2.0 TASK 01 - ORIENTATION - Continued

2.2 DOE/GRI Operating Committee - Continued

2) BI-GAS Pilot Plant - Phillips Petroleum, Homer City, Pa.
DOE Project Manager: Paul Musser
Phillips Contact: Don Hull - (412) 479-9081
Prime Contractor: BCR, Monroeville, Pa.
BCR Contact: Erle Diehl
Stearns-Roger Contact: Enoch Fox

The pilot plant was down February through June 1978 due to a fire which resulted in equipment damage. They have installed improved valves and meters and made a safety analysis. The first Kellogg visit should not be before 30 October 1978, as they are undergoing an in-house technical audit. The BI-GAS Pilot Plant will be operated under the joint program through 31 December 1978. It will continue to operate through 30 September 1979 under DOE sponsorship. The Operating Committee will advise as to what activity Kellogg should take in monitoring this pilot plant after 31 December 1978.

3) Synthane Pilot Plant - Lummus, Bruceton, Pa.
DOE Project Manager: Bob Lewis - (412) 892-2400

The Synthane pilot plant was not a part of the joint program and was funded by DOE only. Braun monitored the progress of the pilot plant under the joint program and Kellogg is to continue to monitor progress under the joint program.

2.0 TASK 01 - ORIENTATION - Continued

2.2 DOE/GRI Operating Committee - Continued

4) Rockwell International, Inc. - Energy Systems Group
Canoga Park, California
DOE Project Manager: Lou Jablansky
Rockwell Contacts: Joe Friedman, Project Manager
(213) 341-1000, Ext. 1246
and
Dr. Jack Silverman
Paul Combs

This process uses liquid fuel rocket injection techniques to obtain rapid devolatilization without producing liquid products or tars. It does produce a char by-product. A 500 lbs/hr PDU has been operated for 1-1/2 years on peat, sub-bituminous and two grades of bituminous coal. The current program is to bring direct hydrogasification utilizing pre-heated hydrogen with optimized reactor configuration to demonstration plant status within three years and investigate scaling factors. Kellogg should not plan to visit before 1 November 1978.

5) Exxon - Baytown, Texas
DOE Project Manager: Alan Berusch
Exxon Contact: Dr. Charles Euker - (713) 427-5711, Ext. 3912.

This is a single reactor catalytic process operating at 1200 to 1300°F and 500 psia which will produce 50/50 Methane/CO_2. A one ton per day PDU at Baytown, Texas owned by Exxon incorporates catalyst and gas recycle. Exxon have evaluated the existing pilot plants in the program and have identified the Synthane plant as the

2.0 TASK 01 - ORIENTATION - Continued

2.2 DOE/GRI Operating Committee - Continued

5) Exxon - Baytown, Texas - Continued
best choice for conversion to this process. Exxon test and work plans are expected by the end of 1978. The final pre-development contract report will be issued soon.

6) Westinghouse - Madison, Pa.
DOE Project Manager: Mayo Carrington
Westinghouse Contact: Dr. John Holmgren - (412) 722-5552
and Louis Salvador, also,
Dave Archer - Churchill, Pa.
This is a two-stage process which utilizes a central draft tube with a single coal injection point between the fluid bed and fast fluid bed. They have built a 1200 lb/hr PDU with air feed which operates at 1800°F, 325 psi. The DOE/GRI program is for steam-oxygen only. Some problems have been encountered with plugging of the first cyclone due to poor design. They plan extensive oxygen-blown testing next year. The program is planned to extend through 1980, maybe 1981. Westinghouse has looked at plans to scale up to 2 to 2-1/2 tons per hour using the CO_2 Acceptor pilot plant for low and medium Btu gas.

7) Bell Aerospace Textron - Buffalo, N. Y.
DOE Project Manager: Lou Jablansky
Bell Aerospace Contacts: Tony Simpkin - (716) 297-100
Ext. 574
and George Melrose - Marketing

2.0 TASK 01 - ORIENTATION - Continued

2.2 DOE/GRI Operating Committee - Continued

5) Bell Aerospace Textron - Buffalo, N. Y. - Continued
This process also utilizes rocket technology to obtain a high mass throughput per unit of reactor volume. Presently the PDU is running with air preheated to 600°F and reaction temperature of 2400 ± 200°F at 15 atmospheres. Reactor is 42 inches long by 5 inches diameter and a feed rate of 1/2 ton coal per hour for a mass throughput of approximately 10,000 lbs/hr/ft^3. Kris Knudsen (DOE) is working with Gilbert Associates to obtain an independent economic evaluation. This process produces molten ash from the bottom of the reactor. Some buildup problems have been encountered. The Bell final report will be published soon.

GRI is not interested in the air oxidation process and would like to see rapid development of the steam-oxygen system. GRI thinks the Bell gasifier can demonstrate the AVCO approach which Parsons says is promising. Kellogg is to make a feasibility study.

8) Peat Gasification Program - IGT, Chicago, Illinois
DOE Project Manager: Melvin Kopstein
IGT Contact: Dharam V. Punwani - (312) 567-3713

Since peat can contain over 50 percent moisture, dewatering is a significant factor in peat gasification. The approach envisioned for peat gasification is to identify and then evaluate the coal gasification technique which appears most applicable to peat. IGT has been evaluating peat gasification in a differential reactor and their final report will be available 27 November 1978. IGT is expected to suggest that the Hygas reactor be converted to peat gasification evaluation.

2.0 TASK 01 - ORIENTATION - Continued

2.2 DOE/GRI Operating Committee - Continued

- The Operating Committee made the following task assignments:

  1) As part of the orientation program, visit each of the pilot plants and the process development units and gather necessary background data for familiarization with the plan, status and facilities of each of the units.

  2) Review Braun's Final Report for the Coal Gasification Program and advise what further action is recommended.

  3) Assign a metallurgist to represent Pullman Kellogg on the Metal Properties Council.

2.3 Hygas Pilot Plant

A. E. Cover, J. M. Gunderson and M. R. Smith met with Bill Bair of IGT at Chicago, Ill. on 31 October for orientation on the Hygas coal gasification pilot plant program. The plant was in the start-up phase for run 76 at the time of our visit and access to the processing structure and control room was therefore limited. Operations are planned to cease at the Hygas pilot plant at the end of June 1979.

Martin Smith visited the Hygas pilot plant on 27-28 November for the scheduled debriefing meeting for runs 75 and 76. That meeting was postponed, so Mr. Smith used this opportunity to take a thorough plant tour to receive piping and instrumentation diagrams, to review operating and safety procedures, to examine the operator log books

2.0 TASK 01 - ORIENTATION - Continued

2.3 Hygas Pilot Plant - Continued

for runs 75 and 76 and to read the IGT memoranda detailing the objectives for runs 75 and 76. Mr. Smith also met with two of the Scientific Design engineers who are monitoring the Hygas operation for DOE. Runs 75 and 76 are to obtain specific information requested by Procon to assist them in their design of a commercial/demonstration unit rather than primarily for development of the process.

Coordination will be between IGT's Bill Bair and Kellogg's Martin Smith.

2.4 Bell Aerospace Process Development Unit (PDU)

A. E. Cover, J. M. Gunderson and B. P. Castiglioni met with G. B. Melrose, A. J. Simpkin, Dr. K. Berman, and F. R. Herud of Bell Aerospace Textron at Niagara Falls, N. Y. on 7 November for orientation on the Bell Aerospace High Mass Flux (HMF) Gasifier Program. After an orientation presentation the test facilities and control room were inspected. Experimental effort to date has been with air combustion to produce low Btu gas. The existing 0.5 ton per hour unit test gasifier is 5 inches ID and 42 inches long from injector face to the entrance of the discharge nozzle. This unit is modular to facilitate component replacement and configuration changes. A modular concept is envisioned for a scaled-up unit. A unique feature of Bell's approach is the mass flux of 10,000 pounds per hour of reactants (i.e., 2200 pounds per hour of coal and 7800 pounds per hour of air) per cubic foot of reactor volume. This high mass flux and resultant short residence time reflect Bell's background in rocket engine technology.

