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December 8, 1978

Mr. J. H. Fatum
Project Director
Erie Mining Company
Pickands Mather & Company, Managing Agent
1100 Superior Avenue
Cleveland, OH 44114

MASTER

SUBJECT: Erie Mining Company
Coal Gasification Project
D.O.E. Contract EW-78-C-02-5066
(ET-78-C-01-2578)
McKee Contract 4814A
REF: MEL-625

COMMERCIAL PLANT DESIGN AND
ECONOMIC EVALUATION

Dear Mr. Fatum:

Attached for your information and use are twenty (20) copies of the Commercial Plant Design and Economic Evaluation for the Erie Mining Company Fuel Gas Demonstration Plant Program.

This document consisting of two volumes contains many of the deliverables called for in the McKee/Erie Contract. These deliverables are indicated in Section 2.03 of these volumes.

We are also sending an additional twenty (20) copies of this document for transmittal to D.O.E.

Yours truly,

ARTHUR G. McKEE & COMPANY

Irwin Hess
Project Manager

IHH/jlr

cc: w/o attachment
G. A. Peterson
C. A. Stiles
R. A. Davis
E. L. Wilkins
I. H. Hess
D. A. Miller/J. H. Loweree
Project Files 5.03, 15.01

#10

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ERIE MINING COMPANY

FUEL GAS

DEMONSTRATION PLANT

PROGRAM

SMALL-SCALE INDUSTRIAL PROJECT

COMMERCIAL PLANT DESIGN

AND ECONOMIC EVALUATION

PHASE I

INTERIM REPORT

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DECEMBER, 1978

D.O.E. CONTRACT ET-78-C-01-2578

FOREWORD

So that Erie Mining Company and the Department of Energy can receive the capital costs and economic costs on a timely basis, it was agreed that McKee would prepare this interim report. It provides capital cost data and economic data based on the state of the project on November 10, 1978.

The economic data is considered sufficiently complete and accurate to permit the necessary judgements relative to initiation of Phase II.

The drawings contained in the report generally reflect the basis for the economic data. Since data on the gasifiers were received too late to be integrated into the overall plant design, and the data for the sulfur removal section of the plant have not yet been received, the various drawings, specifications and engineering requisitions have not been finalized and some discrepancies exist. None of these discrepancies have a significant effect on plant costs, however, and particular efforts have been made to ensure that all important cost elements are on a consistent basis.

The time limitations in the instructions to McKee have precluded a thorough consistency check and finalization of the documentation in the report.

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SUMMARY

This report contains the description of a proposed Commercial Coal Gasification Plant to be built for Erie Mining Company at Hoyt Lakes, Minnesota. It also contains a Capital Cost Estimate for the plant and examines the economics of the plant operations.

A Commercial Plant to utilize Eastern coal can be built at a capital cost of \$95.8 million based on 1978 costs. This plant, utilizing Eastern coal costing \$40 per ton, must sell low Btu gas at \$6.64 per million Btu to produce a 12% internal rate of return.

A Commercial Plant to utilize Western coal can be built at a capital cost of \$81.6 million based on 1978 costs. This plant, utilizing Western coal costing \$31 per ton, must sell low Btu gas at \$6.39 per million Btu to produce a 12% internal rate of return.

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2.0

INTRODUCTION

2.01 PROJECT OVERVIEW

The Fuel Gas Demonstration Plant Program envisions a coal gasification facility to produce low Btu fuel gas. The facility will provide low Btu gas to the Erie Mining Company taconite pelletizing operations at Hoyt Lakes, Minnesota. Initially, it will consist of a Demonstration Plant which will be sized to supply 7.4 billion Btu (HHV) of fuel energy per day, which is approximately 37 percent of Erie Mining Company's daily energy requirement for the induration of pellets. The Demonstration Plant will be designed to permit ultimate expansion to a Commercial Plant capable of supplying the entire fuel gas requirement of the pellet plant.

Erie Mining Company is one of the largest producers of iron ore pellets in the United States. Its plant consists of 27 shaft furnaces with an annual production capacity of 10.3 million tons. The furnaces now operate on natural gas and use fuel oil as a backup energy supply. Fuel consumption is normally equivalent to 20 billion Btu per day.

The contract arrangement between the Department of Energy and Erie Mining Company provides mutually advantageous opportunity and means for:

- Employing coal gasification technology and equipment which is now commercially available, for production and use of low Btu gas in an industrial environment under actual operating conditions,
- Identifying, defining and resolving problems and operational unknowns that have heretofore retarded industrial use of synthetic gas,
- Establishing parameters for retrofitting existing industrial furnaces for use of low Btu gas, and
- Determining and demonstrating the technical and economic feasibility of the proposed scheme.

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The Demonstration Plant will be designed as the initial module of a Commercial Plant sized to supply the entire energy requirement of the pellet plant. Expansion of the Demonstration Plant to the ultimately desired capacity will require only the installation of additional processing units.

Detail design of the full scale Commercial Plant is not a part of the present contract.

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2.0 INTRODUCTION (continued)

2.02 OVERALL SCOPE OF WORK

The Demonstration Plant Program is divided into three phases:

- Phase I - Program Development and Conceptual Design

This phase includes selection of the gasifier process to be used, development of the conceptual design for both a commercial scale plant, and a Demonstration Plant.

Sufficient data will be developed for the Commercial Plant to produce a +20% capital cost estimate and an economic analysis of the operation.

The Demonstration Plant design will be carried to the point of completion corresponding to a "front end design package" suitable for use in the detailed engineering of Phase II. A +15% capital cost estimate will be produced with a corresponding economic analysis of the operation.

Both plants will operate with high sulfur high caking Eastern coals as well as Western coals.

- Phase II - Demonstration Plant Final Design, Procurement and Construction

This phase includes all of the detailed engineering, procurement, and construction of the Demonstration Plant.

- Phase III - Demonstration Plant Operation

This phase covers the operating portion of the program, includes training of personnel, shakedown testing with both low sulfur non-caking coal, and high sulfur, high caking coal, and testing of various practices and optimization schemes.

Each Phase of the overall Program comprises a series of Tasks which are identified and defined. The Tasks to be completed in Phase I are:

- A. Conceptual Design and Evaluation of Commercial Scale Plant
- B. Demonstration Plant Process and Mechanical Design

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- C. Current Working Estimates for Phases II and III
- D. Site Evaluation and Agreements
- E. Demonstration Plant Environmental Analysis
- F. Materials, Licenses and Agreements
- G. Proposed Methods and Plans for Phases II and III Accomplishments
- H. Economic Reassessment
- I. Technical Support Plan
- J. Project Management Plan and Project Manual
- K. Long Lead Time Item Procurement

The foregoing tasks are in turn broken down into their principal elements ("deliverables"), the detail of which is shown in the chart, "Timetable of Deliverables - Phase I" in this section.

The several Tasks and the Timetable of Deliverables for Phases II and III are detailed in Section V of the "Management Plan - Phase I" issued in January, 1978.

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2.0 INTRODUCTION (continued)

2.03 SCOPE OF THIS REPORT

This interim report provides plant descriptive data, capital cost estimates, and economic analysis of the Commercial Plant.

As illustrated in the "Timetable of Deliverables - Phase I", on the following page, the work to be done in Phase I is divided into eleven Tasks (A through K), and the principal Deliverables of each Task are identified and defined.

Deliverables which are covered by this report are:

<u>Task</u>	<u>Item</u>	<u>Description</u>
A	2	Process Engineering Design
A	4	Project Engineering Design
A	5	Cost Estimate
H	1	Economic Reassessment of Commercial Plant

2.03 SCOPE OF THIS REPORT (continued)

COMMERCIAL PLANT

TIMETABLE OF DELIVERABLES—McKee ONLY

PHASE I - Program Development and Conceptual Design		STATUS																
		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	
I. A.	Conceptual Design and Evaluation of Commercial Plant.																	
	1. Gasification Technology Selection.	Complete																
	2. Process Engineering Design.	**																
	3. Risk Analysis	Deleted																
	4. Project Engineering Design.	**																
	5. Cost Estimate	**																
	6. Economic Impact Analysis	Deleted																
	7. Environmental Impact Analysis	Deleted																
	8. Demonstration Plant Recommendations	*																
I. B.	Demonstration Plant Process and Mechanical Design																	
	1. Process Engineering Design	*																
	2. Process Description and Rationale	* Part Deleted																
	3. Preliminary Engineering and Layouts	*																
	4. Engineering and Equipment Specifications																	
	a. Scale Area Model	Terminated																
	b. Scale Plant Model	Terminated																
	c. Engineering and Equipment Specifications	*																
	5. Demonstration Plant Process Engineering Report	* Part Deleted																
	6. Preliminary Procurement Requisitions	With B-4C																
I. C.	Phases II and III Current Working Estimates																	
	1. Detailed Current Working Estimate for Phase II	*																
	2. Detailed Current Working Estimate for Phase III	*																
I. D.	Site Evaluation and Agreements																	
	1. Site Data and Evaluation	Terminated																
	2. Site Agreement Summary	Erie Only																
I. E.	Demonstration Plant Environmental Analysis																	
	1. Project Description for Environmental Analysis	Terminated																
	2. Demonstration Plant Environment Report	With E-1																
	3. Report of Significance of Project Operation with Respect to the Environment	With E-1																
	4. Mitigation Measures Report	With E-1																
	5. Report of Adverse Environmental Effects which cannot be Avoided	With E-1																
	6. Report of Relationship Between Local Short-Term Uses of the Environment and Long-Term Productivity	With E-1																
	7. Report of Irreversible and Irretrievable Commitments of Resources	With E-1																
	8. Report of Alternatives to Proposed Action	With E-1																
	9. Environment Impact Assessment Report	With E-1																
	10. Environmental Data	With E-1																
I. F.	Materials, Licenses and Agreements Report/Plans																	
	1. Plan for Obtaining Coal, Water, Power, Chemicals	Terminated																
	2. Plans for Use and Disposition of Products	With F-1																
	3. Report of Proprietary Process Licenses	With F-1																
	4. Report of Applicable Construction Codes and Ordinances	With F-1																
	5. Plans for Acquiring Permits and Licenses	With F-1																
I. G.	Proposed Methods and Plans for Phase II and III Accomplishments																	
	1. Demonstration Plant Construction Plan	*																
	2. Demonstration Plant Operation Plan	*																
	3. Preliminary Operation and Maintenance Manuals	Deleted																
I. H.	Economic Reassessment																	
	1. Economic Reassessment of Commercial Plant	**																
	2. Economic Reassessment of Demonstration Plant	*																
I. I.	Technical Support Plan	Deleted																
I. J.	Project Management Plan																	
I. K.	Long Lead Item Procurement																	
	1. Procurement Schedule for Long Lead Items	With G-1																
	2. Vendor Quotations for Long Lead Items	With C-1																

*Delivered with this Report

**Delivered with Commercial Plant Report

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2.0 INTRODUCTION (continued)

2.04 BASIS FOR CONCEPTUAL DESIGN OF THE COMMERCIAL PLANT

Except for differences with respect to scale, the basic design criteria for the Commercial Plant, which are listed in Section 3.01 of this report, are an extension of those for the Demonstration Plant. In brief general terms, the basis for the conceptual design of the Commercial Plant, which is the subject of this report, are as follows:

- The plant shall be designed for a minimum life of twenty years. It will be integrated with Erie Mining Company's existing pellet plant at Hoyt Lakes, Minnesota, and will incorporate the Demonstration Plant as an operating unit.
- The plant shall be designed and sized to process approximately 1500 tons of coal per day to produce a fuel gas with a nominal heating value including sensible heat, prior to sulfur removal, of 160 to 180 Btu per cubic foot. The total daily volume of fuel gas production shall have a nominal heating value of 20 billion Btu, and will replace all of the natural gas now being used for the induration of iron ore pellets.
- The plant shall be capable of processing high sulfur, high caking Eastern coals, as well as Western coals.
- Total plant onstream availability (operating hours per year divided by 8760) shall be at least 95%.

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2.0 INTRODUCTION (continued)

2.05 BASIS FOR DESIGN OF DEMONSTRATION PLANT

The process design basis for the Demonstration Plant, which is described and evaluated in another report, can be summarized as follows:

- The plant shall be designed to convert approximately 500 tons of coal per day to 7.4 billion Btu of clean fuel gas suitable for use in Erie Mining Company's pelletizing plant shaft furnaces. The fuel gas product shall have a nominal heating value including sensible heat, prior to sulfur removal, of 160 to 180 Btu per cubic foot.
- Capability shall be provided for processing both Western coals, and high caking Eastern coals with sulfur contents of 2.5% and greater, and free swelling indices greater than 5.0. Stretford sulfur removal technology shall be employed.
- The plant shall be designed as the initial module of a Commercial Scale Plant, making full provision for eventual expansion of capacity to 20 billion Btu per day.
- The fuel burning facilities of the pellet plant shaft furnaces shall be modified to permit the use of low Btu gas as fuel to the combustion chambers. It is intended that the program shall provide definition of problems and operational unknowns associated with the retrofitting of existing industrial facilities for utilization of low Btu gas in energy intensive industries.
- As a minimum, the facilities to be provided will include those required for Materials Handling, Coal Gasification, Sulfur Removal, Gas Transmission, Waste Treatment and Disposal, Utilities, Safety, and Shaft Furnace Retrofit.
- The materials handling systems, gas transmission facilities, and utilities shall be sized to satisfy the operating requirements of the Commercial Scale Plant.
- Air quality shall be controlled to meet or exceed all applicable federal, state and local standards.
- There will be no discharge of contaminated process waste waters to the environment. Contaminated process waters will be reused in the gasifier or disposed of in an environmentally acceptable

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manner. Warmed cooling water will be utilized in the existing pellet plant facilities.

- The gasification complex will produce tar and oil as by-products and ash and sulfur as solid wastes.

The tar and oil shall be used as fuel for boilers or for process applications.

Ash will be disposed of in existing ash disposal areas on the Erie Mining Company property. Sulfur will be disposed of on site in a manner that will permit reclamation if markets become available. Ground disposal of solid wastes will be accomplished in a manner meeting all applicable environmental standards respecting leaching and ground water pollution.

- The total gasification facility shall be so designed as to maximize energy conservation and reuse, e.g. recycling of warmed cooling water to the pellet plant, injection of carbon bearing dusts removed from gas streams, energy conserving design and construction methods, and energy efficient lighting.

2.0 INTRODUCTION (continued)

2.06 COAL BASIS

The plant is designed to handle a range of coals encompassing high sulfur, high swelling bituminous Eastern coals, and suitably sized or briquetted sub-bituminous Western coals. A wide range of coals can be accepted including those indicated on Page 30 of Engineering Requisition W-20, in Section 11.0 of this report.

Samples of Rosebud-McKay coals and of a Brookville-Clarion-Kittanning mix were analyzed. The analyses were adjusted for use as the bases for material and energy balances for the gasification unit. These coal analyses are indicated in Section 3.01.3, "Bases for Process Design". Throughout this report the coal described as "Western" refers to the Rosebud-McKay material and the coal described as "Eastern" refers to the Brookville-Clarion-Kittanning mix. After initiation of the project it was learned that available Western sub-bituminous coals would contain excessive amounts of fines which could not be processed in the gasifier retort. For these economic studies it is assumed that the Western sub-bituminous coal can be suitably briquetted at a reasonable cost.

The economics derived with the above limitations are a reasonable representation for the coal gasification plant described in this report.

3.0COMMERCIAL PLANT PROCESS DESCRIPTION3.01 BASES FOR PROCESS DESIGN

The Process Design Bases take into account factors which involve both the Demonstration Plant and the Commercial Plant. The bases as outlined below pertain to both plants and factors specific to one plant or the other are so indicated.

3.01.1 General

- A. The Demonstration Plant coal gasification facility shall be designed to produce fuel gas from coal that, upon combustion, will yield 7.4 billion Btu/day (HHV) of energy. This fuel gas will be used in Erie Mining Company's pellet plant as a replacement fuel for the natural gas now being used for induration of iron ore pellets.
- B. The Commercial Plant shall be designed to produce fuel gas that, upon combustion, will yield 20 billion Btu/day (HHV) of energy.
- C. Total plant onstream availability (operating hours per year divided by 8760) shall be at least 95%.

3.01.2 Coal Handling and Preparation

- A. The coal handling facilities shall be designed to unload run of the mine sub-bituminous Western coal at the rate of 1433 tons/day and sized bituminous Eastern coal at the rate of 1349 tons/day. Coal analyses are given in Section 3.01.3 below. The Western coal design rate assumes future provision for briquetting the high percentage of coal fines contained in Western coal. The briquetting plant does not fall within the scope of the present study.
- B. The coal storage area shall provide sufficient capacity for storage of a 180 day supply of coal feedstock, based on the Commercial Plant coal usage rates.

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- C. Coal will be delivered in unit trains consisting of 100 cars of 100 ton capacity each. Fifty cars at a time will be delivered to the gasification plant for unloading. Provision shall be made for receiving coal at Hoyt Lakes via railroad or at Taconite Harbor via water.
- D. The coal handling facilities shall include coal fines loadout facilities. Fines loadout capacities will be based on commercial scale operations, using sized Eastern coal, generating 12% fines during handling.

3.01.3 Coal Gasification

- A. The coal gasification facilities shall consist of multiple two-stage, fixed bed, dry grate gasifiers with associated equipment including cyclones, coolers, tar and oil precipitators and waste heat recovery systems.
- B. Two process designs shall be made: one for the Commercial Plant and one for the Demonstration Plant. The Demonstration Plant will be a module of the Commercial Plant. The fuel gas heating value outputs for the plants, after desulfurization, will be as follows:

DEMONSTRATION PLANT

Five gasifiers - four operating, one spare, producing 7.4×10^9 Btu/day (HHV)

COMMERCIAL PLANT

Twelve gasifiers - Eleven operating, one spare, producing 20×10^9 Btu/day (HHV)

- C. The gasifiers shall be designed for use with non-caking sub-bituminous coal feedstocks, as well as highly caking coal feedstocks with free swelling indices greater than 5.0.

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- D. Heat and material balances for the coal gasification section are based on a Western sub-bituminous coal (Rosebud-McKay) and an Eastern bituminous coal (Brookville-Clarion-Kittanning mix) with these analyses:

<u>Component</u>	<u>Western Coal</u> <u>Wt. %</u>	<u>Eastern Coal</u> <u>Wt. %</u>
Moisture, as received	25.6	4.3
Proximate Analysis:		
Volatile Matter	32.6	39.4
Fixed Carbon	33.5	46.7
Ash	8.3	9.6
TOTAL	100.0	100.0
Free Swelling Index	0	8.0
Hardgrove Grind, Index 50@20.32% H_2O	46.8@ 1.33% H_2O	
HHV, Btu/lb	8775	12997
Ash Softening Temperatures - $^{\circ}F$ ($^{\circ}F$ - degrees F)		
Reducing Conditions		
Initial Deformation	2140	2000
Spherhical	2150	2080
Hemispherical	2165	2310
Fluid	2175	2490

The above analyses are based on two coal samples sent to Babcock Contractors, Inc. by Pickands Mather. They were analyzed by Commercial Testing and Engineering on May 22, 1978, and May 3, 1978. The water content of the Western coal was adjusted from the reported value of 22.8 wt. % to 25.6 wt. % and that of the Eastern coal from 5.5. wt. % to 4.3 wt. %. The equipment in the gasification section shall be sized to handle the range of moisture bracketted by these two adjusted coal analyses.

- E. The gasifier ash removal system shall be designed to handle the ash from coal with 16.6% ash by weight. The ash shall be transported via pneumatic or belt conveyors to silo storage. Storage capacity shall be provided for a four day accumulation, based on commercial level operations using coal with 16.6% ash. Ash shall be moved by mobile equipment from storage to landfill.

3.01.4 Gas Cleanup and Waste Heat Recovery

- A. Gasifier dust shall be removed via gas cyclones and disposed of in a safe and environmentally acceptable manner.
- B. Waste heat recovery shall generate 125 psig saturated steam in process gas coolers on the hot bottom gas outlet.
- C. Precipitated tar and oil shall be combined and pumped to new storage facilities for use as an alternate fuel for iron ore pellet induration and/or firing of the packaged boilers and the waste water incinerator.
- D. The product fuel gas will be tar and particulate free (not more than 0.01 gr/scf of tar and 0.01 gr/scf of particulate at the coal gasification battery limits) as it exits the gas cleaning/waste heat recovery units. The gas shall be cooled to a temperature of 95°F for processing through an H₂S removal system.
- E. Temperature and pressure design conditions at the outlet from the electrostatic precipitator (de-oiler) shall be 95°F and 20" H₂O gauge respectively.

3.01.5 Hydrogen Sulfide Removal

- A. Two process designs of a Stretford H₂S removal system shall be made: one for the Demonstration Plant and a second one which, when added to the Demonstration Plant unit, will provide sufficient capacity for the Commercial Plant unit. The two designs shall be based on use of a high sulfur coal feedstock to the gasifiers (Eastern bituminous coal with a sulfur content of 4.1% by weight), and the following inlet gas composition and flow rates:

Composition		Flow Rates
Component	Vol. %	
H ₂ O	5.58	Demonstration Plant 1.89 x 10 ⁶ scfh
CO	27.13	
CO ₂	3.50	Commercial Plant 5.09 x 10 ⁶ scfh
H ₂	18.90	
N ₂	41.90	
CH ₄	2.09	
C ₂ H ₆	0.07	
H ₂ S	0.75	

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<u>Component</u>	<u>Vol. %</u>
COS	0.08
HCN	10 ppmv
NH ₃	70 ppmv
	100.0

Since the Stretford and Gasifier process designs were developed concurrently, the above gas composition and rates are based on a preliminary gasifier heat and material balance. The effects of the change in gas composition from the above to the final gasifier Eastern coal heat and material balance figures must be evaluated.

- B. Stretford unit oxidizer off-gas shall be discharged to the suction of the gasifier air blowers.
- C. The battery limits design conditions are as follows:
 - Inlet gas: temperature 95°F
 - pressure 20" H₂O gauge
 - Outlet gas: pressure 5" H₂O gauge
- D. The process designs shall not include Stretford solution purge facilities. Liquid purge shall be disposed of to the landfill.
- E. The Commercial and Demonstration plants shall incorporate centrifuges, and a backup system of sulfur melters and decanters. The melters and decanters will be sized to process sulfur froth from the froth tank when the centrifuges are inoperative.
- F. Sulfur shall be disposed of to a landfill site provided by Erie Mining Company.

3.01.6 Gas Compression, Gas Transmission, Retrofit

- A. Two compression process designs shall be made: one for the Demonstration Plant and one for the Commercial Plant. The Demonstration Plant design shall utilize equipment that can readily become part of the Commercial Plant design.

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- B. The fuel gas temperature to the compressors shall be a nominal 100°F. The fuel gas shall be compressed from 5" H₂O gauge to a nominal 12 psig for transmission to the pellet plant.
- C. The fuel gas product pipeline shall be sized for the commercial scale plant.
- D. A new gas distribution system shall be designed for the shaft furnace retrofit application.
- E. For the Demonstration Plant, twelve shaft furnaces shall be retrofitted to accept fuel gas. Of these twelve, three shall be designed to accept tar as well as fuel gas.
- F. For the Commercial Plant, all 27 shaft furnaces shall be retrofitted to accept fuel gas. Six of these furnaces shall be designed to accept tar also.

3.01.7 Waste Water Treatment

- A. As much as possible of the waste water effluent from the gasification plant shall be evaporated and the vapor fed into the fuel gas main to the pellet plant. The waste water remaining after evaporation shall be incinerated.
- B. Sanitary waste shall be handled through the existing pellet plant sewer system.

3.01.8 Gas Effluent Treatment

- A. The Stretford unit off-gas shall be fed to the suction of the gasifier air blowers. The off-gas composition used as the basis for the Eastern coal gasifier heat and material balance is as follows:

<u>Component</u>	<u>Vol. %</u>
CO ₂	0.5
CO	0.1
H ₂	0.1
N ₂	75.5
H ₂ O	7.2
O ₂	<u>16.6</u>
	100.0

Traces of ammonia and methane will also be present.

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- B. Minor differences between the above off-gas composition and the final figures from the Stretford heat and material balance will have no significant effect on the gasifier heat and material balance.
- C. Provisions shall be made to flare the coal gas produced during start up, shutdown and emergency situations. Flares shall be located at the gasifiers proper and also on the suction line to the fuel gas compressors.

3.01.9 Utilities, Buildings and Enclosures

- A. Electric power shall be supplied through an existing substation located on the east side of the pellet plant concentrator. The source voltage will be 13.8kv. New transformers, as required, shall be provided for the coal gasification plant. An emergency electrical back up system shall be installed.
- B. An inert gas generation system with dryers shall be installed. The generator shall be fired with low Btu fuel gas. A liquid nitrogen system shall be installed as a backup to the inert gas generator.
- C. Packaged steam boilers shall be utilized for start up and supplemental use. They will be fired with product tar and/or fuel oil.
- D. Plant and instrument air, including driers for the instrument air, shall be supplied from a new air compressor installation independent of existing facilities. Plant air shall not be dried.
- E. Cooling water shall be supplied through a tie-in to an existing line below the concentrator head tanks. Cooling water shall be returned to the concentrator tailings sump.
- F. Boiler feedwater shall be supplied by treating water from the existing freshwater source in the pellet plant concentrator building.

Potable water will be supplied from the existing pellet plant system.

The firewater system shall tie into the existing plant reservoir and will include new firewater pumps and piping.

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- G. A control room suitable for controlling the facilities for coal gasification, Stretford H₂S removal and gas compression shall be included in one main control center. The coal handling, utility, and waste water incinerator control centers shall be located in their three respective areas.
- H. Wash and change rooms, laboratory facilities and limited work shop facilities shall be provided in the plant area.
- I. Conveyor galleries, coal crushing and screening stations, coal gasification facilities, gas and air compression, pumps, and utility service facilities shall all be enclosed. The Stretford unit shall also be enclosed, with the exception of the venturi scrubbers and knockout drums.

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A process description of the Commercial Plant which has been designed in accordance with the foregoing criteria is presented in the subsequent parts of this section.

3.0 COMMERCIAL PLANT PROCESS DESCRIPTION (continued)

3.02 COAL HANDLING AND PREPARATION

3.02.1 General

The coal handling and preparation system is sized to support operations of the Commercial Plant, and includes all facilities required for unloading, stacking, reclaiming, crushing, screening, fines loadout and delivery of feed to the gasifiers.

The system is designed for handling unsized sub-bituminous Western coal. It will also handle sized Eastern coal to the extent required.

At normal operation the gasifiers will require delivery of plus 1/2" to minus 1-1/2" coal feed or plus 1" to minus 3".

Coal is shipped to the plant in unit trains of 100 cars, each car of 100 tons capacity. On arriving at the south end of the plant a unit train is cut into two strings of 50 cars each for movement to the coal unloading station.

No incoming shipments are scheduled for the four winter months. Train arrivals are scheduled at the rate of about six per month over the other eight months.

An area provided for coal storage has capacity for a 12 month supply.

The flow of materials through the system is shown on flow diagram drawing Y-01-56-2 and is further described under the area headings which follow.

3.02.2 Unloading, Weighing and Stacking

Normally, all unit trains consist of gondola cars equipped with rotary couplers, but there may be an occasional train made up with cars of random lengths and widths and not equipped with rotating couplers. The unloading facilities are capable of handling both types.

A thaw shed is provided for heating any cars arriving with frozen loads. Cars are moved through it at the rate of 5 per hour.

3.02.2 Unloading, Weighing and Stacking (continued)

Gondolas are positioned by the car positioner (CP-101) in the rotary car dumper (DU-101) which discharges the coal into the dumper hopper (BN-101) at the rate of approximately 17 cars per hour.

Random cars are positioned in the rotary dumper, manually uncoupled, and dumped at the rate of approximately 14 cars per hour.

Coal is discharged from the dumper hopper onto three vibrating feeders (MF-101) to collecting conveyor CO-101, which discharges to transfer conveyor CO-102. The transfer conveyor is equipped with a weigh scale (WS-101) which monitors and records the quantity of incoming coal.

Transfer conveyor CO-102 discharges to the active storage pile through a lowering pipe (X-101) which minimizes dust generation. The lowering pipe is equipped with ports covered with rubber flaps. As coal builds up in the pipe, it pours out of the ports nearest to the high point of the pile.

When the active storage pile is filled to its capacity of 5000 tons, or when coal of a different quality arrives, the flow is diverted to conveyor CO-103. From this conveyor the coal is discharged through lowering pipe X-103 to the bypass pile.

Coal is transferred by mobile equipment from the bypass pile to the 180 day storage supply pile, where it is layered, compacted and sealed for protective storage.

3.02.3 Reclaiming

Coal reclaiming is a two shift per day, seven days per week operation.

The daily coal requirement for gasifier feed is supplied from active storage. The active storage pile stands above two reclaim hoppers (BN-102). Two additional reclaim hoppers (BN-103), located outside the storage area, are provided for emergency use.

3.02.3 Reclaiming (continued)

Coal is drawn from the reclaim hoppers by actuation of vibrating feeders (MF-102) or (MF-103), and is discharged on collecting conveyor CO-104. This conveyor is equipped with two tramp metal detectors (X-105), a tramp iron pickup magnet (X-102) and a belt scale (WS-102). Upon detection of ferrous or non-ferrous metal passed by the tramp iron magnet, the protection system automatically shuts down the upstream material supply equipment and marks the location of the tramp metal on the bed of material.

Coal from conveyor CO-104 is normally discharged through a chute to conveyor CO-105 and then to a 1-1/2" x 1-1/2" grizzly for scalping off the plus 1-1/2" material for subsequent crushing by the coal crusher (X-104). If delivered coal sized to plus 1/2" to minus 1-1/2" is being handled, the grizzly is removed manually and the entire flow is delivered through a chute to surge bin BN-104 bypassing the coal crusher.

Coal is removed from the surge bin by two feeders (MF-104) discharging on two single deck screens (VS-101) where the minus 1/2" material is diverted as fines and the plus 1/2" to minus 1-1/2" material is discharged on conveyor CO-106.

Conveyor CO-106 is equipped with a belt (WS-103) scale which monitors and records the amount of coal supplied to the gasification plant. This conveyor discharges the sized coal to the gasifier feed tripper conveyor (CO-107) which automatically controls discharges into twelve gasifier feed surge hoppers. These bins are capable of holding a 12 hour supply of coal to the gasifiers.

3.02.4 Fines Handling

The fines handling system operates two shifts per day and seven days per week.

The minus 1/2" fines flow through chutes from the vibrating screens (VS-101), to collecting conveyor CO-108, then to transfer conveyor CO-109 and then through lowering pipe X-106 to the active fines storage pile. Fines from active storage are moved by mobile equipment to either the fines storage pile in the case of Western coal or to a loading hopper (BN-106) in the case of Eastern coal.

