

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

PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT

Progress Report No. 16

(BCR Report L-504)

I. INTRODUCTION

This report summarizes progress achieved during December, 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 sixteenth 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 16C, 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 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 DECEMBER 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 December. Gas processing studies continued in accordance with the updated time schedule presented in Figure 163, Progress Report No. 14.

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 164, Progress Report No. 14. 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 feasibility of the schemes for the BI-GAS process.

(1) Harshaw Catalysts: Data for the Harshaw catalysts currently being studied were presented last month. BCR is awaiting word from Harshaw on the results of studies on spent catalyst samples sent earlier in the year.

(2) Chemetron Catalysts: Three lots of catalyst were received from Chemetron Corporation during the past month.

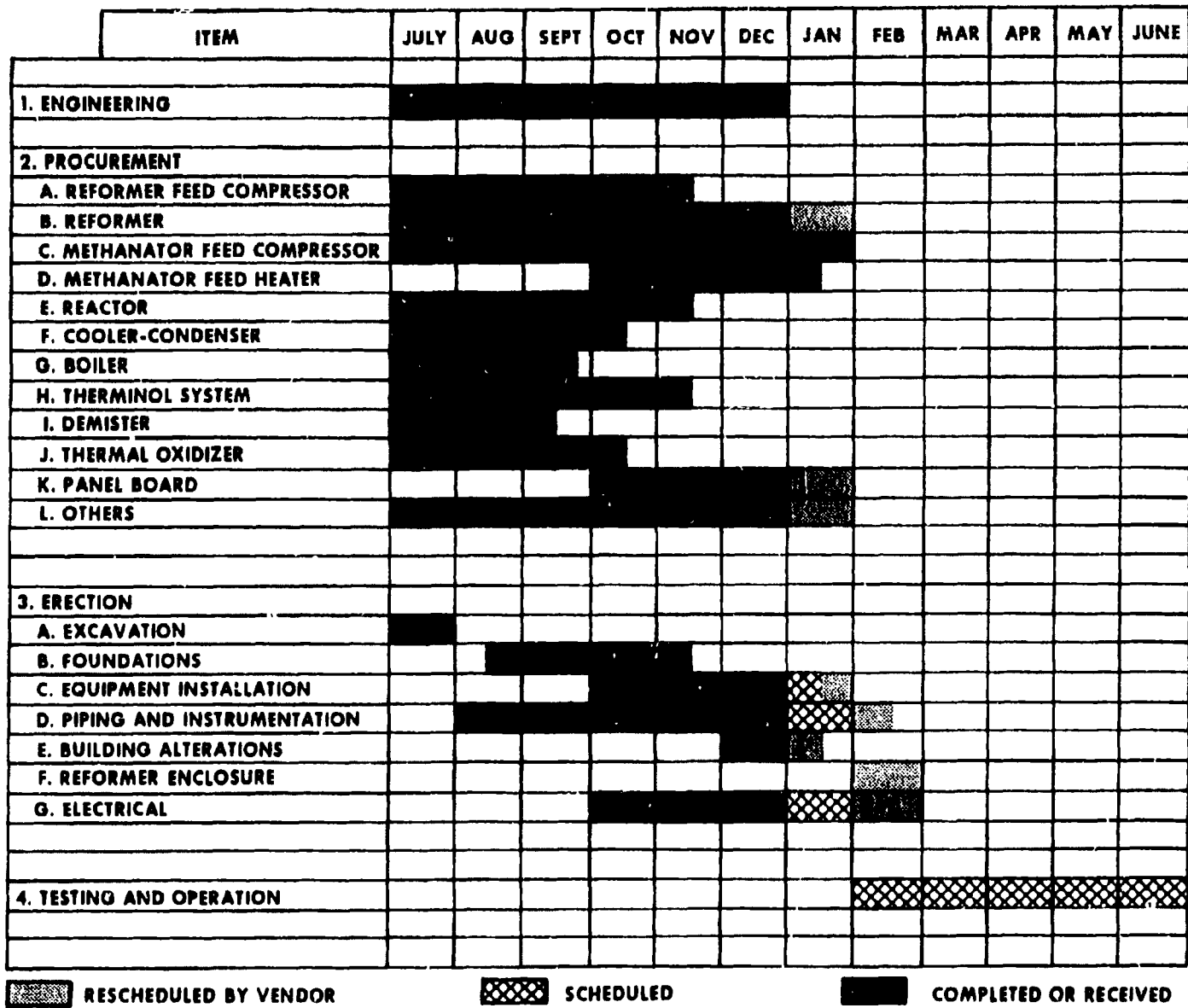
<u>BCR Lot No.</u>	<u>Chemetron No.</u>	<u>Nominal Composition</u>
3082	T-1943	20% MoO ₃ - 80% Al ₂ O ₃
3083	T-1977	10% MoO ₃ - 90% Al ₂ O ₃
3084	T-1978	30% MoO ₃ - 70% Al ₂ O ₃

Physical property measurements are currently being made. These data will be reported next month. The three Chemetron catalysts have been charged into the life test unit along with a sample of BCR Lot 2903 catalyst. Data will be available next month for the four samples.

(3) Union Carbide Catalysts: A meeting was held between BCR and a representative from Union Carbide molecular sieve group pertaining to their role in development of methanation catalysts. A secrecy agreement is under negotiation to permit BCR and Union Carbide to exchange information on methanation.

(4) American Cyanamid: Representatives from American Cyanamid and BCR met during December to discuss methanation catalysts under an existing secrecy agreement. No further contact has been made with Cyanamid since that discussion.

b. FEDU Studies: Progress continued on construction of the methanation FEDU during December. The updated construction schedule for the project, based on currently available delivery data, is given in Figure 204.



 RESCHEDULED BY VENDOR
  SCHEDULED
  COMPLETED OR RECEIVED

Bituminous Coal Research, Inc. 8040G88

Figure 204. Current Methanation PEDU Schedule for Fiscal 1973

820.

(1) Engineering: Koppers completed detail engineering during December. Engineering time under the general assistance part of the contract is still available as required.

During December, final drawings and specifications for the analyzer panel were received.

(2) Procurement: Table 147 shows the revised status of major FEDU equipment items.

During December, visits were made to Gas Atmospheres, Cleveland, Ohio, to inspect fabrication of the reformer, Item MX-100, and to Monroe Boiler for a final inspection of the water break tank, Item MV-766. The reformer is about 90 percent complete and shipment could be sooner than the scheduled date of January 31. Item MV-766 was rejected due to improper code stamping; this will be corrected but the delivery date has been revised.

During December, materials continued to arrive. Purchasing of all equipment and instrument items was completed except for some minor supplies.

(3) Construction: FEDU construction is proceeding according to the schedule shown in Figure 204. Some construction photographs are shown in Figures 205 through 212.

(a) Piping Installation: Piping work by BCR personnel continued during December. During this period, the following work was completed:

- (1) Therminol piping, except for control valves.
- (2) Boiler piping downstream of demineralizer.
- (3) Vent gas piping in high pressure stall.
- (4) Cooling water to cooler-condenser.
- (5) Natural gas piping to MK-102.

(b) Structural Construction Work: During December the structural work included:

- (1) Completion of some modifications in Building 3.
- (2) Location of the natural gas compressor, MK-102.
- (3) Location of the Cardox CO₂ storage tank.

(c) Electrical Construction Work: During December, the electrical construction work progressed satisfactorily. The work included the following:

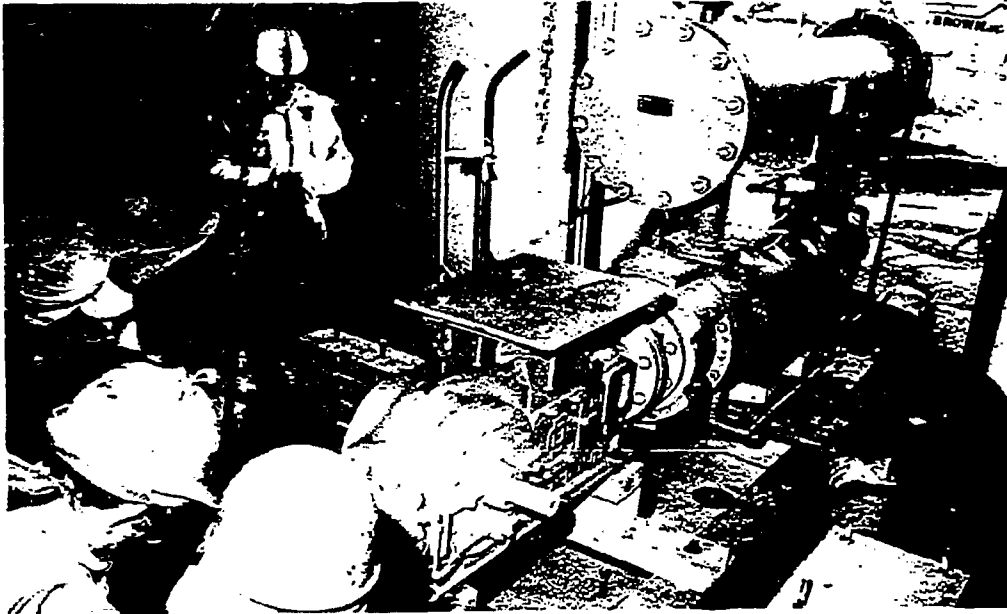
- (1) Installation of low-voltage switch gear on the existing transformer pad.
- (2) Continued installation of conduit in the methanation electrical area.
- (3) Initiated placement of conduit and equipment in the high pressure stall and compressor room areas.