2.0 TASK 01 - ORIENTATION - Continued

2.4 Bell Aerospace PDU - Continued

For air combustion, coal which is 70% - 200 mesh, is transported from a pressurized feed hopper as a dense phase containing 3% by weight nitrogen into the gasifier through a nozzle in the center of the top head. Preheated air enters through an annulus around the coal nozzle. Operating at 15 atmospheres and 2400°F with a superficial residence time of normally 80 milliseconds, carbon conversion has ranged from 80 to 90%.

In the DOE/GRI program Bell will study an oxygen-blown gasifier. New equipment will be designed for higher pressures because indications are that higher pressures favor the formation of more methane in the effluent gas. Bell agreed to provide additional information on their oxygen-blown process after Kellogg signed a secrecy agreement.

Bell is scheduled to evaluate materials of construction of the cold wall and liner of the gasifier during the period of January to March 1979. During this period they will perform the initial design of the gasifier.

During the months of April to June, the gasifier will be fabricated and the test system modified. In June the test runs will commence. In other words, in the latter part of 1979 and in the early part of 1980, the process will be defined. In 1980, feed rates of 1.5 to 2.0 tons per hour will be studied. In 1981, continuous operation will be tested.

Coordination will be between Bell's Tony Simpkin and Kellogg's Bruno Castiglioni.

2.0 TASK 01 - ORIENTATION - Continued

2.5 BI-GAS Pilot Plant

A. E. Cover, J. M. Gunderson, J-P. G. Jacks and D. A. Hubbard met with D. E. Hull and C. G. Houser of Phillips Petroleum Co. at Homer City, Pa. on 8 November for orientation on the BI-GAS pilot plant program. The plant was shut down for inspection and turn-around following run G-6C at the time of our visit.

Mr. Hull reviewed the pilot plant management organization and procedures which served to identify information sources. Arrangements were made to obtain reports drawings and diagrams which would aid in our orientation. A review of the chronology of operation of the plant was also presented by Mr. Hull which identified significant losses of test time. These losses of test time were caused by failure of the gasifier overhead quench system in August 1976, curtailment of natural gas in December 1977, a fire in the gasifier structure in February 1978, and an extended plant safety review after the fire.

Next, the BI-GAS plant test program and problems were reviewed. The most notable problem has been inability to sustain a reasonable period of steady state operation. This problem has been primarily due to slag tap hole plugging and lack of confirmation of slag tapping. Additional problems are inability to measure (1) coal and char flow to the gasifier, (2) coal and char cyclone losses in gas washer effluent and (3) amount of slag formed.

Mr. Houser then showed the team the BI-GAS gasifier model and pilot plant model and conducted a tour of the plant.

Mr. Hull reported that Phillips was preparing a proposal to Bituminous Coal Research (BCR) for the cost of continuing operations thru September 1979, since their program was funded only thru 1978.

Coordination will be between Phillips' Don Hull and Kellogg's Jean-Pierre Jacks.

2.0 TASK 01 - ORIENTATION - Continued

2.6 Westinghouse PDU

A. E. Cover, J. M. Gunderson, D. A. Hubbard and J-P. G. Jacks met with L. A. Salvador, P. Cherish, L. K. Rath, E. Vidt and R. E. Andermann of Westinghouse at Madison, Pa. on 9 November for orientation on their fluidized bed coal gasification process development unit (PDU) program.

Westinghouse is interested in combined cycle low Btu gas production as well as high Btu gas production. As a result they have done extensive air-blown testing as well as a limited amount of oxygen-blown testing. Two unique features of the Westinghouse gasifier are the use of a draft tube to control solids recirculation in the fluidized bed and controlled operation to produce agglomerated ash particles which are free flowing. Leaching tests on the ash agglomerates indicate possible acceptability for land fill.

Since the PDU uses only one roughing cyclone to treat raw gas, Westinghouse is planning to recover fines which are carried over into the raw gas scrubber water and recycle them to the gasifier.

At the time of our visit, the plant was in the start-up phase for run TP-019-2. The next series of runs will be with oxygen and, early next year, the PDU will be converted to an integrated devolatilizer/gasifier operation with air feed.

Coordination will be between Westinghouse's Lou Salvador and Kellogg's Don Hubbard.

2.0 TASK 01 - ORIENTATION - Continued

2.7 Synthane Pilot Plant

A. E. Cover, J. M. Gunderson, J-P. G. Jacks and D. A. Hubbard met with R. Lewis and R. Santore of DOE - Synthane, at Bruceton, Pa. on 15 November 1978 for orientation on the Synthane pilot plant program. Norris Dorsey of Lummus conducted a tour of the plant. Mr. Lewis had expressed his concern during the GRI Project Advisors' meeting about the lack of funding for Synthane in 1979. At the time of our visit, the plant was shut down for repairs of the high pressure boiler. Plans were for the boiler to be repaired by the first of January 1979 and for the unit to be started. However, present funding would only carry the operation through about March 1979. Coordination will be between DOE's Bob Lewis and Kellogg's Don Hubbard.

In late November the decision was made by DOE to mothball the Synthane plant with a target completion date of January 31, 1979.

2.8 Rockwell Reactor Development Unit (RDU)

A. E. Cover, J. M. Gunderson and J-P. G. Jacks met with J. Silverman, Joseph Friedman, L. P. Combs and Daniel R. Kahn of Rockwell International at Canoga Park, California on 28 November for orientation on their short residence time hydrogasifier PDU program.

The objectives of Rockwell's Hydrogasifier Development program, to date, have been to develop a single-stage, short residence-time hydrogasifier design for a coal gasification process, and to generate the process data necessary to design a pilot plant. The basic process concept is to produce most of the product methane (greater than 90%) by the direct reaction of coal with hydrogen. It has been assumed that the technology for hydrogen production

2.8 Rockwell PDU - Continued

from unreacted char is available through such processes as the Texaco Partial Oxidation scheme.

Rockwell's early work on coal conversion was geared toward coal liquefaction. In light of DOE interest in 100% "gasification", Rockwell began running for gas production in early 1977.

The new (September 1978 to September 1981) Rockwell contract covers:

- Modification of the existing 1/4 TPH facility to increase run durations to one hour.
- Design and construction of a 4 TPH facility (construction should be complete after 21 months).
- Preparation of a preliminary design for a commercial hydrogasifier plant.

This new contract starts with DOE in September 1978 and comes under the joint DOE/GRI program on 1 January 1979. Some testing will be done in the 0.25 ton per hour unit in December 1978 and then the unit will be moved to another rocket engine test stand at their Santa Susana site near Canoga Park. Operations are expected to resume in the 0.25 TPH unit in March 1979. This development work is leading to the design of a 4 TPH PDU.

Coordination will be between Rockwell's Joe Friedman and Kellogg's Jean-Pierre Jacks.

2.0 TASK 01 - ORIENTATION - Continued

2.9 Peatgas PDU

A. E. Cover, J. M. Gunderson, L. E. Bostwick and M. R. Smith met with D. V. Punwani, C. L. Tsaros and S. Weil of IGT at Chicago, Illinois, on 7 December for orientation on IGT's Peatgas process development unit (PDU) program. All test apparati used was inspected in an conducted tour of both State Street and 36th Street locations. All Peatgas reports through October, 1978 have now been received and analyzed, including six reports that were arranged for at the 7 December meeting. Report FE-2469-33, for October 1978, is the first report within the Pullman Kellogg scope of work. The previous reports were reviewed for background.

