

BITUMINOUS COAL RESEARCH, INC.
OCR/AGA-SPONSORED RESEARCH PROGRAM

PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT

Progress Report No. 14

(BCR Report L-492)

I. INTRODUCTION

This report summarizes progress achieved during October, 1972, on a part of the program, "Gas Generator Research and Development," being conducted by Bituminous Coal Research, Inc., for the Office of Coal Research. The overall program was initiated under Contract No. 14-01-0001-324, December 20, 1963, and was transferred to Contract No. 14-32-0001-1207 on August 19, 1971. Under the new prime contract, a portion of the work is being sponsored jointly by OCR and the American Gas Association. Thus, this report represents the fourteenth report of progress on the jointly-sponsored OCR/AGA program.

The objective of this part of the program continues to be to develop processes for gasifying coal to produce high-Btu pipeline gas.

Laboratory-scale coal gasification experimentation is to be continued together with process and equipment development. With the aid of engineering subcontractor(s), a multipurpose research pilot plant facility is to be designed, constructed, and test operated.

A. Work Schedule

Work on the project is being conducted according to a schedule reflecting the program outlined under the new prime contract. This schedule was shown in Figure 1, page 2, Progress Report No. 1 and revised as shown in Figure 160, Progress Report No. 13, to reflect only that part of the overall program sponsored by both OCR and AGA.

B. Monthly Progress Charts

Monthly progress charts reflecting proposed rate of effort and expenditures on that part of the contract sponsored jointly by OCR and AGA, through Fiscal Year 1974, are shown in Apperdexes A-1 and A-2. The projected costs are quarterly costs divided by three to obtain monthly costs, and will be adjusted when anticipated monthly expenditures are received from Stearns-Roger. These progress charts will be further revised to reflect the complete contract period when project planning and expenditure estimates for the period beginning with Fiscal Year 1975 are complete.

II. PHASE II PROGRESS ACHIEVED DURING MONTH ENDING OCTOBER 25, 1972

A. Laboratory-scale Process Studies

1. Gas Processing (M. S. Graboski): This report summarizes progress achieved in the bench-scale and FEDU gas processing programs during October. Gas processing studies continued in accordance with the updated time schedule presented in Figure 163.

a. Bench Scale Studies: The purpose of the bench-scale program is to investigate methanation catalysts under conditions imposed by the BI-GAS process. These include high carbon monoxide concentrations, high pressure, and a nominal 3/1 hydrogen to carbon monoxide ratio.

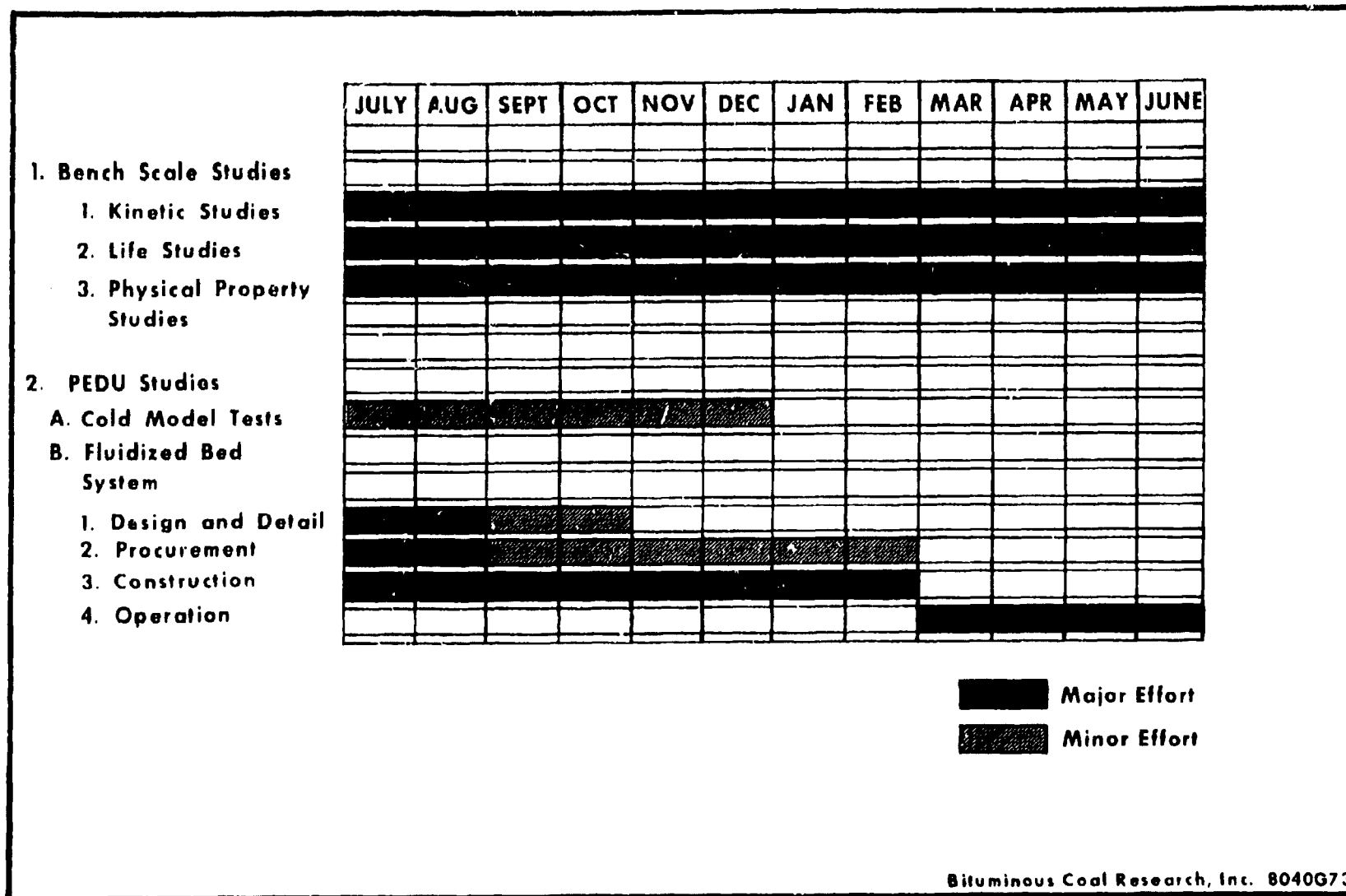
Three processing schemes are currently under investigation. These are summarized in Figure 164. Scheme A reflects current planning where methanation follows shift conversion and acid gas removal; Scheme B considers hydrogen sulfide removal before and carbon dioxide removal after methanation; and Scheme C is based on methanation of the synthesis gas containing all acid gas components. The purpose of both the bench-scale and FEDU programs is to determine the feasibility of the schemes for the BI-GAS process.

(1) Harshaw Catalysts: In Progress Report No. 12, physical properties were reported for four new methanation catalysts, BCR Lots 3049 through 3052, obtained from Harshaw. During September and October, work covered activity testing of these catalysts.

As reported in September, samples of the four catalysts were tested at 850 F, 1000 psig, at a nominal 1000 space velocity, and based on feed gases having a 3/1 hydrogen to carbon monoxide ratio. After 48 hours, two catalysts, BCR Lots 3050 and 3052, had lost all activity. Samples 3049 and 3051, both composed of nickel, molybdenum and alumina, were processed for 340 hours. During the first 70 hours, the feed gas was free of carbon dioxide while for the last 170 hours, it contained 15 percent of that component. Figure 165 shows the effect of time on conversion for the two catalysts. Data presented in the figure indicate that both catalysts were beginning to exhibit stabilized activity following some deactivation. Catalyst 3049 appears to be more stable than 3051. The four catalyst samples were returned to Harshaw for postmortem analysis to determine the reasons for deactivation of all four samples. These data will be useful in producing an improved catalyst.

The life test unit was charged with samples of catalyst lots 2903, 3049, and 3051. The purpose of this test was to compare the activities of the newly-obtained nickel molybdenum catalysts with the Harshaw molybdenum oxide catalyst found effective in past testing. The catalyst charges used were the following:

<u>Tube Number</u>	<u>Catalyst Lot</u>	<u>Mass, g</u>
1	2903	3.08
2	3051	3.08
3	3049A	2.99
4	3049B	3.01



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Figure 163. Gas Processing Work Schedule for Fiscal 1973