TABLE 147. 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	F	1/15/73 ²
ME-410	Filter Blowback Heater	R	
ME-605	Cooler Condenser	R	
ME-700	Water Cooler	R	
MF-420	Catalyst Filters	F	2/23/73
MK-102	Natural Gas Compressor	R	
MK-305	Methanator Feed Gas Compressor	F/A	1/31/73 ²
ME-305	Bypass Cooler	F/A	1/31/73 ²
MK-770	Air Compressor	R	
MP-710	Cooling Water Pump	R	
MR-420	Fluid Bed Methanator	R	
MV-104	Reformer Feed Gas Receiver	R	
MV-260	H ₂ S Flash Tank	R	
MV-307	Oil Separator	R	
MV-310	Methanator Feed Gas Receiver	R	
MV-610	Water Metering Tank	R	
MV-615	Water Letdown Tank	F/A	1/15/73 ²
MV-620	Demister	R	
MV-710	Cooling Water Tank	R	
MV-763 A & B	H ₂ S Removal Towers	R	
MV-764	Drip Pot	R	
MV-766	Water Break Tank	F/A	1/15/73 ²
MX-100	Reformer	F/A	1/31/73
MX-500	Therminol System	R	
MX-720	Steam Boiler	R	
MX-750	Demineralizer	F/A	2/01/73
MX-770	Thermal Oxidizer	R	
MY-700	Reformer Enclosure	F	1/31/73
	Panel	P	1/31/73 ²
MX-210	CO ₂ Storage Tank	R	

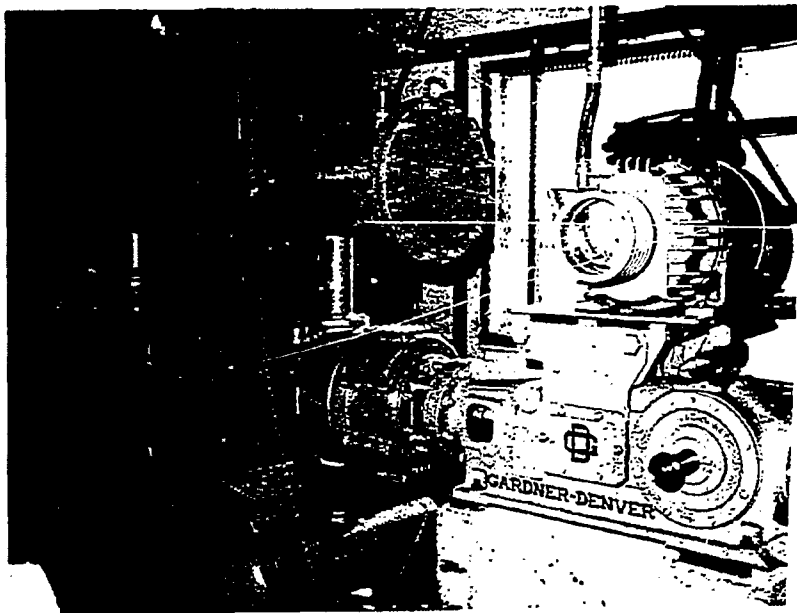
¹ P Procurement Stage
 F/A Procured and Vendors Drawings Approved
 R Received

² Vendor delay; delivery date revised



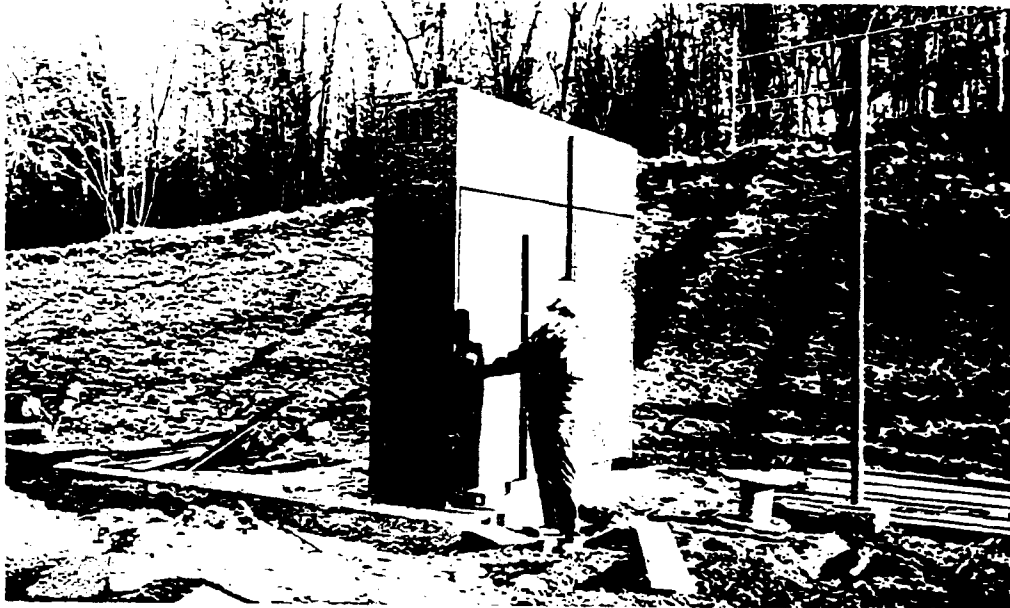
8040P39

Figure 205. Installation of the Natural Gas Compressor



8040P40

Figure 206. Natural Gas Compressor after Installation



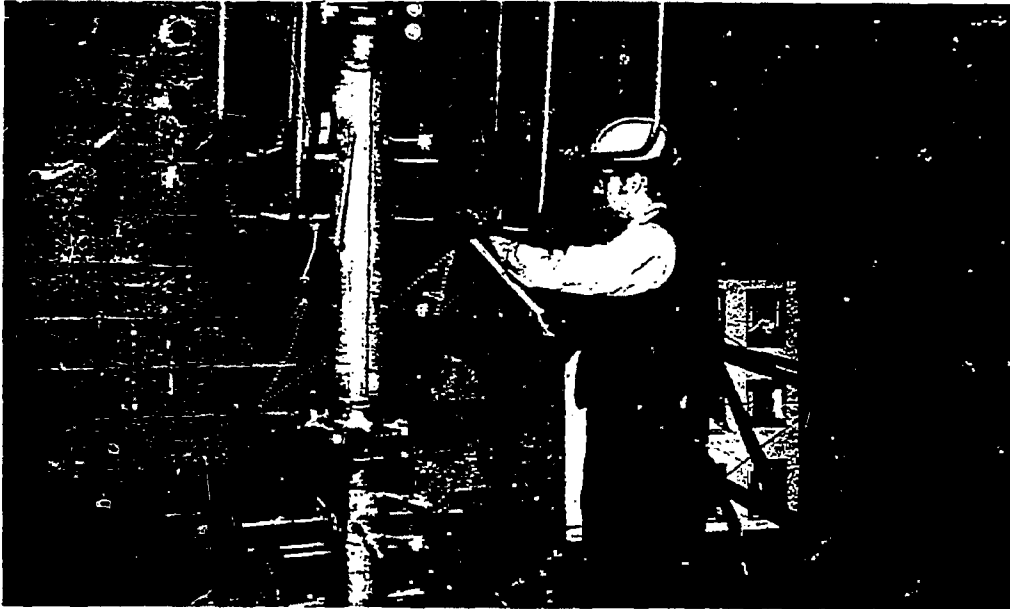
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Figure 207. Electrical Switchgear