Briefly, the status of the Peatgas program is as follows. Physical property evaluations show that Minnesota, Maine, and North Carolina peats are roughly similar and indicate that peats are higher than other coal types in moisture, nitrogen, volatile matter and oxygen, and lower in fixed carbon, heating value, sulfur, and ash. Thermobalance studies indicate peats are more reactive to gasification than lignite, sub-bituminous coals, and bituminous coals. Kinetic equations for devolatilization and gasification have been developed using the thermobalance apparatus and two bench-scale systems - a coiled-tube reactor feeding 6 to 30 grams/hr of peat and a larger "lift-line" reactor feeding 10 pounds/hr. of peat.

Various combinations of steam, hydrogen, and simulated mixtures of gas from steam/oxygen gasification have been used in the bench-scale reactors at a wide range of temperatures, pressures, steam rates, and hydrogen partial pressures.

2.0 TASK 01 - ORIENTATION - Continued

2.9 Peatgas PDU - Continued

The bench-scale experiments were supplemented by studies of steam/oxygen gasification of devolatilized char in two reactor systems which had been used for Hygas development.

Optimum conditions were found to be 500 psig, 50% moisture in peat feed, and temperatures of 450°F (slurry dryer bed), 1475°F (hydrogasifier), and 1700°F (steam/oxygen gasifier section). It has been concluded that the High Temperature Hydrogasifier section in the Hygas reactor will not be needed. A plant design has been completed by IGT and costs are to be published soon.

Coordination will be between IGT's Dharam Punwani and Kellogg's Martin Smith.

2.10 Exxon PDU

A. E. Cover, L. E. Bostwick, J. M. Gunderson and B. P. Castiglioni met with Dr. C. A. Euker, D. R. Hattaway, R. D. Wesselhoft, R. W. Kistler and J. E. Gallagher of Exxon at Baytown, Texas on 14 December for orientation on the Exxon Catalytic Coal Gasification PDU program.

Exxon has a $16.8 MM contract with DOE to operate a one-ton per day PDU. Exxon has already spent three million dollars of their own funds for this PDU facility since they want to use this facility later for proprietary studies. The overall objective of this contract is to develop sufficient scientific and technical information to advance to a 50 to 100 T/D pilot plant by 1981. To achieve this overall objective the program is divided into laboratory work and engineering work.

2.0 TASK 01 - ORIENTATION - Continued

2.10 Exxon PDU - Continued

The laboratory work is subdivided into PDU operations and bench-scale work. The PDU will operate at commercial plant conditions on Illinois coal and will integrate the gas recycle loop and catalyst recovery loop. Bench-scale work will complement the PDU operations with emphasis on catalyst recovery studies, evaluation of other bituminous coals and environmental studies. An advanced bench study program will explore the reactions of catalyst with coal and the kinetics of devolatilization and gasification. The engineering work will define the process features required for the conceptual design of a large pilot plant.

Exxon described their approach to economic evaluation of projects at various stages of development. They also described a statistical program they have for data reconciliation; i.e., a method for obtaining 100% material balances based on many measured values and several material balance constraints.

Kellogg was asked to sign a secrecy agreement in order to receive Exxon's reports before patent clearance has been obtained.

Coordination will be between Exxon's Charlie Euker and Kellogg's Bruno Castiglioni.

2.11 Planned Future Activities

The formal orientation task of introduction to the processes, pilot plants, PDUs and the personnel involved has been completed. No need is anticipated for further formal orientation. A work plan will be issued for the monitoring and evaluation of these pilot plants and process development units.

3.0 TASK 02 - ADMINISTRATION

3.1 Activities

During this reporting period, due to promotions within Kellogg, Mr. R. N. McAdow was replaced by A. E. Cover as Project Manager. Mr. A. E. Cover was replaced by Mr. L. E. Bostwick as Process Manager.

The Principal Process Investigators selected for monitoring the pilot plants and PDUs are as follows:

Hygas	-	M. R. Smith
BCR/BI-GAS	-	J-P. G. Jacks
Synthane	-	D. A. Hubbard
Westinghouse	-	D. A. Hubbard
Exxon	-	B. P. Castiglioni
Rockwell	-	J-P. G. Jacks
Bell Aerospace	-	B. P. Castiglioni
Peat Gasification	-	M. R. Smith

In addition, Mr. L. A. Zeis and his alternate, Mr. S. Y. Sathe have been selected to participate in the Metal Properties Council activities.

The Kellogg Project Plan and the Kellogg Coordination Procedure (both are internal documents) were issued. These documents respectively define the plan for implementing the project and define the communication, reporting and documentation requirements for the project.

3.2 Planned Future Activities

Modifications to plans are expected as new task orders are received.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING

This task involves three sub-tasks:

- Attending and recording the GRI Project Advisors' Meetings held at each facility (if any were held).
- Monitoring the facility operation and performance. (A suggested outline for trip reports is shown in Table 4.1).
- Reviewing and evaluating contractors' reports (if any were received).

4.1 Hygas Pilot Plant

4.1.1 Facility Monitoring

The Hygas debriefing meeting for Tests 75 and 76 scheduled for 8 December 1978 was cancelled and has not as yet been re-scheduled. No trips were made to the Hygas pilot plant during December. Telephone conversations with W. G. Bair indicated the following activities during December. Turn-around following Test 76 - which terminated 17 November - continued into early December. Test 77 light-off was achieved on 8 December.

The objectives for Test 77 are to feed "Run-of-Mine" Illinois #6 coal for a steady-state period of two days at Test 71 conditions (560 psig, 1750°F). Steam to carbon ratio is to approach the 1.3 mol steam per mol char as in the Procon design. Char feed rate will be 2 tons/hour. After the two-day demonstration, temperature is to be raised to 1800°F to demonstrate a higher char conversion without sinter formation.

Severe weather in Chicago during most of the month has made progress of Test 77 very spotty. Delays were encountered due to crushing system problems and instrument freeze-ups.

TABLE 4.1
GUIDELINES FOR TRIP REPORTS

INTRODUCTION

1. Who went where on what dates
2. Purpose of trip
3. Purpose of run or meeting
4. Objectives of run

SUMMARY

Capsulized description of run or meeting, including mention of key events only.

CHRONOLOGY

Blow-by-blow chronicle of events. For each give:

1. Event number
2. Short description, e.g., "Began coal feed"
3. Time as on 24-hour clock
4. Date

DISCUSSION OF CHRONOLOGY

Basically, a narrative history of the run or meeting. Explain significance of key events, relationships of various events. Postulate causes of failures with extra discussion as required.

VESSEL INSPECTION

Report on observation of equipment after run termination. Tie this in to discussion of events. Note impact of mechanical difficulties on process performance.

CONCLUSIONS

Crystallize into a short paragraph what the outcome of the run or meeting was, or particularly what knowledge was gained/confirmed by the run.

FUTURE OPERATIONS

Explain philosophy and objectives of next run. Include bases for parameters, e.g., bench scale study results, equipment modifications, etc.

ATTACHMENTS

1. Operating data from run
2. Sketches for illustration of points made in discussion.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.1 Hygas Pilot Plant - Continued

4.1.1 Facility Monitoring - Continued

Pretreated run-of-mine char was not fed to the reactor until 16 December and first self-sustained operation was at 20:00 on 17 December. The following day the pretreated char screw conveyor broke down and reactor was put on stand-by. A leak in the water line feeding the pretreater quench system was still delaying reactor operation on 22 December. Other short periods of self-sustained operation of 20-24 hours duration were achieved on 24-25 December, 27 December, and 31 December, but conversions were lower than desired. At month's end it was believed that modifications made to pretreater operation for run-of-mine coal would improve operations. These modifications included raising the superficial velocity from 0.4 to 0.6 ft/sec. In the final week an air heater had to be installed on the coal mill feed hopper to prevent freeze-up. On 25 December the base of the secondary fan on the coal mill system was found cracked and required repair. Pretreated char feed interruptions occurred several times due to wet and freezing coal and weighbelt flow calibration troubles. Sub-zero temperatures were setting in as the year ended.