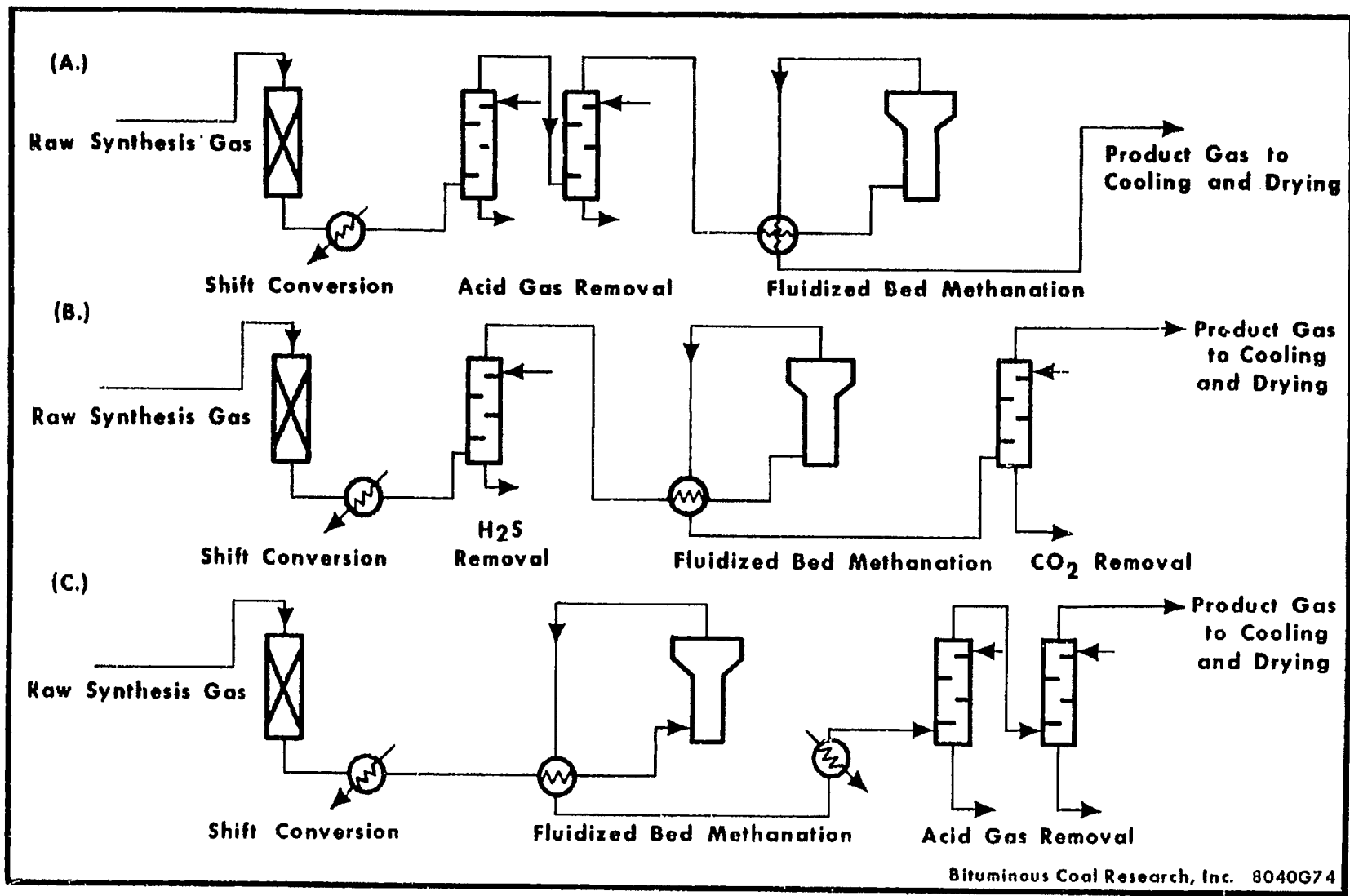


Figure 164. BI-GAS Gas Processing Systems

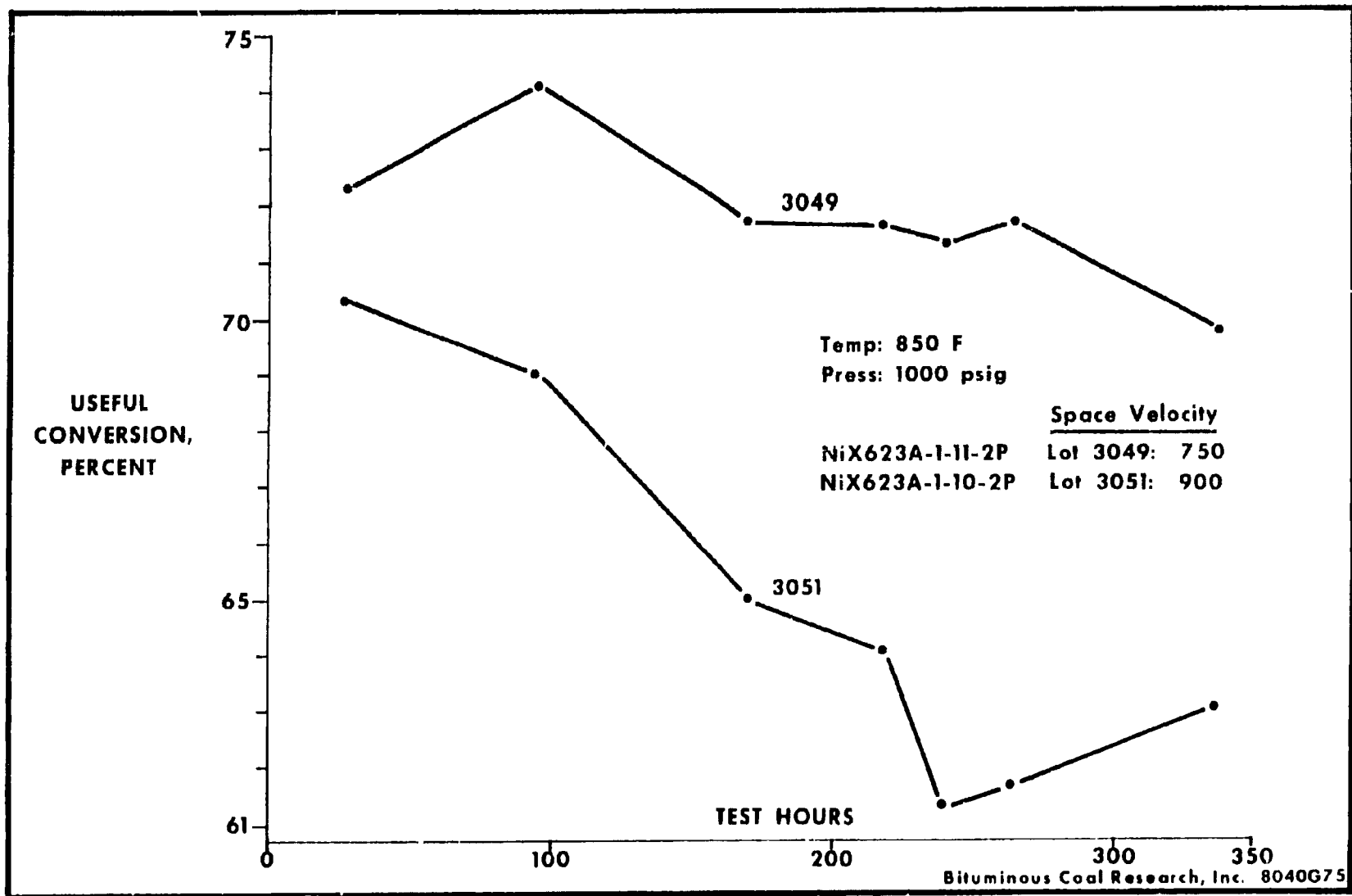


Figure 165. Effect of Time on Conversion for the Synthesis of Methane over Two Nickel Molybdenum Catalysts

The test conditions chosen were a nominal 1000 space velocity, 850 F, 1000 psig, and a feed gas composed of 25 percent carbon monoxide and 75 percent hydrogen. At 340 hours of testing, tube rupture occurred and the test was temporarily discontinued. The inconel outlet tubes were apparently subject to hydrochloric acid attack as evidenced by acid water found trapped at the point of failure. All product water samples collected from the tube containing Lot 3049A during the 340-hour test were analyzed and found to exhibit a range of pH from 3.7 at the start of the test to 2.3 at the conclusion. The Number 3 outlet tube was sent to Koppers for metallurgical analysis. Harshaw was notified of the problem, and they will endeavor to produce chloride-free catalysts in the future.

During the 270 to 340-hour period of the test, the detector block in the gas chromatograph used for life test gas analysis had to be changed and recalibrated. Erratic results occurred for samples taken at 340 hours. Results for the test are shown in Figure 166. Activity of both Lot 3049 and Lot 3051 were considerably higher than for Lot 2903. From Figure 166 it is apparent that the addition of a small quantity of nickel to the basic molybdenum catalyst greatly improves the methanation activity.

The life test reactor outlet tubes were replaced with new tubes composed of glass-lined inconel. The system was put back on stream at the same test conditions and all four catalyst charges exhibited continued activity.

(2) Chemetron Catalysts: A letter was received from Chemetron outlining a formal plan of catalyst development. A meeting between BCR and Chemetron personnel is scheduled for November 3, 1972 at BCR to discuss the program.

b. PEDU Studies: Progress continued on the methanation PEDU construction during October. The updated construction schedule for the project, based on currently available delivery data, is given in Figure 167.

(1) Engineering: Koppers continued detail engineering during October. As Figure 167 indicates, Koppers' services have been continued through November. Only minor effort is anticipated for this period.

During October, engineering on several process modifications was completed. These concerned the thermol system and the recycle gas system. Design drawings for the analyzer panel were submitted for review. Instrument air conduit drawings were received. In addition, the Koppers engineering staff was asked to evaluate sets of quotations for diaphragm control valves and self-acting control valves for the PEDU. Reports have been prepared and are currently being submitted to BCR.

(2) Procurement: Table 143 shows the revised delivery status of the major PEDU equipment items. During October, inspection visits were made to Nooter Corporation, St. Louis, Missouri, National Annealing Box Company, Washington, Pa., and Brown Fin Tube, Elyria, Ohio. Both the NABCO unit, item ME-410, and the Brown unit, item ME-605, have been received. A final inspection of the methanator being fabricated by Nooter is planned in early November.

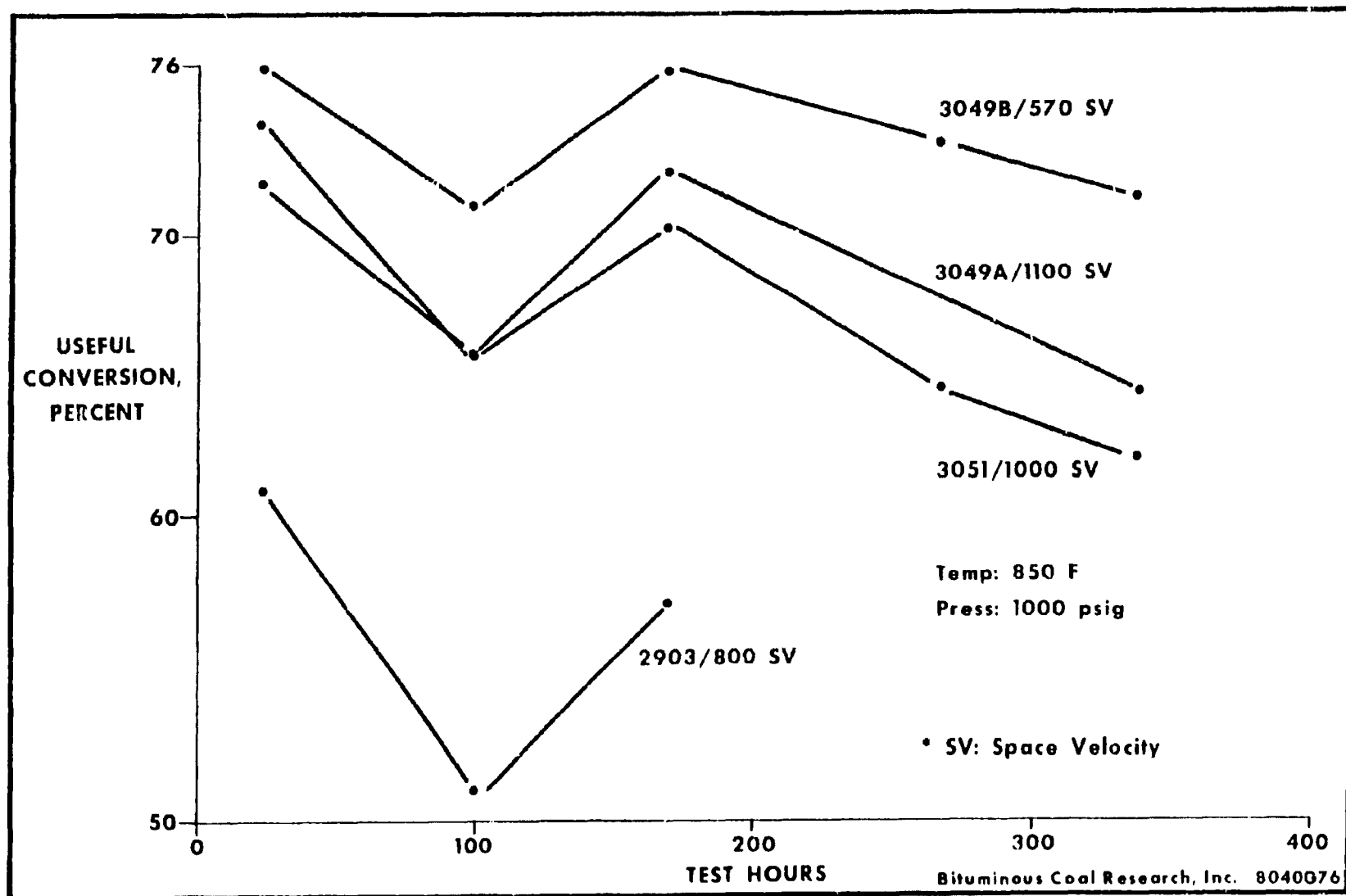
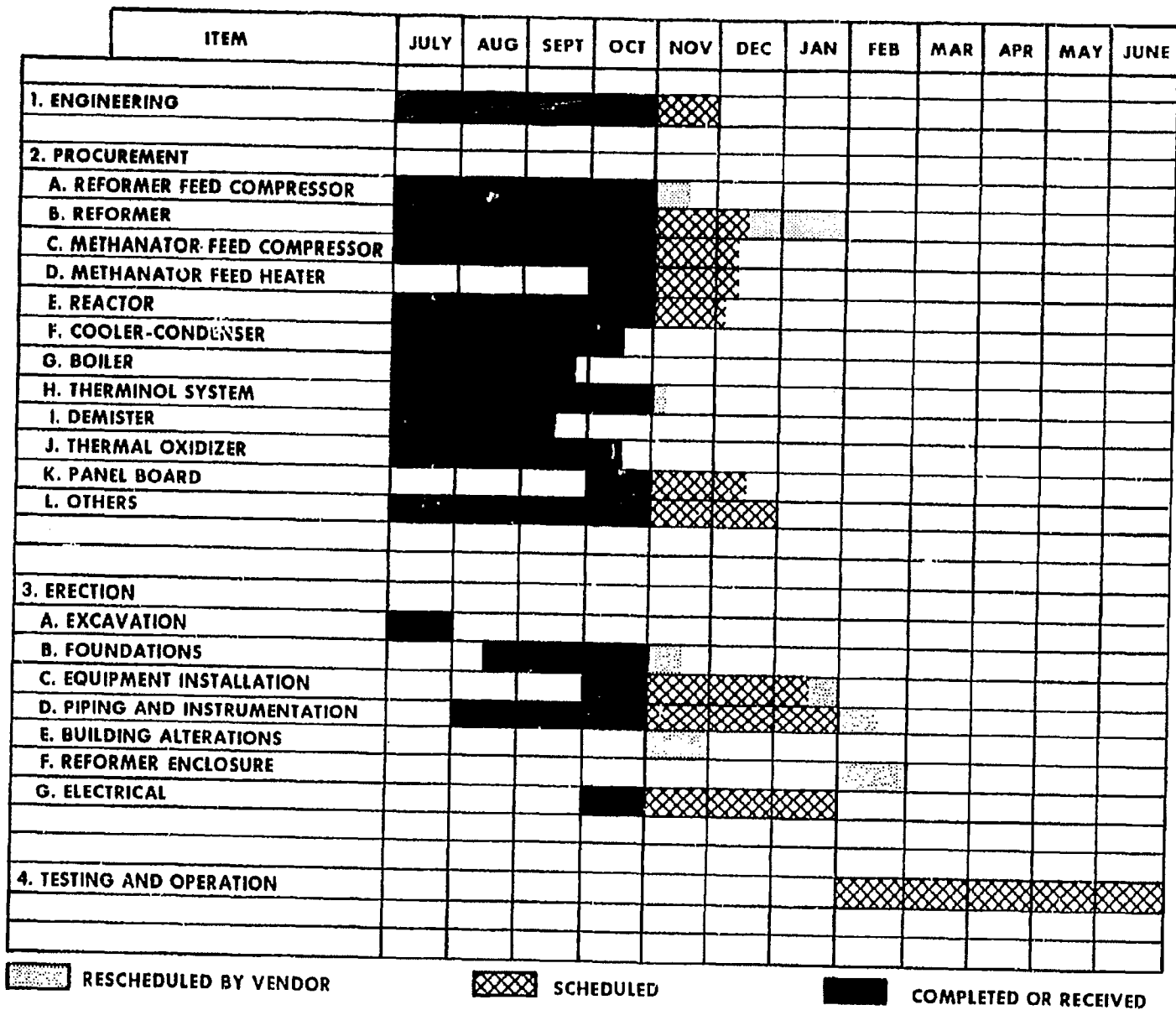