3.02.4 Fines Handling (continued)

Eastern coal fines from loading hopper BN-106 flow to a vibrating feeder (MF-105) to conveyor CO-110 and then into a storage bin (BN-107). Conveyor CO-110 is equipped with a weigh scale (WS-104) which monitors and records the weight of fines being sent to the storage bin. These fines are shipped by rail to Taconite Harbor as trains become available, except that no shipments are made during the months of severe winter weather.

On the Western coal fines, the briquetting facilities are not included within the scope of the equipment requirements for this plant, although an allowance for these facilities is included in the economic analysis of the Western coal case.

3.02.5 Unloading (Alternate)

At the request of Erie Mining Company, an alternate method for unloading incoming coal is shown on drawing 4814X-SK-0001-2.

Flow of coal from the Rotary Car Dumper to conveyor CO-102 is the same as that described under item 3.02.2, but instead of discharging into a lowering pipe it is discharged into a coal unloading radial stacker. The stacker discharges into two separate coal storage piles, one live and one for coals of different quality. Reclaiming from either pile is essentially the same as that described under item 3.02.3.

Installation of this stacker deletes tag numbers X-101 and X-103 (lowering pipes) and CO-103 (conveyor) together with their related appurtenances and also shortens the length of CO-102 (conveyor).

Cost differential for this alternate may be found under item 5.0.

3.0 DEMONSTRATION PLANT PROCESS DESCRIPTION (continued)

3.03 GASIFICATION AND GAS CLEAN UP

3.03.1 General

In this area of the plant coal is processed with steam and air, in gasifier retorts, to form low Btu synthesis gas and condensable by-products. This raw gas is then processed through cyclones, coolers, and electrostatic precipitators to remove solids, tar and oils before being sent to the Sulfur Removal area of the plant. The basic reaction of coal and steam is $C+H_2O \rightleftharpoons H_2+CO$. This reaction is highly endothermic and requires the addition of oxygen to provide the necessary high temperature and heat by reacting with the carbon, hydrogen and carbon monoxide. In practice several reactions are simultaneous and an equilibrium mixture results. The main reactions can be summarized as follows:

In addition to the above the resultant gas mixture contains nitrogen from the air used to supply the oxygen plus tar and oil vapors contained in the coals. The presence of sulfur and other trace elements in the coal will also result in their presence in various chemical combinations in the synthesis gas. Depending on the coals used, typical top gas mixtures would be:

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3.03.1 General (continued)

<u>Component</u>	<u>Western Coal</u>		<u>Eastern Coal</u>	
	<u>Feed</u>	<u>Vol. %</u>	<u>Feed</u>	<u>Vol. %</u>
CO		20.4		22.4
CO ₂		5.5		5.5
H ₂		18.0		17.6
N ₂		34.3		41.56
CH ₄		0.7		1.8
H ₂ O		20.7		9.4
C ₂ to C ₅		0.2		0.8
H ₂ S		0.1		0.8
COS		0.04		0.08
Ammonia		0.06		0.06
HCN		40 ppm		59 ppm
Chloride		14 ppm		130

Virtually all the coal is converted to gas with the exception of a slight amount of unburned carbon and coal ash. A typical ash composition would be:

<u>Component</u>	<u>Wt. %</u>
SiO ₂	37.2
Al ₂ O ₃	21.5
Fe ₂ O ₃	5.3
TiO ₂	0.8
P ₂ O ₅	0.4
CaO	13.4
MgO	4.6
Na ₂ O	2.8
K ₂ O	0.7
SO ₃	13.3
TOTAL	100.0

3.03.1 General (continued)

The typical analyses of tar produced, using the Western and Eastern coals specified for this plant, will be as follows:

TYPICAL ANALYSIS OF TAR PRODUCED

Specific gravity at 60°F	1.0855
Viscosity at 122°F	555.4 cantistokes
210°F	21.25
250°F	9.40

ASTM Dist, correct to atmospheric pressure from test made at 1.2-1.4 mm Hg absolute:

Pour Point	80°F
Flash Point	315°F
Carbon Residue (Rambottom)	4.10 wt.%
Sediment by Extration:	
with Benzene	0.78 wt.%
with Carbon Tet	4.16 wt.%

<u>Ultimate Analysis of Tar</u>	<u>Wt. %</u>
C	82.18
H	9.37
O	7.40
N	0.46
S	0.40
Ash	0.19
	100.0
Heating Value	16,400 Btu/lb

The properties of the oil produced will be similar to those of a light aromatic hydrocarbon mixture.

3.03 GASIFICATION AND GAS CLEAN UP(continued)

3.03.2 Gasifiers

The plant will utilize fixed bed, stirred, two stage gasifiers. The lower stage will be a standard gasifier configuration. The upper stage will be an undivided distillation section containing a slowly rotating stirrer which will also move vertically through the bed. The bottom of the gasifier will contain a standard dry grate and will have lock hoppers to discharge the ash.

This type of gasifier provides high coal utilization. It also distills the tars and oils from the coal in the upper zone at minimum temperatures, thereby providing minimum viscosity liquid fuels which can be used for the induration of iron ore pellets. The very hot bottom gases leaving the combustion zone, after passing through a cyclone to remove coal and ash dust can be used to generate steam. This steam is in addition to the steam generated in the water jacket of the lower zone which is used in the steam air blast to the bottom of the gasifier retort.

A typical gasifier is shown in Figure 1.

A disadvantage of this type of gasifier is the limited size range of feed stock it can accept. Coal fed to the unit must not exceed the size span of 3 to 1. It can handle a maximum of 10% fines. This means only coal ranging from minus 3" to plus 1" or from minus 1-1/2" to plus 1/2", containing no more than 10% fines smaller than these respective minimum sizes, can be used in the plant. Excess fines must be disposed of or agglomerated for recycling. For purposes of the economic studies it is assumed that agglomerated Western coal feed will be made available, but McKee's estimates of capital costs do not include agglomerating facilities.

3.03.3 Gasification Retort Area

Coal is fed to the gasifiers from an overhead surge hopper which provides a 12 hour supply. It is fed into the top of each gasifier with a coal feed system comprised of belt feeders, lock hoppers, level sensors, and feed chambers. Fluctuations in the coal level are handled in the feed chamber which maintains a constant level in the gasifier, never permitting coal to drop into the gasifier and generate fines. The coal level is allowed to fluctuate in the feed chamber between two levels. The low level sensor serves to start the lock hopper cycle and operate the feeder.

The Commercial Plant will utilize twelve two stage gasifiers. Coal is introduced into the top of each gasifier and gravitates through the gasifier in counter flow to the rising gas. The gas is produced by combustion with the air and steam fed into the bottom of each gasifier. As the coal moves down through the upper section of the gasifier, the retort section, it is gradually heated by the rising gas. Volatile matter and moisture are slowly driven off and carried out in the top gas stream. The devolatilized coal travelling down through the gasifier retort zone reacts with the up flowing gas until it reaches the combustion zone. Here the remaining carbon is burned with the incoming air and steam blast, producing gas and the heat for the gasification reactions as well as the devolatilization in the upper stage. The ash forms a bed which supports the combustion zone, protects the grate and preheats the steam/air blast. The condition of the ash is controlled by varying the ratio of steam to air in the blast. The ash is discharged from the bottom of the gasifier, crushed between a revolving ash grate and fixed breaker ring and dropped into the ash lock hopper. From there it is mechanically conveyed to a storage silo prior to disposal to landfill. The quantities of ash produced in the Commercial Plant range from 120 to 150 tons per day, depending on the coal feedstock being used. With a carbon conversion in the gasifier of 98% by weight and an ash content of 9.6 by weight, the carbon content of the ash would be approximately 15% by weight.

3.03.3 Gasification Retort Area (continued)

Air for the gasifiers is supplied at a pressure of 80 inches water gauge by a centrifugal blower. Five blowers are installed, four operating and one spare. Part of the air, about 15 wt. %, will come from the Stretford oxidizer off gas when the Stretford unit is operating. This stream, slightly lower in oxygen content than atmospheric air, is then mixed with the steam produced in the water jackets surrounding the combustion zones of the gasifiers. The steam/air mixture enters the gasifier through the rotating grate and is preheated as it passes through the ash bed. The gasification reactions take place just above the combustion zone, producing the low Btu gas consisting mainly of carbon monoxide, carbon dioxide, hydrogen, water vapor and nitrogen.

At a point just above the gasification zone, a portion of the bottom gas is withdrawn from the gasifier at a temperature in the range of 900°-1200°F. This stream, the "clear gas", exits at the side of the gasifier. The remainder of the gas travels through the upper portion of the gasifier drying and devolatilizing the descending coal. This stream, the "top gas", leaves the gasifier at about 250°F. The flow split between the top gas and the clear gas is controlled to achieve proper coal devolatilization while maintaining a gentle distillation of the coal tars.

3.03.4 Gas Cooling and Waste Heat Recovery

The top gas, containing tar, oil and vaporized water, is collected in a header and passes first through electrostatic precipitators (de-tarrers) where tar mist is coalesced and separated from the gas stream. Six electrostatic precipitators in parallel are provided for this service. After tar removal the gas is combined with cooled clear gas and the mixed gases pass to the final gas coolers. These are shell and tube heat exchangers where the gas is cooled with water to about 95°F. Here water vapor and oil are condensed. The cooled gas flows to a second bank of Six electrostatic precipitators (de-oilers). The oil and water condensed in the final gas coolers is separated from the gas stream and flows by gravity to a decanter tank.

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3.03.4 Gas Cooling and Waste Heat Recovery

The clear gas exits the lower zone of the gasifiers at a temperature of about 1200 F and passes through refractory lined cyclones where the slight amount of entrained char is removed. The char consists mainly of carbon and ash. It may be wetted down and conveyed with the ash to the ash storage silo and from there disposed of to a controlled landfill, or the wetted char may be sent to the coal fines area for mixing with coal fines. Plans for disposition of this char have not been finalized.

The clear gas passes next through a process gas cooler where most of the sensible heat in the gas is recovered in the form of steam. The process gas cooler generated 125 psig steam which is used for general plant heating and other process uses. The clear gas is then combined with the top gas as discussed above. The clean cool gas exiting the precipitators is suitable for introduction into the Stretford hydrogen sulfide removal unit.

When operating with low moisture Eastern coal, a small water spray is added to the gas stream prior to the final gas coolers. This is done since without the spray, there would be no water condensation in the final gas coolers, and chlorides in the gas would pass through to the Stretford unit. By adding a spray of sufficient quantity to cause a small amount of condensation, these chlorides, as well as some ammonia and cyanide, can be removed from the gas stream.

3.03.5 Tar and Oil

Oil and water from the coolers and de-oilers are separated in a decanter tank. The oil is then combined with the tar from the de-tarrers and stored for use as supplemental fuel for the pellet furnaces, for steam generation, or for incineration of liquid wastes. The yield of tar and oil is a function of the volatile matter in the coal. Production of tars and oils will amount to approximately 7722 lbs/hr with use of Western coal and approximately 18,724 lbs/hr with Eastern coal.

3.03.6 Waste Water

The waste water condensed in the gasifier section is pumped from the oil/water decanter tank to a waste water storage tank. The quantity of water can vary greatly depending on the moisture content of the coal feedstock. It can range from near zero with use of a low moisture Eastern coal to about 32,000 gallons per day with a high moisture Western coal.

FIGURE 1

TWO STAGE GASIFIER

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3.0 COMMERCIAL PLANT PROCESS DESCRIPTION (continued)

3.04 SULFUR REMOVAL

In the Stretford process, the Stretford solution absorbs H_2S , converts it to sulfur and is reoxidized by air. The process is based on the ability of vanadium, when in a five-valent state, to react with the bisulfide in an alkaline solution and oxidize it to elemental sulfur. In this reaction the vanadium is reduced to a four-valent state. Oxidation of the solution with air oxidizes the ADA, which is a component of the solution, which in turn oxidizes the vanadium back to the five-valent state for reuse in H_2S removal.

For the Commercial Plant gas flow, a second Stretford unit is added to the Demonstration Plant unit with essentially twice the capacity. The process steps for both units are identical and are as follows:

In the Stretford Unit, the fuel gas first enters the venturi scrubber where it is contacted with lean Stretford solution. This gas/liquid mixture is discharged into the Stretford knock-out drum. The overhead product gas from the knock-out drum contains less than 10 ppm H_2S . The Stretford solution from the bottom of the absorber flows to the reaction tank. Residence time for the sulfur reaction to go to completion takes place in the reaction tank. The overall reaction is:

The solution flows by gravity from the reaction tank through three oxidizers in series, where turbine aerators are used to disperse air supplied by the air blower. The oxidizer tanks perform the dual function of floating off elemental sulfur froth and converting the Stretford solution to the oxidized state. Sulfur froth is collected in the last oxidizer by a launder and flows by gravity to the froth tank. The oxidized solution flows from the last oxidizer to the balance tank, where it is circulated through jacketed pipe and a cooler for maintaining heat and water balance. Stretford solution from the balance tank is pumped back to the venturi scrubber to complete the cycle.

The sulfur froth which has flowed to the froth tank is agitated gently, deaerated, and kept in suspension prior to being pumped to the centrifuge. The centrifuge produces a 40-50% sulfur slurry which is then pumped to the decanter after passing through a heat

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exchanger. The steam melts the sulfur crystals by increasing the slurry temperature. The sulfur is removed from the decanter under level control through a steam jacketed line to the molten sulfur storage tank. Upon sufficient accumulation, molten sulfur is pumped to the flaker for more convenient storage and handling. Stretford solution flows out the top of the decanter and returns to the balance tank on back pressure control.

Auxiliary equipment necessary for the performance of the unit consists of a make-up pit for preparing fresh Stretford solution and adding make-up chemicals; and an additive injection package for adding diesel oil to the solution to aid in flotation of sulfur crystals in the oxidizer tanks.

Several side reactions take place in the circulated Stretford solution producing soluble sulfate salts. When these salts have built up to about 25 weight percent total dissolved salt concentration, a continuous side stream from the circulated solution is drawn off to a purge tank for further disposal.

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3.0 COMMERCIAL PLANT PROCESS DESCRIPTION (continued)

3.05 GAS COMPRESSION, TRANSMISSION AND RETROFIT

- 3.05.1 From the Stretford hydrogen sulfide removal unit, gas passes next to the main gas compressors. It should be noted that when operating on low-sulfur Western Coal, the Stretford unit is by-passed and the gas passes directly from the gas clean-up section to the compressors.

Compression is necessary because the pellet furnace combustion chambers, where the product gas is burned, operate at pressures of 4 to 6 psig. In addition to this, a pressure drop allowance must be made for frictional losses in piping, in control valves at the burners, and in the burners themselves. Including contingency, the total required discharge pressure is about 12 psig. The suction pressure of the compressor is virtually atmospheric since most of the pressure available at the gasifier is taken up in the gas clean-up and Stretford sections.

Three multi-stage centrifugal compressors, two operating and one spare, are provided for this service. Each of the three units is sized to handle 50 percent of the total requirement.

There are two major control loops at the compressors. The first is the discharge pressure control loop in which the pressure in the product gas transmission line is controlled by throttling the suction of the compressors. The second controls the compressor suction pressure upstream of the above throttle valve. The pressure here is controlled by resetting the flow control of combustion air to the gasifiers. The two control loops work together to modulate gasifier output in proportion to gas demand.

3.05.2 Gas Transmission

From the compressors, the gas is transmitted approximately 1200 feet to the Pellet Plant furnaces. The transmission line is 48 inches in diameter. The gas is distributed within the pellet plant through four 24-inch headers.

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3.05.2 Gas Transmission (continued)

The low Btu gas transfer lines are insulated but are not heat traced. The heat of compression is sufficient to maintain the temperature of the gas above its dew-point in cold weather. Low point drains are provided for any condensation that might occur during start-up.

3.05.3 Retrofit

With use of new burners, low Btu gas can readily replace natural gas as fuel in the pellet plant shaft furnaces. New burners are required because the volume of low Btu gas required for a given heat output is much higher than that of natural gas. The new burners specified are capable of firing low Btu gas, natural gas, No. 2 fuel oil, No. 6 fuel oil, and the tar/oil by-product produced in the gasification plant. The low Btu gas pressure drop required for the new burners under normal flow conditions is 1 to 2 psi.

In the existing pellet plant there are two combustion chambers per shaft furnace, each with its own combustion chamber temperature control and combustion controls for natural gas and fuel oil. For the retrofit a new burner is fitted to the existing combustion chamber and the existing valving and instrumentation for natural gas and fuel oil are utilized. New lines and new combustion control valving are added for low Btu gas and for gasifier tar/oil. These controls tie into the existing combustion chamber temperature control loop and the furnace shutdown system.

The low Btu gas lines to the combustion chambers are 10 inches in diameter. A temperature control valve, a pressure control valve, and a manual shut-off valve are provided for each burner train.

The basic control functions provided in the low Btu gas burner trains are identical to those provided in the existing natural gas controls. However, since the operating pressure of the low Btu gas header is much closer to the combustion chamber operating pressure, an additional safety measure is included. A flow sensing device coupled with a low flow shutdown switch is provided at each burner to detect and stop any backflow of air from the combustion chamber should an upset occur.

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3.05.3 Retrofit (continued)

All of the pellet plant's twenty-seven (27) shaft furnaces are retrofitted for use of low Btu gas, and six of them are additionally equipped for use of gasifier tar/oil. The fuel output from the Commercial Plant will supply 100 percent of the pellet plant requirement.

3.0 COMMERCIAL PLANT PROCESS DESCRIPTION (continued)

3.06 UTILITIES

3.06.1 Inert Gas

Commercial Plant inert gas requirements are approximately 15,000 scfh. The generating system is designed to produce 20,000 scfh.

There are three primary uses of inert gas in the plant, namely:

- For pressurizing the gasifier lock hoppers to minimize coal gas leakage at the coal feed mechanism. This accounts for most of the total requirement.
- For purging the gasifier flare lines to prevent entry of air.
- For purging of instrumentation.

Inert gas is supplied by a system consisting of a generator, an aftercooler, a compressor and a dryer. The aftercooler, in which gas from the combustion chamber is cooled, is a shell and tube heat exchanger as opposed to the direct cooling type with a water spray. This choice was made to minimize waste water effluent from the unit.

The generator produces inert gas by precise metering of low Btu fuel gas and air to the combustion chamber in proportions ensuring that complete combustion occurs. The combustion product contains N_2 , CO_2 , water vapor and traces of SO_2 and NH_3 and oxygen.

On leaving the combustion chamber the gas enters the water cooled shell and tube exchanger, in which most of the SO_2 and NH_3 is absorbed by condensing water vapor. Saturated with water vapor, the gas leaves the exchanger at 100°F and 0.3 psig and flows to the compressor.

3.06.1 Inert Gas (continued)

The compressor is a two-stage reciprocating type. Because of the corrosive nature of a liquid water-carbon dioxide mixture, all pipe containing inert gas saturated with water vapor, is steam traced and insulated to maintain the gas at or above its dew point. The saturated gas leaves the compressor aftercooler at 100°F and 110 psig.

The gas then flows to a desiccant dryer where it is dried to a dew point of -50°F. The composition of the final inert gas product is approximately 20.3% CO₂ and 79.7% N₂.

A liquified nitrogen storage tank and an electric vaporizer are provided as backup to supply inert gas at startup and during periods when the generating system is not operating.

3.06.2 Steam

Steam Requirements - A steam balance, based on operation during the winter season with Western coal feed to the gasifiers, indicates a total steam demand of 124,000 pounds per hour for the Commercial Plant. This case requires the maximum quantity of steam and sets the design requirements for steam and boiler feedwater.

Steam Supply - The steam demand is met by contributions from four sources, as follows:

- The Process Gas Coolers, each of which is designed to produce 125 psig steam at the rate of 6040 lb/hr, when operating on Eastern coal. The steam balance requires a combined total steam production by the process gas coolers of 23,000 lb/hr for the Commercial Plant when operating on Western coal.
- The Waste Water Incinerator produces 125 psig steam at a rate of approximately 16,900 lb/hr for the Commercial Plant. A detailed description of the incinerator is given in Section 3.07.

The amounts of steam produced by the process gas coolers and the incinerator are fairly constant and are not controlled. The production rates are a function of the level of plant output and the coal being gasified.

3.06.2 Steam (continued)

- The "Packaged" Boilers, each of which is designed to produce 27,600 lbs/hr. of 125 psig steam. The duty of the packaged boilers is twofold: during normal operations they supply the difference between the amount of steam produced by the process gas coolers and the incinerator, and the total 125 psig steam requirement; and when the process is shut down they supply the entire requirement for area heating, and the steam required for start up.

Two packaged boilers are to be installed for the Demonstration Plant, with provision for addition of a third unit for the Commercial Plant. The need for a third boiler will depend on the coal selected for the Commercial Plant. During normal operation of the Commercial Plant one or two boilers are base loaded, furnishing steam at a constant rate; the other is swing loaded, maintaining pressure in the 125 psig header in the event of surges in demand. The rate at which the base loaded boiler supplies steam is established by the type of coal being gasified (which determines the amount of steam produced by the process gas coolers and the incinerator), by the amount of the requirement of process heat, and by the building heat requirement which varies with the seasons.

- The gasifier jackets, producing 25 psig steam, all of which is consumed in the gasification process.

The pressure levels and approximate quantities of steam required for winter operation on Western coal are as follows:

Steam Requirements - Pounds Per Hour (Winter Operation - Western Coal)

<u>Grade</u>	<u>Commercial Plant</u>
125 psig, saturated	92,420
50 psig, saturated(not reqd. with West.)	0
25 psig 353°F	7,440
25 psig gasifier process steam	<u>37,240</u>
TOTAL	137,100

3.06.02 Steam (continued)

The 125 psig steam from the process gas coolers, the incinerator and the package boilers is sent to a single header, from which the requirements for building heat and other users are taken. Steam from the single header is also sent to reducing stations for production of 50 psig and 25 psig steam. The 50 psig steam is used in the sulfur melter in the Stretford unit when the plant is operating on Eastern coal, and must be desuperheated because of the temperature-viscosity relationship of liquid sulfur. The 25 psig steam is used for deaerating boiler feedwater, and as process steam for the gasifiers at startup. Desuperheating is not required for these uses.

Condensate System

The condensate from approximately half of the above steam is returned to the deaerator for reuse as boiler feedwater. The condensate first enters a deaerator feed surge tank through a sparge nozzle and is mixed with treated makeup water, thereby preheating the make up. The mixture is pumped to the deaerator and is then ready for vaporization.

Boiler Feedwater

Approximately 150 gpm of treated makeup must be supplied to the steam generating equipment. To produce this quantity of treated water requires a maximum of 200 gpm of raw water, which allows for blowdown, backwashing of filters and regeneration of softeners. The raw water is brought from the 18 inch Colby Lake Reservoir water line at Erie Mining Company's Pellet Plant concentrator to the boiler feedwater treatment system. Boiler feedwater treatment consists of the following sequence of processes:

- Clarification, the purpose of which is to remove dissolved matter and turbidity by adding various flocculating agents to the raw water. The clarifier basin provides for addition and mixing of these agents with the raw water, settling of the floc and removal of the coagulated matter. The clarifier underflow is sent to the evaporation pond.

3.06.2 Steam (continued)

- Filtration, where suspended matter not settled out in the clarifier basin is removed mechanically by passing the water through porous media. The development of excessive pressure drop across the filter bed signals a bed condition nearing saturation with contaminants and the need for backwashing. This is accomplished by passing filtered water through the bed in the direction opposite of normal, at a rate sufficient to lift and expand it, thus dislodging the impurities. Backwash effluent goes to the evaporation pond. Filtered effluent goes to the Clearwell sump, which provides surge capacity for filtered water. Its level is controlled by throttling the flow of raw water into the clarifier.
- Softening, to remove the calcium and magnesium ions which form scale on hot surfaces of steam generating equipment. This is done by passing the water through a bed of ion exchange resin which adsorbs the hard calcium and magnesium ions and replaces them with soft sodium ions. In due course the ion exchange medium becomes saturated with hard ions and loses effectiveness. At this point the softener is regenerated by passing through it a strong brine solution rich in sodium ions. The hard ions and the excess salt solution are sent to the evaporation pond. The softened water goes to the deaerator surge tank where it is mixed with returned condensate.
- Deaeration. The feed surge tank operates at atmospheric pressure and at temperatures of 150°F to 180°F. A level control valve in the line between the softener and the tank controls the rate at which the softened makeup is admitted. The makeup-condensate mixture is next pumped to the deaerator, which operates at 5 psig and 225°F, where it is heated to saturation temperature by injection of steam at 25 psig and 353°F. At this temperature all of the carbon dioxide which was dissolved in the makeup water, and most of the oxygen, is released. The final oxygen content is about 0.005 cc/liter. The water is then ready to be pumped to the steam generating equipment.

Two boiler feedwater pumps are provided, one low pressure and the other high pressure. The low pressure pump, which has a design capacity of 85 gpm, sends water to the gasifier jackets for production of the 25 psig steam required in the gasification process. The high pressure pump, which has a design capacity of 200 gpm, sends water to the generators

of 125 psig steam, i.e., the process gas coolers, the waste water incinerator, and the packaged boilers.

3.06.3 Cooling Water

The cooling system is a "once through" design in which the water is passed through heat exchange equipment and is then discharged. The water flows by gravity from a line below the existing Concentrator Head Tanks at the pellet plant to the gasification plant, and returns by gravity to the Tailings Sump in the Concentrator building.

A hydrostatic head of 25 to 30 psi is available for getting the water from the concentrator head tanks, through the gasification plant cooling equipment, and back to the tailings sump. The allowable pressure drop through the cooling equipment is specified as 10 psi, which leaves 15 to 20 psi for frictional pressure loss through the piping. Because of the length of the water supply and return lines (approximately 6200 feet of straight pipe plus fittings) a 24 inch diameter pipe is required for both lines.

No treatment is necessary because no evaporation occurs in the system, and thus there is no concentration of impurities in the water. Erie Mining Company has long used tailings pond water in this manner for cooling and has encountered no corrosion or fouling problems.

The only cost involved are the capital cost of installing the supply and return pipelines, and the operating cost of pumping gasification plant cooling water from the tailings pond to the concentrator head tanks.

3.06.4 Instrument and Plant Air

Total instrument air and plant air requirements are furnished by two identical 500 scfm compressors. The discharge pressure from the compressors is 110 psig.

On leaving the compressor aftercooler the air flow is split. Plant air goes directly to a receiver and thence to the plant air header. Instrument air goes first through a desiccant dryer where it is dried to a dew point of -50°F and then to an instrument air receiver.

3.06.4 Instrument and Plant Air (continued)

Without safeguards, an abnormally heavy demand for plant air would cause a pressure drop in the instrument air header. Occurrence of this condition is prevented by a low pressure switch in the instrument air header which activates a valve to cut off the flow to the plant air header.

To maintain instrument controls in the event of an air compression system failure, provision has been made for supplying nitrogen from the backup nitrogen system described in Paragraph 3.05.1. When the pressure in the instrument air receiver drops below a set point an automatically activated control valve admits nitrogen to the system. At the same time a valve in the discharge line from the air dryers is closed to prevent air from entering the inert gas system.

3.06.5 Electric Power

Distribution

Electrical power for the fuel gas plant is supplied through Erie Mining Company's existing substation No. 1 located on the east side of the pellet plant concentrator. The source voltage is 13.8 kv.

It being desired to centralize the electrical equipment so far as practical, the greater part of it is installed in a main electrical room located adjacent to the gasifiers. However, because of the large loads in the car dumper area and the long distance between that area and the main electrical room, a second load center is located at the car dumper. Also, because of the long runs between the various buildings and conveyors, the motor control centers are located centrally with respect to the loads they feed.

A 13.8 kv feeder runs from the substation to the main electrical room of the gasification plant. It is sized to handle the maximum load capacity of the 7500/8400/10,500 kva transformer at the main electrical room plus that of the 7500/8400 kva transformer at the car dumper electrical room. A secondary feeder, tapped into the main feeder, runs to the car dumper electrical room.

3.06.5 Electric Power (continued)

The major items of electrical equipment, and their locations, are as follows:

- Main Electrical Room: 1 - 7500/8400/10,500 kvs transformer
 2 - 1500/1725 kva transformer
 1 - 4.16 kv switchgear
 1 - 480 v switchgear
 1 - 4000 v motor control center
 3 - 460 v motor control center
- Car Dumper Electrical 1 - 17500/8400 kva transformer
Room: 1 - 4000 v motor control center
 1 - 500 kva transformer
 1 - 460 v motor control center
- Sulfur Removal Building: 1 - 460 v motor control center
- Screening Station: 1 - 460 v motor control center
- Utilities Building: 2 - 460 v motor control centers
- Incinerator Building: 1 - 460 v motor control center

The 13.8 kv feeder voltage is transformed to 4.16 kv at the 7500 kva transformers and the plant power distribution begins at the 4.16 kv switchgear.

The 4.16 kv switchgear feeds the 4000 hp motors, 4000 V motor control centers and the 1500 kva transformers.

The 1500 kva transformers change the 4.16 kv to 480 V and feed the 480 V loads through 480 V switchgear and 460 V motor control centers.

Instrumentation

The instrumentation provided is of the latest proven designs. In general the instruments are electronic. Any required transformation of control signals from electric to pneumatic, etc. are made at the final control device.

The gasifiers and Stretford unit are controlled from a main control room located at the gasifier building. Local control panels are provided in the utilities, waste water treatment and compressor areas.

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3.0 COMMERCIAL PLANT PROCESS DESCRIPTION (continued)

3.07 WASTE WATER INCINERATION

Process waste water is generated by condensation from the process gas stream when it is cooled. This effluent contains contaminants (such as phenols, cyanide, and chlorides) which must be dealt with to avoid pollution of natural waterways. To dispose of this stream, along with two other minor effluent streams, a system of evaporation followed by incineration is used. The other two streams, both less than one gallon per minute, are effluent from the inert gas generating system and water from the flare seal drum.

The major components of the evaporation/incineration system are a dirty water sump, a waste water storage tank, a waste water evaporator and the incinerator. A second evaporator, roughly twice the size of the first, will be added for the Commercial Plant. The other components are sized for the Commercial Plant. Operation on Western coal, with its high moisture content, sets the sizing requirements for all components in this system. For operation on Eastern coal, this entire system is run intermittently to dispose of the relatively small quantity of aqueous waste produced. The waste water incinerator package consists of an incinerator, a waste heat recovery unit, a steam drum, two combustion air compressors, and associated instrumentation.

The contaminated waste water streams flow to the dirty water sump where the aqueous and hydrocarbon phases are separated. Levels in the sump are maintained by on-off control of the sump pumps. The hydrocarbon phase is pumped to the tar and oil storage tanks. The aqueous phase is pumped to the waste water storage tank, which is sized for three days' capacity at the Commercial Plant rate. Because of its outdoor location, the storage tank is insulated and heated with an internal steam coil to prevent freezing.

Waste water is pumped from the storage tank to the evaporator, a kettle-type exchanger using 125 psig saturated steam as the heating medium. Its purpose is to evaporate as much of the water as possible, to minimize the amount remaining to be incinerated. Experience with similar applications indicates that a practical evaporation rate could be about 80% of the feed rate. During operation of the Demonstration Plant, efforts will be made to determine the maximum practical evaporation rate.

