Industrial Fuel Gas Demonstration Plant Program

DOE/ET/13046--T9

PLAN FOR USE AND DISPOSITION
OF INDUSTRIAL FUEL GAS

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**MEMPHIS LIGHT, GAS AND WATER DIVISION
P.O. BOX 430, MEMPHIS, TENNESSEE 38145**

**In Association with
FOSTER WHEELER ENERGY CORPORATION
INSTITUTE OF GAS TECHNOLOGY
DELTA REFINING COMPANY**

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MEMPHIS INDUSTRIAL FUEL GAS

DEMONSTRATION PLANT PROJECT

PLANS FOR USE AND DISPOSITION OF PRODUCTS
(Deliverable #29)

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MEMPHIS LIGHT, GAS & WATER DIVISION
P.O. Box 430
MEMPHIS, TENNESSEE 38101

PREPARED FOR THE
U. S. DEPARTMENT OF ENERGY
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INTRODUCTION

The Memphis Light, Gas and Water Division (MLGW) has the responsibility of supplying electricity, gas, and water to Shelby County, Tennessee. During the 1970's, industry in the Memphis area has experienced considerable growth and, consequently, an increased need for energy. This increasing need for energy, particularly in the form of natural gas, coupled with a decreasing supply has had a major adverse effect on economic growth in the Memphis area. These factors have driven the industrial customer to search for an alternate energy source. The source of energy most frequently turned to is fuel oil, much of which is imported. The scarcity of natural gas and the rising prices and uncertainty of supply of imported oil has left the industrial customer facing a seemingly unsolvable dilemma. We believe that coal gasification is the answer to the energy problem in Memphis and can be a model for the future development of this energy source throughout the country.

The objective of the coal gasification demonstration plant is to provide a supplemental fuel at a competitive price with assurance of supply and reliability. A marketing plan has been formulated that addresses the business, technical, socio-economic, and environmental problems associated with coal gasification and distributional sales of the product gas. The marketing program has identified customers for the industrial fuel gas (IFG) and has obtained letters of intent to purchase the total plant output at a competitive price.

With the solution of the above problems along with proof of a working system, MLGW can significantly improve the city's future and act as a model for other cities to follow in developing similar energy sources for their needs. A coal gas demonstration plant in Memphis, developed jointly by the utility, the Government, and industry, will add a new dimension to the energy needs of the Memphis area.

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SUMMARY AND CONCLUSIONS

The IFG plant will convert 3160 tons per day of high-sulfur coal to produce 175 million cubic feet of medium-Btu gas daily, which is the equivalent of 50 billion Btu's per day of natural gas. The plant will provide an assurance of supply and reliability of IFG to potential customers by using a credit generating unit that methanates and injects a small portion of gas into the natural gas pipeline. The gas is credited to the IFG customers and is supplied to them during periods when the IFG plant is shut down.

We have identified 25 prospective customers, which include existing industrial customers and Tennessee Valley Authority's (TVA's) Allen Generating Station, who provide a large market potential for IFG. In addition, future customers in Pidgeon and Rivergate Industrial Parks also would provide outlet for the plant product. Most of our existing industrial customers use fuel oil as an alternate fuel supply during natural gas curtailment, but they would prefer IFG at a competitive price because of the cleaner burning characteristics and lower maintenance cost incurred with IFG. The Allen Generating Station, which is located near the proposed coal gasification demonstration plant, can use the total output of IFG, but their supply will be based on an "as available" basis to allow for future industrial growth in Pidgeon and Rivergate Industrial Parks. As new customers are considered during the development of the industrial parks, the generating station's supply would be reduced in proportion to the added loads.

Industrial fuel gas has a heating value of approximately 300 Btu's per standard cubic foot, which is one-third that of natural gas; therefore, it is transported to the industrial customers through a separate distribution pipeline. Combustion trials with IFG were conducted in equipment similar to the identified customers' boilers to provide information on its utilization. The study also considered the cost of converting existing equipment to use IFG and concluded that most of the customers' equipment does not require major changes.

In support of MLGW's marketing efforts, letters of intent from identified existing customers are included in this report. These letters confirm the customers' intent to support the coal gasification program by negotiating for the purchase of IFG, and they represent over 100% of the plant's total output.

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The following conclusions may be drawn from the market survey and the plan contained in this report:

- The IFG is viewed as a crucial step toward providing supplemental energy for MLGW's industrial customers.
- A large immediate market exists for the total output of IFG.
- Letters of intent to negotiate to purchase about 100% of the plant output have been obtained, thus meeting the contractual requirements.
- Combustion tests show the feasibility of using IFG in the customers' existing equipment.
- The IFG distribution system, including the credit system and underground gas storage, will provide a 365-day/yr assured and reliable fuel supply to the customers.

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MARKETING PROGRAM

The objective of the marketing program was to assess the IFG market within MLGW's service area, identify prospective customers for the IFG, and obtain from them an intent to negotiate to purchase of the IFG. The marketing of IFG produced in the demonstration plant is based on distributional sales of the gas to various customers via a separate and dedicated pipeline system. Because applications of IFG, both in the United States and in foreign countries, are limited to a single captive use, information for several engineering and institutional problems of a multiple-user plant was not readily available. Therefore, a comprehensive program consisting of a market study and support studies was conducted.

Market Survey

Two surveys have been conducted to determine the market and the customers for IFG. The first survey evaluated all existing natural gas customers of MLGW to determine the potential and then the prospective customers. The second survey was a more detailed evaluation and inventory of the prospective customers' burner equipment to determine the need for modifications to utilize IFG.

Initial Customer Survey

In this survey all MLGW industrial customers using natural gas were surveyed for the feasibility of IFG utilization based on past MLGW records and limited customer contact. The criteria for selection at this time was the customer's fuel demand; load pattern; application (such as space heating, steam production, or other); and distance from the proposed demonstration plant site. Based on these criteria, 44 customers were selected as potential users of IFG, as shown in Table 1.

A second iteration of these potential customers was then conducted using the additional criteria of feasibility of technically retrofitting their processes to achieve the required combustion performance, a minimum fuel usage, safety aspects of IFG utilization, and constant load demand. This screening narrowed the list to 24 customers as prospective customers of IFG, as shown in Table 2. In addition, the Allen Generating Station operated by TVA was also identified as a large prospective customer for use of IFG in their boilers. TVA was considered a customer of last resort as they would purchase a varying quantity of gas depending on the excess supply available. The total IFG demand

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Table 1. LIST OF POTENTIAL CUSTOMERS