Figure 166. Effect of Time on Conversion for the Synthesis of Methane Over Several Catalysts



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Figure 167. Methanation PEDU Schedule for Fiscal 1973

TABLE 143. SUMMARY OF STATUS OF FEDU EQUIPMENT ITEMS

<u>Index</u>	<u>Equipment Item</u>	<u>Status¹</u>	<u>Estimated Delivery Date</u>
ME-405	Feed Gas Preheater	P	12/15/72
ME-410	Filter Blowback Heater	P/A	R
ME-605	Cooler Condenser	P/A	R
ME-700	Water Cooler	P/A	R
MF-420	Catalyst Filters	Q	--
MK-102	Natural Gas Compressor	P/A	10/09/72
MK-305	Methanator Feed Gas Compressor	P/A	12/04/72
ME-305	Bypass Cooler	P/A	12/04/72
MK-770	Air Compressor	P/A	R
MF-710	Cooling Water Pump	P/A	R
MR-420	Fluid Bed Methanator	P/A	12/04/72
MV-104	Reformer Feed Gas Receiver	P/A	R
MV-260	H ₂ S Flash Tank	P/A	R
MV-307	Oil Separator	P/A	R
MV-310	Methanator Feed Gas Receiver	P/A	R
MV-610	Water Metering Tank	P/A	R
MV-615	Water Letdown Tank	P/A	10/15/72
MV-620	Demister	P/A	R
MV-710	Cooling Water Tank	P/A	R
MV-763 A & B	H ₂ S Removal Towers	P/A	R
MV-764	Drip Pot	P	R
MV-766	Water Break Tank	P/A	10/15/72
MX-100	Reformer	P/A	01/31/73
MX-500	Therminol System	P/A	10/30/72
MX-720	Steam Boiler	P/A	R
MX-750	Demineralizer	P/A	--
MX-770	Thermal Oxidizer	P	R
MY-700	Reformer Enclosure	P	10/15/72
	Panel	P	12/15/72

- ¹ Q Quote Stage
P Procurement Stage
P/A Procured and Vendors Drawings Approved
R Received

During October, the thermal oxidizer, MX-770, was received and the drip pot, item MV-764, was fabricated by BCR personnel. Conversations with Gas Atmospheres indicate that the reformer delivery may be further delayed to late January due to late delivery of instrumentation items.

(3) Construction: PEDU construction is proceeding according to the schedule shown in Figure 167. Due to the revision in the reformer schedule, the equipment installation period has been extended several weeks and the reformer enclosure erection has been rescheduled. The building alteration work which was arranged for October will now be completed in November after foundation work in the compressor area is finished. Some construction photographs are presented in Figures 168 through 177.

(a) Piping Installation: Piping work by BCR personnel continued during October. During this period, yard rack utility piping, including low and medium pressure process gas, vent gas, natural gas, carbon dioxide, steam, city water, and cooling water, was installed. Supports for indoor piping were fabricated along with a number of minor vessels and cooling water thermometer wells. The cooling water pump and reformer feed gas receiver were set in place.

(b) Structural Construction Work: Mellon-Stuart, the low bidder on the construction package, was awarded a purchase order in early October and has begun work on foundations and structural steel fabrication. During October, pads were constructed for the carbon dioxide storage tank, thermal oxidizer, reformer feed gas receiver, and the sulfur removal towers. All excavation for foundations has been completed and the remaining foundation work will be completed by mid-November. BCR has reviewed and approved steel work drawings prepared by Mellon-Stuart.

(c) Electrical Construction Work: Current work includes:

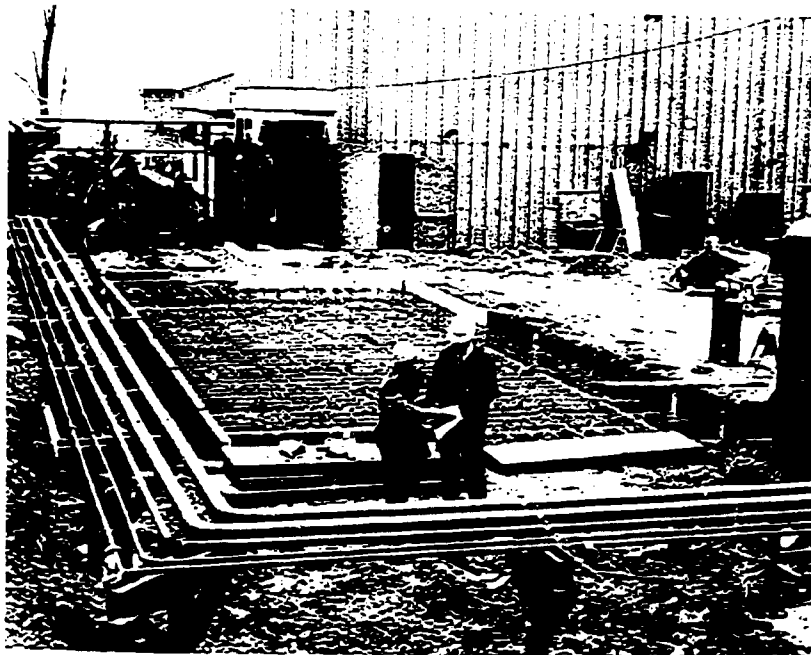
1. Continuous grounding of all methanation buildings and systems.
2. Installation of embedded conduit runs, which contain four, 3-inch rigid conduits, starting at the 750 KVA transformer pad and being stubbed-up near the northeast corner of Building No. 3.
3. Installation of one embedded 4-inch conduit run which begins at the 750 KVA transformer pad and is terminated at a Duquesne Light Co. pole approximately 130 feet away.

All embedded conduit work should be completed by the first week of November.

A work schedule from Lord Electric Co., Inc., is not available at this time, but should be submitted to BCR early in November.

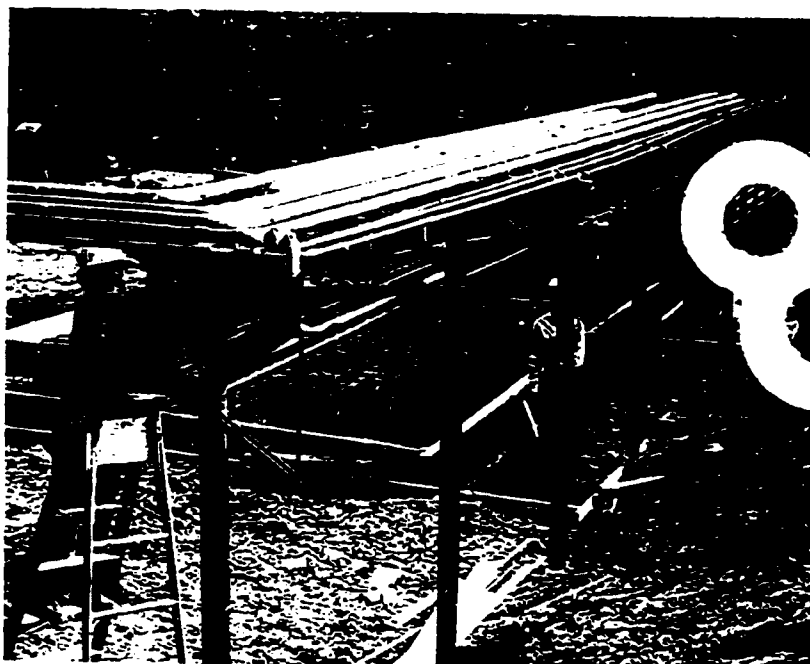
(d) Work Scheduled: During November, construction work planned includes:

1. Further installation of outdoor PEDU piping.
2. Installation of hydrogen sulfide removal towers, thermal oxidizer and cooling water hold tank.



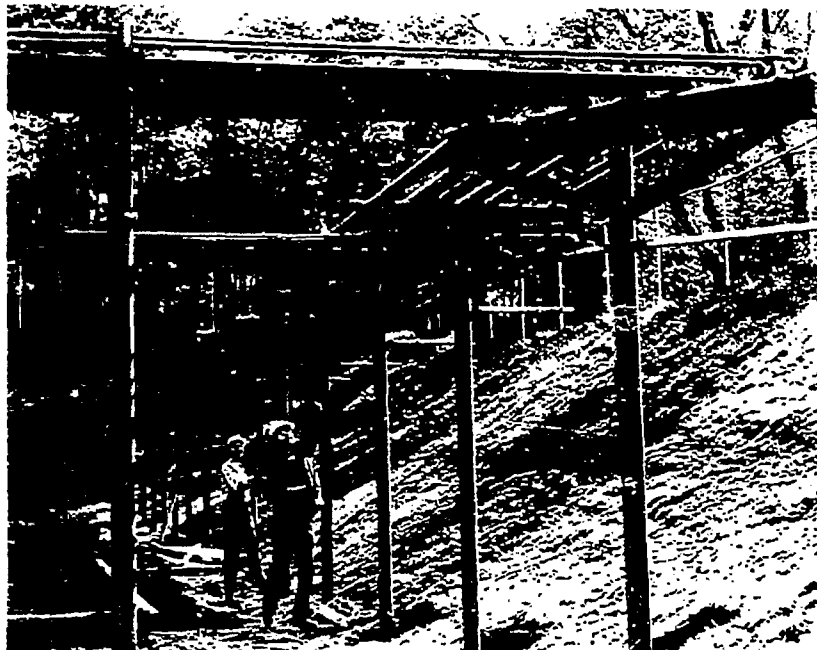
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Figure 168. General View of Construction Site