A trip report describing Test 75 from log-book and other information obtained 27-28 November was prepared. Objective of Test 75 was to demonstrate sinter-free operation while approaching steam to carbon mol ratio of 1.3 in the commercial design. This was to be done by gradually replacing steam with nitrogen while maintaining 1.2 ft/sec superficial velocity in the gasifier zone to maintain good temperature control.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.1 Hygas Pilot Plant - Continued

4.1.1 Facility Monitoring - Continued

Self-sustained operation was achieved on 1 October and the first phase of the operation was established (900 psig, 2 tons/hr - char feed, temperature to give 80-82% conversion). On 3 October, coal mill problems forced reduction of char feed rate, but this was corrected. On October 4, trouble with H.P. slurry pumps and solids flow (LV 339) delayed operations. A major leak in a Grayloc flange early on 6 October forced a shut-down. Only the first phase of objectives was achieved, but subsequent Test 76 (2 November through 17 November) was said to have completed all four phases of the replacement of steam from 9000 lbs/hr to 6,381 lbs/hr, which corresponds to steam to char ratio of 1.58.

Past reports, process flow-sheets, written start-up procedures, and twelve piping and instrumentation diagrams obtained on 27-28 November trip were thoroughly studied.

4.1.2 Report Reviews

FE-2434-38, "Pipeline Gas From Coal-Hydrogenation (IGT Hydrogasification Process) Monthly Status Report - October, 1978:

> Current operations are described with minimum of process results and accounts of operating problems encountered. A time scale of operating and maintenance time which is included is helpful. Accounts of Run 75, the start of Run 76, and inspection results of equipment between the runs are given. Two new material balances and operating conditions furnished to Procon - for washed and un-washed coal - are included. Tentative conclusion is that washing will be uneconomical due to Btu loss and extra cost.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.2 BCR/BI-GAS Pilot Plant

4.2.1 Project Advisor Meetings

- A. E. Cover and J-P. G. Jacks met with the GRI Project Advisors, BCR, Phillips Petroleum and Stearns-Roger personnel at the BI-GAS pilot plant on 14 November for the GRI Project Advisors meeting. Topics on the agenda were plant improvements and accomplishments, review of operations since plant start-up, review of hazards studies and status of instrument development.

  During the question and answer session, major points brought up were the status of items on Phillips' work plan diagram and the possibility of switching to another type of coal in order to avoid the problems associated with the peculiar slag viscosity characteristics of the Montana Rosebud coal. Test G-6D had just started on the morning of our visit.

- A. E. Cover and J-P. G. Jacks met with the GRI Project Advisors and BCR personnel at the BCR Center in Monroeville, Pa. on 14 November for the GRI Project Advisors meeting. Topics on the agenda were BI-GAS pilot plant support activities and BCR in-house methanation research. Mr. Diehl gave a brief description of BCR's Tri-Gas low Btu gas project and a tour of their facilities was taken.

4.2.2 Facility Monitoring

- Two BI-GAS pilot plant tests were conducted during the month of December. As in all previous tests, plant feed was Montana Rosebud coal. Also, both tests were of the G-6 series, and thus involved slagging operation without the addition of a flux. Close contact was maintained with Phillips BI-GAS

plant staff by telephone, throughout the month. At test time, Jean-Pierre Jacks traveled to Homer City to monitor the conduct post- test equipment inspections, and attend the post-test review meetings.

- Test G-6E started on 1 December. Coal was fed to Stage II of the gasifier for a total of 9 hours and char was fed to Stage I for a total of 24 minutes. Coal feed was interrupted once after 52 minutes, and char feed was turned-off once after 14 minutes. The test was terminated because of failure of both of the Stage I thermocouple sheaths. Leaking high pressure steam boiler relief valves also contributed to the decision to terminate the run. The thermocouple sheath failures were later attributed to an error in machining of the chromia-coated portion of the sheaths. This exposed a section of thin uncoated sheath to near Stage I conditions. Test G-6E established that use of a horizontal spray across the water level in the slag quench section enhances rather than reduces fogging. Minimum fogging was found to occur with no water flow to the top of the slag quench section. It was also established that the impact of char flow on slag quench section fogging is reversible and immediate. Fogging becomes very heavy when char is introduced to the gasifier and fogging clears up very rapidly when char feed is stopped. One of the prime objectives of test G-6E, obtaining a good material balance, was not achieved because of the short test duration.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.2 BCR/BI-GAS Pilot Plant - Continued

4.2.2 Facility Monitoring - Continued

- Test G-6F started on 13 December. Coal was fed to Stage II for a total of 27 hours and char was fed to Stage I for a total of 26 hours 12 minutes. There was one 15-minute coal feed interruption and one 2 hours, 51-minutes char feed interruption. The test was terminated because of:

  (1) Loss of visual confirmation of slag tapping
  (2) Unreliable readings from Stage I thermocouple TE 3401-10
  (3) Two unsuccessful attempts to relight the slag tap burner
  (4) Unsuccessful attempts to remove slag from the slag quench section.

  The objectives of Test G-6F were nearly the same as those of Test G-6E, namely:

  (1) Achieve a good material balance around the spray dryer - gasifier - raw gas washer system
  (2) Evaluate the effect of reduced spray dryer recycle gas flow on coal cyclone performance, coal feed stability, and Stage II temperature.
  (3) Continue slag quench section fogging studies, this time using a full spray over tne water surface
  (4) Determine if slag tapping can be maintained without operation of the slag tap burner
  (5) Determine whether the variation in char burner dP's can be reduced by significantly increasing by-pass steam flow to the burners.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.2 BCR/BI-GAS Pilot Plant - Continued

4.2.2 Facility Monitoring - Continued

(6) Determine if the indicated char temperature increases and if the ΔP across the char legs eductors and burners changes, when the purge gas flow to the expansion joints on the char legs is reduced.

Results were as follows:

- It was found that minimum quench section fogging occurs when no water flow is introduced above the liquid level in the quench section.

- The reduced spray dryer recycle gas flow investigated resulted in a reduction in coal feed temperature (exit the spray dryer) from a value of 525°F to a value of 500°F. This appeared to have no significant effect on coal feed stability. The effect of reduced recycle gas flow on coal cyclone performance is still being evaluated by Phillips. Unstable level control in the V-203 water degassing tank, during the run, complicates evaluation of the data.

- Material balance results are inconclusive because of sampling problems and various vessel level control problems.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.2 BCR/BI-GAS Pilot Plant - Continued

4.2.2 Facility Monitoring - Continued

- Shutting off the slag tap burner resulted in slag solidification at the tap hole and loss of the TV picture because of lack of light. It was established that tapping could be reinitiated by relighting the tap burner. Operation with the tap burner at one-third firing rate resulted in viscous tapping and gradual build-up of a stalactite shroud around the bottom of the tap hole. This shroud eventually obscured observation of tapping.

- Significantly increasing steam flow to the char burners did not reduce the variation in dP measured across the burners.

- The next plant test is not scheduled until early February. A variety of maintenance and change work items are in progress. The February test will begin the G-7 test series and will investigate operation with a raised tap stone with a 2-inch diameter tap hole (vs. 6-inch diameter in the existing tap stone). A washing machine type agitator - slag crusher will also be installed prior to Test G-7. It is believed that the raised tap stone will maintain the tap hole at a higher temperature by bringing it closer to the char burners, and that the smaller tap opening will concentrate the slag into a more steady stream. This steady stream tapping is believed to favor frit formation over "angel hair" formation in the slag quench section. Installation of the agitator-type

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.2 BCR/BI-GAS Pilot Plant - Continued

4.2.2 Facility Monitoring - Continued

slag crusher is an attempt to improve slag withdrawal from the slag quench section. A complete review of all maintenance items and changes planned prior to Test G-7 is too lengthy for this summary.