<u>Number</u>		
1	National Distillers	2459 Channel
2	Trumbull Asphalt	2301 Channel
3	Cargill, Inc.	1877 Channel
4	Nat Buring Packing Company	1837 Harbor
5	Western Tar	1471 Channel
6	Koppers Company	1285 Channel
7	Humble-Exxon	454 West Wisconsin
8	Armour Packing Company	1337 Riverside
9	Container Corporation	265 West Trigg
10	National Linen	1312 Louisiana
11	Dixico	276 South Parkway West
12	Delta Refining Company	2255 Fisher
12	Delta Refining Company	2246 Fisher
13	Refined Metal (Mphs. Lead)	304 West Industrial
14	Conley Frog & Switch Company	362 East Bodley
15	Rexham Corporation (Reigel)	2000 Latham
16	Jos. E. Seagrams Distillers	155 Wisconsin
17	Kroger	1029 Florida
18	Methodist Hospital	1265 Union
19	Wesson Foods	1351 Williams
19	Wesson Foods	1351 Williams
20	White Rose Laundry	299 South Dunlap
21	U.T. Medical Center	8 South Dunlap
22	Sealtest Dairy	175 Walnut
23	Baptist Hospital	899 Madison
24	John Gaston Hospital	860 Madison
25	City of Memphis Hospital	951 Court
26	U.T. Hospital	842 Jefferson
27	Memphis Steam Laundry	941 Jefferson
28	LeBonheur Children's Hospital	848 Adams
29	Tennessee Psychiatric	865 Poplar
30	Veterans Hospital	1030 Jefferson
31	St. Joseph Hospital	254 Jackson
32	St. Jude Hospital	332 North Lauderdale
33	Conwood Corporation	46 Keel
34	Buckman Lab	1256 North McLean
35	Buckeye Cellulose	2782 Chelsea
36	J. Morrell & Company	1400 Warford
37	Dietz Forge	1337 Warford
38	Velsicol Chemical	1199 Warford
39	Owens Illinois Glass Company	3176 Jackson
40	Plough, Inc.	3022 Jackson
41	Buckeye Cellulose	2899 Jackson
42	Humko Chemical	1231 Pope
42	Humko Chemical	1231 Pope
43	Imperial Chemical (Atlas)	1285 Pope
44	Quaker Oats	3324 Chelsea

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Table 2. LIST OF PROSPECTIVE CUSTOMERS

Number

1	Cargill, Inc.	1877 Channel
2	Nat Burning Packing Company	1837 Harbon
3	Humble-Exxon	454 West Wisconsin
4	Delta Refining Company	2255 Fisher
5	Refined Metal	304 West Industrial
6	Conley Frog & Switch Company	362 East Bodley
7	Kroger	1029 Florida
8	Methodist Hospital	1265 Union
9	Wesson Foods	1351 Williams
10	Kraft-Dairy Group	175 Walnut
11	Baptist Hospital	899 Madison
12	John Gaston Hospital	860 Madison
13	City of Memphis Hospital	951 Court
14	U. T. Hospital	842 Jefferson
15	LeBonheur Childrens Hospital	848 Adams
16	Veterans' Hospital	1030 Jefferson
17	St. Joseph Hospital	254 Jackson
18	St. Jude Hospital	332 North Lauderdale
19	Buckman Lab	1256 North McLean
20	Buckeye Cellulose (Chelsea)	2782 Chelsea
21	Velsicol Chemical	1199 Warford
22	Buckeye Cellulose (Jackson)	2899 Jackson
23	Humko Chemical	1231 Pope
24	Quaker Oats	3324 Chelsea
25	Tennessee Valley Authority	Mitchell Road Ext.

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of these customers is close to the target of 50 billion Btu per day, and their location is within a radius of 10 miles from the plant site. Each company was then visited, and the processes in use were surveyed. This further survey provided the facts necessary for planning the required follow-up work. Each of the processes was categorized into one of three groups. The first group of processes was known to convert to a medium-Btu gas without the need for equipment changes or with only small in-plant changes. The second group of processes required an analysis of performance using available literature data. The third group required experimental work to develop recommendations for necessary changes to utilize IFG. Details of the survey are outlined in, "Plan for Obtaining Data Required for Retrofitting Burners to IFG," Deliverable No. 44.

Burner Conversion Survey

The purpose of this survey was to determine the feasibility of converting the existing natural gas burners of the proposed 24 customers to use IFG. To do this, additional detailed information was obtained for each burner installation, and letters were sent to the manufacturers giving the combustion properties of the IFG and requesting the manufacturers' recommendation regarding the feasibility of firing IFG and any modifications necessary.

Eighty-six burner installations were identified among the 21 customers surveyed. These 86 burner installations identified were represented by 19 manufacturers, which are listed in Table 3. Twelve of the manufacturers responded to the letter. Those companies responding corresponded to 79 of the 86 installations, or better than 90% response.

The results of this survey indicate that the great majority of burner and equipment manufacturers recommend that the IFG can be utilized with their equipment. This is especially true with the boilers that make up the largest part of the load among the prospective customers of IFG. Thus, there is a technically feasible market among the 24 companies on the survey for almost all of the 50 billion Btu/day production of the demonstration plant. Details of this survey are outlined in, "Technical Support Report, Combustion System Data, Part 2 - Burner Conversion Survey," Deliverable No. 46.

Prospective Customer Contact

Personal contact with each of the customers identified in the market survey as prospective users of the IFG from the demonstration plant was initiated

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Table 3. BURNER MANUFACTURERS

1. Baker-Perkins
2. Cleaver Brooks
3. Ace Engineering
4. Barker Manufacturing Co., Inc.
5. Babcock and Wilcox, Inc.
6. The C. M. Kemp Manufacturing Co.
7. Coen Company
8. Combustion Engineering, Inc., (Includes Wickes)
9. Oswego Package Boiler Co., Inc.
10. Eclipse Combustion
11. Industrial Combustion, Inc.
12. John Zink Company
13. Maxon Corporation
14. North American Manufacturing
15. Peabody Gordon-Piatt, Inc.
16. Ransome Gas Industries, Inc.
17. Ray Burner Company
18. Webster Engineering
19. Boiler Engineering and Supply

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to brief them on the project and also to inquire about their concerns, questions, and need of experimental information concerning the use of IFG in their equipment. Several meetings were held, as discussed below.

MLGW's management met on an individual basis with representatives from Tennessee Valley Authority and large existing natural gas users to brief them on the status of the Industrial Fuel Gas Demonstration Plant Program. TVA was pleased with the proposal and was willing to discuss further with MLGW the conditions under which the Allen Generating Station would be able to purchase and use the IFG. Most of the large natural gas users were invited to a luncheon meeting where they were informed about the program and were asked permission for MLGW's combustion crew to conduct a burner study on their boilers. The remaining customers were contacted and informed by telephone or by a visit to their offices. All of the prospective IFG customers showed interest in the project and granted permission for the combustion crew to conduct a burner study on their equipment.

On October 26, 1979, the large existing natural gas users were invited to another meeting with MLGW's management. The meeting was attended by technical personnel representing 14 of the companies invited. During the meeting, the customers were up-dated on the IFG Program and informed of the availability of IFG as a substitute to the natural gas or fuel oil they are using now. The customers were briefed on the combustion trials of IFG on an actual burner at the Institute of Gas Technology's test furnace facility and shown pictures and results of the successful trials. The discussion also included the plan of utilizing a credit system to assure a reliable, uncurtailable fuel supply to the customers 365 days a year. During the briefing, the companies showed great interest and enthusiasm about the project and accepted a request to provide letters of intent to purchase the IFG with suitable terms.

Letters of Intent for Purchase of IFG

The prospective customers were asked to submit letters of intent to enter into negotiations to purchase the IFG. The initial aim was to obtain intents of purchase and thus obtain a commitment of sale of more than 75% of the plant output. Because the availability of the IFG from the demonstration plant could not be guaranteed, the time frame of the plant production start-up could not be projected, and the sale price of IFG could not be determined at this time, a firm commitment to purchase the gas was not solicited from the prospective

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customers. Instead, letters of intent to enter into negotiations to purchase the gas under the terms and conditions outlined in the sample letter shown in Figure 1 were requested.

An overwhelming interest and enthusiasm was shown by the customers, as evidenced by submission of letters of intent from 21 of the 25 prospective customers. (See Table 4.) This represents an intent to purchase about 100% of the total plant production and thus fulfills the Phase I contractual requirements. Copies of the letters of intent from the 21 companies are included as Appendix A.