8040P42

Figure 208. New Lighting Panels and Conduit



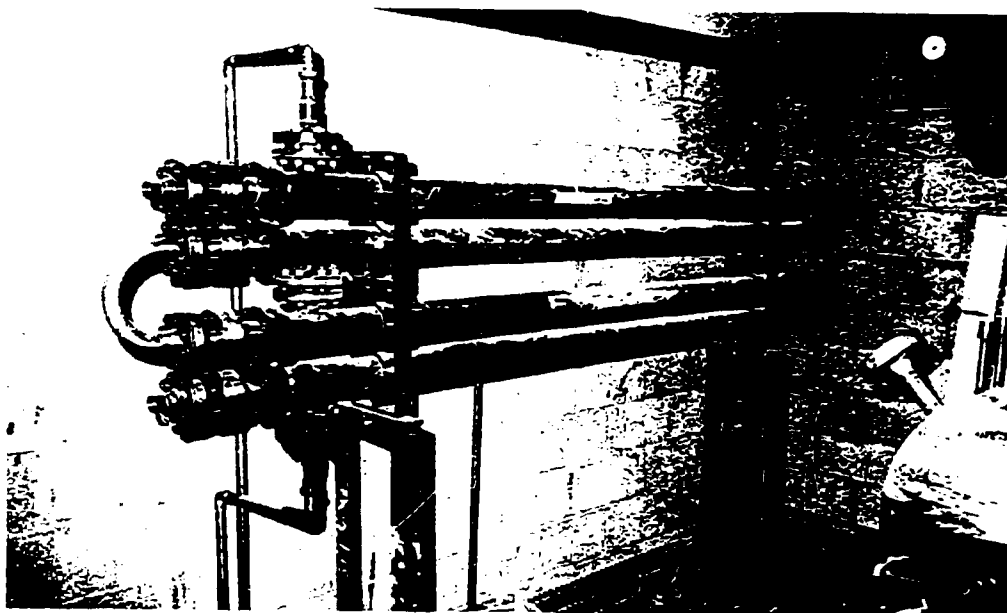
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Figure 209. Installation of Therminol Piping



8040P44

**Figure 210. The Methanator Disengaging Zone
after Placement in the High Pressure Stall**



8040P45

Figure 211. The Effluent Cooler Condenser



8040P46

Figure 212. The Steam Boiler after Completion of Piping and Electrical Work

- (4) Pulled main feeder cables as follows:
 - (a) From low-voltage switch gear to power panel "M."
 - (b) From power panel "M" to the electric boiler.
- (5) Initiated installation of the yard lighting equipment.
- (6) Continued work on conduit run along the yard pipe rack to the transformer.

An updated work schedule for Lord Electric based on current progress is given in Figure 213.

(d) Other: The electric company has scheduled installation of transformer and poles for early January.

(e) Work Scheduled: During January, construction work planned includes:

- (1) Piping of gas mixing stand.
- (2) Piping of valve house.
- (3) Piping of high pressure stall.
- (4) Installation of 750 KVA transformer.
- (5) Continued work on yard lighting.
- (6) Continued electrical work on high pressure stall.

c. Model Studies: No model work was conducted in December.

d. Future Work: Work for January includes:

- (1) Bench-scale testing of catalysts.
- (2) Continued PEDU construction.

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

3. Gas Chromatographic Procedures (J. E. Noll): Data were obtained for the automated gas analysis system to be used for the methanation PEDU, including retention times and scheme of operation. Only two analyses per hour can be made under the experimental conditions used, but with a change in the analytical system, more analyses will be possible. The data reported can be the basis for writing a computer program to control the automated system because projected changes will not change the scheme of operation, only the times.

The automated gas analysis system as described in an earlier report (OCR Progress Report No. 12, August 1972, p. 655) was operated using neon as a carrier gas and a gas sample approximating the product gas from the methanation PEDU.

The conditions selected for operation of the automated gas analysis system were based on previous work using a similar gas chromatograph (Progress Report

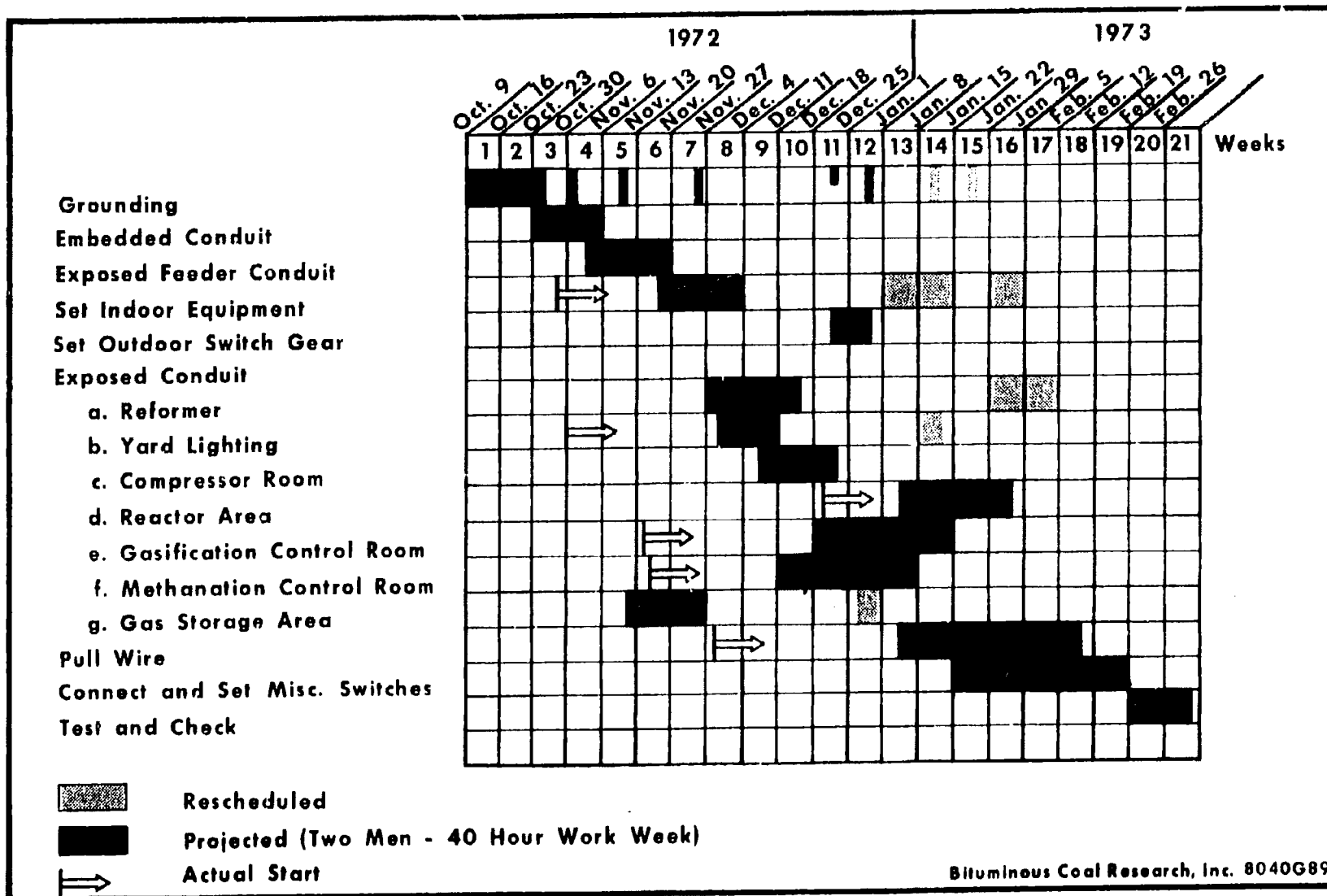


Figure 213. Electrical Sub-contractor's Work Schedule

No. 11, July 1972, p. 619). The conditions were selected for adequate separation of the various gases and for maximum response (i.e., sensitivity), although response factors were not determined in this experiment. A comparison of the results is shown in Table 148. Except for the retention time of ethane, there is good agreement.

The longer retention time for ethane, i.e., 200 seconds, increases the analysis time approximately 10 minutes. Therefore, only two analyses can be made per hour as opposed to the three to four desired. The large increase in analytical time is caused by an extended tailing, typical of longer retention times, and back flush time.

To shorten the analytical time, three methods can be used: (1) an increase in the flow of the carrier gas, (2) an increase in the oven temperature, or (3) a decrease in the length of the Porapak Q column. An increase in the flow rate of the carrier gas will decrease the response and hence decrease the sensitivity of the system for the detection of methane. An increase in oven temperature will decrease retention times but increase tailing of the gas peaks, leading to poorer separation. A decrease in column length will have little effect on the peak shape (i.e., response) but will drastically lower the retention time. This appears to be the most promising method.