4.2.3 BCR Methanation Studies

BCR attempted one Process Equipment and Development Unit (PEDU) methanation test (PDU Test No. 33) in December. The test started on 11 December. Its objective was to test BCR Lot No. 4189 noble metal-promoted nickel catalyst for an extended run ($\sim$ 5 days vs. 18 hours), operating at low H_2/CO ratio ($\sim$1.4:1 or 1:1 vs. 1.6:1). The run ended after approximately eighteen hours, when after introduction of synthesis gas, the temperature in the distributor area of the reactor could not be controlled. Post run equipment inspection revealed that the catalyst had degraded to a large amount of fines and had compacted in the distributor area of the reactor. A particle size analysis of the material indicated that 53 wt.% of the catalyst in the compacted area was less than 325 mesh (44 microns) in size, and 50% of the 53% was minus 10 microns in size.

Life tests were conducted on four samples of a Ni/Mo blend catalyst containing various promoter metals added for thermal stability. One of the samples was somewhat analogous to the Homer City catalyst and was very active. All four samples performed well at 1100°F. However, when the temperature was

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.2 BCR/BI-GAS Pilot Plant - Continued

4.2.3 BCR Methanation Studies - Continued

dropped from 1100°F to 800°, conversions dropped from the upper 80%'s to ~ 70%. These results have not yet been communicated to the catalyst supplier. BCR plans some additional testing of this catalyst.

A PEDU test is scheduled for mid-January using the Ni/Cu/Mo Homer City catalyst that was used in PDU tests No. 30 and No. 31. The purpose of the run will be to test the performance of the Homer City catalyst during extended operation at low H_2/CO ratio (~1.4 H_2/CO). Some people have questioned whether earlier 14 hour runs were of sufficient duration to test catalyst performance.

4.3 Synthane Pilot Plant

4.3.1 Project Advisors Meeting

A. E. Cover, J. M. Gunderson, D. A. Hubbard and J-P G. Jacks met with the GRI Project Advisors, DOE/Synthane and Lummus personnel at the Synthane pilot plant on 15 November for the GRI Project Advisors meeting. Topics on the agenda were review of plant operations and problems, description of the boiler explosion damage and repairs and recommendations for modifications to the pilot plant. The most significant problem was "clinker" formation in the gasifier but they are still having problems with feed control, scrubbing of product gas, coal pretreating and fines carryover from the gasifier. A tour of the facility was taken after the meeting adjourned.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.3 Synthane Pilot Plant

4.3.2 Facility Monitoring

Since the DOE has directed that the Synthane facility be placed on standby with no further operation, recent activities have been concentrated on deactivation of all equipment. Mothballing operations are scheduled for completion by 31 January 1979. Boiler repairs are continuing on schedule.

4.3.3 Report Reviews

COO-0003-34, "Contractor Monthly Progress Report No. 49 for the period September 1-31, 1978", Synthane Process, The Lummus Company, October 1978.

The plant was not operated during this period; an explosion in the high-pressure boiler on 21 September resulted in significant damage which will delay operation until early 1979. Technical items include a correlation of the method of oxygen injection to clinker formation, the heat and material balances for steady state period 21 of Run 1-DB with Montana Rosebud coal, and results of experimental activities regarding coal grinding. Engineering time was directed to several areas including a larger H.P. slurry tank and an inert gas drying system. Maintenance items included repairs to the gasifier, modifications in the coal feeding system, and cleanup in several areas.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.3 Synthane Pilot Plant

4.3.3 Report Reviews

COO-0003-35, "Contractor Quarterly Operations Report No. 16 for the Period July 1 - September 30, 1978", Synthane Process, The Lummus Company, November 1978.

During July and August four runs were made for a total of about forty days of operation. The last of these runs was the first successful trial of the integrated pretreater and gasifier. Operating conditions for the July-August runs are reported. The new steam/oxygen injection system was apparently helpful for reducing clinker formation and also reduced oxygen consumption substantially. Plugging of the coal feeding system caused several upsets; at one time the reactor was restarted after being held on standby. The gasifier bed height was controlled automatically for part of the operation.

An explosion at the high-pressure boiler occurred on 21 September, with considerable damage to the boiler and to electrical wiring in the immediate area. This will curtail operations until early 1979.

Technical effort was directed toward several areas, notably the correlation of steam/oxygen injection method and clinker formation, cyclone and pretreater operations, coal grinding tests, and study of the inert gas system. Engineering effort was mainly spent on work on the coal feed system, the high pressure slurry system, and various concrete/foundation items. Maintenance concentrated on modifications to the gas scrubbing system, the lock hoppers, the coal preparation system, and the inert gas system.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.3 Synthane Pilot Plant

4.3.3 Report Reviews

COO-0003-37, "Contractor Monthly Progress Report No. 50 for the Period October 1-31, 1978", Synthane Process, The Lummus Company, November, 1978.

The plant was down all month due to boiler repairs. Upon completion of electrical repairs, other utilities were restarted. Changes were defined for the inert gas generator to reduce NO_x levels, and a design for revised oxygen injection at the gasifier was prepared. Engineering activities involved the cyclone dip leg eductor, the inert gas drying system, control panel modifications, and boiler startup. Maintenance items were mostly related to valves and piping.

COO-0003-38, "Contractor Monthly Report No. 51 for the Period November 1-30, 1978", Synthane Process, the Lummus Company, December, 1978.

The plant remained down all month due to boiler repairs. DOE have directed that the plant be placed on standby for 1979 and 1980 due to a lack of funding. Technical activities included coal grinding tests, investigation of means to avoid clinker formation, study of gasifier heat balances, design modifications for the char slurry system, and study of storage of Illinois No. 6 coal. Engineering continued various projects involving the boiler, inert gas generator, the char slurry system, control panel modifications, and the cyclone dip leg. Maintenance activity was concentrated on boiler repair.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.4 Westinghouse PDU

4.4.1 Facility Monitoring

- Based on data obtained by the end of our orientation meeting with Westinghouse, the approach to shift equilibrium was calculated for several test run set points of the Westinghouse gasifier. Specifically, these calculations involve the reaction:

$$CO_2\ (g) + H_2\ (g) = CO\ (g) + H_2O\ (g)$$

Where the reaction equilibrium constant, Kp is defined as:

$$Kp = \frac{(CO)\ (H_2O)}{(CO_2)\ (H_2)}$$

with all terms as partial pressure. The approach to equilibrium was stated as a temperature differential, defined as actual gasifier outlet temperature minus equilibrium temperature.

Results of these calculations are shown in Figure 4.1. As can be seen, there are a few points where the approach was reasonably good, e.g., about 100°F. For most, however, the approach was on the order of 400°F or more. Normally, it would be expected that approach to equilibrium would not be close at the lower gasifier temperature and usually the approach is closer at higher temperature. Westinghouse has explained that the poor correlation is due to inaccuracies in water analyses.

