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

PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT

Progress Report No. 12

(BCR Report L-484)

I. INTRODUCTION

This report summarizes progress achieved during August, 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 twelfth 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.

B. Monthly Progress Charts

Revised 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 Appendixes 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 AUGUST 25, 1972

A. Laboratory-scale Process Studies

1. Gas Processing (M. S. Graboski): Work continued in the area of gas processing methanation studies in accordance with the updated time schedule

presented in Figure 146, Progress Report No. 11, July 1972. This report summarizes progress achieved in the bench-scale and PEDU gas processing programs during August.

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 were summarized in Figure 107, Progress Report No. 7. 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 program and the PEDU programs is to determine the feasibility of the schemes for the BI-GAS process.

During the past several months BCR has been meeting with Harshaw and Chemetron, under secrecy terms, regarding the development of methanation catalysts. In early June, BCR and Harshaw met to discuss improvement of catalysts which BCR has found effective for methanation. During early August, the same type of meeting was held between BCR and Chemetron personnel in Louisville, Kentucky.

In the July report, the basic Harshaw program, along with the catalysts to be tested, was discussed. During August, the physical properties of the four Harshaw catalysts, Lots 3049 through 3052, were measured and activity testing was begun.

Figures 154 and 155 show the fluidization velocities for the four new catalysts. Since Lots 3049, 3051, and 3052 are composed of different metals impregnated on the same support material, (Harshaw Al-1401 P, BCR Lot 3013), the fluidization characteristics should be close. The data presented in Figure 154 represent the mean results for the three catalysts. Actual data show a range of 55 to 60 cc per minute of gas required for minimum fluidization for the three catalysts. This velocity agrees well with that for BCR Lot 2903, a molybdenum catalyst, which also is based on the Lot 3013 support. The fluidization velocity for Lot 3050 is higher but agrees well with data obtained for Lot 2904 chrome catalyst. Lot 3050 is basically Lot 2904 with a small amount of nickel added.

Figures 156 and 157 show the size distribution data for the catalysts. Lots 3049, 3051, and 3052 have the same size distribution; these are shown in Figure 156.

Bulk densities at minimum fluidization were measured for the four catalysts. Values obtained were within a range of ten percent.

Catalyst Lot	Density, lb per cu ft
3049	60
3050	59
3051	56
3052	51

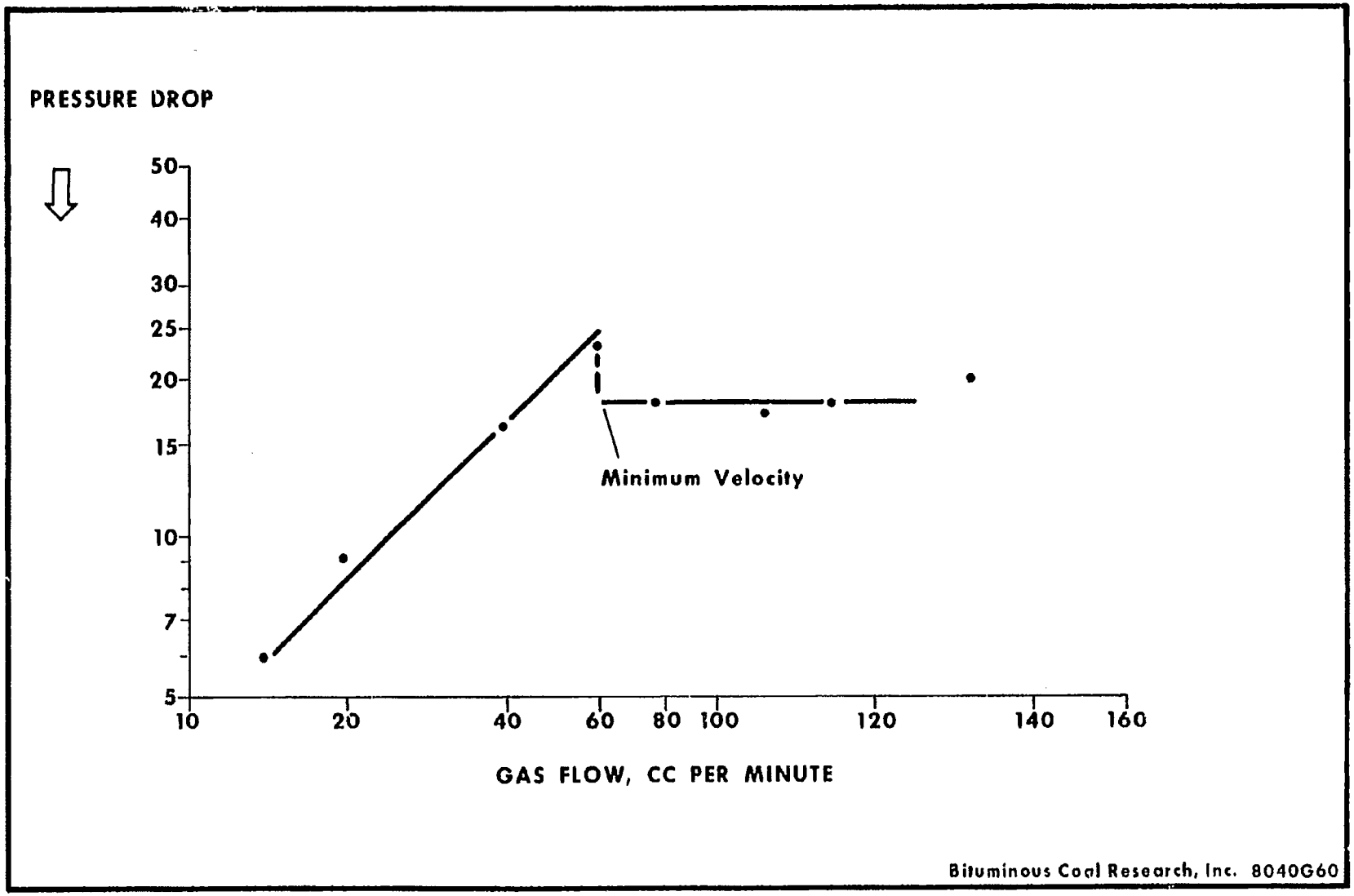


Figure 154. Minimum Fluidization Velocity for BCR Lot 3049, 3051, and 3052 Catalyst in Ambient Air

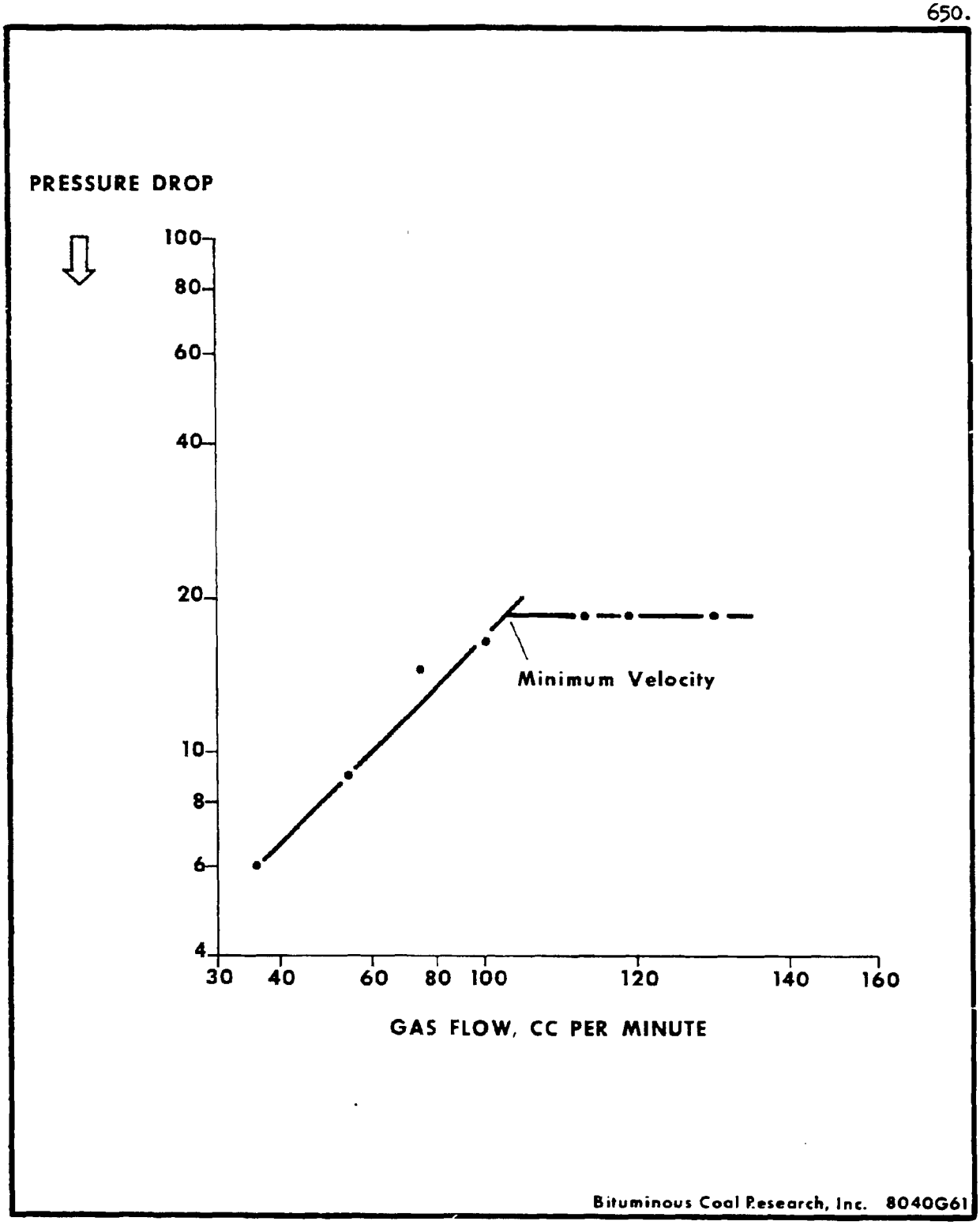


Figure 155. Minimum Fluidization Velocity Data for BCR Lot 3050 Catalyst in Ambient Air