Future Additional Customers

There are good possibilities of additional customers for IFG in the future as the demonstration plant program nears completion and industry can make definite plans on a new source of energy becoming available. The current market plan is based on TVA purchasing the excess supply of gas after the 24 prospective customers' demand is satisfied. As the IFG program obtains future additional customers, the supply of IFG to TVA will be proportionately reduced to satisfy the new customers' demand. Three future additional customers are currently envisaged: Delta Refining Company's Synthetic Gasoline Plant, Rivergate Industrial Park, and Frank Pidgeon Industrial Park.

Delta Refining Company

Delta Refining Company has proposed to demonstrate production of gasoline motor fuel from synthetic gas as a contractor to the Department of Energy (DOE). Delta Refining Company's proposed plant is somewhat unique in that it not only demonstrates the gasoline from synthetic gas technology and multi-use plant concept, but allows a much lower level of investment, operational flexibility, and assures the marketing of the synthetic gasolining production into company-owned retail stations.

This proposed synthetic gasoline plant would be a scaled down version of those that others are currently proposing to DOE. By utilizing up to 30% of the output of the Memphis Fuel Gas Demonstration Plant (15 billion Btu per day) as feedstock for Delta's plant and by utilizing the Chem Systems (synthetic gas-to-methanol) process and the Mobil (methanol-to-gasoline) process, Delta will produce 1350 barrels per day of commercial quality unleaded motor gasoline. This plant will provide nationwide technical advancement and favorable supply impact in the Memphis/Mid-South area.

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Memphis Light, Gas and Water Division
P. O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Gentlemen:

This letter confirms _____ intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 Btu per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of an equivalent amount of No. 2 fuel oil.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.
3. IFG will become available for sale in approximately 1985.

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

COMPANY: _____

BY: _____

TITLE: _____

Figure 1. SAMPLE LETTER OF INTENT

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Table 4. CUSTOMERS SUBMITTING LETTERS OF
INTENT FOR PURCHASING IFG

<u>Number</u>		<u>Maximum Demand, 10⁶ Btu/day</u>	<u>% Plant Output</u>
1	Cargill, Inc.	4320	9.6
2	Nat Burning Packing Company	175	0.4
3	Delta Refining Company	7280	14.6
4	Refined Metal	747	1.7
5	Conley Frog & Switch Company	656	1.5
6	Kroger	285	0.6
7	Wesson Foods	2175	4.8
8	Baptist Hospital	1294	2.9
9	John Gaston Hospital	848	1.9
10	City of Memphis Hospital	720	1.6
11	LeBonheur Childrens Hospital	117	0.3
12	Veterans' Hospital	782	1.7
13	St. Joseph Hospital	860	1.9
14	St. Jude Hospital	816	1.8
15	Buckman Lab	1138	2.5
16	Buckeye Cellulose (Chelsea)	1472	3.3
17	Velsicol Chemical	4040	9.0
18	Buckeye Cellulose (Jackson)	6211	13.8
19	Humko Chemical	5605	12.5
20	Quaker Oats	5568	12.4
Total Percent of Plant's Output			98.8
21	Tennessee Valley Authority	Customer of Excess Supply	-

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Delta has proposed immediate commencement of this project and an expedited schedule for the industrial fuel gas demonstration plant to allow concurrent IFG demonstration plant and synthetic gasoline plant start-up. It is planned to have both plants producing commercial motor gasoline and industrial fuel gas for Memphis during 1984.

Rivergate Industrial Park

The Rivergate Industrial Park has been developed for the use of approximately 60 small commercial or industrial establishments. It has been filled to above flood level, the infrastructure is being completed, and the area has been zoned as industrial. The Rivergate site is south of the Nonconnah Creek near the Delta Refining Company's oil refiners and about 3 miles from the IFG demonstration plant site.

As the demonstration plant nears production stage, customers are expected to be drawn to this developed industrial park because of the added benefit of an assured supply of fuel gas. The size of the market in this park will be dependent on the type of industrial establishments; however, their products would be expected to be high-unit-energy users because of the availability of IFG.

Frank Pidgeon Industrial Park

The Frank Pidgeon Industrial Park development is planned to cover approximately 4000 acres. The site has existing levees and would require only a minimum of landfill. It is zoned for industrial use and is located about 1 mile south of the IFG demonstration plant site. This park is expected to be developed later than Rivergate Industrial Park, but it would be able to accommodate large industrial facilities.

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IFG DISTRIBUTION SYSTEM

The IFG distribution system has been designed with the primary purpose of providing a reliable, non-curtailable, and assured supply of fuel gas to the customers. The marketing of IFG is based on distributional sale of IFG to several customers. The fuel gas will be supplied to the customers through a separate and dedicated pipeline. Reliability and supply assurance is provided by using a unique credit generating system and an underground gas storage facility. Thus the proposed IFG distribution system will provide fuel gas to customers without any intervention by either the State Power Commission or the Federal Energy Regulatory Commission under current regulations and laws. The Memphis City Council will act as an equivalent regulatory agency for all aspects of the demonstration plant including sales of IFG.

The IFG Pipeline

Because IFG has a heating value of about only one-third that of natural gas and because it contains carbon monoxide, a separate pipeline has been designed to supply IFG to the various customers. This same pipeline will also be used to supply the backup fuel (30% natural gas/70% air mixture) to the customers when the IFG plant is not operational.

The planned industrial fuel gas pipeline is shown in Figure 2. The pipeline is about 35 miles long and has three major legs, one each to the President's Island, the industrial parks, and the north industrial area. Most of the pipeline will be constructed to follow the existing city streets and thus will not require obtaining any major rights-of-way.

The pipeline will operate at a pressure of 150 psig with the last connections maintained at 80 psig. The design capacity of the pipeline will be 50 billion Btu per day of either IFG and/or the backup fuel. Both the gases will be odorized before introduction into the pipeline.

The Credit System

A common proposed application for medium-Btu coal gasification plants is one of captive use, in that an owner-operator would utilize the facility and the output in other plants or operations that he controls. In this manner, the fluctuations of the coal gasification plant demand are well known and the owner can more easily accommodate periods of downtime. However, distributional

Figure 2. INDUSTRIAL FUEL GAS DISTRIBUTION SYSTEM

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sale of gas from a central medium-Btu coal gasification facility has to overcome some unique marketing and business related problems. Two fundamental problems exist:

1. Reliability of Supply to Customer

In order to sell the relatively expensive product gas, the potential customer must be assured of a completely reliable supply of gas in the quantities for which he has contracted. This reliability would allow the customer to depend on the gasification facility without the need for backup supplies. Unfortunately, even the best operated plant has to be shut down for maintenance and occasionally experiences unscheduled downtime. Because there is no widespread distributional system for this gas, each plant will have its own system completely dependent on the plant for its gas. The question then arises, "How do you supply customers when the plant is down?"

2. Load Factor (Reduction in Demand)

A coal gasification facility is not one that is easily controlled unless it is operated in a steady-state manner because instantaneous fluctuations are difficult to accommodate. In addition, turning the plant down over periods of time results in reduced output, which causes severe economic penalties or higher prices. The problem is to accommodate demand variations caused by a fixed number of customers without requiring the plant to operate in a constantly changing manner and to accomplish this in the most economic manner.

The "credit" system is a process scheme that solves these two fundamental business problems. As shown in Figure 3, the IFG plant produces a medium-Btu gas. The plant has the primary function of supplying IFG to customers, who must receive a 100% reliable supply of medium-Btu gas. Under normal, steady-state conditions, the majority of gas produced by the plant is distributed to the customer, and a small stream of the output of the plant is diverted to a "credit generating unit" where the medium-Btu gas is upgraded in Btu content to be compatible with natural gas in the natural gas pipeline system. The resulting gas from the credit generating unit is inserted into the natural gas pipeline. During this steady-state operation, the amount of gas produced by the generating unit and inserted into the pipeline is "credited" to the IFG customers in much the same way as a bank would credit a depositor for his savings account.

