DOE/EW/05066-
DISTRIBUTION CATAGORY UC-89

FUEL GAS DEMONSTRATION PLANT PROGRAM

SMALL-SCALE INDUSTRIAL PROJECT

ERIE MINING COMPANY
PICKANDS MATHER & COMPANY, MANAGING AGENT
1100 SUPERIOR AVENUE
CLEVELAND, OHIO 44114

PREPARED FOR THE
U. S. DEPARTMENT OF ENERGY
ASSISTANT SECRETARY FOR ENERGY TECHNOLOGY
OFFICE OF FOSSIL FUELS

UNDER CONTRACT EW-78-C-02-5066
(FORMERLY CONTRACT ET-78-C-01-2578)

COO--5066-T16(Vol. 1)

11.

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

ALL PROPRIETARY MATERIAL

HAS BEEN

DELETED FROM THIS MANUAL

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

P.C. 8/6/79

ERIE MINING COMPANY

PICKANDS MATHER & COMPANY MANAGING AGENT

FUEL GAS
DEMONSTRATION PLANT
PROGRAM

VOLUME I
FUEL GAS DEMONSTRATION PLANT
PROJECT MANUAL

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

INDEX

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

INDEX (continued)

5.0 Appendix

1.0

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 1.0 - GENERAL

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

1.1

1.0 GENERAL

1.1 Project Description - Facility Design Basis

1.1.1 General

The objective of this project is for Babcock Contractors Inc. (BCI) to provide process designs, and gasifier retort design for a fuel gas demonstration plant for Erie Mining Company at Hoyt Lake, Minnesota. The fuel gas produced in this facility will be used to supplement natural gas and fuel oil as the fuel for iron ore pellet induration.

The fuel gas demonstration plant will consist of five (5) stirred two-stage, fixed bed gasifier retorts capable of handling caking and non-caking coals, and provisions for the installation of a sixth retort. The process and unit design has been based on a facility operation with caking coals. However, the retorts have also been designed for easy conversion to handle non-caking coals. For the description of the conversion procedures see Stirrer Package Section 6.1.

The demonstration unit has been designed to be expanded to provide for the future requirements for the installation of a commercial plant unit (described in Commercial Plant Package) in an economical manner.

The coal gasifiers and the auxiliary equipment will be in a building enclosure that will be designed by others.

The design does not include the design of a control room. Board space for the controls will be provided in a common plant control room to be designed by others.

The design includes all on-site equipment and required utilities within the specified battery limits.

The binding Scope of Work Document for the design of this demonstration plant is Arthur G. McKee and Company requisition order E/R W-20 for McKee Contract 4814.

1.0 GENERAL

1.1 Project Description - Facility Design Basis (continued)

1.1.2 Scope of Work

The following items are supplied in the Demonstration Unit Process Design Specification package:

a. Complete piping and instrumentation diagrams.

b. Process Flow Diagrams

c. General Arrangement Drawings

d. External Gasifier Drawings

e. Vessel Design Drawings

f. Internal Gasifier Arrangement Drawings

g. All equipment sized and specified in detail, including internals.

h. Material specification for all process equipment and lines.

i. Plot plan and elevations to scale showing all major equipment items.

j. List of and prices for laboratory equipment and/or test facilities required to monitor unit performance.

k. Major inline instrumentation data sheets.

l. Flare, blowdown and emergency systems flow diagrams.

m. Electrical area classification drawings.

n. Electrical single line diagrams.

o. Start-up and shutdown procedures in outline form including emergency shutdown procedures.

p. Preliminary operating manual in outline form.

q. Lubrication and hydraulic systems specifications.

1.0 GENERAL

1.1 Project Description - Facility Design Basis (continued)

1.1.2 Scope of Work (continued)

r. Maintenance supply requirements for the gasifier retorts:

1. Routine supplies
2. Recommended inventory
3. Recommended major spare parts

s. Ash handling system to ash storage silo including system flow diagram and all equipment sized and specified.

t. Gasifier support arrangement drawings

u. Gasifier design calculations for vessel and supports including a tabulation of weights, operating and test loads.

1.1.3 Basis for Design and Design Criteria

a. The basis of the components design for the facility has been the requirement to provide a fuel gas product capacity that yields 6.9 billion BTU/day LHV, (nominally 7.4 billion BTU/day HHV) utilizing as design feedstock caking Rosebud coal (sub-bituminous) and non-caking Kittaning coal (bituminous). For description of these coals see Section 1.3.1 - Coal Composition and Characteristics-Coal Test Report, of this Demonstration Plant Design Report.

The term of "caking coal", as used in this context refers to a coal with a free swelling index greater than 2.5 and a sulphur content over 2.5%. The term "non-caking coal", as used in this context refers to a coal with a free swelling index lower than 2.5.

The gasifier units will be capable of a turndown to 25% of the design rate.

1.0 GENERAL

1.1 Project Description - Facility Design Basis

1.1.3 Basis for Design and Design Criteria (continued)

b. Utility Data:

Utilities	Process Design Pressure, psig	Temperature °F
1. Inert Gas	100	Amb (Dew Pt.-50°F)
2. Steam		
High	125	353
Medium	50	297
Low	25	265
3. Cooling Water		
Summer Supply	75	75
Winter Supply	75	35
Return	55	(Max. 40°F Rise)
4. Fire Water	160-170 (with main pumps running)	
5. Boiler Feed Water		
Low Pressure	50	220
High Pressure	175	220
6. Potable Water	95	Amb.
7. Insrument Air	100	Amb. (Dew Pt.-50°F)
8. Plant Air	100	Amb. (Dew Pt.-50°F)
9. Make-up Water	40	Amb.
10. Cold Condensate	100	100

c. Electricity

Available Power	4160, 480, 240/120V
Up to 3/4 HP	115/230 volts, 1 Phase, 60 H_z
Over 3/4 HP & Under 125 HP	480 volts, 3 Phase, 60 H_z
125 HP and Up	4160 Volts

d. Electrical Area Classification

See electrical classification drawings - Section 4.1.6

1.0 GENERAL

1.1 Project Description - Facility Design Basis

1.1.3 Basis for Design and Design Criteria

e. Site and Meteorological Design Conditions

1. Site Elevation:	1542 ft. above MSL
2. Ambient Air Temperatures:	Max. Dry Bulb - 102°F Min. Dry Bulb - Minus 42°F
3. Wind Loading:	30 PSF
4. Snow Design Loading:	40 PSF
5. Soil Conditions:	Ledge rock covered by a shallow layer of glacial till with occasional outcrop of ledge rock. Design soil pressure 3000 PSF.
6. Seismic Zone:	Production blasting produces maximum particle velocity of 0.5 in/sec at one mile from blast, maximum sound reaching one mile from blast is 140 decibles (linear). Zone 1

f. Facility (Plant) and Influent Requirements

See process flow diagrams - Section 4.1.2

g. Facility (Plant) Product and Effluent Requirements

See Process flow diagrams - Section 4.1.2

1.0 GENERAL

1.1 Project Description - Facility Design Basis

1.1.4 Ability of WD 2-Stage Gasifiers to Gasify Lignites

The standard WD 2-stage gasifier is capable of handling a range of lignites without mechanical modification to the gasifier itself. North Dakota lignite has been successfully gasified in a 2-stage gasifier in South Africa and no problems were reported with degradation of the lignite in the gasifier.

There is also extensive experience in Chomotov, Czechoslovakia, with the gasification of very low grade lignite (up to 30% ash and 33% water contents) in a specially simplified gasifier design, without clear gas offtake or retort section divisions. Preliminary heat balances indicate that for the typical U.S. Great Plains lignites (Wydak), the clear gas/top gas split will be about 10-90.

For this gasification plant the downstream equipment is designed to process the gas produced by bituminous or sub-bituminous coal. When operating on lignite, it is likely that the top gas cleaning and cooling equipment will limit the production from the gasifier. Also, as the clear gas flow will be much smaller in design, the operation of the process gas cooler with these low flows would have to be carefully evaluated and probably should be by-passed for operating on lignite.

In the case of the stirred gasifier, initial operation would most probably best be carried out on lignite with the stirrer either stationary or withdrawn. Depending on the physical characteristics of the lignite, the use of the stirrer might be advantageous if it enabled an increased proportion of fines to be used, or disadvantageous if it caused degradation of the lignite within the gasifier.

For any given lignite or range of lignite analysis, prediction of the gasifier output and operability of downstream equipment should be evaluated based on the detailed analysis of the lignites.

1.2

1.0 GENERAL

1.2 Process Description

1.2.1 Process Description - Demonstration Plant

The following process description is for the Five-Gasifier Demonstration Plant. Reference is made to both stirred and conventional gasifiers, and to operation on both Western and Eastern coal.

Reference may be made to the Process Flow Diagrams included in Section 4.1.2 for major equipment items, flow rates and analyses for various streams. Drawings No's. 4814-Y-02-05-2 and 4814-Y-02-06-2 are for Western coal and Drawings No. 4814-Y-02-07-2 and 4814-Y-02-08-2 are for Eastern coal.

a. Coal Feed System

The functions of the coal feed system are first, to provide a surge capacity between the coal handling plant and the gasifiers, and second, to meter coal into the gasifiers such that the coal level is maintained constant and no "free fall" of coal, which might generate fires carry over, occurs within the gasifier.

Sized coal from plot limits is fed by tripper conveyor to the coal surge hoppers, BN201, one per gasifier. The coal feeding sequence is initiated by a low-level signal in the gasifier buffer hopper. Variations in the coal level take place in this hopper, out of the gas flow, and a flooded feed condition is maintained in the main part of the gasifier throughout normal operation. This signal causes the lower valve of the coal lock-hopper, MF201, to open, thereby refilling the buffer hopper with coal. The lower valve closes, the lock-hopper is purged with inert gas, the upper valve opens and the coal feeder MF 202 operates until the lock-hopper load cells detect that the programmed amount of coal has been fed into the lock hopper. The coal feeder then stops, and the upper lock hopper valve closes, completing the cycle.

1.0 GENERAL

1.2 Process Description

1.2.1 Process Description - Demonstration Plant (continued)

b. Gasifiers

Coal enters the top of the gasifiers, R 201, where it encounters an upward flow of gas which leaves the gasifier at 250°F. As the coal descends counter-current to the gas flow, it is first dried, and then heated until at about 500°F, gas and light hydrocarbons start to evolve. This carbonization process continues as the coal falls to lower levels and higher gas temperatures, with the evolution of heavier oils and tars.

Because the Western coal is non-agglomerating, it remains as discrete solid particles throughout the carbonization phase, and reaches the bottom of the retort section of the gasifier as a char. The Eastern coal is a strongly coking coal, and becomes fluid during the carbonization process. In a metallurgical coke oven, conditions are such that adjacent coal particles become fully liquid simultaneously, and upon loss of tar and re-solidification, a coherent mass of very strong coke results. Although a comparable process takes place in the two-stage gasifier, a combination of moderate heating conditions and relatively large coal particles results in the more gradual formation of a weaker and more reactive coke.

A key aspect of gasifier design is to maintain a uniform flow of gas over the entire gasifier cross section, and also to ensure that coal does not "bridge" across the gasifier during carbonization. This is relatively straightforward in the lower section of the gasifier, because the coke present in this section cannot swell, become fluid, or agglomerate.

In the retort section of the conventional gasifier, uniform gas distribution and smooth coal flow are ensured by dividing the gasifier into five sectors.

1.0 GENERAL

1.2 Process Description

1.2.1 Process Description - Demonstration Plant (continued)

b. Gasifiers (continued)

Refractory brick walls radiate from the center of the gasifier. In addition, the outer wall of the gasifier is tapered outwards to prevent "bridging" by caking coal. This conventional type of gasifier is suitable for coals with a Free Swelling Index (FSI) of up to 2-1/2.

A stirred two-stage gasifier has been designed for use with high swelling coals. If fed to a conventional two-stage gasifier, these coals would expand to such an extent during carbonization that they would join in the gasifier retort, and would also prevent uniform flow of gas upwards through the coal. The mechanical stirrer, described in detail in Stirrer Section continually breaks up the carbonizing coal. This maintains open gas passages, and also breaks up any "bridges" of partly carbonized coal.

The temperature profile across the gasifier for both Western and Eastern coals is shown on BCI Drawing No. M-341.

At the bottom of the retort section of the gasifier, the char or coke is essentially free of volatile matter, and is in contact with a rising gas stream at about 1200°F. As the coke descends further, the temperature becomes high enough for the major gasification reactions to occur, the carbon of the coke reacting with both carbon dioxide and with steam:

$$C + CO_2 \longrightarrow 2\ CO$$

$$C + H_2O \longrightarrow CO + H_2$$

These reactions take place at and above 1500°F in a zone which extends throughout most of the water-jacketed lower section of the gasifier.

1.0 GENERAL

1.2 Process Description

1.2.1 Process Description - Demonstration Plant

b. Gasifiers (continued)

As the remaining coke reaches the level immediately above the grate, it encounters oxygen from the gasification air/steam mixture, and the carbon burns forming both carbon monoxide and carbon dioxide:

$$2\ C + O_2 \longrightarrow 2\ CO$$

$$C + O_2 \longrightarrow CO_2$$

These reactions liberate heat and take place in a relatively narrow zone immediately above the grate. The temperature of this zone is maintained close to ash fusion temperatures, 2100-2200°F, by the addition of steam to the gasifier air. The steam acts as a coolant both by dilution and by entering into the water-gas reaction:

$$C + H_2O \longrightarrow CO + H_2$$

which absorbs heat and thereby assists in controlling the temperature of the combustion zone so as to prevent excessive ash fusion and clinker formation.

The ash formed as the last of the carbon in the coke is burned forms a protective layer above the gasifier grate. In this layer, heat is exchanged from the hot ash to the incoming gasification air/steam mixture, before the ash is withdrawn by the rotation of the grate to the two ash pockets on either side of the gasifier below the grate. Any large clinkers which may be formed are forced by lobes on the grate's outer ring against a cast breaker ring immediately below the water jacket.

The ash is discharged from the gasifiers by the lock hoppers, MF203. These hoppers provide a seal on the bottom of the gasifier, and provide a chamber for partial cooling of the ash by counter

1.0 GENERAL

1.2 Process Description

1.2.1 Process Description - Demonstration Plant

b. Gasifiers (continued)

current flow with air. The ash is then conveyed to an ash storage hopper BN108. Alternate systems for ash handling are discussed in Section 5.1.

Gasification air is supplied by blowers B201 and is mixed with steam before admission to the gasifier grate. The steam required is generated in the gasifier water jacket and steam drum, D201. The air/steam mixture is evenly distributed across the gasifier cross section by the grate, and then passes upwards through the ash layer before entering into the combustion and gasification reactions described above.

The steam/air ratio is adjusted in operation to obtain a controlled combustion zone temperature by observation of the ash produced. Insufficient steam results in too high a combustion temperature and excessive clinkering; too much steam results in too low a temperature, and "fluffy" unclinkered ash.

The level of the ash layer is monitored by the grate thermocouple. Rotation, and hence ash extraction, will stop if the temperature rises too high, and will be resumed once the ash layer has become deeper.

At the base of the retort section, where the gas temperature is 1200°F, the gas flow divides into two. The alternate paths available for gas flow are (a) upwards through the descending column of coal in the retort section (b) through gas flues in the walls of the retort. The pressure drop through the flues is significantly lower than that through the column of coal, and gas is forced to flow through the coal by throttling the flue gas offtake (after cooling) with a butterfly valve.

Sufficient 1200°F gas is caused to pass through

1.0 GENERAL

1.2 Process Description

1.2.1 Process Description - Demonstration Plant

b. Gasifiers (continued)

the coal in the retort section to carbonize and dry the coal, and give a gas exit temperature of about 250°F. This gas stream contains all the volatile matter and water present in the coal, and is termed "top gas".

The balance of the 1200°F gas, not required in the retort section, passes through refractory flues in the retort walls. A small amount of heat is transferred to the coal from this gas stream. This gas is termed "clear gas", because it is free of tar.

c. Gas Clean-Up

The gas clean-up section of the plant exploits the separation of the tar-containing top gas from the high temperature clear gas. By treating the two streams separately, tar and dust removal, plus waste heat recovery, can be carried out in a straight forward manner.

The top gas leaves the gasifier at 250°F, and contains a fine mist of tar droplets. The top gas passes through a cyclone CY202 to remove any large tar droplets and then to the tar precipitators M201. These electrostatic precipitators effectively remove the mist of tar droplets. Because the gas is above its dew point with respect to water, the tar is recovered with a very low water content, and needs no dehydration, etc., before being used as a fuel or distillation feedstock.

The clear gas at 1200°F, containing no tar but carrying some coke dust, passes through cyclone CY201 and is cooled to 400°F in process gas cooler E201. The butterfly valve which regulates the top gas:clear gas split is located downstream of E201, and is reset by a temperature controller in the top gas line.

1.0 GENERAL

1.2 Process Description

1.2.1 Process Description - Demonstration Plant

c. Gas Clean-Up (continued)

The clear gas and top gas streams are then combined and enter E202, the combined gas coolers. The gas temperature is reduced to 95°F, and a mixed oil and aqueous condensate is removed. To ensure complete removal of condensate mist, the cooled gas is passed through oil precipitators M202, and the cooled gas passes to battery limits.

Separation of the light oil from the aqueous condensate takes place in oil/water separator TN201. Aqueous condensate is pumped to the water treatment plant, and the light oil is combined with the tar for use as fuel oil.

1.0 GENERAL

1.2 Process Description

1.2.2 Process Control Description

The major control loops for the gasification plant are described in this section. The loop numbering system is defined on Sketch Number 0 in the Instrumentation Specification Section, Section 3.4. Where there is more than one identical loop, such as the Temperature Control of the Gasifier, one loop is described in this section.

a. Coal Surge Hopper-Level (Loop-21101)

A Level Probe LE-21101 senses the coal level in the Surge Hopper BN 201 and transmits a signal to the Level Switch. Two originally preset levels (high and low) are input signals for a programmable Controller WUC-21000.