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Operation of the evaporator is controlled by the ratio of vapor generated to water entering. This ratio is controlled by adjusting the steam rate to the exchanger so that a given amount of vapor is produced from a given amount of influent. Vapor leaves the exchanger at approximately 15 psig and 250 degrees F. Its pressure is reduced to about 12 psig as the gas is fed to the product gas transmission line.

Water from the evaporator flows to a surge drum, whence it is pumped to the incinerator. The level of the surge drum is controlled by throttling the incinerator feed pump discharge. Water flows from the surge drum to the incinerator at rates ranging from a minimum of 5 gpm to a maximum of 25 gpm. Its approximate composition for Western coal is:

pH	7.9
Total Dissolved Solids	1800 ppm
Sulfide (as H ₂ S)	330 ppm
Total Sulfur	380 ppm
Fatty Acids (as Acetic)	370 ppm
Ammonia (free)	6000 ppm
(fixed)	300 ppm
Carbonate (as CO ₂)	7500 ppm
Cyanide (as CN)	10 ppm
Thiocyanate (CNS)	100 ppm
Chloride (as Cl)	150 ppm

The incinerator is fired with a mixture of by-product tar and oil from the gasification process, or with Bunker "C" fuel oil as backup. The waste water is sprayed into the combustion chamber where it is vaporized and combustible components are bulk oxidized. These, together with the combustion products from the fuel, are vented to the stack.

As mentioned earlier, a waste heat recovery unit is incorporated in the design of the incinerator to recover part of the heat from the hot stack gas. Boiler feedwater is circulated through the tubes of this heat exchanger and steam is exported from the steam drum. The system is designed to produce 15,000 to 20,000 lb/hr of 125 psig steam.

3.0 COMMERCIAL PLANT PROCESS DESCRIPTION (continued)

3.08 SAFETY SYSTEM

To provide for safe operation during certain upsets and also for ease of startup, the plant design includes a flare system which is independent of those provided at the gasifiers. It is tied into the gas circuit upstream of the gas compressors.

The primary function of this system is to provide pressure relief during any upset which causes an overpressure condition on the suction side of the compressor. This condition could occur in the event of a trip of the gas compressor and subsequent failure of the check valves on the compressor discharge.

A second function of the system is to provide an alternate means of gas disposal during start up. The flare is located downstream of the gas clean up and hydrogen sulfide removal facilities. Thus, during start up, gas flow can be initiated through those units and vented to the flare without starting up the compressor and burning the gas in the pellet furnaces. Venting in this manner would also be of value in the event of a compressor failure, since the gasifiers, the gas clean up and the hydrogen sulfide removal sections could stay on line during commissioning of the spare compressor.

The flare itself is essentially a 20 inch diameter carbon steel pipe with a stainless steel flare tip. The tip is equipped with pilots and a pilot ignition system. The flare is tied into the gas compressor suction through a water seal drum which acts as the pressure relief seal and vents gas to the flare when the gas pressure exceeds 30 inches w.g. A second leg in the seal drum is set at a lower pressure. This leg is tied into the gas compressor suction through a pressure control valve and is provided as the alternate vent for startup. In this case the seal drum serves to prevent flashbacks when the system is in use. The flare stack is sized to handle 25 percent of the normal flow of the Commercial Plant, with a short term maximum of 100 percent.

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3.0 COMMERCIAL PLANT PROCESS DESCRIPTION (continued)

3.09 ENVIRONMENTAL CONSIDERATIONS

The Commercial Plant, by virtue of process and equipment selection, safeguards, monitoring and use of available technology, controls environmental pollutants at less than maximum levels allowed by regulatory agencies.

An Environmental Impact Assessment for this plant is being prepared by Erie Mining Company. It will contain data necessary to insure compliance with Federal, Minnesota State and local regulations.

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3.0 COMMERCIAL PLANT PROCESS DESCRIPTION (continued)

3.10 PROCESS FLOW DIAGRAMS

Flow diagrams relating to Commercial Plant processes are listed below by plant area, drawing number, and title. The flow diagrams will be found by reference to the Drawing Index in Section 9, Volume 2, of this report.

<u>Drawing Number</u>	<u>Title</u>
<u>General - Area 00</u>	
Y-00-51-2	Conceptual Block Flow Diagram
Y-00-52-2	Conceptual Flow Diagram
<u>Material Handling - Area 01</u>	
Y-01-54-2	Block Flow Diagram - Eastern Coal
Y-01-55-2	Block Flow Diagram - Western Coal
Y-01-56-2	Coal Handling and Preparation
<u>Gasification - Area 02</u>	
Y-02-85-2	Process Flow Diagram Western Coal - Sheet 1
Y-02-86-2	Process Flow Diagram Western Coal - Sheet 2
Y-02-87-2	Process Flow Diagram Eastern Coal - Sheet 1
Y-02-88-2	Process Flow Diagram Eastern Coal - Sheet 2
<u>Sulfur Removal - Area 03</u>	
* Y-03-51-2	Process Flow Diagram - Stage I
* Y-03-52-2	Process Flow Diagram - Stage I
* Y-03-53-2	Process Flow Diagram - Stage II
* Y-03-54-2	Process Flow Diagram - Stage II
<u>Gas Transmission - Area 04</u>	
Y-04-51-2	Gas Compression (PFD)

* PROPRIETARY DATA, DELETED

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Drawing NumberTitleWaste Treatment - Area 05

Y-05-51-2	Wastewater Facilities - Western Coal
Y-05-52-2	Wastewater Facilities - Eastern Coal

Utilities - Area 06

Y-06-51-2	Cooling Water
Y-06-52-2	Inert Gas and Nitrogen
Y-06-54-2	Plant and Instrument Air
Y-06-55-2	Potable Water and Sanitary Sewer
Y-06-56-2	Steam, Boiler Feedwater and Condensate
Y-06-57-2	Boiler Feedwater Treatment
Y-06-59-2	Settling Pond Water

4.0

PLANT DESCRIPTION

4.01 GENERAL

The Commercial Plant and its facilities are described by reference to the major equipment summaries, other engineering data and drawings contained in Volume 2 of this report.

Under separate headings on the following pages, for each individual plant area, are the following items:

- A list of the equipment within the area.
- Reference to related descriptive material in Section 9.0 of this report.
- References to related drawings in Section 10.0.

The plant areas are:

00	General Plant Area
01	Coal Handling
02	Gasification
03	Sulfur Removal
04	Gas Compression and Transmission
05	Waste Water Treatment
06	Utilities
07	Safety System
08	Pellet Plant Retrofit

4.0 PLANT DESCRIPTION (continued)

4.02 PLANT SITE AND LAYOUT

The plant is sited on Erie Mining Company property west of and adjacent to the battery limits of the existing pellet plant. It is in a hollow, at an elevation lower than that of the pelletizing facilities.

The plant layout is based on the sequential material flow pattern, and incorporates generally accepted equipment spacing standards and safety precautions.

The layout requirements are integrated into the selected site in accordance with good engineering practice. Allowances are made throughout for later expansion of the Demonstration Plant to the Commercial Plant.

The track arrangement is designed for unloading and handling 50 car segments of unit trains, taking into account the specified spacing requirements between the commercial railroad and the Erie Mining Company railroad.

Further descriptive detail with respect to the site and layout will be found in reference to the following materials in other parts of this report.

RELATED ENGINEERING DATA (in Section 9.0, Volume 2)

Engineering Requisition W-1 Preliminary Plant Site Subsurface Explorations

Engineering Requisition W-40 Ambient Noise Surveys

DRAWINGS (in Section 10.0, Volume 2)

<u>Drawing No.</u>	<u>Title</u>
X-00-51-2	Track Plan and Profile
X-00-52-2	General Arrangement
X-00-53-2	Plant Area Profiles
X-00-55-2	Plan of Plant
X-00-56-2	Conveyor Elevations
X-02-51-2	Gasifier Building Arrangement
X-02-65-2	Gas Cleaning Plant
X-02-66-2	Plan and Elevation
X-03-61-2	Stretford Unit Building Arrangement
X-04-51-2	Gas Compressor Building Arrangement
X-05-51-2	Incinerator Building Arrangement
X-06-51-2	Utilities Building Arrangement

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DRAWINGS (in Section 10.0, Volume 2) (continued)

<u>Drawing No.</u>	<u>Title</u>
X-06-53-2	Pump House and Settling Pond
X-09-51-2	Employee Facilities

4.0 PLANT DESCRIPTION (continued)**4.03 COAL HANDLING FACILITIES - AREA 01**

Equipment lists for this area are shown on the immediately following pages.

Further descriptive detail will be found on reference to the following materials in other parts of this report:

RELATED ENGINEERING DATA (in Section 9.0, Volume 2)

Design Data Summary - Pumps - Material Handling - 01

Engineering Requisition U-1 Train Positioner/Car Dumper

Engineering Requisition U-2 Coal Crusher

DRAWINGS (in Section 10.0, Volume 2)

<u>Drawing No.</u>	<u>Title</u>
S-01-51-2	Dust Flow Diagram
S-01-52-2	Dust Flow Diagram
Y-01-60-2	Coal Unloading Station
Y-01-61-2	Coal Storage
Y-01-62-2	Auxiliary Hopper and Transfer Station
Y-01-63-2	Coal Screening and Crushing
Y-01-64-2	Gasifier Feed Conveyor
Y-01-65-2	Coal Fines Reclaiming
Y-01-66-2	Ash Handling

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MCKEE CORPORATION

EQUIPMENT LIST

CONTRACT MC-4814

DATE OCTOBER 26, 1978

CLIENT ERIE MINING COMPANY

UNIT COMMERCIAL

AREA MATERIAL HANDLING 01

DOE CONTRACT ET-78-C-01-2578

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TAG	E/R	P & I NO.	DESCRIPTION
BN-101	U-1	Y-01-60-2	Bin (Dumper Hopper)
BN-102A/B		Y-01-61-2	Bin (Live Storage Reclaim)
BN-103A/B		Y-01-62-2	Bin (Auxiliary Reclaim)
BN-104		Y-01-63-2	Bin (Vibrating Screen Surge Hopper)
BN-106		Y-01-65-2	Bin (Fines Storage Reclaim)
BN-107		Y-01-65-2	Bin (Fine Loadout)
BN-108		Y-01-66-2	Ash Silo
C-101		Y-01-66-2	Air Slide Blower, Ash Silo

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TAG	E/R	P & I NO.	DESCRIPTION	
CO-101		Y-01-60-2	Track Hopper Collecting Conveyor	
CO-102		Y-01-60-2 Y-01-61-2	Raw Coal Transport Conveyor	
CO-103		Y-01-61-2	Raw Coal to Test Pile Conveyor	
CO-104		Y-01-61-2 Y-01-62-2	Reclaim Collecting Conveyor	
CO-105		Y-01-62-2 Y-01-63-2	Coal Transporting Conveyor	
CO-106		Y-01-63-2 Y-01-64-2	Screened Coal Collecting Conveyor	
CO-107		Y-01-64-2	Gasifier Feed Tripper Conveyor	
CO-108		Y-01-63-2	Coal Fines Collecting Conveyor	
CO-109		Y-01-63-2	Fines Transporting Conveyor	
CO-110		Y-01-65-2	Reclaim Fines Transporting Conveyor	
CO-111		X-01-58-2	Raw Coal Transporting Conveyor	Modification of Existing Unloading Station for Existing Heating Plant
COV-112		X-00-51-2 X-01-58-2	Extension to Existing Conv. H-4	Modification of Existing Unloading Station for Existing Heating Plant
CP-101	U-1	Y-01-60-2	Train Positioner	

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TAG	E/R	P & I NO.	DESCRIPTION
DC-101		S-01-51-2 Y-01-63-2	Dust Collector (Crushing & Screening Station)
DC-102		S-01-51-2 Y-01-62-2	Dust Collector (Junction House)
DC-103		S-01-51-2 Y-01-64-2	Dust Collector (Surge Bin)
DC-104		S-01-51-2 Y-01-61-2	Dust Collector (Conveyor CO-102 & 103)
DC-105		S-01-52-2 Y-01-66-2	Dust Suppression (Ash Silo)
DC-106		S-01-52-2 Y-01-60-2	Dust Suppression (Car Dumper Area)
DC-107		S-01-52-2 Y-01-61-2 Y-01-62-2	Dust Collector (Live Storage Area)
DC-108		S-01-52-2 Y-01-65-2	Dust Suppression (Fines Loadout)
DC-109		S-01-52-2 Y-01-63-2 Y-01-65-2	Dust Suppression (Conveyor CO-109, BN-106, & CO-110)
DC-110		S-01-51-2 Y-01-11-2	Dust Collector (Conveyor CO-103)
DC-111			Vacuum Cleaning System for Conveyor CO-102 Gallery
DC-112			Vacuum Cleaning System for Conveyor CO-104 Gallery & Transfer Station
DC-113			Vacuum Cleaning System for Conveyor CO-105 & CO-106 Galleries

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TAG	E/R	P & I NO.	DESCRIPTION
DC-114			Vacuum Cleaning System for Conveyor
			CO-109 Gallery, Crushing & Screening
			Station
DC-115			Vacuum Cleaning System for Conveyor
			CO-107 Gallery
DU-101	U-1	Y-01-60-2	Rotary Car Dumper
H-101		Y-01-60-2	Thaw Shed Heaters

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TAG	E/R	P & I NO.	DESCRIPTION
ME-101			Car Dumper Dozer
ME-102A/B			Raw Coal Dozer
ME-103A/B			Raw Coal Stockpile Scrapers
ME-104			Coal Fines Wheel Loader
MF-101A/B/C		Y-01-60-2	Dumper Hopper Reclaim Vibrating Feeders
MF-102A/B		Y-01-61-2	Storage Pile Reclaim Vibrating Feeders
MF-103A/B		Y-01-62-2	Storage Pile Emergency Reclaim
			Vibrating Feeders
MF-104A/B		Y-01-63-2	Vibrating Screen Vibrating Feeders
MF-105		Y-01-65-2	Fine Storage Reclaim Vibrating Feeder
MF-106		Y-01-66-2	Ash Silo Star Feeder
MF-107		Y-01-66-2	Rotary Wetter/Unloader Feeder

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TAG	E/R	P & I NO.	DESCRIPTION
WS-101		Y-01-60-2	Belt Scale - Conveyor C0-102
WS-102		Y-01-62-2	Belt Scale - Conveyor C0-104
WS-103		Y-01-64-2	Belt Scale - Conveyor C0-106
WS-104		Y-01-65-2	Belt Scale - Conveyor C0-110
X-101		Y-01-61-2	Lowering Pipe
X-102		Y-01-62-2	Tramp Iron Pick-Up Magnet - C0-104
X-103		Y-01-61-2	Lowering Pipe
X-104	U-2	Y-01-63-2	Gasifier Feed Preparation Crusher
X-105A/B		Y-01-62-2	Metal Detector - C0-104
X-106		Y-01-63-2	Lowering Pipe - Fines
X-110			Trolley Hoist - Crushing & Screening Station

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4.0 PLANT DESCRIPTION (continued)

4.04 GASIFICATION - AREA 02

Equipment lists for this area are shown on the immediately following pages.

Further descriptive detail will be found on reference to the following materials in other parts of this report:

RELATED ENGINEERING DATA (in Section 9.0, Volume 2)

Design Data Summary - Pumps - Gasification - 02
Design Data Summary - Tanks - Gasification - 02
Design Data Summary - Vessels - Gasification - 02
Design Data Summary - Exchangers - Gasification - 02

Engineering Requisition W-20 - Coal Gasification Unit Subcontract
Gas Booster Compressors

DRAWINGS (in Section 10.0, Volume 2)

<u>Drawing No.</u>		<u>Title</u>
<u>Stage I</u>	<u>Stage II</u>	
	Y-02-55-2	Symbol and Legend
	Y-02-56-2	Gasifier Module (Typical of 12)
Y-02-68-2	Y-02-69-2	Process Interconnecting
Y-02-70-2	Y-02-71-2	Detarring
Y-02-72-2	Y-02-73-2	Deoiling
Y-02-74-2	Y-02-75-2	Gas Cooling
Y-02-76-2	Y-02-77-2	Utility
Y-02-78-2	Y-02-79-2	Utility
Y-02-80-2	Y-02-81-2	Ash Handling
Y-02-82-2	Y-02-83-2	Ash Handling

MCKEE CORPORATION**EQUIPMENT LIST****CONTRACT** MC-4814**DATE** August 14, 1978**CLIENT** Erie Mining Company**UNIT** Commercial**AREA** Gasification - 02**D.O.E. CONTRACT** ET-78-C-01-2578

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TAG	E/R	P & I NO.	DESCRIPTION
B-201A		Y-02-74-2	Comb. Air Blower
B-201B		Y-02-74-2	Comb. Air Blower
B-201C		Y-02-74-2	Comb. Air Blower
B-201D		Y-02-75-2	Comb. Air Blower
B-201E		Y-02-75-2	Comb. Air Blower
B-202		Y-02-80-2	Ash Cooling Blower
B-203A		Y-02-80-2	Aeration Blower
B-203B		Y-02-80-2	Aeration Blower
B-203C		Y-02-81-2	Aeration Blower
B-203D		Y-02-81-2	Aeration Blower

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TAG	E/R	P & I NO.	DESCRIPTION
BN-201A		Y-02-56-2	Coal Surge Hopper
BN-201B		Y-02-57-2	Coal Surge Hopper
BN-201C		Y-02-58-2	Coal Surge Hopper
BN-201D		Y-02-59-2	Coal Surge Hopper
BN-201E		Y-02-60-2	Coal Surge Hopper
BN-201F		Y-02-61-2	Coal Surge Hopper
BN-201G		Y-02-62-2	Coal Surge Hopper
BN-201H		Y-02-63-2	Coal Surge Hopper
BN-201J		Y-02-64-2	Coal Surge Hopper
BN-201K		Y-02-65-2	Coal Surge Hopper
BN-201L		Y-02-66-2	Coal Surge Hopper
BN-201M		Y-02-67-2	Coal Surge Hopper
BN-203A		Y-02-82-2	Cyclone Dust Bin
BN-203B		Y-02-82-2	Cyclone Dust Bin
BN-203C		Y-02-82-2	Cyclone Dust Bin
BN-203D		Y-02-83-2	Cyclone Dust Bin
BN-203E		Y-02-83-2	Cyclone Dust Bin

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TAG	E/R	P & I NO.	DESCRIPTION
BN-203F		Y-02-83-2	Cyclone Dust Bin
CO-201A		Y-02-80-2	Drag Link Conveyor
CO-201B		Y-02-81-2	Drag Link Conveyor
CO-202A		Y-02-80-2	Drag Link Conveyor
CO-202B		Y-02-81-2	Drag Link Conveyor
CO-203		Y-02-80-2	Drag Link Conveyor
CO-204		Y-02-80-2	Bucket Elevator

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TAG	E/R	P & I NO.	DESCRIPTION
D-201A		Y-02-56-2	L. P. Steam Drum
D-201B		Y-02-57-2	L. P. Steam Drum
D-201C		Y-02-58-2	L. P. Steam Drum
D-201D		Y-02-59-2	L. P. Steam Drum
D-201E		Y-02-60-2	L. P. Steam Drum
D-201F		Y-02-61-2	L. P. Steam Drum
D-201G		Y-02-62-2	L. P. Steam Drum
D-201H		Y-02-63-2	L. P. Steam Drum
D-201J		Y-02-64-2	L. P. Steam Drum
D-201K		Y-02-65-2	L. P. Steam Drum
D-201L		Y-02-66-2	L. P. Steam Drum
D-201M		Y-02-67-2	L. P. Steam Drum
D-202A		Y-02-70-2	HP Steam Drum
D-202B		Y-02-71-2	HP Steam Drum

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TAG	E/R	P & I NO.	DESCRIPTION	
D-203		Y-02-78-2	Flash Tank	BCI Tag No. TN203
E-201A		Y-02-56-2	Process Gas Cooler	
E-201B		Y-02-57-2	Process Gas Cooler	
E-201C		Y-02-58-2	Process Gas Cooler	
E-201D		Y-02-59-2	Process Gas Cooler	
E-201E		Y-02-60-2	Process Gas Cooler	
E-201F		Y-02-61-2	Process Gas Cooler	
E-201G		Y-02-62-2	Process Gas Cooler	
E-201H		Y-02-63-2	Process Gas Cooler	
E-201J		Y-02-64-2	Process Gas Cooler	
E-201K		Y-02-65-2	Process Gas Cooler	
E-201L		Y-02-66-2	Process Gas Cooler	
E-201M		Y-02-67-2	Process Gas Cooler	

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TAG	E/R	P & I NO.	DESCRIPTION
MF-203A		Y-02-80-2	Ash Lock Hopper Assembly
MF-203B		Y-02-80-2	Ash Lock Hopper Assembly
MF-203C		Y-02-80-2	Ash Lock Hopper Assembly
MF-203D		Y-02-80-2	Ash Lock Hopper Assembly
MF-203E		Y-02-80-2	Ash Lock Hopper Assembly
MF-203F		Y-02-80-2	Ash Lock Hopper Assembly
MF-203G		Y-02-80-2	Ash Lock Hopper Assembly
MF-203H		Y-02-80-2	Ash Lock Hopper Assembly
MF-203J		Y-02-80-2	Ash Lock Hopper Assembly
MF-203K		Y-02-80-2	Ash Lock Hopper Assembly
MF-203L		Y-02-80-2	Ash Lock Hopper Assembly
MF-203M		Y-02-80-2	Ash Lock Hopper Assembly
MF-203N		Y-02-81-2	Ash Lock Hopper Assembly
MF-203P		Y-02-81-2	Ash Lock Hopper Assembly
MF-203Q		Y-02-81-2	Ash Lock Hopper Assembly
MF-203R		Y-02-81-2	Ash Lock Hopper Assembly
MF-203S		Y-02-81-2	Ash Lock Hopper Assembly
MF-203T		Y-02-81-2	Ash Lock Hopper Assembly
MF-203U		Y-02-81-2	Ash Lock Hopper Assembly

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TAG	E/R	P & I NO.	DESCRIPTION
P-201A		Y-02-74-2	Tar Transfer Pump - Oper.
P-201B		Y-02-74-2	Tar Transfer Pump - Spare
P-202A		Y-02-74-2	Aqueous Eff. Pump
P-202B		Y-02-74-2	Aqueous Eff. Pump
P-202C		Y-02-75-2	Aqueous Eff. Pump
P-202D		Y-02-75-2	Aqueous Eff. Pump
P-203A		Y-02-74-2	Oil Transfer Pump
P-203B		Y-02-74-2	Oil Transfer Pump
P-203C		Y-02-75-2	Oil Transfer Pump
P-203D		Y-02-75-2	Oil Transfer Pump

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TAG	E/R	P & I NO.	DESCRIPTION
P-204A		Y-02-74-2	Sludge Pump
P-204B		Y-02-75-2	Sludge Pump
P-205		Y-02-78-2	Chemical Sump Pump
P-206A		Y-02-82-2	Hydro Ejector Pump
P-206B		Y-02-82-2	Hydro Ejector Pump
P-206C		Y-02-83-2	Hydro Ejector Pump
P-206D		Y-02-83-2	Hydro Ejector Pump
P-207A		Not Shown	Hydraulic Pump
P-207B		Not Shown	Hydraulic Pump
P-207C		Not Shown	Hydraulic Pump
P-207D		Not Shown	Hydraulic Pump
PIT-201		Y-02-82-2	Chemical Sump

BCI Tag No. TN-204

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TAG	E/R	P & I NO.	DESCRIPTION	
TK-201A		Y-02-74-2	Oil/Water Separator	BCI Tag No. TN-201A&B
TK-201B		Y-02-75-2	Oil/Water Separator	BCI Tag No. TN-201A&B
TK-202		Y-02-74-2	Tar Tank	BCI Tag No. TN-202
X-201A		Y-02-70-2	Tar Precipitator	BCI Tag No. M-201A
X-201B		Y-02-70-2	Tar Precipitator	BCI Tag No. M-201B
X-201C		Y-02-70-2	Tar Precipitator	BCI Tag No. M-201C
X-201D		Y-02-71-2	Tar Precipitator	BCI Tag No. M-201D
X-201E		Y-02-71-2	Tar Precipitator	BCI Tag No. M-201E
X-201F		Y-02-71-2	Tar Precipitator	BCI Tag No. M-201F

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TAG	E/R	P & I NO.	DESCRIPTION	
X-205A		Y-02-72-2	Ash Grate Lube System	BCI Tag No. W-202A
X-205B		Y-02-72-2	Ash Grate Lube System	BCI Tag No. W-202B
X-205C		Y-02-72-2	Ash Grate Lube System	BCI Tag No. W-202C
X-205D		Y-02-72-2	Ash Grate Lube System	BCI Tag No. W-202D
X-205E		Y-02-72-2	Ash Grate Lube System	BCI Tag No. W-202E
X-205F		Y-02-72-2	Ash Grate Lube System	BCI Tag No. W-202F
X-205G		Y-02-72-2	Ash Grate Lube System	BCI Tag No. W-202G
X-205H		Y-02-72-2	Ash Grate Lube System	BCI Tag No. W-202H
X-205J		Y-02-72-2	Ash Grate Lube System	BCI Tag No. W-202J
X-205K		Y-02-72-2	Ash Grate Lube System	BCI Tag No. W-202K
X-205L		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202L
X-205M		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202M
X-205N		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202N
X-205P		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202P
X-205Q		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202Q
X-205R		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202R
X-205S		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202S
X-205T		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202T
X-205U		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202U

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TAG	E/R	P & I NO.	DESCRIPTION	
X-205V		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202V
X-205W		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202W
X-202X		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202X
X-202Y		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202Y
X-202Z		Y-02-73-2	Ash Grate Lube System	BCI Tag No. W-202Z
X-206A		Y-02-74-2	Flare Stack	BCI Tag No. J-201A
X-206B		Y-02-74-2	Flare Stack	BCI Tag No. J-201B
X-206C		Y-02-74-2	Flare Stack	BCI Tag No. J-201C
X-206D		Y-02-75-2	Flare Stack	BCI Tag No. J-201D
X-206E		Y-02-75-2	Flare Stack	BCI Tag No. J-201E
X-206F		Y-02-75-2	Flare Stack	BCI Tag No. J-201F
X-207A		Y-02-72-2	Lock Hopper Lube System	BCI Tag No. W-203A
X-207B		Y-02-73-2	Lock Hopper Lube System	BCI Tag No. W-203B

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4.0 PLANT DESCRIPTION (continued)

4.05 SULFUR REMOVAL - AREA 03

Equipment lists for this area are shown in the immediately following pages.

Further descriptive detail will be found on reference to the following materials in other parts of this report:

RELATED ENGINEERING DATA (in Section 9.0, Volume 2)

Design Data Summary - Pumps - Sulfur Removal - 03
 Design Data Summary - Tanks - Sulfur Removal - 03
 Design Data Summary - Vessels - Sulfur Removal - 03
 Design Data Summary - Exchangers - Sulfur Removal - 03

Engineering Requisition W-21 - Stretford Unit Subcontract

DRAWINGS (in Section 10.0, Volume 2)

<u>Drawing No.</u>		<u>Title</u>
<u>Stage I</u>	<u>Stage II</u>	
Y-03-61-2 *	Y-03-72-2*	Venturi, K.O. Drum, Stretford Solution Cooler
Y-03-62-2	Y-03-73-2*	Reaction and Oxidizer Tank
Y-03-63-2	Y-03-74-2	Oxidizer Air Blowers and Details
Y-03-64-2 *	Y-03-75-2	Froth Tank
Y-03-65-2 *	Y-03-76-2*	Balance Tank and Stretford Solution Heater
Y-03-66-2 *	Y-03-77-2*	Slurry Accumulator, Centrifuge and Make Up Pit
Y-03-67-2 *	Y-03-78-2*	Sulfur Decanter No. 1
Y-03-68-2 *	Y-03-79-2*	Sulfur Decanter No. 2
Y-03-69-2 *	Y-03-80-2*	Sulfur Storage Tank and Flaker
Y-03-70-2	Y-03-81-2	Caustic Tank and Purge Tank
Y-03-71-2	Y-03-82-2	Utilities.

* Proprietary Data - Deleted

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EQUIPMENT LIST

CONTRACT MC-4814

DATE 5-24-78

CLIENT Erie Mining Co.