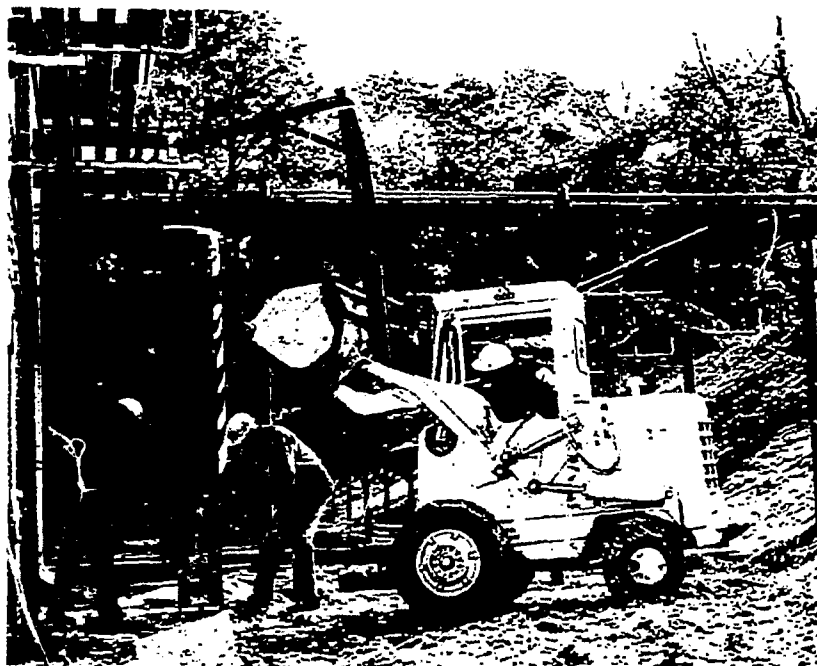
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Figure 169. Installing One Carbon Dioxide Feed Line to the Reformer



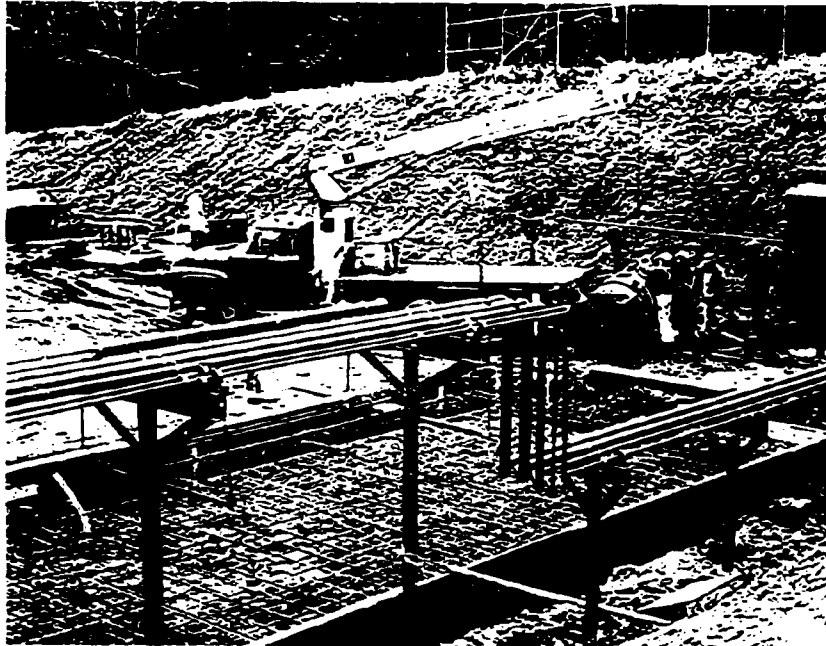
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Figure 170. Piping the High Pressure Gas Line to the Reformer



8040P20

Figure 171. Location of Reformer Feed Gas Receiver



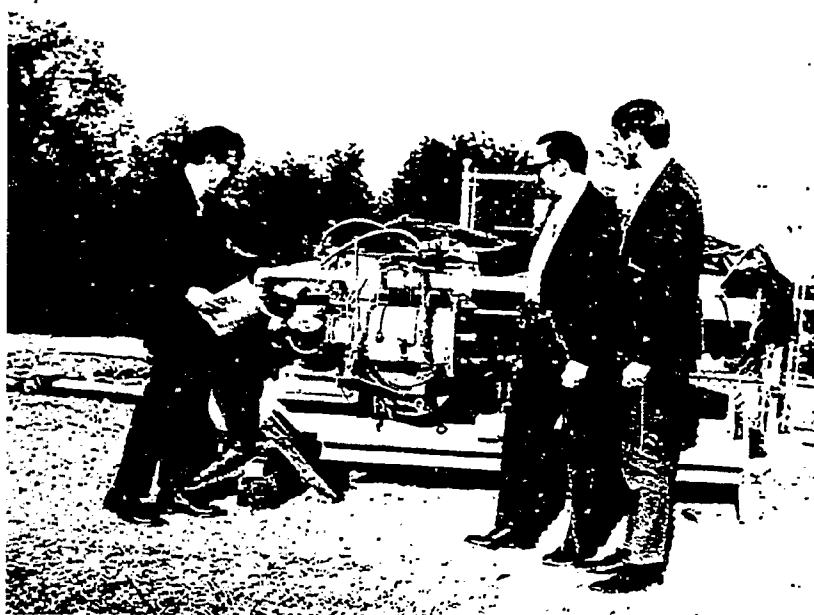
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Figure 174. Contractor Rigging an H₂S Removal Tank



8040P24

Figure 175. Setting an H₂S Removal Tank



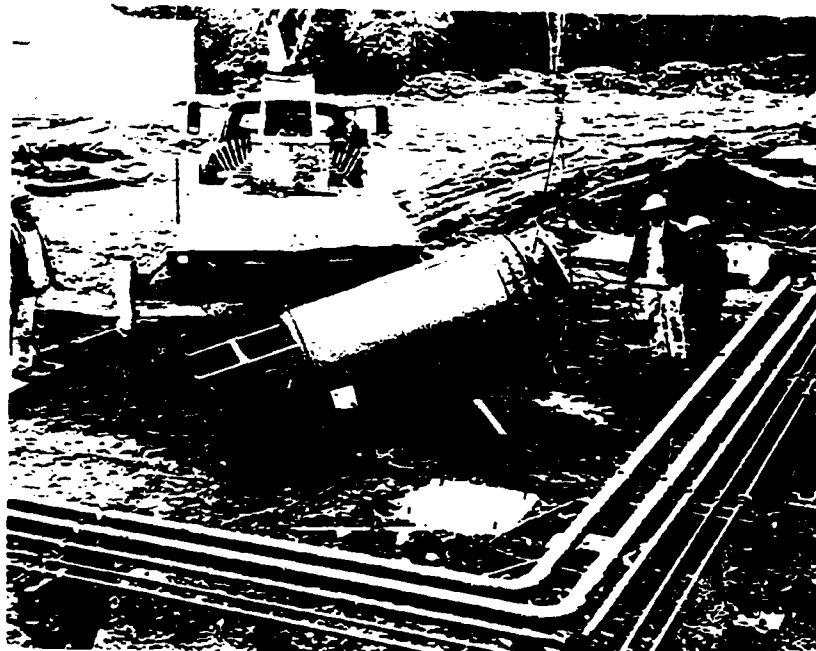
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Figure 172. Inspection of the Thermal Oxidizer



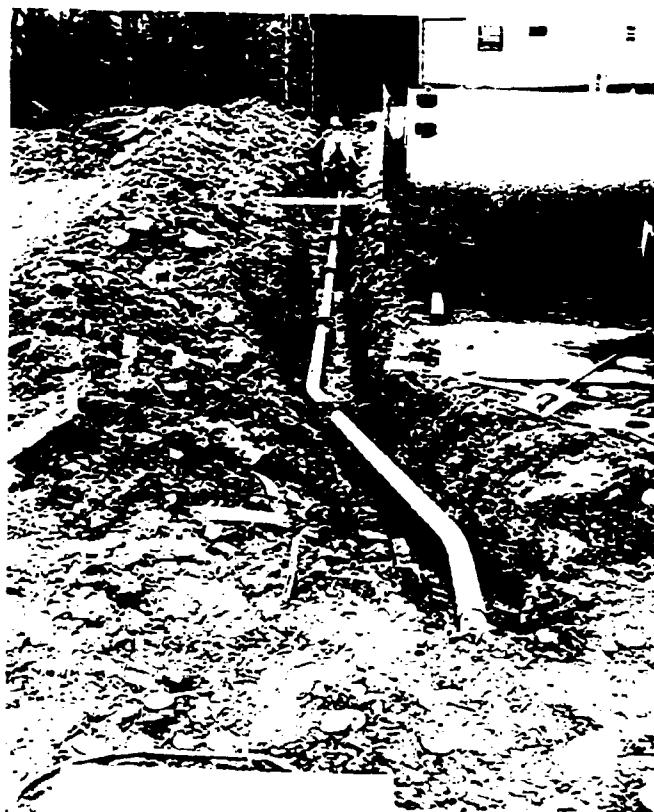
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Figure 173. Pouring the Thermal Oxidizer Pad



8040P25

Figure 176. Raising an H₂S Removal Tank



8040P26

Figure 177. Contractor Installing Electrical Conduit to the Transformer

3. Erection of some structural steel.
4. Completion of all foundation work.
5. Completion of continuous grounding network.
6. Initiation of installation of electrical conduit.
7. Installation of electrical equipment.

c. Model Studies: No model study work was conducted during October.

d. Future Work: Work for November includes the following:

1. Bench-scale test of methanation catalysts.
2. Continued PEDU construction including piping, foundation, structural, and electrical construction.

2. Analytical Services (J. E. Noll): During the past month, forty-nine samples from the methanation unit were analyzed by gas chromatography.

3. Gas Chromatographic Procedures (J. E. Noll): The system for automated gas analysis for the methanation PEDU is being standardized. The flame ionization detector (FID) gas chromatograph has been partially standardized.

a. Automated Gas Analysis System: This system has been run using helium as a carrier gas to obtain time values and experience in handling the valves and setting flow rates. Results indicate that sufficient time elapses between various events so that manual control can be readily adapted in case the automated system fails; and that the flow rates can be set so that the switching of the valves causes minimum interference with the integrators.

A carrier gas pressure safety switch and a T-tube arrangement to permit interchange between neon and helium, as carrier gases, are being installed. This will allow the gas chromatograph to be on standby with helium as a carrier gas and thus use the neon only during analytical determinations. Standardization, using neon as a carrier gas, will be started next month, and steps to automate the system using computer control will begin.

b. FID Gas Chromatograph: The FID gas chromatograph was equipped with a thermocouple to monitor the flame and provide a visual check. A low-temperature reading on the thermocouple represents no flame. Thus, if hydrogen is on, appropriate steps can be taken to eliminate explosion possibilities from a buildup of hydrogen.

75.

The unit was qualitatively standardized for most of the compounds that are expected in the water samples from the methanation runs. Quantitative calibration will be made in the near future.

B. Cold Flow Model Studies - 5 ton/hr Two-stage Gasifier (R. J. Grace, R. D. Harris, R. L. Zahradnik, and E. E. Donath)

The summary report on the cold flow model studies is undergoing final editing and will be issued as Special Report No. 3. The model equipment is being maintained in working condition for occasional demonstrations in anticipation of future modeling programs.

C. Data Processing (R. K. Young and D. R. Hauck)

1. Automated Data Acquisition: The BCR real time software system and the bench-scale methanator data acquisition program have been utilized to acquire, store, and report the data from BSM Test 78. These programs will be used in all future BSM tests.

Complete descriptions of the BCR real time software system and the BSM data acquisition program are being written and will be included in the next progress report.

2. BI-GAS Process: No commercial gasifier simulation runs were requested during this period.

3. Future Work: Plans for the next report period include:
- a. Logging and processing data from the bench-scale methanation unit.
 - b. Completion of the descriptions of the BCR real time software system and the BSM data acquisition program.
 - c. Generation of simulation runs with subroutine GASIFY as requested and authorized.
 - d. Investigation of possible problem areas in interfacing the FDP8/E computer with the methanation FEDU.

D. Multipurpose Research Pilot Plant Facility (MPRF)

1. Pilot Plant: As approved by OCR and AGA, subcontracts have been awarded by Stearns-Roger for initial site work at Homer City covering Site Survey and Topography, Site Clearing and Grubbing, and Subsurface Investigation and Mining Study. Field work at the site was scheduled to begin October 27 and will probably continue until the end of the year. The Stearns-Roger field supervisor has been assigned to coordinate and supervise field activities while crews are at the jobsite.

A project review meeting was held at Stearns-Roger in Denver on October 12-13, 1972, to review progress on the project in detail, with particular emphasis on process engineering. It is planned to hold project review meetings on a monthly basis, or more often if necessary. The next scheduled meeting is November 7-8, 1972, in Denver.