This controller is capable of sequencing the operation of a tripper conveyor, to be supplied by others.

Two lights are provided on the control panel, which indicate if the hopper is being charged, or if the hopper is charged. A separate low level alarm is also provided on the hopper which will indicate that the charging sequence has not started when called for.

b. Gasifier Coal Charge Control (Loop-21102,21103)

A Level Probe LE-21102 senses coal level in the Gasifier R-201A (thru E). A proportional signal to the coal level enters level indicating switch and at low level trips a loading start contact in Programmable Controller WUC-21000. A Solenoid Valve FY-21102 is energized and the Coal Charging Valve FV-21102 opens-- discharging the coal from the Lock Hopper into the Gasifier. Two Limit Switches indicate whether the valve is open or closed by lights on the panel.

Two extreme points give an audio visual alarm on the control panel when coal level in Gasifier reaches critical high or low level.

1.0 GENERAL

1.2 Process Description (continued)

1.2.2 Process Control Description (continued)

The four Load Cells FE-21103 sense the weights of the Coal Lock Hopper MF201A (thru E) and coal weight is recorded on the QR-21103 Recorder. Two limit switches in the Recorder, set on low and high load, trigger the start and stop coal loading sequences respectively, through the Programmable Controller WUC-21000.

After the coal is dumped in the gasifier, low weight switch in the recorder starts conveyors belt, opens the top Charging Valve FV-21103 and shuts the inert gas flow. Two Limit Switches indicate the Valve FV-21103 open-closed position by lights on the panel. The charging sequences can be activated manually by Selector Switch HS-21103.

After the coal is dumped from the Lock Hopper into the Gasifier, but before the Valve FV-21102 closes Programmable Controller WUC-21100 de-energizes the Solenoid Valve in Loop 21117 and inert gas enters into the Lock Hopper and stays on until Solenoid Valve is again energized and I.G. flow cut off by Programmable Controller.

c. Low Pressure Steam Drum Controls D201-A (Thru E)

The Boiler-Level Controlled by Loop 21104 water level in the Boiler D201A (thru E) is sensed by the Level Transmitter LT-21104. A signal proportional to the water level is sent to the Current Switches LSH-21104 and LSL-21104, as well as to the Level Controller LIC-21104, which resets the Control Valve LV-21104. High and low level are alarmed on Control Panel Annunciator System.

The steam drive pressure floats on the pressure in the L.P. Steam Main. This pressure is contracted in the utility area. The steam drum pressure is recorded by Loop-21106. Steam drum pressure is sensed by the Pressure Transmitter PT-21106. The pressure variations are recorded on the

1.0 GENERAL

1.2 Process Description (continued)

1.2.2 Process Control Description (continued)

c. Low Pressure Steam Drum Controls D201-A (thru E) (continued)

Recorder PR-21106. High and low steam pressure in the boiler are alarmed by the Annunciator on the Control Panel.

The steam flow from the drum is recorded by Loop 21108. An Annubar Flow Sensor FE-21108 creates a ΔP proportional to the steam flow. The Transmitter FT-21108 sends a 4-20 ma signal to the Recorder FR-21108.

d. Control of Air and Steam to the Gasifier

Air flow is recorded and controlled as follows:

The control loop contains a Flow Element FE-21111 (Annubar), a Flow Recorder FR-21111, a Flow Controller FIC-21111, an I/P-21111 (Current to Pneumatic Converter) and a Control Valve FV-21111. The set point of each Controller FIC-21111 thru FIC-21511 is controlled by a clean gas pressure transmitter, upstream of distribution gas compressors. Signal from the Flow Transmitter FT-21111 enters the Flow Ratio Controller FFC-21109 as the remote set point which holds the steam/air ratio constant.

The combustion steam flow ratio is controlled by Loop 21109. A flow element FE-21109 (Annubar) measures Δ P proportional to the steam flow. Two wires from Flow Transmitter sends a signal into the Flow Recorder FR-21109 and the Signal Proportioning Controller FFC-21109. The required steam rate is set by FT-21111 and controlled by pneumatically operated Control Valve FV-21109. The Pressure Gauge PI-21109 shows the steam pressure upstream of the steam-air eductor.

A restricting Orifice RO-21109 keeps a steady steam rate ($\sim$1/4 of nominal flow) flowing into gasifier.

1.0 GENERAL

1.2 Process Description (continued)

1.2.2 Process Control Description (continued)

d. Control of Air and Steam to the Gasifier (continued)

Pressure and temperature of the steam-air mixture after eductor are recorded by Loop 21110 and pressure level is alarmed on the Control Panel. TI-21110 and PI-21110 indicates locally temperature and pressure, respectively.

e. Top Gas Temperature Control (Loop 21114)

Top gas temperature is measured in the duct after Cyclone CY202A (thru E) by a Thermocouple TE-21114 and transmitted (TT-21114) to TS-21114 for alarming purposes, to Recorder FR-21114 and to Controller TIC-21114. TIC-21114 controls the Valve TV-21114 in the clear gas duct downstream the Process Gas Cooler E201A (thru E). The clear gas temperature is indicated on Ti-21114 Field Thermometer.

f. Gasifier Bed Temperature, Record and Grate Speed Control (Loop 21124)

A dual Thermocouple TE-21124 (A & B) measures the grate temperature. The "A" portion of the dual thermocouple records the temperature and its variations so the operator can follow it. A 4-20 ma D.C. Current Signal, proportional to the grate temperature enters through an HS-21124 Selector Switch (Auto/Manual) into a SC-21124 (DC Current to Frequency Converter).

For a temperature range of 450-550°F, the frequency should change between 0.011 H_Z and 0H_Z (D.C.) respectively and energizes or de-energizes the Solenoid Sy-21124, which hydraulically rotates the grate for 1/2 rev/hour at 450°F. The grate does not move at the temperature of 550°F, so an ash layer above grate can be built to reduce the grate temperature.

1.0 GENERAL

1.2 Process Description (continued)

1.2.2 Process Control Description (continued)

g. Emergency Power Failure Systems

During emergency power failure, the gasifier is automatically vented to the flare by Loops 21125 and 21126. The associated Solenoids FY21125 and FY21126 are de-energized, and a 15 psi pneumatic signal opens the Valves FV-21125 and FV-21126. After a preset time (approximately 10 minutes), and with power from the emergency generator, the two Valves FV-21125 and FV-21126 are closed. The Valve PV-21130 to the chimney is opened by de-energizing the Solenoid FY-21130 and applying a 15 psi pneumatic signal to the valve. At the same time that the valve to the chimney is opened, Solenoid Valve FY-21127 is de-energized and 15 psi air pressure enters the Pneumatic Actuator opening Valve FV-21127. This places the gasifier on natural draft.

All four Valves, FV-21125, FV-21126, FV-21127, and PV-21130 can be operated from the panel by a hand controller during normal start-up and shutdown procedures and are equipped with a handwheel for manual operation.

h. Combustion Air from Blowers - Pressure Control

The combustion air pressure is measured on a 30" main duct upstream of eductors. The Loop 21800 consists of a Recorder, High Pressure Alarm and Controller which releases overpressure, through the Valve PV-21800, to the atmosphere. A separate low pressure alarm is provided on each blower discharge.

i. High Pressure Steam Drum Controls

Water level in the Boiler D 202A is measured by the Level Transmitter LT-21804. A P/El signal proportional to the water level is sent to the Current Switches LSH-21804 and LSL-28104, as well

1.0 GENERAL

1.2 Process Description (continued)

1.2.2 Process Control Description (continued)

i. High Pressure Steam Drum Controls (continued)

as to the Level Controller LIC-21804. High and low level are alarmed on the Annunciator System. The water level is controlled by modulating the Valve LV-21804.

The H.P. Steam Drum pressure floats on the pressure in the H.P. steam main. This pressure is controlled in the utility area. The H.P. steam drum pressure is recorded by Loop 22806. High and low steam pressure in the boiler are alarmed by the annunciator in the control panel.

1.0 GENERAL

1.2 Process Descriptions

1.2.3 Facility Description

a. General

The following facilities description is for the Demonstration Plant, designed to have a capacity of 7.4×10^9 Btu (HHV) of gas. Reference may be made to the Piping and Instrument Diagrams included in Section 4.1.3 of this report. The required plant capacity can be produced when four (4) Two-stage gasifiers of a nominal I.D. of 3.6 meters or 12ft. are in operation; a fifth gasifier provides standby capacity. The design of the demonstration plant is therefore based on five gasifiers. However, successful operation of the demonstration would lead to quick expansion of the plant to twelve gasifiers to provide a plant with a capacity of 20×10^9 Btu/day. This philosophy has been considered in the design of the demonstration plant; the gasifier building has been designed to accommodate six gasifers, and the comman gas clean up facility has been designed around a capacity of 10×10^9 BTU/day of gas.

b. Coal Feed System

Sized coal from plot limits is fed by tripper conveyor to the coal surge hoppers, BN201 A thru F. These surge hoppers are designed to provide a 12 hour capacity of coal above the gasifier (the capacity is slightly more for eastern coal operation). This will enable the plant to continue to operate while the coal feeding system is being maintained. Charging of the surge hoppers is sequenced by a programmable controller, which receives signals from level probes in the surge hoppers.

Six coal surge hoppers are supplied with the demonstration plant. BN201F will not be used, but is supplied with the demonstration plant as the surge hoppers are an integral part of the structural steel. A slide valve is provided under the surge hopper for isolation of the surge hopper and for maintenance on the associated

1.0 GENERAL

1.2 Process Descriptions

1.2.3 Facility Description

b. Coal Feed System (continued)

coal feeder and lock hopper.

Coal is fed from the surge hopper to the gasifier via coal feeders MF202A to E, and lock hoppers MF201 A to E. The coal charging sequence is controlled by a level probe, and programmable controller, which sequence the charging operation.

The lock hoppers are mounted on load cells, which enable the weight of coal charged to the gasifier per batch to be recorded and totalized. Load cells were selected for this duty as they are considered to require less maintenance and give a higher accuracy than weigh belt feeders.

c. Gasifiers

Five gasifiers, R201A thru E, are provided for the demonstration plant. The design of these gasifiers is based on proven design of the conventional two stage gasifier with a nominal diameter of 3.6 meters or 12 ft. The conventional two stage gasifier has a refractory lined retort section, together with refractory walls inside the gasifier which divide the retort into five 'pie' shaped sections. This division of the retort ensures a uniform gas distribution, and a smooth coal flow during the carbonization of coals with a Free Swelling Index (FSI) of up to 2-1/2.

The stirred two-stage gasifier included in this plant is a modification of the conventional gasifier, designed for use with high swelling coals. To accomplish this each gasifier is fitted with a stirrer A201A thru E. This stirrer is designed to operate only in the zone where the coal is carbonizing, and continually break up the carbonizing coal, and maintain open gas passages. The stirrer is basically in two sections, capable of rotating in opposite directions, and

1.0 GENERAL

1.2 Process Descriptions

1.2.3 Facility Description

c. Gasifiers (continued)

also of vertical movement. This will enable the stirrer to pass through every point in the carbonizing zone. The design of the stirrer is described in detail in the Stirrer Section of this report.

The refractory lining of the retort has been redesigned for the stirrer. This primarily required the removal of the refractory dividing walls. The taper of the outside refractory walls was maintained the same as for a conventional gasifier. This will not interfere with the stirrer and will facilitate the modification of the gasifier to a conventional unstirred two-stage gasifier. Some modifications were also made to the gas channels in the outside refractory wall, to compensate for the removal of the refractory dividing walls and their associated gas channels. The detailed brick design has also been simplified, to use standard shapes where ever possible and minimize the total number of shapes required.

The lower section of each gasifier is surrounded by a water jacket, which utilizes some of the excess heat of reaction to generate steam. Each jacket connected to its own steam drum D201A thru E by a thermosyphon. The water jacket and steam drum are designed to ASME section 1.

The conical grate is cast iron, and the design is unchanged from a conventional two-stage gasifier. The grate rests on a slide ring, and is rotated by two hydraulic cylinders driving a gear wheel. The grate is surrounded by a fixed breaker ring with lobes protruding from it. Ash is crushed between the grate and breaker ring and drops into the ash discharge system, which is described in Section 1.2.4 of this report.

A central hydraulic system W201A provides the power to drive the hydraulic cylinders on six

1.0 GENERAL

1.2 Process Descriptions

1.2.3 Facility Description

c. Gasifiers (continued)

gasifiers. These cylinders also drive a cam which drives a grease cylinder (two per gasifier) and this forces grease through grooves in the gasifier slide ring.

d. Air and Steam Feed to the Gasifiers

Three blowers, B201A thru C, provide the air required for gasification. These units are designed on the basis of 10 x 10^9 Btu/day gas production with 10% overcapacity. On this basis, two units would be running and one standby. The flow of air to the gasifiers is basically controlled by throttling the air to each gasifier. An individual air control is provided in each gasifier to take account of any variation in the performance of individual gasifiers. Because of this, the blowers are essentially being restricted on the discharge side. To prevent surging of the blowers during operation at reduced thruput, an automatic blowoff, through a silencer is provided on the common blower discharge.

The L.P. steam drums, D201A thru E, are connected to the low pressure steam main, and the pressure in the main. Steam from the low pressure steam drums is mixed with the air to the bottom of the gasifiers by a flow ratio control.

e. Flare Stacks

Three flare stacks are provided with the demonstration plant (X201A thru C). The stacks provide for safe venting of the gasifier during start-up, shutdown and emergency conditions. One flare stack is provided for two gasifiers, (so the three included with the demonstration plant can serve six gasifiers). The flare stacks are designed to handle the full output of a single gasifier, automatic shutdown sequences will reduce the air supply to the gasifiers to reduce the

1.0 GENERAL

1.2 Process Descriptions

1.2.3 Facility Description

e. Flare Stacks (continued)

gasifier thruput to 50% when diverting to flare. The recommended type of flare is a 'ground flare' mounted on the top of the gasifier structure with this type of flare combustion takes place inside an enclosure, which enables gases with an HHV down to 50 Btu/SCF to be flared, and minimizes the problem of radiation from the flare. A continuous purge of inert gas is required in the lines to the flare.

f. Gas Cleaning and Cooling

The top gas and clear gas from the two-stage gasifier are initially cleaned separately.

The clear gas initially passes through a refractory lined duct, to refractory lined cyclones, CY201A to E, (one per gasifier). The cyclones are designed to operate at a pressure drop of 3" WG for eastern coal, with 100% removal of particles greater in size than 30 microns. The Dust Handling System is discussed with the Ash System, Section 1.2.4 of this report. The clear gas then passes through a refractory lined duct, to the tube side of vertical process gas coolers E201A to E (one per gasifier). The shell side of the coolers are linked by a thermosyphon to the high pressure steam drum, D202A. One high pressure steam drum is provided for six gasifiers, and steam at 125 psig is separated in the steam drum, and piped to the high pressure steam main. The clean gas out of the waste heat boilers is at a temperature of 400°F.

The top gas from the gasifiers passes through a tar cyclone, CY202A to E (one per gasifier). The cyclones are designed to remove the larger droplets of tar from the top gas stream, and will operate at a pressure drop of 3" WC for western coal, with 100% removal of particles greater in size than 30 microns. The tar flows by gravity to the tar tank, TK 202. The tar lines are steam

1.0 GENERAL

1.2 Process Descriptions

1.2.3 Facility Description

f. Gas Cleaning and Cooling (continued)

traced within the gasifier building and electric traced outside the building.

Individual gasifiers, and associated process gas coolers may be isolated by closing gate valves, and installing blind flanges in the top gas line downstream of the tar cyclone, and in the clear gas line downstream of the process gas cooler. In addition, taps have been provided in these lines, so that during operation the top and clear gas flow from each gasifier can be measured by a pitot tube traverse.

After initial detarring in the cyclones, the top gas flows to the common gas cleaning plant. The processing units in the gas cleaning plant are designed around a capacity of 10×10^9 Btu/day of product gas, to facilitate expansion of the plant to 20×10^9 Btu/day. The top gas passes through three tar precipitators in parallel (X201 A thru C). These precipitators are designed on the basis of 10×10^9 Btu/day, with 10% overcapacity; and will remove in excess of 99% of all droplets with a particle size of one micron or greater. Individual precipitators can be isolated by valves and blind flanges for cleaning with steam. When one precipitator is off line for cleaning, the total gas production can be passed through the two remaining precipitators, with a small reduction in efficiency. The tar collected flows by gravity through traced lines to the tar storage tank. A purge stream of a partially dry gas is required to the insulator compartments of the precipitators, to prevent condensation. The present design of this plant is based on inert gas purge. Probably the design could be based on a gas recycle from the gas booster discharge, which would save operating costs.

The detarred top gas, and partially cooled clear

1.0 GENERAL

1.2 Process Descriptions

1.2.3 Facility Description

f. Gas Cleaning and Cooling (continued)

gas are combined together and flow to the combined gas cooler E202A to C. Three 50% units are supplied based on 10 x 10^9 Btu/day product gas; two units will be running, one on standby. The gas passes through the tubeside of the units, as this is the side with the greatest potential fouling problem. Each exchanger can be individually isolated and blanked off for cleaning. The exchangers are designed to cool the gas to 95°F. For the western coal, this reduces the gas below its dew point, so that water condenses out of the gas, which will dissolve the chlorides from the gas. The eastern coal would not be cooled below its dew point, and the chlorides would stay in the gas stream. This could cause problems in downstream processing units. Therefore, when operating on eastern coal, water will be sprayed into the gas stream upstream of the exchanger to ensure that the gas is below its dewpoint at 95°F, and the chlorides are dissolved from the gas. Oils are also condensed from the gas in the exchanger, and the oil-water mixer flow by gravity to the oil water separator, TK201A.