UNIT Commercial

AREA Sulfur Removal 03

D.O.E. CONTRACT ET-78-C-01-2578

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1 6-20-78 RPH

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TAG	E/R	P & I NO.	DESCRIPTION
322		Y-03-62-2	Reaction Tank Agitator
A-323-A		Y-03-62-2	Turbine Aerator No. 1
A-323-B		Y-03-62-2	Turbine Aerator No. 2
A-323-C		Y-03-62-2	Turbine Aerator No. 3
A-324		Y-03-64-2	Froth Tank Agitator
A-325		Y-03-77-2	Slurry Accumulator Agitator
A-326		Y-03-65-2	Balance Tank Agitator
A-327		Y-03-66-2	Make-up Sump Agitator
A-372		Y-03-73-2	Reaction Tank Agitator
A-373-A		Y-03-73-2	Turbine Aerator No. 1
A-373-B		Y-03-73-2	Turbine Aerator No. 2
A-373-C		Y-03-73-2	Turbine Aerator No. 3
A-374		Y-03-75-2	Froth Tank Agitator
A-375		Y-03-77-2	Slurry Accumulator Agitator
A-376		Y-03-76-2	Balance Tank Agitator
A-377		Y-03-77-2	Make-up Sump Agitator

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TAG	E/R	P & I NO.	DESCRIPTION	
B-311-A		Y-03-63-2	Oxidizer Air Blower No. 1	
B-311-B		Y-03-63-2	Oxidizer Air Blower No. 2	(Spare)
B-312-A		Y-03-62-2	Exhaust Fan No. 1	
B-312-B		Y-03-62-2	Exhaust Fan No. 2	(Spare)
B-361-A		Y-03-74-2	Oxidizer Air Blower No. 1	
B-361-B		Y-03-74-2	Oxidizer Air Blower No. 2	(Spare)
B-362-A		Y-03-73-2	Exhaust Fan	
B-362-B		Y-03-73-2	Exhaust Fan	(Spare)
E-337		Y-03-65-2	Jacketed Pipe	
E-303-A		Y-03-67-2	Sulfur Melter No. 1	
E-303-B		Y-03-68-2	Sulfur Melter No. 2	
E-304		Y-03-61-2	Stretford Solution Cooler	
E-333		Y-03-63-2	Condensate Unit Condenser	
E-353-A		Y-03-78-2	Sulfur Melter No. 1	
E-353-B		Y-03-79-2	Sulfur Melter No. 1	

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TAG	E/R	P & I NO.	DESCRIPTION
E-354		Y-03-72-2	Stretford Solution Cooler
E-384		Y-03-76-2	Jacketed Pipe
E-385		Y-03-81-2	Purge Tank Heater
E-386		Y-03-81-2	Caustic Tank Heater
D-315		Y-03-64-2	Froth Tank
D-317		Y-03-65-2	Balance Tank
MS-321		Y-03-69-2	Flaker
MS-328		Y-03-61-2	Venturi Scrubber
MS-329		Y-03-62-2	Additive Injection Package
MS-371		Y-03-80-2	Flaker
MS-378		Y-03-72-2	Venturi Scrubber

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TAG	E/R	P & I NO.	DESCRIPTION	
P-305-A		Y-03-64-2	Slurry Charge Pump No. 1	
P-305B		Y-03-64-2	Slurry Charge Pump No. 2	(Spare)
P-306-A		Y-03-65-2	Solution Circulating Pump No. 1	
P-306-B		Y-03-65-2	Solution Circulating Pump No. 2	
P-306-C		Y-03-65-2	Solution Circulating Pump No. 3	(Spare)
P-307		Y-03-66-2	Centrifuge Slurry Pump	
P-308		Y-03-66-2	Make-up Pump	
P-309-A		Y-03-69-2	Flaker Feed Pump No. 1	
P-309-B		Y-03-69-2	Flaker Feed Pump No. 2	(Spare)
P-310-A		Y-03-70-2	Caustic Metering Pump	
P-310-B		Y-03-70-2	Caustic Metering Pump	(Spare)
P-331-A		Y-03-61-2	Wash Water Pump	
P-331-B		Y-03-61-2	Wash Water Pump	(Spare)
P-334-A		Y-03-63-2	Condensate Pump	
P-334-B		Y-03-63-2	Condensate Pump	(Spare)
P-335		Y-03-70-2	Purge Unloading Pump	
P-355-A		Y-03-75-2	Slurry Charge Pump No. 1	
P-355-B		Y-03-75-2	Slurry Charge Pump No. 2	(Spare)

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TAG	E/R	P & I NO.	DESCRIPTION	
P-356-A		Y-03-76-2	Solution Circulating Pump No. 1	
P-356-B		Y-03-76-2	Solution Circulating Pump No. 2	
P-356-C		Y-03-76-2	Solution Circulating Pump No. 3	(Spare)
P-357		Y-03-77-2	Centrifuge Slurry Pump	
P-358		Y-03-77-2	Make-up Pump	
P-359-A		Y-03-80-2	Flaker Feed Pump No. 1	
P-359-B		Y-03-80-2	Flaker Feed Pump No. 2	(Spare)
P-360-A		Y-03-81-2	Caustic Metering Pump No. 1	
P-360-B		Y-03-81-2	Caustic Metering Pump No. 2	
P-381-A		Y-03-72-2	Wash Water Pump	
P-381-B		Y-03-72-2	Wash Water Pump	(Spare)
P-382		Y-03-81-2	Purge Unloading Pump	
PIT-330		Y-03-66-2	Make-up Sump	
PIT-380		Y-03-77-2	Make-up Sump	

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TAG	E/R	P & I NO.	DESCRIPTION
T-301		Y-03-61-2	Knockout Drum
T-351		Y-03-72-2	Knockout Drum
TK-302-A		Y-03-67-2	Sulfur Decanter No. 1
TK-302-B		Y-03-68-2	Sulfur Decanter No. 2
TK-313		Y-03-62-2	Reaction Tank
TK-314-A		Y-03-62-2	Oxidizer Tank No. 1
TK-314-B		Y-03-62-2	Oxidizer Tank No. 2
TK-314-C		Y-03-62-2	Oxidizer Tank No. 3
TK-316		Y-03-66-2	Slurry Accumulator
TK-318		Y-03-69-2	Sulfur Tank
TK-319		Y-03-70-2	Caustic Tank
TK-332		Y-03-63-2	Condensate Drum
TK-336		Y-03-70-2	Purge Tank
TK-352-A		Y-03-78-2	Sulfur Decanter No. 1
TK-353-B		Y-03-79-2	Sulfur Decanter No. 2
TK-363		Y-03-73-2	Reaction Tank

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4.0 PLANT DESCRIPTION (continued)

4.06 GAS COMPRESSION AND TRANSMISSION - AREA 04

Equipment lists for this area are shown in the immediately following pages.

Further descriptive detail will be found on reference to the following materials in other parts of this report:

RELATED ENGINEERING DATA (in Section 9.0, Volume 2)

Design Data Summary - Compressors - Gas Transmission - 04

Engineering Requisition G-1 - Gas Booster Compressors

DRAWINGS (in Section 10.0, Volume 2)

<u>Drawing No.</u>	<u>Title</u>
Y-04-61-2	Gas Compression

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4.0 PLANT DESCRIPTION (continued)4.07 WASTE WATER TREATMENT - AREA 05

Equipment lists for this area are shown in the immediately following pages.

Further descriptive detail will be found on reference to the following materials in other parts of this report.

RELATED ENGINEERING DATA (in Section 9.0, Volume 2)

Design Data Summary - Pumps - Waste Treatment - 05
Design Data Summary - Tanks - Waste Treatment - 05
Design Data Summary - Vessels - Waste Treatment - 05
Design Data Summary - Exchangers - Waste Treatment - 05

DRAWINGS (in Section 10.0, Volume 2)

<u>Drawing No.</u>	<u>Title</u>
Y-05-61-2	Waste Water Evaporation
Y-05-62-2	Incinerator and Stack System

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TAG	E/R	P & I NO.	DESCRIPTION	
B-501A/B		Y-05-62-2	Combustion Blowers	See X-501
D-501		Y-05-61-2	Surge Drum	
E-501		Y-05-61-2	Waste Water Evaporator	
E-502		Y-05-61-2	Waste Water Evaporator	
E-503		Y-05-61-2	Waste Water Storage Tank Htr. (incl. with TK-501)	
P-501A/B		Y-05-61-2	Evaporator Feed Pumps	
P-502A/B		Y-05-61-2	Incinerator Feed Pumps	
P-503		Y-05-61-2	Dirty Oil Sump Pump	
P-504		Y-05-61-2	Dirty Water Sump Pump	
PIT-501		Y-05-61-2	Oil/Water Separator Sump	
TK-501		Y-05-61-2	Waste Water Storage Tank	
X-501		Y-05-62-2	Waste Water Incinerator Package (incl. with package) B501A/B Combustion Blowers	

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4.0 PLANT DESCRIPTION (continued)

4.08 UTILITIES - AREA 06

Equipment lists for this area are shown in the immediately following pages.

Further descriptive detail will be found on reference to the following materials in other parts of this report.

RELATED ENGINEERING DATA (in Section 9.0, Volume 2)

Design Data Summary - Pumps - Utilities - 06
Design Data Summary - Tanks - Utilities - 06
Design Data Summary - Compressors - Utilities - 06
Design Data Summary - Vessels - Utilities - 06
Design Data Summary - Exchangers - Utilities - 06

Engineering Requisition H-6 - Packaged Steam Boilers

DRAWINGS (in Section 10.0, Volume 2)

<u>Drawing No.</u>	<u>Title</u>
Y-06-70-2	Inert Gas Generation
Y-06-71-2	Inert Gas Compression and Drying
Y-06-72-2	Liquid Nitrogen Storage and Vaporization
Y-06-73-2	Instrument and Plant Air System
Y-06-74-2	Bunker "C" and Tar/Oil
Y-06-75-2	BFW Filtration
Y-06-76-2	BFW Softening
Y-06-77-2	BFW Deaeration and Pumps
Y-06-78-2	Steam Generation
Y-06-79-2	Fire Control Diagram
Y-06-80-2	Settling Pond Water
Y-06-82-2	Steam Reducing Stations
Y-06-90-2	Cooling and Potable Water
Y-06-92-2	Steam, Condensate and Feed Water
Y-06-94-2	Plant and Instrument Air - Sheet 1
Y-06-95-2	Plant and Instrument Air - Sheet 2
Y-06-96-2	Underground Piping - Sheet 1
Y-06-97-2	Underground Piping - Sheet 2
Y-06-98-2	Inert Gas
Y-06-99-2	Utilities Tie-In

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TAG	E/R	P & I NO.	DESCRIPTION	
A-601		Y-06-75-2	Alum Feed Tank Agitator	See X-604
A-602		Y-06-75-2	Chlorine Feed Tank Agitator	See X-604
A-603		Y-06-75-2	Polymer Feed Tank Agitator	See X-604
B-601		Y-06-70-2	Inert Gas Generator Air Blower	See X-601
C-601A/B		Y-06-71-2	Inert Gas Compressors (inc. w/package) E-602 Inert Gas Compressor Aftercooler E-606 Inert Gas Compressor Intercooler	
C-602A/B		Y-06-73-2	Instrument & Utilities Air Compressors (included with package) E-607A/B Inst. & Plant Air Intercoolers	
			E-608A/B Inst. & Plant Air Aftercoolers	
D-601		Y-06-71-2	Inert Gas Compressor Suction KO Drum	
D-602		Y-06-71-2	Inert Gas Surge Drum	
D-603		Y-06-72-2	Liq. Nitrogen Storage Tank (by others)	See X-608
D-604		Y-06-77-2	Deaerator Feed Surge Tank	
D-606		Y-06-73-2	Instrument Air Receiver	
D-607		Y-06-78-2	Packaged Boiler Blowdown Separator Drum	Common for H-601, A, B and C
D-608		Y-06-73-2	Plant Air Receiver	

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TAG	E/R	P & I NO.	DESCRIPTION	
E-601		Y-06-70-2	Inert Gas Generator Aftercooler	See X-601
E-602		Y-06-71-2	Inert Gas Compressor Aftercooler	See C-601A/B
E-603		Y-06-72-2	Liq. Nitrogen Vaporizer (by others)	See X-608
E-604		Y-06-74-2	Bunker "C" Oil Heater	
E-605		Y-06-74-2	Tar/Oil Heater	
E-606		Y-06-71-2	Inert Gas Compressor Intercooler	See C-601A/B
E-607A/B		Y-06-73-2	Instrument & Plant Air Intercoolers	See C-602A/B
E-608A/B		Y-06-73-2	Instrument & Plant Air Aftercoolers	See C-602A/B
E-609		Y-06-77-2	Stretford Condensate Cooler	
E-610		Y-06-74-2	Bunker "C" Oil Tank Heater	with TK-605
E-611		Y-06-74-2	Tar/Oil Tank Heater	with TK-606
EG-601			Engine Driven Synchronous Generator	
EG-602			Emergency Power Control System	
EG-603			Non-interruptible Power System	
FIL-601A/B		Y-06-75-2	Boiler Feedwater Filters	See X-604

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TAG	E/R	P & I NO.	DESCRIPTION	
H-601A/B/C		Y-06-78-2	Packaged Steam Boilers (incl. w/package)	
			D-607 Packaged Boiler Blowdown Sep.	
			Drum	
			B-603 A, B & C Combustion Air Blowers	
			C-603 A, B & C Atomizing Air Compressors	
P-601A/B		Y-06-75-2	Boiler Feedwater Softener Feed Pumps	
P-602A/B		Y-06-77-2	Deaerator Feed Pumps	
P-603A/B		Y-06-77-2	Low Pressure Boiler Feed Pumps	
P-604A/B		Y-06-77-2	High Pressure Boiler Feed Pumps	
P-605		Y-06-75-2	Alum Metering Pump	See X-604
P-606		Y-06-75-2	Chlorine Metering Pump	See X-604
P-607		Y-06-75-2	Polymer Metering Pump	See X-604
P-608 A/B		Y-06-74-2	Bunker "C" Oil Pumps	
P-609A/B		Y-06-74-2	Tar/Oil Pumps	
P-610A/B		Y-06-79-2	Fire Water Loop Pumps	
P-611		Y-06-80-2	Settling Pond Overflow Pump	
P-612A/B		Y-06-77-2	Stretford Process Water Pumps	

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TAG	E/R	P & I NO.	DESCRIPTION	
P-613		Y-06-80-2	Pond Sump Water Pump	
P-614		Y-06-80-2	Pond Sump Oil Pump	
P-615		Y-06-96-2	Sewage Lift Station	
TK-601		Y-06-75-2	Alum Feed Tank	See X-604
TK-602		Y-06-75-2	Chlorine Feed Tank	See X-604
TK-603		Y-06-75-2	Polymer Feed Tank	See X-604
TK-605		Y-06-74-2	Bunker "C" Oil Tank	
TK-606		Y-06-74-2	Tar/Oil Tank	
PIT-601		Y-06-75-2	Clearwell	
PIT-602		Y-06-80-2	Pond Sump	
X-601		Y-06-70-2	Inert Gas Generator	
			(included with package)	
			B-601 Inert Gas Generator Air Blower	
			E-601 Inert Gas Generator Aftercooler	

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TAG	E/R	P & I NO.	DESCRIPTION
X-602A/B		Y-06-71-2	Inert Gas Dryers
X-603		Y-06-73-2	Instrument Air Dryer
X-604		Y-06-75-2	Boiler Feedwater Clarifier
			(Included with package)
			A-601 Alum Feed Tank Agitator
			A-602 Chlorine Feed Tank Agitator
			A-603 Polymer Feed Tank Agitator
			A-605 Alum Metering Pump
			A-606 Chlorine Metering Pump
			A-607 Polymer Metering Pump
			TK-601 Alum Feed Tank
			TK-602 Chlorine Feed Tank
			TK-603 Polymer Feed Tank
			FIL-601A/B BFW Filters
X-606A/B		Y-06-76-2	Boiler Feedwater Softeners
X-607		Y-06-77-2	Boiler Feedwater Deaerator

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4.0 PLANT DESCRIPTION (continued)

4.09 SAFETY SYSTEM - AREA 07

Equipment lists for this area are shown in the immediately following pages.

Further descriptive detail will be found on reference to the following materials in other parts of this report.

RELATED ENGINEERING DATA (in Section 9.0, Volume 2)

Design Data Summary - Vessels - Safety System - 07

DRAWINGS (in Section 10.0, Volume 2)

<u>Drawing No.</u>	<u>Title</u>
Y-07-60-2	Seal Drum and Flare Stack

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4.0 PLANT DESCRIPTION (continued)

4.10 PELLET PLANT RETROFIT - AREA 08

Equipment lists for this area are shown in the immediately following pages.

Further descriptive detail will be found on reference to the following materials in other parts of this report.

DRAWINGS (in Section 10.0, Volume 2)

<u>Drawing No.</u>	<u>Title</u>
Y-08-60-2	Routing Diagram
Y-08-61-2	Details at Typical Combustion Chamber

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TAG	E/R	P & I NO.	DESCRIPTION
X-801		Y-08-61-2	Shaft Furnace Multiple Fuel Burner
X-801-D1A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace D-1
X-801-D1B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace D-1
X-801-D2A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace D-2
X-801-D2B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace D-2
X-801-D3A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace D-3
X-801-D3B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace D-3
X-801-D4A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace D-4
X-801-D4B		Y-08-61-2	Burner of West Combustion Chamber of Shaft Furnace D-4
X-801-E1A		Y-08-61-2	Burner of East Combustion Chamber of Shaft Furnace E-1
X-801-E1B		Y-08-61-2	Burner of West Combustion Chamber of Shaft Furnace E-1
X-801-E2A		Y-08-61-2	Burner of East Combustion Chamber of Shaft Furnace E-2
X-801-E2B		Y-08-61-2	Burner of West Combustion Chamber of Shaft Furnace E-2
X-801-E3A		Y-08-61-2	Burner of East Combustion Chamber of Shaft Furnace E-3
X-801-E3B		Y-08-61-2	Burner of West Combustion Chamber of Shaft Furnace E-3
X-801-E4A		Y-08-61-2	Burner of East Combustion Chamber of Shaft Furnace E-4
X-801-E4B		Y-08-61-2	Burner of West Combustion Chamber of Shaft Furnace E-4
X-801-F1A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace F-1
X-801-F1B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace F-1

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TAG	E/R	P & I NO.	DESCRIPTION
X-801-F2A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace F-2
X-801-F2B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace F-2
X-801-F3A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace F-3
X-801-F3B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace F-3
X-801-F4A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace F-4
X-801-F4B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace F-4
X-801-A1A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace A-1
X-801-A1B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace A-1
X-801-A2A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace A-2
X-801-A2B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace A-2
X-801-A3A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace A-3
X-801-A3B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace A-3
X-801-A4A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace A-4
X-801-A4B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace A-4
X-801-B1A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace B-1
X-801-B1B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace B-1
X-801-B2A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace B-2
X-801-B2B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace B-2

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X-801-B3A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace B-3
X-801-B3B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace B-3
X-801-B4A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace B-4
X-801-B4B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace B-4
X-801-C1A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace C-1
X-801-C1B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace C-1
X-801-C2A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace C-2
X-801-C2B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace C-2
X-801-C3A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace C-3
X-801-C3B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace C-3
X-801-C4A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace C-4
X-801-C4B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace C-4
X-801-G1A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace G-1
X-801-G1B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace G-1
X-801-G3A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace G-3
X-801-G3B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace G-3
X-801-H1A		Y-08-61-2	Burner for East Combustion Chamber of Shaft Furnace H-1
X-801-H1B		Y-08-61-2	Burner for West Combustion Chamber of Shaft Furnace H-1

5.0

CAPITAL COSTS

5.01 CAPITAL COST SUMMARY

The capital cost for the Commercial Plant, estimated to an accuracy of $\pm 20\%$, is as follows:

TABLE 7

CAPITAL COST SUMMARY

(4th Quarter 1978 Price Basis)

<u>Plant Area</u>	<u>With Sulfur Removal</u>	<u>Without Sulfur Removal</u>
01 - Material Handling	\$ 15,984,000	\$ 15,984,000
02 - Gasification	27,303,000	24,864,000
03 - Sulfur Removal	10,480,000	-
04 - Gas Compression	3,074,000	3,074,000
05 - Waste Treatment	855,000	855,000
06 - Utilities	13,367,000	13,367,000
07 - Safety Systems	143,000	143,000
08 - Retrofit	3,038,000	3,038,000
09 - Employee Facilities	189,000	189,000
 TOTAL DIRECT COST	 \$ 74,433,000	 \$ 61,514,000
 Construction Management (including overhead and fee)	 4,118,000	 4,118,000
 Professional Services (including overhead and fee)	 13,962,000	 13,462,000
 Royalties (Know How Fees)	 525,000	 204,000
 Taxes	 1,998,000	 1,651,000
 Insurance	 752,000	 621,000
 TOTAL PLANT COST	 \$ 95,788,000	 \$ 81,570,000
 Potential Escalation	 19,158,000	 16,314,000
 Contingency Recommendation	 9,579,000	 8,157,000
 TOTAL CAPITAL INVESTMENT	 \$124,525,000	 \$106,041,000

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5.0 CAPITAL COST SUMMARY

5.02 DETAIL ESTIMATES

General

The following represents the details and bases used for the preparation of the Capital Cost Estimate.

Detailed estimates for each plant area are summarized on McKee's standard three-page Direct Cost Summary sheets. The total project is then summarized, first by plant area, and then by discipline.

Area Description

The following is a brief description of the basis of estimate used. It also indicates the general philosophy developed for the allocation of direct costs.

Area 01 - Material Handling

This area includes most of the material handling equipment for the entire plant. The coal handling equipment train begins with the car dumper/positioner and continues with conveyors, feeders, screens, crushers, bins and hoppers, and terminates with conveyor CO-106, which carries coal into the Gasifier Building. Included also, are all site improvements except the settling pond, which is in Area 06 - Utilities. Included in site improvements are the new railroad tracks, overpass, bin walls, roads, parking areas and the overall site grading. Included also, are all foundations, buildings, structures, electrical work and instrumentation supporting the material handling equipment. The conveyor galleries and structures, from the coal reclaim hoppers, to the Gasifier Building, are heated and carry insulated siding. The structures and galleries supporting incoming coal and fines disposal are unheated with uninsulated siding. Piping, except for that included in dust suppression or vacuum cleaning systems, is included in Area 06 - Utilities. This material handling section is sized for a Commercial Plant with a capacity three times that of the Demonstration Plant.

Area 01 - Soils Problem

The subsurface exploration report indicates that the area west of the existing pelletizing plant, which is the site selected for the Gasification Plant, is underlain by a layer of peat, from two to ten feet thick and from six to ten feet below the surface. Subsequent conversations with local builders who took part in the original construction in the late 1950's indicate that much of the rubble, debris and large boulders removed from the original construction site were dumped in this area. The estimate, therefore,

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5.02 DETAIL ESTIMATES (continued)

Area 01 - Soils Problem (continued)

includes the cost for removing and stockpiling the rubble fill, stripping, and disposal of the peat, replacement with granular fill from Erie's coarse tailings pond, and reinstallation of that stockpiled material which is found suitable. This remedial earthwork is included only in the immediate area of the building and equipment foundations. The coal piles, which will compress the underlying peat, will be located on a higher level, to be specified by the soils engineer, so that after compression of the peat, the base of the piles will be at plant grade.

Area 02 - Gasification

The Gasification Section is made up of an estimate prepared by BCI plus an estimate prepared by McKee.

The BCI estimate contains the twelve gasifiers and all auxiliary equipment, process piping, electrical and instrumentation, equipment foundations and structural supports, and platform steel.

The McKee estimate contains the gasification building 244 feet long, structural steel, building foundations, control room, electrical room, HVAC, elevator, cranes and the incoming tripper conveyor CO-107. Included also are all electrical work and primary electrical services, and the 13,800 volt feeders from the concentrator main substation. The instrument panels in the control room are included but no instrument wiring. All siding is insulated. The control and electrical rooms and the penthouse carrying the incoming coal feed conveyor are heated. The balance of the building housing the gasifiers is unheated. Piping for building services is included with Area 06 - Utilities.

For the economic case of the plant operating on non-caking low sulfur Western coal, the gasifier retorts are installed without stirrers.

Area 03 - Sulfur Removal

The Sulfur Removal Section, The Stretford Plant, is made up of two estimates.

5.02 DETAIL. ESTIMATES (continued)

Area 03 - Sulfur Removal (continued)

One estimate is based on the original Parsons proposal estimate and includes the process equipment, foundations, piping, electrical and instrumentation work required to provide a complete operating Stretford Plant.

The McKee estimate includes a 350 foot long building, foundations, structural steel, HVAC equipment, building crane, electrical for building services, and the 480 volt motor control centers. The building has insulated siding and is heated. Piping for building services is included with Area 06.

For the economic case of the plant operating on non-caking, low sulfur Western coals, there is no Sulfur Removal Section in the plant.

Area 04 - Gas Compression

The estimate includes the three low Btu product gas compressors, and the pre-engineered insulated building in which they are housed. Also included are building and equipment foundations, heating and ventilating, electrical for building and process and instrumentation. Process and building services piping are included with Area 06.

Area 05 - Waste Water Treatment

This system collects oily waste water from the gasifier decanter tanks and various plant drains. Oil which is separated out in the oil separator sump is transferred to the tar oil storage tank for use as fuel in the indurating furnaces. The remaining waste water is then evaporated and incinerated. The estimate includes all equipment, foundations, insulated/heated pre-engineered building and related electrical and instrumentation. All piping is with Area 06.

Area 06 - Utilities

This estimate includes the settling pond and all auxiliary and supporting equipment for the entire plant, including three package boilers, feedwater treatment, air compressors, inert gas generator, storage tanks and fire pumps. The equipment is housed in an insulated, heating, pre-engineered building. Also included is all electrical wiring and equipment serving the utility equipment and yard lighting and grounding systems. Included in piping is all process piping for the gasification plant outside the scope of the BCI and Parsons estimates, and all utility and building

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5.02 DETAIL ESTIMATES (continued)

Area 06 - Utilities (continued)

services for the entire plant.

Area 07 - Safety Systems

This estimate includes the seal drum, flame front generator, flare tip, and a 150 foot guyed flare stack for flaring of product gas in emergencies. Also included are foundations, electrical and instrumentation. Piping is included in Area 06.

Area 08 - Retrofit

The estimate includes only the burners, process piping, electrical and instrumentation work required to retrofit 27 of the existing induration furnaces for firing of low Btu gas, natural gas, No. 6 fuel oil or residual tars and oils from the gasification process. The work, which begins with the supply manifolds on the west wall, is contained entirely within the existing pelletizing building.

Area 09 - Employee Facilities

The estimate includes the insulated, heated, pre-engineered building housing the employee locker and lunch rooms. Electrical building services include the 480 volt panels. Piping for building services is included with Area 06.

Estimate Quality

The BCI estimate for the process portion of Area 02 - Gasification, is labelled "preliminary" based on the design concept in effect as of August, 1978, when BCI suspended work pending resolution of certain contractual matters. No "basis" is available from BCI for this estimate. Therefore, following a brief review of the major cost areas with BCI estimating personnel, an arbitrary accuracy has been assigned to their estimate by McKee.

The Parsons estimate for the process portion of Area 03 - Sulfur Removal - was not received due to contractual problems. The estimate used for the Stretford Plant is the budget estimate provided by Parsons with their original proposal, adjusted for the addition of a flaker. No breakdown was provided by Parsons beyond a split between major equipment and tagged instruments and construction costs. An arbitrary accuracy has also been assigned by McKee to the Parsons budget estimate.

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5.02 DETAIL ESTIMATES (continued)

Major Equipment Costs

Major equipment is indicated in the equipment lists and flow diagrams. Engineering requisitions were prepared for the long lead time items which include only the product gas compressors, car dumper/positioner, and package boilers. The remaining equipment was described on simple price requests. Fixed price competitive bids were solicited by the Purchasing Department and all quotations were analyzed by the Engineering Department for technical compliance. The lowest technically responsive bids were utilized in the estimate. All equipment pricing includes the cost of freight to Hoyt Lakes, Minnesota. For certain equipment categories, where vendor supervision is usually advisable during the startup period, an allowance was added based on the number of days the vendors representative would be required.

The following equipment is assumed to be purchased on an installed cost basis.

- Car Dumper/Positioner
- Ash Silo
- Coal Bins, Chutes and Hoppers
- Field Erected Tanks

The balance of the 0100 to 1900 Code major equipment would be purchased f.o.b. jobsite for installation by the contractors discussed under Subcontracts.

Bulk Materials

The category of bulk materials, for Cost Codes 2000 through 6400 on the Direct Cost Summary Sheets, is divided into two (2) columns for procurement purposes. The Direct P/O Material column lists those items which would be obtained through McKee's Purchasing Department. These items are limited to the following:

Cost Code

2000	Piping bulk materials less 5% for S/C "shorts"
3100	Settling Pond Liner
3700	Building HVAC equipment and elevator subcontract
4000	Electrical equipment
4100	Electrical bulk materials less 5% for S/C "shorts"
5000	Tagged instruments and panels

5.02 DETAIL ESTIMATES (continued)

Bulk Materials (continued)

The balance of the bulk materials which would be furnished by the subcontractors, are found in the Subcontracting Material column.

A semi-rigorous take-off was made from the basic design drawings and flow diagrams for all bulk materials.

Resolution and surplus factors were added to the bare take-off quantities to recognize the additional scope definition which would be provided on the final detailed design drawings. The factors utilized are as follows:

Piping	10%
Concrete	25%
Structural Steel	20%
Electrical	10%

Direct Hire Labor

As the current management plan calls for all work to be subcontracted, no provision is included for direct hire labor in the direct cost estimate.

Subcontract Material and Labor

Subcontract labor manhours were estimated for all elements except the following items which were quoted on an installed basis by the equipment vendors:

- Car Dumper/Positioner
- Ash Silo
- Field Erected Tanks
- Elevator in Gasifier Building

McKee's standard manhours per unit of production were utilized for the following disciplines:

- Equipment Installation
- Piping and Ductwork
- Miscellaneous Architectural Trades
- Electrical and Instrumentation
- Insulation and Painting

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5.02 DETAIL ESTIMATES (continued)

Subcontract Material and Labor (continued)

For the following disciplines, single source vendor quotations were solicited and utilized after verifying their compatibility with costs currently being experienced. These vendors quoted labor and material costs.

- Excavation
- Concrete
- Roofing and Siding
- Structural Steel

The section on Labor Productivity and Subcontract Labor Rates further on in this text explains the procedures used to establish units subcontract manhour rates and productivity.

Construction Management/Field Indirect Cost

Because this project is to be 100% subcontracted, the major portion of these costs normally considered field indirect costs are carried by subcontractors. These costs have been factored into the subcontract labor manhour rates. The McKee Field Indirect Cost Estimate is then, for this project, the Construction Management Estimate, which was prepared by the Home Office Construction Department. The Construction Management Team consists of a resident Construction Manager and his staff of area and speciality Superintendents who would oversee the work of the subcontractors. In addition, warehousing facilities and unloading equipment is provided for the receipt, storage and dispensing of McKee purchased equipment and bulk materials, and auxiliary labor is provided for certain general site requirements, such as snow removal.

Professional Services

The following is a tabulation of Pro-Services manhours required for the detailed design of the plant.

<u>DISCIPLINE</u>	<u>COMMERCIAL PLANT WITH SULFUR REMOVAL</u>
	<u>MANHOURS</u>
Project Administration	20,000
Basic Design	900

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5.02 DETAIL ESTIMATES (continued)

Professional Services (continued)

<u>DISCIPLINE</u>	<u>COMMERCIAL PLANT WITH SULFUR REMOVAL</u>
	<u>MANHOURS</u>
Process	7,100
Mechanical	16,850
Material Handling	8,400
Dust Collection	5,970
HVAC	5,030
Civil/Concrete	44,740
Structural Steel	31,220
Instrumentation	30,740
Electrical	24,330
Piping	102,840
General Engineering/Miscellaneous Services	<u>13,790</u>
Subtotal Design Engineering	311,910
Clerical	62,380
Estimating	5,000
Cost Control	25,000
Print Services	12,480
Scheduling	7,850
Procurement	60,000
Home Office Construction	6,500
Include S/C Administration	--
Miscellaneous Salaries	<u>18,710</u>
Total Pro-Services Manhours	509,830

A detailed estimate of Engineering computer utilization and model costs for the design disciplines, was prepared by the McKee Engineering Department. The estimate recognized that all of the process work on the Gasifier and Stretford plants, and the detailed design for the gasifier retorts has been completed during Phase I. The detailed design for the balance of the gasifier and Stretford plants, as well as the remaining seven (7) plant areas, would be done during Phase II. The Civil/Concrete manhours were influenced heavily by the soils Engineering problems inherent in this plant site.

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5.02 DETAIL ESTIMATES (continued)

Professional Services (continued)

Estimating manhours have been included for preparation of a Definitive Capital Cost Estimate (plus/minus 15%) at the time when Engineering is approximately 35% complete and for recasting the Definitive Estimate into subcontract packages, and for development of change order estimates after the subcontract packages have been awarded.

Cost Engineering manhours were established by the McKee Cost Control Department. These manhours include the services of a full-time Cost Engineer and Associate Cost Engineer and part-time clerical and supervisory personnel for approximately thirty months.

Schedule Control manhours were established by the McKee Scheduling Department. These home office manhours are devoted to the preparation of computerized critical path schedules, with updates on the average of every 8 to 10 weeks.