The Porapak Q analytical column shows a more than adequate separation between methane and carbon dioxide, the controlling point of the analysis. Calculations based on the theoretical plates, or column efficiency, indicate that marginal separation, about 95 percent, could be attained on a column which is half the length of the one now being used. A column between 4 ft and 8 ft should give the desired separation with the lower retention times, and hence reduce the analysis time.

The chromatogram for the automated system is shown in Figure 214 with retention time, valve change time, and start and stop integration time indicated. This is essentially the chromatogram given in Progress Report No. 12 (p. 657) with times assigned to the peaks. Table 149 lists the times for the important points necessary for computer control of the system.

Future Work: Shorter Porapak Q columns will be investigated as a means to shorten the analysis time.

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

Special Report No. 3, "Cold Flow Model Experiments, Five Ton/Hour Two-Stage Gasifier," was submitted to OCR and AGA on December 19, 1972. 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: In planning for automated data acquisition from the FEDU methanator unit, it was decided that the PDP 8/E computer and peripherals should be moved as close to the methanator control

TABLE 148. COMPARISON OF RETENTION TIMES BETWEEN CHROMATOGRAPHS

Gas Chromatograph Model	GOW MAC 69-500	GOW MAC 69-550	
		No. 1	No. 2
Oven Temperature, C	75	73.0	78.0
Carrier Gas Flow (Neon), ml/min	25	24.5	24.5
Cell Current, ma	150	150.0	150.0
Cell Temperature, C	95	94.0	94.0

Gas	Column‡	Retention Time, Sec.	
Hydrogen	MS5A	114	111.0*
Oxygen		171	169.0*
Nitrogen		250	248.0*
Methane		368	385.0*
Carbon Monoxide		589	651.0*
Hydrogen	PPQ	145	
Composite		172	202.0
Methane		219	264.0
Carbon Dioxide		365	397.0
Ethane		632	832.0

* These retention times are corrected for passage through the first chromatograph.

‡ PPQ = Porapak Q
MS5A = Molecular Sieve 5A

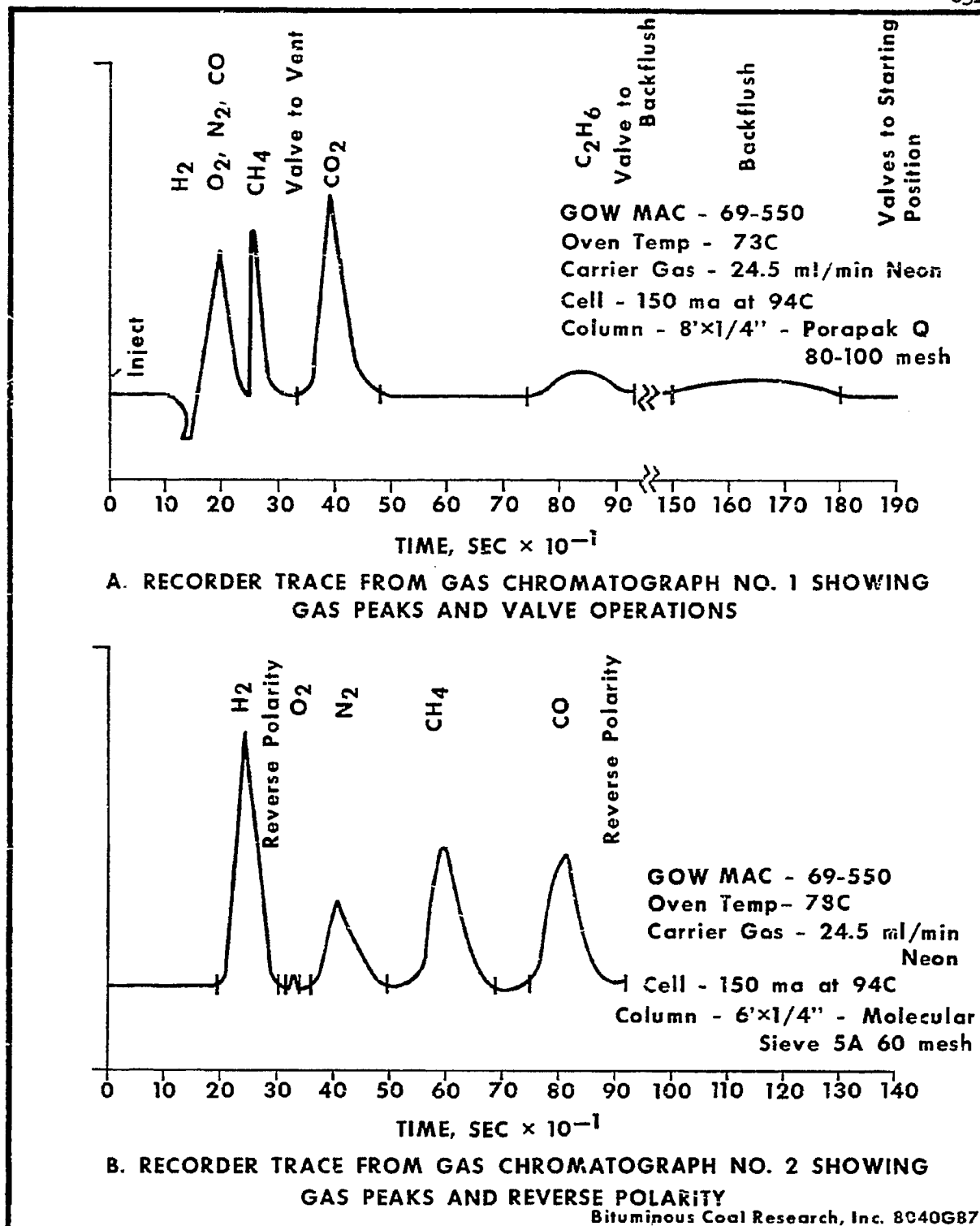


Figure 214. Chromatograms from Gas Analysis Showing Time Scale

TABLE 149. TIME FACTORS FOR AUTOMATED GAS ANALYSIS SYSTEM

Chromatograph No. 1 (Porapak Q)		Chromatograph No. 2 (MS5A)	
Time	Condition	Time	Condition
0	Sample Inject	0	
336	Valve 2 PPQ → Vent	215	S.I. H ₂
360	S.I. CO ₂	256	Peak H ₂
397	Peak CO ₂	307	E.I. H ₂
480	E.I. CO ₂		Polarity POS
765	S.I. C ₂ H ₆		S.I. O ₂ (if present)
832	Peak C ₂ H ₆	340	Peak O ₂
945	E.I. C ₂ H ₆	370	E.I. C ₂
947	Valve 1 to Backflush	375	S.I. N ₂
1515	S.I. Backflush	420	Peak N ₂
1625	Peak Backflush	495	E.I. N ₂
1817	E.I. Backflush	560	S.I. CH ₄
1900	Valve 1 to Normal	604	Peak CH ₄
	Valve 2 PPQ → MS5A	700	E.I. CH ₄
		765	S.I. CO
		823	Peak CO
S.I. Start Integration (Start of Peak)		945	E.I. CO
E.I. End Integration (End of Peak)			Polarity NEG

panel as possible. This would eliminate the installation of 700 feet of signal cable necessary to connect the methanator instrumentation to the computer at its present location. The computer will therefore be installed at the PEDU methanator site during March, 1973.

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

3. Future Work: Plans for the next report period include:

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

b. Modify subroutine GASIFY to accommodate simulation runs in the equilibrium mode as well as the kinetic and set yield modes.

c. Begin writing data acquisition programs for the PEDU methanator unit.

D. Multipurpose Research Pilot Plant Facility (MRF)

1. Pilot Plant: Site work progress continues--the locations of initial test holes have been spotted at the pilot plant site, soils testing has been started, and the topography has been completed. Copies of the plot plan for the Homer City pilot plant were submitted to OCR and AGA on December 5, 1972, for approval in concept; this approval was received by OCR letter dated December 29, 1972.

Following discussions with personnel from Stearns-Roger, Blaw-Knox, and C. F. Braun, several modifications to the pilot plant not covered by original plans and specifications have been proposed. These changes concern enclosure of the gasifier structure and coal preparation facilities, provision of concrete or floor plate for the gasifier structure, and paving of additional plant roads and parking areas, at an estimated order-of-magnitude cost of \$325,000.00. Approval to proceed with these modifications as recommended was requested in BCR letter of December 6, 1972, to OCR and AGA; approval was granted in OCR letter of December 29, 1972.