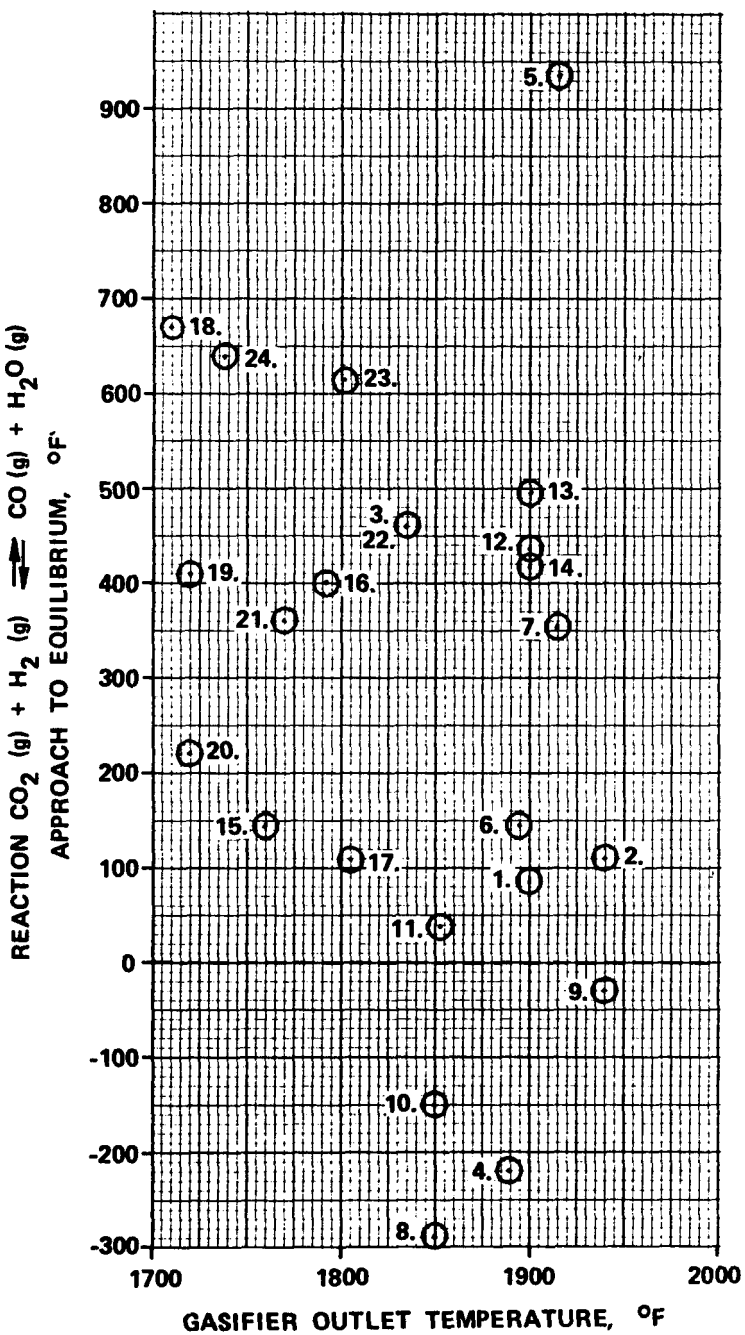

Figure 4.1

APPROACH TO WATER GAS SHIFT EQUILIBRIUM
VS TEMPERATURE
WESTINGHOUSE DATA

POINT NO.	TEST NO. & SET POINT NO.
1.	TP-011-5, #2
2.	TP-011-5, #1
3.	TP-011-6
4.	TP-012-1
5.	TP-012-2, #1
6.	TP-012-3, #1A
7.	TP-012-3, #1B
8.	TP-012-4, #1
9.	TP-012-4, #2
10.	TP-012-6, #1
11.	TP-012-6, #2
12.	TP-013-1, #1
13.	TP-013-1, #2
14.	TP-013-1, #4
15.	TP-013-2, #2
16.	TP-013-2, #3
17.	TP-013-2, #4
18.	TP-013-2, #5
19.	TP-013-3, #1
20.	TP-013-3, #2
21.	TP-013-3, #3
22.	TP-013-4, #1A
23.	TP-013-4, #1B
24.	TP-013-4, #2

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.4 Westinghouse PDU - Continued

4.4.1 Facility Monitoring - Continued

- The Westinghouse pilot plant was operated in the single-gasifier, oxygen-blown mode with Western Kentucky coal feed (Run TP-019-3) during the period from 5 December until 19 December. Ignition was delayed initially (until late on 8 December) by failure of an electric heater. Shutdown was necessary late on 10 December when refractory breaking away from the lower portion of the gasifier blocked the ash withdrawal system. Repairs were completed, and the unit was restarted, with ignition on 16 December. No further refractory breakage was evident during the remainder of the run. Operational difficulties during the run, other than those caused by refractory breakage, involved freezing of analyzer sample lines and plugging due to wet coal feed. Frequent (but easily overcome) feed outages caused reaction upsets which aborted attempts to operate the ash/char interface on automatic control.

  After the shutdown, activities were primarily those of securing the plant and assimilation of run data. Plans are being made for air-blown testing in the integrated gasifier-devolatilizer mode in late February, 1979.

  Don Hubbard was at the Westinghouse site during the period 8-12 December. While there, he followed pilot plant operations and attended each day's planning and review meeting. He also met with Westinghouse engineers to obtain additional background in the areas of pilot plant operation and process calculations.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.4 Westinghouse PDU - Continued

4.4.1 Facility Monitoring - Continued

Before and after this visit, Mr. Hubbard maintained contact by telephone with Westinghouse in regard to pilot plant activities and status.

Additional work accomplished on the Westinghouse process was as follows:

- An In-Depth review of all gasifier runs to-date is being prepared, to augment and to simplify the data as presented in Westinghouse monthly reports. This can be used as an independent evaluation of Westinghouse pilot plant performance.

- A table summarizing the key information for each gasifier run has been prepared. A copy of that table is included at the end of this report.

- Simplified process flow diagrams which show only critical instrumentation (as opposed to the detail of piping and instrument diagrams) are being prepared for the Westinghouse pilot plant in its current configuration. These will be used as flag sheets, which allow a clear simultaneous display of the flowsheet and operating data.

- A trip report for Mr. Hubbard's visit to the site has been prepared, as have been minutes of meetings held with Westinghouse during that visit.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.5 Rockwell Short Residence Time Hydrogasifier PDU

4.5.1 Facility Monitoring

Rockwell completed six test runs in their short residence time (SRT) hydrogasifier unit at Rocketdyne's Laser Energy Test Facility (LETF) in the Santa Susana mountains. Three tests were conducted with Kentucky No. 9 bituminous coal and three with Montana Rosebud subbituminous coal. Results will be reported when product analyses have been completed.

Rockwell reports that a preliminary draft of the 4 TPH hydrogasifier material and energy balance report was distributed and that they have received a first draft of the liquid hydrogen pumping system specification from Rocketdyne Facilities and Industrial Engineering.

In early January, program plans will be translated to schedule and other chart form to aid visualization of project status. Also, the planned 1/4 TPH testing will be reviewed in light of goals applicable to the 4 TPH reactor development.

The 1/4 TPH system is currently being dismantled and moved to a new position in the Energy Systems Group Bowl Control Center, to ensure complete dedication of the hydrogasifier facility to the needs of the program. Relocation is expected to take about 3 months.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.6 Peatgas PDU

4.6.1 Report Reviews

FE-2469-33 "Experimental Program for the Development of Peat Gasification", Monthly Status Report for October, 1978. Published date not noted. Received 18 December 1978.

The Task Numbers have been altered from the original eight tasks (for Minnesota peats only). Since North Carolina and Maine peats have been added, the tasks now are:

Task 1. Thermobalance tests with North Carolina and Maine peats were completed. Eleven tests were made on North Carolina and Maine peats.

Task 2. Hydrogasification tests in the "lift line reactor" PDU. One test with Minnesota peat and three with North Carolina peats were run.

Task 3. Oxygen-steam char gasification in the 6" diameter fludized bed PDU. One test (with Minnesota peat) was conducted and results of two previous tests were presented.

Task 4. Economic Analysis. Cost estimation was completed and results will be presented in an interim report.

The above refers to the extension tasks to be completed by 31 March 1979. Results in Task 1 are shown by carbon conversion plots only. Tasks 2 and 3 results are tabular data in good detail.

4.0 TASK 03 - PILOT PLANT AND PDU MONITORING - Continued

4.7 Planned Future Activities

Pilot plant and PDU monitoring activities will continue in accordance with the schedule shown in Figure 4.2 and will expand in scope to include more support activities.

5.0 TASK 04 - METAL PROPERTIES COUNCIL PROGRAM

Mr. L. A. Zeis has been active with the Metal Properties Council (MPC) and is now designated as the DOE/GRI representative on the Council. He will be assisted in this work by Mr. S. Y. Sathe.

Mr. L. A. Zeis and Mr. S. Y. Sathe have been assigned to review the Braun reports on MPC programs and materials of construction under Task 05.