Several process and mechanical flow diagrams were issued to BCR, Blaw-Knox, and C. F. Braun on October 26, 1972, for approval in principal only to firmly establish and finalize the process functions and equipment requirements. Final approval diagrams will be issued when utility requirements, complete line sizing and indexing, and other miscellaneous information is developed. A meeting is planned for November 9-10, 1972, at Stearns-Roger in Denver to further review the flow diagrams after all parties have had the opportunity to make their review and compile comments for discussion at the meeting.

a. Stearns-Roger, Inc.: Current engineering effort by Stearns-Roger is reported in their Project Status Report No. 3, Appendix B of this report.

b. Blaw-Knox Chemical Plants, Inc.: Blaw-Knox continues to provide surveillance services in connection with the Homer City pilot plant. In addition to the regular day to day surveillance, Blaw-Knox has instituted a weekly review meeting with the Stearns-Roger Project Manager and has started issuing a bi-weekly status report. Assistance has been given in selection of materials of construction, lock hopper valves, and gasifier burners. Review of the project schedule and master logic diagrams has resulted in recommending certain modifications and suggesting areas of the logic diagrams that require investigation. Stearns-Roger General Specifications have been reviewed and approved as appropriate.

2. Materials Evaluation Program: A meeting of the Task Group on Materials Design Data for Coal Gasification Equipment was held on October 26, 1972, at the United Engineering Center in New York City.

Discussions included contractual agreement with IRI Research Institute for work on corrosion testing of sixteen materials intended for use in coal gasification equipment, finalization of inorganic coatings and refractory materials test program, and other possible test programs involving materials behavior in both low and elevated temperature environments not yet considered by the Task Group.

The next meeting of the Task Group is scheduled for November 21, 1972, at the Institute of Gas Technology, Chicago, Illinois.

E. Literature Search (V. E. Gleason)

Annotated literature references completed during the month are listed in Appendix C.

F. Outside Engineering and Services

1. Koppers Company, Inc.: Koppers continues to provide engineering assistance as required and as reported in their Progress Report No. 39, Appendix D of this report.

G. Other

1. Prime Contract Matters: By letter dated October 23, 1972, to Mr. Howard Thunberg, we advised OCR of the various items of surplus nonexpendable equipment from Contract No. 14-01-0001-324 that were picked up by personnel from the U.S. Bureau of Mines, Bruceton, Pa., on October 20, 1972.

2. Patent Matters: Worthwhile ideas continue to be written as invention disclosures for submission to OCR for consideration. Status of the various disclosures is as follows:

a. OCR-866 and OCR-1078: A U.S. patent application entitled "Gasification of Carbonaceous Solids," containing nine claims, was filed together with the Assignment on September 22, 1971, and given Serial No. 182,652.

Patent applications have been filed in Australia, India, South Africa, Canada, Great Britain, and West Germany. On September 20, 1972, an application was filed in Japan under Serial No. 94477/72. On September 22, 1972, an application was filed in France under Serial No. 72 33 761. Confirmatory license to the government was executed by BCR on January 12, 1972.

b. OCR-1860 and OCR-1861: These disclosures were combined into a single patent application entitled "Two-stage Gasification of Pretreated Coal." This application, containing 12 claims, was filed together with Assignment on March 23, 1972, and given Serial No. 237,332.

Patent applications are being prepared for filing in France, West Germany, and Japan. Confirmatory license was executed by BCR on May 8, 1972.

c. OCR-1862: A U.S. patent application entitled "Three Stage Gasification of Coal," containing eight claims, was filed together with Assignment on March 23, 1972, and assigned Serial No. 237,333.

Patent applications are being prepared for filing in France, West Germany, and Japan. Confirmatory license was executed by BCR on May 8, 1972.

d. OCR-1863: A U.S. patent application was prepared for this disclosure entitled "Two-stage Downflow Gasification of Coal." This application, containing seven claims, was filed together with Assignment on March 23, 1972, and given Serial No. 237,454.

Applications are being prepared for filing in France, West Germany, and Japan. Confirmatory license was executed by BCR on May 8, 1972.

e. OCR-1864: A U.S. patent application entitled "Two-stage Gasification of coal with Forced Reactant Mixing and Steam Treatment of Recycled Char," was prepared for this disclosure. The application contains 13 claims and was filed on March 23, 1972, together with the Assignment, and assigned Serial No. 237,360.

Patent applications are being prepared for filing in France, West Germany, and Japan. Confirmatory license to the government was executed by BCR on May 8, 1972.

f. CCR-2044: An Invention Disclosure (Form DI 1217) entitled "Combined Methanation - Shift Reaction Process," was submitted to OCR for consideration on June 14, 1972. Use of this process simplifies and reduces the cost of making synthetic pipeline gas, especially from coal, using the BI-GAS or other coal gasification processes.

In a memorandum dated July 20, 1972, Mr. M. Howard Silverstein, Branch of Patents, notified OCR that this Invention Disclosure has been assigned Interior Case No. OCR-2044. BCR will prepare and file a U.S. patent application for this disclosure as authorized in OCR letter of August 14, 1972, to Mr. S. J. Price, BCR's patent attorney.

3. Reports and Papers: As approved by OCR, R. J. Grace presented a paper entitled "BI-GAS Program Enters Pilot Plant Stage" at the AGA Synthetic Pipeline Gas Symposium, October 30, 1972, in Chicago, Illinois. An advance copy of the text of the paper was sent to OCR by letter dated October 19, 1972. Copies of the final paper will be forwarded to OCR as soon as available.

H. Visitors During October, 1972

October 3, 1972

Mr. Hayward H. Chappel
Manager, Catalyst Development
American Cyanamid Company
Refinery Chemical Department
Bound Brook, New Jersey 08802

October 10, 1972

Dr. Werner Peters
Mr. K. H. Hawner
Steinkohlenbergbauverein
Bergbau-Forschung GmbH
Bergwerksverband GmbH
Frillendorfer Strasse 351
43 Essen Kray
GERMANY

October 20, 1972

Mr. Jack M. Marsten
Raymond/Bartlett/Snow
Combustion Engineering, Inc.
135 Cedar Boulevard
Pittsburgh, Pa. 15228

October 23, 1972

Mr. Ronald Spray
William J. Murdoch Engineers, Inc.
411 Seventh Avenue
Pittsburgh, Pa. 15219

Mr. G. E. Fassett
Central Indiana County
Water Authority
355 Main Street
Homer City, Pa. 15748

October 25, 1972

Mr. J. F. Cudmore
Australian Coal Industry Research
Laboratories, Ltd.
P. O. Box 169
Chatswood, N.S.W. 2067

October 27, 1972

Mr. Neal P. Cochran
Division of Research & Development
Office of Coal Research
U.S. Department of the Interior
Washington, D. C. 20240

October 30, 1972

Mr. Noel F. Boyd
Blaw-Knox Chemical Plants, Inc.
One Oliver Plaza
Pittsburgh, Pa. 15222

I. Trips and Meetings During October, 1972

October 2-3, 1972	Stearns-Roger, Inc. Denver, Colorado	R. J. Grace E. E. Donath J. P. Tassoney
October 4, 1972	National Annealing Box Co. Washington, Pa.	M. S. Graboski
October 10, 1972	Brown Fin Tube Co., and Harshaw Chemical Co. Cleveland, Ohio	M. S. Graboski
October 12-13, 1972	Project Review Meeting Stearns-Roger, Inc. Denver, Colorado	J. P. Tassoney R. K. Young
October 16, 1972	Nooter Corporation St. Louis, Missouri	M. S. Graboski
October 30-31, 1972	AGA Synthetic Pipeline Gas Symposium Chicago, Illinois	E. E. Donath R. J. Grace J. P. Tassoney R. K. Young R. L. Zahradnik

J. Requests for Information

Mr. Ken D. Bovee
S.E.R.C.
Venture Center, Room 212
University of Montana
Missoula, Montana 59801

K. Papers Presented

October 30-31, 1972	AGA Synthetic Pipeline Gas Symposium Chicago, Illinois	"BI-GAS Program Enters Pilot Plant Stage" R. J. Grace R. L. Zahradnik
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III. WORK PLANNED FOR NOVEMBER, 1972

The work planned for November will basically be a continuation of the on-going program which has been underway for the past few months.

Bench-scale testing of methanation catalysts will continue. Work on the methanation PEDU will continue. Building alterations, yard rack piping, and most foundations will be completed. The electrical work will be continued.

Special Report No. 3 will be issued.

The data acquisition program for the bench-scale methanator will be continued. A complete description of this program will be written.

Meetings with Stearns-Roger and Blaw-Knox will continue to discuss various technical details.

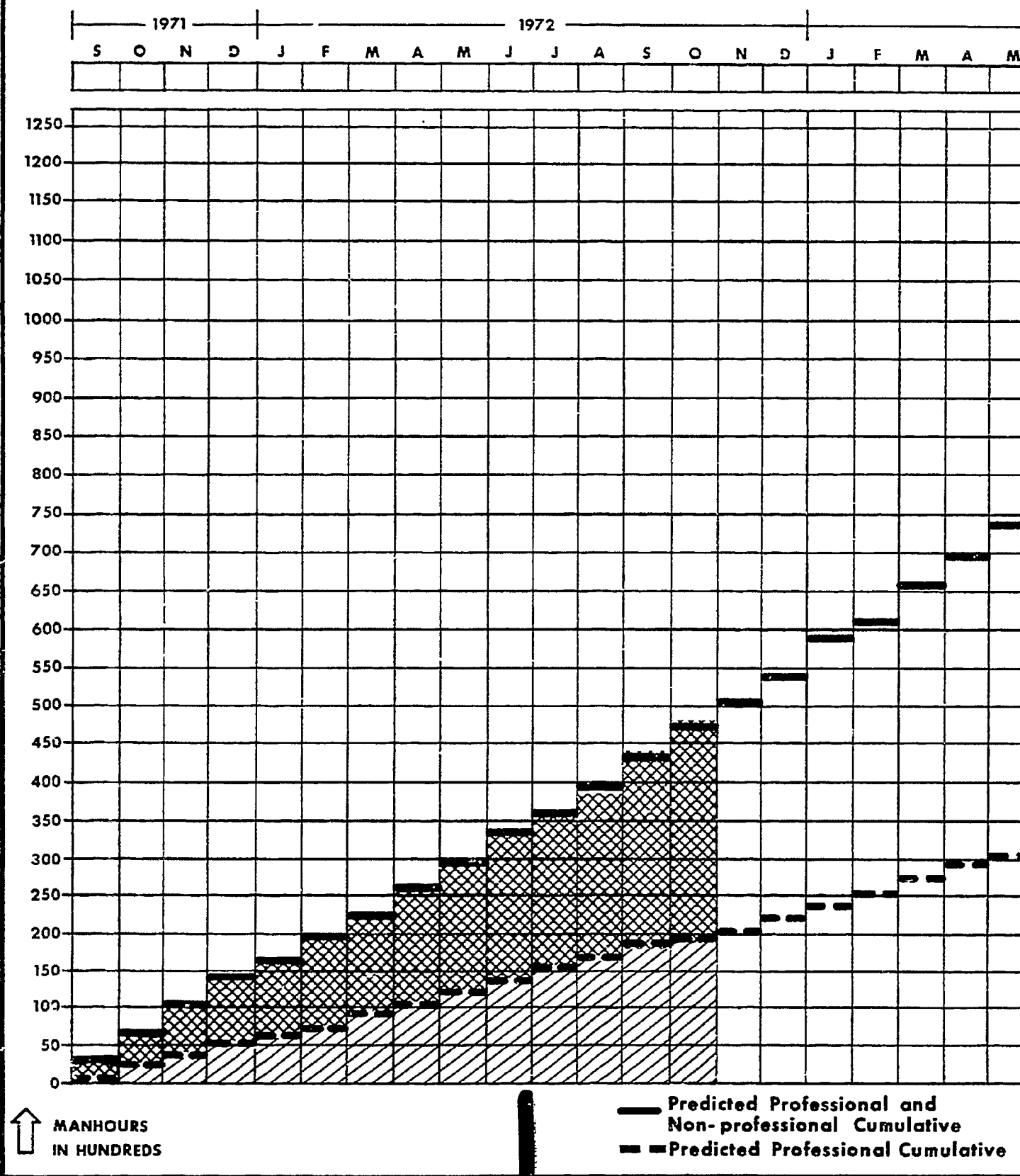
A. Trips and Meetings Planned

November 6, 1972	Nooter Corporation St. Louis, Missouri	M. S. Graboski
November 7-8, 1972	Stearns-Roger, Inc. Denver, Colorado	J. P. Tassoney R. K. Young
November 9-10, 1972	Stearns-Roger, Inc. Denver, Colorado	R. J. Grace
November 14, 1972	CCR Contractors Meeting Princeton, New Jersey	J. P. Tassoney
November 15, 1972	Gas Atmospheres Cleveland, Ohio	M. S. Graboski