As approved by OCR, the Homer City Municipal plant will be used to supply water to the pilot plant.

The project review meeting scheduled for December was postponed. January 12, 1973, has been tentatively set for the next review meeting in Denver.

a. Stearns-Roger, Inc: Current engineering effort by Stearns-Roger, Inc., is reported in their Project Status Report No. 5, Appendix B of this report.

b. Blaw-Knox Chemical Plants, Inc: Blaw-Knox continues to provide assistance to BCR. A screen analysis of a Blast furnace slag was obtained, the location of truck weigh scales in the Homer City area was determined, potential vendors for the high pressure rotary feeders were investigated, and a possible layout for the maintenance and service building was suggested.

To improve the schedule for the process work, which would permit other engineering activities to be started sooner, Blaw-Knox suggested that the Mechanical Flow Diagrams be approved without the piping line index being marked on the drawings. The Piping Specification will be approved, by all concerned, as a separate document and it then becomes a mechanical function to transfer the approved specification to the drawings. If it is necessary to wait until the line index is included on the drawings, before issuing the Flow Diagrams for approval, it will require a minimum of 10 to 12 weeks to reach this point. BCR, Stearns-Roger, and Blaw-Knox all agreed that the Flow Diagrams could be approved without the line index but C. F. Braun and Company has advised that they will not approve the Flow Diagrams until all information, including the piping line index, is shown on the drawings.

2. Materials Evaluation Program: A subcommittee group of the Task Group on Materials Design Data for Coal Gasification Equipment met at IGT in Chicago on December 20, 1972, to recommend three programs for evaluation of refractory materials, as follows:

- (1) Refractory materials to be evaluated in the current OCR/AGA pilot plants at Rapid City, South Dakota and IGT, Chicago, Illinois.
- (2) A life-test bench-scale unit.
- (3) Long-range research program at the university level to study the volatility of elements in the refractory materials.

On December 21, 1972, the Task Group met at IGT to review two proposals covering (a) pilot plant corrosion test studies, and (b) a laboratory aqueous corrosion test program simulating various quench system conditions. The two proposals reviewed were prepared by C. F. Braun & Company. These two proposals will be prepared as a bid package and sent out for bids by the Metal Properties Council.

No future meeting date was set by the Task Group.

3. Pressure Optimization Study: BCR continues to provide information as requested in relation to the pressure optimization study of the BI-GAS process being conducted by C. F. Braun for OCR/AGA. Additional information was forwarded to Braun on December 1, 1972.

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 reported in their Progress Report No. 41, Appendix E of this report.

G. Other

1. 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, West Germany, Japan, and France. Confirmatory license to the government was executed by BCR on January 12, 1972.

The First Office Action was issued by the U.S. Patent Office on October 6, 1972. All nine claims were rejected by the Examiner.

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.

This patent application has been examined by the U.S. Patent Office Examiner and the First Office Action was issued November 9, 1972. All 13 claims have been rejected by the Examiner. References cited by the Examiner will be reviewed to determine whether foreign applications should be filed.

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 CCR that this Invention Disclosure had 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. A draft of the application has been prepared and is currently being reviewed by the inventors. After their review, an application will be prepared in final form for filing in the U.S. Patent Office.

2. Reports and Papers: Copies of the paper "New Markets--Coal Gasification," were forwarded to OCR on December 19, 1972. This paper was presented by J. W. Tiemar at the Annual Meeting of the Coal Mining Institute of America, December 7, 1972, Pittsburgh, Pa.

H. Visitors During December, 1972

December 4, 1972

Mr. J. M. Marsten
Regional Manager
Combustion Engineering, Inc.
Raymond Division
135 Cedar Boulevard
Pittsburgh, Pa. 15228

December 7 and 8, 1972

Mr. C. M. Stone, Project Executive
Mr. T. G. Strickland, Vice President
Stearns-Roger, Inc.
P. O. Box 5888
Denver, Colorado 80217

December 14, 1972

Mr. J. M. Marsten
Regional Manager
Combustion Engineering, Inc.
Raymond Division
135 Cedar Boulevard
Pittsburgh, Pa. 15228

December 20, 1972

Mr. C. F. McDonough
Mr. R. M. Yarrington
American Cyanamid Company
Bound Brook, New Jersey 08805

I. Trips and Meetings During December, 1972

December 13, 1972	Office of Coal Research Washington, D. C.	J. W. Igoe J. R. Garvey R. K. Young
December 20-21, 1972	Meeting of Task Group on Materials Design Data Chicago, Illinois	J. P. Tassoney

III. WORK PLANNED FOR JANUARY, 1973

The work planned for January 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 supplied by Chemetron will continue. Work on the methanation FEDU will continue with emphasis on completion of the major electrical installations.

The data acquisition program for the bench-scale methanator will be continued. Work will continue to determine the materials necessary for interfacing the computer with the methanation FEDU.

A. Trips and Meetings Planned

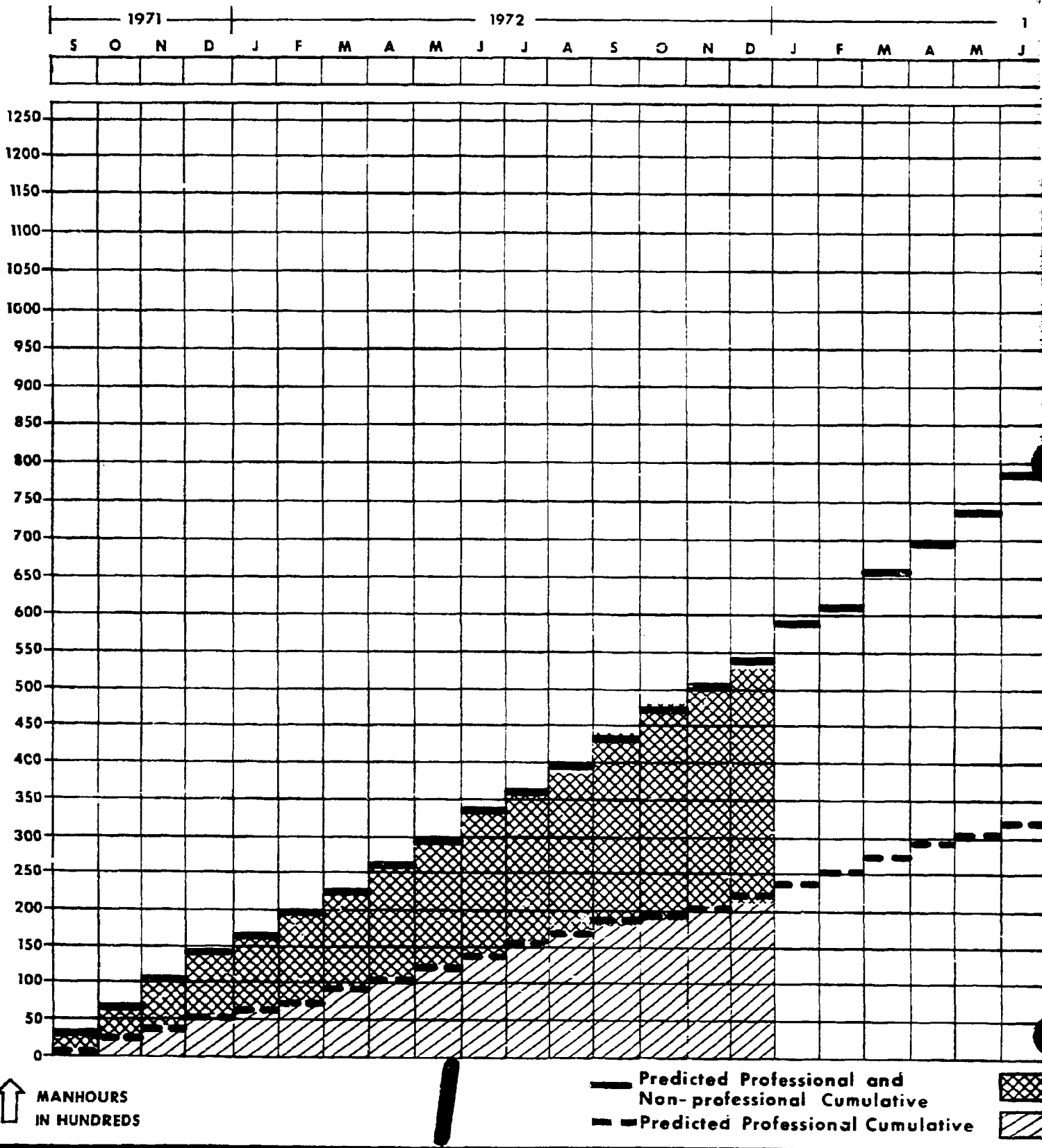
January 5-6, 1973	Meeting with OCR Staff Leadership Systems, Inc. Silver Spring, Maryland	R. K. Young
January 11-12, 1973	Stearns-Roger, Inc. Denver, Colorado	J. P. Tassoney R. K. Young