The gas from the coolers passes through three oil precipitators in parallel (X202A to C). The precipitators are designed on the basis of 10 x 10^9 Btu/day, with 10% overcapacity and will remove in excess of 99% of all droplets with a particle size of one micron or greater. The philosophy of shut down of units for cleaning is the same as for the tar precipitators, and purge gas is required for the insulator compartments. Water and oil, and some dust removed in the oil precipitator flow by gravity to the oil water separator. The oil and water are separate phases, the oil being the lighter phase. The oil phase overflows a wier to an integral compartment where it is pumped to a battery limits. The water flows under a baffle to a chamber from which it is pumped to battery limits. Operation of both sets of pumps

1.0 GENERAL

1.2 Process Descriptions

1.2.3 Facility Description

f. Gas Cleaning and Cooling (continued)

is intermittent and initiated automatically based on level in the compartments. The bottom of the unit is sloped to collect the sludge. The sludge is removed periodically by a manually operated sludge pump.

1.0 GENERAL

1.2 Process Descriptions

1.2.4 Ash Handling System Description

The ash recovery, handling and storage systems described in this Section represent the basis of design for the Gasifier Plant as proported in this report. Ash will be collected from two (2) main areas within the plant:

(1) Gasifier Bottom Ash

(2) Cyclone Ash

a. Gasifier Bottom Ash

In general, hot ash from each gasifier will discharge via two (2) ash lock hopper arrangements and will be removed by means of a drag link conveyor system.

Each ash locking arrangement (MF201A/K) will consist of three (3) chambers connected by cylinder knife gate valves rated for 1000°F at 3 psig service. The ash from each of the gasifier outlets will be collected at a pre-determined rate and discharged into the top chamber. At the end of the collection sequence, the ash will be discharged into the middle cooling chamber where the material will be cooled by air supplied from a 360CFM aeration blower system (B203A & B). Cooling air will be applied to each cooling chamber via twelve (12) 6-inch diameter aeration pads. Cooling air will be discharged from the middle chamber via air lock vent filters. Upon completion of the cooling cycle, the material will be discharged into a third chamber prior to entering the conveyor system. This chamber also provides additional protection against the possible leakage of gas from the gasifier into the conveyor system.

Ash from each row of gasifiers will discharge into respective drag link conveyors (CO201A & B). These conveyors are rated at 2TPH and will be completely insulated with fiberglass with a 22 gauge aluminum jacket. These conveyors will discharge into a cross conveyor (CO203) which will transfer the

1.0 GENERAL

1.2 Process Descriptions

1.2.4 Ash Handling System Description

a. Gasifier Bottom Ash (continued)

collected ash to a bucket elevator. The cross conveyor is rated at 4TPH and will be completely insulated and will be equipped with a cooling system. The cooling system will consist of a blower package rated at 3000 CFM and is provided to supply additional cooling for the larger ash particles before the material reaches the silo. The velocity of air entering this conveyor will be sufficiently low so as not to entrain the ash in the air.

The ash will be lifted from the cross conveyor to the ash silo by a bucket elevator (CO204).

The central control panel for this system will have all the controls and programmers required for automatically controlling the system.

b. Cyclone Ash

The cyclone ash will be discharged from five (5) cyclones into three (3) sand tanks (BN203A/C) by means of five (5) 8-inch rotary feeders (MF207A/E) and an 8-inch slide pipe. Each tank will be constructed of 1/4 inch carbon steel plate, 4 feet square with a 60 degree pyrimidal hopper. The sand tanks will be water impounded and will be provided with an overflow louver to eliminate water as the ash displaces it. The ash will be removed form the sand tanks by means of three (3) 3-inch x 4-inch x 45 degree tangential hydro-ejectors. Each hydro-ejector will require 550gpm at 175 psig provided by pump (P206 A/B) rated at 700 gpm at 125 psig. Sluiced ash will be transferred by means of a 6-inch ashcolite pipe.

The sand tanks will require emptying approximately once every six hours. The control sequence will be initiated manually after which it will automatically sequence through all three (3) recovery stations. The entire recovery and transfer cycle will take approximately 10 minutes.

1.0 GENERAL

1.2 Process Descriptions

1.2.4 Ash Handling System Description

c. Silo

The ash silo will be provided by A.G. McKee as part of their package.

d. Alternate System

Included in the Appendix, Section 5.1, is an evaluation of an alternate system which will facilitate the removal of gasifier bottom ash pneumatically.

1.3

1.0 GENERAL

1.3 Main Process Parameters

1.3.1 Coal Composition and Characteristics

a. Coal Samples

Two samples of coal were shipped to BCI for testing. The first sample was received at BCI offices on April 10, 1978, marked "Erie Mining Company, Coal Sample DOE Contract No. ET-78-C-01-2578, Clarion-Brookville-Kittanning Penna. MS-Washed 2" x 0. Wt. 47 lbs." McKee confirmed that this sample was to be considered the Eastern coal for the design of the gasification plant, provided that the coal test results indicated no unacceptable properties.

b. Coal Testing

BCI arranged for testing of the coal samples at the Denver Laboratory of Commercial Testing and Engineering Co. (CTE). This laboratory is one of the few laboratories in the U.S.A. which has access to the equipment required for the Fischer Assay. CTE were requested to carryout the following set of tests on the two coal samples:

- Proximate and ultimate analysis of the coal
- Free swelling index
- Ash fusion temperature
- Hardgrove Grindability Index
- Complete Fischer assay including:

  Distilled gas: components by weight and volume
  Water from distillation : weight
  Char: Weight and ultimate analysis
  Tar: Weight and ultimate analysis

CTE identified the Western coal sample as Sample No. 3001-1. They carried out two complete sets of tests on the Western coal; the first set of test results was issued to BCI in a report dated May 4, 1978 and the second set of results in a report dated May 22,1978.

1.0 GENERAL

1.3 Main Process Parameters

1.3.1 Coal Composition and Characteristics (continued)

b. Coal Testing (continued)

CTE identified the Eastern coal sample as Sample No. 3001-2. The report on this coal was issued in three parts, dated May 3, 12, and 22, 1978.

Copies of the CTE test reports are included in Appendix 5.2 of this report.

c. Adjustments to Coal Test Results

The gasification plant is to be designed to handle coals which fall between two extremes, a sub-bituminous coal, represented by the Western coal sample, and a bituminous coal represented by the Eastern coal. Because of variations during sampling, and changes during transportation, it was possible that the two samples which were tested did not represent the extremes of coals which might be processed in the plant. One of the properties which largely effects the operation of the gasification plant is the moisture content of the coal - this primarily effects the top gas/clear gas split and the sizing of downstream equipment. It was therefore agreed by BCI, McKee and Erie Mining Company that the test results for the Western coal would be adjusted so that the coal contained 25.6% moisture, as received, and that the test results for the Eastern coal would be adjusted so that the coal contained 4.3% moisture.

The test results from the laboratory are summarized as an elemental balance of the results of the Fischer assay. This summary for the first set of Western coal tests, sample No. 3001-1, dated May 4, 1978, are given in Table 1.3-1. These tests did not provide as accurate a balance as was expected, and therefore CTE was requested to repeat the test. These test results for Sample No. 3001-1 were contained in the CTE report dated May 22, 1978, and are summarized in Table 1.3-2. The summary of the

1.0 GENERAL

1.3 Main Process Parameters

1.3.1 Coal Composition and Characteristics

c. Adjustments to Coal Test Results (continued)

tests for the Eastern coal, Sample No. 3001-2 is given in Table 1.3-3. These results are within the accuracy expected from these laboratory analyses.

To establish a material balance for the gasification plant it is necessary to start with a set of coal test data which accurately balance. The Eastern and Western coal test data was therefore adjusted to obtain an accurate balance, based on BCI's experience and discussions with McKee. This modified coal test data is summarized as an elemental balance in Table 1.3-4 for Western coal and in Table 1.3-5 for Eastern coal.

d. Discussion of Coal Test Results - Western Coal

Sub-bituminous coals degrade if proper precautions are not taken during transportation and storage of the coal. However, provided that the coal has not degraded, the test results show that the coal is suitable for gasification in a conventional two stage gasifier with a divided retort.

The western coal should be suitable for gasification in the stirred two stage gasifier developed as part of this project. Because of the non-caking and friable nature of the coal, it is probable that for the best operation, the speed of the stirrer should be set to a minimum to avoid degradation of the coal.

The ash fusion temperature for the western coal is towards the lower limit of the acceptable range for gasification. However, this can be handled by the gasifier by a slight increase in the amount of steam used for gasification. This is reflected in a blast saturation temperature of 147°F. which is used for the mass balance (vs. 140°F for the Eastern coal).

1.0 GENERAL

1.3 Main Process Parameters

1.3.1 Coal Composition and Characteristics

d. Discussion of Coal Test Results - Western Coal (continued)

The char produced by the Fischer assay of this coal is very reactive and will slowly react with air even when cold. The descrepancy in the balance of the laboratory test results can be attributed to this reactivity.

e. Discussion of Coal Test Results - Eastern Coal

The Eastern coal test results are typical of a high swelling bituminous coal. Provided that the stirrer enables the two stage gasifier retort to carbonise the coal effectively, the resultant coke should be suitable for gasification. The ash fusion temperature shows a wide range and high range, which make it ideal for gasification, and will offset the lower reactivity of coke derived from Eastern coal compared with the very reactive Western char.

Because of the high swelling number of the Eastern Coal, the sample size used in the Fischer test had to be reduced in size from the standard. The tar yield from the test was therefore low, and the tar produced was very heavy. This made it difficult to obtain an accurate ultimate analysis of the tar. Precautions have been taken in the design of the tar handling system to ensure the tar from the Eastern coal remains fluid. These include tracing of the tar lines, and provision of steam purging connections on the tar lines.

	Raw Coal	COKE			TAR			WATER			GAS				
	100#	% RC	#	%	% RC	#	%	% RC	#	%	% RC	#	%	Total % RC	Total #
H_2O	25.60								25.60						25.6
Ash	8.27	97.6	8.07	14.80										97.6	8.07
C	50.74	79.94	40.56	74.34	11.37	5.77	83.56				5.42	2.75	44.93	96.73	49.08
H	3.53	45.61	1.61	2.96	9.63	0.34	4.88	20.40	0.72	-	11.33	0.40	6.54	86.97	3.07
N	0.87	80.45	0.70	1.29	4.60	0.04	0.56							85.05	0.74
S	0.87	71.26	0.62	1.13	2.30	0.02	0.30				17.24	0.15	2.45	90.80	0.79
O	10.11	29.48	2.98	5.48	7.32	0.74	10.70	56.87	5.75		27.89	2.82	46.08	121.56	12.29
Cl.	0.01														
TOTALS	100		54.54	100		6.91	100		6.47			6.12	100		99.64

TABLE 1.3-1 FIRST WESTERN COAL TEST

SAMPLE NO. 3001-1

	Raw Coal	COKE			TAR			WATER			GAS				
	100#	% RC	#	%	% RC	#	%	% RC	#	%	% RC	#	%	Total % RC	Total #
H_2O	25.60								25.60						25.60
Ash	8.27	99.03	8.19	14.81										99.03	8.19
C	50.74	81.00	41.10	74.29	10.05	5.10	82.18				5.24	2.66	46.02	96.29	48.86
H	3.53	48.44	1.71	3.09	13.73	0.58	9.37	18.98	0.67		11.61	0.41	7.09	92.76	3.37
N	0.87	60.92	0.53	0.96	3.45	0.03	0.46							64.37	0.56
S	0.87	67.81	0.59	1.07	2.3	0.02	0.40				10.34	0.09	1.56	80.45	0.7
O	10.11	31.65	3.20	5.78	4.55	0.46	7.40	53.01	5.36		25.91	2.62	45.33	115.12	11.64
Cl.	0.01														
TOTALS	100		55.33	100		6.20	100		31.63			5.78	100		98.93

TABLE 1.3-2 SECOND WESTERN COAL TEST

SAMPLE NO. 3001-1

	Raw Coal	COKE			TAR			WATER			GAS				
	100#	% RC	#	%	% RC	#	%	% RC	#	%	% RC	#	%	Total % RC	Total #
H_2O	25.60								25.60						25.60
Ash	8.27	100	8.27	15.0											
C	50.74	83.21	42.22	76.5	11.37	5.77	88.23				5.42	2.75	43.93	100	50.74
H	3.53	55.81	1.97	3.57	12.46	0.44	6.72	20.40	0.72		11.33	0.40	6.39	100	3.53
N	0.87	79.31	0.69	1.25	4.60	0.04	0.61				16.09	0.14	2.24	100	0.87
S	0.87	72.41	0.63	1.14	10.34	0.09	1.38				17.25	0.15	2.40	100	0.87
O	10.11	13.25	1.34	2.43	1.98	0.20	3.06	56.87	5.75		27.90	2.82	45.04	100	10.11
Cl.	0.01	100	0.01	0.02										100	0.01
TOTALS	100		55.13	100		6.54	100		32.07			6.26	100		100

TABLE 1.3-3 WESTERN COAL ANALYSIS FOR MASS BALANCE

	Raw Coal	COKE			TAR			WATER			GAS				
	100#	% RC	#	%	% RC	#	%	% RC	#	%	% RC	#	%	Total % RC	Total #
H_2O	4.3								4.3						4.3
Ash	9.61	107.4	10.320	15.04										107.4	10.32
C	71.21	72.11	51.346	74.83	22.09	15.74	85.51				3.88	2.765	57.01	98.08	69.85
H	5.05	40.77	2.059	3.00	34.26	1.73	9.41	5.39	0.272		14.71	0.743	15.32	95.13	4.80
N	1.13	56.46	0.638	0.93	16.81	0.19	1.06							73.27	0.83
S	3.33	66.16	2.312	3.37	5.71	0.19	1.06				24.02	0.800	16.49	95.89	3.30
O	5.30	37.68	1.887	2.75	10.19	0.54	2.96	41.0	2.173		10.23	0.542	11.18	99.10	5.14
Cl.	0.07	78.57	0.055	0.08										78.57	0.06
TOTALS	100		68.617	100		18.39	100		2.445			4.85	100		98.6

TABLE 1.3-4 EASTERN COAL TEST

SAMPLE NO. 3001-2

BCI Contract 3001

	Raw Coal	COKE			TAR			WATER			GAS				
	100#	% RC	#	%	% RC	#	%	% RC	#	%	% RC	#	%	Total % RC	Total #
H_2O	4.3								4.3						4.3
Ash	9.61	100	9.61	13.90											9.61
C	71.21	73.71	52.485	75.94	22.41	15.96	84.11				3.88	2.765	53.57	100	71.21
H	5.05	44.65	2.255	3.26	35.25	1.78	9.38	5.39	0.272		14.71	0.743	14.39	100	5.05
N	1.13	56.46	0.638	0.92	15.93	0.18	0.95				27.61	0.312	6.04	100	1.13
S	3.33	60.96	2.03	2.94	15.02	0.50	2.64				24.02	0.800	15.50	100	3.33
O	5.30	38.30	2.03	2.94	10.47	0.555	2.92	41.0	2.173		10.23	0.542	10.50	100	5.30
Cl.	0.07	100	0.07	0.10										100	0.07
TOTALS	100		69.118	100		18.975	100		6.745			5.162	100		100

TABLE 1.3-5 EASTERN COAL ANALYSIS FOR MASS BALANCE

1.0 GENERAL

1.3 Main Process Parameters

1.3.2 Coal Residence Time in Gasifier

The two stage gasifier has a long residence time, to provide gentle distillation of the coal, and prevent cracking of the tars and oils to pitch. The coal residence time in the gasifier retort is approximately six (6) hours, and the residence time in the water jacketed section is approximately 4-1/2 hours.

1.0 GENERAL

1.3 Main Process Parameters

1.3.3 Pressure Drops through the Gasifier

The pressure drop through the gasifier is based on data from the operation of other two-stage gasifiers. These gasifiers operate with a total pressure drop across the gasifier of between 10" W.C. and 15" w.g. The pressure drop allowed across the gasifier to the clear gas outlet is 20" w.g., and the pressure drop allowed to the top gas outlet is 30" w.g.

The maximum pressure drop through the dust cyclones is 3" w.g., and the maximum pressure drop through the tar cyclones is 1.7" w.g.

2.0

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 2.0 - OPERATING DATA

DOE Contract ET-78-C-01-2578

McKee Contract 4814A/W2

BCI Contract 3001

2.1

2.0 OPERATING DATA

2.1 Start-up and Shutdown Procedures in Outline Form

2.1.1 Start-up Procedures

Complete pressure testing of plant.

Check operation of all mechanical items of equipment.

Dry out and cure the refractory in the gasifier and ducts, using a propane heater.

Assemble wooden starter boxes and fill with burlap to within 2" of the top.

Place starter boxes in the producer, and lead lengths of burlap from the boxes to the access ports in the grate.

Position pipes through rodding holes to the starter boxes.

Cover the grate between the starter boxes with ash to within 3" of the top of the boxes. Add 1 ft. of charcoal on top of the ash and the boxes. Spray fuel oil on the charcoal.

Add nut coke on top of charcoal to the bottom of the distillation retort.

Add fuel oil to the starter boxes thru the pipes. Remove pipes from the gasifier. Spray the burlap inside the access port with fuel oil.

Light the burlap wick simultaneously, close the the access ports, and start the blower. Gradually bleed air to the gasifier. The gasifier is vented thru the chimney.

After about one hour, open the lines to the flare, and close the gasifier vent.

Check level of coke in the gasification section, and add coke thru the gasifier lock hopper to maintain the coke level in the gasification section.