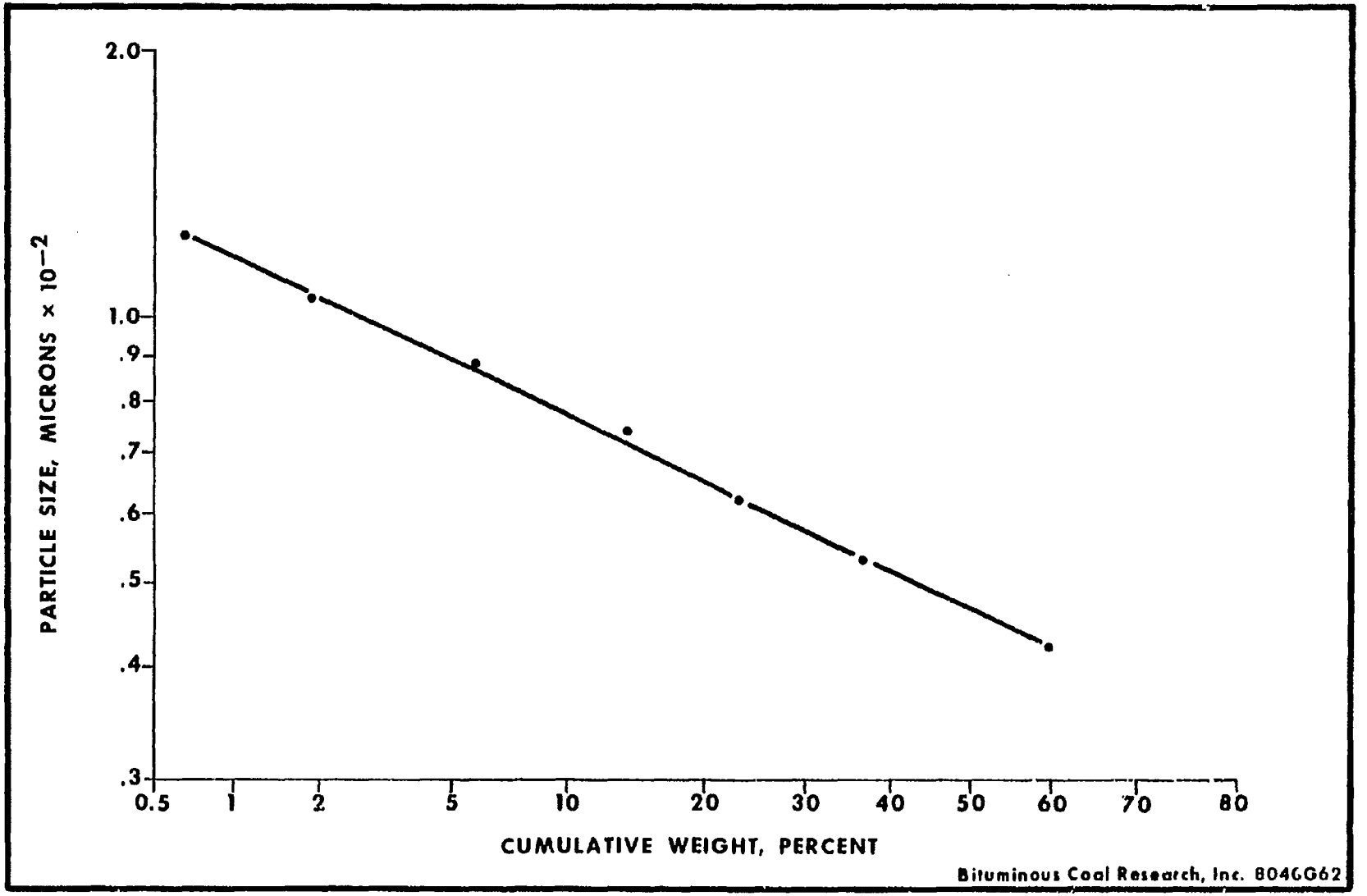


Figure 156. Size Distribution Data for BCR Catalyst Lots 3049, 3051, and 3052

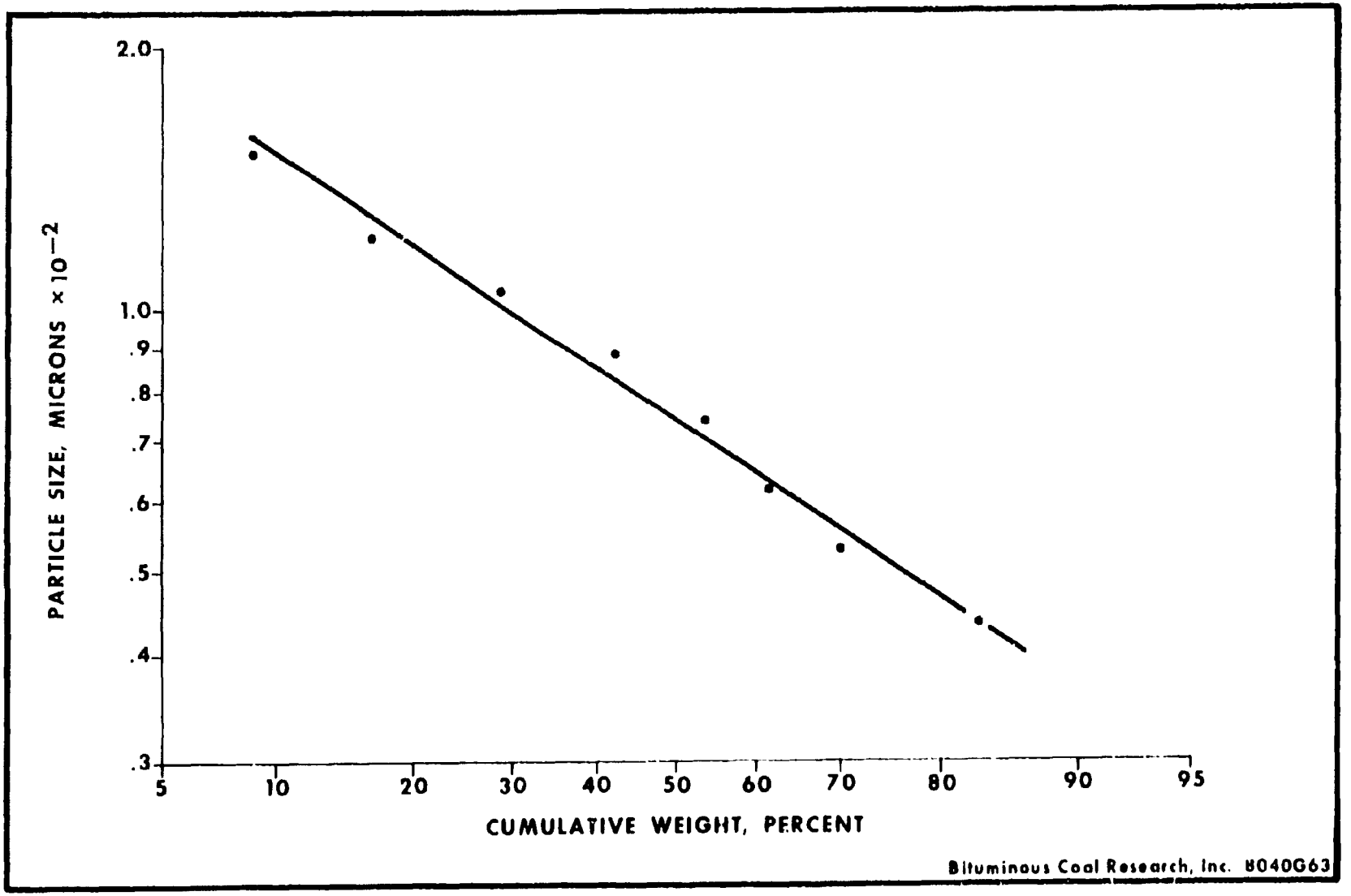


Figure 157. Size Distribution Data for BCR Lot 3050 Catalyst

Activity and life testing of the four catalysts was hampered this month due to an equipment failure which resulted in a need to rebuild the reactor units. The system was reconstructed and has been put back on stream. Data should be available next month. BSM testing was not conducted since life test results are to be used to dictate which catalyst should undergo more rigorous investigation.

BCR and Chemetron Corporation met to discuss methanation catalysts. Chemetron plans to submit a research proposal in the near future for the development of an improved catalyst based on BCR's experimental results.

b. PEDU Studies: Progress continued to be made on the methanation PEDU.