B. Papers to be Presented

April, 1973	National ACS Meeting Division of Fuel Chemistry Dallas, Texas	"Chemistry and Physics of Entrained High Pressure Coal Gasification" R. L. Zahradnik R. J. Grace
July, 1973	Presentation to be made at 1973 Gordon Conference on Coal Science	"Chemistry and Physics of Entrained Coal Gasification" R. L. Zahradnik R. J. Grace

OCR/AGA PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT

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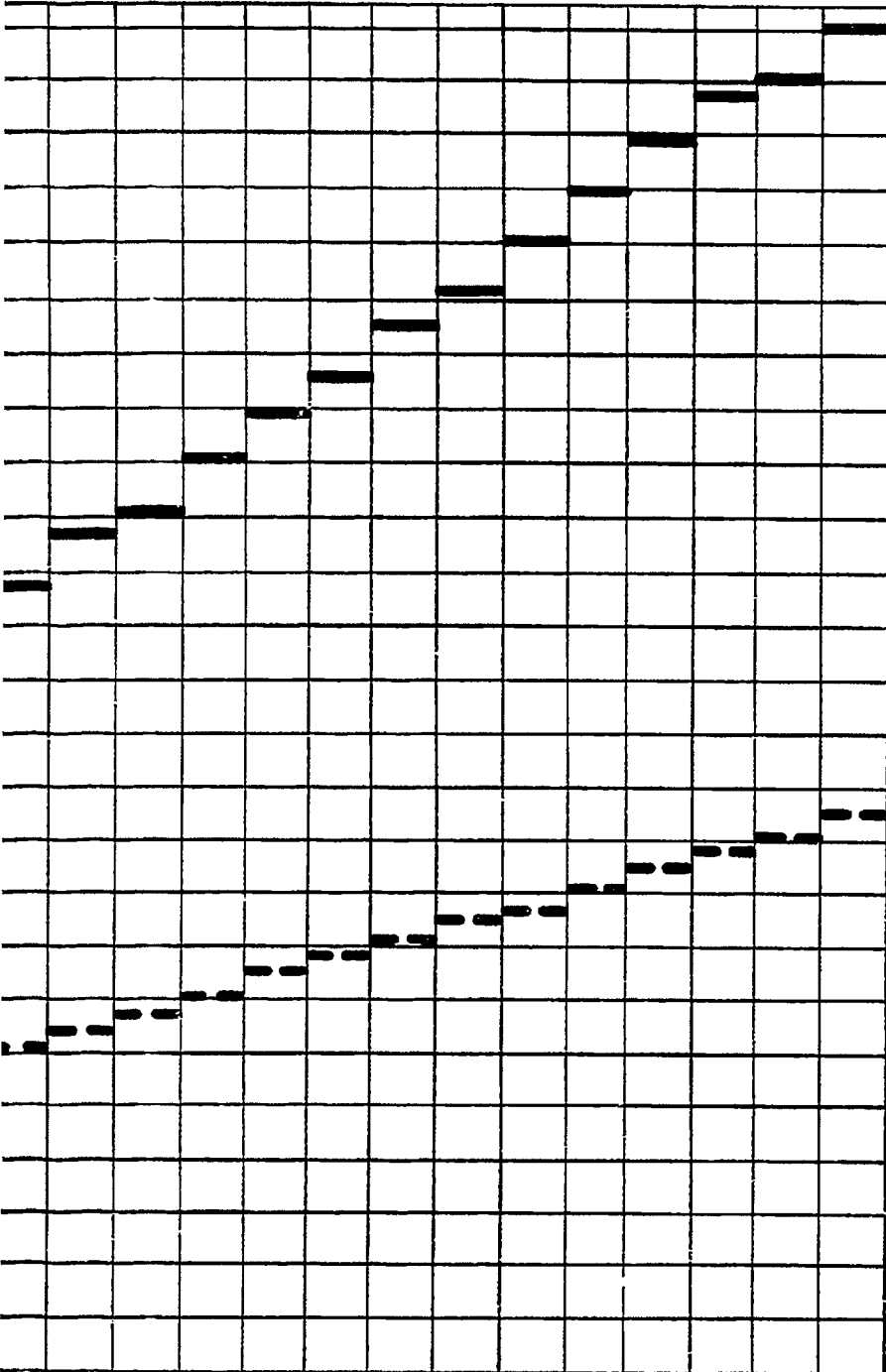


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MANHOURS
IN HUNDREDS

— Predicted Professional and Non-professional Cumulative
 — Predicted Professional Cumulative

CUMULATIVE MANHOURS

1973												1974						JULY 1974...AUG 1976	
W	J	J	A	S	O	N	D	J	F	M	A	M	J						



NOT YET ESTIMATED

2

-  Actual Non-professional Cumulative
-  Actual Professional Cumulative

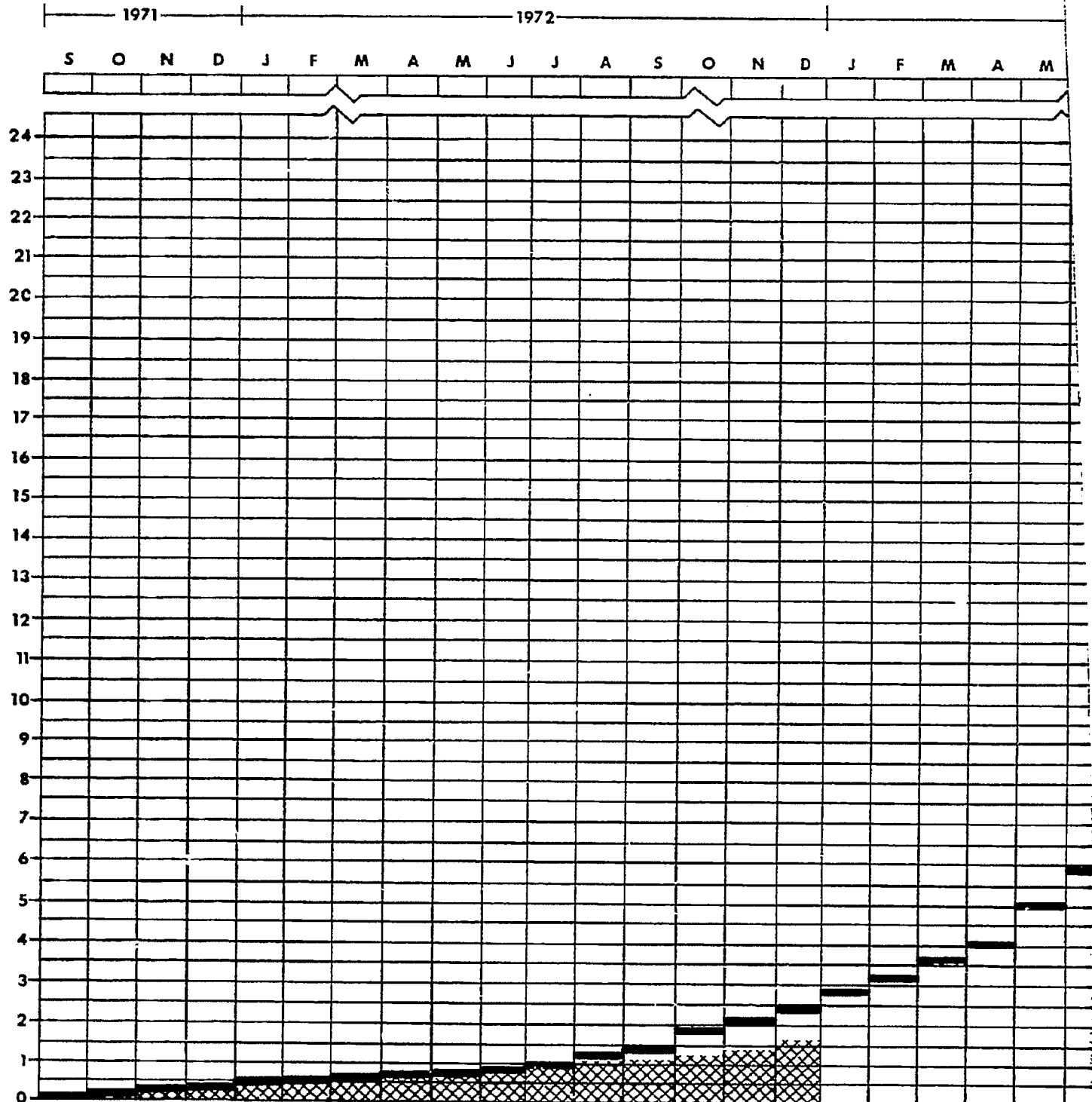
OCR/AGA PIPELINE GAS GENERATOR RESEARCH AND DEVELOPMENT
Schedule of Predicted and Actual Manhours