After about 1-1/2 hours, increase the air flow

2.0 OPERATING DATA (continued)

2.1 Start-up and Shutdown Procedures (continued)

2.1.1 Start-up Procedures (continued)

to the gasifier to about 25% of design flow. Simultaneously start adding steam to the blast. The proportion of steam should be increased to the normal blast saturation temperature over a period of 1-1/2 hours. Continue to check the fire zone and ash level thru the poke holes.

When the clear gas off-take temperature reaches 400°F, start the agitator at minimum speed and gradually add coke to fill the gasifier to the normal level. The gasifier can then be placed on level control for coke addition.

Manually bring the top gas temperature to 250°F over a period of 4 hours, venting the top gas and clear gas to flare.

Increase the thruput of the gasifier to approximately 50% of design, and continue operating until the clear gas temperature is above 200°F. Observe the position of the control valve in the clear gas line.

Start feeding coal to the retort. Periodically check the bed in the retort by inserting a rod thru one of the upper poke holes. The rod should have a temperature sensor at its tip to enable the temperature profile across the bed to be checked. The area of the bed where the agitator is operating should be adjusted according to the temperature profile.

Maintain constant gasifier thruput, at about 50% of design. Observe the position of the clear gas control valve; if the valve closes appreciably, increase speed of agitation.

Purge downstream equipment with nitrogen. Analyze the purge off gases for oxygen.

Divert low Btu gas from the flare thru the system.

2.0 OPERATING DATA (continued)

2.1 Start-up and Shutdown Procedures in Outline Form (continued)

2.1.2 Normal Shut Down Procedures

Stop coal feed to gasifier, whilst maintaining gas make. Continue operation until the coal level has dropped to the bottom of the retort.

Divert the gas make from the gas cleaning plant to the flare. Gradually reduce the plant thruput to approximately 50% of design. Continue to operate the plant, checking that the fire zone is still lit by rodding.

When the fire burns itself out (there should be little coke left in the gasifier), stop the air flow to the gasifier, and quench the gasifier with steam for 5 mins. Close the lines to the flare, and open the gasifier chimney. Open the emergency air line to the bottom of the gasifier.

Isolate the gasifier by installing blanks on the clear gas and top gas line. Isolate the steam drum from the steam system, and vent and drain the drum and water jacket.

Remove any coke and ash remaing in the gasifier thru the access ports around the grate.

2.1.3 Emergency Shut Down Procedure (Operating Emergency)

In the event that it is desired to shut down the gasifier as quickly as possible, the following procedure should be followed:

Open lines to flare and close valves in top gas and clear gas lines.

Stop air flow to the gasifier and increase steam flow to a maximum.

Check that the fire zone is completely extinguished.

The coal may be removed from the gasifier by the

2.0 OPERATING DATA (continued)

2.1 Start-up and Shutdown Procedures in Outline Form continued

2.1.3 Emergency Shutdown Procedure (Operating Emergency) continued

grate. However, it should not be handled in the ash system, and would have to be collected under the gasifier.

2.1.4 Emergency Shut Down Procedure (Power Failure)

The following sequence occurs automatically:

The automatic valve to the flare opens to depressurize the system.

The valve in the steam supply to the gasifier fails to a preset position to set the steam flow a approximately 25% of design flow.

After a preset time, the valve to the chimney opens, and the valves to the flare close. The emergency air inlet valve opens. Air is drawn thru the eductor by the steam and maintains the fire zone in the gasification section.

The gasifier may safely be held in this condition for a number of days, and may then be brought back on stream in a matter of hours, by turning on the air blower, and gradually bringing the gasifier up to capacity.

2.1.5 Unusual Safety Problems

Low Btu gas is poisonous, and potentially explosive. The chance of leaks will be minimized by proper design of the plant. However, CO alarms will be provided in the building to give an early warning of any leaks before the danger level is reached.

A problem has been reported on one or two existing plants with explosion occuring in the base of the gasifier during power failures. The design of this

2.0 OPERATING DATA

2.1 Start-up and Shutdown Procedures in Outline Form

2.1.5 Unusual Safety Problems (continued)

plant includes provisions to minimize the possibility of explosion during power failure. The gasification plant is automatically vented to the flare, steam is maintained to the bottom of the gasifier, and after a time delay, the gasifier is put on natural draft.

Adequate safety systems will be designed into the plant ot protect operator and facilities from the results of process upsets. Through proper design the plant will achieve an excellent safety record. Proper training of operators in all aspects of plant operation and plant safety is a prerequisite of safe plant operation.

22

2.0 OPERATING DATA

2.2 Preliminary Operating Manual in Outline Form

2.2.1 Start-up and Shutdown

Plant start-up and shutdown procedures as outlined in Section 2.1 are a part of plant operating procedures.

2.2.2 Normal Operating Values

The normal operating values of the steam within the plant are shown on the Process Flow Diagrams - Demonstration Plant for either the East or West coal.

The rates represent the flows with four gasifiers operating at design conditions.

2.2.3 Gasifier Operation

Coal is fed to the gasifier via a lock hopper and level hopper thru dip legs into the gasifier retort. The level hopper is fitted with high and low level alarms, which will indicate any problems with the coal feed. A slide valve is provided for isolation of the lock hopper for maintenance. Two sets of five rodding holes are provided around the upper cores of each gasifier to permit rodding of the retort if there appears to be problems with the coal/gas flow through the retort. Problems of coal flow will be shown up by problems with the coal feed, and fluctuation in the gas offtake temperature. Rodding of the retort should not be required on a regular basis.

The gasifiers are fitted with a temperature probe in the center of the grate to control the ash level. However, the ash level, and the firebed should be checked once per shift by inserting rods at five (5)

2.0 OPERATING DATA

2.2 Preliminary Operating Manual in Outline Form

2.2.3 Gasifier Operation (continued)

locations. Based on visual inspection of the rods, the set point of the grate temperature controller can be reset, or the speed of grate rotation can be manually adjusted. If the ash layer or fire zone are unlevel, the bed must be rodded to break up clinker.

The quality of the ash leaving each gasifier should be observed once per shift. Corrections to the steam/air ratio are made to adjust the ash size range to the desired level.

2.2.4 Gas Cleanup Plant Operation

High level alarms are provided on the dust and tar cyclones, which will indicate any problem with discharge of the tar or dust. A routine check should be made of the temperature of the gas out of the process gas coolers. This will indicate if there is any problem with fouling in the exchanger. In the event that the exchanger requires cleaning, the associated gasifier should be isolated, shut down and purged.

The tar and oil precipitators should require little maintenance. Problems such as breakdown of insulation or building of material on the electrodes will be indicated by a drop in voltage from the rectifier. The faulty unit should be isolated from the gas cleanup train (the remaining units can handle the full gas thruput. Although at slightly reduced thruput) and cleaned with steam. Periodic checks are required to ensure that the insulator heator and gas purge are operating.

The temperature indicators on the cooling water outlet of the combined gas cooler should be recorded daily. Any significant difference in the ΔT across the exchangers indicates that the exchanger with the lowered DT is fouling. The exchanger should be isolated, purged and the tubes cleaned.

2.3

2.0 OPERATING DATA

2.3 Product and By-Product Yield Quantities and Compositions

2.3.1 Basis of Design

The plant is designed on the basis of producing 7.4 x 10^9 Btu/day (as H.H.V.) of gas from four gasifiers when operating on Eastern coal. The heat and material balance is shown on Drawings No. 4814-Y-02-07-2 and 4814-Y-02-08-2, entitled: Gasification, Demonstration Unit, P.F.D. - East Coal.

The plant is also designed on the basis of producing 7.4 x 10^9 Btu/day (as H.H.V.) of gas from eleven gasifiers when operating on Western coal. The heat and material balance is shown on Drawings No. 4814-Y-02-05-2 and 4814-Y-02-06-2 entitled: Gasification, Demonstration Unit, P.F.D. - West Coal.

2.3.2 Product Gas

The product gas from the gasification plant is shown under stream 15 on the process flow diagrams, and is termed cooled gas on these drawings

- Eastern Coal:

Gas Composition	%V/V dry
CO	25.3
CO_2	6.1

2.0 OPERATING DATA (continued)

2.3 Product and By-Product Yield Quantities and Compositions (continued)

2.3.2 Product Gas (continued)

Gas Composition	% V/V dry
H_2	19.7
N_2	47.2
CH_4	0.7
C_2-C_5	0.3
H_2S	0.55
COS	0.1
NH_3	0.05
	100.00

Oil Content 7 grains/100DSCF
HCN Content 1.5 grains/100DSCF

HHV (including minor constituents) 164Btu/DSCF
LHV (including minor constituents) 152Btu/DSCF

- Western Coal:

Gas Composition	% V/V (dry)
CO	26.0
CO_2	6.8
H_2	22.9
N_2	43.2
CH_4	0.6
C_2-C_5	0.2
H_2S	0.15
COS	0.05
NH_3	0.1
	100.0

Oil Content 3.5 grains/100 DSCF
HCN Content 1.5 grains/100 DSCF

HHV (including minor constituents) 171Btu/DSCF
LHV (including minor constituents) 158Btu/DSCF

2.3.3 Tar/Oil By-Product

The only stream from the plant which is considered a

2.0 OPERATING DATA (continued)

2.3 Product and By-Product Yield Quantities and Compositions (continued)

2.3.3 Tar/Oil By-Product (continued)

by-product is the tar/oil stream. For handling, the properties of this stream can be considered to be similar to a No. 6 fuel oil. Based on data available from operation of other gasifers, we would expect that the tar/oil from the Eastern coal to be heavier than the tar/oil from the Western coal. However, the sample obtained during coal testing is too small to quantify this difference.

- Eastern Coal:

Flow Rate 13.9 GPM

Composition	%W/W
C	84.11
H	9.38
N	0.95
Cl	0.00
S	2.64
O	2.92
	100.00

HHV 16,000 Btu/#
SG 1.0

- Western Coal:

Flow Rate 5.7 GPM

Composition	%W/W
C	88.23
H	6.72
N	0.61
Cl	0.00
S	1.38
O	3.06
	100.00

HHV 16,000 Btu/#
SG 1.0

2.4

2.0 OPERATING DATA (continued)

2.4 Effluent Streams, Yield Quantities and Compositions

2.4.1 Gaseous Effluents

There are three possible sources of gaseous effluent emissions. These three sources are discussed in greater detail below.

Gasifier Chimneys: The chimneys will be in operation during the initial phases of start-up, and during the emergency shut down holding condition only.

The approximate composition of the gas out of the chimney is as follows:

	Eastern Coal	Western Coal
CO_2	17 %	17.5%
H_2O	7.7%	7.4%
SO_2	0.3%	0.1%
N_2	75 %	75 %
	100	100
Volume of gas per Chimney	2,000 SCFM	1750 SCFM

Gas Temperature Out of Chimney 200 to 500°F

During start up, each chimney is expected to operate for approximately one (1) hour. Each gasifier may be expected to start up twice per year.

During emergency power failure, the gasifier will automatic vent thru the chimney, and then go into a hold hot situation. For environmental considerations, this condition should be considered to last for six (6) hours per year.

- Flare Stacks (X201 A to C): The flare stacks will be in operation during start up, shut down, and emergency conditions. One flare stack is provided for two gasifiers.

2.0 OPERATING DATA (continued)

2.4 Effluent Streams, Yield Quantities and Compositions (continued)

2.4.1 Gaseous Effluents (continued)

The approximate composition of the gas out of the stack is as follows (assuming 50% x S air to stack):

	Eastern Coal	Western Coal
CO_2	11	12
H_2O	5	5
SO_2	0.2	0.1
N_2	77	76
O_2	6.8	6.9
	100	100

	Eastern Coal	Western Coal
Max. Volume of gas Per Chimney	30,000 SCFM	25,000 SCFM
Exit Temperature from Flare		750 - 2,000°F

During start up of a gasifier, each stack will be in operation for approximately 24 hours, and the average flow to the stack will be approximately 50% of the maximum flow. Each gasifier may be expected to start up twice per year.

During certain emergency conditions, such as instrument air failure, the gasifier will vent to the stack at an average flow rate of 50% of maximum. For environmental considerations the condition should be considered to last 12 hours/year.

- Fugative Emissions: These can arise because of minor leaks of process gases. However, these gases are poisonous and potentially explosive, so every precaution will be taken to keep fugative emissions to zero. These precautions include providing CO alarms within the building.

2.4.2 Liquid Effluent

There are four possible sources of liquid effluents -

2.0 OPERATING DATA (continued)

2.4 Effluent Streams, Yield Quantities and Compositions (continued)

2.4.2 Liquid Effluent (continued)

the aqueous effluent from the oil water separator, cyclone dust/water slurry, sludge from the separator, and spills and process blowdowns. These sources are discussed in greater detail below.

- Aqueous Effluent: The oil/water separator (TK201A) separates the water and oil condensed from the gas stream. The aqueous effluent is pumped to battery limits to maintain a constant level in the separator. Alterante methods for disposing of the effluent are discussed in Appendix 5.2 of this report.

	Eastern Coal	Western Coal
Flow Rate	2.35 gpm	23
Impurities	ppm	ppm
Oil	350	350
Carbonate (as CO_2)	5400	3850
Sulfide (as H_2S)	8000	175
NH_3	15,000	800
HCN	4500	250
Chlorides	23,000	350

- Cyclone Dust: The proposed scheme is based on collecting the cyclone dust in sand tanks (BN203 A/C). The dust is removed from the sand tanks periodically as a slurry of dust in water and pumped to battery limits.

	Eastern Coal	Western Coal
Average flow rate of Slurry	926 #/hr.	1,111 #/hr.
Max Flow rate of Slurry	550 gpm	550 gpm
Solids content of Slurry	10%	10%

2.0 OPERATING DATA (continued)

2.4 Effluent Streams, Yield Quantities and Compositions (continued)

2.4.2 Liquid Effluent (continued)

The dust content of the slurry will contain approximately 50% Carbon.

- Sludge: A sludge of dust and tar will gradually collect in the bottom of the separator. A sludge pump is provided to pump this sludge to battery units. The average rate of sludge removal is expected to be approximately 1 gallon per hour. The sludge will contain approximately 20% solids, which will be dust and heavy tar.

- Spills and Process Blowdowns: Any equipment which could need cleaning or maintenance on a regular basis has the drain or blowdown connection piped to the chemical sump. The contents of the chemical sump can be pumped to battery limits.

2.4.3 Solid Effluents

The only solid effluent from the gasification plant is the ash. The ash is an inert material which could possibly be used as a filler for building block or as a base for road beds. The ash will contain about 10% carbon.

	Eastern Coal	Western Coal
Ash Quantity	46 tons/day	48 tons/day

The ash will normally be a granular material within the site range 1/8" to 2". During process upset, lumps up to a size of 6" may occur.

2.5

2.0 OPERATING DATA (continued)

2.5 Operating Data

2.5.1 Manpower Requirements for Operations and Maintenance

The operating manpower required for the plant is five men per shift. The men's duties will basically be split as follows:

One panel operator, who will remain in the control room at all times, and control the overall operation of the plant.

One operator per shift for the gas cleanup plant. This operator will act as backup for the panel operator, and will be responsible for outside instrument readings and operating of the cleaning plant.

One gasifier operator is assigned per two gasifiers. For the demonstration plant (five gasifiers) , three gasifier operators are required. Their duties will include rodding the gasifier to check on the reaction zone, checking the condition of the ash leaving the gasifier, and checking the operation of the coal feed mechanism.

The recommended allowance for operating supplies is 30% of the wage cost of process labor.

2.5.2 Raw Material Feed Quantities

- Coal feed for the gasifiers is to be delivered to the surge hoppers as required. The ratio between the top size and the bottom size for the coal feed is 3:1, and as fed to the gasifier, the coal should contain no more than 10% less than the minimum size.

The limits of the ranges which are recommended for feeding to the gasifier are:

Maximum Range	3" x 1"
Mimimum Range	1-1/2" x 1/2"

2.0 OPERATING DATA (continued)

2.5 Operating Data (continued)

2.5.2 Raw Material Feed Quantities (continued)

	Eastern Coal	Western Coal
Coal Feed,#/hr	36,598	44,178
Coal Feed, Ton/day	439	530

- Start up supplies include coke, No. 2 fuel oil and charcoal.

Approximately 5 gallons of fuel oil are required during lighting up a gasifier. It is recommended that two 40 gallon drums of No. 2 fuel oil be maintained in the plant store.

Approximately one ton of charcoal is required during the start up of a gasifier.

Approximately 75 tons of nut coke are required during the start up of a gasifier.

2.5.3 Estimated Utilities

The utility summary is attached as Table 2.5 - 1. This gives the overall plant utility flows for the plant when operating at four (4) different thruputs with the two alternate design coals, the East coal and the West coal.

For economic evaluations on the demonstration plant, the normal utilities usage for the plant operating at 7.4 x 10^9 Btu/day should be used.

For utility supply systems to the total plant, and line sizing on the main piperack, the design flow for 20 x 10^9 Btu/day should be used, under the Column Design 3 of the Table.

2.0 OPERATING DATA (continued)

2.5 Operating Data (continued)

2.5.3 Estimated Utilities (continued)

For the utility header running down the gasifier building, the line sizing should be based on possibility of six (6) gasifiers operating in that section of the gasifier building. This is equivalent to 11.1×10^9 Btu/day of product gas, and the design flow is noted under the column Design 2 of the Table.

The demonstration plant includes three gas coolers, and these each have a duty equivalent to 5×10^9 Btu/day when operating on Western coal. When the plant is expanded to the full commercial plant, it is possible that the three coolers supplied as part of the demonstration unit could be operating at design load. The design flow of cooling water to these gas coolers should be 4500 gpm.

For designing building heating and ventilating systems, the heat loss to the building is estimated as 200,000 Btu/hr per gasifier. Consideration should also be given to the heat loss from downstream equipment within the building.