(1) Engineering: Koppers continued with detail engineering through August. Their schedule shows that only minor effort during the next two months will be required to complete the program.

(a) Vessels: Essentially all vessel designs were completed by late May, 1972. The last outstanding item, design of feed gas heater ME-405, was transmitted to BCR in late August.

(b) Buildings: Building specifications and modification requirements were completed in June, 1972.

(c) Piping and General Arrangement: During August, final piping drawings for the compressor room and the high pressure stall area were received, along with modifications of several other piping drawings previously received. In order to complete this portion of the engineering, Koppers has some utility piping and the instrument air signal runs to detail.

(d) Electrical: The electrical package is essentially complete. Some minor modifications still need to be made.

(e) Instrumentation: Instrument work has been completed.

(f) Foundations: Foundation drawings for the carbon dioxide and hydrogen sulfide pad and the compressor area pad have been received. Koppers will be prepared to submit designs for the thermal oxidizer pad and the reformer pad at an early date. The other miscellaneous foundation work is currently being completed.

(g) P & I Drawings: During August, BCR again reviewed the plant P & I drawings in depth. Based on this effort, some minor changes in the gas recycle system and therminol system will be made.

The gas recycle system for startup, as designed, will not permit flexibility in flow rate. To improve the system, an additional flow controller will be added to the process system.

The therminol cooling system was previously specified with shutoff valves on the tube passes to permit control of the cooling fluid. This could create problems since trapped therminol could degrade, producing deposits which would reduce the system heat transfer coefficient.

(2) Procurement: Table 134, Progress Report No. 11, July, 1972, summarizes the equipment procurement status. Quotations are currently being solicited for the gas heater. The panel board has been requoted and will be purchased early in September. During August arrangements were made to rent the carbon dicxide storage system.

(3) Permits: All necessary permits have been acquired.

(4) Utilities: Duquesne light is finalizing pole locations in preparation for installation of the transformer. This can be done as soon as the pad is completed.

The Peoples Natural Gas Company reviewed the gas system and is currently preparing to alter the existing gas meter and control valve for the PEDU system.

(5) Construction: PEDU construction is proceeding.

During August, Steel-Bilt Company started work on a portion of the foundations. These include the yard rack piping piers, cooling tower piers, hydrogen sulfide removal tower pads, and the transformer pad. This work should be completed by mid-September. Steel-Bilt Company was also awarded a contract to perform the building alterations. This work will begin in September.

BCR is currently developing a complete construction package including all remaining structural, concrete, and rigging work required for the PEDU.

During August, bids were received for the electrical portion of the construction job. Lord Electric Company submitted the lowest bid. Contract talks are currently taking place. Work is scheduled to start October 2, 1972, with the completion date set at February 2, 1973.

BCR is currently talking with welding contractors to obtain a cost on the installation of the three-inch and four-inch yard rack lines.

Piping work has been started by BCR personnel. Currently, bills of material are being prepared and single-line piping sketches from Koppers drawings are being made where necessary. Actual routing of pipe will begin in early September.

(6) PEDU Problem Areas

(a) Reformer: During early August, a meeting was held with Gas Atmospheres to obtain information on the reformer. Adequate information was received for the purpose of foundation design. Elevation drawings were supplied, thus permitting the reformer enclosure vendor to complete the design of that item. Currently, BCR still needs data from Gas Atmospheres to complete the electrical portion of the engineering, and information on the location and size of relief valves to complete the piping design.

(b) Thermal Oxidizer: Some problems have arisen with respect to the thermal oxidizer. These basically center on several of the

equipment items to be supplied. BCR and Thermal Research are conferring in an attempt to solve these difficulties.

(c) Model Studies: No model work was conducted during August.

c. Future Work: Work planned for September includes the following:

(1) Bench-scale testing of the four new methanation catalysts.

(2) PEDU construction work including some piping, foundation, and building alteration work.

(3) Minor engineering effort from Koppers.

2. Analytical Services (J. E. Noll): During the past month no samples were analyzed by gas chromatography.

3. Gas Chromatographic Procedures (J. E. Noll): The system for automated gas analysis for the methanation PEDU was assembled and is now being tested prior to standardization. The flame ionization gas chromatograph has been tested and is now being standardized.

a. Automated Gas Analysis System: Two gas chromatographs were assembled in series with the necessary valves, fittings, and columns so that a gas sample containing hydrogen, oxygen, nitrogen, methane, carbon monoxide, carbon dioxide (C_2 and C_3) hydrocarbons could be analyzed using a computer for control. The flow diagram for the system is shown in Figure 158 and explained below.

Two Gow Mac gas chromatographs (Gow Mac Corporation, Madison, New Jersey) were connected together, as shown in Figure 158, so that GC-1 would receive carrier gas for both reference and analytical columns and GC-2 would receive carrier gas for the analytical column, only as needed, through valve 2. Each of the carrier gas lines have pressure-flow control valves. The reference column of GC-1 is connected directly to the reference column of GC-2. The analytical column of GC-1 is connected in series with the analytical column of GC-2 through switching valve 2.

The sample valve is an eight-port micro sampling valve (Carle Instruments Inc., Fullerton, California) with two 1.0 cc sample loops. It is operated by an actuator to be controlled by the computer. When one loop is injecting a sample into the analytical column, the other loop is being purged with sample gas for the next analytical run.

The sample with the carrier gas enters the analytical column of GC-1 from the sample loop, and the first separation occurs. The first column is a stainless steel tube, 8 feet x 1/4-inch diameter, packed with Poropak Q (Waters Associates, Inc., Framingham, Massachusetts). The sample is separated by this column into its components; and, as each component is detected, the area of the peak and the time from injection is measured and printed out by a digital integrator (Vidar 6300-02, Vidar Autolab, Mountain View, California). The chromatogram is also recorded on a recorder. A typical chromatogram for GC-1 is shown in Figure 159-A.