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	1,241.5	2,136.0	1,866.0	21,183.5	20,575.0	29,185.5	30,115.5
Dec. '72	1,440.0	960.0*	2,048.0	1,476.0*	22,623.5	21,535.0*	31,233.5	31,591.5*
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

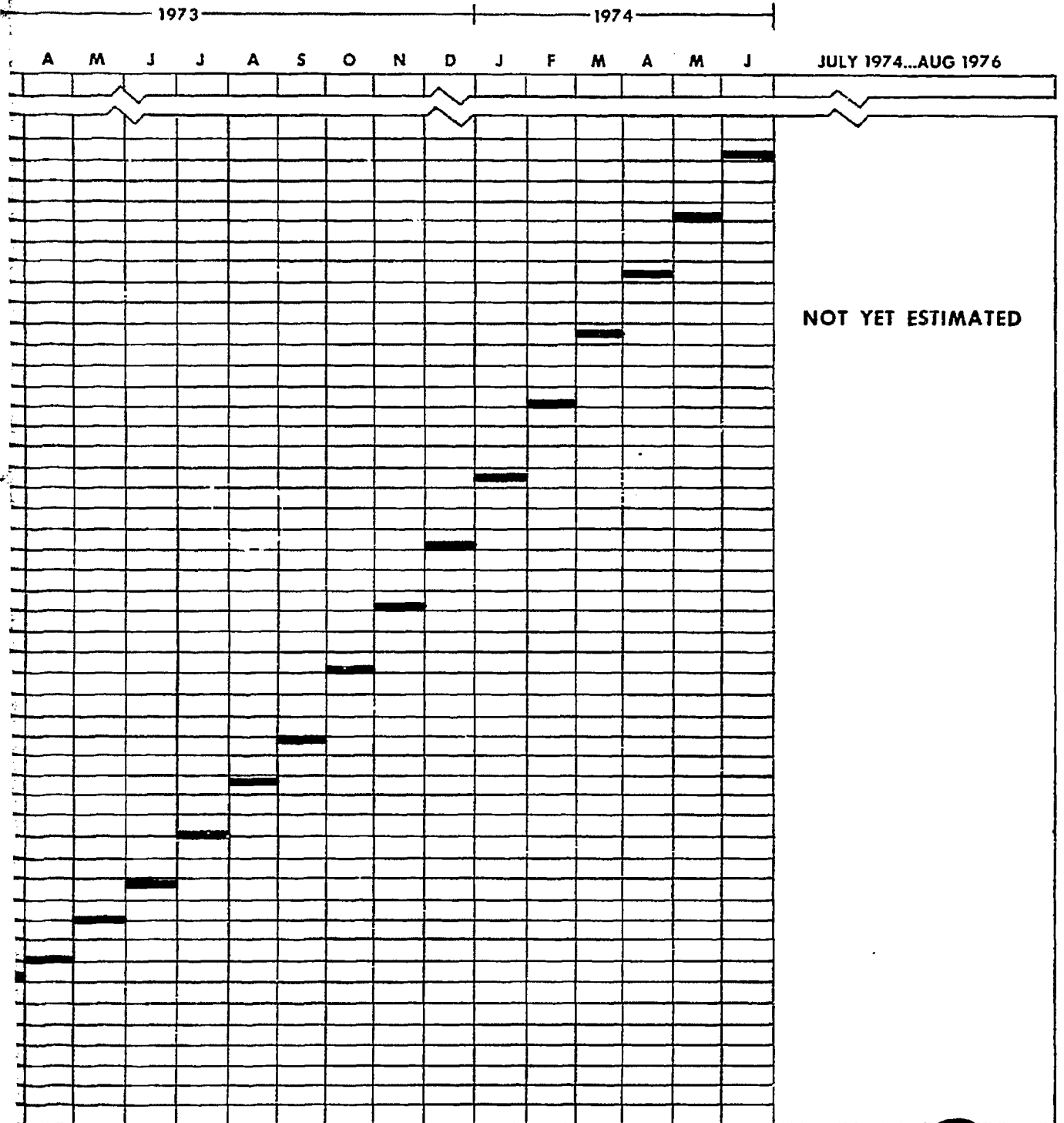


↑ DOLLARS IN MILLIONS

— Predicted Expenditures, C
 [Cross-hatched box] Actual Expenditures, Cumu

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DEVELOPMENT CUMULATIVE EXPENDITURES



Expenditures, Cumulative
Expenditures, Cumulative

2

CCR/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	168,013	2,139,211	1,422,438
Dec.	331,672	216,108*	2,470,883	1,638,546*
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				

NOT YET ESTIMATED

* Estimated

APPENDIX B

HOMER CITY, PENNSYLVANIA
COAL GASIFICATION PILOT PLANT

JOB NO. C-11630

STEARNS-ROGER PROJECT STATUS REPORT

NO. 5

JANUARY 8, 1973

GENERAL

This report covers job progress from December 7, 1972 to January 5, 1973.

A meeting was held in Washington, D.C. on December 13, 1972 between OCR, BCR and Stearns-Roger. The principal subject of discussion was a review of the gasifier situation to date and its effect on the overall project schedule. As a result of this meeting, Stearns-Roger was directed to solicit proposals from other vendors for an alternate design gasifier which could perhaps be furnished in a shorter time than the B&W design considered to this point in time.

Alternate gasifier proposals are due January 19, 1973. Pending receipt of gasifier proposals, schedule information in this report continues to be based upon the previously used B&W gasifier schedule.

PHYSICAL DESIGN

The plot plan was approved in concept on December 11, 1972. This was used as the basis for Phase I soil testing boring locations.

BCR approval and comments on the office and laboratory building layouts were received December 26, 1972.

As noted in the two previous reports, recommendations have been made to BCR concerning enclosing the gasifier structure, enclosing coal preparation facilities, operating floor design and plant roads and parking areas. No decisions have been furnished to Stearns-Roger on these items.

Recommendations submitted by Stearns-Roger on December 5, 1972, concerning the use of a plant model are still pending.

A preliminary layout of the plant shop and warehouse has been transmitted to BCR for approval.

Preliminary plant layout and addition of information to flow sheets is in progress.

GENERAL SPECIFICATIONS

Nineteen (19) general and project specifications have been routed for approval and issued for construction purposes. Work in this area is nearing completion. Piping specifications are being developed. Selection of specialized valves to be used is the major problem preventing completion of piping specifications.

FIELD PROGRESS

Phase I soil test drilling activities were completed during the last week of December.

The Phase I mining study and preliminary soil test report is scheduled to be received early in January.

No further field work is in progress at this time.

PROCESS ENGINEERING

1. Coal Handling

Meetings are scheduled the week of January 8 with the two most likely vendors for the coal crushing and drying equipment. It is planned to purchase all major system components from a single vendor who will be responsible for compatibility of the various components.

It is expected that proposals will be received by February 1 and a selection made. This will allow completion of process work in this area and design engineering to proceed with respect to final layout of the equipment and determination of conveyor requirements.

Quotations are due the week of January 8, for the slag and lime-stone pulverizer.

2. Coal Feed

Process design in this area is still firm. Equipment quotations have been solicited. As stated in the last report, difficulty is being experienced obtaining suitable equipment offerings.

All 14 major items are out for quote. Adequate quotations are on hand for 7 items. Since the last report, additional vendors have been asked to quote coal feeders. All declined. It appears coal feeders will have to be single sourced to the one vendor willing to quote.

3. Gasification

Heat loss data for the B&W design gasifier was received from B&W December 8, 1972. Fuel gas, oxygen and steam systems around the gasifier have been designed using this information. Any future changes caused by a change in gasifier design will cause rework of the process design accomplished to date.

The cooling water flow system has not been designed pending receipt of

3. Gasification - continued

B-844.

requirements from either B&W or other possible gasifier vendors. This effort will have to follow selection of a gasifier vendor.

Section 300 pressure vessels are out for quotation. Other auxiliary equipment items are being held until requirements defined by the gasifier become firm.