Procurement salaries were furnished by the McKee Purchasing Department for the purchase of all major equipment items and all piping and electrical bulk (less 5% for subcontractor shorts).

Home Office Construction manhours include supervision from the Cleveland Office over the Construction Management staff and procurement and administration of approximately 13 subcontracts.

Know How Fees

The following Know How Fees have been included in the estimate.

	<u>\$M</u>
<u>Babcock Contractors, Inc.</u>	
Twelve gasifiers	204
<u>Ralph M. Parsons Company</u>	
Demonstration Plant 154,698 English Pounds	<u>321</u>
Total	525

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5.02 DETAIL ESTIMATES (continued)

Insurance

Insurance rates were obtained from the McKee Insurance Department.

Taxes

Minnesota 4% sales taxes will be required on all equipment, bulk materials, consumables and bare rental equipment. Tax computations were:

	<u>Commercial</u>	
	<u>Value</u>	<u>4% Tax</u>
	<u>\$M</u>	<u>\$M</u>
Major Equipment	24,477	979
Bulk Materials	25,242	1,010
Direct Cost Consumables and Rental Equipment	(Included in Subcontract Labor Cost)	
Construction Management - Temporary Construction and Rental Equipment	<u>236</u>	<u>9</u>
Totals	49,955	1,998

Overhead and Fringes

The estimate contains an overhead and fringe cost rate of 117.1%. This is based on current allowable costs as determined by McKee.

Labor Productivity

The labor manhours estimate for this project are based on McKee's standard manhour units for each element of work. The total manhours are, therefore, the standard or "normal" manhours required to complete the project under "normal" conditions. They are adjusted by applying a Productivity Factor or multiplier which recognizes the difference between standard productivity and that which can be anticipated at the Hoyt Lakes site at the time the project is under construction.

The Productivity Factor is defined as:

$$PF = \frac{\text{Standard Manhours Required}}{\text{Actual Manhours Required}}$$

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5.02 DETAIL ESTIMATES (continued)

Labor Productivity (continued)

The analysis of a productivity decision for this project was developed from several sources.

First, a labor survey of the Hoyt Lakes area was conducted by McKee's Construction Department in June, 1978. This survey indicated that most of the major construction projects on the Iron Range have reached peak employment and are beginning to wane. Because no other major projects are currently planned, the availability of sufficient productive craft labor, without the inducement of overtime is considered to be good to excellent.

Second, a productivity analysis has been prepared for another large current McKee project on the Iron Range. This analysis compares the productivity being experienced on the (20) current sub-contract packages, of which all but one are lump sum packages. This analysis indicates that productivity for that project is currently projected at 1.12 or 12% better than standard.

Third, budget unit prices for the Erie project were solicited from several of the subcontractors listed in Table I. These unit prices, which reflect their anticipated productivity, are consistent with the unit costs which they are known to be experiencing.

Based on these three elements, the productivity factors selected for this project were:

Equipment	1.0
Piping	1.20
Sitework, Concrete Work, Building Work	1.0
Structural Steel	1.15
Electrical, Instrumentation	1.10
Insulation, Painting	1.0

Productivity factors (other than 1.0) have been applied to this estimate before transfer to the Direct Cost Summary Sheets by dividing the total standard manhours shown by the productivity factor.

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5.02 DETAIL. ESTIMATES (continued)

Subcontract Labor Rates

To develop the Subcontract Composite Crew Labor Rates employed for this project, the following procedure was used.

Table 8 indicates the labor rates and fringe benefit build up for each craft based on data obtained in the Construction Department Labor Survey conducted in June, 1978.

Based on composite crew build up for each major work discipline field experience and a review of current experience with McKee's Construction Department, composite rates were developed for each work discipline.

Weighted average composite crew rates were adjusted by a multiplier to cover (1) payroll burdens and (2) field indirect costs. These multipliers were developed from McKee AIDS library and other industry literature. After application of this multiplier, 15% is added to cover the subcontractors overhead and profit. The resultant Subcontract Composite Crew Labor Rates are then utilized on the Direct Cost Summary Sheets as rounded to the nearest dollar. For this project, they are as follows:

<u>WORK DESCRIPTION</u>	<u>TOTAL SUBCONTRACT RATE</u> <u>\$/MANHOUR</u>
Major Equipment Installation	23.00
Piping	24.00
Site Work	29.00
Concrete	20.00
Buildings	22.00
Structural Steel	27.00
Electrical	23.00
Instrumentation	23.00
Insulation	23.00
Painting	21.00

These craft labor rates and fringe benefits are in accordance with the Taconite Master Labor Agreement, under which this project would be constructed.

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5.02 DETAIL ESTIMATES (continued)

Summary Sheets

The immediately following Direct Cost Summary Sheets provide a summary of all the capital costs and a breakdown indicating the components for each area of the plant.

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COMMERCIAL PLANT

ALL MANHOURS & DOLLARS IN, 1000'S

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DIRECT COST SUMMARY SHEET
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COMMERCIAL PLANT

ALL MANHOURS & DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA Total Plant Summary - By Discipline								PROJECT NO. MC-4814A					
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY								BY L. GASE		DATE 11/13/78			
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT					DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES	
		QTY	UNIT		MATERIAL \$	LABOR			GRAND TOTAL	MAN HRS.	RATE	TOTAL \$		ITEM TO CAT	ITEM TO TOTAL
						MAN HRS.	RATE	TOTAL \$							
2000	PIPING & DUCTWORK	Lot		7,405	390	417	24-	9,884	10,274				17,679		
	Pipe Excavation & Backfill	21,000	CY	-	-	2	29-	73	73				73		
	Misc. Structures	Lot		-	57	3	20-	54	111				111		
	SUBTOTAL			7,405	447	422		10,011	10,458				17,863		
3100	SITE DEVELOPMENT														
	Clearing, Grading, Fill	340,000	CY	-	-	30	29-	878	878				878		
	Roads & Parking	17,500	SY	-	84	1	29-	34	118				118		
	Overpass & Crib Walls	Lot		-	284	4	29-	117	401				401		
	Track Work	12,000	LF	-	436	7	29-	188	624				624		
	Settling Pond	5.5	AC	135	-	3	29-	70	70				205		
	SUBTOTAL			135	804	45	29-	1,287	2,091				2,226		
3600	CONCRETE WORK	17,865	CY	-	1,384	123	20-	2,452	3,836				3,836		
	FDTN. EXCAV. & BACKFILL	48,700	CY	-	-	13	29-	385	385				385		
	SUBTOTAL				1,384	136		2,837	4,221				4,221		
3700	BUILDING WORK	Lot		517	1,366	58	22-	1,266	2,632				3,149		
3800	STRUCTURAL STEEL	5,741	Tons	-	6,625	84	27-	2,272	8,897				8,897		

DIRECT COST SUMMARY SHEET

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ALL MANHOURS & DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA Total Plant Summary - By Discipline								PROJECT NO. MC-4814A					
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY								BY L. GASE		DATE 11/13/78			
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR			GRAND TOTAL	MAN HRS.	RATE		TOTAL \$	ITEM TO CAT	ITEM TO TOTAL
	ELECTRICAL														
4000	MAJOR EQUIPMENT	Lot		1,876									1,876		
4100	MISCELLANEOUS DEVICES														
4200	ABOVEGROUND-BULK MAT'LS.	Lot		477	72	118	23-	2,724	2,796				3,273		
4300	BELOWGROUND-BULK MAT'LS.														
	INSTRUMENTATION														
5000	TAGGED ITEMS	Lot		2,940									2,940		
5100	BULK MATERIALS	Lot		-	208	22	23-	501	709				709		
	MISCELLANEOUS														
6100	EQUIPMENT INSULATION	Lot		-	44	3	23-	58	102				102		
6200	PIPING INSULATION	Lot		-	807	45	23-	1,044	1,851				1,851		
6400	PAINTING	Lot		-	135	20	21-	414	549				549		
	TOTAL DIRECT COST			37,827	11,892	1,053		24,714	36,606				74,433		

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COMMERCIAL

ALL ~~FINANCIAL~~ DOLLARS IN 1000'S

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DIRECT COST SUMMARY SHEET

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COMMERCIAL

ALL ~~UNITED STATES~~ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 01 - Material Handling								PROJECT NO. MC-4814A					
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY								BY L. GASE		DATE 11/13/78			
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGE		
		QTY	UNIT		MATERIAL \$	LABOR			GRAND TOTAL	MAN HRS.	RATE		TOTAL \$	ITEM TO CAT	ITEM TO TOTAL
						MAN HRS.	RATE	TOTAL \$							
2000	PIPING & DUCTWORK														
3100	SITE DEVELOPMENT														
	Site Clearing & Grading	50	AC	-	-	600	29-	17	17			17			
	Site Grading & Fill	340,000	CY	-	-	29,700	29-	861	861			861			
	Roads & Parking	17,500	SY	-	84	1,170	29-	34	118			118			
	Overpass @ Hoyt Road	100	LF	-	190	1,400	29-	41	231			231			
	Crib Walls	17,000	SF	-	94	2,620	29-	76	170			170			
	Track Work	12,000	LF	-	436	6,500	29-	188	624			624			
	SUBTOTAL 3100			-	804	41,990	29-	1,217	2,021			2,021			
3600	CONCRETE WORK	11,050	CY	-	888	79,160	20-	1,583	2,471			2,471			
	FDTN. EXCAV. & BACKFILL	31,000	CY	-	-	7,600	29-	220	220			220			
	SUBTOTAL 3600			-	888	87,760		1,803	2,691			2,691			
3700	BUILDING WORK														
	All Structures	Lot		104	297	14,740	22-	324	621			725			
3800	STRUCTURAL STEEL	1,539	T	-	2,079	30,230	27-	816	2,895			2,895			

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COMMERCIAL

ALL ~~EXPENSES~~ DOLLARS IN, 1000'S

PROJECT		PLANT AREA		PROJECT NO.										
COAL GASIFICATION		01 - Material Handling		MC-4814A										
LOCATION		OWNER		BY										
HOYT LAKES, MINNESOTA		ERIE MINING COMPANY		L. GASE										
				DATE										
				11/13/78										
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT			DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGE		
		QTY	UNIT		MATERIAL \$	MAN HRS.	RATE	TOTAL \$	GRAND TOTAL	MAN HRS.		RATE	TOTAL \$	ITEM TO CAT
	ELECTRICAL													
4000	MAJOR EQUIPMENT	Lot		118								118		
4100	MISCELLANEOUS DEVICES													
4200	ABOVEGROUND-BULK MAT'LS.	Lot		215	16	11,030	23-	254	270			485		
4300	BELOWGROUND-BULK MAT'LS.													
	INSTRUMENTATION													
5000	TAGGED ITEMS			7	-							7		
5100	BULK MATERIALS					280	23-	6	6			6		
	MISCELLANEOUS													
6100	EQUIPMENT INSULATION	None												
6200	PIPING INSULATION	w/06												
6300	FIREPROOFING	None												
6400	PAINTING	Lot			34	4,760	21-	100	134			134		
	TOTAL DIRECT COST			6,302	4,118	236,190	23.55	5,564	9,682			15,984		

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ALL ~~XXXXXXXXXX~~ DOLLARS IN, 1000'S

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ALL ~~VALUES~~ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 02 - Gasification (Bldg.)							PROJECT NO. MC-4814A						
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY							BY L. GASE		DATE 11/13/78				
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	MAN HRS.	RATE	TOTAL \$	GRAND TOTAL	MAN HRS.	RATE		TOTAL \$	ITEM TO CAT	ITEM TO TOTAL
2000	PIPING & DUCTWORK					w/Area 06									
3100	SITE DEVELOPMENT					w/Area 06									
3600	CONCRETE WORK - Bldg. Fdtns.	1,390	CY	-	92	7,350	20-	147	239				239		
	FDTN. EXCAV. & BACKFILL	3,000	CY	-	-	710	29-	21	21				21		
3700	BUILDING WORK	Lot		188	426	17,160	22-	378	804				992		
3800	STRUCTURAL STEEL	1,244	Tons	-	1,223	13,790	27-	372	1,595				1,595		

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ALL ██████████ DOLLARS IN, 1000'S

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ALL ~~VALUES~~ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 02 - Gasification (Process)		PROJECT NO. MC-4814A										
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY		BY L. GASE										
				DATE 11/13/78										
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT			DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	MAN HRS.	RATE	TOTAL \$	GRAND TOTAL	MAN HRS.		RATE	TOTAL \$	ITEM TO CAT
	MAJOR EQUIPMENT													
1000	MATERIAL HANDLING	Lot		1,796		5,660								
1100	BINS, SILOS, CHUTES, HOPPERS	Lot		366		2,340								
1200	DUST COLLECTION	Lot		122		800								
1300	WATER TREATMENT	Lot		70		300								
1400	TANKS, VESSELS, DRUMS	Lot		434		1,180								
1500	CRANES & HOISTS					w/Bldg.								
1600	HEAT EXCHANGERS, COOLING TOWERS, BOILERS	Lot		1,112		1,240								
1700	FANS & COMPRESSORS	Lot		202		500								
1800	PUMPS	Lot		8		100								
1900	SPECIAL EQUIPMENT													
	Misc.	Lot		22		300								
	Gasifiers	12		3,850		8,020								
	Stirrers	12		2,330		4,730								
	Auxiliaries	Lot		190		1,200								
	Precipitators	Lot		1,100		4,360								
	Expansion Joints	Lot		230		2,140								
	SUBTOTAL 1900			7,722		20,750								
	TOTAL EQUIPMENT			11,832	-	32,870	23-	756	756			12,588		

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COMMERCIAL PLANT

ALL DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 02 - Gasification (Process)							PROJECT NO. MC-4814A						
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY							BY L. GASE		DATE 11/13/78				
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR		GRAND TOTAL	MAN HRS.	RATE	TOTAL \$		ITEM TO CAT	ITEM TO TOTAL	
2000	PIPING & DUCTWORK	Lot		1,627	86	67,270	24-	1,614	1,700				3,327		
3100	SITE DEVELOPMENT														
3600	CONCRETE WORK	Lot			79	6,290	20-	126	205				205		
	FDTN. EXCAV. & BACKFILL	Lot			-	2,400	29-	67	67				67		
3700	BUILDING WORK	Lot			6	740	22-	16	22				22		
3800	STRUCTURAL STEEL	Lot			1,148	13,590	27-	367	1,515				1,515		

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ALL ~~XXXXXXXXXX~~ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 02 - Gasification (Process)		PROJECT NO. MC-4814A											
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY		BY L. GASE											
				DATE 11/13/78											
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR		GRAND TOTAL	MAN HRS.	RATE	TOTAL \$		ITEM TO CAT	ITEM TO TOTAL	
	ELECTRICAL														
4000	MAJOR EQUIPMENT	Lot		553									553		
4100	MISCELLANEOUS DEVICES														
4200	ABOVEGROUND-BULK MAT'LS.	Lot			29	52,380	23-	1,205	1,234				1,234		
4300	BELOWGROUND-BULK MAT'LS.														
	INSTRUMENTATION														
5000	TAGGED ITEMS	Lot		1,480									1,480		
5100	BULK MATERIALS	Lot			158	8,400	23-	194	352				352		
	MISCELLANEOUS														
6100	EQUIPMENT INSULATION	None													
6200	PIPING INSULATION	Lot			216	6,140	23-	142	358				358		
6400	PAINTING	Lot			30	4,380	21-	92	122				122		
	TOTAL DIRECT COST			15,492	1,752	194,460	23.54	4,579	6,331				21,823		

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ALL ~~VALUES~~ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 03 - Sulfur Removal (Bldg.)							PROJECT NO. MC-4814A						
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY							BY L. GASE		DATE 11/13/78				
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR			GRAND TOTAL	MAN HRS.	RATE		TOTAL \$	ITEM TO CAT	ITEM TO TOTAL
						MAN HRS.	RATE	TOTAL \$							
	MAJOR EQUIPMENT														
1000	MATERIAL HANDLING	-													
1100	BINS, SILOS, CHUTES, HOPPERS	-													
1200	DUST COLLECTION	-													
1300	WATER TREATMENT	-													
1400	TANKS, VESSELS, DRUMS	-													
1500	CRANES & HOISTS	1	Ea.	74		1,000									
1600	HEAT EXCHANGERS, COOLING TOWERS, BOILERS	-													
1700	FANS & COMPRESSORS	-													
1800	PUMPS	-													
1900	SPECIAL EQUIPMENT	-													
	TOTAL EQUIPMENT			74	-	1,000	23-	23	23				97		

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COMMERCIAL PLANT

ALL ~~EXPENSES~~ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 03 - Sulfur Removal (Bldg.)								PROJECT NO. MC-4814A					
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY								BY L. GASE		DATE 11/13/78			
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR	GRAND TOTAL	MAN HRS.	RATE	TOTAL \$	ITEM TO CAT		ITEM TO TOTAL		
2000	PIPING & DUCTWORK					w/Area 06									
3100	SITE DEVELOPMENT					w/Area 06									
3600	CONCRETE WORK	1,350	CY	-	87	6,740	20-	135	222				222		
	FDTN. EXCAV. & BACKFILL	3,000	CY	-		730	29-	21	21				21		
3700	BUILDING WORK	38,200	SF	128	254	11,410	22-	251	505				633		
3800	STRUCTURAL STEEL	754	Tons	-	722	7,890	27-	213	935				935		

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ALL ~~EXPENSES~~ DOLLARS IN, 1000'S

PROJECT Coal Gasification		PLANT AREA 03 - Sulfur Removal (Process)		PROJECT NO. MC-4814A										
LOCATION Hoyt Lakes, Minnesota		OWNER Erie Mining Company		BY L. Gase										
				DATE 11/13/78										
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT			DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR MAN HRS.	RATE	TOTAL \$	GRAND TOTAL	MAN HRS.		RATE	TOTAL \$	ITEM TO CAT
	Stretford Unit													
	Process package for equipment, instruments, piping, electrical and equipment foundations.													
	Based on McKee evaluation of proposal estimates dated March 9, 1978.													
	Commercial Plant - 34.6 LT/Day													
	Major equipment and tagged instruments	Lot		2,676								2,676		
	Bulk materials	Lot		2,237	118			118				2,355		
	Plant construction	Lot				142,400	23.25	3,311	3,311			3,311		
	TOTAL COST			4,913	118	142,400	23.25	3,311	3,429			8,342		
	No further breakdown is available for this element.													

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ALL ██████████ DOLLARS IN 1000'S

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COMMERCIAL PLANT

ALL ~~AMOUNTS~~ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 04 - GAS COMPRESSION								PROJECT NO. MC-4814A					
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY								BY L. GASE		DATE 11/13/78			
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	MAN HRS.	RATE	TOTAL \$	GRAND TOTAL	MAN HRS.	RATE		TOTAL \$	ITEM TO CAT	ITEM TO TOTAL
2000	PIPING & DUCTWORK				w/	AREA	06								
3100	SITE DEVELOPMENT				w/	AREA	01								
3600	CONCRETE WORK	1182	cy	-	99	9800	20-	196	295			295			
	FDTN. EXCAV. & BACKFILL	1200	cy		-	250	29-	7	7			7			
3700	BUILDING WORK	4914	^s f	5	58	1060	22-	23	81			86		-	
	PRE-ENGINEERED BLDG.														
3800	STRUCTURAL STEEL				w/	BUILDING									

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ALL _____ & DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 04 - GAS COMPRESSION							PROJECT NO. MC-4814A						
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY							BY L. GASE		DATE 11/13/78				
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR		GRAND TOTAL	MAN HRS.	RATE	TOTAL \$		ITEM TO CAT	ITEM TO TOTAL	
	ELECTRICAL														
4000	MAJOR EQUIPMENT	LOT		79									79	-	
4100	MISCELLANEOUS DEVICES														
4200	ABOVEGROUND-BULK MAT'LS.														
4300	BELOWGROUND-BULK MAT'LS.			31	4	3250	23-	75	79				110	-	
	INSTRUMENTATION														
5000	TAGGED ITEMS			99									99	-	
5100	BULK MATERIALS				4	910	23-	21	25				25	-	
	MISCELLANEOUS														
6100	EQUIPMENT INSULATION							NONE REQUIRED							
6200	PIPING INSULATION							w/ AREA 06							
6400	PAINTING	LOT		-	1	300	21-	6	7				7	-	
	TOTAL DIRECT COST			2442	166	21570	21- ⁶⁰	466	632				3074		

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ALL ~~FIGURES~~ DOLLARS IN, 1000'S

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ALL ~~EXPENSES~~ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 05 - WASTE TREATMENT							PROJECT NO. MC-4814A						
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY							BY L. GASE		DATE 11/13/78				
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR			GRAND TOTAL	MAN HRS.	RATE		TOTAL \$	ITEM TO CAT	ITEM TO TOTAL
						MAN HRS.	RATE	TOTAL \$							
2000	PIPING & DUCTWORK														
3100	SITE DEVELOPMENT														
3600	CONCRETE WORK	342	cy	-	28	2640	20	53	81			81	-		
	FDTN. EXCAV. & BACKFILL	700	cy		-	200	29	6	6			6	-		
3700	BUILDING WORK	3224	sf	3	40	820	22	18	58			61	-		
3800	STRUCTURAL STEEL														

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ALL ~~EXPENSES~~ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 05 - WASTE TREATMENT								PROJECT NO. MC-4814A					
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY								BY L. GASE		DATE 11/13/78			
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR			GRAND TOTAL	MAN HRS.	RATE		TOTAL \$	ITEM TO CAT	ITEM TO TOTAL
	ELECTRICAL														
4000	MAJOR EQUIPMENT	LOT		18									18	-	
4100	MISCELLANEOUS DEVICES														
4200	ABOVEGROUND-BULK MAT'LS.	LOT		31	3	3070	23-	71	74				105	-	
4300	BELOWGROUND-BULK MAT'LS.														
	INSTRUMENTATION														
5000	TAGGED ITEMS			36									36	-	
5100	BULK MATERIALS				5	1460	23-	34	39				39	-	
	MISCELLANEOUS														
6100	EQUIPMENT INSULATION	6780	sf	-	18	1030	23-	24	42				42	-	
6200	PIPING INSULATION														
6400	PAINTING	LOT			2	400	21-	8	10				10	-	
	TOTAL DIRECT COST			486	96	12,200	22.37	273	369				855		

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ALL ~~EXPENSES~~ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 06 - UTILITIES								PROJECT NO. MC-4814A				
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY								BY L. GASE		DATE 11/13/78		
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES	
		QTY	UNIT		MATERIAL \$	LABOR		GRAND TOTAL	MAN HRS.	RATE	TOTAL \$		ITEM TO CAT	ITEM TO TOTAL
2000	PIPING & DUCTWORK	115350	Lf	2659	140	172,300	24-	4135	4275				6934	-
	PIPE EXCAV. & BACKFILL	21,000	cy	-	-	2520	29-	73	73				73	-
	MISC. STRUCTURES	LOT		-	57	2700	20-	54	111				111	-
3100	SITE DEVELOPMENT													
	SETTLING POND	LOT		135	-	2430	29-	70	70				205	-
3600	CONCRETE WORK	1145	cy		91	8690	20-	174	265				265	-
	FDTN. EXCAV. & BACKFILL	5200	cy			1250	29-	36	36				36	-
3700	BUILDING WORK	LOT		81	239	9040	22-	199	438				519	-
3800	STRUCTURAL STEEL	970	tons	-	1453	18650	27-	504	1957				1957	-

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ALL ██████████ DOLLARS IN, 1000'S

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ALL ~~NUMBERS~~ DOLLARS IN, 1000'S

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ALL _____ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 07 - SAFETY SYSTEMS							PROJECT NO. MC-48T4A						
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY							BY L. GASE		DATE 11/13/78				
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGE		
		QTY	UNIT		MATERIAL \$	LABOR			GRAND TOTAL	MAN HRS.	RATE		TOTAL \$	ITEM TO CAT	ITEM TO TOTAL
						MAN HRS.	RATE	TOTAL \$							
2000	PIPING & DUCTWORK														
3100	SITE DEVELOPMENT														
3600	CONCRETE WORK	146	CY	-	12	1,240	20	25	37				37		
	FDTN. EXCAV. & BACKFILL	400	CY	-	-	90	29	3	3				3		
3700	BUILDING WORK														
3800	STRUCTURAL STEEL														

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ALL ~~XXXXXXXXXX~~ DOLLARS IN, 1000'S

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COMMERCIAL PLANT

ALL ~~VALUES~~ DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 08 - RETROFIT								PROJECT NO. MC-4814A					
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY								BY L. GASE		DATE 11/13/78			
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR		GRAND TOTAL	MAN HRS.	RATE	TOTAL \$		ITEM TO CAT	ITEM TO TOTAL	
2000	PIPING & DUCTWORK	12030	Lf	882	46	34340	24	824	870				1752	-	
3100	SITE DEVELOPMENT	NONE													
3600	CONCRETE WORK FDTN. EXCAV. & BACKFILL	NONE													
3700	BUILDING WORK	NONE													
3800	STRUCTURAL STEEL	NONE													

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ALL DOLLARS IN, 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 08 - RETROFIT								PROJECT NO. MC-4814A					
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY								BY L. GASE		DATE 11/13/78			
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	MAN HRS.	RATE	TOTAL \$	GRAND TOTAL	MAN HRS.	RATE		TOTAL \$	ITEM TO CAT	ITEM TO TOTAL
	ELECTRICAL														
4000	MAJOR EQUIPMENT														
4100	MISCELLANEOUS DEVICES														
4200	ABOVEGROUND-BULK MAT'LS.														
4300	BELOWGROUND-BULK MAT'LS.	LOT		41	6	4300	23-	99	105				146	-	
	INSTRUMENTATION														
5000	TAGGED ITEMS			338									338	-	
5100	BULK MATERIALS				37	8620	23-	198	235				235	-	
	MISCELLANEOUS														
6100	EQUIPMENT INSULATION								NONE REQUIRED						
6200	PIPING INSULATION	6770	Lf		106	7580	23-	174	280				280	-	
6400	PAINTING - PIPE	LOT			11	770	21-	16	27				27	-	
	TOTAL DIRECT COST			1473	206	57690	23 ⁵⁵	1359	1565				3038		

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ALL ~~VALUES~~ DOLLARS IN 1000'S

PROJECT COAL GASIFICATION		PLANT AREA 09 - EMPLOYEE FACILITIES								PROJECT NO. MC-4814A					
LOCATION HOYT LAKES, MINNESOTA		OWNER ERIE MINING COMPANY								BY L. GASE		DATE 11/13/78			
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGE		
		QTY	UNIT		MATERIAL \$	MAN HRS.	LABOR RATE	TOTAL \$	GRAND TOTAL	MAN HRS.	RATE		TOTAL \$	ITEM TO CAT	ITEM TO TOTAL
2000	PIPING & DUCTWORK														
3100	SITE DEVELOPMENT														
3600	CONCRETE WORK	110	cy	-	8	640	20-	13	21			21	-		
	FDTN. EXCAV. & BACKFILL	600	cy	-	-	150	29-	4	4			4	-		
3700	BUILDING WORK	2533	sf	8	46	2570	22-	57	103			111	-		
3800	STRUCTURAL STEEL														

ALL ~~AMOUNTS~~ DOLLARS IN, 1000'S

PROJECT		PLANT AREA							PROJECT NO.					
COAL GASIFICATION		09 - EMPLOYEE FACILITIES							MC-4814A					
LOCATION		OWNER							BY			DATE		
HOYT LAKES, MINNESOTA		ERIE MINING COMPANY							L. GASE			11/13/78		
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES	
		QTY	UNIT		MATERIAL \$	LABOR		GRAND TOTAL	MAN HRS.	RATE	TOTAL \$		ITEM TO CAT	ITEM TO TOTAL
	ELECTRICAL													
4000	MAJOR EQUIPMENT			11								11	-	
4100	MISCELLANEOUS DEVICES				-									
4200	ABOVEGROUND-BULK MAT'LS.			12	1	1250	23-	29	30			42	-	
4300	BELOWGROUND-BULK MAT'LS.													
	INSTRUMENTATION				NONE REQUIRED									
5000	TAGGED ITEMS													
5100	BULK MATERIALS													
	MISCELLANEOUS													
6100	EQUIPMENT INSULATION				w/	BUILDING								
6200	PIPING INSULATION				w/	BUILDING								
6400	PAINTING				w/	BUILDING								
	TOTAL DIRECT COST			31	55	4610		103	158			189		

5.03 STACKER STUDY CAPITAL COST ESTIMATE

The following represents a $\pm 20\%$ capital cost estimate for the net direct costs additions and deletions to the capital cost estimate for Area 01 - Material Handling, if a slewing radial stacker is substituted for the system of conveyor galleries and lowering tubes.

<u>Additions</u>	<u>\$M</u>	<u>Price Source</u>
Stacker Conveyor	565	(4) budget quotations factored from base estimate single source quotation
CO-102 (300 Ft.)	191	
Telescopic Unloading Chute	73	
SUBTOTAL EQUIPMENT	829	
Concrete Work (800 cy)	226	In-house take-off and pricing
Building Work	31	
TOTAL ADDITIONS	1,086	
<u>Deletions</u>		
Conveyor CO-102 (600 Ft.)	386	From Base Capital Cost Estimate
Conveyor CO-103 (215 Ft.)	172	
Lowering Pipes X-101,X-103	367	
Hoists X-118, X-119	27	
SUBTOTAL EQUIPMENT	952	
Concrete Work (410 cy)	109	From Base Capital Cost Estimate
Building Work (Conv. Galler)	70	
Structural Steel (402 tons)	783	
Electrical	38	
TOTAL DELETIONS	1,949	
NET CHANGE (DELETION)	\$ 863M	

Note that these costs are direct cost only with no provision for Engineering, Indirect Costs, Taxes, Insurance, Escalation or Contingency.