B. Papers to be Presented

December 7-8, 1972	Annual Meeting of the Coal Mining Institute of America Pittsburgh, Pennsylvania	"New Markets - Coal Gasification" J. W. Tieman
July, 1973	Presentation to be made at 1973 Gordon Conference on Coal Science	"The Chemistry and Physics of Entrained Coal Gasification" R. L. Zahradnik R. J. Grace

CCR/AGA PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT

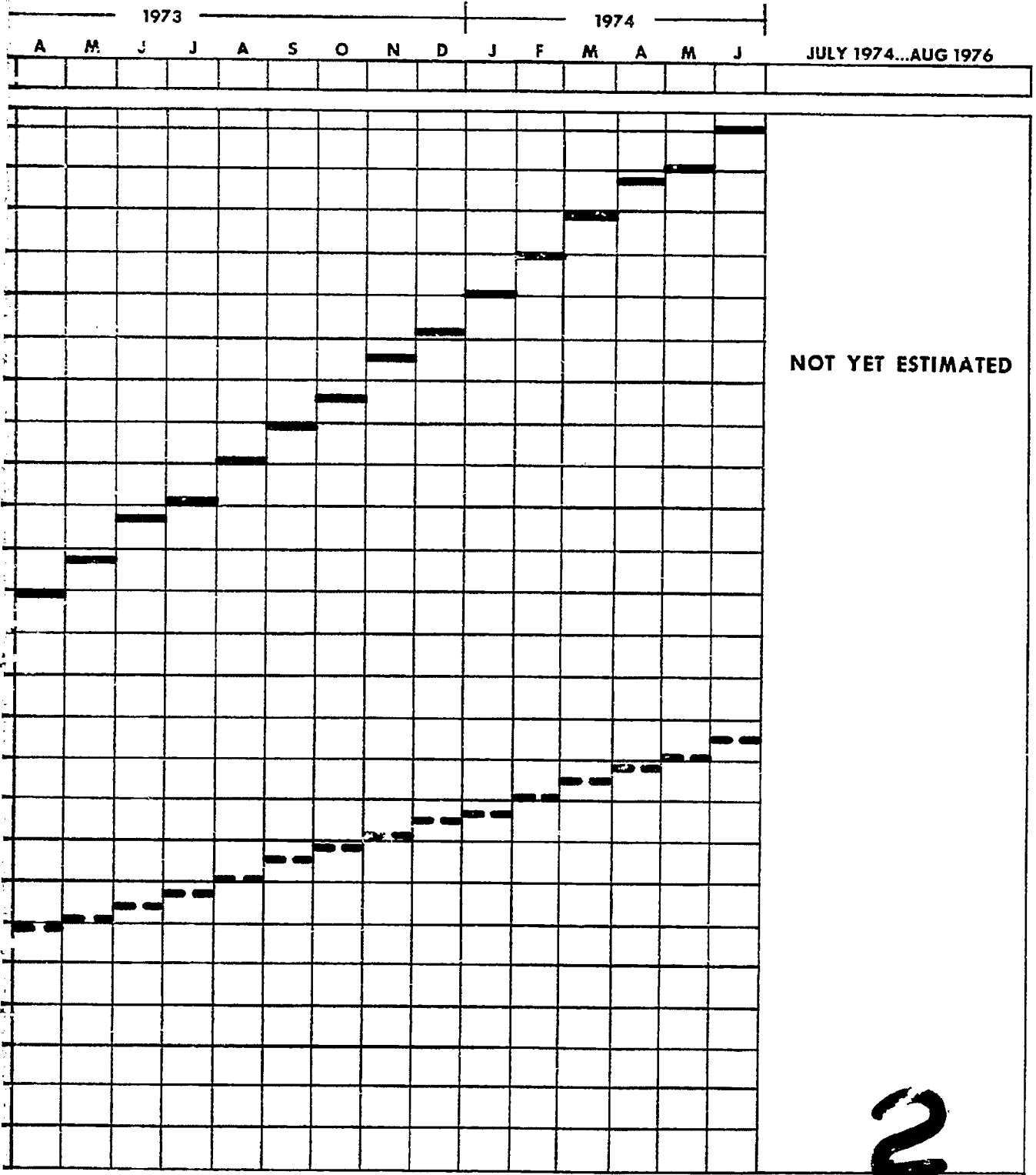


↑ MANHOURS IN HUNDREDS

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 ■ Predicted Professional Cumulative



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CUMULATIVE MANHOURS



NOT YET ESTIMATED

2

 Actual Non-professional Cumulative
 Actual Professional Cumulative

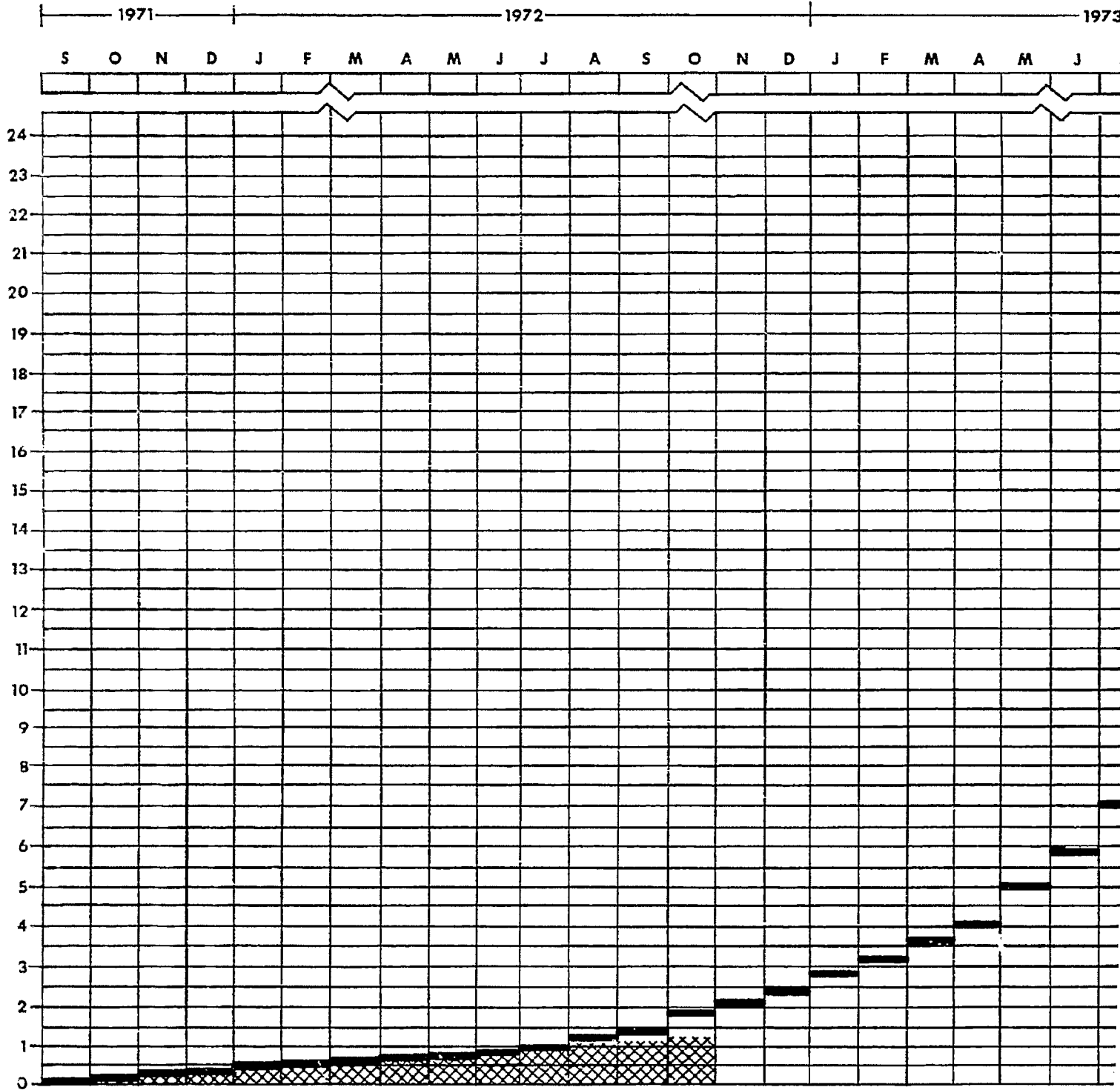
OCR/AGA PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT
Schedule of Predicted and Actual Manhours

Month	This Month				Cumulative			
	Professional		Non-Professional		Professional		Non-Professional	
	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual
Sept. '71		1,606.5		2,253.5	1,606.5		2,253.5	
Oct. '71		1,144.0		1,716.0	2,750.5		3,969.5	
Nov. '71		1,490.0		2,126.5	4,240.5		6,096.0	
Dec. '71		1,290.5		1,875.5	5,531.0		7,971.5	
Jan. '72		1,465.0		1,612.5	6,996.0		9,584.0	
Feb. '72		1,285.0		1,656.5	8,281.0		11,240.5	
Mar. '72		1,337.0		2,042.5	9,618.0		13,283.0	
Apr. '72		1,400.0		2,026.0	11,018.0		15,309.0	
May '72		1,506.0		1,884.5	12,524.0		17,193.5	
June '72		1,555.0		2,054.0	14,079.0		19,247.5	
July '72		1,224.5		1,370.0	15,303.5		20,617.5	
Aug. '72	1,432.0	1,193.0	2,136.0	1,573.5	16,735.5	16,496.5	22,753.5	22,191.0
Sept. '72	1,544.0	1,301.5	2,152.0	1,549.5	18,279.5	17,798.0	24,905.5	26,455.0
Oct. '72	1,456.0	1,535.5*	2,144.0	1,794.5*	19,735.5	19,333.5*	27,049.5	28,249.5*
Nov. '72	1,448.0		2,136.0		21,183.5		29,185.5	
Dec. '72	1,440.0		2,048.0		22,623.5		31,233.5	
Jan. '73	1,664.0		2,328.0		24,287.5		33,561.5	
Feb. '73	1,664.0		2,336.0		25,951.5		35,897.5	
Mar. '73	1,672.0		2,344.0		27,623.5		38,241.5	
Apr. '73	1,624.0		2,280.0		29,247.5		40,521.5	
May '73	1,632.0		2,280.0		30,879.5		42,801.5	
June '73	1,632.0		2,288.0		32,511.5		45,089.5	
July '73	1,656.0		2,328.0		34,167.5		47,417.5	
Aug. '73	1,656.0		2,320.0		35,823.5		49,737.5	
Sept. '73	1,656.0		2,320.0		37,479.5		52,057.5	
Oct. '73	1,640.0		2,288.0		39,119.5		54,345.5	
Nov. '73	1,656.0		2,288.0		40,775.5		56,633.5	
Dec. '73	1,656.0		2,264.0		42,431.5		58,897.5	
Jan. '74	1,672.0		2,328.0		44,103.5		61,225.5	
Feb. '74	1,656.0		2,320.0		45,759.5		63,545.5	
Mar. '74	1,640.0		2,320.0		47,399.5		65,865.5	
Apr. '74	1,640.0		2,280.0		49,039.5		68,145.5	
May '74	1,656.0		2,288.0		50,695.5		70,433.5	
June '74	1,656.0		2,272.0		52,351.5		72,705.5	
July '74 to Aug. '76								