GASIFIER

A meeting was held in Washington, D.C. on December 13, 1972 to review the gasifier situation. This meeting was attended by OCR, BCR and Stearns-Roger.

As a result of this meeting, Stearns-Roger was directed to take immediate steps to obtain proposals for gasifier designs other than the B&W concept pursued to this point in time. Stearns-Roger immediately started contacting potential vendors and held various meetings with individual vendors starting December 15, 1972 to acquaint vendors with the problem and design requirements.

On December 20, 1972, OCR/AGA requested all potential vendors be asked to meet in Denver for a proposal briefing meeting, at which time a proposal due date would be established.

This meeting was held in Denver on December 28, 1972. The meeting was attended by OCR, AGA, Stearns-Roger and representatives of the following vendors: B&W, Combustion Engineering, Foster-Wheeler, Struther-Wells, Wyatt and F. W. Glitsch & Sons, Inc. At the conclusion of this meeting, January 19, 1973 was established as the due date for proposals. All vendors present promised to submit proposals.

Prior to the above meetings, an engineering subcontract with B&W for gasifier initial design had been submitted for OCR/AGA approval. This subcontract has not been approved, pending receiving other gasifier proposals.

4. Gas Wash

The previously mentioned B&W heat loss data has been used to complete gas washer process design. Equipment data sheets for inquiry of equipment are being prepared on this basis. Basic design in this area is expected to remain firm regardless of gasifier selection as normal operation sets design conditions.

A design approach has been determined for the gasifier effluent line using equalized pressure between the process and jacket water sides of this line. This appears to solve one of the major problems mentioned in the last report.

5. Char and Lime Systems .

Process design remains firm in this area. With resolution of overhead line design problems, design of cooling water systems is in progress.

5. Char and Lime Systems - continued

All major equipment, except for cooling water system components, is out for quotation. As with coal feeders, it appears rotary feeders for this area are limited to the one vendor willing to quote.

6. CO Shift

Process design is still firm. All major equipment is out for quotation, except for two exchangers. Quotations are due the third week of January.

7. Acid Gas Removal

The SELEXOL Process has been selected for removal of acid gases. Flow sheets are to the stage of development that "approved in principle" can be requested. Allied Chemical Co. visited Stearns-Roger the week of December 13, 1972 to furnish required process data. Approximately 50% of the process equipment is out for quotations. Required secrecy agreements need to be executed with Allied before distribution of proprietary data.

8. Methanation

Process design is firm. Flow sheets need to be "approved in principle". Approximately 60% of the process equipment is out for quotation. Inquiry specifications are in progress on the remainder.

9. Utilities

It was pointed out in the last report that information regarding availability of commercial fuel gas was required. This information has not been received. Design has been based upon the assumption that fuel gas will be made available.

Process design of the purge gas system is 90% complete.

Design of the steam system flow diagrams is in progress.

Oxygen, nitrogen and CO₂ distribution flow diagrams have been developed.

Process design of the sour water stripper is essentially complete. Design of safe and adequate over-pressure relief of this system is a problem area.

Waste water treatment and effluent disposal facility requirements have been determined. Stearns-Roger personnel plan to meet with Pennsylvania authorities approximately February 1, 1973 to obtain concurrence with the basic design before proceeding further.

APPENDIX CADDITIONS TO ABSTRACT FILE, DECEMBER, 1972

Lunde, F. J. and Kester, F. L., "Kinetics of carbon dioxide methanation on a ruthenium catalyst," ACS Div. Fuel Chem. Preprints 17 (1), 11-27 (1972). ACS

This paper examines the kinetics of the reaction using a Ruthenium catalyst, and derives from experimental data a correlation describing the kinetics of this catalysis in the 400° F to 700° F temperature range. (From authors' introduction)

Ruth, L. A., Squires, A. M., and Graff, R. A., "Desulfurization of fuels with half-calcined dolomite: first kinetic data," Environ. Sci. Technol. 6 (12), 1609-14 (1972). Journal

This paper was presented at the ACS National Meeting, March 1971. It was abstracted in BCR Rept. I-410, Prog. Rept. 88 to OCR--Contract 14-01-0001-324, p. 3610.

"Synthane coal gasification pilot plant to demonstrate feasibility of converting coal to substitute natural gas," U.S. Bur. Mines, FES 72-28 (Aug. 22, 1972).

75 pp. U.S. Dept. Comm. NTIS, EIS-AA-72-5175-F. Bur. Mines

The environmental impact of site preparation, plant construction, and plant operation are discussed in this Final Statement. A number of comments on the Draft Environmental Statement and the Bureau's reply to these are included.

Wood, R. E. and Hill, G. R., "Coal hydrogenation in small tube reactors,"

ACS Div. Fuel Chem. Preprints 17 (1), 28-36 (1972). ACS

Results of hydrogenation of a number of different coals in a reactor of 1/8 in. ID are presented. The characteristics of these coals in regard to feeding, reactivity, and plugging of the reactor are evaluated. The tests were carried out at 1750 and 2000 psi and at 650 and 675 C.

Zareski, G. K., "The gas supplies of the United States--present and future,"

ACS Div. Fuel Chem. Preprints 17 (1), 49-66 (1972). ACS

This review of the gas industry projects the future domestic gas supply and discusses various means of supplementing it, including coal gasification.

APPENDIX D.

D-347.

PROGRESS REPORT #41

Bituminous Coal Research, Inc.
Coal Gasification

December, 1972

Koppers Contract 2415

I. STATUS OF CONTRACT

A. Pilot Plant Engineering Bid Package

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 material, and specifications were transmitted by Koppers Company, Inc. to BCR:

<u>Letter</u>	<u>Dwg. No.</u>	<u>Rev. No.</u>	<u>Title</u>	<u>Date Trans.</u>
2415-C474	2415-9A701	4	Graphic Panel Layout	05DEC72
"	2415-9A702	3	Recorder and Analyzer Panels	"
"	2415-9A703	3	N.G. Comp., Reformer Unit and Add. Flows Interconnection Schematics	"
"	2415-9A704	3	Meth. Flow, Feed Gas and Reactor Safety Ckt., Interconn. Schematic	"
"	2415-9A705	3	Filter Blowback, Demister Level Product Gas Press. Graphic Panel	"
"	2415-9A706	3	Elect. Power Distribution	"
"	2415-9A707	2	Graphic Pnl. Annunciator and Air Supply Interconnection Schematic	"
"	2415-9A707	2	Gas Press. and Flow, Meth. Pressures, Product Gas Flow, Therminol Flows and Temp.	"
"	2415-9A708	3	Meth. and Heat Windings Temps.	"
"	2415-9A709	3	Infrared Analyzers Recorders Heat Windings Ckt. and Record	"
"	2415-9A710	3	Panel Elect. Air Supply and H ₂ S Controls	"
"	2415-9A710	3	Electric Terminal and Pneumatic Bulkhead Arrangements	"
"	2415-9A711	-	Analyzer Panel Interconnection Schematic	"

<u>Letter</u>	<u>Dwg. No.</u>	<u>Rev. No.</u>	<u>Title</u>	<u>Date Trans.</u>
2415-C476	2415-9F327	1	Controllers - Local, Shts. 1-6	11DEC72
"	2415-9F328	1	Control Valves, Shts. 1-24	"
"	2415-9F329	3	Relief Valves, Shts. 1-7	"
"	2415-9F334	2	Pressure Control Valves (Self-Acting) Shts. 1-10	"

Fluid Bed Gasification PEDU

BCR's letter of 26JUN72 relieved Koppers of the responsibility for fluidized-bed gasification engineering under Amendment No. 6 and No. 7 Subcontract No. 2, OCR Contract No. 14-32-001-1207.

C. General Engineering Assistance & Consultation

Koppers transmitted a memorandum by J. De Nelle, dated 30NOV72, which presents a review of the Panel Board Vendors drawing requested 27NOV72 by BCR (Koppers letter 2415-C475 dated 05DEC72).

Koppers transmitted the following correspondence and Technical Brochures pertaining to high temperature valves for the methanator reactor:

1. Letter from Mr. Robert Galo (Nupro Company) to Mr. Ralph Benz (President of Pittsburgh Valve and Fitting Company) dated 15JUN72.
2. Letter from Mr. Ralph Benz to Mr. I. D'Amico (Koppers Company) dated 21JUN72.
3. Nupro Technical Bulletin No. 28.

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 & Assistant General Manager of Engineering and Construction Division, Koppers Company, Inc., were transmitted to BCR in our letter 2415-C183 dated 18OCT71. Receipt of these copies was acknowledged by BCR in their letter dated 18OCT71.

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