During periods when the IFG plant is down, the IFG customers would receive a diluted natural gas mixture as fuel, as shown in Figure 4. Natural gas from the pipeline is drawn and sent to an air dilution unit where the gas is diluted

Figure 3. "CREDIT SYSTEM" - PLANT NORMAL OPERATION

Figure 4. "CREDIT SYSTEM" — OPERATION DURING PLANT OUTAGE

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from a high-Btu content to a medium-Btu content and inserted into the IFG distribution system. During this period of plant outage, the IFG plant and the generation unit are not operating and are isolated from the IFG customers.

During periods when the IFG plant is operating and the IFG customers have a reduction in total demand, the IFG plant would continue to operate at a full load. (See Figure 5.) This system not only allows the plant to operate in a steady-state, full-load manner, but also generates revenue which otherwise would be lost. The excess "credits" would be sold, at prevailing market prices, to supplemental natural gas customers.

The recommended credit generation unit is one which incorporates methanation of the product gas to upgrade the output to pipeline quality. The capacity of this unit has been recommended as follows:

Maximum U-GAS Input:	15 mmm Btu day (30% plant output)
Normal Operation:	5 mmm Btu day (10% plant output)

The rate of normal operation has been determined by the 90% service factor of the IFG plant itself, thereby requiring 10% "credits."

The maximum capacity of 30% of IFG plant output was determined as follows:

- Marketing Considerations

The MLGW/DOE contract required 75% of plant output to be "sold" prior to entering into Phase II, which would indicate a possible load factor of 75%. The 30% credit unit will allow full-load operation.

- Competitive Evaluation/Product Price

The contract requires that the product price for evaluation/sales purposes be based on 75% load factors. With the credit unit, this evaluation price will be lowered by the revenue generated by the credit unit upgrading the "unsold" plant capacity.

Underground Storage

During the winter season, a possibility exists that the MLGW natural gas pipeline system could not be drawn upon to retrieve the stored natural gas credits. Therefore, provisions have been made to store an equivalent of 15 days of IFG production in rental or purchased underground storage to assure a 365-day fuel supply to IFG customers. This facility will have a storage

Figure 5. "CREDIT SYSTEM" — REDUCED DEMAND OPERATION

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capacity of approximately 2 billion cubic feet.

The exact location of the storage system has not been selected, but it will be located near the natural gas supplier's pipeline so that a transporting and interchange arrangement can be made with the supplier. Possible underground storage facilities include an abandoned coal mine or a depleted natural gas well field that could be either leased or purchased by MLGW. Natural gas will be purchased from a pipeline supplier and stored underground, usually during low-demand periods. When the IFG plant is down on peak-demand days, credits may still be withdrawn from the MLGW system to serve medium-Btu customers. In order to prevent MLGW from exceeding their natural gas purchase limitations when this situation occurs, an equivalent amount of natural gas will be withdrawn from the storage facility and injected into the Texas Gas Transmission (TGT) pipeline. This will assure the medium-Btu customers of a 100% reliable supply without exceeding their natural gas purchase limitations or penalizing natural gas customers.

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SUPPORT STUDIES

A number of engineering support studies, both experimental and analytical, were conducted to provide data for combustion of IFG and to foster customer confidence in the purchase and ultimate use of IFG in their equipment. The studies were conducted by the Institute of Gas Technology (IGT) and Babcock and Wilcox's (B&W's) Industrial and Marine Division.

Combustion Trials

Based on the market survey, it was determined that the spud-type boiler burner was the most common among the third group of burners and that experimental information for combustion of a gas similar in characteristics to IFG was not available for the spud-type boiler burner. Therefore, this burner was selected for combustion trials of IFG. The purpose of the tests was to give the prospective customers and burner manufacturers enough information to evaluate the suitability of the spud-type burner for using IFG.

Combustion data for the boiler spud burner were obtained at the Combustion Research Facility at the IGT Pilot Plant as a part of the program to supply to potential users of IFG the information necessary to make decisions regarding the suitability of their burners for this fuel. In addition, a mixture of 30% natural gas and 70% air by volume was evaluated as a temporary replacement fuel for IFG to be used during gasifier shutdowns. Natural gas was used to gather baseline data before the IFG and the natural gas/air mixture were tested. Comparisons were made of flame stability and shape, thermal efficiency, the load heat absorption profile, temperature profiles, and flue gas analysis for these three fuel gases. The nozzle metal temperatures as well as the fuel and combustion air static pressures required for the different fuels were monitored. All three fuels were tested at two firing rates: a fuel enthalpy input rate of 5 million Btu/hr (higher rate) and a fuel enthalpy rate of 3 million Btu/hr (lower rate). In conjunction with B&W, two sets of fuel spuds were designed for use with IGT's boiler burner. One set of spuds was designed for the natural gas tests; the other set was designed for both the IFG and the natural gas/air mixture tests.

No stability problems were encountered on any test fuel at either input rate. Both the IFG and the backup mixture yielded thermal efficiencies equal to or better than those for natural gas. The flame lengths were shorter for

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both the natural gas/air mixture and the IFG than for natural gas. IFG gave significantly lower NO_x levels than natural gas (50% lower), while the natural gas/air mixture yielded about the same NO_x levels as natural gas.

Both the IFG and the natural gas/air mixture required greater supply pressure of both air and gas. These requirements could be reduced by further design modifications. There was no problem encountered with the fuel spud metal temperatures. For both firing rates, the metal temperature was very close to the inlet fuel temperature.

In all combustion aspects tested, IFG performed as well as or better than natural gas. The 30% natural gas/70% air mixture also performed in a superior fashion to natural gas. During the combustion trials with the natural gas/air mixture, the nozzle position had to be readjusted to maximize combustion efficiency when switching from IFG to the natural gas/air mixture.

The conclusions of the combustion trials can be summarized as follows:

- A spud-type boiler burner designed for natural gas can be easily modified to burn the IFG and the natural gas/air backup fuel.
- The proposed IFG can perform as well as natural gas in terms of heat transfer to the load.
- The proposed natural gas/air backup fuel also performed as well as or better than natural gas in terms of heat transfer to the load.
- The IFG and natural gas/air fuel gave short flames with high peak flame temperatures using the recommended fuel injectors, and this could result in high heat absorption rates in boiler tubes near the burner.
- The IFG and the natural gas/air fuel required higher air plenum static pressures. Further modifications to the fuel injectors and/or the burner block would be required to lower the required pressure.
- The fuel injector position that optimized the IFG flame was not the optimum position for the natural gas/air mixture.

Backup Fuel Gas

For the periods when the demonstration plant is not on-line, either during the routine maintenance period or due to operational problems, the planned fuel supply to IFG customers is a mixture of 30% natural gas and 70% air by volume. The backup fuel supply integrates well with the credit system that is described below. During the combustion trials it was shown that the backup fuel combusts as well as both natural gas and IFG. The 30% natural gas/70%

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air mixture is, therefore, interchangeable with IFG and can be used as a backup fuel, thus assuring the prospective customers of a continuous and reliable fuel supply.

A study was also conducted for IGT by Safety Consulting Engineers, Inc., to determine if mixtures of IFG and the natural gas/air replacement fuel could be explosive. The compositions tested by Safety Consulting Engineers, Inc., simulated the range of mixtures that would be encountered in the fuel distribution piping during a changeover from IFG to the 30% natural gas/70% air mixture.