UTILITY SUMMARY

PLANT OUTPUT 10^9Btu/day	7.4		10			11.1 (6 Gasifiers)			20.0		
BASIS / UTILITY	East Coal	West Coal	East Coal	West Coal	Design 1	East Coal	West Coal	Design 2	East Coal	West Coal	Design 3
125 p.s.i. Steam Produced #/hr	18,400	6,950	-	-	-	27,600	10,425	29,900	49,800	18,800	55,000
High Pressure Boiler Feedwater #/hr	20,300	7,650	-	-	-	30,500	11,500	33,000	54,800	20,700	60,500
20 p.s.i. Steam #/hr Export (Import)	1,740	(950)	-	-	-	2,600	(1500)	3,000 (3,000)	4,700	(2500)	6,000 (6000)
Cooling Water (75°F,20°F T)G.P.M.	1,000	2,000	1,360	2,700	3,000	-	-	-	2,700	5,400	5,500
Inert Gas SCFM	300	300	-	-	-	350	350	1,500	660	660	2,000
Instrument Air, SCFM	120	120	-	-	-	150	150	175	240	240	250
Power KVA	1,000	1,000	-	-	-	1,100	1,100	1,390	2,000	2,000	2,625

TABLE 2.5 - 1

DEMONSTRATION PLANT

TABLE 2.5-2 MCTOR LIST

ITEM	DESCRIPTION	HP	KW	Demand KW
BM201A	Combustion Air Blower	300	241	241
BM201B	Combustion Air Blower	300	241	241
BM201C	Combustion Air Blower	300	241	-
AM201A	Stirrer Hyd. Oil Pump	30	24	24
AM201B	Stirrer Hyd. Oil Pump	30	24	-
AM201C	Stirrer Hyd. Oil Pump	30	24	-
AM201D	Stirrer Hyd. Oil Pump	30	24	-
AM201E	Stirrer Hyd. Oil Pump	30	24	-
AM201F	Stirrer Hyd. Oil Pump	30	24	-
MFM202A	Coal Feeder	2	2	2
MFM202B	Coal Feeder	2	2	2
MFM202C	Coal Feeder	2	2	2
MFM202D	Coal Feeder	2	2	2
MFM202E	Coal Feeder	2	2	2
MFM202F	Coal Feeder	2	2	2
X201A	Tar Precipitator (Total)	-	45	45
X201B	Tar Precipitator (Total)	-	45	45
X201C	Tar Precipitator (Total)	-	45	45
PM201A	Tar Pump	3	3	3
PM201B	Tar Pump	3	3	-
PM207A	Hyd. Oil Pump (Grate Drive)	40	35	35
PM207B	Hyd. Oil Pump (Grate Drive)	40	35	-

DEMONSTRATION PLANT

TABLE 2.5-2 MOTOR LIST
continued

ITEM	DESCRIPTION	HP	KW	Demand KW
X202A	Oil Precipitator (Total)	-	45	45
X202B	Oil Precipitator (Total)	-	45	45
X202C	Oil Precipitator (Total)	-	45	45
PM203A	Oil Transfer Pump	1	1	1
PM203B	Oil Transfer Pump	1	1	-
- -	Oil Immersion Heater	-	10	10
PM204A	Sludge Pump	1-1/2	1	1
- -	Sludge Immersion Heater	-	5	5
PM202A	Aqueous Eff. Pump	1	1	1
PM202B	Aqueous Eff. Pump	1	1	-
- -	Effluent Immersion Heater	-	10	10
PM205	Chemical Sump Pump	2	2	2
PM208A	Lock Hopper Lube Pump	3	3	3
PM208B	Lock Hopper Lube Pump	3	3	-
PM206A	Ejecter Pump	100	82	82
PM206B	Ejecter Pump	100	82	-
BM203A	Aeration Pad Blower	10	9	9
BM203B	Aeration Pad Blower	10	9	-
- -	Aeration Pad Blower Heater	-	35	35
COM201A	Drag Link Conveyor	7-1/2	7	7
COM202A	Drag Link Conveyor	7-1/2	7	7
COM203A	Drag Link Conveyor	7-1/2	7	7

DEMONSTRATION PLANT

TABLE 2.5-2 MOTOR LIST
continued

ITEM	DESCRIPTION	HP	KW	Demand KW
COM204	Bucket Elevator	5	4	4
BM202	Ash Cooling Blower	5	4	4
- -	Heat Tracing	-	45	45
- -	Trans/Rect Building Ltg.	-	5	5
- -	Cont. Rm HVAC	55	48	24
- -	Platform Lighting	-	75	52
	TOTAL	1499	1682	1138

Total Connected KVA (0.32PF) 2050
Max Demand KVA (0.82PF) 1390

2.6

2.0 OPERATING DATA

2.6 Maintenance Supply Requirements

2.6.1 Routine Supplies

Routine supplies are defined as those additives to a system or systems required to render a unit operable such as greases, oils, hydraulic fluids. With the exception, possibly, of hydraulic fluids these routine supplies will be compatible with those presently required in various other areas of the Plant Facilities.

2.6.2 Recommended Inventory

Recommended inventory of routine supplies - quantities shown are for the Demonstration Plant consisting of five (5) stirred gasifiers. Where spare or standby units have been installed, they have been considered as operating full time for purposes of this recommended inventory. No consideration has been given to abnormal operations, such as transmission line breaks, etc. in setting these quantities.

Operating Unit		No. of Units	Media	Annual Reqmts.
MF201	Entry Plug Valve	10	E.P.Grease	400 lb.
	Exit Plug Valve	10	E.P.Grease	
	Vent Plug Valve	5	E.P.Grease	
B201	Comb. Air Blower	3	Oil	200 gal.
	Air Blower Motors	3	Grease	400 lb.
P201	Tar Pump and Motor	2	Grease	50 lb.
TK201	Aqueous Eff. Pump & Motor	2	Grease	250 lb.
	Oil Trans. Pump and Motor	2	Grease	
	Sludge Pump and Motor	1	Grease	
MF202	Coal Feeders	5	Grease	250 lb.
X201	Hydraulic System	1	Hyd. Fluid	500 gal.
	Hyd. Pump and Motor		Grease	100 lb.

2.0 OPERATING DATA

2.6 Maintenance Supply Requirements

2.6.2 Recommended Inventory (continued)

Operating Unit	No. of Units	Media	Annual Reqmts.
X202 Grate Lube System	10	High Temp. Grease	5000 lb.
P205 Chemical Pump & Motor	1	Grease	50 lb.
A201 Stirrer Hyd. System	2	Hyd. Fluid	500 gal.
Hyd. Pump and Motor	2	Grease	50 lb.
Jack Screws	4	Grease	100 lb.
Gear Box	4	Oil	55 gal.
Vertical Reducer	4	Oil	
Bull Gear	2	Grease	200 lb.
Pinion	4	Grease	
Spline	2	Grease	
Misc. Valve Operators	Lot	Grease	200 lb.
Gear Couplings	Lot	Grease	300 lb.

2.6.3 Recommended Major Spare Parts

a. Major Items

Equipment	Description	Required Spares DEMO
Gasifier (R201)	Rodding Ports	10
	Blast Inlet Assembly	1
	Gasifier Grate Assembly	1
	Refractory (Shaped)	1 set (Comp)
Comb.Air Blower (B201)	Complete Rotor (Wheel, Shaft, Coupling)	1
	Inboard Bearing	2
	Outboard Bearing	2
	Manual B/F Valve	0
Coal Surge Hopper (BN201)	Slide Gate Valve	2

2.0 OPERATING DATA

2.6 Maintenance Supply Requirements

2.6.3 Recommended Major Spare Parts

a. Major Items

Equipment	Description	Required Spares DEMO
Coal Lock Hopper (MF201)	Expansion Joint	2
Oil Water Sep. (TK201)	Aqueous Effluent Pump and Motor	1
	Oil Transfer Pump & Motor	1
	Sludge Pump and Motor	1
Tar Precipitator (X201)	Electrodes Complete	1
	Trans/Rectifier	1
Oil Precipitator (X202)	Electrode Complete	1
	Trans/Rectifier	1
Stirrer (A201)	Item 13 - Pinion Gear	1
	Item 14 - Spline	1
	Item 15 - Spline	1
	Upper Rabble Arms (Set)	1
	Lower Rabble Arms (Set)	1
	Item 55 - Bronze Bearing	4
	Item 50 Lubrite Bushing	4

2.0 OPERATING DATA

2.6 Maintenance Supply Requirements

2.6.3 Recommended Major Spare Parts

b. Instrumentation

ITEM	QUANTITY IN USE	SPEC. SP-	DESCRIPTION	REQ'D. SPARES
I/F Converter	5	8021	Similar Unit	1
Elec. Switch	45	8030	Similar Unit	5
I/P Converter	44	8041	Similar Unit	4
Min.Recorder	38	8111	Similar Unit	4
Min.Pnl.Ind.	4	8131	Similar Unit	1
Manual Loader	25	8141	Similar Unit	3
Min.Controller	18	8142	Similar 3-Mode Ctl'r.	2
Ratio Ctl'r.	5	8149	Similar Unit	1
Annunciator	1	8150	Spare Annun. Modules	6
Time Delay Relay	5	8161	Similar Unit	1
Dial Thermometer	28	8201	Similar Unit	3
Indicating Pyrometer	5	8206	Similar Unit	1
Thermocouple Assemblies	14 5	8216 8216	(9" U-Dim.) Similar Unit (13'-9"U-Dim.)Similar Unit	1 1
MV/I Trans.	25	8236	Similar Unit	3
Pressure Gauge	26	8301	Similar Unit	3
Pressure Trans.	13	8311	Similar Unit	1
ΔP Transmitter	15	8312	Similar Unit	2
Press. Switch	3	8331	Similar Unit	1

2.0 OPERATING DATA

2.6 Maintenance Supply Requirements

2.6.3 Recommended Major Spare Parts

b. Instrumentation (continued)

ITEM	QUANTITY IN USE	SPEC. SP-	DESCRIPTION	REQ'D. SPARES
Level Gauge	12	8400	Similar Unit	1
Rotameter	16	8405	Similar Unit	2
Restricting Orifice	5	8420	Similar Unit	1
Annubar	10	8424	(6") Similar Unit	1
Annubar	5	8424	(14") Similar Unit	1
Level Transmitter Displ.	6	8522	Similar Unit	1
Level Transmitter Capacitance	6	8527	Similar Unit	1
Switch Ball Float	6	8540	Similar Unit	1
Level Switch Capacitance	15	8542	Similar Unit	2
Butterfly Control Valve	5	8610	12" Carb. Steel	1
Butterfly Control Valve	5	8610	14" Carb. Steel	1
Butterfly Control Valve	5	8610	16" Carb.Steel	1
Butterfly Control Valve	10	8610	16" Stain.Steel	1
Butterfly Control Valve	1	8610	18" Carbon Steel	1

2.0 OPERATING DATA

2.6 Maintenance Supply Requirements

2.6.3 Recommended Major Spare Parts

b. Instrumentation (continued)

ITEM	QUANTITY IN USE	SPEC. SP-	DESCRIPTION	REQ'D. SPARES
Butterfly Control Valve	1	8610	30" Carbon Steel	1
Butterfly Control Valve	5	8610	30" Stain. Steel	1
Globe Control Valve	5	8612	1" Carbon Steel	1
Globe Control Valve	5	8612	2" Carbon Steel	1
Globe Control Valve	1	8612	3" Carbon Steel	1
Globe Control Valve	5	8612	6" Carbon Steel	1
Plug Valve	10	8616	Similar Unit	1
3-Port Ctl. Valve	1	8620	Similar Unit	1
Press. Regulator	1	8660	2" Nat. Gas	1
Press. Regulator	3	8660	1" Nat.Gas	1
Press. Regulator	2	8660	2" Inert Gas	1
Press. Regulator	5	8660	1" Inert Gas	1
Safety Relief Valve	5	8710	13200 lb/hr 30 psig ASME Sec. 1	1
Safety Relief Valve	5	8710	20104 lb/hr 135psig ASME Sec. 8	1

2.0 OPERATING DATA

2.6 Maintenance Supply Requirements

2.6.3 Recommended Major Spare Parts

b. Instrumentation (continued)

ITEM	QUANTITY IN USE	SPEC. SP-	DESCRIPTION	REQ'D. SPARES
Safety Relief Valve	1	3710	20,104 lb/hr 135psig ASME Sec. 1	1
Programmable Controller	1	8800	Input Modules	10
			Output Modules	10
Weigh System	5	8820		1

c. Other

Spare parts requirements for other items of equipment should be consistent with established preventative maintenance policies of Erie Mining Company.

27

2.0 OPERATING DATA (continued)

2.7 List of Prices for Laboratory Equipment Required to Monitor Plant Performance

2.7.1 Process Streams to be Tested

The process streams within the battery limits of BCI design which require test equipment to monitor unit performance are as follows:

a. Coal
b. Ash and Dust
c. Tar and Oil
d. Fuel Gas (Cooled Gas)
e. Boiler Blowdown, Feedwater Steam Condensate
f. Aqueous Effluent

2.7.2 Test Methods

Test methods used to monitor unit performance are derived from these sources:

a. Coal, Ash, Dust and Fuel Gas

"Annual Book of ASTM Standards"
American Society for Testing and Materials
Volume 26, 1976

b. Tar and Oil

"Annual Book of ASTM Standards"
American Society for Testing and Materials,
Volume 23, 24 and 25, 1976.

c. Boiler Blowdown, Boiler Feedwater, Steam Concepts and Aqueous Effluent

"Standard Methods for the Examination of Water and Wastewater"
American Public Health Association, 13th Edition.

2.7.3 Monitoring Philosophy

The contract phrase "Equipment . . . to monitor

2.0 OPERATING DATA (continued)

2.7 List of Prices for Laboratory Equipment Required to Monitor Plant Performance (continued)

2.7.3 Monitoring Philosophy (continued)

. . . . performance" permits a range of interpretation. The level of monitoring required will vary with the age of the plant and presence or absence of upset conditions. The individuals and organizations involved in this project will perceive different monitoring requirements based on their needs and preferences. Finally, the need for equipment depends heavily on how many tests are performed in other labs on a fee basis.

It appears that the most useful presentation is to give two lists reflecting maximum and minimum needs as defined below. This permits the choice of either list by those who will operate the plant. These lists are based on well defined and published methods so that equipment can be added or subtracted on a rational basis. The use of these methods to select equipment also has several advantages in related areas outside BCI scope, as follows:

a. Specification of equipment in terms understandable to vendors is facilitated.

b. Laboratory layout is facilitated.

c. Requirements for non-equipment items, such as reagents and supplies is defined.

d. The knowledge and skills which must be acquired by lab technicians is defined.

e. Test results will be generally recognized.

2.7.4 Maximum Equipment Requirements

This is the equipment required when:

a. All Tests are performed on-site.

b. Test results, along with process instrumentation,

2.0 OPERATING DATA (continued)

2.7 List of Prices for Laboratory Equipment Required to Monitor Plant Performance (continued)

2.7.4 Maximum Equipment Requirements (continued)

permit accurate material and energy balances over the gasification unit.

c. The composition and physical character of streams entering and leaving the unit are determined.

2.7.5 Minimum Equipment Requirements

This is the equipment required when:

a. All possible tests are performed by other labs off-site.

b. On-site lab tests are used chiefly to confirm normal operation and occasionally to diagnose upset conditions.

2.7.6 Tabulated Information

a. Thirteen tables are attached to this report, as listed below and on the following page.

b. Each pair of tables (1,2; 3,4; etc.) list information for one of the six streams to be tested.

c. Odd numbered tables (except Table 13) list the ASTM or SM Tests for a given stream.

d. Even numbered tables list test equipment for a given stream.

e. Prices are listed in Table 13.