6.0 TASK 05 - REVIEW OF C. F. BRAUN's FINAL REPORT

The various subjects addressed in the Braun final report were assigned to the appropriate Kellogg specialists. The subjects addressed are:

1. Coverage of Pilot Plant Operations
    a. Hygas Steam-Oxygen
    b. Hygas Steam-Iron
    c. CO_2 Acceptor
    d. BI-GAS
    e. Synthane
    f. Liquid Phase Methanation
    g. Applied Technology Molten Iron

CLIENT DOE/GRI Coal Gasification Research Program

DATE ISSUED 1-25-79

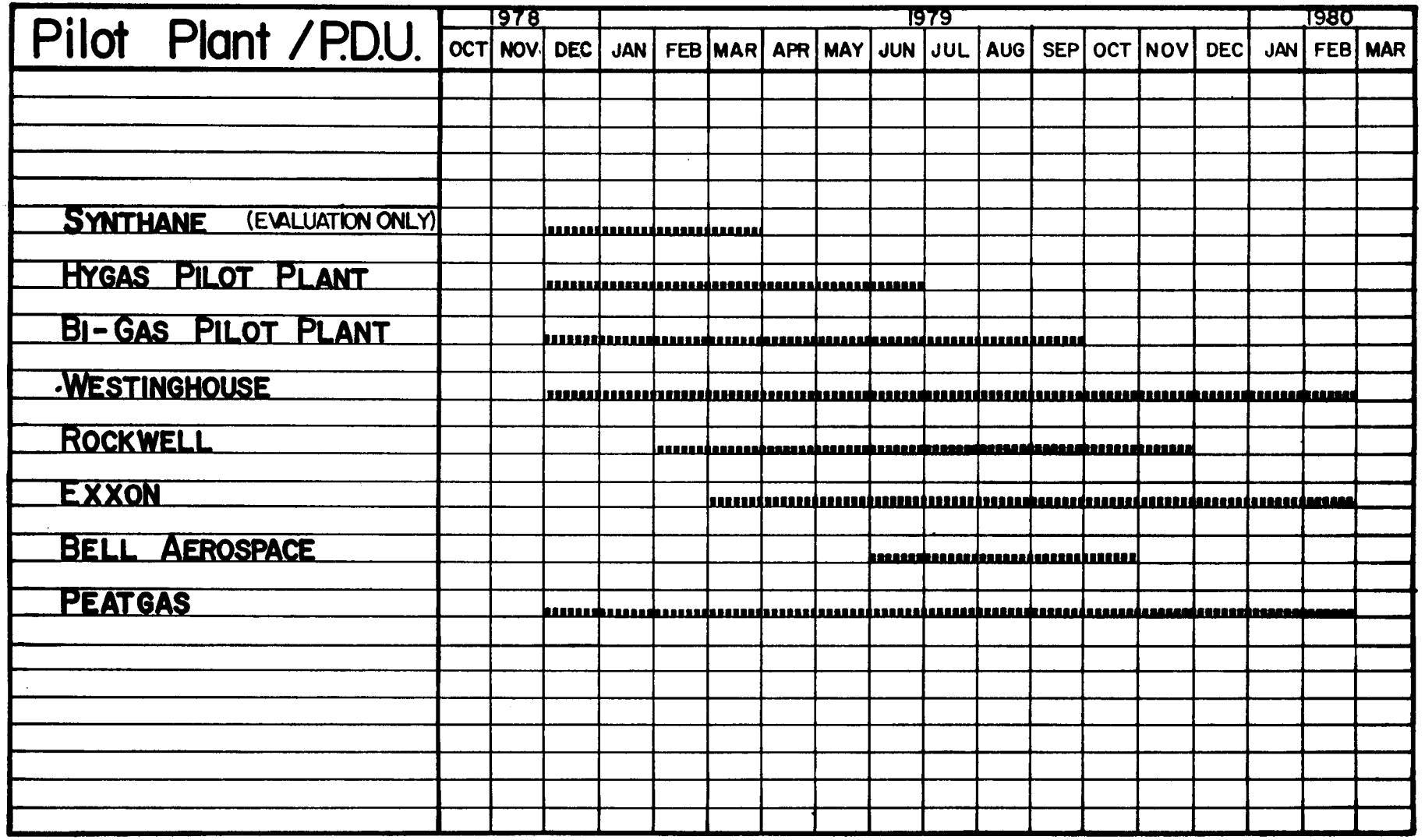

FIGURE 4.2

MONITORING - TASK - 03

SCHEDULED INVOLVMENT OF PRINCIPAL PROCESS INVESTIGATORS IN PROCESS OPERATIONS

6.0 TASK 05 - REVIEW OF C. F. BRAUN's FINAL REPORT - Continued

2. Mechanical Development
   a. Coal Grinding
   b. Coal Drying
   c. Pumps for Coal Slurry Feed
   d. Seal Valves and Rotary Valves
   e. Control Valves
   f. Dry Solids Feeders
   g. Packed Reactor Shape
   h. Vessel Design Specifications
   i. Refractories and Materials of Construction
   j. Solids Flow Instruments
   k. Reactor Temperature Measurement
   l. Solid Gas Separators
   m. Power Recovery

3. Special Analysis and Evaluation
   a. Commercial Hydrogen Comparison
   b. Safety Assurance Studies of Pilot Plants
   c. Considerations in Sizing a Coal Gasification Plant
   d. Materials of Construction Programs

4. Process Studies
   a. Coal Pretreatment
   b. Shift Conversion
   c. Gas Purification
   d. Methanation
   e. Effluent Treatment

A summary of recommendations will be transmitted to the DOE/GRI Operating Committee near the end of January, 1979.

A. E. Cover
Project Manager

SUMMARY - WESTINGHOUSE GASIFIER TEST RUNS

Dates of Run	Run Number	Time	Oxidant	Solid Feed(s)	Highlights of Run	Cause of Shutdown	Inspection	#Sets of Data
Dec 9-19 1976	TP-011-1	23 hrs	Air	Coke Breeze	1. Demo'd startup from "cold" to steady state. 2. Demo'd ignition & temp. control abilities. 3. Demo'd solids feeding & withdrawal capability.			None
Jan 12-24	TP-11-2	6 hrs	Air	Coke Breeze	1. Demo'd good heatup ramp. 2. No agglomerates formed.	Broken CW Line		One
Feb 22-25 Feb 27-Mar 1, 1977	TP-011-3	52 hrs	Air	Coke Breeze	1. Recycle gas used to cool annulus. 2. Used long hot-air dryout during S/U. 3. Ran @ 1900°-1950°F for 28 hrs, w/agglomerates discharged for 20 hrs.	Large agglomerates blocked withdrawal port. Also other mechanical problems.		One
Mar 14-19 1977	TP-011-4	40 hrs	Air	Coke Breeze	1. Ash concentration in bed controlled @ 20-35% with annulus at 50-80% ash 2. Noted effect on sintering by mixing at top of air tube and by continuous ash withdrawal 3. Noted that slugging in annulus can cause temperature excursions. 4. Noted primary controls are air flow & temperature, steam flow.	Plug in char fines feed line, also other mechanical problems.	Ash clinker found inside reactor	One
Mar 28-Apr 2 1977	TP-011-5	65 hrs	Air	Coke Breeze	1. Noted slag buildup causes low temperature readings. 2. Operated 50% ash in bed, 95% ash in annulus.	Voluntary, was planned.	Slag buildup 1"- 1-1/2" on walls, blocking annulus, bridging at air tube	Two
May 4-6 1977	TP-011-6	45 hrs	Air	Coke Breeze	1. Operated as-built, with radial fines feed system. 2. Modified instrumentation.	Voluntary, although a char feed line was cracked	Minor buildup of slag and clinkers.	One

SUMMARY - WESTINGHOUSE GASIFIER TEST RUNS (Continued)