DIRECT COST SUMMARY SHEET

McKee

Form M-1359A 2/77

STACKER STUDY

ALL MATERIALS IN DOLLARS IN 1000'S

PROJECT		PLANT AREA		PROJECT NO.										
LOCATION		OWNER		DATE										
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT			DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR		GRAND TOTAL	MAN HRS.	RATE		TOTAL \$	ITEM TO CAT	ITEM TO TOTAL
						MAN HRS.	RATE							
Additions														
0100	Material Handling Equipment													
	Stacker Conveyor	LOT		450	5000		115							
	Conveyor CO-102	300 LF		150	1800		41							
	Telescopic Chute	LOT		50	1000		23							
	Total Equip.			650	7800	23-	179	179				829		
3600	Concrete Work													
	Concrete Fdn's	800	cy	-	68	6800	20-	136	204			204		
	Excav. & Backfill					760	29-	22	22			22		
3700	Building Work													
	Misc - Enclosure @ Head of CO-102	LOT		-	20	1500	22-	11	31			31		
	Total Additions			650	188	15860	22-	348	436			1086		

DIRECT COST SUMMARY SHEET

McKee

Form M-1359 A 2/77

STACKER STUDY

ALL MANHOURS & DOLLARS IN, 1000'S

PROJECT		PLANT AREA		PROJECT NO.											
		01-MATERIAL HANDLING		MC-4814 A											
LOCATION		OWNER		BY		DATE									
				L. GASE		11/21/78									
CODE NO.	DESCRIPTION	MILESTONE		DIRECT P/O MATERIAL TOTAL \$	SUBCONTRACT				DIRECT HIRE LABOR			GRAND TOTAL \$	PERCENTAGES		
		QTY	UNIT		MATERIAL \$	LABOR		GRAND TOTAL	MAN HRS.	RATE	TOTAL \$		ITEM TO CAT	ITEM TO TOTAL	
						MAN HRS.	RATE								TOTAL \$
	<u>Deletions</u>														
0100	Material Handling Equipment														
	Conv. CO-102	600	LF	303		3600		83							
	Conv. CO-103	215	LF	135		1610		37							
	Lowering Pipe X-101	100	LF	189		850		39							
	" " X-103	100	LF	159		850									
1500	Hoists X-118, X-119	2	EA	25		80		2							
	Total Equipment			791	-	6990	23	161	161			952			
3600	Concrete Work														
	Concrete Fdn's	410	CY	-	35	3080	20	62	97			97			
	Excav. 4' x 4'					380	29	12	12			12			
3700	Building Work														
	Conv. Galleries	LOT		-	37	1480	22	33	70			70			
	102 & 103														
3800	Structural Steel														
	Conv. Gall 102 & 103	402	Tons		575	7720	27	208	783			783			
4000	Electrical Work														
	Allow			10	2	1000	23	23	25			35			
	Total Deletions			801	649	10,650	24	499	1148			1949			

5.0 CAPITAL COSTS (continued)

5.04 WORKING CAPITAL AND START UP COSTS

Working Capital

The factors used in estimating the working capital requirements are as follows:

- Coal Inventory:

For a 60 day supply at full operation, the capital tied up in coal storage will be

Western Coal (1433 tpd x 60 x \$31)	\$2,665,000
Eastern Coal (1349 tpd x 60 x \$40)	3,238,000

- Materials, Supplies and Spare Parts:

Purchase of an initial inventory of operating and maintenance supplies and spares will require a sum approximately equivalent to 0.9% of the total plant investment, thus

Operating with Western Coal	698,000
Operating with Eastern Coal	833,000

- Accounts Receivable:

The amount required for carrying accounts receivable is estimated at 1/24th of annual gas revenues. This allows for a collection lag of about 15 days.

1,012,000

Total working capital requirement:

Operating with Western Coal	\$4,375,000
Operating with Eastern Coal	\$5,083,000

Start Up Costs

These costs are estimated at a fraction of the gross annual operating cost which corresponds to the time required for start up. For purposes of the economic evaluation, this expense will be capitalized.

5.04 WORKING CAPITAL AND START UP COSTS (continued)

Since the experience gained in the Demonstration Plant Program will permit faster and more efficient start up of the Commercial Plant, the cost in this case is assumed to equal 5% of the gross (before by-product credits) operating cost.

The actual start up period will probably be longer than 5% of one year, but some product will be produced, which will offset a part of the cost.

Net start up cost, at 5% of gross annual operating cost, will be:

Operating with Western Coal	\$1,220,000
Operating with Eastern Coal	\$1,500,000

5.0 CAPITAL COSTS (continued)

5.05 CONSTRUCTION MANAGEMENT PLAN

General

McKee will supply full construction management services for construction of the coal gasification project. The construction work will be performed under a series of eight to twelve subcontracts encompassing individual work disciplines. The contracts will be awarded directly by Erie Mining Company and McKee will act as Erie Mining Company's agent for complete management of the contracts. The management duties will include preparation of the subcontract packages, issuance of invitations to bid, analyses and recommendations to Erie Mining Company with respect to awards, and supervision and management of the actual construction work to be performed.

Organization

For performance of the above services McKee will provide an experienced management team, under the direction of a Resident Construction Manager, as shown in the organization chart on Page 8 of this section. The responsibilities and functions of the management team, briefly summarized, will be as follows:

- Discipline Craft Supervisors will be assigned to supervise and monitor the work under each subcontract. Each supervisor will be in charge of one or more contracts, and will be responsible for the contractor's compliance with the terms and conditions of the contract plans and specifications, for insuring that qualified craftsmen are used, and for performance of work in accordance with the project schedule.
- The Chief Field Engineer will direct a staff of quality control engineers assigned by discipline with the basic responsibility for insuring that construction work achieves the function required by the engineering design. Their work will consist of regular audits of all construction procedures and maintenance of appropriate related records.
- The Contracts Administrator will direct a staff of experienced administrators charged with such responsibilities as procurement, overall coordination, and other tasks relating to contract administration. This staff will include a Contracts Coordinator who will work closely with the Project Procurement Manager, members of the project team and McKee Engineering and Construction Department representatives to effect optimum selection of contractors, timely placement of work, and effective management and control of contractor performance.

5.05 CONSTRUCTION MANAGEMENT PLAN (continued)

- The Administrative Manager will direct an accounting staff handling the details of progress payments made to subcontractors, providing all required financial records, etc., a personnel officer; and a Material Control Manager handling field purchasing, receiving, and warehousing of all equipment and materials whether home office or field purchased, and issuance of such equipment to installation contractors as required.
- The Project Control Manager will direct a staff of cost and scheduling engineers assigned to monitor the progress of the construction work.
- The Safety Engineer, in conjunction with McKee's home office Manager of Safety, will establish a project safety program combining the requirements of McKee, Erie Mining Company and OSHA. This responsibility includes all reports and documentation required by State and Federal regulatory agencies. A first aid station and a full time registered nurse will be provided.

Decisions on the division of subcontract packages will be the responsibility of the Project Manager in consultation with Erie Mining Company and appropriate engineering, purchasing and construction personnel. The preparation of subcontract inquiry packages, development of bidding slates, solicitation and analysis of bids, preparation and issuance of the subcontracts and management of the subcontract will be the responsibility of the Cleveland Subcontracts Department, which is an integral part of McKee's Construction Department.

Continuous project planning will be accomplished by a weekly coordination meeting between the McKee supervisory staff and representatives of each construction subcontractor. These meetings will provide the planning of the project work for the ensuing two weeks and will provide coordination between various subcontractors working in the same area.

Erie Mining Company's field representative will be informed of the construction progress by weekly review meetings with the McKee field staff in addition to the normal day-to-day contact with McKee supervisors.

5.05 CONSTRUCTION MANAGEMENT PLAN (continued)Project Bidding Slate

The project size and location, in conjunction with the discipline of work to be performed, generally dictates the selection of subcontractors forming the bidding slate. From the Subcontracts Department file of subcontractors who have submitted information on their company's capability and expertise, plus information contained in the AIA Form A-305 on file, a project bidding slate will be prepared for discussion, review and approval with the Project Team, Construction Department and Erie Mining Company.

Since McKee has performed work recently in the proposed jobsite area, special efforts will be made to include in the bidding slate those subcontractors who have performed well on recent work. Some of the criteria used for evaluating a subcontractor's qualifications are as follows:

- Contractor's size and location.
- Proficiency in the craft disciplines involved.
- Previous experience (particularly with Erie or McKee)
- Availability of key supervisory personnel.
- Ability to supply manpower required.
- Current financial position.
- Current and future workload.
- Local history (in particular relationships with labor and local authorities).

Preparation of Contract Inquiry

In the initial stages of the project, a contract plan (McKee Form M-1139) will be prepared. This plan will be a joint effort of the Project Team, Construction Department, Scheduling Department and Erie Mining Company representatives, to determine the packages of work to be contracted, how best the work can be awarded and a proposed schedule of work. This plan forms the basis for the preparation of subcontract inquiry packages by the Engineering Department defining the scope of the work. Upon receipt of the Engineering package, the Subcontract Coordinator, with the assistance of the Manager of Subcontracts, will prepare the inquiry which shall include as a minimum the following information and/or proposal requirements:

5.05 CONSTRUCTION MANAGEMENT PLAN (continued)

- Scope of work which is described by the Engineering package and amplified upon as required by the Subcontracts Department personnel.
- Contract General Terms and Conditions, Form M-588.
- Contract Special Conditions (outlining requirements indigenous to the project).
- Inquiry questionnaire.
- Proposal form.
- Insurance requirements.
- Forms for Field Cost Control.
- Schedule.

Inquiries will generally be solicited on one of the following bases:

- Lump sum - Used where the design has proceeded sufficiently to adequately define the work. This will require complete drawings and specifications.
- Unit Price - Used where design has not proceeded but the schedule dictates early award. Typical drawings and specifications illustrating the work will be required plus an approximate quantity breakdown so that the units can be determined and the bidders can evaluate the approximate final cost.
- Cost Plus/Cost Plus Fixed Fee/Incentive Type - Typical drawings and specifications plus approximate quantities so that bidders can evaluate their overhead and other fixed costs. In addition, a system of job control and accounting and auditing procedures will be provided to the bidders. The inquiry will also request bidders to submit information which will be used in both the evaluation of proposals and managing of successful contractor's work. Items requested are:
 - A detailed schedule listing the major components of work against which progress will be monitored.
 - An organization chart and a list of key personnel and their resumes.

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5.05 CONSTRUCTION MANAGEMENT PLAN (continued)

- A manpower estimate (by craft) and a projected manpower curve for the work.
- A tool and equipment list.
- A list of proposed subcontractors (if any).
- Special procedures.

Evaluation of Proposals

Upon receipt of proposals, they will be evaluated, using the Tabulation of Subcontract Bids, Form M-1088. In general, the following criteria are used for the evaluation and recommendation:

- Cost of Work - note that this includes the projected final contract amount and takes into consideration all potential cost factors, such as escalation, scope additions, bonding, unit price or cost plus formulas, terms of payments, etc.
- Anticipated quality of the work.
- Can contractor maintain the required schedule?
- Technical expertise of the contractor.
- Completeness of the proposal (exceptions taken, alternates quoted).
- Potential effect on other phases of the work.

Subcontract Award

During the evaluation of proposals, it will usually be necessary to arrange proposal conditioning meetings with two or more bidders. During the conditioning meeting, all qualifications and exceptions will be explored and interviews may be held with key personnel and a complete reviewing of the proposal will be made. When full agreement is reached by all parties concerned, and Erie Mining Company has concurred with McKee's recommended selection of a subcontractor, a draft of the subcontract will be prepared. This draft will be reviewed with the successful subcontractor; and if both parties are in agreement, the final subcontract will be prepared and signed by both parties.

5.05 CONSTRUCTION MANAGEMENT PLAN (continued)

Contract Control

Subcontracts will be controlled both from McKee's home office and the Construction Office. The Subcontracts Coordinator, in conjunction with the Project Team and assisted by home office departments as required (Scheduling, Cost Engineering, Safety and Construction) will administer the subcontract. The field construction will be monitored by the Construction staff plus a Field Subcontracts Administrator to supervise the subcontractors performance, adherence to schedule, cost control and projection, compliance with all safety requirements and evaluation of additional field costs.

In addition to monitoring and management by the Construction Department, other specialists may be assigned from the home office to assist in maintaining quality assurance programs, critical schedule performance, adherence to Government and Erie Mining Company safety standards and setting up of cost control procedures. The Field Subcontracts Administrator will be involved with all of these activities from an administration standpoint and will maintain the formal contact with the subcontractors regarding compliance with the requirements of the field supervisors and/or home office specialists. In addition, the Field Subcontracts Coordinator in conjunction with the home office Subcontracts Department, will insure that change order work directives are properly written, are indeed beyond the scope of the original contract work, and that the costs are determined in accordance with the terms of the subcontract. The Field Administrator will attend the regularly scheduled coordination meetings held with the subcontractors and insure that the necessary action is taken to resolve any interfacing problems that may arise.

Labor Relations

Construction of the project will be administered and executed under the terms of the Taconite Agreement. Prior to the start of construction, the McKee Construction Services Department will conduct a labor survey of the union locals in the area surrounding the project site to determine the availability or lack thereof of the various craft workers. Each subcontractor will be responsible for his own labor relations functions, and for hiring and firing of all personnel on a direct hire basis and for the settlement of any disputes or any other problems arising during execution of the subcontract. McKee's Construction Services Department, which consists of experienced labor negotiators, will be available to assist and/or advise any of the subcontractors in settling difficult jurisdictional problems. They will also be available to assist in alleviating craft manpower shortages by obtaining workers from other areas.

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5.05 CONSTRUCTION MANAGEMENT PLAN (continued)

Project Control

The Field Cost Engineering staff will monitor all phases of construction cost and will prepare a monthly field cost report. These reports will indicate budgeted, actual and projected costs and will provide productivity ratings and curves for each subcontract. These will be indicated by the ratio of budgeted manhours to manhours actually expended.

The Field Scheduling staff will monitor progress of each subcontract and the project as a whole. Each subcontractor will be required to provide a detailed schedule of his work and a separate short term work schedule and bar graph which will be reviewed and updated each week. The project schedule will be updated on a monthly basis.

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**CONSTRUCTION MANAGEMENT STAFF
ORGANIZATION CHART**

5.0 CAPITAL COSTS (continued)5.06 ENGINEERING, PROCUREMENT AND CONSTRUCTION SCHEDULEGeneral

Total elapsed time for detailed engineering, procurement and construction for the Commercial Plant is 34 months. For the purposes of the economic evaluation it is assumed that detailed engineering starts on March 1, 1979. The schedule reflects this assumption. Other basic criteria used in the development of the schedule are:

- The schedule assumes a single Engineer/Architect is responsible for all detailed engineering and procurement except that for the gasifiers, which the gasifier vendor as subcontractor will engineer, procure and install. All construction work will be performed by subcontractors under the management of the same Engineer/Architect that did the engineering.
- Engineering will start in the first month and is projected to be 95% completed in the fourteenth month.
- Procurement will start in the first month and proceed continuously over a span of twenty four months.
- An overall construction period of thirty four months will begin with site borings in the first month. The Commercial Plant is projected to be ready for start up in January 1, 1982.
- The schedule times shown for gasification and sulfur removal items were developed without benefit of detailed data from the vendors. The vendor data was not available when the schedule was prepared.

Engineering

The engineering segment of the schedule is based on orderly completion of detailed engineering activities, logical engineering restraints and the estimated engineering manhours. Detailed engineering is scheduled to begin on March 1, 1979, utilizing the front end engineering packages developed by others.

The schedule indicates completion of equipment engineering requisitions and completion of building designs by the thirteenth month. This will provide sufficient time for procurement of long lead time equipment.

Engineering (continued)

Engineering is considered to be 95% complete on May 1, 1980, with field resolution continuing throughout the project.

Procurement

As above indicated, delivery lead time requirements are recognized and provided for throughout the entire schedule. Gasifiers, process gas coolers and refractory lined cyclones must be purchased at the very beginning of the detailed engineering phase and must arrive at the site by February, 1981. Other long lead time items, compressors for example, must also be purchased early in this period.

Construction

Construction work during the first year will consist of major earthwork, trackwork and critical concrete work. Site borings taken in the first month will facilitate an early start on the extensive cutting, filling and replacement of earth in the Material Handling, Gasification and Sulfur Removal areas.

Construction work during the 1979-1980 winter season would contribute very little to the overall progress of the project, so no construction activity is scheduled for those months.

On completion of the major earthwork, the trackwork, gasifier building foundations and car dumper concrete work will begin.

Since construction of the gasifier building will be critical to the project, the structural steel work for this area should start early in the Spring, 1980. In order to complete the project on schedule the gasifier building must be enclosed by late November, enabling construction to continue through the 1980-1981 winter season.

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5.07 TAKE OUT VALUE OF STIRRERS

Credit for removal of stirrers from all five retorts is
\$1.02 million, direct cost only with no engineering.

6.0

OPERATING COSTS

6.01 GENERAL

The estimates of operating costs for the Commercial Plant are based on those developed in the Demonstration Plant report, differing only in scale.

6.02 OPERATING PLAN

Operations at the Commercial level will be preceded by at least two years of demonstration activities, as described in the Demonstration Plant report, to determine:

- The composition and quantities of feed, yields, products and by-products at each process step.
- The composition and quantities of waste products and emissions from each process step.
- Utility requirements under various sets of conditions.
- Optimum operating conditions.

The Commercial Plant is assumed to benefit from the operating experience of the Demonstration Plant, and will, therefore, require no more than a normal one month shakedown period followed by a one month period to bring the plant to full capacity (95% operability). Thereafter operations will be maintained at capacity over the remainder of the 20 year plant life.

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6.0 OPERATING COSTS

6.03 MANNING SCHEDULE

The coal gasification plant will have its own operating staff. Table I below lists the projected operating labor requirements with associated costs. It assumes that 4.7 men will be required to provide one man coverage around-the-clock, seven days per week. It will be noted that in the Western coal case, the Sulfur Removal Operator will not be required.

Maintenance labor is expected to be provided from Erie Mining Company's maintenance pool and billed against gasifier plant at actual cost. For purposes of the economic evaluation, annual maintenance labor costs are assumed to be 1.5% of the total plant investment.

TABLE I

OPERATING MANNING SCHEDULE

<u>Job Title</u>	<u>Hourly Rate Inc.Fringes & Overhead</u>	<u>Number of Men Required</u>			<u>Total Men Required</u>	<u>Annual Cost Per Man</u>	<u>Total Annual Labor Cost</u>
		<u>1st Shift</u>	<u>2nd Shift</u>	<u>3rd Shift</u>			
Plant Superintendent	32.59	1	-	-	1	65,180	\$ 65,180
Laboratory Technician	14.00	2	-	-	2	28,000	56,000
Shift Foreman	23.35	1	1	1	5	46,700	233,500
Chief Operator	17.51	1	1	1	5	35,020	175,100
Coal Feed Operator	16.20	4	4	4	20	32,400	648,000
Gasifier Operator	16.20	3	3	3	15	32,400	486,000
Sulfur Removal Operator	16.20	1	1	1	5	32,400	162,000
Utilities Operator	16.20	1	1	1	5	32,400	162,000
Floating Operator	16.20	1	1	1	5	32,400	162,000
Laborers	14.68	4	0	0	4	29,360	117,400
TOTAL		19	12	12	67		\$2,267,220

6.0 OPERATING COSTS (continued)

6.04 RAW MATERIALS, BY-PRODUCTS AND WASTE PRODUCTS

The quantities and unit costs raw materials and by-products are as follows:

6.04.1 Coal

The basic raw material for the plant is coal of the kinds, sizes and analyses specified in other sections of this report. The basic unit prices for coals, extracted from Erie Mining Company's Coal Handling Study, are:

- Eastern Coal, Delivered \$40 per ton
- Western Coal, Delivered \$26
- Agglomeration Charge \$ 5 \$31 per ton

For Western coal an additional cost of \$5 per ton must be added, since all indications are that its friability and high fines content make it impractical to use as a gasifier feedstock without some type of prior agglomeration. Detailed estimates of capital and operating costs for such an agglomeration plant were not made. The \$5 per ton figure, which is also taken from the Erie Mining Company Study, covers all capital and operating charges for an agglomeration plant.

Table 2 below gives a breakdown of total annual coal requirements and costs. The cost shown for Western coal includes the agglomeration charge.

TABLE 2

COAL QUANTITIES AND COSTS

	<u>Eastern Coal</u>	<u>Western Coal</u>
Deliveries to Plant Site		
Tons per Year	468,103	497,251
Feed to Gasifiers		
Tons per Stream Day	1,187	1,433
Tons per Year	411,889	497,182
Fines to Taconite Harbor		
Tons per Year	56,214	---
Cost of Coal Purchased		
Dollars per Year	18,724,000	15,415,000
Credit for Fines		
Dollars per Year	2,122,000	---

6.04.2 By-Products

Fines

Coal fines are considered a by-product. With Eastern coal operation the minus 1/2" fraction is screened off prior to gasification and, it is assumed for this analysis, shipped to Taconite Harbor for use in Erie Mining Company's power plant.

The cost to Erie for coal delivered at Taconite Harbor is \$39 per ton. The credit allowance to the gasification plant for fines is thus \$39 less \$1.25 per ton for getting them to Taconite Harbor (\$0.20 for loading, \$1.00 for rail transport, and a \$0.05 cost differential for unloading rail cars versus unloading ships).

It being assumed that Western coal fines will be agglomerated, there will be no fines credit for that case.

Tar and Oil

Significant quantities of those by-products will be produced. Their properties are similar to those of No. 5 and No. 6 fuel oil. Plans are to mix the tar and oil and use them as fuel in the gasification plant, and as a supplemental fuel in the pellet plant.

It is possible that the tar/oil mix produced from operation on high sulfur Eastern coal will have a sulfur content in excess of the 2% by weight sulfur limitation currently set by environmental regulations. The actual tar/oil sulfur content is presently uncertain, but the credit for this by-product is an essential part of the overall plant economics. It is therefore assumed that, if the tar/oil sulfur content exceeds 2%, it can be blended prior to combustion with a low sulfur fuel to utilize its value as a as a fuel.

A portion of the tar/oil is burned at the gasification plant as fuel for the packaged boilers and the waste water incinerator. The demand for this purpose varies seasonally according to steam requirements and according to the quantity of water to be incinerated. For Western coal, the demand for tar/oil will exceed the quantity produced during winter operation and supplemental No. 6 fuel oil must be purchased during these periods. For Eastern coal, the quantity produced always exceeds the captive demand.

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6.04.2 By-Products (continued)

To handle these various situations in a simple manner, the tar/oil and No. 6 fuel oil have been put on an equivalent price basis of \$3/MMBtu. Annualized averages for tar/oil and fuel oil demand can then be subtracted from the tar/oil production, and a net tar/oil credit is obtained. The table below shows tar/oil production and average tar/oil or fuel oil demand for the Western and Eastern coal cases.

TABLE 3

NET TAR/OIL CREDITS

	<u>Western Coal</u>	<u>Eastern Coal</u>
<u>Production</u>		
Tar/Oil produced, lbs/hr.	7,722	18,724
<u>Demand</u>		
Tar/oil or fuel oil required for packaged boilers- annual average lbs/hr.	1,214	219
Tar/oil or fuel oil required for wastewater incinerator - annual average lbs/hr.	1,559	182
TOTAL DEMAND	1,773	401
<u>Net Tar/Oil Credit</u>		
Pounds per hour	4,949	18,323
Annual Value (\$3/MMBtu, 16,400 Btu/lb)	\$2,028,000	\$7,508,000

6.04.3 Waste Products

Gasifier ash, Stretford purge, and sulfur (although the latter is a potentially marketable by-product) must be disposed of. Present plans are to truck these materials to a landfill, and the cost of these operations must be taken into account in the plant operating costs. The estimated costs for disposing of these materials are \$4.00 per ton for ash and sulfur, and \$5.00 per 100 gallons for Stretford purge.

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6.0 OPERATING COSTS (continued)

6.05 CHEMICALS

The only significant user of chemicals is the Stretford Unit. The quantities and unit prices for its requirements are given below.

TABLE 4

STRETFORD CHEMICALS

<u>Item</u>	<u>Requirements lbs/hr.</u>	<u>Unit Price \$1 lb.</u>	<u>Annual Cost Dollars</u>
ADA	3.8	6.25	198,400
Vanasol	10.0	5.85	488,600
Caustic	212.0	0.07	124,000
TOTAL			\$811,000

In addition to the above, small quantities of sodium chloride, hypochloride, alum and flocculant are required for boiler feedwater treatment. These are accounted for as miscellaneous chemicals in the operating cost summary.

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6.0 OPERATING COSTS (continued)

6.06 UTILITIES

Unit prices for utilities are listed below, followed by a breakdown, by area and by coal type, of the requirements for each.

- Cooling Water, \$0.05/Mgal.

This price is for non-contact cooling water taken from the existing pellet plant concentrator and returned to the concentrator tailings sump.

- Reservoir Water, \$0.10/Mgal.

Used as the raw water supply for boiler feedwater production.

- Inert Gas, \$0.40/Mscf.

This value is used to account for the low Btu gas required as fuel to produce inert gas. The calculation is based on a value of \$4.00/MMBtu for the low Btu gas used. The capital costs and utilities required for inert gas production are taken into account in the overall capital and operating cost estimates.

- Back-up Liquid Nitrogen, \$2.85/Mscf.

Quoted by suppliers in the Hoyt Lakes area.

- Electric Power, \$0.02/kwhr.

From Erie Mining Company.

The utility requirements are given in Table 5 on the following page.

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6.06 UTILITIES (continued)

TABLE 5
UTILITY REQUIREMENTS

<u>Item</u>	<u>Area</u>	<u>Unit</u>	<u>Requirements</u>	
			<u>Western Coal</u>	<u>Eastern Coal</u>
COOLING WATER	01	gpm.	15	15
	02	gpm.	2,714	1,350
	03	gpm.	0	1,990
	04	gpm.	75	75
	06	gpm.	177.5	222.5
	07	gpm.	0.5	0.5
		TOTAL	2,982	3,653
BOILER FEEDWATER	02	mlb/hr.	64.5	99.0
	03	mlb/hr.	0	4.5
	05	mlb/hr.	17.7	2.18
	06	mlb/hr.	15.2	0.94
		TOTAL	97.4	106.62
Less Returned Condensate			49.98	26.91
Required Make-up			47.42	79.71
INERT GAS	02	scfm.	240	240
	All (1)	scfm.	10	10
		TOTAL	250	250
BACK-UP NITROGEN	06 (2)	scfm.	17	17
		TOTAL	17	17
ELECTRIC POWER	01	kw.	871	871
	02	kw.	1,141	1,139
	03	kw.	0	1,620
	04	kw.	4,510	4,510
	05	kw.	113	113
	06	kw.	460	439
		TOTAL	7,095	8,692

(1) Inert gas used in all areas for purging instrumentation

(2) Back-up for inert gas system and instrument air

6.07 OPERATING COST SUMMARY

The plant operating costs are summarized in Table 6 on the following page. The variable costs are based on the onstream factor of 9.5%. Reasonable factors are included for such fixed costs as supplies, administrative and general overhead, local taxes and insurance.

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TABLE 6
SUMMARY OF ANNUAL OPERATING COSTS

<u>VARIABLE COSTS</u>	<u>WESTERN COAL</u>	<u>EASTERN COAL</u>
Coal (Western, \$31/T, Eastern \$40/T)	\$15,415,000	\$18,724,000
Stretford Chemicals	-	811,000
Miscellaneous Chemicals	10,000	10,000
Electric Power (\$0.02/kwhr.)	1,182,000	1,448,000
Cooling Water (\$0.05/Mgal)	75,000	91,000
Reservoir Water (\$0.10/Mgal)	5,000	8,000
Inert Gas (\$0.40/Mscf)	50,000	50,000
Back-up Nitrogen (\$2.85/Mscf)	24,000	24,000
Ash Disposal (\$4.00/t)	134,000	129,000
Stretford Purge Disposal (\$5.00/100 gal)	-	32,000
Sulfur Disposal \$4.00/T)	-	41,000
TOTAL	16,891,000	21,368,000
Less By-Product Credits:		
Excess Tar/Oil to Pellet Plant (\$3.00/MMBtu)	(2,028,000)	(7,508,000)
Eastern Coal Fines to Taconite Harbor (\$37.75/T) -	-	(2,122,000)
TOTAL VARIABLE COSTS	14,863,000	11,738,000
<u>FIXED COSTS</u>		
Operating Labor	2,105,000	2,267,000
Maintenance Labor (1.5% of Plant Investment)	1,163,000	1,388,000
Supervision (10% of Operating & Maint. Labor)	327,000	366,000
Operating Supplies (10% of Operating Labor)	211,000	227,000
Maintenance Supplies (1.5% of Plant Investment)	1,163,000	1,388,000
Admin. & General Overhead (15% of Total Labor)	539,000	603,000
Total Taxes & Insurance (2.5% of Plant Investment)	1,939,000	2,313,000
TOTAL FIXED COSTS	\$ 7,447,000	\$ 8,552,000
NET TOTAL OPERATING COST	\$22,314,000	\$20,290,000

7.0

ECONOMIC ANALYSIS

7.01 GENERAL

This section presents McKee's evaluation of the overall economic feasibility of the project.

Work on the economic analysis proceeded concurrently with the development of the final capital cost estimate presented in Section 5.0. For this reason the capital cost figures used in this section and in obtaining some of the operating cost elements in Section 6.0 do not coincide exactly with the final cost figures presented in Section 5.0. However, the figures used are close to the final numbers. Furthermore, as part of the analysis, the sensitivity of gas price to capital investment is presented, which permits evaluation of the impact of any discrepancies.

The capital costs used are presented in Table 9. For purposes of the economic analysis, start up costs and working capital are included in the total capital requirement. Government participation in financing the project is not taken into account.

TABLE 9

CAPITAL COST USED FOR
ECONOMIC EVALUATION OF COMMERCIAL PLANT

(4th QUARTER, 1978 DOLLARS)

	<u>Eastern Coal(1)</u>	<u>Western Coal(2)</u>
Total Direct Cost	\$ 77,283,000	\$ 63,803,000
Construction Management	2,657,000	2,587,000
Professional Services and Overhead	12,184,000	10,854,000
Royalties	400,000	320,000
TOTAL PLANT INVESTMENT	<u>\$ 92,524,000</u>	<u>\$ 77,564,000</u>
Start Up Costs	1,500,000	1,220,000
Working Capital	5,083,000	4,375,000
TOTAL CAPITAL REQUIREMENT	<u>\$ 99,107,000</u>	<u>\$ 83,159,000</u>

- (1) Eastern coal figures are based on 12 stirred gasifiers and a Stretford Unit.
- (2) Western coal figures are for 12 conventional gasifiers and no Stretford Unit.

7.02 METHODOLOGY

The study period starts with the date of the contract award for detailed engineering, continues through the construction period, and then spans twenty years of plant operation.

The economic analysis is based on the project internal rate of return (IRR) using discounted cash flow. The internal rate of return is determined by the discount factors for uniform compounding of the project cash flow over each year of the study period.

The cash flow used is for the hypothetical case of total equity financing (no debt or interest payments). The IRR is that interest rate which, when applied to the future cash flows to discount them to their present value, makes the cumulative discounted cash flow zero at the end of the study period. In this method of analysis, the retention value of the business (book value including working capital) at the close of the final year of the study period is taken as a cash inflow to close the analysis.

With regard to escalation and inflation, the analysis has been performed on two different bases. The first uses constant 1978 dollars over the entire study period without regard to inflation or escalation. The second takes into account the escalation of capital expenditures from the Fourth Quarter of 1978 through the construction period at 6% per year. It also assumes continuous inflation of operating cost items and revenues at 7% per year from the Fourth Quarter of 1978 through the life of the project. The inflated case gives the 1978 price of the gas required to achieve the desired IRR throughout the life of the project. That gas price is inflated at 7% per year for each year of the project. This method yields a lower 1978 selling price of gas since increasing revenues with time minimize the cost effects of capital expenditures early in the project for a given IRR. The IRR for this price in constant dollars is 5%.