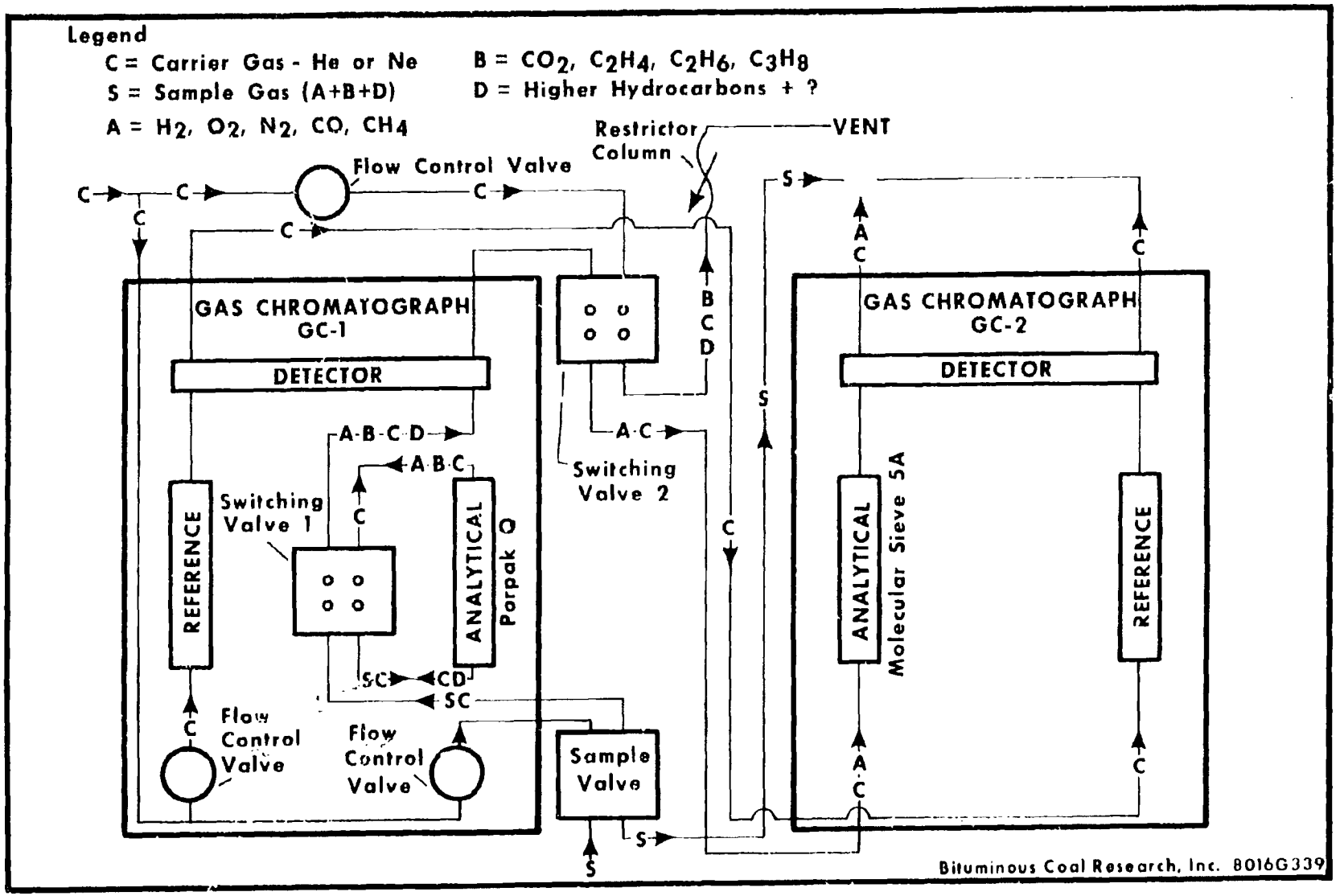
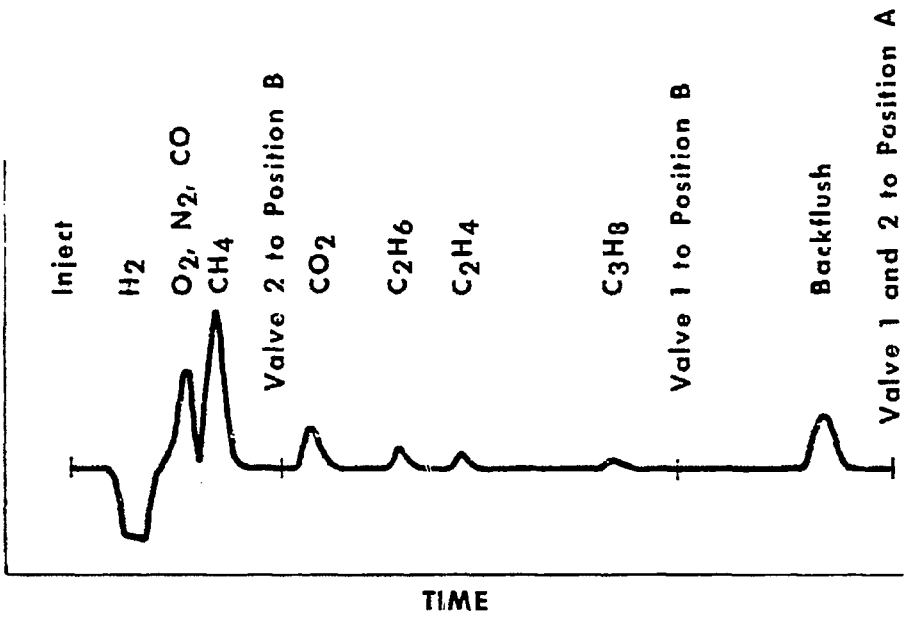
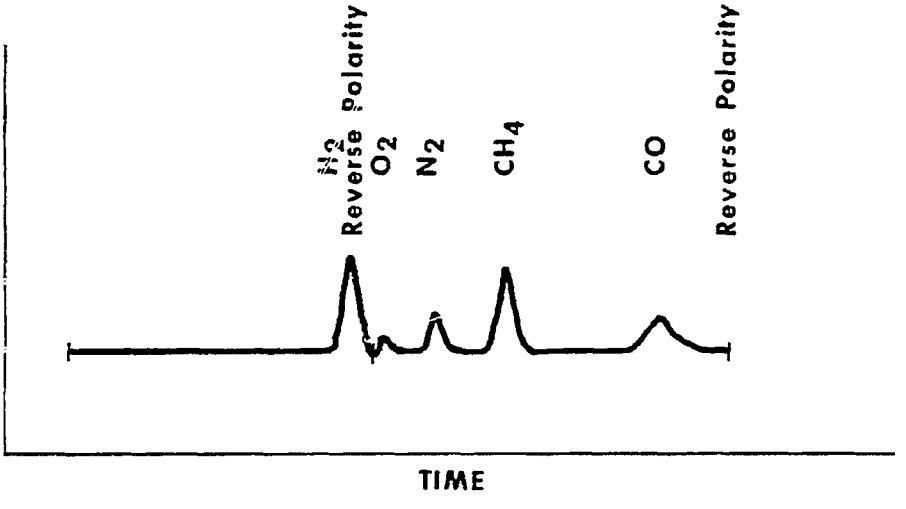


Figure 158. Flow Diagram Automated Gas Analysis Equipment



159A. Recorder Trace from Gas Chromatograph 1 Showing Gas Peaks and Valve Operations (Neon Carrier Gas)



159B. Recorder Trace from Gas Chromatograph 2 Showing Gas Peaks and Reverse Polarity Positions (Neon Carrier Gas)

Bituminous Coal Research, Inc. 8016G340

Figure 159. Typical Chromatograms from Gas Analysis

The hydrogen peak will be negative because neon is the carrier gas. Since the area data from this column is not needed, it will not be counted; hence, GC-1 does not change polarity during the analytical run. Just prior to the detection of the carbon dioxide peak, the valve 2 is switched to position B so that the gas which, up to this point, has been passing to GC-2 is now ejected to the air through a restrictor column. The restrictor column is used so that the flow remains constant and the gases (carbon dioxide, ethylene, ethane, propane, etc.) are ejected to prevent them from reaching and poisoning the second analytical column. After the propane peak, the valve 1 is switched to position B to backflush the first analytical column, thus removing any high retention time materials which would eventually affect the stability of the base line. After backflushing, both valve 1 and valve 2 are returned to their original positions.

The gas which had passed to GC-2 enters another analytical column, 6 feet x 1/4-inch stainless steel tube containing molecular sieve 5A (Union Carbide Corporation), which separates the gas into its components. The peaks are measured by a second digital integrator and graphed by a second recorder. A typical trace is shown in Figure 159-B.

The hydrogen peak will be negative, but since the area information is necessary, the GC-2 will be at a polarity to give a positive peak. When the hydrogen peak is completed, the polarity will be reversed so that the remaining gas peaks are also positive. After the carbon monoxide peak, the GC-2 will be switched to its original polarity to be ready for the next analysis.

The system has been assembled as described and tested for leaks at pressures up to 60 psig. When all leaks had been secured, the system was heated to temperature in preparation for standardization. Initially, the valves and polarity change will be controlled manually but will be controlled by a computer at a later date.

b. Flame Ionization Gas Chromatograph: A Gow Mac 69-750 F.I.D. Gas Chromatograph was assembled with the proper tubing and flow measuring systems to operate through a Vidar 6250 digital integrator and a Honeywell recorder.

Single compounds, representative of those present in the water from the methanation PEDU, are being run to determine retention times prior to standardization.

c. Future Work:

(1) Gas samples w ll be analyzed as required.

(2) Both the automated gas chromatograph system and the flame ionization gas chromatograph will be standardized.

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 and 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, which is the program that controls all the computer's peripheral devices for data acquisition, has been completely debugged. The bench scale methanator data acquisition program which logs, processes, reports, and stores data from the bench-scale methanation unit, has also been debugged. These programs will be utilized to handle all future data generated from the BSM unit.

A complete description of both the real time software system and the BSM data acquisition program 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. Writing a complete description of the real time software system and the BSM data acquisition program.

c. Generation of simulation runs with subroutine GASIFY as requested and authorized.

D. Multipurpose Research Pilot Plant Facility (MPRF)

1. Pilot Plant: Several technical meetings have been held during the month in Monroeville and Denver with Blaw-Knox, Stearns-Roger, BCR, and B & W to set design criteria for the gasifier and startup procedures for the BI-GAS pilot plant. As a result of these meetings, a revised drawing of the gasifier was prepared by B & W for review by BCR, Stearns-Roger, and C. F. Braun at meetings held in Denver on August 30-31, 1972. Discussions were also held at this time with regard to materials of construction for the gasifier and the possibility of slurry feeding for the pilot plant.

As approved by OCR, arrangements are being made to ship the plant-scale model to Stearns-Roger in Denver for their use during the engineering phase of the project.

BCR has supplied Stearns-Roger with information and material pertaining to the Homer City pilot plant site for their site survey and preparation work. Stearns-Roger plans to develop Bid Packages in relation to this work.

a. Stearns-Roger, Inc.: Stearns-Roger's current engineering effort is reported in their Project Status Report No. 1, Appendix B of this report.

b. Blaw-Knox Chemical Plants, Inc.: Blaw-Knox continues to provide project management and surveillance services in connection with the Homer City pilot plant. To facilitate the conduct of the project, the Project Manager has relocated to the offices of Stearns-Roger in Denver, Colorado.

Stearns-Roger is developing process flow diagrams which should be ready for approval in the latter part of September. Specifications for the gasifier are being developed and a proposal will be submitted by B & W in early September. An engineering schedule cannot be completed until further information is available on the engineering time required for the gasifier.

2. Materials Evaluation Program: No meeting has been announced by the Metals Properties Council regarding the final selection of IIT Research Proposal No. 72-406B, "Corrosion of Materials at Temperatures and Environments Expected in Proposed Processes for the Gasification of Solid Fuels."

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. 37, Appendix D of this report.

G. Other

1. Prime Contract Matters: A list of all nonexpendable equipment on the inventory as of the expiration date of Contract No. 14-01-0001-324 is being developed. This list will indicate what equipment should be transferred to Contract No. 14-32-0001-1207 and what should be declared as scrap.

As reported in letters dated August 31, 1972, to Mr. Howard Thunberg, the following items of surplus equipment and supplies were picked up during the month by other OCR contractors and/or government agencies:

Coulter Counter and auxiliaries	- Mr. Sienkiewicz, Institute of Gas Technology, Chicago, Illinois
Radioactive Carbon-14	- Mr. R. Stewart, Bureau of Mines, Morgantown, West Virginia
Brooks Rotameters (5)	- Mr. J. Millick, Bureau of Mines, Bruceton, Pa.