The results show that no flammable mixtures were observed at 150°F and ambient pressure or at 100 psig and ambient temperature. Safety Consulting Engineers, Inc., recommended that the amount of oxygen be monitored continuously whenever the two fuels, the natural gas/air backup fuel and the IFG, are mixed.

B&W Boiler Analysis

Babcock and Wilcox conducted an analytical study to determine the feasibility of operating one of the boilers at Buckeye Cellulose with IFG. This analysis was useful in determining, from a boiler and a burner manufacturer, the changes necessary in the auxiliary equipment of a boiler. The scope of the study consisted of the following:

- Analyze the effects of burning industrial fuel gas with a HHV of 284 Btu/SCF
- Determine if any modifications to the burner would be required
- Determine any increase in either boiler bank or flue draft
- Determine if a new fan would be required.

The conclusion of the study was that the boiler at Buckeye Cellulose Division of Proctor and Gamble Company can burn IFG instead of natural gas and can be changed from natural gas firing to the industrial gas firing. The maximum capacity in steam flow is unchanged, and the existing fan is satisfactory. The burner requires revision to allow for higher fuel gas flow, and the control system requires a few modifications and revised valves for the industrial gas.

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Other Market Studies

Several market studies have been performed by other organizations to determine the potential market for medium-Btu gas nationwide. These studies show that there is a substantial market for medium-Btu gas in both single-user and multi-user types of applications. Thus, the results and information made available by the construction and operation of the demonstration plant will be directly useable in other parts of the country in increasing the use of coal in an environmentally acceptable manner.

In September 1979, SRI International completed a study for the Memphis Light, Gas and Water Division titled: "Industrial Market Potential for Intermediate Btu Gas from Coal in the United States". The objective of this study was to assess U.S. market potential of medium-Btu gas using the marketing system concepts developed by MLGW. It is noted that an earlier SRI study, commissioned by the Department of Energy, concluded that the U.S. market for this gas was limited (0.5 Quad in 1980's-90's). The latest study, conducted with the Memphis marketing system assumptions, concluded that the potential available market is much larger (7.0 Quads in 2000) than originally anticipated.

The first SRI study assumed that medium-Btu gas would only be marketed to one high-load-factor user, such as a steel mill or petroleum refinery. Under this assumption, the cost of the medium-Btu gas would have to be competitive with the alternative fuel of choice, No. 6 fuel oil, thereby limiting the market. MLGW has concluded that the sale of medium-Btu gas is feasible using a separate distribution pipeline to 20 or more industrial customers, which together, can constitute a high-load factor. MLGW has also developed a credit system concept that, a) is a swing "customer" that keeps plant load factor high and b) can supply the industrial load when the medium-Btu coal gas plant can not. Another factor that affected the study was that the alternate fuel for many of the smaller medium-Btu gas users is not No. 6 fuel oil, but No. 2 fuel oil. At this writing, No. 2 fuel oil costs in excess of \$525. per million Btu.

In July 1979, Booz, Allen & Hamilton, Inc., completed a market study for low- and medium-Btu gas commissioned by the Office of Resource Applications, DOE. This study did not use the Memphis marketing concepts, but focused only on manufacturing markets in the 1985 time frame. Although this assumption limited the potential markets, the study concluded that U.S. manufacturing industries could support 300 medium-Btu coal gasification plants with total

12/79

output of 2.9 Quads.

Quoting from the study, "...the implication of this findings is that substantial potential exists for national benefit." The study also concluded that the first priority for DOE action should be the medium-Btu multiple-user plant -- the same concept originally envisioned by MLGW in 1976 and confirmed by subsequent MLGW technical and economic studies.

The summaries and conclusion from these two studies are included as Appendix B.

12/79

APPENDIX A.

Letters of Intent From Prospective Customers
for
Purchase of Industrial Fuel Gas

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WAS INTENTIONALLY
LEFT BLANK

Memphis Light Gas and Water Division
P.O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Gentlemen:

This letter confirms Cargill, Inc. 1877 Channel Ave., Mphs, Tn. Intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 BTU per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with regular natural gas when/if it is normally available.
3. The price will be competitive with the current price of an equivalent amount of our alternate fuel source during normal curtailment condition of natural gas.
4. During shutdown of gasification plant natural gas will be blended with air to give proper BTU content in supply line.
5. Memphis Light, Gas, and Water Division would supply and install supply line and meter beside existing natural gas line and meter on Cargill, Inc. property.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimate capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facility will be a subject included in subsequent negotiation.

3. IFG will become available for sale approximately 1985.

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

COMPANY: CARGILL, INCORPORATED

BY: Harry E. Bryant 11-7-79

TITLE: PLANT SUPERINTENDENT

King Cotton Division

Post Office Box 13039
1837 Harbor Avenue
Memphis, Tennessee 38113
(901) 942-3221

Buring Food Group, Inc.

November 16, 1979

Memphis Light, Gas and Water Division
P. O. Box 430
Memphis, Tennessee 38101

RE: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Gentlemen:

This letter confirms Buring Food Group, Inc.'s intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 Btu per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of an equivalent amount of No. 2 fuel oil.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.
3. IFG will become available for sale in approximately 1985.

Memphis Light, Gas and Water Division
November 16, 1979
Page 2

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

Sincerely,

BURING FOOD GROUP, INC.

A handwritten signature in cursive script, appearing to read "Jerry K. Chism".

Jerry K. Chism
Chief Engineer

/em

DELTA REFINING COMPANY

An Earth Resources Company

box 9097 • memphis tennessee 38109 • 901•774•3100

November 2, 1979

Memphis Light, Gas and Water Division
P. O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Gentlemen:

This letter confirms Delta Refining Company's intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 Btu per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of a Btu equivalent amount of No. 2 fuel oil.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.
3. IFG will become available for sale in approximately 1985.

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

Yours very truly,

R. T. Prater
President

MEMPHIS PLANT
257 West Mallory Avenue
P. O. Box 9006
Memphis, Tennessee 38109
(901) 775-3770

JACKSONVILLE PLANT
2640 Capitola Street
P. O. Box 40746
Jacksonville, Florida 32203
(904) 353-4317

October 31, 1979

Reply To:

Memphis Light Gas and Water Division
P. O. Box 430
Memphis, TN 38101

Gentlemen:

This letter confirms Refined Metals Corporation intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 BTU per standard cubic foot.

Our intent is predicated on the condition that any negotiated quantity of supply will be non-curtable except for force majeure. This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modification needed to utilize it in our facilities.
2. Cost of physical modification of our facilities will be a subject included in subsequent negotiations.
3. IFG will become available for sale in approximately 1985.

This letter is valid through December of 1980 at which time we require MLGW to inform us of their decision to proceed and the mechanism to incorporate the above mentioned conditions.

Sincerely,

REFINED METALS CORPORATION

A handwritten signature in cursive script, appearing to read "T. W. Freudiger".

T. W. Freudiger
Director of Manufacturing

TWF:dy

CONLEY FROG AND SWITCH CO.

Manufacturers of

RAILROAD TRACK MATERIALS - SELF GUARDED FROGS - MANGANESE
BRIDGE RAILS - SLIDING JOINTS - CROSSINGS - FROGS - SWITCHES
ACCESSORIES - RAIL AND MANGANESE
COMMERCIAL FORGINGS - ALLOY - CARBON - HEAT TREATING - DIES
387 E. BODLEY AVE. MEMPHIS, TENN. 38109 PHONE 948-4591

November 9, 1979

Memphis Light, Gas and Water Division
P.O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas

Gentlemen:

This letter is to advise of our interest and support of your Coal Gasification Program. A definite commitment to use this gas would be predicated upon conditions that exist at that time. However we would be most interested in an uninterrupted supply of energy and this program looks like it might well be the answer.