LIST OF TABLES

2.0 OPERATING DATA (continued)

2.7 List of Prices for Laboratory Equipment Required to Monitor Plant Performance (continued)

2.7.6 Tabulated Information (continued)

LIST OF TABLES
(continued)

TABLE 1

COAL TEST METHODS

ASIM NUMBER	NAME	REQUIRED FOR: (A) MAX.	MIN.
D409	Test for Grindability of coal by the Hargrove Machine Method	X	
D410	Sieve Analysis of Coal	X	X
D720	Test for Free Swelling Index of Coal	X	
D2013	Preparing Coal Samples for Analysis	X	X
D2361	Test for Chlorine in Coal	X	
D3173	Test for Moisture in the Analysis Sample of Coal and Coke	X	X
D3174	Test for Ash in the Analysis Sample of Coal and Coke	X	
D3175	Test for Volatile Matter in the Analysis Sample of Coal and Coke	X	
D3177	Test for Total Sulfur in the Analysis Sample for Coal and Coke	X	
D3178	Test for Carbon and Hydrogen in the Analysis Sample for Coal and Coke	X	
D3179	Test for Nitrogen in the Analysis Sample for Coal and Coke	X	
D3286	Test for Gross Calorific Value of Solid Fuel by the Iso-Thermal Jacketed Bomb Calorimeter	X	

(A) See text Sections 2.7.4 and 2.7.5

TABLE 2

EQUIPMENT FOR COAL TESTS

ITEM	NO. REQUIRED (A) MAX.	MIN.	DESCRIPTION/ASTM METHOD
1	1	1	Analytical Balance. Sensitivity 0.1 mg, Capacity 1000g/ D409, D720, D2013, D2361
2	1	0	Balance.Sensitivity 1g, Capacity 1,500g/ D409
3	1	1	Sample divider per ASTM 2013/D409, D2013
4	1	1	Set of sieves, , 8" diameter, conform to ASTM E-11 and ASTM 409 as follows: 5/8", No.'s 4,8,16,20,30,50,100, 200/D409, D410, D2013
5	1	0	Laboratory Crusher/D409
6	1	1	Mechanical Sieving Machine for 8" Circular sieves/D409
7	1	0	Grindability Machine, per ASTM D409/D409
8	1	1	Set of Round Hole Screens per ASTM D410 and E-323. 12 screens as follows: 8", 6", 4", 3" 2-1/2", 2", 1-1/2", 1-1/4", 1", 3/4", 1/2", 3/8"/D410
9	6	0	Crucible, translucent silica, low form, with one (1) pierced and one (1) unpierced lid per ASTM D720/D720
10	1	0	Sight tube, per ASTM D-720/D720
11	1	0	Thermocouple and potentiometer, per ASTM D720/D720
12	1	0	Weight, 500g./D720
13	1	0	Furnace, conforming to ASTM D720 and including: chimney, crucible support, rheostat, A-C Ammeter and two (2) timers/D720
14	1	0	Air Drying Oven. One (1) to four (4) air changes per hour, max 40°C, per ASTM D2013 capacity 100lbs/D2013

TABLE 2 (continued)

EQUIPMENT FOR COAL TESTS

ITEM	NO. REQUIRED (A) MAX.	MIN.	DESCRIPTION/ASTM METHOD
15	10	0	Drying pans per ASTM D2013/D2013
16	1	0	Scale. Sensitivity 0.05lb., capacity 100lb/D2013
17	1	1	Laboratory Crusher for reduction of 3" lumps/D2013
18	1	1	Pulverizer to reduce samples to minus 60 mesh/D2013
19	1	1	Backing Board per ASTM D2013/D2013
20	1	1	Feed Scoop per ASTM D2013/D2013
21	1	1	Feed Chute per ASTM D2013/D2013
22	1	1	Mixing Wheel per ASTM D2013/D2013
23	10	10	Laboratory Sample containers per ASTM D2013/D2013
24	1	0	Bomb Calorimeter for ASTM D2361/D2361
25	1	0	Eschka Combustion Apparatus for ASTM D2361/2361
26	1	0	Apparatus for Potiometric Titration per ASTM D2361/D2361
27	1	1	Drying oven, 110°C, per ASTM D3173/D3713
28	25	25	Capsules with covers, per ASTM D3173/D3173
29	1	0	Electric Muffle Furnace, 700-750°C/D3174
30	10	0	Porcelain capsules per ASTM D3174/D3174
31	5	0	Platinum Crucible with cover per ASTM D3175/D3175
32	1	0	Electric Muffle Furnace, 950°C/D3175

TABLE 2 (continued)

EQUIPMENT FOR COAL TESTS

ITEM	NO. REQUIRED (A) MAX.	MIN.	DESCRIPTION/ASTM METHOD
33	1	0	Apparatus for Determinization of Sulfur in Coal per ASTM D3177. Note: Available as package with Microprocessor /D3177
34	1	0	Oxygen purifying train per ASTM D3178/ D3178
35	1	0	Flowmeter. 50-100ml/min./D3178
36	1	0	Combustion unit per ASTM D3178/D3178
37	1	0	Adsorption train per D3178/D3178
38	6	0	Kjeldahl Digestion Apparatus /D3679
39	6	0	Kjeldahl Distillation Unit with Condenser /D3179
40	6	0	Kjeldahl flask, pyrex 300ml /D3179
41	6	0	Kjeldahl connecting bolt per ASTM D3179/ D3179
42	12	0	Erlenmeyer Flask, 300ml /D3179
43	1	0	Calorimeter for ASTM D3286 including: bomb, calorimeter, jacket, thermometers, sample crucibles, accessories and microprocessor controls /D3286

(A) See Text - Sections 2.7.4 and 2.7.5

TABLE 3

TEST METHODS FOR ASH AND DUST

ASIM NUMBER	NAME	REQUIRED FOR: (A) MAX.	MIN.
D2795	Analysis of Coal and Coke Ash	X	
D1857	Test for the Fusibility of Coal and Coke Ash	X	

BCI Contract 3001

(A) See text Sections 2.7.4 and 2.7.5

TABLE 4

EQUIPMENT FOR ASH AND DUST TESTS

ITEM	NO. REQUIRED (A) MAX.	MIN.	DESCRIPTION/ASTM METHOD
1	(B)	0	Analytical Balance / D3795
2	6	0	Nickel crucibles, 50cc/D3795
3	(B)	0	Platinum crucibles/D3795
4	1	0	Emission Flame Photometer/D3795
5	(B)	0	Muffle Furnace, 75°C /D3795
6	1	0	Absorption Spectophotometer, 380-780mm/ D3795
7	1	0	Furnace, per ASTM D1857/D1875
8	1	0	Cone Mold, per ASTM D1857 3/4" high by 1/2" wide/ D1857
9	1	0	Optical Pyrometer per ASTM D1857/D1857
10	1	0	Ash Cone Refractory support/D1857
11	1	0	Refractory Support Mold /D1875
12	(C)	0	Gold wire per ASTM D1875/D1875
13	(C)	0	Nickel wire per ASTM D1875/D1875

(A) See text - Sections 2.7.4 and 2.7.5 for definition of maximum and minimum.
(B) Duplicate Coal Apparatus.
(c) Supply items, as required.

TABLE 5

TEST METHODS FOR TAR AND OIL

ASIM NUMBER	NAME	REQUIRED FOR: (A) MAX.	MIN.
D240	Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter	X	
D287	API Gravity of Crude Petroleum and Petroleum Products	X	X
D445	Kinematic Viscosity of Transparent and Opague Liquids	X	
D1744	Water in Liquid Petroleum Products by Karl Fischer Reagent	X	X

(A) See text Sections 2.7.4 and 2.7.5

TABLE 6

EQUIPMENT FOR TAR AND OIL TESTS

ITEM	NO. REQUIRED (A) MAX.	MIN.	DESCRIPTION/ASTM METHOD
1	1	1	Set of Hydrometers per ASTM E100 and D287/D287
2	1	0	Thermometers, -5 to 215°F, per ASTM D287 E-1/D287
3	1	1	Set of Hydrometer Cylinders per ASTM D287/D287
4	1	0	Calorimeter per ASTM D240/D240
5	1	1	Equipment for Fisher Titration, conforming to ASTM D1744/D1744
6	1	0	Viscometers, Viscometer holders, thermometers firing device and both conforming to ASTM D445/D445

(A) See text - Sections 2.7.4 and 2.7.5

TABLE 7

TEST METHODS FOR FUEL GAS

ASTM NUMBER	NAME	REQUIRED FOR (A) MAX.	MIN.
D1072	Total Sulfur in Fuel Gases		X
D1136	Analysis of Natural Gases by the Volumeric - Chemical Method		X
D1137	Chemical Composition of Natural Gases by Mass Spectrometer	X	
D1247	Sampling Manufactured Gas	X	X
D1826	Calorific Value of Gases in the Natural Gas Range by Continuous Recording Calorimeter	X	
D1946	Analysis of Reformed Gas by Gas Chromatography	X	

(A) See text Sections 2.7.4 and 2.7.5

TABLE 8

EQUIPMENT FOR FUEL GAS TESTS

ITEM	NO. REQUIRED (A) MAX.	MIN.	DESCRIPTION/ASTM METHOD
1	0	1	Burner per ASTM D1072/D1072
2	0	3	Chimneys, adsorbers and spray trays per ASTM D1072/D1072
3	0	1	Flowmeter per D1072/D1072
4	0	1	Air Purifying System per D1072/D1072
5	0	1	Manometer per D1072/D1072
6	0	1	Conventional Volumetric gas apparatus suitable for ASTM D1136/D1136
7	1	0	Mass Spectrometer per ASTM D1137/D1137
8	1	0	Gas Chromotagraph per D1946/D1946
9	1	0	Calorimeter per ASTM D1826 and consisting of two principal parts: a) Calorimeter proper; b) Recording device / D1826
10	4	4	Sample containers per ASTM D1247/D1247

(A) See text - Sections 2.7.4 and 2.7.5

TABLE 9

TEST METHODS FOR BOILER BLOWDOWN, BOILER FEEDWATER, AND STEAM CONDENSATE

STANDARD METHOD	NAME	REQUIRED FOR (A) MAX.	MIN.
201	Alkalinity	X	X
203A	Chlorides	X	X
122B	Hardness	X	X
218	Dissolved Oxygen	X	X
221	pH	X	X
223	Phosphate (ortho and poly)	X	X
224	Total Dissolved Solids	X	X
225	Conductivity	X	X
223	Sulfite	X	X

(A) See text Sections 2.7.4 and 2.7.5

TABLE 10

EQUIPMENT FOR BOILER BLOWDOWN, BOILER FEEDWATER AND STEAM CONDENSATE TESTS (B)

ITEM	NO. REQUIRED MAX.	MIN.	DESCRIPTION/ STANDARD METHOD
1	1	1	Lamp with daylight fluorescent bulb/SM201
2	1	1	Electrically operated titrator/SM201
3	1	1	Dissolved oxygen meter/SM218F
4	1	1	pH Meter/SM221
5	(C)	(C)	Analytical Balances/General Use
6	1	1	Autoclave, 15-20 psig/SM 223
7	0	1	Filter Photometer/SM223
8	1	1	Filter per SM148A2/SM224
9	1	1	Steam Bath/SM22
10	10	10	Evaporating Dish/SM224
11	1	1	Drying oven 100-105° C/SM224
12	1	1	Conductivity Meter/SM226
13	1	0	Spectophotometer/SM223

(A) See text Sections 2.7.4 and 2.7.5

(B) Common laboratory beakers, flaskets, burets, etc. are required for these tests.

(C) One analytical balance for water, coal, etc.

TABLE 11

TEST METHODS FOR AQUEOUS EFFLUENT

STANDARD METHOD	NAME	REQUIRED FOR (A) MAX.	REQUIRED FOR (A) MIN.
212	Ammonia (Ref. 132A & C)	X	
203A	Chloride (do not use 203C)	X	
207	Cyanide	X	X
221	pH	X	X
222	Phenol	X	
228	Sulfide	X	
(B)	Thiocyanate	X	
138	TOC	X	X
224	Total Solids	X	X

(B) Tentative ASTM Method. Requires no additional equipment.

(A) See text Sections 2.7.4 and 2.7.5

TABLE 12

EQUIPMENT FOR AQUEOUS EFFLUENT TESTS

ITEM	NO. REQUIRED (A) MAX.	MIN.	NAME/STANDARD METHOD
1	1	0	Distillation Apparatus per SM132A2a consisting of distillation flask and condenser/SM212
2	(B)	0	Spectophotometer/SM212, SM222
3	1	0	Magnetic Stirrer/SM212
4	1	1	Cyanide distillation Apparatus per SM207A2 /SM207
5	1	1	Koch Microburet, 5ml/SM207B
6	6	6	Soxhet Extractor/SM209
7	6	6	Vacuum Aspirator/SM209
8	3	3	Buchner Funnels, 12cm, 15cm/SM209, SM222
9	3	3	Electric Heating Mantle for Soxheat Extractor/SM209
10	(B)	(B)	pH meter/SM221, SM222
11	(B)	(B)	Analytic Balance/General use
12	3	0	Separatory funnel,1000 ml/SM222
13	1 set	0	Nessler Tubes, matched, 50ml, tall form/SM222
14	1	0	Reaction flask, 1 liter per SM228/SM228
15	2	0	Adsorption flasks, Erlenmeyer, 250 ml SM228
16	1	1	Apparatus for TOC per SM138A/SM138
17	(B)	(B)	Apparatus for total solids per SM224/ SM224
18	0	(B)	Photometer/SM222

(A) See text, Sections 2.7.4 and 2.7.5
(B) Duplicates Equipment listed in Table 10
(C) Common laboratory beakers, flasks, burets etc. required for these tests.

TABLE 13

LABORATORY EQUIPMENT COSTS FOR PROCESS STREAM TESTING

ITEM	PROCESS STREAM	EQUIPMENT COSTS (A) MAXIMUM	MINIMUM
a.	Coal	$46,650.	$ 5,100.
b.	Ash and Dust	8,150.	0
c.	Tar and Oil	6,200.	3,500.
d.	Fuel Gas (Cooled Gas)	150,000.	4,000.
e.	Boiler Blowdown, Boiler Feedwater, and Steam Condensate	5,700.	5,700.
f.	Aqueous Effluent	2,100.	1,800.
	TOTAL	$218,800.	$20,100.

(A) See text Section 2.7.4 and 2.7.5

3.0

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 3.0 - EQUIPMENT LIST AND SPECIFICATIONS

3.1 Equipment List
3.2 Equipment Specifications (Process)
3.3 Equipment Specifications (Mechanical)
3.4 Piping Material Specifications
3.5 Instrumentation Specifications

DOE Contract ET-78-C-01-2578
McKee Contract 2814A/W2
BCI Contract 3001

3.1

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

3.1 EQUIPMENT LIST

Sheet No.	Description
1	Coal Surge Hopper
2	Lock Hopper
3	Gasifier
4	Combustion Air Blower
5	Ash Handling System
6	Tar Cyclone
7	Dust Cyclone
8	Tar Precipitator
9	Process Gas Cooler
10	Combined Gas Cooler
11	Void
12	Cyclone Ash Disposal
13	Tar Tank
14	Tar Transfer Pump
15	Oil/Condensate Separation System
16	Coal Feeder
17	Oil Precipitator
18	Ash Grate Hydraulic System
19	Ash Grate Lube System
20	Stirrer
21	Flare Stack
22	Chemical Collection System
23	Flash Tank
24	Lock Hopper Lube System

PROJECT TITLE: COAL GASIFICATION-DEMO.
CLIENT: McKEE E. & C.
PROJECT NO.: 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

Coal Surge Hopper

SHEET 1 OF 34
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQ'D.	TITLE	PROCESS SPEC. NO.	PROCESS SPEC. REV.	PROCESS SPEC. DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
BN201 A ✓		1	Coal Surge Hopper	BN201AH	1	11/29/7[illegible]								—	4814-X-02-02-2	66T Capacity Each - Internal
BN 201 B		1	Coal Surge Hopper											—		Surfaces Lined with Poly-Hi, Inc.
BN 201 C		1	Coal Surge Hopper											—		"TIVAR-88 Mine Plate for
BN 201 D		1	Coal Surge Hopper											—		Abrasion Resistance & Non-Spark-
BN 201 E		1	Coal Surge Hopper											—		ing Characteristics - Area
BN 201 F		1	Coal Surge Hopper											—		Hazard Classification - Class II
																Div I Group F
		6	Slide Gate											—		Manually Operated

PROJECT TITLE:	COAL GASIFICATION-DEMO.
CLIENT:	McKEE E. & C.
PROJECT NO.:	4814
B.C.I. PROJ. NO.:	3001

EQUIPMENT LIST

Lock Hopper (Batch Feeder)

SHEET 2 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
MF 201 A		1	Lock Hopper	MF201	1	11/29/78	-5		Reynolds Mfg Co.					—	4814-X-02-03-2	Area Hazard Classification -
MF 201 B		1	Lock Hopper	A/E										—		Class I Div II Group D
MF 201 C		1	Lock Hopper											—		
MF 201 D		1	Lock Hopper											—		
MF 201 E		1	Lock Hopper											—		
MF 201 F		-	(Future)											—		
	Instr.	5	Vent Plug Valve											—		
	Instr.	5	Entry Plug Valve											—		
	Instr.	5	Exit Plug Valve											—		
	Instr	5	Load Cell Assembly											Instrument		
		5	Expansion Joint												4814-Y-02-10-2	
X 203		1	Lube System	X203	0	9/5/78										

PROJECT TITLE : COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO. : 3001

EQUIPMENT LIST

GASIFIER (REACTOR)

SHEET 3 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 1/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	PROCESS SPEC. REV.	PROCESS SPEC. DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
R 201 A ✓		1	GASIFIER	R201A/E	1	11/29/78								—	4814-X-02-04-2	Area Hazard Classification –
R 201 B		1	GASIFIER											—	"	Class I Div II Group D
R 201 C		1	GASIFIER											—	"	
R 201 D		1	GASIFIER											—	"	
R 201 E		1	GASIFIER											—	"	
R 201 F		-	(FUTURE)											—	"	
	CE-1/5	5	COAL ENTRY SHELL				11		CAPITAL CITY IRON WORKS					—		
	CD-1/5	5	COAL DISTRIBUTOR				11		CAPITAL CITY IRON WORKS					—		
	RS-1/5	5	REACTOR SHELL				11		CAPITAL CITY IRON WORKS					—		
	WT-1/5	5	WATER TUBE SECTION				16		R. MUNROE & SONS MFG CORP.					—		
	SR-1/4	4	SHAPED REFRACTORY				1		BIGELOW-LIPTAK CORP.					—		
	AG-1/5	5	ASH GRATE ASSEMBLY				7		SOMERSET FNDRY & MACH CO					—		
	CF-1	1	CASTABLE REFRACTORY				8		HARBISON-WALKER REF.					—		
	RP	120	RODDING PORT ASSEMBLY				2		MACHINE & WELD SPECIALISTS	INC				—		
	BI-1/5	5	BLAST INLET ASSEMBLY				11		CAPITAL CITY IRON WORKS					—		
D 201 A ✓		1	L.P. STEAM DRUM	D201A/E	0	11/29/78	16		R. MUNROE & SONS MFG CORP					—	4814-X-02-04-2	
D 201 B		1	L.P. STEAM DRUM				16		"					—	"	
D 201 C		1	L.P. STEAM DRUM				16		"					—	"	
D 201 D		1	L.P. STEAM DRUM				16		"					—	"	
D 201 E		1	L.P. STEAM DRUM				16		"					—	"	
D 201 F		-	(FUTURE)				-		—					—	"	