A copy of OCR letter dated August 18, 1972, together with an enclosed form requesting information on the BI-GAS pilot plant for the Department's Office of Equal Opportunity, was forwarded to our construction subcontractor, Stearns-Roger, for completion. In view of the August 31 deadline for receipt of the form, Stearns-Roger was instructed to send the completed form directly to OCR.

2. FPC National Gas Survey - Economics of Manufacturing SNG from Coal:

Gas costs for the manufacture of SNG from both Montana subbituminous coal and Western Kentucky No. 11 seam coal using the BCR/OCR BI-GAS coal gasification process to produce 250 MM scfd of pipeline gas were submitted to OCR for review.[1] No further studies have been requested or required by OCR.

3. 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 Assignment on September 22, 1971, and given Serial No. 182,652.

Patent applications have been field in Australia, India, South Africa, Canada, and Great Britain, and applications are being prepared for filing in France, Japan, and West Germany. Confirmatory license to the government was executed by BCR on January 12, 1972.

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[1] BCR Report: "Economics of Manufacturing SNG by BCR/OCR BI-GAS Coal Gasification Process Using Western Kentucky No. 11 Bituminous Coal," July 5, 1972.

Air Products Report: "Economics of Manufacturing SNG by BCR/OCR BI-GAS Coal Gasification Process Using Montana Subbituminous Coal," May 1, 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. OCR-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.

4. Reports and Papers: As approved by OCR, R. J. Grace will present a paper entitled "BI-GAS Program Enters Pilot Plant Stage" at the forthcoming AGA Synthetic Pipeline Gas Symposium, October 30, 1972, at Chicago, Illinois. Authors of the paper will be R. J. Grace and R. L. Zahradnik. An advance copy of the paper will be submitted to OCR when available.

H. Visitors During August, 1972

August 3, 1972

Dr. Roger F. Detman
Project Manager
C. F. Braun & Co.
Alhambra, California

August 8, 1972

Mr. Stanley Kasper
Mr. F. S. Glessner
Blaw-Knox Chemical Plants, Inc.
One Oliver Plaza
Pittsburgh, Pa. 15222

August 14, 1972

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

August 15, 1972

Mr. Arel L. Langston
Mr. David Lohr
Mr. Victor Brant
Ms. Jean Reese
Stearns-Roger Corporation
P. O. Box 5888
Denver, Colorado 80217

Mr. Paul B. Probert
Mr. Charles R. Bibbee
Babcock & Wilcox
Barberton, Ohio

August 15, 1972

Mr. Stanley Kasper
Mr. F. S. Glessner
Mr. John C. Kuli
Blaw-Knox Chemical Plants, Inc.
One Oliver Plaza
Pittsburgh, Pa. 15222

August 22, 1972

Mr. Joseph Talago, Jr.
Mr. Philip Borish
American Gas Association
1515 Wilson Boulevard
Arlington, Virginia 22209

August 24, 1972

Mr. F. S. Glessner
Mr. N. F. Boyd
Blaw-Knox Chemical Plants, Inc.
One Oliver Plaza
Pittsburgh, Pennsylvania 15222

August 29, 1972

Mr. W. F. Crabb
Mr. T. F. Buirgy
Stearns-Roger Corporation
P. O. Box 5888
Denver, Colorado 80217

I. Trips, Visits, and Meetings During August, 1972

August 14, 1972	Chemetron Corporation Louisville, Kentucky	M. S. Graboski
August 17-18, 1972	Dedication Ceremonies Consol Pilot Plant Rapid City, South Dakota	J. W. Tieman J. P. Tassoney
August 30-31, 1972	Stearns-Roger, Inc. Denver, Colorado	R. J. Grace J. P. Tassoney

J. Requests for Information

Dr. Bernie Baker
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15 Durant Avenue

Ms. Dolores Billmyer
Associate Editor
Coal Age Editorial Dept.
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New York, New York 10021

Mr. James Ridgeway
1065 - 31st Street, N.W.
Washington, D. C. 20007

Mr. John J. McDermott
Pennsylvania Department
of Education
Division of Science & Mathematics
Harrisburg, Pennsylvania

Mr. S. W. Vance
Dorr-Oliver, Inc.
77 Havemeyer Lane
Stanford, Connecticut 06094

III. WORK PLANNED FOR SEPTEMBER, 1972

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

The four catalysts scheduled for test in the bench-scale methanator were not tested, due to a failure of the equipment. The equipment has now been repaired, and the tests will be made to continue the catalyst evaluation program. Life tests will be made on those catalysts which show promise. Methanation PEDU work will continue and will include some piping, foundation work, and building alterations. Bids on equipment will continue to be solicited and approved items will be purchased.

The automated gas analysis system for the methanation PEDU, consisting of two gas chromatographs connected in series, will be standardized.

The summary report on the results of the cold model studies will be issued as Special Report No. 3.

The bench-scale methanator data acquisition program should begin. This program logs, processes, reports, and stores data from the BSM unit. A complete description of the real time software system and the BSM data acquisition program will be written. Simulation runs with subroutine GASIFY will be generated as requested.

Meetings with Stearns-Roger and Blaw-Knox will continue to discuss various technical details. The scale model gasification plant will be shipped to Stearns-Roger for their use during the next few months.

A. Trips and Meetings Planned

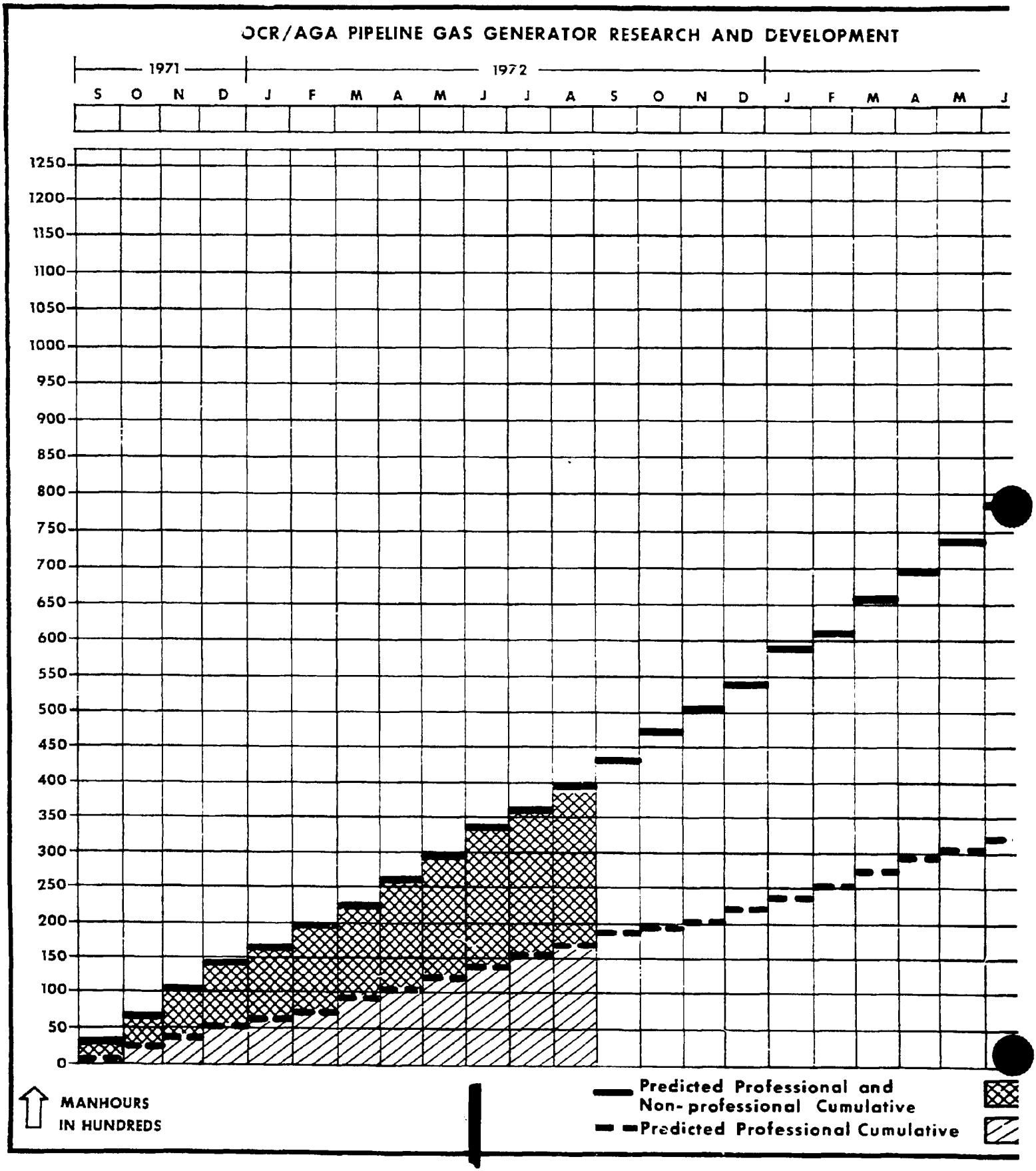
September 12, 1972	OCR/AGA Project Advisors Meeting BCR Laboratory Monroeville, Pa.