Dates of Run	Run Number	Time	Oxidant	Solid Feed(s)	Highlights of Run	Cause of Shutdown	Inspection	#Sets of Data
June 10-15, 1977	TP-012-1	95 hrs	Air	Coke Breeze	1. Tested new air tube design, w/top 18" below 2. Smooth operations, with 95 hrs continuous combustion. 3. Ash at 20% in bed, 70% in agglomerates.	Blocked starwheel in ash withdrawal	Slag buildup 1"-1-1/2" on walls, no clinkers.	One
June 23-28, 1977	TP-012-2	85 hrs	Air	Coke Breeze	1. Tested air tube 0" below grid. 2. Smooth run- few malfunctions. 3. Ash removal on auto control for first time, 18 hours. 4. Ash at 20% in bed, 80±5% in agglomerates.	Erosion-perforation of a char feed line.	Slag buildup 1"-1-1/2" on walls, no clinkers.	Two
July 13-21, 1977	TP-012-3	80 hrs	Air	Coke Breeze	1. Tested air tube 36" below grid . 2. Could not run ash removal on auto control.	Voluntary, to avoid line plugging due to large agglomerates.	Minor slag on walls, large clinker at grid.	Two
July 30-Aug. 8,	TP-012-4	146 hrs	Air	Coke Breeze	1. Tested air tube 15" below grid. 2. Could not run ash removal on automatic. 3. Bed was 18-25% ash, agglomerates were 70°-90% ash.	Normal & planned - No mechanical problems.	No clinkers, no major slag deposits.	Two
Aug 23-30 1977	TP-013-1	97 hrs	Air	1. Coke Breeze 2. Recycled Fines	1. 70 hrs of 80% ash in aggomerates, incl. 20 hr at 90%. 2. Demo'd on-line feed switch.	Cyclone problems.	Ash buildup on walls of reactor.	Three
Sept 22-26, 1977	TP-012-5	24 hrs	Air	Coke Breeze	1. Tested modified air tube with annulus CSA reduced 25%. 2. Studied fines elutriation vs. bed height and freeboard velocity.	Large slag buildup in lower portion of reactor.		One
Oct. 6-12 1977	TP-012-6	80 hrs	Air	1. Coke Breeze 2. FMC char	1. Demo'd air transport of feed. 2. Good ash/char separation at low fluidizing rates. 3. Reactor operated with fines feed only. 4. High carbon utilization.	Cyclone outlet line cracked; lockhopper capacity too small for FMC char rates req'd .		Two

SUMMARY - WESTINGHOUSE GASIFIER TEST RUNS (Continued)

Dates of Run	Run Number	Time	Oxidant	Solid Feed(s)	Highlights of Run	Cause of Shutdown	Inspection	#Sets of Data
Oct 24-31, 1977	TP-014-1	60 hrs	Air	1. Coke Breeze & recycled fines 2. Minnehaha char & fines	1. Mechanical problems delayed S/U. 2. Demo'd 90% carbon utilization. 3. Reactor on "Hold" for 7 hrs during repairs	Broken starwheel feeder in ash removal.	Large clinker at grid plate.	Three
Nov 12-21 1977	TP-013-2	115 hrs	Air	1. Coke breeze 2. Renton char & fines 3. W.Kentucky char 4. Utah char	1. Air tube set at grid, w/coaxial feed 2-3/4" recessed. 2. Ran Minnehaha coal a few hours 3. New feedstocks gasified with agglomerates formed.	Bridge of agglomerated material in reactor.	Clinker at grid plate.	Four
Nov 26-Dec 2, 1977	TP-013-3	75 hrs	Air	1. Minnehaha coal 2. Wyoming coal 3. Champion coal	1. Demo'd operability with coal feeds. 2. Coaxial feed effective for caking coal, avoiding pretreating. 3. Minimal steam input, low oil, tar, and fly ash production.	Fire in PDU structure due to an error.	No slag or clinkers in reactor.	Three
Mar 28-Apr 13, 1978	TP-015	196 hrs	Air	1. Coke breeze 2. Recycled fines 3. W.Kentucky char 4. Pittsbg.coal	1. Demo'd operability of new 4-section gasifier. 2. Carbon utilization over 90%. 3. Made 105 BTU/SCF gas from coal.	Normal after achieving objectives.	No slag or clinkers in reactor.	Four
Apr 25-May 3 1978	TP-016	141 hrs	Air	Pittsburgh coal.	1. Tested modified air tube. 2. Successful gasification of coal of 7-1/2 FSI 3. No oil or tar produced. 4. Carbon utilization over 90%.	Wet coal plugged Starwheel feeder.	No material buildup in reactor	Four
May 16-25 1978	TP-017	171 hrs	Air	Pittsburgh coal.	1. Demo'd effect of temperature & steam rate on gas HHV. 2. Demo'd turndown capability.	Wet coal plugging in feed system .	No buildup in reactor	Five

Dates of Run	Run Number	Time	Oxidant	Solid Feed(s)	Highlights of Run	Cause of Shutdown	Inspection	#Sets of Data
June 25-29 1978	TP-018-1	10 hrs	Air	Coke breeze	First attempt at O_2-blown gasification	Numerous mechanical problems.		None
July 17-31	TP-018-2	180 hrs	Oxygen	1. Coke breeze 2. Pittsbg.coal	1. Fed caking coal 46 hrs. without problems in operation. 2. Ran O_2 at 20-36% vol. 3. Product gas HHV 165-260. 4. Tested two temperatures and two steam routes.	Problems with cyclone		Six
Aug 16-23 1978	TP-018-3	99 hrs	Oxygen	Pittsbg.coal	1. Ran coal with steam/02 2. Steam split: air tube and grid. 3. O_2 range 35-50%. 4. Gas from coal at 200-220 HHV 5. All fines collected and recycled.	Plug at cyclone entry .	Reactor had a minor buildup of sintered material at transition pieces.	Three
Sept 12-17 1978	TP-018-4	69 hrs	Oxygen	Pittsbg.coal	1. Ran coal with steam/O_2 for 48 hrs. 2. Tested revised cyclone entry. 3. Ash concentrated to 70%. 4. Gas from coal at 210-235 HHV. 5. All fines collected and recycled.	Plug at cyclone entry.	Minor buildup in reactor.	Two
Sept 25-Oct 5, 1978	TP-018-5	118 hrs	Oxygen	Pittsbg.coal	1. Ran coal with steam/02 for 85 hrs. 2. A 24-hr downtime for repair requ'd during the run. 3. Fines recycled only during last of the run. 4. Gas from coal at 220-240 HHV. 5. Ash contained sintered material.	Plug at cyclone entry.		Five
Oct 18-29 1978	TP-019-1	140 hrs	Oxygen	1. Rosebud coal 2. Indiana coal	1. Ran 70 hrs on Rosebud, with gas at 260-306 HHV. O_2 at 48-70%, 60% ash withdrawn. 2. Ran 20 hrs on Indiana coal, w/gas at 238HHV. O_2 at 57%, 34% ash withdrawn 3. Fines recycled part-time. 4. Wet coal feeding problems.	Packing leak at ash starwheel feeder.	No buildup in cyclone or reactor.	Six

SUMMARY - WESTINGHOUSE GASIFIER TEST RUNS (Continued)

Dates of Run	Run Number	Time	Oxidant	Solid Feed(s)	Highlights of Run	Cause of Shutdown	Inspection	#Sets of Data
Nov 6-17 1978	TP-019-2	180 hrs	Oxygen	1. Indiana coal 2. W.Kentucky coal	1. Ran 90 hrs on Indiana coal, with gas at 180-190 HHV. O_2 at 48%. 2. Ran 60 hrs on W.Kentucky coal, with gas at 210 HHV. O_2 at 35%. 3. All fines collected and recycled. 4. Many problems with wet coal caused upsets, led to poor Ash/char separation.	Plugging at ash removal system due to improper thermocouple installation.		Seven

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