PROJECT TITLE : COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

Combustion Air Blower

SHEET 4 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQ'D.	TITLE	PROCESS SPEC. NO.	REV.	DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APP'D.	APP'D.	CERT.	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
B 201 A		1	Comb. Air Blower	B201 A/C	1	11/29/78	12		Davidson Fan					—	4814-X-02-06-3	Area Hazard Classification –
B 201 B		1	Comb. Air Blower											—	"	Class I Div II Group D
B 201 C		1	Comb. Air Blower											—	"	
BM201 A		1	Comb. Air Blwr Drive	—			12		Davidson Fan					300/3600	4814-N-02-01-2	4160V/3φ/60 Hz
BM201 B		1	Comb. Air Blwr Drive	—										300/3600	"	" " "
BM201 C		1	Comb. Air Blwr Drive	—										300/3600	"	" " "
		1	Inlet Silencer				12		Davidson Fan					—		
		3	Flexible Connector				12		Davidson Fan					—		
		3	Vibration Isolator											—		
		3	Manual B/F Valve											—		
		3	Discharge Silencer				12		Davidson Fan					—		
		1	Blow Off Silencer				12		Davidson Fan					—		

PROJECT TITLE: COAL GASIFICATION–DEMO.
CLIENT: McKEE E. & C.
PROJECT NO.: 4814
B.C.I. PROJ. NO.: 3001

SHEET 5 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

EQUIPMENT LIST

Ash Handling System (Bottom Ash)

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQ'D.	TITLE	PROCESS SPEC. NO.	PROCESS SPEC. REV.	PROCESS SPEC. DATE	RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APP'D.	APP'D.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
Co 201 A		1	Drag Link Conveyor	X205	0	9/29/78	–		Allen Sherman Hoff					—	4814-X-02-06-2	Area Hazard Classification - Class I Div II Group D
Co 202 A		1	Drag Link Conveyor											—	4814-X-02-06-2	
Co 203		1	Drag Link Conveyor											—	4814-X-02-06-2	
Co 204		1	Bucket Elevator											—		
B 202		1	Ash Cooling Blower				–		Allen Sherman Hoff					—	4814-X-02-06-2	
B 203 A		1	Aeration Blower											—	4814-X-02-06-2	
B 203 B		1	Aeration Blower											—	4814-X-02-06-2	
MF 203 A		1	Ash Lock Assembly				–		Allen Sherman Hoff					—	Shown on 4814-X-02-07-2 Not Labeled	Two (2) Req'd per Gasifier
MF 203 B		1	Ash Lock Assembly											—		
MF 203 C		1	Ash Lock Assembly											—		
MF 203 D		1	Ash Lock Assembly											—		
MF 203 E		1	Ash Lock Assembly											—		
MF 203 F		1	Ash Lock Assembly											—		
MF 203 G		1	Ash Lock Assembly											—		
MF 203 H		1	Ash Lock Assembly											—		
MF 203 J		1	Ash Lock Assembly											—		
MF 203 K		1	Ash Lock Assembly											—		
CoM 201 A		1	Conveyor Drive Motor				–		Allen Sherman Hoff					7½/1800	4814-N-02-03-2	
CoM 202 A		1	Conveyor Drive Motor											7½/1800	4814-N-02-03-2	
CoM 203		1	Conveyor Drive Motor											7½/1800	4814-N-02-03-2	
CoM 204		1	Elevator Drive Motor											5/1800	4814-N-02-03-2	
BM 202		1	Cooling Blower Motor				–		Allen Sherman Hoff					5/1800	4814-N-02-03-2	
BM 203 A		1	Aeration Blwr Motor											10/1800	4814-N-02-03-2	
BM 203 B		1	Aeration Blwr Motor											10/1800	4814-N-02-03-2	
		1	Aer Pad Blwr Htrs											35 KW	4814-N-02-03-2	
		10	24" Cyl Op Slide Gate													One (1) Req'd per Ash Lock Assy
		20	12" Cyl Op Slide Gate													Two (2) " " " "
		120	Aeration Pads													Twelve (12) " " " "

PROJECT TITLE : COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

SHEET 6 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

EQUIPMENT LIST

TAR CYCLONE (TOP GAS)

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
CY 202 A		1	TAR CYCLONE	CY202 A/E	0	6/8/78	20							—	4814-X-02-03-2	Area Hazard Classification -
CY 202 B		1	TAR CYCLONE											—		Class I Div II Group D
CY 202 C		1	TAR CYCLONE											—		
CY 202 D		1	TAR CYCLONE											—		
CY 202 E		1	TAR CYCLONE											—		
CY 202 F		–	(FUTURE)											—		

PROJECT TITLE: COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

SHEET 7 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

EQUIPMENT LIST

Dust Cyclone (Bottom Gas Cleanup)

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
CY 201 A		1	Dust Cyclone	CY 201 A/E	0	6/8/78	10		Fluotherm Company					—	4814-X-02-03-2	Area Hazard Classification - Class I Div II Group D
CY 201 B		1	Dust Cyclone											—		
CY 201 C		1	Dust Cyclone											—		
CY 201 D		1	Dust Cyclone											—		
CY 201 E		1	Dust Cyclone											—		
CY 201 F		-	(Future)											—		

PROJECT TITLE : COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

SHEET 8 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

EQUIPMENT LIST

TAR PRECIPITATOR (ELECTROSTATIC)

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
X 201 A		1	TAR PRECIPITATOR	X201 A/C	0	6/9/78	4		RESEARCH-COTTRELL					—	4814-X-02-09-2	Area Hazard Classification -
X 201 B		1	TAR PRECIPITATOR											—		Class I Div II Group D
X 201 C		1	TAR PRECIPITATOR											—		
Power Reqmts (Each Unit)																
			Precipitator - Discharge Electrodes						RESEARCH-COTTRELL					45 KW	4814-N-02-02-2	
			Insulator Heaters													
			Pothead Heaters													
			Low Voltage Supply											460V/3φ/60Hz		
			Transformer/Rectifier Room												4814-X-02-09-2	

PROJECT TITLE: COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

Process Gas Cooler

SHEET 9 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
E 201 A		1	Process Gas Cooler	E201A/E	1	11/29/78	19		Deltak					—	4814-x-02-03-2	Area Hazard Classification –
E 201 B		1	Process Gas Cooler											—		Class I Div II Group D
E 201 C		1	Process Gas Cooler											—		
E 201 D		1	Process Gas Cooler											—		
E 201 E		1	Process Gas Cooler											—		
E 201 F		-	(Future)						—					—		
D 202 A		1	H.P. Steam Drum	D 202 A	1	11/29/78	19		Deltak					—	4814-x-02-02-2	
			SYSTEM	X1204A	1	11/29/78										

PROJECT TITLE: COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

Combined Gas Cooler

SHEET 10 OF 34
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	PROCESS SPEC. REV.	PROCESS SPEC. DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
E 202 A		1	Combined Gas Cooler	E202 A/C	1	1/29/78	9							—	4814-X-02-09-2	Area Hazard Classification -
E 202 B		1	Combined Gas Cooler											—		Class I Div II Group D
E 202 C		1	Combined Gas Cooler											—		

PROJECT TITLE: COAL GASIFICATION-DEMO.
CLIENT: McKEE E. & C.
PROJECT NO.: 4814
B.C.I. PROJ. NO.: 3001

SHEET 11 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

EQUIPMENT LIST

ASH STORAGE SYSTEM (BOTTOM ASH)

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
~~BN 202~~		1	~~ASH STORAGE SILO~~				—		~~ALLEN SHERMAN HOFF~~					—		Area Hazard Classification - Class I Div II Group D
~~MF 204~~		1	~~ASH GRINDER~~						~~ALLEN-SHERMAN-HOFF~~					—		DELETE
~~MF 205~~		1	~~SILO ROTARY FEEDER~~											—		DELETE
~~MF 206~~		1	~~CONTINUOUS LOADER~~											—		DELETE
~~MFM 204~~		1	~~ASH GRINDER DRIVE~~						~~ALLEN SHERMAN HOFF~~					~~10/1800~~		DELETE
~~MFM 205~~		1	~~SILO FEEDER DRIVE~~											~~5/1800~~		DELETE
~~MFM 206~~		1	~~CONT. LOADER DRIVE~~											~~5/1800~~		DELETE
		~~2~~	~~FLEXIBLE CONNECTORS~~						~~ALLEN-SHERMAN-HOFF~~					—		DELETE
		~~1~~	~~BIN VENT FILTER~~											—		DELETE

NOTE:

DELETE: ITEM WILL BE FURNISHED BY OTHERS

PROJECT TITLE: COAL GASIFICATION—DEMO.
CLIENT: McKEE E. & C.
PROJECT NO.: 4314
B.C.I. PROJ. NO.: 3001

SHEET 12 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

EQUIPMENT LIST

Cyclone Ash Disposal System

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQ'D	TITLE	PROCESS SPEC. NO.	REV.	DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
BN 203 A		1	Dust Bin				—		Allen-Sherman-Hoff					—	4814-X-02-06-2	Area Hazard Classification –
BN 203 B		1	Dust Bin											—		Class I Div II Group D
BN 203 C		1	Dust Bin											—		
MF 207 A		1	Dust Rotary Feeder						Allen-Sherman-Hoff					—	Not Shown	
MF 207 B		1	Dust Rotary Feeder											—		
MF 207 C		1	Dust Rotary Feeder											—		
MF 207 D		1	Dust Rotary Feeder											—		
MF 207 E		1	Dust Rotary Feeder											—		
MF 207 F		–	(Future)											—		
P 206 A		1	Hydro-Ejector Pump						Allen-Sherman-Hoff					—		
P 206 B		1	Hydro-Ejector Pump											—		
MFM 207 A		1	Rotary Feeder Drive						Allen-Sherman-Hoff					1/2/1800	Not Shown	
MFM 207 B		1	Rotary Feeder Drive											1/2/1800		
MFM 207 C		1	Rotary Feeder Drive											1/2/1800		
MFM 207 D		1	Rotary Feeder Drive											1/2/1800		
MFM 208 E		1	Rotary Feeder Drive											1/2/1800		
MFM 207 F		–	(Future Drive)											—		
PM 206 A		1	Ejector Pump Drive						Allen-Sherman-Hoff					100/1800	4814-N-02-03-2	
PM 206 B		1	Ejector Pump Drive											100/1800		
		3	Hydro-Ejectors						Allen-Sherman-Hoff						Not Shown	
		3	Diaphram Cont. Vlve													
		3	Cyl Op Cont. Vlve													
		2	Manual S/O Vlve													
		1	Check Valve													
		Lot	Ashcolite Pipe & Ftgs													

PROJECT TITLE: COAL GASIFICATION–DEMO.
CLIENT: McKEE E. & C.
PROJECT NO.: 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

TAR TANK

SHEET 13 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	PROCESS SPEC. REV.	PROCESS SPEC. DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
TK 202	✓	1	TAR TANK	TK 202	1	8/18/78	15		MODERN WELDING Co.					—	4814-X-02-09-2	Area Hazard Classification – Class I Div II Group D

PROJECT TITLE: COAL GASIFICATION-DEMO.
CLIENT: McKEE E. & C.
PROJECT NO.: 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

TAR TRANSFER PUMPS

SHEET 14 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	RFQ	PO	EQUIPMENT PROCUREMENT VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
P 201 A		1	TAR TRANSFER PUMP	P 201 A/B	1	2/2/79	13		WEINMAN PUMP & SUPPLY CO.							Area Hazard Classification -
P 201 B		1	TAR TRANSFER PUMP						|							Class I Div II Group D
PM 201 A		1	TAR TRANS. PUMP DRIVE						WEINMAN PUMP & SUPPLY CO.					3/1800	4814-N-02-02-2	
PM 201 B		1	TAR TRANS. PUMP DRIVE						|				3/1800	|	

PROJECT TITLE: COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

Oil/Condensate Separation System

SHEET 15 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	RFQ	PO	EQUIPMENT PROCUREMENT VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
TK 201 A		1	Oil/Water Sep Tank	TK201A	0	8/18/78	–		AFL Industries Inc						4814-X-02-09-2	Area Hazard Classification – Class I Div II Group D
P 202 A		1	Aqueous Eff. Pump						AFL Industries Inc						Not Shown	
P 202 B		1	Aqueous Eff. Pump													
P 203 A		1	Oil Transfer Pump													
P 203 B		1	Oil Transfer Pump													
P 204 A		1	Sludge Pump													
PM202 A		1	Aq. Eff. Pump Drive						AFL Industries Inc					1/1800	4814-N-02-03-2	
PM202 B		1	Aq. Eff. Pump Drive											1/1800		
PM203 A		1	Oil Trans Pump Drive											1/1800		
PM203 B		1	Oil Trans Pump Drive											1/1800		
PM 204 A		1	Sludge Pump Drive											1½/1800		
		2	Immersion Heater											5 Kw (Ea)		
		1	Immersion Heater											2.5 Kw		

PROJECT TITLE : COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO. : 3001

EQUIPMENT LIST

COAL FEEDER

SHEET 16 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	PROCESS SPEC. REV.	PROCESS SPEC. DATE	RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
MF 202 A		1	COAL FEEDER	MF202A/E	0	8/22/78								—		Area Hazard Classification -
MF 202 B		1	COAL FEEDER											—		Class I Div II Group D
MF 202 C		1	COAL FEEDER											—		
MF 202 D		1	COAL FEEDER											—		
MF 202 E		1	COAL FEEDER											—		
MF 202 F		-	(FUTURE)											—		
MFM 202 A		1	COAL FEEDER DRIVE											2/1800		
MFM 202 B		1	COAL FEEDER DRIVE											2/1800		
MFM 202 C		1	COAL FEEDER DRIVE											2/1800		
MFM 202 D		1	COAL FEEDER DRIVE											2/1800		
MFM 202 E		1	COAL FEEDER DRIVE											2/1800		
MFM 202 F		-	(FUTURE)											—		

PROJECT TITLE: COAL GASIFICATION-DEMO.
CLIENT: McKEE E. & C.
PROJECT NO.: 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

Oil Precipitator (Electrostatic)

SHEET 17 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	RFQ	PO	EQUIPMENT PROCUREMENT VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
X202 A		1	Oil Precipitator	X202 A/C	0	6/9/78	3		Research-Cottrell					—	4814-X-02-09-2	Area Hazard Classification –
X 202 B		1	Oil Precipitator											—		Class I Div II Group D
X 202 C		1	Oil Precipitator											—		
Power Reqmts (Each Unit)																
			Precipitator - Discharge Electrodes						Research-Cottrell					45 KW		
			Insulator Heaters													
			Pothead Heaters													
			Low Voltage Supply											460V/3φ/60Hz		
			Transformer/Rectifier Room												4814-X-02-09-2	

PROJECT TITLE : COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO. : 3001

EQUIPMENT LIST

Ash Grate Drive (Hydraulic System)

SHEET 18 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
W 201		–	Hydraulic System				—		Miller Fluid Power					—	Not Shown	Area Hazard Classification – Class I Div II Group D
P 207A		1	Hydraulic Pump						Miller Fluid Power					—	Not Shown	
P 207B		1	Hydraulic Pump											—		
PM 207 A		1	Hyd. Pump Drive						Miller Fluid Power					40/1200	4814-N-02-02-2	
PM 207 B		1	Hyd. Pump Drive											40/1200		
		1	Relief Valve						Miller Fluid Power						Not Shown	
		2	Suction Filters													
		1	Return Filter													
		1	Pressure Gage & Cock													
		6	Directional Cont. Vlvs													
		6	Bolt Kit													
		6	Sequence Valve													
		4	Center Manifold													
		6	Throttle/Check Vlv													
		1	Front End Manifold													
		1	Rear End Manifold													
		1	Heat Exchanger													
		3	Check Valve													
		1	Shut-Off Valve													
		10	Cyls - 10" Bore & 8" Stroke													
		10	Rod Clevis & Pin													

PROJECT TITLE: COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

Ash Grate Lube System (Grease)

SHEET 19 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	RFQ	PO	EQUIPMENT PROCUREMENT VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
W 202 A		1	Grate Lube System				23		Eaton Corporation							Area Hazard Classification –
W 202 B		1	Grate Lube System													Class I Div II Group D
W 202 C		1	Grate Lube System													
W 202 D		1	Grate Lube System													Note! Two (2) Grate Lube
W 202 E		1	Grate Lube System													Systems required for
W 202 F		1	Grate Lube System													one (1) Gasifier
W 202 G		1	Grate Lube System													
W 202 H		1	Grate Lube System													
W 202 J		1	Grate Lube System													
W 202 K		1	Grate Lube System													
Each Grate Lube System Contains:—																
		1	Cam Operated Pump													
		2	Reservoir													
		1	Single Line Manifold													
		8	Rupture Disc Inicators													
		Lot	Tube, Clamps, & Fittings													

PROJECT TITLE: COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

STIRRER

SHEET 20 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
A 201 A		1	STIRRER						Babcock Contractors, Inc.					—	4814-X-02-03-2	Area Hazard Classification —
A 201 B		–	(FUTURE)											—		Class I Div II Group D
A 201 C		–	(FUTURE)											—		
A 201 D		–	(FUTURE)											—		
A 201 E		–	(FUTURE)											—		
A 201 F		–	(FUTURE)											—		
AM 201 A		1	STIRRER HYD. DRIVE						Babcock Contractors, Inc.					30/1200	4814-N-02-02-2	

NOTE!- STIRRER NOT COMPLETE

PROJECT TITLE: COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

FLARE STACK

SHEET 21 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
X 201 A		1	FLARE SYSTEM	X206A/C	0	6/9/78	18		JOHN ZINK COMPANY					—	4814-X-02-02-2	Area Hazard Classification -
X 201 B		1	FLARE SYSTEM											—		Unclassified
X 201 C		1	FLARE SYSTEM											—		

PROJECT TITLE : COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

Chemical Collection System

SHEET 22 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	REV.	DATE	RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
TK 205		1	Chemical Sump	P-205	1	2/2/79								—	Not Shown	Area Hazard Classification — Class I Div II Group D
P 205		1	Chemical Sump Pump	P-205	1	2/2/79								—	Not Shown	
PM 205		1	Chem Sump Pump Drive											2/1800	4814-N-02-03-2	