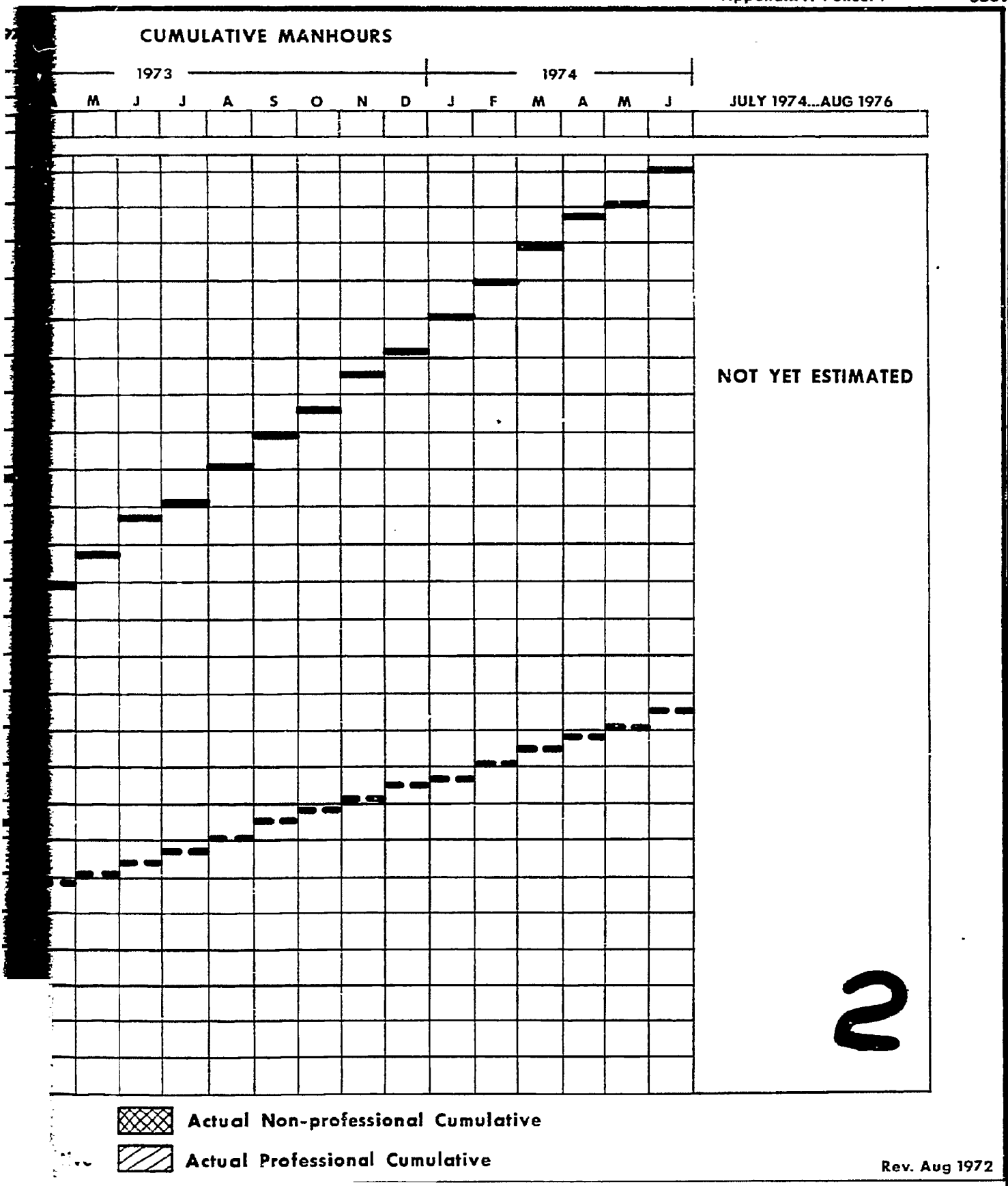
B. Papers to be Presented

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

C. Visitors Expected

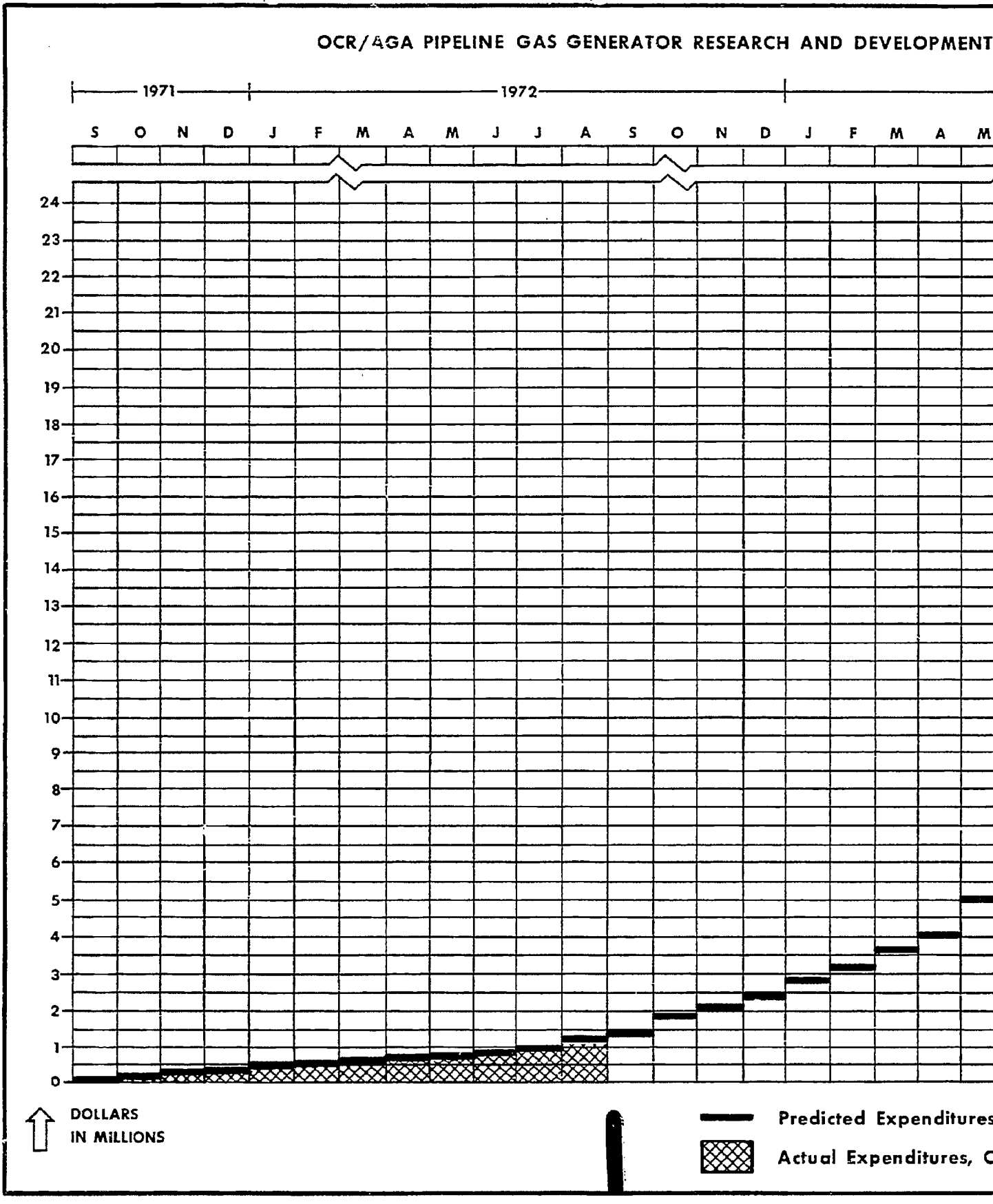
October 9-11, 1972	Steinkohlenbergbauverein Bergbau-Forschung GmbH 43 Essen-Kray GERMANY	Dr. Werner Peters Mr. K. H. Hawner


OCR/AGA PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT
1971
1972
S O N D J F M A M J J A S O N D J F M A M J
1250
1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
MANHOURS
IN HUNDREDS
Predicted Professional and
Non-professional Cumulative
Predicted 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		2,152.0		18,279.5		24,905.5	
Oct. '72	1,456.0		2,144.0		19,735.5		27,049.5	
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							