Very truly yours,

CONLEY FROG & SWITCH CO.

J. M. Logan
Assistant to General Manager

JML:mlm

THE KROGER CO.

1240 STATE AVE.

CINCINNATI, OHIO 45204

November 27, 1979

Memphis Light, Gas and Water Division
P.O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Gentlemen:

This letter confirms The Kroger Co.'s intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 BTU per standard cubic foot.

Our intent is predicted on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of an equivalent amount of natural gas.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.
3. IFG will become available for sale in approximately 1985.

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

Sincerely,

A handwritten signature in cursive script, appearing to read "Ken Gosser".

Ken Gosser
Buyer

KG/es

HUNT-WESSON FOODS

A
NORTON SIMON INC
COMPANY

Hunt-Wesson Foods, Inc.
1645 West Valencia Drive
Fullerton, California 92634
714 871-2100

November 19, 1979

Memphis, Light, Gas and Water Division
P. O. Box 430
Memphis, Tennessee 38101

Gentlemen:

Re: Coal Gasification - Industrial Fuel
Gas (IFG) - (Market Potential)

This letter confirms Hunt-Wesson Foods, Inc., Memphis Refinery's interest in the Coal Gasification project to be undertaken by M.L.G.&W./D.O.E. Certainly the need for future energy sources demands that we all work together in developing and evaluating new programs to meet these needs. This project definitely fits the short-range, fast-track alternatives that we must all be seriously considering.

Further, it is our understanding that the heating value of this gas would be in the neighborhood of 300 btu's per standard cubic foot. At this point in time we do not have a thorough analysis of the gas product and in order to fully determine its feasibility, an indepth study would be necessary. As you may be aware, we are in the middle of a construction project in which two (2) new 80,000 lb./hr. boilers are to be installed to replace the old boiler system.

We made a preliminary contact with Nebraska Boiler on this subject. Their response again was contingent upon data and information pertaining to the operating efficiency of the IFG. When quizzed on the feasibility, they responded that a thorough study would be necessary to determine the required modifications to utilize this product in our facility. The economic consequences of these changes would have a direct bearing upon its practicality.

It would be less likely that this product could be used as feedstock to our hydrogen gas generating plant located at this same facility.

Memphis Light, Gas and Water Division
November 19, 1979
Page Two

Let me emphasize that we support you in this program and are vitally interested in seeing it through to the demonstration plant.

Very truly yours,

HUNT-WESSON FOODS, INC.

A handwritten signature in cursive script, reading "David A. Gubser". The signature is written in dark ink and is positioned above the printed name.

David A. Gubser
Group Leader
Refinery Engineering

DAG:el

cc: D. L. Aquino
B. D. Gunter
D. E. Messinger
G. W. Stetzel
H. W. Sommer

BAPTIST MEMORIAL HOSPITAL

899 MADISON AVENUE
MEMPHIS, TENNESSEE 38146

JOSEPH H. POWELL, EXECUTIVE VICE PRESIDENT

November 8, 1979

Mr. David F. Hansen
President
Memphis Light, Gas and Water Division
P.O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Dear Mr. Hansen:

This letter confirms Baptist Memorial Hospital's intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 Btu per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive on a Btu basis with the then-current price of alternative fuel sources.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.

3. IFG will become available for sale in approximately 1985.

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

Sincerely,

A handwritten signature in cursive script that reads "Joseph H. Powell". The signature is written in dark ink and is positioned above the typed name.

Joseph H. Powell
Executive Vice President

JHP/sk

City of Memphis Hospital

860 MADISON AVENUE
MEMPHIS, TENNESSEE 38103

November 1, 1979

Memphis Light, Gas & Water Division
P.O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Gentlemen:

This letter confirms the City of Memphis Hospital intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 Btu per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with alternate sources of fuel.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.
3. IFG will become available for sale in approximately 1985.

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

COMPANY: CITY OF MEMPHIS HOSPITAL

BY: *Mack W. Land*

TITLE: CHIEF HOSPITAL ENGINEER/ CMH

cc: Mr. David Coombes
Col. Samuel F. Langley

LE BONHEUR CHILDREN'S HOSPITAL

EUGENE K. CASHMAN, JR.
President

November 19, 1979

Memphis Light, Gas & Water Division
P. O. Box 430
Memphis, Tennessee 38101

RE: Coal Gasification - Industrial Fuel Gas
(IFG) (Market Potential)

Gentlemen:

This letter confirms Le Bonheur Children's Hospital's intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 Btu per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of an equivalent amount of No. 2 fuel oil.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.
3. IFG will become available for sale in approximately 1985.

This letter is valid through December 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

Sincerely,

LE BONHEUR CHILDREN'S HOSPITAL

Frederick F. Nowak
Senior Vice President

Memphis Light, Gas and Water Division
P. O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Gentlemen:

VA Medical Center, Memphis, TN

This letter confirms _____ (Company) _____ intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 Btu per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of an equivalent amount of No. 2 fuel oil.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.
3. IFG will become available for sale in approximately 1985.

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

COMPANY: VA Medical Center

BY: JOHN B. BYRD

TITLE: Director

NOV 09 1979

St. Joseph Hospital 220 Overton Avenue Memphis, Tennessee 38105

November 5, 1979

Memphis Light, Gas & Water Division
P.O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification

This letter confirms St. Joseph Hospital will support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 BTU per standard cubic foot. The price must be competitive with the then current price of an equivalent amount of No. 2 fuel oil.

Memphis Light, Gas & Water Division must provide data and information pertaining to the operating efficiency of industrial fuel gas as well as estimated capital cost for modifications needed to utilize it in our facilities. The cost of physical modification of our facilities will be a subject included in subsequent negotiation. I understand that industrial fuel gas will become available for sale in approximately 1985. This letter is valid through December of 1980 by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

The Central Office, owner of St. Joseph Hospital must approve the final contract with MLGW. This is the Central Office that approved the purchase of steam and chilled water from waste burning plant with the recommendation of Administration of St. Joseph Hospital.

Good luck on meeting our energy needs in the future.

Sincerely,

A.D. Poole
Assistant Director
St. Joseph Hospital

cc: Sister M. Rita, Executive Director

ST. JUDE CHILDREN'S RESEARCH HOSPITAL

332 North Lauderdale, P.O. Box 318,
Memphis, Tennessee 38101
(901) 525-8381

Danny Thomas, Founder

October 31, 1979

Memphis Light, Gas and Water Division
P. O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)

Gentlemen:

This letter confirms St. Jude Children's Research Hospital intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 BTU per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract.

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of an equivalent amount of No. 2 fuel oil.

The commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.
3. IFG will become available for sale in approximately 1985.

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

Sincerely,

John H. Johnson
John H. Johnson
Chief Engineer

President's E Star Award for Exports

Buckman Laboratories, Inc.

BUCKMAN LABORATORIES INTERNATIONAL, INC.
BUCKMAN LABORATORIES WHTC, INC.