With regard to other facts, the "sum-of-the-years-digits" method of depreciation was used with a 15 year write-off for equipment and a 25 year write-off for buildings and structures. A comprehensive 50% income tax rate is used to cover federal, state and local taxes. For calculation of operating costs and gas revenues a 95% (347 days per year) onstream factor was used.

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7.03 RESULTS

A computer program was used to determine the IRR for the various cases studied and to investigate the sensitivity of gas price to the important economic variables. Samples of typical computer output and an explanation are contained in Section 7.05.

Project guidelines call for a determination of the selling price of gas for a 12% discounted cash flow return in investment (IRR=12%). Table 10 below shows the selling price of gas required to achieve this return on investment for the constant dollar case and the inflated case.

TABLE 10

GAS SELLING PRICE FOR 12% IRR

	<u>Constant 1978 Dollars</u>	<u>Inflation at 7%/Year</u>
Eastern Coal (\$/million Btu)	6.64	4.90
Western Coal (\$/million Btu)	6.39	4.90

In the Commercial Plant the price of gas is lower for Western coal because of deletion of the gasifier stirrers and the Stretford unit. These savings more than offset the effects of the briquetting charge and the lower quantities of tar and oil in the Western coal case.

7.04 SENSITIVITY ANALYSIS

In order to evaluate the impact of changes in project scope, changes in coal costs and other important parameters, curves were developed showing the sensitivity of gas price to a number of variables. These curves, shown in Figures 2 through 9, are briefly described as follows:

Figures 2-3 - IRR vs. GAS SELLING PRICE

These curves show the variation in IRR with gas price.

Figures 4-5 - GAS SELLING PRICE vs. PLANT INVESTMENT

Using these curves, the effect of changes in project scope resulting in lower capital investment can be evaluated when variable operating costs and IRR are held constant.

Figures 6-7 - GAS SELLING PRICE vs. VARIABLE OPERATING COSTS

Here variable operating costs are expressed in dollars per million Btu and consist of costs for coal, chemicals, utilities and disposal of waste products. Using these curves the impact of changes in coal costs can be determined. Capital investment and IRR are constant.

Figures 8-9 - GAS SELLING PRICE vs. PRODUCTION VOLUME

These curves show the change in gas price with variation in annual gas production. They can be used to determine potential savings if higher than design gasification plant output can be achieved. Capital investment, variable operating costs, and IRR are constant.

FIGURE 2
INTERNAL RATE OF RETURN VERSUS GAS SELLING PRICE
COMMERCIAL PLANT
EASTERN COAL

FIGURE 3
INTERNAL RATE OF RETURN VERSUS GAS SELLING PRICE
COMMERCIAL PLANT
WESTERN COAL

FIGURE 4
GAS SELLING PRICE VS. PRODUCTION VOLUME
COMMERCIAL PLANT
EASTERN COAL

FIGURE 5
GAS SELLING PRICE VS. PRODUCTION VOLUME
COMMERCIAL PLANT
WESTERN COAL

FIGURE 6
GAS SELLING PRICE VS. VARIABLE OPERATING COSTS

COMMERCIAL PLANT
EASTERN COAL

FIGURE 7
GAS SELLING PRICE VS. VARIABLE OPERATING COSTS

COMMERCIAL PLANT
WESTERN COAL

FIGURE 8
GAS SELLING PRICE VS. PRODUCTION VOLUME
COMMERCIAL PLANT
EASTERN COAL

FIGURE 9
GAS SELLING PRICE VS. PRODUCTION VOLUME
COMMERCIAL PLANT
WESTERN COAL

7.05 COMPUTER OUTPUT

Computer output for the two most typical cases (12% IRR for Eastern and Western coal) is presented in the following pages. In the computer program, variable costs are expressed in dollars per million Btu and do not include by-product credits. These credits are treated as "other income." Case 1 refers to Eastern coal and Case 2 refers to Western coal.

The output provides four categories of information for each case. They are:

1. Sensitivity Matrix - shows the change in IRR with changes in major input variables. The range of values used is shown at the bottom of the page.
2. Profit and Loss Statement - gives yearly income, taxes and net profits.
3. Balance Sheet - gives yearly assets and liabilities when all earnings are retained.
4. Earnings Summary - gives yearly cash flows, cumulative cash flow, net present value at 10% and IRR.

VENTURE ANALYSIS SYSTEM

VENTURE IDENTIFICATION ERIE MINING CASE IV

INTERNAL VENTURE DCF/ROI SENSITIVITY ANALYSIS PROGRAM-ABBREVIATED INPUT

PROFIT & LOSS STATEMENT

THIS OUTPUT IS BASED ON THE ESTIMATES OF THE MOST LIKELY VALUES OF THE INPUT VARIABLES.

PROFIT & LOSS STATEMENT

(PUBLIC ACCOUNTING BASIS)

CURRENT DOLLARS(\$THOUSAND)

DURING YEAR	SALES		COST OF SALES.....		DEPR		EXPENSES.....			PROFIT ON OPNS	OTHER INCOME	INCCME* TAXES	NET PROFIT
	SEMI-VAR	VAR	= TOTAL		EXP	SEMI-VAR	VAR	OTHER	= TOTAL				
1979	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1981	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1982	44346.6	7447.0	16864.2	24311.2	2512.1	0.0	0.0	0.0	0.0	17523.3	2028.0	9775.6	9775.6
1983	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1984	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1985	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2026.0	8519.6	8519.6
1986	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1987	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1988	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1989	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1990	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1991	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1992	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1993	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1994	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1995	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1996	44346.6	7447.0	16864.2	24311.2	5024.2	0.0	0.0	0.0	0.0	15011.2	2028.0	8519.6	8519.6
1997	44346.6	7447.0	16864.2	24311.2	2668.0	0.0	0.0	0.0	0.0	17367.3	2028.0	9697.7	9697.7
1998	44346.6	7447.0	16864.2	24311.2	311.8	0.0	0.0	0.0	0.0	19723.5	2028.0	10875.8	10875.8
1999	44346.6	7447.0	16864.2	24311.2	311.8	0.0	0.0	0.0	0.0	19723.5	2028.0	10875.8	10875.8
2000	44346.6	7447.0	16864.2	24311.2	311.8	0.0	0.0	0.0	0.0	19723.5	2028.0	10875.8	10875.8
2001	44346.6	7447.0	16864.2	24311.2	311.8	0.0	0.0	0.0	0.0	19723.5	2028.0	10875.8	10875.8

* NEGATIVE INCOME TAXES INDICATE A REDUCTION IN TOTAL CO. INCOME TAX DUE TO OPERATING LOSSES ON THIS VENTURE

VENTURE ANALYSIS SYSTEM

VENTURE IDENTIFICATION = ERIE MINING CASE IV

INTERNAL VENTURE DCF/ROI SENSITIVITY ANALYSIS PROGRAM-ABBREVIATED INPUT SENSITIVITY ANALYSIS RESULTS

DCF/ROI VALUES(PERCENT)

VARIABLE VALUE RANGE

VARIABLE NAMES *****	1 MIN	2	3	4	5	6	7	8	9	10 MAX
SELLING PRICE	-8.4	3.7	9.6	14.0	17.6	20.7	23.5	26.0	28.3	30.4
TARGET VOLUME	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
INVESTMENTS	17.8	16.5	15.4	14.5	13.6	12.8	12.1	11.5	10.9	10.3
COST OF SALES										
SEMI-VARIABLE	12.6	12.4	12.2	12.1	11.9	11.7	11.5	11.4	11.2	11.0
VARIABLE	16.4	15.5	14.5	13.5	12.4	11.3	10.1	8.9	7.5	6.0
EXPERIENCE CURVE	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
EXPENSES										
SEMI-VARIABLE	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
VARIABLE	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
OTHER EXPENSE	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
OTHER INCOME	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
INFLATION	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1

CASE 4 - COMMERCIAL WESTERN

	MINIMUM	MOST LIKELY	MAXIMUM
Selling Price \$/Million Btu's	3.00	6.39	15.00
Variable Costs \$/Million Btu's	1.00	2.43	4.00
Semi Variable Costs \$1000/yr	6503	7447	9756
Investment \$1000	50,000	83,159	100,000

VENTURE ANALYSIS SYSTEM

VENTURE IDENTIFICATION ERIE MINING CASE IV

INTERNAL VENTURE DCF/ROI SENSITIVITY ANALYSIS PROGRAM-ABBREVIATED INPUT BALANCE SHEET

THIS OUTPUT IS BASED ON THE ESTIMATES OF THE MOST LIKELY VALUES OF THE INPUT VARIABLES.

BALANCE SHEET

(PUBLIC ACCOUNTING BASIS)

CURRENT DOLLARS(\$THOUSAND)

END OF YEAR	ASSETS				TOTAL	CURRENT LIABILITIES	EQUITY	END OF YEAR
	CURRENT	GROSS P&E	LONG TERM - CUM DEPR	NET P&E				
1979	0.0	27720.0	0.0	27720.0	27720.0	0.0	27720.0	1979
1980	0.0	55440.0	0.0	55440.0	55440.0	0.0	55440.0	1980
1981	0.0	83160.0	0.0	83160.0	83160.0	0.0	83160.0	1981
1982	4434.7	83160.0	2512.1	80647.9	85082.5	0.0	85082.5	1982
1983	4434.7	83160.0	7536.4	75623.6	80058.3	0.0	80058.3	1983
1984	4434.7	83160.0	12560.6	70599.4	75034.0	0.0	75034.0	1984
1985	4434.7	83160.0	17584.9	65575.1	70009.8	0.0	70009.8	1985
1986	4434.7	83160.0	22609.1	60550.9	64985.6	0.0	64985.6	1986
1987	4434.7	83160.0	27633.4	55526.6	59961.3	0.0	59961.3	1987
1988	4434.7	83160.0	32657.6	50502.4	54937.1	0.0	54937.1	1988
1989	4434.7	83160.0	37681.8	45478.2	49912.8	0.0	49912.8	1989
1990	4434.7	83160.0	42706.1	40453.9	44888.6	0.0	44888.6	1990
1991	4434.7	83160.0	47730.3	35429.7	39864.3	0.0	39864.3	1991
1992	4434.7	83160.0	52754.6	30405.4	34840.1	0.0	34840.1	1992
1993	4434.7	83160.0	57778.8	25381.2	29815.8	0.0	29815.8	1993
1994	4434.7	83160.0	62803.1	20356.9	24791.6	0.0	24791.6	1994
1995	4434.7	83160.0	67827.3	15332.7	19767.3	0.0	19767.3	1995
1996	4434.7	83160.0	72851.5	10308.5	14743.2	0.0	14743.2	1996
1997	4434.7	83160.0	75519.5	7640.5	12075.2	0.0	12075.2	1997
1998	4434.7	83160.0	75831.3	7328.7	11763.3	0.0	11763.3	1998
1999	4434.7	83160.0	76143.1	7016.9	11451.5	0.0	11451.5	1999
2000	4434.7	83160.0	76454.9	6705.1	11139.7	0.0	11139.7	2000
2001	4434.7	83160.0	76766.8	6393.3	10827.9	0.0	10827.9	2001

VENTURE ANALYSIS SYSTEM

VENTURE IDENTIFICATION ERIE MINING CASE IV

INTERNAL VENTURE DCF/ROI SENSITIVITY ANALYSIS PROGRAM-ABBREVIATED INPUT CASH FLOW / ROE / EARNINGS SUMMARY

THIS OUTPUT IS BASED ON THE ESTIMATES OF THE MOST LIKELY VALUES OF THE INPUT VARIABLES.

CURRENT DOLLARS (\$THOUSAND)

DURING YEAR	INVEST- MENTS	CASH OUTFLOW TAXES	CHANGE WORKING CAPITAL	COS & EXPI	CASH INFLOW SALES	ADJ FOR PROGRES PAYMENT	OTHER INCOME2	NET ANNUAL CASH FLOW	CUM ANNUAL CASH FLOW	RETURN ON EQUITY (PC) 3	EARNINGS ERR THS SHARES (\$/K-SH) 4	RETURN ON SALES (PC)	NET PRESENT VALUE
1979	27720.0	0.0	0.0	0.0	0.0	0.0	0.0	-27720.0	-27720.0	0.0	0.0	0.0	-26368.1
1980	27720.0	0.0	0.0	0.0	0.0	0.0	0.0	-27720.0	-55440.0	0.0	0.0	0.0	-50226.9
1981	27720.0	0.0	0.0	0.0	0.0	0.0	0.0	-27720.0	-83160.0	0.0	0.0	0.0	-71815.3
1982	0.0	8705.8	4434.7	24311.2	44346.6	0.0	2028.0	8922.9	-74237.1	11.5	9.7756	22.04	-65527.4
1983	0.0	6610.0	0.0	24311.2	44346.6	0.0	2028.0	15453.4	-58783.6	10.6	8.5196	19.21	-55673.8
1984	0.0	6904.5	0.0	24311.2	44346.6	0.0	2028.0	15158.9	-43624.7	11.4	8.5196	19.21	-46927.9
1985	0.0	7199.0	0.0	24311.2	44346.6	0.0	2028.0	14864.4	-28760.4	12.2	8.5196	19.21	-39168.0
1986	0.0	7493.5	0.0	24311.2	44346.6	0.0	2028.0	14569.9	-14190.5	13.1	8.5196	19.21	-32285.7
1987	0.0	7738.1	0.0	24311.2	44346.6	0.0	2028.0	14275.3	84.8	14.2	8.5196	19.21	-26184.2
1988	0.0	8082.6	0.0	24311.2	44346.6	0.0	2028.0	13980.8	14065.6	15.5	8.5196	19.21	-20777.3
1989	0.0	8377.1	0.0	24311.2	44346.6	0.0	2028.0	13686.3	27751.9	17.1	8.5196	19.21	-15987.9
1990	0.0	8671.6	0.0	24311.2	44346.6	0.0	2028.0	13391.8	41143.6	19.0	8.5196	19.21	-11747.6
1991	0.0	8966.2	0.0	24311.2	44346.6	0.0	2028.0	13097.2	54240.9	21.4	8.5196	19.21	-7995.2
1992	0.0	9260.7	0.0	24311.2	44346.6	0.0	2028.0	12802.7	67043.6	24.5	8.5196	19.21	-4676.2
1993	0.0	9555.2	0.0	24311.2	44346.6	0.0	2028.0	12508.2	79551.7	28.6	8.5196	19.21	-1742.2
1994	0.0	9849.7	0.0	24311.2	44346.6	0.0	2028.0	12213.7	91765.3	34.4	8.5196	19.21	850.2
1995	0.0	10144.3	0.0	24311.2	44346.6	0.0	2028.0	11919.1	103684.4	43.1	8.5196	19.21	3139.2
1996	0.0	10438.8	0.0	24311.2	44346.6	0.0	2028.0	11624.6	115309.0	57.8	8.5196	19.21	5159.3
1997	0.0	10733.3	0.0	24311.2	44346.6	0.0	2028.0	11330.1	126639.1	80.3	9.6977	21.87	6940.8
1998	0.0	10880.6	0.0	24311.2	44346.6	0.0	2028.0	11182.8	137821.9	92.5	10.8758	24.52	8531.8
1999	0.0	10880.6	0.0	24311.2	44346.6	0.0	2028.0	11182.8	149004.7	95.0	10.8758	24.52	9971.5
2000	0.0	10880.6	0.0	24311.2	44346.6	0.0	2028.0	11182.8	160187.5	97.6	10.8758	24.52	11274.1
2001	0.0	10880.6	0.0	24311.2	44346.6	0.0	2028.0	11182.8	171370.3	100.4	10.8758	24.52	13546.8

1 COS & EXP INCLUDES 'R&D' AND 'OTHER EXPENSES' INPUT AS A FUNCTION OF TIME.

2 OTHER INCOME INCLUDES BOTH 'OTHER INCOME' SPECIFIED AS A FUNCTION OF TIME AND INFLOW AS A RESULT OF SALVAGE VALUE.

3 RETURN ON EQUITY EQUALS NET PROFIT DIVIDED BY EQUITY TIMES 100.

4 EARNINGS PER THOUSAND SHARES EQUALS NET PROFIT DIVIDED BY THOUSANDS OF COM SHARES OUTSTANDING.

TAX BOOK VALUE 6497.9 BOOK VALUE 6392.9 RETENTION VALUE 10932.5 (INPUT OR TAX B.V. + W.C.)

* CCF/ROI 12.13 PC *

DEPLETION ALLOWANCE 0.0 PC

DEPLETION ALLOWANCE APPLIED TO 0.0 PC OF SALES

VENTURE ANALYSIS SYSTEM

VENTURE IDENTIFICATION ERIE MINING CASE IV

INTERNAL VENTURE DCF/KOI SENSITIVITY ANALYSIS PROGRAM-ABBREVIATED INPUT SUMMARY OF OPERATIONS

THIS OUTPUT IS BASED ON THE ESTIMATES OF THE MOST LIKELY VALUES OF THE INPUT VARIABLES.

DURING YEAR	CURRENT DOLLARS (\$THOUSAND)							PRODUCTION UNITS..							
	INVESTMENT EXPENDITURES.....						SL	TAX	SHIP-	WORK	..	PROD	PROD	UPN	EXPER
	BUILD	EQUIP	UTIL	OTHER	LAND1	ASSGD2	DEPR	DEPR	MENTS	CAP'L	TARGET VOL	PROD VOL	PROD CAP	CGST3	CURVE
1979	4158.0	23562.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.0	1.00
1980	4158.0	23562.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.0	1.00
1981	4158.0	23562.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.0	1.00
1982	0.0	0.0	0.0	0.0	0.0	0.0	2512.1	4651.8	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1983	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	8843.4	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1984	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	8254.4	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1985	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	7665.3	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1986	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	7076.3	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1987	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	6487.2	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1988	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	5898.2	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1989	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	5309.1	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1990	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	4720.1	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1991	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	4131.0	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1992	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	3542.0	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1993	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	2952.9	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1994	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	2363.9	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1995	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	1774.8	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1996	0.0	0.0	0.0	0.0	0.0	0.0	5024.2	1195.8	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1997	0.0	0.0	0.0	0.0	0.0	0.0	2668.0	596.7	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1998	0.0	0.0	0.0	0.0	0.0	0.0	311.8	302.2	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
1999	0.0	0.0	0.0	0.0	0.0	0.0	311.8	302.2	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
2000	0.0	0.0	0.0	0.0	0.0	0.0	311.8	302.2	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00
2001	0.0	0.0	0.0	0.0	0.0	0.0	311.8	302.2	44346.6	4434.7	6940.	6940.	7500.	3.5	1.00

1 NOT DEPRECIATED: LAND IS HELD AT PURCHASE PRICE

2 NOT DEPRECIATED: ASSOCIATED EXPENSES ARE PERIOD EXPENSES

3 OPERATION COST EQUALS TOTAL COST OF SALES DIVIDED BY TOTAL PRODUCTION VOLUME

VENTURE ANALYSIS SYSTEM

VENTURE IDENTIFICATION = ERIE MINING CASE 3

INTERNAL VENTURE DCF/ROI SENSITIVITY ANALYSIS PROGRAM-ABBREVIATED INPUT SENSITIVITY ANALYSIS RESULTS

DCF/ROI VALUES(PERCENT)

VARIABLE VALUE RANGE

VARIABLE NAMES *****	1 MIN	2	3	4	5	6	7	8	9	10 MAX
SELLING PRICE	-4.5	4.1	9.1	13.0	16.2	19.0	21.5	23.8	25.9	27.8
TARGET VOLUME	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
INVESTMENTS	17.6	16.3	15.2	14.3	13.4	12.6	11.9	11.3	10.7	10.2
COST OF SALES										
SEMI-VARIABLE	13.0	12.8	12.7	12.5	12.3	12.1	12.0	11.8	11.6	11.4
VARIABLE	17.1	16.1	15.1	14.0	12.8	11.6	10.3	8.8	7.3	5.6
EXPERIENCE CURVE	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
EXPENSES										
SEMI-VARIABLE	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
VARIABLE	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
OTHER EXPENSE	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
OTHER INCOME	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
INFLATION	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0

CASE 3 - COMMERCIAL EASTERN

	MINIMUM	MOST LIKELY	MAXIMUM
Selling Price \$/Million Btu's	3.00	6.64	15.00
Variable Costs \$/Million Btu's	1.00	3.07	5.00
Semi Variable Costs \$1000/yr	6000	8552	10,000
Investment \$1000	60,000	99,107	120,000

VENTURE ANALYSIS SYSTEM

VENTURE IDENTIFICATION ERIE MINING CASE 3

INTERNAL VENTURE DCF/ROI SENSITIVITY ANALYSIS PROGRAM-ABBREVIATED INPUT PROFIT & LOSS STATEMENT

THIS OUTPUT IS BASED ON THE ESTIMATES OF THE MOST LIKELY VALUES OF THE INPUT VARIABLES.

PROFIT & LOSS STATEMENT

(PUBLIC ACCOUNTING BASIS)

CURRENT DOLLARS (\$THOUSAND)

DURING YEAR	SALES	COST OF SALES.....			DEPR	EXPENSES.....				PROFIT	OTHER	INCOME*	NET
		SEMI-VAR	VAR	= TOTAL	EXP	SEMI-VAR	VAR	OTHER	= TOTAL	ON OPNS	INCOME	TAXES	PROFIT
1979	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1980	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1981	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1982	46081.6	8552.0	21305.8	29857.8	2993.8	0.0	0.0	0.0	0.0	13230.0	9630.0	11430.0	11430.0
1983	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1984	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1985	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1986	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1987	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1988	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1989	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1990	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1991	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1992	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1993	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1994	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1995	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1996	46081.6	8552.0	21305.8	29857.8	5987.6	0.0	0.0	0.0	0.0	10236.2	9630.0	9933.1	9933.1
1997	46081.6	8552.0	21305.8	29857.8	3179.6	0.0	0.0	0.0	0.0	13044.2	9630.0	11337.1	11337.1
1998	46081.6	8552.0	21305.8	29857.8	371.6	0.0	0.0	0.0	0.0	15852.2	9630.0	12741.1	12741.1
1999	46081.6	8552.0	21305.8	29857.8	371.6	0.0	0.0	0.0	0.0	15852.2	9630.0	12741.1	12741.1
2000	46081.6	8552.0	21305.8	29857.8	371.6	0.0	0.0	0.0	0.0	15852.2	9630.0	12741.1	12741.1
2001	46081.6	8552.0	21305.8	29857.8	371.6	0.0	0.0	0.0	0.0	15852.2	9630.0	12741.1	12741.1

* NEGATIVE INCOME TAXES INDICATE A REDUCTION IN TOTAL CO. INCOME TAX DUE TO OPERATING LOSSES ON THIS VENTURE

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VENTURE ANALYSIS SYSTEM

VENTURE IDENTIFICATION ERIE MINING CASE 3

INTERNAL VENTURE DCF/ROI SENSITIVITY ANALYSIS PROGRAM-ABBREVIATED INPUT BALANCE SHEET

THIS OUTPUT IS BASED ON THE ESTIMATES OF THE MOST LIKELY VALUES OF THE INPUT VARIABLES.

BALANCE SHEET

(PUBLIC ACCOUNTING BASIS)

CURRENT DOLLARS(\$THOUSAND)

END OF YEAR	ASSETS				TOTAL	CURRENT LIABILITIES	EQUITY	END OF YEAR
	CURRENT	+	LONG TERM	=				
	GROSS P&E - CUM DEPR	=	NET P&E					
1979	0.0	33035.0	0.0	33035.0	33035.0	0.0	33035.0	1979
1980	0.0	66070.0	0.0	66070.0	66070.0	0.0	66070.0	1980
1981	0.0	99105.0	0.0	99105.0	99105.0	0.0	99105.0	1981
1982	4608.2	99105.0	2993.8	96111.2	100719.3	0.0	100719.3	1982
1983	4608.2	99105.0	8981.4	90123.6	94731.7	0.0	94731.7	1983
1984	4608.2	99105.0	14969.1	84135.9	88744.1	0.0	88744.1	1984
1985	4608.2	99105.0	20956.7	78148.3	82756.4	0.0	82756.4	1985
1986	4608.2	99105.0	26944.3	72160.7	76768.8	0.0	76768.8	1986
1987	4608.2	99105.0	32931.9	66173.1	70781.2	0.0	70781.2	1987
1988	4608.2	99105.0	38919.6	60185.4	64793.6	0.0	64793.6	1988
1989	4608.2	99105.0	44907.2	54197.8	58806.0	0.0	58806.0	1989
1990	4608.2	99105.0	50894.8	48210.2	52813.3	0.0	52813.3	1990
1991	4608.2	99105.0	56882.4	42222.6	46830.7	0.0	46830.7	1991
1992	4608.2	99105.0	62870.1	36234.9	40843.1	0.0	40843.1	1992
1993	4608.2	99105.0	68857.7	30247.3	34855.5	0.0	34855.5	1993
1994	4608.2	99105.0	74845.3	24259.7	28867.8	0.0	28867.8	1994
1995	4608.2	99105.0	80832.9	18272.1	22880.2	0.0	22880.2	1995
1996	4608.2	99105.0	86820.6	12284.4	16892.6	0.0	16892.6	1996
1997	4608.2	99105.0	90000.2	9104.8	13713.0	0.0	13713.0	1997
1998	4608.2	99105.0	90371.8	8733.2	13341.3	0.0	13341.3	1998
1999	4608.2	99105.0	90743.4	8361.6	12969.7	0.0	12969.7	1999
2000	4608.2	99105.0	91115.1	7989.9	12598.1	0.0	12598.1	2000
2001	4608.2	99105.0	91486.7	7618.3	12226.5	0.0	12226.5	2001

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VENTURE ANALYSIS SYSTEM

VENTURE IDENTIFICATION ERIE MINING CASE 3

INTERNAL VENTURE DCF/ROI SENSITIVITY ANALYSIS PROGRAM-ABBREVIATED INPUT CASH FLOW / ROE / EARNINGS SUMMARY

THIS OUTPUT IS BASED ON THE ESTIMATES OF THE MOST LIKELY VALUES OF THE INPUT VARIABLES.

CURRENT DOLLARS (\$THOUSAND)

DURING YEAR	INVEST- MENTS	CASH OUTFLOW TAXES	CHANGE WORKING CAPITAL	COS & EXP1	SALES	CASH INFLOW ADJ FOR PROGRES PAYMENT	OTHER INCOME2	NET ANNUAL CASH FLOW	CUM ANNUAL CASH FLOW	RETURN ON EQUITY (PC) 3	EARNINGS ERR THS SHARES (\$/K-SH) 4 (PC)	RETURN ON SALES (PC)	NET PRESENT VALUE
1979	33035.0	0.0	0.0	0.0	0.0	0.0	0.0	-33035.0	-33035.0	0.0	0.0	0.0	-31423.9
1980	33035.0	0.0	0.0	0.0	0.0	0.0	0.0	-33035.0	-66070.0	0.0	0.0	0.0	-59857.4
1981	33035.0	0.0	0.0	0.0	0.0	0.0	0.0	-33035.0	-99105.0	0.0	0.0	0.0	-85585.0
1982	0.0	10155.0	4608.2	29857.8	46081.6	0.0	9630.0	11090.6	-88014.4	11.3	11.4300	24.80	-77769.6
1983	0.0	7657.3	0.0	29857.8	46081.6	0.0	9630.0	18196.5	-69817.9	10.5	9.9331	21.56	-66166.9
1984	0.0	8008.3	0.0	29857.8	46081.6	0.0	9630.0	17845.5	-51972.4	11.2	9.9331	21.56	-55871.0
1985	0.0	8359.3	0.0	29857.8	46081.6	0.0	9630.0	17494.5	-34477.9	12.0	9.9331	21.56	-46738.1
1986	0.0	8710.3	0.0	29857.8	46081.6	0.0	9630.0	17143.5	-17334.4	12.9	9.9331	21.56	-38640.1
1987	0.0	9061.3	0.0	29857.8	46081.6	0.0	9630.0	16792.5	-542.0	14.0	9.9331	21.56	-31462.7
1988	0.0	9412.3	0.0	29857.8	46081.6	0.0	9630.0	16441.5	15899.5	15.3	9.9331	21.56	-25104.1
1989	0.0	9763.3	0.0	29857.8	46081.6	0.0	9630.0	16090.5	31990.0	16.9	9.9331	21.56	-19473.5
1990	0.0	10114.3	0.0	29857.8	46081.6	0.0	9630.0	15739.5	47729.5	18.8	9.9331	21.56	-14489.8
1991	0.0	10465.3	0.0	29857.8	46081.6	0.0	9630.0	15388.5	63117.9	21.2	9.9331	21.56	-10080.9
1992	0.0	10816.3	0.0	29857.8	46081.6	0.0	9630.0	15037.5	78155.4	24.3	9.9331	21.56	-6182.6
1993	0.0	11167.3	0.0	29857.8	46081.6	0.0	9630.0	14686.5	92841.8	28.5	9.9331	21.56	-2737.5
1994	0.0	11518.3	0.0	29857.8	46081.6	0.0	9630.0	14335.5	107177.3	34.4	9.9331	21.56	305.1
1995	0.0	11869.3	0.0	29857.8	46081.6	0.0	9630.0	13984.5	121161.7	43.4	9.9331	21.56	2990.9
1996	0.0	12220.3	0.0	29857.8	46081.6	0.0	9630.0	13633.5	134795.1	58.8	9.9331	21.56	5360.0
1997	0.0	12571.3	0.0	29857.8	46081.6	0.0	9630.0	13282.5	148077.6	82.7	11.3371	24.60	7448.5
1998	0.0	12746.8	0.0	29857.8	46081.6	0.0	9630.0	13107.0	161184.5	95.5	12.7411	27.65	9313.3
1999	0.0	12746.8	0.0	29857.8	46081.6	0.0	9630.0	13107.0	174291.4	98.2	12.7411	27.65	11000.6
2000	0.0	12746.8	0.0	29857.8	46081.6	0.0	9630.0	13107.0	187398.4	101.1	12.7411	27.65	12527.4
2001	0.0	12746.8	0.0	29857.8	46081.6	0.0	9630.0	13107.0	200505.3	104.2	12.7411	27.65	15147.2

1 COS & EXP INCLUDES 'R&D' AND 'OTHER EXPENSES' INPUT AS A FUNCTION OF TIME.

2 OTHER INCOME INCLUDES BOTH ' OTHER INCOME' SPECIFIED AS A FUNCTION OF TIME AND INFLOW AS A RESULT OF SALVAGE VALUE.

3 RETURN ON EQUITY EQUALS NET PROFIT DIVIDED BY EQUITY TIMES 100.

4 EARNINGS PER THOUSAND SHARES EQUALS NET PROFIT DIVIDED BY THOUSANDS OF COM SHARES OUTSTANDING.

TAX BOOK VALUE 7743.4 BOOK VALUE 7618.3 RETENTION VALUE 12351.5 (INPUT OR TAX B.V. + W.C.)