OCR/AGA PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT
1971
1972
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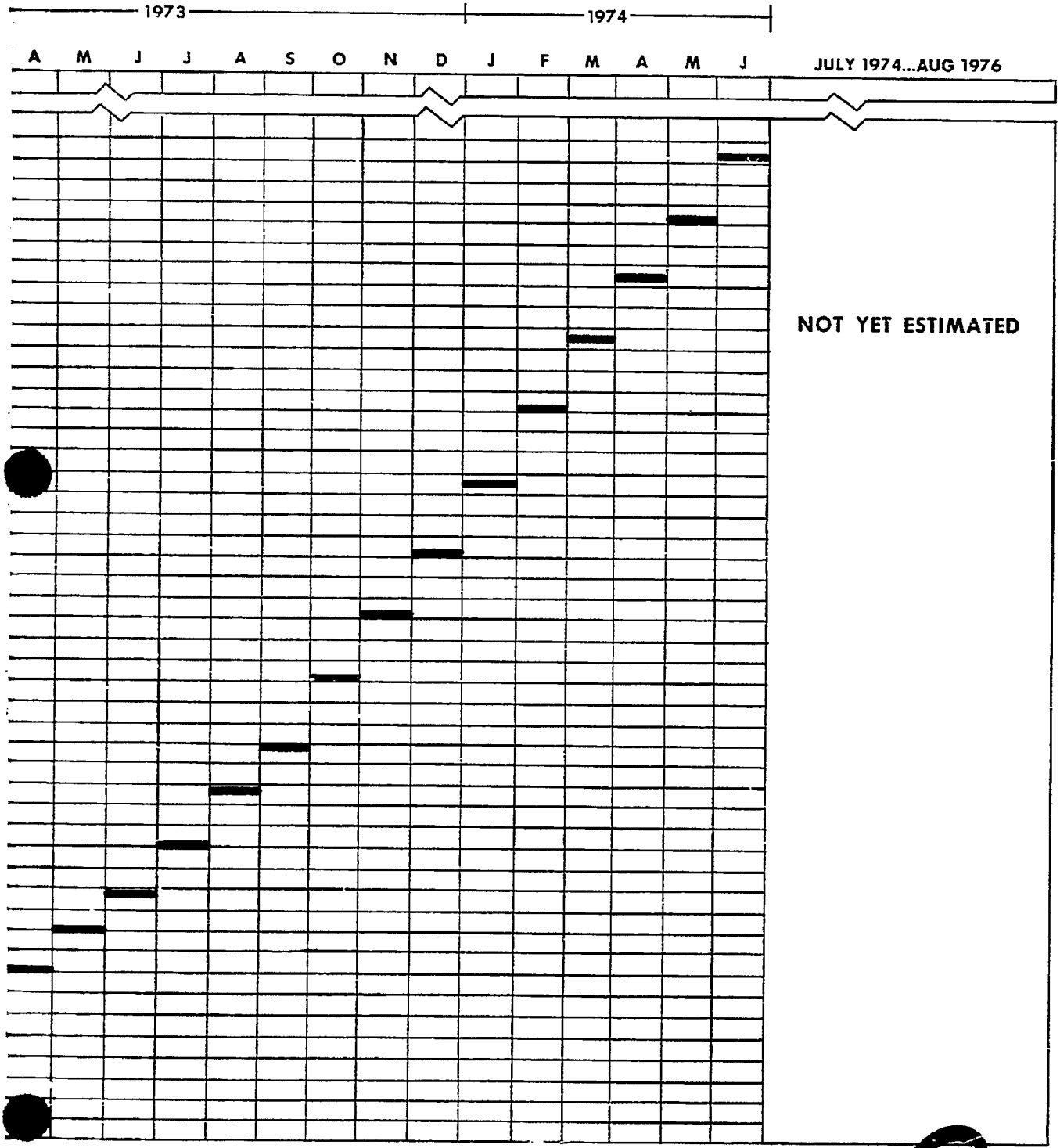

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CCR/AGA PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT
Schedule of Predicted and Actual Expenditures

	Current Month		Cumulative to Date	
Month	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		1,469,148	
Oct.	335,032		1,804,180	
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	1,456,868		23,604,300	
July to Aug. '76	N O T Y E T E S T I M A T E D			

APPENDIX B

HOMER CITY, PENNSYLVANIA
COAL GASIFICATION PILOT PLANT
C-11630

STEARNS-ROGER PROJECT STATUS REPORT
NO. 1
SEPTEMBER 11, 1972

GENERAL

This report outlines job progress from award of contract to September 8, 1972.

An initial meeting was held at BCR's offices in Monroeville, Pennsylvania on July 6-7, 1972, between BCR, Stearns-Roger and Blaw-Knox. This meeting was devoted to acquainting Stearns-Roger with the project background information and discussion of BCR's reaction to Stearns-Roger proposal alternates.

On July 17-18, 1972, representatives of OCR, AGA, BCR, Stearns-Roger, Blaw-Knox, C. F. Braun and Babcock and Wilcox met in Denver. This meeting was devoted to an overall process review and had as its purpose definition of the basic project scope. Also, at this meeting B&W presented and discussed a concept drawing for a single-wall, water tube cooled type gasifier. It was agreed to forego the Koppers design and proceed to design the gasifier using the concepts presented by B&W.

An additional meeting was held on July 19, 1972, with the AGA Advisory Committee. This meeting was to acquaint this group with the design philosophy and the decisions made during the meetings of the two previous days.

Stearns-Roger's assigned scope of work was the Koppers bid package, amended as agreed during these meetings. It was further agreed that Stearns-Roger would start work by rechecking the complete process design and developing complete new process and mechanical flow diagrams.

After this series of meetings, work was started immediately with B&W on development of the gasifier design. Process design work on other areas of the plant started approximately August 1, 1972.

PROCESS ENGINEERING

Process engineering is approximately 10% complete as of August 31, 1972. Progress to this date with respect to the various process areas is as follows.

PROJECT STATUS REPORT - NO. 1

PROCESS ENGINEERING - continued

1. Coal Handling: Process design in this area is approximately 40% complete. Material balance requirements have been checked. The flow sheet and preliminary arrangement drawings have been developed to the extent that work can be started writing equipment inquiry specifications for some of the major equipment. Instrumentation requirements for this area have not been developed to date.

2. Coal Feed: Process design in this area is approximately 60% complete. A preliminary P&I flow sheet with major instrumentation defined has been drawn. Equipment specifications for inquiry of major equipment items can be started.

3. Gasification: Major emphasis has been placed upon design of the gasifier. Stearns-Roger requested B&W's proposals for the engineering and fabrication phases of the program on July 26, 1972.

   On August 8, 1972, a preliminary proposal was received which projected a schedule of 91 weeks to design and fabricate the gasifier. B&W was advised that this schedule was not acceptable. At the same time, it was recognized that B&W could not prepare a realistic schedule until fundamental design concepts and criteria were developed.

   To expedite design, a meeting was held at BCR's office in Monroeville on August 15, 1972. This meeting was attended by representatives of BCR, Stearns-Roger, Blaw-Knox and B&W. This meeting resulted in establishing the intended start-up procedure and design and arrangement criteria for the vessel. Maintenance access and replacement features, particularly for Stage I, were included. Tentative material selections for vessel and cooling tube materials were also made.

   Later, it developed that an out of date code book had been used for allowable material stresses at the August 15 meeting. This required a new look at materials, possible use of clad-plate and further consideration of possible corrosion problems.

   To resolve these problems, a meeting was held in Denver on August 30, 1972. This meeting was attended by representatives of BCR, Stearns-Roger, Blaw-Knox, B&W and C. F. Braun. Vessel design people and metallurgists from the respective organizations were present. The material selection problem was resolved and corrosion allowances, considerations, etc., established to the satisfaction of all parties present. This meeting was also utilized to acquaint C. F. Braun with overall progress to this point. C. F. Braun personnel expressed the opinion that design to this point looks good. At the conclusion of this meeting B&W agreed that design information was now available to realistically estimate cost and develop an overall engineering, procurement and fabrication schedule for the gasifier.

   B&W has promised a new proposal, estimate and schedule by approximately September 20, 1972. The vessel drawings are also being revised to reflect

PROCESS ENGINEERING - continued

results of the meetings. The next issue of B&W's gasifier drawings will be the first issue to be submitted to the involved organizations for formal review and comment.

Overall process work is approximately 5% complete in the gasification area. Flow sheets for the burner and slag removal systems are in progress. Three flow sheets in this area have not been started.

4. Gas Wash: Process design in this area is approximately 50% complete. The preliminary flow sheet for this system and the char separation system have been drawn. The char-slurry handling flow diagram has not been drawn.

5. Char and Lime Systems: Process design is approximately 60% complete. The preliminary flow diagram has been drawn. Equipment inquiry specifications can be started for some major equipment items.

6. CO Shift: Process design and a flow sheet based upon use of the originally specified catalyst is 90% complete. Stearns-Roger was instructed to redesign this system to eliminate heat exchange and eliminate the high reactor pressure drop shown in the Koppers package. BCR has requested that alternate catalysts be investigated. Work on this system has progressed as far as possible until vendor data is received and the catalyst question is resolved. Catalyst selection is not expected to cause extensive rework on the engineering completed to date. However, the design cannot be considered firm until a catalyst is selected.

7. Acid Gas Removal: Three processes are being investigated - SELEXOL, Rectisol and Alkazid. Cost estimates are being furnished by the licensors for Rectisol and Alkazid. SELEXOL Process requirements are known and Stearns-Roger is developing a cost for comparing this process with the others under consideration. It is expected that a process will be recommended for selection within the next 3-4 weeks. The flow sheets can be developed quite rapidly upon approval of a selected process.

8. Methanation: BCR is currently developing design criteria for the methanation catalyst to be used. Changes in catalyst properties, reaction temperature, space velocities, etc., are expected to result in increased costs, added process engineering and perhaps create delivery problems - particularly with respect to the methanator reactor. Stearns-Roger considers methanation as potentially a major problem area.

9. Utilities and Effluent Treating: Preliminary process work has been started on sewage disposal, fire water and plant oxygen requirements.

The week of August 28, Stearns-Roger discovered that the gas utility company had cancelled BCR's previous application for fuel gas to serve the plant. BCR is working on this problem, which is considered a high priority item. Stearns-Roger has furnished BCR fuel gas requirements, recognizing gasifier start-up, for BCR use in negotiating a gas supply.

PROCESS ENGINEERING - continued

Also, quick-look cost data for providing propane facilities if natural gas turns out to be non-available.

BCR is determining the schedule and available amounts of Homer City water for plant use. This data is essential before firm decisions can be made to eliminate the creek pump station for water supply.