AUSTRALIA	CANADA	SOUTH AFRICA
BELGIUM	JAPAN	U.S.A.-Memphis, Tenn.
BRAZIL	MEXICO	U.S.A.-Cadet, Missouri

1256 NORTH McLEAN BOULEVARD / MEMPHIS, TENNESSEE 38108, U.S.A. / TELEPHONE (901) 278-0330 / TELEX 5-3868 / CABLE ADDRESS BULAB

November 7, 1979

Memphis Light, Gas and Water Division
P. O. Box 430
Memphis, Tennessee 38101

RE: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Gentlemen:

This letter confirms Buckman Laboratories intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 BTU per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of an equivalent amount of No. 6 fuel oil.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.
3. IFG will become available for sale in approximately 1985.

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate and their mechanism to establish the above listed conditions and assumptions.

COMPANY: BUCKMAN LABORATORIES, INC.

BY: *R. L. Frank*

TITLE: MANAGER-MANUF. SERVICES

Buckeye Cotton Oil Division / THE BUCKEYE CELLULOSE CORPORATION
HOLLYWOOD MILL, P. O. BOX 8326, MEMPHIS, TENNESSEE 38108

November 12, 1979

Memphis Light, Gas and Water Division
P. O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Gentlemen:

This letter confirms The Buckeye Cotton Oil Division's intent to support the Coal Gasification Program by discussing the purchase of industrial fuel gas, which is approximately 300 Btu per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of our cheapest alternative.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent discussion.
3. IFG will become available for sale in approximately 1985.

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

Very truly yours,

THE BUCKEYE CELLULOSE CORPORATION

W. L. Blankenship
Mill Superintendent

WLB/ih

VELSICOL CHEMICAL CORPORATION

341 EAST OHIO STREET • CHICAGO, ILLINOIS 60611 • 312-670-4500

November 8, 1979

Memphis Light, Gas, & Water Division
P.O. Box 430
Memphis, Tennessee
38101

Attn: Mr. David F. Hansen, President

Dear Sir:

This letter confirms that Velsicol Chemical Corporation is interested in the Coal Gasification Program and in negotiating for the purchase of industrial fuel gas (IFG), which is composed primarily of hydrogen and carbon monoxide and has a heat content of approximately 300 BTU per standard cubic foot. We understand that this gas will become available around 1985. In the event that negotiations do not commence by December 31, 1980, Velsicol may find it necessary to consider alternatives.

The interest expressed herein is based upon the following assumptions and concepts:

- 1) IFG supply will be non-curtable except for force-majeure even if it requires substituting a natural gas-air mixture.
- 2) Price will be competitive with suitable alternate fuels.
- 3) MLGW will provide data and technical assistance with respect to utilization of IFG in our facility.
- 4) Costs for modification of our facilities to burn IFG will be included in the negotiations.

VELSICOL CHEMICAL CORPORATION

- 5) Nothing contained in this letter shall constitute a legally binding obligation. Velsicol shall not be legally bound to any obligation regarding IFG until and unless consented to and approved by the Board of Directors of Velsicol.

Sincerely,

VELSICOL CHEMICAL CORPORATION

The image shows a handwritten signature in dark ink. The signature is stylized, starting with a large 'V' and 'J' that are connected, followed by 'Baarman' in a cursive script.

V.J. Baarman
Vice-President, Manufacturing

VJB:clc

THE BUCKEYE CELLULOSE CORPORATION

BUYING DEPARTMENT

P. O. BOX 599 CINCINNATI, OHIO 45201

November 19, 1979

Memphis Light, Gas and Water Division
Post Office Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

This letter confirms The Buckeye Cellulose and Specialties Division's intent to support the Coal Gasification Program by discussing the purchase of industrial fuel gas, which is approximately 300 Btu per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of our lowest cost alternative.

This commitment to consider purchase assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent discussion.
3. IFG will become available for sale in approximately 1985.

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project and their mechanism to establish the above listed conditions and assumptions.

Very truly yours,

THE BUCKEYE CELLULOSE CORPORATION

C. E. Prince
Natural Gas Buyer

CEP:lar

cc Mr. T. R. Turner

Humko Sheffield

Chemical
October 31, 1979

White Station Tower
P. O. Box 398
Memphis, Tennessee 38101
901 / 682 - 9111

Division of
Kraft INC

Memphis Light, Gas and Water Division
P. O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Gentlemen:

This letter confirms Humko Sheffield Chemical's intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 BTU per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of alternate fuel.

This commitment to negotiate assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.
3. IFG will become available for sale in approximately 1985.

Humko Sheffield

Chemical
Memphis, Tennessee 38101

Page 2

Re: Coal Gasification - Industrial Fuel Gas (IFG) - (Market Potential)
October 31, 1979

This letter is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions.

COMPANY: HUMKO SHEFFIELD CHEMICAL
BY:
TITLE: Mgr. Energy, Env. & Quality Assurance

LJR:ww

The Quaker Oats Company, P.O. Box 8035, 3324 Chelsea Avenue, Memphis, Tennessee 38108 (901) 324-8851

November 2, 1979

Memphis Light, Gas and Water Division
P.O. Box 430
Memphis, Tennessee 38101

Re: Coal Gasification - Industrial Fuel Gas (IFG)
(Market Potential)

Gentlemen:

This letter confirms The Quaker Oats Company's intent to support the Coal Gasification Program by negotiating for the purchase of industrial fuel gas, which is approximately 300 Btu per standard cubic foot.

Our intent is predicated on the following conditions which will be incorporated in any future contract:

1. Any negotiated quantity of supply will be non-curtable except for force majeure.
2. The price will be competitive with the then-current price of appropriate alternate fuels.

This interest in negotiation for potential IGF supply assumes the proposed MLGW/DOE project will proceed as well as:

1. MLGW will provide data and information pertaining to the operating efficiency of IFG as well as estimated capital costs for modifications needed to utilize it in our facilities.
2. Costs of physical modification of our facilities will be a subject included in subsequent negotiation.
3. IFG will become available for sale in approximately 1985, and will, in its final form prove usable on an economically viable basis in our facilities.

This letter of intent is valid through December of 1980, by which time we require MLGW to inform us of their decision to proceed with the project, their intention to negotiate, and their mechanism to establish the above listed conditions and assumptions. It is further understood that this letter, while a serious expression of interest in the purchase of IFG given applicable to our facility, is in no way legally binding and merely expresses our intent to enter into negotiations.

Sincerely,

THE QUAKER OATS COMPANY

D. R. Jenkins
Assistant Plant Manager

DRJ/pl

TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

500A Chestnut Street Tower II

November 27, 1979

Mr. David F. Hansen, President
Memphis Light, Gas and Water Division
P. O. Box 430
Memphis, Tennessee 38145

Dear Mr. Hansen:

TVA is pleased to support Memphis Light, Gas and Water's coal gasification project. Medium-Btu gas offers a method for providing clean fuel and feedstock for a variety of industrial uses as well as for electric power generation. Our basic approach is similar to yours, namely, to market medium-Btu gas not required for our operations to industrial users for their use in providing steam, process heat, and feedstock.

As you know, the Allen Steam Plant is located adjacent to your proposed gasification plant. It would be technically feasible to use any surplus gas in this facility to generate electric power. We would be pleased to discuss with you the price and other conditions under which we would be able to purchase such gas.

Ultimately, we would like to use coal gas to fuel cogenerating fuel cells at many of our installations. The fuel cells would continue to supply the steam for industrial use and generate electricity for the TVA system. We are actively supporting the development of commercial cogenerating fuel cells through pilot and demonstration activities. We hope that our efforts on fuel cells combined with those of the Department of Energy, the Electric Power Research Institute, and other utilities will result in commercial fuel cells being offered for sale in the late 1980's. We would, therefore, be most willing to consider installation of cogenerating fuel cells in the Memphis area at industrial firms served by your gasification plant. The actual timing and details of such arrangements will depend upon progress in the demonstration and commercialization of fuel cells, in TVA system needs for new generating capacity, and in the business arrangements we could make with you and the industries in Shelby County.