* DCF/ROI 12.01 PC *

DEPLETION ALLOWANCE 0.0 PC

DEPLETION ALLOWANCE APPLIED TO 0.0 PC OF SALES

INTERNAL VENTURE DCF/ROI SENSITIVITY ANALYSIS PROGRAM-ABBREVIATED INPUT SUMMARY OF OPERATIONS

THIS OUTPUT IS BASED ON THE ESTIMATES OF THE MOST LIKELY VALUES OF THE INPUT VARIABLES.

DURING YEAR	CURRENT DOLLARS(\$THOUSAND).....							..PRODUCTION UNITS..						
	INVESTMENT EXPENDITURES.....							SL	TAX	SHIP-	WORK	TARGET	PROD	OPN
	BUILD	EQUIP	UTIL	OTHER	LAND1	ASSC02	DEPR	DEPR	MENTS	CAP'L	VOL	VOL	CAP	COST3
1979	4955.0	28080.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.0
1980	4955.0	28080.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.0
1981	4955.0	28080.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.0
1982	0.0	0.0	0.0	0.0	0.0	0.0	2993.8	5543.7	46081.6	4608.2	6940.	6940.	7500.	4.3
1983	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	10539.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1984	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	9837.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1985	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	9135.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1986	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	8433.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1987	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	7731.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1988	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	7029.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1989	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	6327.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1990	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	5625.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1991	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	4923.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1992	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	4221.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1993	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	3519.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1994	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	2817.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1995	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	2115.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1996	0.0	0.0	0.0	0.0	0.0	0.0	5987.6	1413.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1997	0.0	0.0	0.0	0.0	0.0	0.0	3179.6	711.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1998	0.0	0.0	0.0	0.0	0.0	0.0	371.6	360.2	46081.6	4608.2	6940.	6940.	7500.	4.3
1999	0.0	0.0	0.0	0.0	0.0	0.0	371.6	360.2	46081.6	4608.2	6940.	6940.	7500.	4.3
2000	0.0	0.0	0.0	0.0	0.0	0.0	371.6	360.2	46081.6	4608.2	6940.	6940.	7500.	4.3
2001	0.0	0.0	0.0	0.0	0.0	0.0	371.6	360.2	46081.6	4608.2	6940.	6940.	7500.	4.3

1 NOT DEPRECIATED: LAND IS HELD AT PURCHASE PRICE

2 NOT DEPRECIATED: ASSOCIATED EXPENSES ARE PERIOD EXPENSES

3 OPERATION COST EQUALS TOTAL COST OF SALES DIVIDED BY TOTAL PRODUCTION VOLUME

COMMERCIAL PLANT DESIGN AND
ECONOMIC EVALUATION - INTERIM REPORT
ERIE MINING COMPANY
COAL GASIFICATION PROJECT
D.O.E. CONTRACT ET-78-C-01-2578
McKee CONTRACT 4814

8.0

COMMERCIAL PLANT RECOMMENDATIONS

Time has not been allocated for development and inclusion in this interim report of an alternate, minimum cost scenario for production of low Btu gas in the Commercial Plant. It is recommended, however, that such an analysis be made for the Commercial Plant; and it is expected that the analysis would indicate lower capital and operating costs than those for the Commercial Plant design described in this report.

To illustrate the nature and extent of possible cost reductions, the content of Section 8.0 in the Demonstration Plant Interim Report is reproduced on the following pages.

8.0DEMONSTRATION PLANT RECOMMENDATIONS8.01 GENERAL

The primary objective of the Fuel Gas Demonstration Plant Program is not necessarily to build a minimum cost gas producing facility. It is rather to provide the means for exploring and testing a range of technological possibilities. Consequently, the Demonstration Plant Design incorporates capability for using a variety of coal feeds, an elaborate materials handling system, alternate processes, and a complement of conservatively designed but out-of-balance facilities. Many of the equipment items have been sized for production on a scale three times the basic design capacity of the plant.

As stated, the design did not aim for the lowest possible capital cost, and was not expected to produce minimum cost low Btu gas. But even with these reservations, the evaluations in this report arrive at an unacceptably high cost for gas. This is due mainly to delivered coal costs much greater than expected and to abnormally high capital costs which include the cost of providing the special capabilities desired for demonstration purposes.

Recognizing the above conditions, comments are made in this Section on the causes of the high costs and specific recommendations are offered for cost reductions.

An Alternate Design Demonstration Plant (referred to herein as ADDP) is presented which incorporates some of these McKee recommendations. The outline is detailed only to the extent possible during the limited time allowed for finalizing the economics of the Demonstration Plant and issuing this interim report.

Briefly summarized, the following conclusions are reached with respect to the Alternate Design Demonstration Plant:

- The plant could be erected on the proposed Hoyt Lakes site for \$44,500,000 (December 1978 price basis).
- The Hoyt Lakes plant, based on the suggested ADDP criteria and using Eastern coal with 12% fines, could produce low Btu gas at a cost of \$8.00 per million Btu.
- It is estimated that such an ADDP plant, strategically located with respect to climate, coal source and gas consumer and operating under optimal conditions, with coal available at \$15.00 per ton delivered, could be built for about \$43,000,000 and could produce gas at a cost of \$6.40 per million Btu.

8.02 RECOMMENDATIONSSite

The Hoyt Lakes site has three disadvantages, namely poor subsurface conditions, its distance from the pellet plant and the utility tie-ins, and the unusually cold climate.

Subsurface analysis of the site discloses the presence of bog-like material under most of the plant. Most of this material must be removed and the site must then be filled and graded. Above normal costs attributed to the bog removal amounts \$350,000.

The present plant site is about 1200 feet from the pellet plant. Significant savings could be realized if the plant were immediately adjacent to the pellet plant. Capital costs related to the gas transmission lines, utilities lines and attendant pipe racks could be saved. Gas compressor operating costs would also be reduced.

The severe Minnesota winters require buildings, and freeze protection throughout, which costs \$2,500,000. In a milder climate these provisions would be unnecessary.

Coal

The cost of coal is the largest single item of operating expense. In the most favorable case examined in this report it represents over 60% of the total operating costs. Any reduction in coal cost would be directly and significantly reflected in the cost of the product gas.

Transportation cost is a substantial part of the cost of coal. For future gasification projects the transportation cost could be reduced by choosing a plant site which is adjacent to a coal mine or is part of a facility which uses coal delivered in very large quantities by very economical means.

The handling of coal fines is expensive. A gasifier designed to utilize one coal feed and its fines, or a limited range of feeds and their fines, would minimize fines handling costs. Optimization of the plant design to handle only a limited range of coals would also reduce capital costs.

8.02 RECOMMENDATIONS (continued)Output

An economic analysis could be prepared, taking into account the total heat output from the present Demonstration Plant design. If five gasifier retorts are operated and credit is taken for the useable tars and oils, the total output of the plant will increase from the 7.4 million Btu per day design basis to:

Gas	9.25 million Btu/day
Tar and Oil	3.2 million Btu/day
Total	12.45 million Btu/day

The plant is designed with flexibility for handling both Eastern and Western coals. It should have an additional 10 to 20% capacity above this total when operations are optimized.

Coal Stacker vs. Lowering Tubes

The plant as designed utilizes lowering tubes at the ends of conveyors to provide a gentle stacking of the incoming coal. A constant height pivoting stacker is suggested as an alternate to the lowering tubes.

This will reduce the cost of the plant. Specifically, removing the lowering tubes and equipment would save \$1,950,000 and replacing it with the stacker and its auxiliary equipment would add \$1,090,000. The net saving would be \$860,000.

8.03 ALTERNATE DESIGN DEMONSTRATION PLANT

The capital cost can be significantly reduced by designing the plant as a minimum cost unit containing no oversized equipment for use in a future expansion. The ADDP plant described here is a top quality facility, but it does not provide generously for assuring 95% operability during the early stages of operation. It will operate readily at 95% with non-high swelling coals. It will take a longer initial period to reach 95% operability with high swelling coal since there would not be a spare gasifier retort in the plant.

An overall layout for the ADDP plant is indicated on McKee Drawing 4814-X-SK-002-2. Equipment lists for the various areas of the plant are provided at the end of this section. A general description of the ADDP plant is given under the headings which follow.

8.03.1 Raw Material

The plant will use an Eastern coal with an analysis similar to that in the Demonstration Plant design basis. Initially, one quarter of the coal delivered will have a free swelling index greater than 5, for use in the one gasifier equipped with a stirrer.

The size analysis of the coal will be that indicated in Erie Mining Company's Coal Handling Trade-Off Study of August 30, 1978. The coal will be received via ship at Taconite Harbor. The 40% fines fraction (minus 1/2") will be screened off and left at Taconite Harbor for use in Erie's boiler plant. It is assumed that the coal going on to Hoyt Lakes will generate 12% fines and that the coal feed mixture to the gasifiers will include 10% fines. A material balance for this coal is shown on McKee Drawing 4814-Y-SK-001-2, a process flow sheet for the coal handling section of the plant based on the ADDP design.

8.03.2 Material Handling - Plant Area 01

The existing coal receiving track will be used. No additional equipment will be needed for the ADDP plant. Under this concept the entire commercially sized coal unloading system, along with its need for new track, is eliminated.

Coal will be moved into and reclaimed from the storage piles with use of two D8 dozers, two front end unloaders, and a reclaiming hopper. Minimum equipment, consistent with the required plant 95% operating factor, will be utilized. Steep rise (50°) conveyors will be used to reduce the

8.03 ALTERNATE DESIGN DEMONSTRATION PLANT (continued)

8.03.2 Material Handling - Plant Area 01 (continued)

capital cost and space requirements for conveying coal. Due allowance will be made for later expansion to commercial scale operations.

The ash handling silo will be deleted and replaced by a three sided concrete block enclosure. Ash will be removed by front end loaders.

8.03.3 Gasification - Plant Area 02

In the ADDP plant there will be only four stirred gasifier retorts (instead of five as in the present design) and corresponding auxiliary equipment. Although ultimately all four will be stirred, initially only one gasifier will be equipped with a stirrer. With this change the building size will be reduced by one third and the corresponding extra coal storage bins will be eliminated.

A new gasifier flare system will replace the scheme proposed by the gasifier subcontractor. The system will consist of a 16" diameter pipe from each reactor running to a 4'0" diameter by 12'0" tall knockout pot each with a 16" diameter stack.

The elevator will also be deleted and the two travelling cranes will be replaced by a one loop type monorail crane. Two gas clean up trains will be utilized as complete trains. Flexibility for isolating any one item in the train will be eliminated, thus reducing valve and manifold costs to a minimum. The gas piping will be sized for the Demonstration unit only.

Since the gasifier section will be designed to use only a low moisture Eastern coal, the pipe sizes in the top gas circuits will be significantly reduced.

8.03.4 Sulfur Removal - Plant Area 03

The Stretford sulfur removal unit described in this report is already sized only for the Demonstration Plant and, therefore, will not be reduced in size. It is not necessary, however. The entire Stretford Unit will be housed in a heated, pre-engineered building. The travelling crane will be deleted. The sulfur flaker, spare sulfur melter and decanter will be eliminated. Liquid sulfur will be discarded to waste.

8.03 ALTERNATE DESIGN DEMONSTRATION PLANT (continued)8.03.5 Gas Compression and Transmission - Plant Area 04

Only one API design compressor (with a spare rotor in storage) will be installed in this area, rather than the two now specified. This single compressor will be sized for the Demonstration Plant only and will, therefore, be smaller than those originally contemplated. All gas piping will be sized solely for the Demonstration Plant requirements. The gas compressor and its auxiliary equipment will be located in the utility building.

8.03.6 Waste Water Treatment - Plant Area 05

With the plant using only Eastern coal, the waste water treatment equipment can be minimized. The evaporator and the incinerator are completely eliminated. The waste water collection sump and a small tank and pump are retained to handle the small remaining quantity of waste water. This small quantity will be disposed of by injection into the gasifier combustion air or into the product gas.

8.03.7 Utilities - Plant Area 06

The utilities specified for the Demonstration Plant are presently designed and sized for the requirements of the Commercial Plant. For the ADDP plant they will be sized solely for the Demonstration Plant.

Only one packaged boiler will be provided.

The No. 6 fuel oil system will be eliminated and a truckload of No. 2 fuel oil will be used as required during start up.

A boiler feedwater treatment system will have approximately one half the capacity of the system currently specified.

Air compressor capacity will be one third of present capacity (dust collection filters will have their own compressors) and the air dryers will be one third of present size.

The inert gas system will be half the present size. The backup nitrogen system will be retained.

The settling pond will be reduced to approximately two thirds the present size.

8.03 ALTERNATE DESIGN DEMONSTRATION PLANT (continued)

8.03.7 Utilities - Plant Area 06 (continued)

The utility tie-in lines will be sized solely for the Demonstration Plant requirements. The principal change will be in the cooling water supply and return lines, which will be reduced from 24" to 16" in diameter. The electrical substation will be suitably sized for only the Demonstration Plant. The emergency generator and electrical backup system will remain as described in the report.

8.03.8 Safety System - Plant Area 07

This area will remain as currently designed.

8.03.9 Pellet Plant Retrofit - Plant Area 08

Thirteen burner systems will be installed, ten suitable for gas and three suitable for oil and tar. The orifice runs will be deleted. This will be sufficient burner capacity for 13 of the 27 shaft furnaces.

8.03.10 Other Modifications

In general, all plant components will be designed or sized to meet only the requirements of the Demonstration Plant.

The employee facilities building will be deleted. Minimum facilities will be provided in the control room area.

The sprinkler system will be cut in size.

Since there will be less equipment and smaller units, the manpower requirement will be about 80% of that estimated for the Demonstration Plant.

An ADDP plant as above outlined, located on the proposed Hoyt Lakes site, would cost approximately \$44,500,000, and would produce gas at a cost of \$8.00 per million Btu.

ADDP equipment lists are given in the immediately following pages.

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REVISIONS ▲ ▲ ▲ ▲ ▲	DATE	BY	CHK	DESCRIPTION	APP.	REVISIONS ▲ ▲ ▲ ▲ ▲	DATE	BY	CHK	DESCRIPTION	APP.	REVISIONS ▲ ▲ ▲ ▲ ▲	DATE	BY	CHK	DESCRIPTION	APP.		

ORIGINAL

MCKEE CORPORATION

EQUIPMENT LIST

CONTRACT MC-4814

DATE November 15, 1978

CLIENT ERIE MINING COMPANY

UNIT Minimum
DEMONSTRATION

AREA MATERIAL HANDLING 01

DOE CONTRACT ET-78-C-01-2578

REV. 0 - 11/15/78

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CONTRACT MC-4814

DATE November 15, 1978

CLIENT Erie Mining Company

UNIT Minimum
Demonstration

AREA Gasification - 02

D.O.E. CONTRACT ET-78-C-01-2578

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TAG	E/R	P & I NO.	DESCRIPTION
A-201A		Y-02-10-2	Stirrer Assembly
A-201B			Stirrer Assembly (Future)
A-201C			Stirrer Assembly (Future)
A-201D			Stirrer Assembly (Future)
B-201A		Y-02-29-2	Comb. Air Blower
B-201B			Comb. Air Blower
B-203A		Y-02-35-2	Aeration Blower
B-203B		Y-02-35-2	Aeration Blower
BN-201A		Y-02-10-2	Coal Surge Hopper
BN-201B			Coal Surge Hopper
BN-201C			Coal Surge Hopper
BN-201D			Coal Surge Hopper

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TAG	E/R	P & I NO.	DESCRIPTION
BN-203A		Y-02-37-2	Cyclone Dust Bin
BN-203B			Cyclone Dust Bin
CO-201A		Y-02-35-2	Drag Link Conveyor
CO-202A			Drag Link Conveyor
CO-203			Drag Link Conveyor
CY-201A		Y-02-10-2	Dust Cyclone
CY-201B			Dust Cyclone
CY-201C			Dust Cyclone
CY-201D			Dust Cyclone
CY-202A		Y-02-10-2	Tar Cyclone
CY-202B			Tar Cyclone
CY-202C			Tar Cyclone
CY-202D			Tar Cyclone

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TAG	E/R	P & I NO.	DESCRIPTION	
D-201A		Y-02-10-2	L.P. Steam Drum	
D-201B			L.P. Steam Drum	
D-201C			L.P. Steam Drum	
D-201D			L.P. Steam Drum	
D-202A		Y-02-25-2	HP Steam Drum	
D-203		Y-02-33-2	Flash Tank	BCI Tag No. TN-203
E-201A		Y-02-10-2	Process Gas Cooler	
E-201B			Process Gas Cooler	
E-201C			Process Gas Cooler	
E-201D			Process Gas Cooler	
E-202A		Y-02-29-2	Combined Gas Cooler	
E-202B			Combined Gas Cooler	
F-201		Y-02-29-2	Comb. Air Blower Filt. Silencer	

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TAG	E/R	P & I NO.	DESCRIPTION
MF-201A		Y-02-10-2	Coal Weigh Lock Hopper
MF-201B			Coal Weigh Lock Hopper
MF-201C			Coal Weigh Lock Hopper
MF-201D			Coal Weigh Lock Hopper
MF-202A		Y-02-10-2	Coal Feeder
MF-202B			Coal Feeder
MF-202C			Coal Feeder
MF-202D			Coal Feeder
MF-203A			Ash Lock Hopper Assembly
MF-203B			Ash Lock Hopper Assembly
MF-203C			Ash Lock Hopper Assembly
MF-203D			Ash Lock Hopper Assembly
MF-203E			Ash Lock Hopper Assembly
MF-203F			Ash Lock Hopper Assembly
MF-203G			Ash Lock Hopper Assembly
MF-203H			Ash Lock Hopper Assembly

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TAG	E/R	P & I NO.	DESCRIPTION
MF-207A		Y-02-37-2	Dust Rotary Feeder
MF-207B			Dust Rotary Feeder
MF-207C			Dust Rotary Feeder
MF-207D			Dust Rotary Feeder
P-201A		Y-02-27-2	Tar Transfer Pump - Operating
P-201B			Tar Transfer Pump - Spare
P-202A		Y-02-27-2	Aqueous Eff Pump - Operating
P-202B		Y-02-27-2	Aqueous Eff Pump - Spare
P-203A		Y-02-27-2	Oil Transfer Pump - Operating
P-203B		Y-02-27-2	Oil Transfer Pump - Spare
P-204		Y-02-27-2	Sludge Pump
P-205		Y-02-33-2	Chemical Sump Pump
P-206 A		Y-02-37-2	Hydro Ejector Pump
P-206B		Y-02-37-2	Hydro Ejector Pump
P-207A		NOT SHOWN	Hydraulic Pump
P-207B		NOT SHOWN	Hydraulic Pump

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TAG	E/R	P & I NO.	DESCRIPTION	
PIT-201		Y-02-33-2	Chemical Sump	BCI Tag No. TN-204
R-201A		Y-02-10-2	Gasifier	
R-201B			Gasifier	
R-201C			Gasifier	
R-201D			Gasifier	
TK-201		Y-02-27-2	Oil/Water Separator	BCI Tag No. TN-201A
TK-202		Y-02-27-2	Tar Tank	BCI Tag No. TN-202
X-201A		Y-02-25-2	Tar Precipitator	BCI Tag No. M-201A
X-201B			Tar Precipitator	BCI Tag No. M-201B
X-202A		Y-02-27-2	Oil Precipitator	BCI Tag No. M-202A
X-202B			Oil Precipitator	BCI Tag No. M-202B
X-204		Y-02-29-2	Ash Grate Drive Hyd. System - Oper.	BCI Tag No. W-201

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TAG	E/R	P & I NO.	DESCRIPTION	
X-205A		Y-02-29-2	Ash Grate Lube System	BCI Tag No. W-202A
X-205B			Ash Grate Lube System	BCI Tag No. W-202B
X-205C			Ash Grate Lube System	BCI Tag No. W-202C
X-205D			Ash Grate Lube System	BCI Tag No. W-202D
X-205E			Ash Grate Lube System	BCI Tag No. W-202E
X-205F			Ash Grate Lube System	BCI Tag No. W-202F
X-205G			Ash Grate Lube System	BCI Tag No. W-202G
X-205H			Ash Grate Lube System	BCI Tag No. W-202H
X-207		Y-02-29-2	Lock Hopper Lube System	BCI Tag No. W-203A
X-209		Y-02-29-2	Combustion Air Blower Vent Silencer	
X-210		Y-02-35-2	Ash Aeration Blower Disch. Silencer	

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DATE November 15, 1978

CLIENT Erie Mining Co.

UNIT Minimum
Demonstration

AREA Sulfur Removal 03

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TAG	E/R	P & I NO.	DESCRIPTION	
A-322		Y-03-12-2	Reaction Tank Agitator	
A-323-A		Y-03-12-2	Turbine Aerator No. 1	
A-323-B		Y-03-12-2	Turbine Aerator No. 2	
A-323-C		Y-03-12-2	Turbine Aerator No. 3	
A-324		Y-03-14-2	Froth Tank Agitator	
A-325		Y-03-16-2	Slurry Accumulator Agitator	
A-326		Y-03-15-2	Balance Tank Agitator	
A-327		Y-03-16-2	Make-up Sump Agitator	
B-311-A		Y-03-13-2	Oxidizer Air Blower No. 1	
B-311-B		Y-03-13-2	Oxidizer Air Blower No. 2	(Spare)
B-312-A		Y-03-12-2	Exhaust Fan No. 1	
B-312-B		Y-03-12-2	Exhaust Fan No. 2	(Spare)
D-315		Y-03-14-2	Froth Tank	
D-317		Y-03-15-2	Balance Tank	

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TAG	E/R	P & I NO.	DESCRIPTION	
E-303-A		Y-03-17-2	Sulfur Melter No. 1	
E-304		Y-03-11-2	Stretford Solution Cooler	
E-333		Y-03-13-2	Condensate Unit Condenser	
E-337		Y-03-15-2	Jacketed Pipe	
MS-328		Y-03-11-2	Venturi Scrubber	
MS-329		Y-03-12-2	Additive Injection Package	
P-305-A		Y-03-14-2	Slurry Charge Pump No. 1	
P-305-B		Y-03-14-2	Slurry Charge Pump No. 2	(Spare)
P-306-A		Y-03-15-2	Solution Circulation Pump No. 1	
P-306-B		Y-03-15-2	Solution Circulating Pump No. 2	
P-306-C		Y-03-15-2	Solution Circulating Pump No. 3	(Spare)
P-307		Y-03-16-2	Centrifuge Slurry Pump	
P-308		Y-03-16-2	Make-up Pump	
P-309-A		Y-03-19-2	Flaker Feed Pump No. 1	
P-309-B		Y-03-19-2	Flaker Feed Pump No. 2	(Spare)
P-310-A		Y-03-20-2	Caustic Metering Pump	
P-310-B		Y-03-20-2	Caustic Metering Pump	(Spare)

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Demonstration**AREA** Gas Transmission 04**D.O.E. CONTRACT** ET-78-C-01-2578

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UNIT Minimum
Demonstration

AREA Water Treatment 05

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CLIENT Erie Mining

Minimum

UNIT Demonstration

AREA Utilities 06

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TAG	E/R	P & I NO.	DESCRIPTION	
A-601		Y-06-25-2	Alum Feed Tank Agitator	See X-604 - one-half of Demo
A-602		Y-06-25-2	Chlorine Feed Tank Agitator	See X-604 - one-half of Demo
A-603		Y-06-25-2	Polymer Feed Tank Agitator	See X-604 - one-half of Demo
B-601		Y-06-20-2	Inert Gas Generator Air Blower	See X-601 - Now 250 scfm. (was 500)
C-601		Y-06-21-2	Inert Gas Compressor (Included with	Now 10,000 scfh. (was 20,000)
			Package) E-602 Inert Gas Compressor	
			Aftercooler	
			E-606 Inert Gas Compressor	
			Intercooler	
C-602A/B		Y-06-23-2	Instrument & Utilities Air Compressors	One-third of Demo
			(Included with Package)	
			E-607A/B Instrument & Plant Air Inter-	
			coolers	
			E-608A/B Instrument & Plant Air Inter-	
			coolers	
D-601		Y-06-21-2	Inert Gas Compressor Suction KO Drum	1'D x 3'T-T
D-602		Y-06-21-2	Inert Gas Surge Drum	2'D x 8'T-T
D-603		Y-06-22-2	Liquid Nitrogen Storage Drum (by others)	
D-604		Y-06-27-2	Deaerator Feed Surge Tank	4'D x 12'T-T

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AREA

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TAG	E/R	P & I NO.	DESCRIPTION	
D-606		Y-06-23-2	Instrument Air Receiver	2'D x 8'T-T
D-607	H-6	Y-06-28-2	Packaged Boiler Blowdown Separator Drum	Common for H-601
D-608		Y-06-23-2	Plant Air Receiver	2'D x 8'T-T
E-601		Y-06-20	Inert Gas Generator Aftercooler	See X-601
E-602		Y-06-21-2	Inert Gas Compressor Aftercooler	For C-601A/B
E-603		Y-06-22-2	Liquified Nitrogen Vaporizer (by others)	See X-608
E-605		Y-06-24-2	Tar/Oil Heater	One-half of Demo
E-606		Y-06-21-2	Inert Gas Compressor Intercooler	For C-601A/B
E-607A/B		Y-06-23-2	Instrument and Plant Air Intercoolers	See C-602A/B
E-608A/B		Y-06-23-2	Instrument and Plant Air Aftercoolers	See C-602A/B
E-609		Y-06-27-2	Stretford Condensate Cooler	100,000 Btu/hr. (was 212,500)
E-611		Y-06-24-2	Tar/Oil Tank Heater (with TK-606)	
EG-601			Engine Driven Synchronous Generator	

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TAG	E/R	P & I NO.	DESCRIPTION	
EG-602			Emergency Power Control System	
EG-603			Non-interruptible Power System	
FIL-601A/B		Y-06-25-2	Boiler Feedwater Filters	See X-604 - one-half of Demo
H-601	H-6	Y-06-28-2	Packaged Steam Boiler (included w/pack.)	
			D-607 Packaged Boiler Blowdn. Sep. Drum	
P-601A/B		Y-06-25-2	Boiler Feedwater Softener Feed Pumps	
P-602A/B		Y-06-27-2	Deaerator Feed Pumps	130 gpm. @ 20 psi. (was 265 gpm)
P-603A/B		Y-06-27-2	Low Pressure Boiler Feed Pumps	45 gpm. @ 70 psi. (was 85 gpm.)
P-604A/B		Y-06-27-2	High Pressure Boiler Feed Pumps	100 gpm. @ 222 psi. (was 200 gpm.)
P-605		Y-06-25-2	Alum Metering Pump	See X-604 - one-half of Demo
P-606		Y-06-25-2	Chlorine Metering Pump	See X-604 - one-half of Demo
P-607		Y-06-25-2	Polymer Metering Pump	See X-604 - one-half of Demo
P-609A/B		Y-06-24-2	Tar/Oil Pumps	50 gpm. @ 250 psi. Δ P (one-half of Demo)
P-610A/B		Y-06-29-2	Firewater Loop Pumps	
P-611		Y-06-30-2	Settling Pond Overflow Pump	
P-612A/B		Y-06-27-2	Stretford Process Water Pumps	2.5 gpm. @ 100 psi (was 5 gpm.)

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TAG	E/R	P & I NO.	DESCRIPTION	
P-613		Y-06-30-2	Pond Sump Water Pump	
P-614		Y-06-30-2	Pond Sump Oil Pump	
P-615		Y-06-46-2	Sewage Lift Station	
PIT-601		Y-06-25-2	Clearwell	
PIT-602		Y-06-30-2	Pond Sump	
TK-601		Y-06-25-2	Alum Feed Tank	See X-604 - one-half of Demo
TK-602		Y-06-25-2	Chlorine Feed Tank	See X-604 - one-half of Demo
TK-603		Y-06-25-2	Polymer Feed Tank	See X-604 - one-half of Demo
TK-606		Y-06-24-2	Tar/Oil Tank	24'D x 16' high
X-601		Y-06-20-2	Inert Gas Generator (included with pack)	Now 10,000 scfh (was 20,000)
			B-601A/B Inert Gas Generator Air Blowers	
			E-601 Inert Gas Generator Aftercoolers	
X-602A/B		Y-06-21-2	Inert Gas Dryers	One-half of Demo Size
X-603		Y-06-23-2	Instrument Air Dryer	

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TAG	E/R	P & I NO.	DESCRIPTION	
X-604		Y-06-25-2	Boiler Feedwater Clarifier	One-half of Demo
			(Included with package)	
			A-601 Alum Feed Tank Agitator	
			A-602 Chlorine Feed Tank Agitator	
			A-603 Polymer Feed Tank Agitator	
			P-605 Alum Metering Pump	
			P-606 Chlorine Metering Pump	
			P-607 Polymer Metering Pump	
			TK-601 Alum Feed Tank	
			TK-602 Chlorine Feed Tank	
			TK-603 Polymer Feed Tank	
			FIL-601A/B BFW Filters	
X-606A/B		Y-06-26-2	Boiler Feedwater Softeners	One-half of Demo
X-607		Y-06-27-2	Boiler Feedwater Deaerator	6'D x 10' T-T

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CONTRACT MC-4814

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CLIENT Erie Mining

UNIT Minimum
Demonstration

AREA Flare - 07
Safety System

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CLIENT Erie Mining

UNIT Minimum
Demonstration

AREA Retrofit 08

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TAG	E/R	P & I NO.	DESCRIPTION
X-801		Y-08-11-2	Shaft Furnace Multiple Fuel Burner
X-801-D1A		Y-08-11-2	Burner for East Combustion Chamber of Shaft Furnace D-1
X-801-D1B		Y-08-11-2	Burner for West Combustion Chamber of Shaft Furnace D-1
X-801-D2A		Y-08-11-2	Burner for East Combustion Chamber of Shaft Furnace D-2
X-801-D2B		Y-08-11-2	Burner for West Combustion Chamber of Shaft Furnace D-2
X-801-D3A		Y-08-11-2	Burner for East Combustion Chamber of Shaft Furnace D-3
X-801-D3B		Y-08-11-2	Burner for West Combustion Chamber of Shaft Furnace D-3
X-801-D4A		Y-08-11-2	Burner for East Combustion Chamber of Shaft Furnace D-4
X-801-D4B		Y-08-11-2	Burner for West Combustion Chamber of Shaft Furnace D-4
X-801-E1A		Y-08-11-2	Burner for East Combustion Chamber of Shaft Furnace E-1
X-801-E1B		Y-08-11-2	Burner for West Combustion Chamber of Shaft Furnace E-1
X-801-E2A		Y-08-11-2	Burner for East Combustion Chamber of Shaft Furnace E-2
X-801-E2B		Y-08-11-2	Burner for West Combustion Chamber of Shaft Furnace E-2
X-801-E3A		Y-08-11-2	Burner for East Combustion Chamber of Shaft Furnace E-3
X-801-E3B		Y-08-11-2	Burner for West Combustion Chamber of Shaft Furnace E-3
X-801-E4A		Y-08-11-2	Burner for East Combustion Chamber of Shaft Furnace E-4
X-801-E4B		Y-08-11-2	Burner for West Combustion Chamber of Shaft Furnace E-4

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