NOT YET ESTIMATED

* Estimated

OCR/AGA PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT



↑ DOLLARS
IN MILLIONS

— Predicted Expenditures, Cumulative
 Actual Expenditures, Cumulative

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DEVELOPMENT

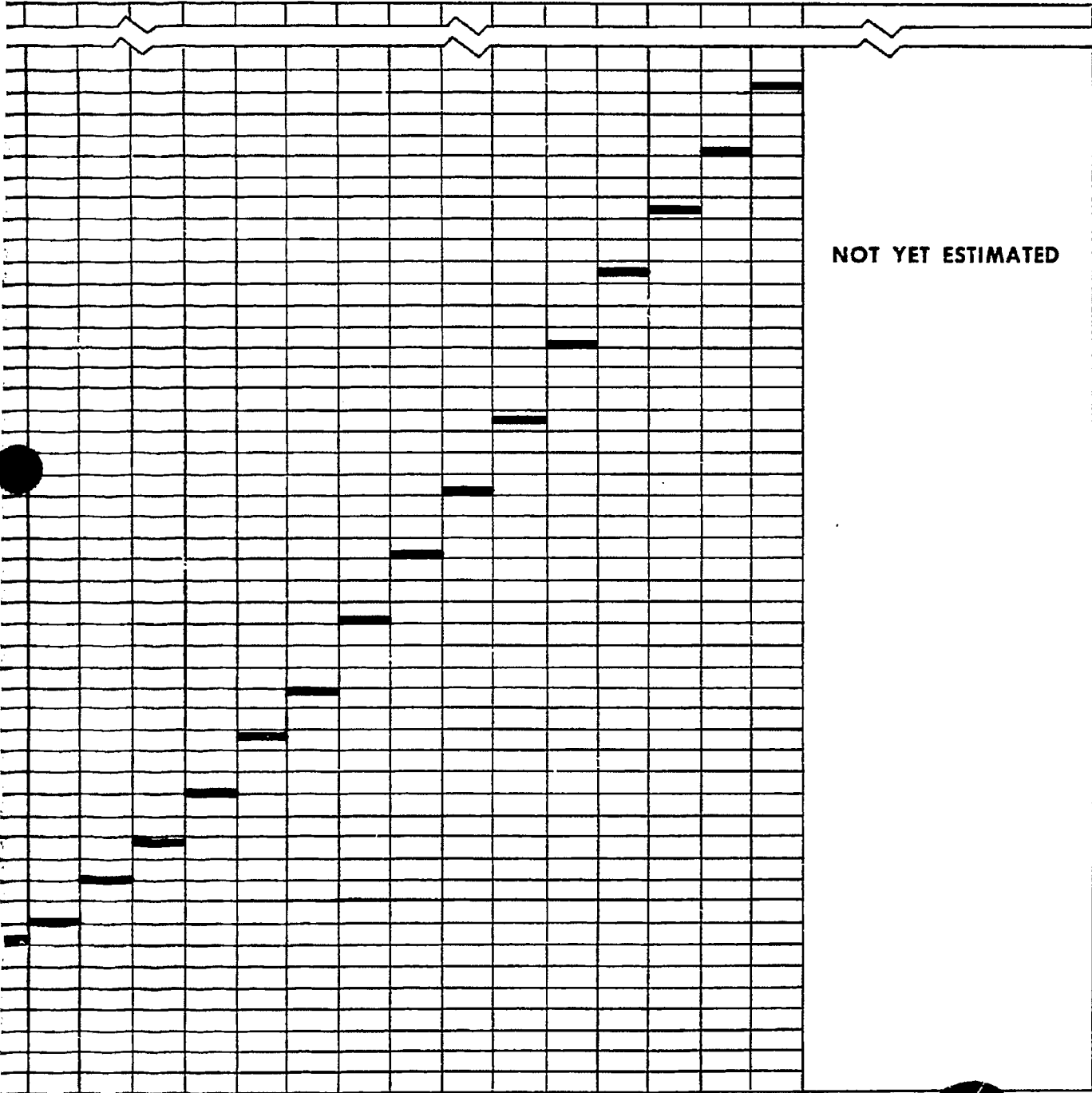
CUMULATIVE EXPENDITURES

1973

1974

A M J J A S O N D J F M A M J

JULY 1974...AUG 1976



NOT YET ESTIMATED

Expenditures, Cumulative

Expenditures, Cumulative

2

OCR/AGA PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT
Schedule of Predicted and Actual Expenditures

Month	Current Month		Cumulative to Date	
	Predicted	Actual	Predicted	Actual
1971				
Sept.		57,900		57,900
Oct.		98,983		156,883
Nov.		129,083		285,966
Dec.		138,572		424,538
1972				
Jan.		95,161		519,699
Feb.		71,459		591,158
March		96,682		687,840
April		47,253		735,093
May		73,220		808,313
June		78,521		886,834
July		79,366		966,200
Aug.	205,974	79,220	1,172,174	1,045,420
Sept.	296,974	79,036	1,469,148	1,124,456
Oct.	335,032	130,050*	1,804,180	1,254,425*
Nov.	335,031		2,139,211	
Dec.	331,672		2,470,883	
1973				
Jan.	357,220		2,828,103	
Feb.	357,220		3,184,423	
March	357,219		3,542,542	
April	758,369		4,300,911	
May	758,389		5,059,300	
June	758,400		5,817,700	
July	1,219,816		7,037,516	
Aug.	1,219,816		8,257,332	
Sept.	1,219,818		9,477,150	
Oct.	1,531,333		11,008,483	
Nov.	1,531,333		12,539,816	
Dec.	1,531,284		14,071,100	
1974				
Jan.	1,720,869		15,791,969	
Feb.	1,720,866		17,512,835	
March	1,720,865		19,233,700	
April	1,456,866		20,690,566	
May	1,456,866		22,147,432	
June	1,456,863		23,604,300	
July to Aug. '76			NOT YET ESTIMATED	

* Estimated

APPENDIX B

HOMER CITY, PENNSYLVANIA
COAL GASIFICATION PILOT PLANT

JOB NO. C-11630

STEARNS-ROGER PROJECT STATUS REPORT

NO. 3

NOVEMBER 6, 1972

GENERAL

This report covers job progress from October 6, 1972 to November 2, 1972.

Since the last report, twelve mechanical and four process flow diagrams have been issued for comments. A meeting to review comments and consolidate necessary changes to flow sheets is scheduled for November 9-10, 1972 in Denver. BCR, Blaw-Knox, Stearns-Roger and C. F. Braun will be represented at this meeting.

The gasifier design, fabrication and a schedule for delivery is a major problem which has been receiving daily attention. Stearns-Roger has been given approval to solicit proposals from vendors other than B&W. This subject is discussed in more detail in the Process Engineering section of this report.

Representatives of Stearns-Roger will attend the OCR contractor meeting on November 14, 1972, at Princeton, New Jersey.

PHYSICAL DESIGN

A preliminary conceptual plot plan has been submitted to BCR for comment.

Subcontracts have been awarded for initial site clearing, topographical surveying and soil testing. Field work was started the week of October 23, 1972. Stearns-Roger has a field representative on the site supervising this work.

Preliminary layout work is in progress to define gasifier mounting and handling requirements.

A preliminary layout of the plant office and laboratory building is in progress.

Recommendations have been made to BCR concerning structure fireproofing, structure enclosing, structure operating platforms and roadway design.

PROCESS ENGINEERING1. Coal Handling

Progress in this area has been somewhat limited, awaiting proposals on coal drying and pulverizing systems.

Requests for bids have been issued on weigh belt feeders, samplers, vibrating feeders and dust suppression systems.

Conveyor work points have been set and lengths determined, bins sized and elevations set. Detailed engineering can continue when an approved plot plan is determined.

2. Coal Feed

Basic process design is complete. Mechanical and process flow diagrams have been issued for comment. Mechanical equipment requirements have been released for preparation of vendor inquiry packages. Some equipment is out to vendors for quotations. Disposition of vent gases is being investigated. Sources of lock hopper valves continue to be investigated with various possible vendors.

3. Gasification

The gasifier cooling water flow diagram and conceptual scheme for operating protection of the equipment has been started. The process information required to size pumps, exchangers and system surge is dependent upon requirements dictated by final gasifier design.

Flow diagrams showing the fuel gas, oxygen, steam, coal, char and recycle gas systems have been issued for comment. The slag removal system, though issued for comment, is being "held" pending efforts to locate a supplier for the slag crusher-grinder. At this point, it appears that it may be necessary to revert to installation of a lock hopper.

GASIFIER

During a project review meeting in Denver on October 13, 1972, attended by representatives of Stearns-Roger, BCR and Blaw-Knox, it was mutually agreed that B&W's proposal for the gasifier could not be accepted. The stated terms and conditions were recognized as a primary obstacle to awarding a purchase order.

B&W was contacted and advised the group later the same date that B&W would essentially accept the inquiry conditions and would furnish engineering and fabrication proposals the next week per the original request for proposals.

B&W offices in Barberton, Ohio were visited by Stearns-Roger on October 17-18, 1972. Discussions regarding gasifier design were productive, particularly with respect to material considerations and resolution of design criteria items. However, at these meetings B&W again presented essentially the same terms and in effect stated their company position in this regard had not changed. In these meetings, Stearns-Roger advised B&W:

1. No firm price proposal could be accepted per B&W terms and conditions.
2. A firm price had not been requested at this point in time - it was too early to define job scope to the extent necessary for firm pricing - acceptance of a firm price now would only result in such a price becoming the basis for extensive change orders and justification for schedule slip - Stearns-Roger would not question the stated price, other than comment it was substantially in excess of previous quotations for the original design gasifier.
3. The schedule presented by B&W showing 78 weeks span time from contract award to gasifier shipment was not realistic because this schedule did not reflect the necessary front end engineering work required before such a schedule could be in effect. The schedule presented allowed no time for Customer drawing approval, etc. Since B&W could offer no encouragement for a shorter shop fabrication schedule, the overall schedule would have to be longer than the stated 78 weeks to complete the work.
4. That Stearns-Roger had no alternative but to report the situation to our Customer and recommend that other fabricators be considered for the work.

Subsequent to this meeting with B&W, Stearns-Roger requested and received approval to obtain competitive proposals for the gasifier from other sources.

In view of this decision and in the interest of not losing engineering design accomplished to date, B&W was contacted to determine their interest in negotiating a contract for furnishing basic engineering services for design of the gasifier. These services to be furnished with B&W fully aware that the work would be used in proposal inquiry packages for submittal to other fabricators.

B&W representatives visited Stearns-Roger offices on October 26, 1972 and agreed to furnish a cost plus fee for type proposal for engineering only within 10 days to two weeks. B&W is currently working up this proposal. In this regard, Mr. Paul Probert of B&W visited Stearns-Roger on November 2-3, 1972, to discuss an intended scope of engineering work and review the required sequence of work.

This information is currently being included by Stearns-Roger in a detailed gasifier schedule which will be used to monitor gasifier progress and acquaint all concerned with problem areas.

The basic gasifier specification was issued for Customer approval on October 30, 1972.

4. Gas Wash

A design of the gas washer vessel and its spray water system is complete. It is being held pending design of the gasifier overhead line jacket water system, jacketed spray system and test cooler. The hold is necessary to assure ourselves that the entire system will handle the worst severe loads imposed upon it. These designs, in turn, are dependent upon finalizing gasifier start-up and operating conditions.

5. Char and Lime Systems

Basic process design is complete, except for design of the gasifier overhead test cooler, spray section and jacket water system. To simplify the system, cooling water requirements for these services are being combined into one circuit. The conveying and feeding equipment for this section is out for quotation.

6. CO Shift

The mechanical flow sheets have been issued for comment. The design range of steam/gas ratio in the shift section has a significant influence on sizing of major equipment. To avoid over-design CCI is developing information limits set by carbon formation and methanation in the shift reactor. The required data from CCI is expected by November 3, 1972. Receipt of this information will allow firming up of basic equipment requirements. Inquiry specifications are being prepared for equipment with firm process requirements.