10. Process Flow Diagrams and Material Balances: Process flow diagrams for the coal handling, coal feed. gasification, gas wash, char and lime and CO shift areas have been drawn. Material balance information is ready to be added to these flow sheets. Process flow sheets for acid gas removal, methanation, utilities and effluent treating remain to be drawn.

11. Slurry Feeding: BCR has requested a recommendation from Stearns-Roger regarding the merits of slurry versus lock hopper feed system to the gasifier. This is being studied as a side effort and a recommendation will be made to BCR, the week of September 10. No design provisions for slurry feeding have been made at this point.

PHYSICAL DESIGN

Proposals have been solicited and received for initial site clearing, topographical surveying and for soil testing and subsurface investigation of site conditions. It is planned to award this work and complete these items within the next 2-3 months. Stearns-Roger field supervision will be required while this work is in progress.

PROCEDURES

The project procedure memorandum has been prepared and reviewed by BCR. BCR comments are being incorporated. The procedure will be issued the week of September 10, 1972.

Stearns-Roger procurement terms and conditions for the project have been prepared and are ready to submit for BCR approval.

APPENDIX C

ADDITIONS TO ABSTRACT FILE, AUGUST 1972

"A current appraisal of underground coal gasification," Arthur D. Little, Inc., Rept. to U.S. Bur. Mines, OFR11-72 (1972). 278 pp. NTIS No. PB-209 274. 535.000 72-2

The conclusion of this thorough review of underground gasification is that it "is technically feasible, but economic feasibility is yet to be determined." There are 328 references to U.S. and foreign literature published in 1960 and subsequently.

Levene, H. D., "A progress report on coal gasification," Coal Mining Process. 9 (8), 38-41, 52, 54 (1972).

Processes being used or being developed in the United States are reviewed and their status is discussed. 540.000 72-5

Louis, J. F. et al., "Open cycle coal burning MHD power generation: an assessment and a plan for action," M.I.T. MHD Power Generation Study Group, Rept. to U.S. Office Coal Res., R & D Rept. No. 71 (1972). 181 pp. OCR M414

This is a revision of OCR Rept. No. 64, Nov. 1971. See BCR Progr. Rept. No. 5, January 1972 page C-309.

PATENTS

Lee, B. S. and Schora, F. C., Jr. (to Inst. Gas Technol.), "Desulfurization of coal," U.S. Pat. 3,640,016 (Feb. 8, 1972). 5 pp. 540.000 Patent

This is a method for desulfurizing coal by reacting sulfur-containing bituminous coal with hydrogen in the presence of a hydrogen sulfide "getter" at a temperature about 600-800° F and at substantially atmospheric pressure. (Abstract of the disclosure adapted)

Hohne, R. (to Metallgesellschaft A.-G.), "Process for removing sulfur from gases," U.S. Pat. 3,634,028 (Jan. 11, 1972). 5 pp. 540.000 Patent

In the process, activated carbon having a steep absorption isotherm is used for sulfur removal from gases (including those produced from coal gasification) and is regenerated with hot inert gas.

Suzuki, S., Kilgren, K. H., and Tjoa, G. H. (to Chevron Research Co.), "Method of removing hydrogen sulfide from gaseous mixtures," U.S. Pat. 3,642,431 (Feb. 15, 1972). 7 pp. 540.000 Patent

The process for selectively removing H_2S and like sulfides from fluids containing them by contact with a substantially hydroxyl-free solvent such as N-methyl-2-pyrrolidone, a dicarboxylic acid anhydride soluble in said solvent and an alkali hydrosulfide. Preferably, in the process an admixture of H_2S and CO_2 in natural gas is contacted with the contacting solution to react the H_2S with said anhydride, the CO_2 and/or like hydrocarbons are rejected from the contacting solution by mild heating and/or pressure reduction and thereafter H_2S is regenerated by heating the remaining solution. (Abstract of the disclosure)

APPENDIX D

D-676.

PROGRESS REPORT #37

Bituminous Coal Research, Inc.
Coal Gasification

August 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

1. Messrs. M. S. Graboski, BCR, and R. W. Whiteacre and R. C. Dorsey, Koppers, met August 1, 1972 with personnel from Gas Atmospheres Inc. in Koppers offices to review the design engineering for the reformer.

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

Drawing No.	Rev. No.	Title	Date Trans.
2415-2F700	0	Water Head Tank Liquid Level Gage	8/1/72
2415-2F701	0	Drip Pot Liquid Level Gage	8/1/72
2415-2F702	0	Water Metering Tank Liquid Level Gage	8/1/72
2415-2F703	0	Cooling Water Hold Tank Liquid Level Gage	8/1/72

Drawing No.	Rev. No.	Title	Date Trans.
2415-2A722	2	Demister	8/1/72
2415-2A726	2	Methanator Feed Gas Receiver	8/1/72
2415-5A700	0	H_2S & CO_2 Storage Area Foundations	8/1/72
2415-2A730	1	H. P. Stall Equipment General Arrangement & Piping & Steel Design Sheet 1 of 3	8/7/72
B/M 2415-2A730 Shts. 1 to 16 incl.	0	H. P. Stall Equipment General Arrangement & Piping & Steel Design Bill of Materials	8/7/72
2415-2A731	1	H. P. Stall Equipment General Arrangement & Piping & Steel Design Sheet 2 of 3	8/7/72
2415-2A732	1	H. P. Stall Equipment General Arrangement & Piping & Steel Design Sheet 3 of 3	8/7/72
DX 3.13		Specification for Materials & Installation of Calcium Silicate Insulation For Pipe	8/7/72
2415-9A701	2	Graphic Panel Layout	8/7/72
2415-9A702	1	Recorder & Analyzer Panels	8/7/72
2415-9A703	1	N.G. Comp., Reformer Unit & Add. Flows-Interconnection Schematics	8/7/72
2415-9A704	1	Meth. Flow, Feed Gas & Reactor Safety Ckt. Interconn. Schematic	8/7/72

Drawing No.	Rev. No.	Title	Date Trans.
2415-9A705	1	Filter Blowback, Demister Level, Product Gas Press., Graphic Panel Elect. Power Distribution	8/7/72
2415-9A706	1	Graphic Panel Annunciator & Air Supply Interconn. Schematic	8/7/72
2415-9A707	0	Feed Gas Press. & Flow, Meth. Pressures, Product Gas Flow, Therminol Flows & Temp.	8/7/72
2415-9A708	1	Meth. & Heat Windings Temps. Infrared Analyzers Recorders	8/7/72
2415-9A709	1	Heat Winding Ckt. & Record. Panel Elect. Air Supply & H_2S Controls	8/7/72
2415-9A710	1	Electric Terminal & Pneumatic Bulk Head Arrangements	8/7/72
2415-9F333	2	Instrument Panels	8/7/72
2415-9F344 Shts. 1 to 15 incl.	0	Operation Descriptions	8/7/72
2415-9F300	1	Analyzers- Infrared	8/10/72
2415-9F302	1	Analyzers- CO Alarms	8/10/72
2415-9F324	1	Panel Mounted Indicators- Pneumatic	8/10/72
2415-9F329	2	Relief Valves	8/10/72
2415-9F334	1	Pressure Control Valves (Self-Acting)	8/10/72
2415-9F339	2	Instrument Specification Index	8/10/72

Drawing No.	Rev. No.	Title	Date Trans.
2415-9F603	3	Temperature Recorders -(MV)- Alterations	8/10/72
2415-9F608	1	Panel Mounted Indicators Pneumatic Alterations	8/10/72
2415-2A745	0	Compressor Room-General Arrangement and Piping Design	8/11/72
B/M 2415-2A745	0	Compressor Room-General Arrangement and Piping Design-Bill of Materials	8/11/72
2415-2A703	2	Process and Utility Flow Diagram Sheet 1 of 4	8/11/72
2415-2A704	2	Process and Utility Flow Diagram Sheet 2 of 4	8/11/72
2415-2A705	2	Process and Utility Flow Diagram Sheet 3 of 4	8/11/72
2415-2A706	2	Process and Utility Flow Diagram Sheet 4 of 4	8/11/72
2415-5A701	0	Compressor Room Equipment Foundations	8/14/72
2415-2A733	4	Plot Plan	8/18/72
2415-2A734	2	Vent Gas & H_2S Removal Flow Diagram	8/18/72
2415-2A740	3	Boiler Room General Arrangement and Piping Design	8/18/72
2415-2A741	1	Yard Rack Piping	8/18/72

Drawing No.	Rev. No.	Title	Date Trans.
B/M 2415-2A741 Shts. 1 to 15 incl.	0	Yard Rack Piping Bill of Materials	8/18/72
2415-2A712	5	General Piping Specifications Sheet 1 of 2	8/23/72
2415-2A713	4	General Piping Specifications Sheet 2 of 2	8/23/72
2415-2A738	0	Methanator Feed Gas Heater Tank	8/23/72
2415-2A746	0	Methanator Feed Gas Heater Tank Coils	8/23/72

3. The following memoranda were transmitted by Koppers Company, Inc. to BCR:

Date	Letter No.	Title	Remarks
8/7/72	C432	National Annealing Box Co. Correspondence	Transmitted NABCO Bills of Materials and Purchase Orders for Demister Item M-V620
8/7/72	C435	Equipment Inspection	Transmitted Inspection Section Progress Report No. 1 for H_2S Flash Tank M-V260 Methanator Feed Gas Receiver M-V310

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.

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