TVA would be willing to enter into detailed discussions concerning both of these applications.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

H. G. Parris
Manager of Power

12/79

APPENDIX B.

SRI Market Study and
Booz, Allen & Hamilton, Inc. Market Study

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**Research
International**

CLIENT PRIVATE

**INDUSTRIAL MARKET POTENTIAL
FOR INTERMEDIATE-Btu GAS
FROM COAL IN THE UNITED STATES**

Final Report

September 1979

By: David L. Olsen, Project Leader
Ronald L. Dickenson, Project Supervisor

Prepared for:

Memphis Light, Gas and Water Division
City of Memphis, Tennessee

SRI International Project No. ECC-8318

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II SUMMARY AND CONCLUSIONS

This report is based on earlier work performed for DOE,¹ although its conclusions differ somewhat from those presented in the previous reports. The principal conclusions of this report are:

- Projected growth in demand for industrial energy and constraints on supplies of fuel oil and natural gas create the prospect of a market for synthetic fuels sometime between 1985 and 1990. The size of this projected requirement in the United States will probably be greater than 300 trillion Btu in 1990, and may be about 2.0 quadrillion Btu by the year 2000.
- Industrial markets for IBG may exist in about 80 U.S. metropolitan areas, and the size of the available fuel market (i.e., that for which IBG may be expected to compete) may approach 7 quadrillion Btu in 2000.
- Because we have considered a wider range of industries in smaller industrial areas in this report than we did in the work for DOE,¹ the estimate of the potential market for IBG presented here considerably exceeds our previous estimate. Under certain conditions, in fact, the industrial fuel market for IBG could be about 500 trillion Btu per year larger than our earlier estimate. The necessary conditions include:
 - Supplies or uses of economically priced alternative fuels must be seriously constrained by cartel actions, market conditions, or government regulations.
 - IBG supply reliability and load factor must be high to assure prospective gas customers of the necessary supply continuity and fuel economy. MLGW proposes to accomplish these goals through a system of gas delivery credits that will be routinely earned during periods of slack industrial demand for IBG and applied during IBG supply interruptions. Inventories of stored natural gas will be used to overcome variations in IBG demand or production capability.
 - The incremental delivered price of IBG must not exceed that of low-sulfur No. 2 fuel oil by more than 10-15%.
 - Gasification facilities producing IBG in quantities as small as 1 billion Btu/hour will have to be able to yield fuel gas at these prices with utility-type financing.

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- In this study, no attempt is made to quantify rigorously the size of the prospective contribution of IBG to domestic chemical feedstock requirements. Although this application is likely to consume only modest quantities of IBG in 2000 (probably less than 0.5 quadrillion Btu), chemical feedstock applications will probably be important in early coal gasification ventures as chemical producers become increasingly dependent on manufacturing schemes using synthesis gas.

EXECUTIVE SUMMARY

ANALYSIS OF INDUSTRIAL MARKETS
FOR LOW- AND MEDIUM-BTU
COAL GASIFICATION

OFFICE OF RESOURCE APPLICATIONS
U.S. DEPARTMENT OF ENERGY

Prepared by:

Booz, Allen & Hamilton Inc.
4330 East-West Highway
Bethesda, Maryland 20014

Bruce A. Pasternack. Officer-in-Charge
John P. Henry, Jr. Consulting Officer
Michael T. Eckhart Project Manager

Pedro S. Ferreira
Alan S. Jacobsen
Craig R. Johnson
Robert C. Moeller

July 30, 1979
DOE Contract No. ET-78-C-01-2625
16600-010-010

EXECUTIVE SUMMARY

Low- and medium-Btu gases (LBG and MBG) can be produced from coal with a variety of 13 existing and 25 emerging processes. Historical experience and previous studies indicate a large potential market for LBG and MBG coal gasification in the manufacturing industries for fuel and feedstocks. However, present use in the U.S. is limited, and industry has not been making substantial moves to invest in the technology.

Near-term (1979-1985) market activity for LBG and MBG is highly uncertain and is complicated by a myriad of pressures on industry for energy-related investments. To assist in planning its program to accelerate the commercialization of LBG and MBG, the Department of Energy (DOE) contracted with Booz, Allen & Hamilton to characterize and forecast the 1985 industrial market for LBG and MBG coal gasification. (The study focuses on manufacturing markets and does not consider potential utility markets.) Based on information from interviews with current users, potential users and the gasifier equipment industry (Exhibit 1), the study draws five major conclusions:

- . There is a large technically feasible market potential in industry for commercially available equipment—exceeding 3 quadrillion Btu per year.
- . Early adopters will be principally steel, chemical, and brick companies. Areas in and adjoining Pennsylvania, the Ohio and Tennessee River Valleys, East Texas, Wyoming, North Dakota, and California are attractive for early adoption.
- . With no additional Federal initiatives, industry commitments to LBG and MBG will moderately increase. The number of additional plants in or near operation by 1985 is estimated to be 10 to 20 LBG plants, 2 to 3 MBG single-user plants, and no MBG multiple-user plants.
- . The major barriers to further market penetration are its lack of economic advantage, an absence of significant operating experience in the U.S.,

EXHIBIT 1
Summary List of Interview Participants

<u>Current User Interviews</u>	
General Refractories	General Motors Corporation
Glen-Gery Corporation	Holston Defense Corporation
Hazleton Brick Company	Howmet Aluminum
National Lime & Stone Company	Land O'Lakes, Inc.
Chemical Exchange Company	Pikeville Coal Gasification Project
Dow Chemical Company	U.S. Bureau of Mines
Gulf & Western Titanium	University of Minnesota
Olin Chemical Corporation	
<u>Potential User Interviews</u>	
Air Products & Chemicals	American Can Company
Del Laboratories, Inc.	American Seating Company
E. I. DuPont de Nemours	Cameron Iron Works
FMC Corporation	Haussey Metals
Mobay Chemical Corporation	Ingalls Iron & Steel
Union Carbide	Mansfield Carbon Products
Armco, Inc.	Midrex
Inland Steel Corporation	Pascoe Steel
Kaiser Aluminum & Chemical Co.	Ideal Basic
Kaiser Steel Company	Martin-Marietta
Luken Steel Company	Acme Brick Company
U.S. Steel Corporation	Brick Institute of America
Ashland Oil	Athlone Industries
Carter Oil Company	Ball Corporation
Shell Oil Company	Brockway Glass Company
Standard Oil Company of Indiana	Chattanooga Glass Company
Tennessee Gas Pipeline Company	Ferro Corporation
Union Oil Company	Guardian Industries Corporation
Jeannette Corporation	Kerr Glass Manufacturing Company
Midland Glass Co., Inc.	Owens-Illinois, Inc.
PPG Industries, Inc.	Susquehanna Corporation
Johnson & Johnson	Mead Paper Company
St. Regis Paper Company	
<u>Equipment Industry Interviews</u>	
American Lurgi Corporation	Gilbert Associates, Inc.
Applied Technology Corporation	Koppers Company, Inc.
Combustion Engineering	Texaco Development Corporation
Davy Powergas, Inc.	Wilputte Corporation
Gas Generation Associates	

uncertainty on government environmental policy,
and limited credible engineering data for retro-
fitting industrial plants.

- . Within the context of generally accepted energy
supply and price forecasts, selected government
action can be a principal factor in accelerating
market penetration.