7. Acid Gas Removal

Required information has been received from vendors of processes being considered for acid gas removal. Stearns-Roger has completed a comparative study and will recommend a process for selection by November 6, 1972. Upon process selection, the mechanical flow diagram can be developed and issued for comment in approximately two weeks. This assumes the process selected does not invoke negotiation of secrecy agreements before design information is released.

8. Methanation

Mechanical flow sheets for the fluid bed methanator and associated cooling system will be issued for comment the week of November 6, 1972. The water concentration present in the feed stream to the fixed bed methanator may cause catalyst deactivation. Catalyst vendors have been contacted to determine if a catalyst is available which will tolerate the water present. If such catalyst is not available, the water will have to be condensed and removed, prior to introduction into the fixed bed methanator. Work has progressed in the non-effected areas while vendors are investigating this problem.

The fluid bed reactor may present special problems which were not anticipated in the Koppers design. Vendors are being contacted for advise before this vessel is sent out for bid to a design which perhaps cannot be fabricated. If such problems are not resolved early, this vessel could be a critical item.

9. Utilities

A recommendation has been made to BCR to utilize Homer City water as the plant supply. Stearns-Roger was advised on November 3, 1972, that BCR was going to approve this recommendation. A significant cost savings will result from elimination of creek pumping station and associated water treating facilities.

Arrangement of a plant fuel gas supply is still pending.

The process design for the plant sewage disposal facilities is in progress.

Process design has been started on the plant purge gas system.

10. Process Flow Diagram and Material Balances

Process flow diagrams and material balances through CO Shift have been issued for comment concurrent with the related mechanical flow sheets.

APPENDIX C

ADDITIONS TO ABSTRACT FILE, OCTOBER 1972

Bresler, S. A. and Ireland, J. D., "Substitute natural gas: processes, equipment, costs," Chem. Eng. 79 (23), 94-108 (1972).

The basic processes and alternatives for producing SNG from naphtha, LPG, crude oil, and coal are analyzed and compared. A table, summarizing the planned development of SNG plants in the United States, lists company, plant location, plant capacity, feedstock, estimated cost, and present status of the project.

"Feasibility study of a coal slurry feeding system for high pressure gasifiers," Air Products and Chemicals, Inc., Final Rept. to U.S. Office Coal Res., R&D Rept. 68 (1972). 14 pp.†

The preliminary design of the CSFS includes slurry preparation, slurry pumping and slurry drying. Because the third step, slurry drying, is considered the most costly and technically uncertain step of the system, a development program to obtain a reliable economical dryer design is recommended. Phase II of this report presents the design and cost estimates for a pilot plant CSFS skid-mounted unit, but omits costs relating to the high pressure spray dryer.

Hebden, D. and Percival, G., "New horizons for pressure gasification: the production of clean energy," Inst. Gas Engrs. J. 12 (8), 229-44 (1972).

This 1971 MacRobert Lecture is a comprehensive review of British work on gasification and a discussion of its relevance to present research on and production of synthetic natural gas, especially in the United States.

Jones, J. F., Schoemann, F. H., Hamshar, J. A., McMunn, B. D., Scotti, L. J., and Eddinger, R. T., "Char oil energy development," FMC Corp., Interim Rept. No. 1 to U.S. Office Coal Res., R&D Rept. 73 (1972). 113 pp.

The operating results of the pilot plant during the period July 1971 - June 1972 are reported. Feeds processed were Bear Mine, Colorado high-volatile B bituminous coal, Big Horn, Wyoming sub-bituminous coal, and Illinois No. 6 seam coal from two different mines. Data from hydrotreating oils derived from the pyrolysis of these coals are also reported.

PATENT

Randhava, S. S. (to Inst. Gas Technol.), "Method for selective methanation of gaseous mixture containing carbon monoxide," U.S. Pat. 3,663,162 (May 16, 1972).

4 pp.

A method for the selective methanation of a gaseous mixture containing hydrogen, carbon dioxide, and carbon monoxide with the carbon monoxide being present in an amount up to about 1 percent, which contemplates the contacting of said gaseous mixture with a Raney-type nickel catalyst containing from about 30-35 percent nickel, 5-18 percent aluminum, and balance $\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$; at elevated temperatures. (Abstract of the disclosure)

APPENDIX D

PROGRESS REPORT #39

D-742.

Bituminous Coal Research, Inc.
Coal Gasification

October 1972

Koppers Contract 2415

I. STATUS OF CONTRACT

A. Pilot Plant Engineering Bid Packages

Step No. 1: Pilot Plant for oxygen-blown, two stage coal gasification system, including general facilities: design and models. For additional information see Part II: Contract Evaluation.

(Work Completed)

Step No. 2: Fluidized bed system.

(Work Deferred)

B. Engineering Assistance And Recommendations For PEDU Program Methanation PEDU

The following Fluid Bed Methanation PEDU drawings, bills of materials, and specifications were transmitted by Koppers Company, Inc. to BCR:

<u>Drawing No.</u>	<u>Rev. No.</u>	<u>Title</u>	<u>Date Trans.</u>
2415-2A700	6	Fluid Bed Methanation PEDU Methanator	10/5/72
2415-2A718	2	Fluid Bed Methanation PEDU Reformer Structure and Cooling Tower-General Arrangement	10/5/72
2415-2A730	1	Fluid Bed Methanation PEDU-HP Stall Equipment-General Arrangement & Piping & Steel Design - Sht. 1 of 3	10/5/72
2415-2A731	1	Fluid Bed Methanation PEDU-HP Stall Equipment-General Arrangement & Piping & Steel Design- Sht. 2 of 3	10/5/72

D-743.

<u>Drawing No.</u>	<u>Rev. No.</u>	<u>Title</u>	<u>Date Trans.</u>
2415-2A732	1	Fluid Bed Methanation-PEDU HP Stall Equipment-General Arrangement & Piping Design- Sht. 3 of 3	10/5/72
2415-2A733	4	Fluid Bed Methanation PEDU- Plot & Plan	10/5/72
2415-2A735	0	Fluid Bed Methanation PEDU- H ₂ S Removal Tower	10/5/72
2415-2A737	1	Fluid Bed Methanation PEDU- H ₂ S Removal Towers-General Arrangement & Piping-Steel Concrete Design	10/5/72
2415-2A740	3	Fluid Bed Methanation-PEDU- Boiler House-General Arrangement & Piping Design	10/5/72
2415-2A741	1	Fluid Bed Methanation PEDU Yard Rack Piping	10/5/72
2415-2A743	1	Fluid Bed Methanation PEDU- Therminal Unit & Water Storage Tank-General Arrangement-Piping Design	10/5/72
2415-4F701	1	Fluid Bed Methanation PEDU- General Notes for Steel Design	10/5/72
2415-5A700	0	Fluid Bed Methanation-PEDU- H ₂ S & CO ₂ - Storage Area Foundations	10/5/72
2415-5A702	0	Fluid Bed Methanation-PEDU- HP Stall Equipment Foundations	10/5/72
2415-5A703	0	Thermal Oxidizer-Foundations	10/5/72
2415-5A704	0	Reformer Building - Foundations	10/5/72
2415-5F700	0	Specifications for Structrual Concrete & Foundations-Design	10/5/72

D-744.

<u>Drawing No.</u>	<u>Rev. No.</u>	<u>Title</u>	<u>Date Trans.</u>
2415-5F701	0	Fluid Bed Methanation- PEDU - Foundations -General Notes	10/5/72
Standard DS 4.12	2		10/5/72
2415-5F701	1	Fluid Bed Methanation-PEDU Foundations -General Notes	10/6/72
2415-9A701	3	Graphic Panel Layout	10/10/72
2415-9A703	2	N.G. Comp., Reformer Unit and Add. Flows Interconnection Schematics	10/10/72
2415-9A704	2	Meth. Flow, Feed Gas and Reactor Safety Ckts. Interconnection Schematics	10/10/72
2415-9A705	2	Filter Blow Back, Demister Level Product Gas Press., Graphic Panel Elect. Power Distribution	10/10/72
2415-9A706	2	Graphic Pnl. Annunciator and Air Supply Interconnection Schematic	10/10/72
2415-9A707	1	Gas Press. and Flow Meth. Pressures, Product Gas Flow, Therminal Flows and Temp.	10/10/72
2415-9A708	2	Meth. and Heat Windings Temps. Infrared Analyzers Recorders	10/10/72
2415-9A709	2	Heat Winding Ckt. and Record Panel Elect. Air Supply and H ₂ S Controls	10/10/72
2415-9A710	1	Electric Terminal and Pneumatic Bulkhead Arrangements	10/10/72
2415-9A702	3	Analyzer Panel Interconnection Schematics	10/23/72
2415-9A708	3	Meth. and Heat Winding Temps. Infrared Analyzers Recorders	10/23/72
2415-9A710	3	Electric Terminal and Pneumatic Bulkhead Arrangements	10/23/72

D-745.

<u>Drawing No.</u>	<u>Rev. No.</u>	<u>Title</u>	<u>Date Trans.</u>
2415-9A711	0	Analyzer Panel Interconnection Schematics	10/23/72
2415-9A702	2	Recorder and Analyzer Panels	10/23/72
2415-2A703	3	Process and Utility Flow Diagram Sheet 1 of 4	10/23/72
2415-2A705	3	Process and Utility Flow Diagram Sheet 3 of 4	10/23/72
2415-2A706	3	Process and Utility Flow Diagram Sheet 4 of 4	10/23/72
2415-2A747	0	Instrument Air and Gauge Piping Sheet 1 of 2	10/23/72
B/M 2415-2A747	0	Instrument Air and Gauge Piping Sheets 1-9 Incl.	10/23/72
2415-2A748	0	Instrument Air and Gauge Piping Sheet 2 of 2	10/23/72
2415-2A743	1	Therminol Unit & Water Stor. Tank Gen. Arrgt. and Piping Design	10/30/72
2415-5A701	1	Compressor Room Equipment Foundations	10/30/72

The following memorandum was transmitted by Koppers Company, Inc. to BCR:

<u>Date</u>	<u>Letter No.</u>	<u>Title</u>	<u>Remarks</u>
10/30/72	468	Boiler Room Partitions	Comments on construction of boiler room partitions and code requirements. Review of discussions with Penna. State Bureau of Occupational and Industrial Safety pertaining to this subject.

C. Fluid Bed Gasification PEDU

1. BCR's letter of June 26, 1972 relieved Koppers of the responsibility for fluidized-bed gasification engineering under Amendments No. 6 and No. 7, Subcontract No. 2, OCR Contract No. 14-32-001-1207.

D. General Engineering Assistance & Consultation

1. Koppers Company, Inc. Inspection Section with personnel from BCR inspected the "Methanator Effluent Cooler" (M-E605) on October 11, 1972 at Brown Fintube Co. and the "Filter Blow Back Heater" (M-E410) on October 13, 1972 at National Annealing Box Co., Washington, Pa.

Testing of these two items was witnessed and approved. Dimensions were as detailed, or within tolerance, and no new work was requested.

2. Koppers Company, Inc. also reviewed letters of clarifications from all the control valve vendors received October 9, 1972 and submitted comments to BCR in a memorandum (C465) dated October 23, 1972.
3. Koppers Company, Inc. reviewed the various instrument Vendor's quotations for self acting pressure control valves and submitted comments to BCR in a memorandum (C466) dated October 26, 1972.

II. CONTRACT EVALUATION

Four (4) copies of Amendment No. 7 to Amended Subcontract No. 2, including Appendices I through VIII, signed by Mr. J. D. Rice, Vice President, Engineering and Construction Division, Koppers Company, Inc. were transmitted to BCR in our letter C-183 dated October 18, 1971. Receipt of these copies was acknowledged by BCR in their letter dated October 18, 1971.

Pilot Plant Engineering Bid Package (Volumes I through VI) was completed in accordance with the scope of work specified under Appendix I-Revised Appendix A, Par. IIIA-5. Step a.: "General Facilities Plus Oxygen - Blown Two-Stage System" of Amendment No. 7 to Amended Subcontract No. 2 (originated under OCR Contract No. 14-01-0001-324 and transferred to OCR Contract No. 14-34-0001-1207) between Bituminous Coal Research, Inc., and Koppers Company, Inc.

J. F. Farnsworth
Project Manager