PROJECT TITLE : COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO.: 3001

EQUIPMENT LIST

FLASH TANK

SHEET 23 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	PROCESS SPEC. REV.	PROCESS SPEC. DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APPD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
TK 203 √		1	FLASH TANK	TK 203	1	8/18/78								—	NOT SHOWN	

PROJECT TITLE : COAL GASIFICATION-DEMO.
CLIENT : McKEE E. & C.
PROJECT NO. : 4814
B.C.I. PROJ. NO. : 3001

EQUIPMENT LIST

Lock Hopper Lube System

SHEET 24 OF 24
ISSUE
REVISION NO. 1
REVISION DATE 2/16/78

PROCESS EQUIP. NO.	AUX. EQUIP. NO.	REQD.	TITLE	PROCESS SPEC. NO.	PROCESS SPEC. REV.	PROCESS SPEC. DATE	EQUIPMENT PROCUREMENT RFQ	PO	VENDOR	VENDOR DWG. STATUS REC'D.	APFD.	APPD.	CERT	MOTOR LIST H.P. / R.P.M.	ARRANGEMENT DRAWING NO.	REMARKS
W 203 A		1	System Complete												Not Shown	

3.2

COAL GASIFICATION DEMONSTRATION PLANT

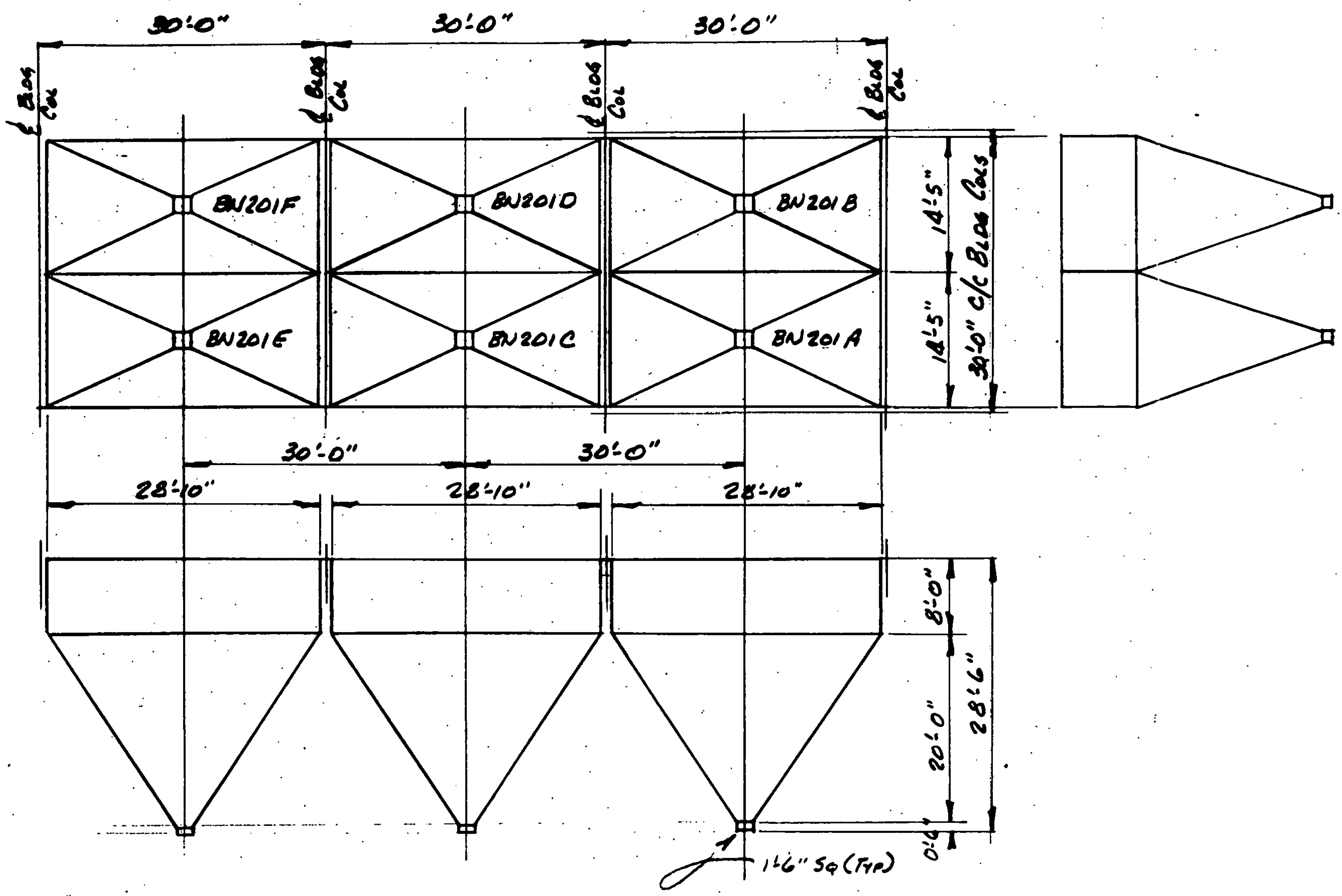
HOYT LAKES, MINNESOTA

SECTION 3.0 - EQUIPMENT LIST AND SPECIFICATIONS

3.2 Equipment Specifications (Process)

Process Specification for:	No.
Coal Surge Hopper	BN201 A/F
Lock Hopper	MF201A/E
Hydraulic System	X203
Reactor	R201A/E
L.P. Steam Drum	D201A/E
Air Supply to Gasifier Plant	B201A/C
Ash System	X205
Tar Cyclone	CY202A/E
Dust Cyclones	CY201A/E
Tar Precipitator	X201A/C
Exchanger	E201A/E
High Pressure Steam Drum	D202
Steam Drum and Process Gas Cooler Package	X204A
Exchanger	E202A/C
Tar Tank	TK202
Tar Transfer Pump	P201A/B
Oil/Water Separator	TK201A
Coal Feeder	MF202A/E
Oil Precipitator	X202A/C
Flare Stacks	X206A/C
Chemical Sump Pump	P205
Flash Tank	TK203

FORM M906



GENERAL NOTES

1. SPECIFICATIONS PER THE BILL OF MATERIAL.
2. THIS DRAWING IS A SCHEMATIC OUTLINE ONLY FOR ELEVATION & ORIENTATION OF ATTACHMENTS, REFER TO
3. FOR ESTIMATING PURPOSES, VESSEL FABRICATOR SHALL INCLUDE THE FOLLOWING CLIPS:
4. Capacity (each Bin) 66 Tons coal size range 1/2" thru 1-1/2" - Bulk density 50 lb/ft^3.
5. Bins shall be lined with non-sparking materials such as Poly-Hi, Inc. "Tivar-88" Mine Plate or approved equal.
6. Internal chute shall be provided in each Bin to minimize coal degradation.
7. One Bin required per gasifier (Six shown).
8. Design basis: 1.85 x 10^9 Btu/Day per gasifier - Western Coal - 12 hour storage.

DESIGN DATA

DESIGN PRESSURE ● °C, °F
OPER. PRESSURE ● °C, °F
VACUUM DESIGN ● °C, °F
OPER. VAC. COND. ● °C, °F
OPER. HYDROSATIC HEAD
SP. GR. OPER. LIQUID
CORROSION ALLOWANCE None
RADIOGRAPHY (FULL) (PARTIAL) (SPOT)
JOINT EFFICIENCY
HEAD TYPE
STRESS RELIEF (REQ'D) (PER CODE)
CODE: ASME SECTION VIII, DIV.
API 650
API 620
X AISC
CODE STAMP (REQ'D) (NOT REQ'D)
EARTHQUAKE: CODE ZONE
WIND DESIGN BASIS:

MATERIALS OF CONSTRUCTION

SHELL: ASTM A-36 HEADS: --
SUPPORT: By Others EXT. CLIPS: --
INTERNALS: See Note 5 & 6 BY VESSEL FAB. X
TRAYS: BY OTHERS
BOLTS: EXT. INT. NUTS: EXT. INT.
PIPE: EXT. INT.
FORGINGS:
PACKING: BY OTHERS
GASKETS:

REFERENCES

SUPPORT: SKIRT TYPE & LEGS LUGS
SADDLES PER STD.
INSUL. SUPP'TS PER STD. FOR THK. INSULATION
FIREPROOFING SUPP'TS PER STD. REQ'D (I.S) (O.S) OF SKIRT
MANWAY DAVITS/HINGES PER STD.
VESSEL DAVIT PER
STRUCTURAL CLIPS PER SPEC. EXH.
SEE GEN. NOTE 3
PAINT PER SPEC.
LIFTING LUGS (REQ'D) (NOT REQ'D)

CONTRACT
B/M No. ITEM No.
EQUIP. TAG No. BN201A/F No. REQ'D. 6
SERVICE Coal Feed for Gasifiers

COAL SURGE HOPPERS

DRAWN
CHECKED
DATE

Babcock Contractors Inc.

DWG. NO. BN201 A/F REV.

MARK	No. REQ'D.	SIZE	RATING	SERVICE	REMARKS	MARK	No. REQ'D.	SIZE	RATING	SERVICE	REMARKS

NOZZLE SCHEDULE

No.	BY	DATE	REVISIONS

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PROCESS SPECIFICATION FOR LOCK HOPPER			PS-MF 201 A to E REVISION 1 PAGE 1 OF 2	
ORIGINAL	BY M.J.H.	DATE 6/8/78	APPD.		DATE
REVISION 1	BY M.J.H.	DATE 11/29/78	APPD.		DATE
CLIENT: McKee				PROJECT NO. 3001	

No. Required: Five

Duty: To control the level in the gasifier to within + 6 ins. and to control the gasifier feed by stop/start of coal feeders MF 202 A to E.

Design Basis: 1.85×10^9 Btu/day per gasifier, Western coal, 25% overcapacity.

Material Handled: Coal within the size range 1/2" to 1 1/2". Bulk density 50 #/ft.^{3}.

Flow Rate: Average design - 13,805 #/hr.

Operation:

System hold-up is to be sized so that at design flow rate given above operates once every 3 minutes. The hopper is to be sized to hold 690# of coal at normal operating level.

System valves and conveyors are to be designed so the complete cycle can operate once every minute.

Description of Operating Cycle:

(a) As the level of coal in the gasifier falls, a level sensing device operates, closing a limit switch which initiates the cycle.
(b) Outlet valve opens, lifting level sensor in gasifier and coal is discharged into gasifier.
(c) Outlet valve closes, level sensor is lowered on to coal.
(d) Vent valve is opened, N2 purge is closed. 1
(e) Inlet valve is opened.
(f) Feeder conveyor runs for approx. 15 seconds to load 690# measured by load cells.
(g) Vent and inlet valves are closed, N2 purge is opened. 1

The above cycle to take place in 60 seconds.
The lock hopper is now in the charged condition awaiting the next cycle.

Supply:

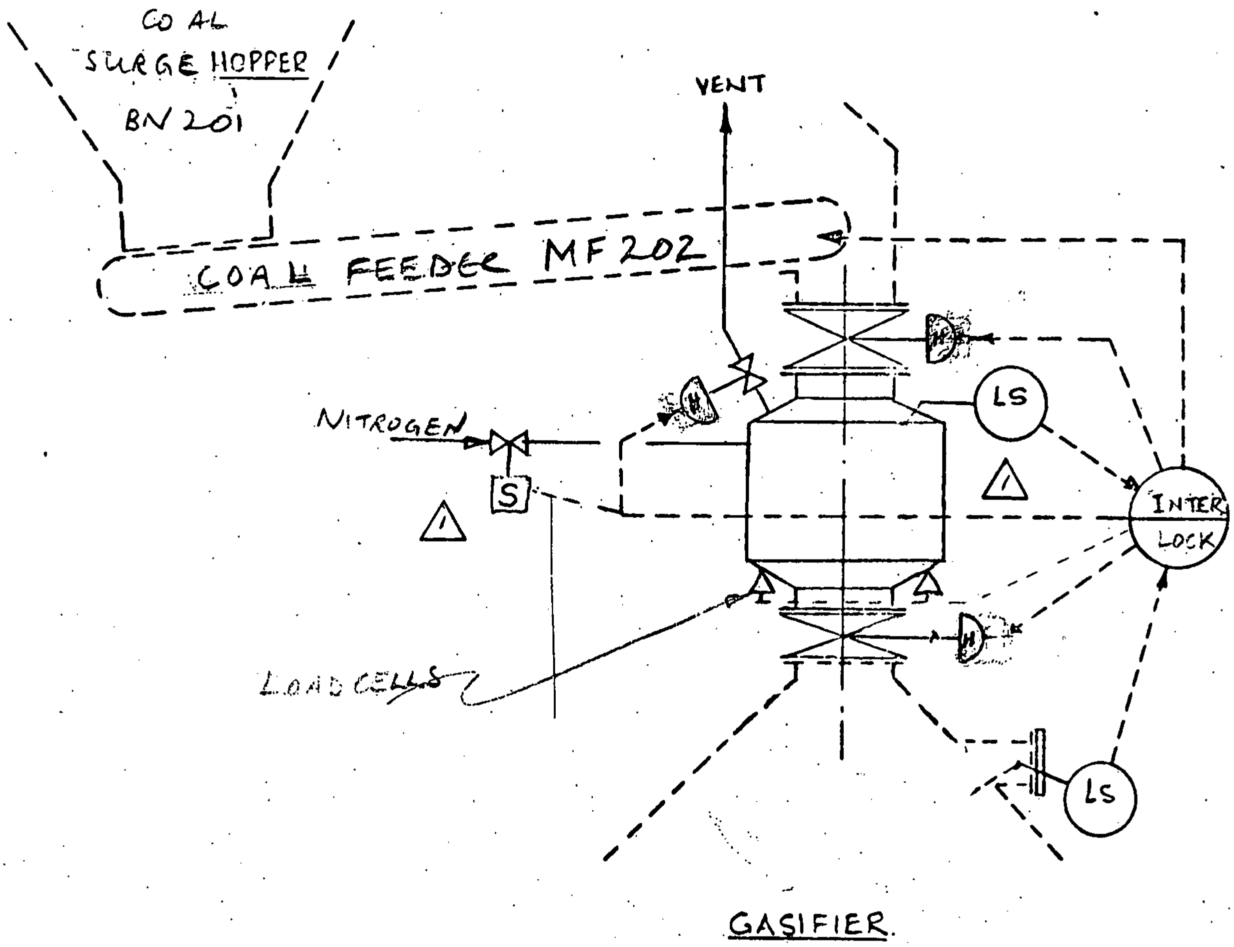
The extent of supply covered by this specification is as follows:

Level measurement
Valve Actuators
Plug Valves (18" nominal size)
Lock Hopper
Plug Valve
Load cells and weight integrator/control

All associated electrical/pneumatic/hydraulic control gear.

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PROCESS SPECIFICATION FOR LOCK HOPPER			PS-MF 201 A to E REVISION 1 PAGE 2 OF 2
ORIGINAL	BY M.J.H.	DATE 6/8/78	APPD.	DATE
REVISION 1	BY M.J.H.	DATE 11/29/78	APPD.	DATE
CLIENT: McKee				PROJECT NO. 3001



(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROCESS SPECIFICATION FOR HYDRAULIC SYSTEM			PS- X203 REVISION 0 PAGE 1 OF 1
ORIGINAL	BY MJH	DATE 9/5/78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: McKee				PROJECT NO. 3001

No. Required: One

Duty: To provide the power necessary to drive the grates of six gasifiers.

Description: The system will include hydraulic storage tank (1), hydraulic pumps (2) - P207 A & B, and hydraulic cylinders for the gasifier. Each gasifier is fitted with two cylinders, which will operate at the same time. Initially ten cylinders (for 5 gasifiers) should be supplied; although the hydraulic pumps and storage tank should be sized for twelve cylinders (six gasifiers).

Each cylinder, when connected to the hydraulic system, must be capable of developing in excess of 65,000 # force, and should have a stroke of 8".

Fluid: The system is to be designed on a water based hydraulic fluid. During abnormal conditions (a total plant shutdown) the temperature of the hydraulic fluid may drop to minus 40°F. Vendor is to confirm that the fluid will not freeze.

Reference Drawing: BCI Drawing No. 3001-M-326 - Hydraulic Circuit for six gasifiers.

ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	PROCESS SPECIFICATION FOR REACTOR			PS-R201 A to E REVISION 2 PAGE 1 OF 7
ORIGINAL	BY MJH	DATE 7/12/78	APPD.	DATE 7/10/78
REVISION 2	BY MJH	DATE 2/19/79	APPD.	DATE
CLIENT: McKee				PROJECT NO. 3001

1. Type:

Two stage, dry grate gasifier.

The gasifiers are to be capable of modification so they can operate in either of two modes:

1.1 As a conventional two stage gasifier.

1.2 As a developmental two stage gasifier, fitted with a stirrer (Item No. A 201).

1.3 The two types of gasifier will be identical, except for the refractory lining (see Section and the stirrer. The stirrer is covered under a separate specification.

1.4 The demonstration plant will consist of four conventional gasifiers, and one stirred gasifier.

2. Nominal Size: 12 ft. I.D. or 3.6 M.

3. Duty:

To gasify coal to a low Btu gas leaving an ash residue. The gasifier produces two product gas streams - a top gas at approximately 250°F, and a clear gas at approximately 1200°F.

3.1 The design basis coal feed to the conventional gasifiers has the following properties:

Analysis:	% W/W
Moisture	25.60
C	50.74
H	3.53
N	0.87
Cl	0.01
S	0.87
O	10.11
Ash	8.27
	100.00

F.S.I.	Non-agglomerating
HHV	8775 Btu/#

Design thruput of specified coal 5.52 tons/hr.

(ENG-050-0278)

3. Duty (Continued):

3.2 The design basis coal feed to the stirred gasifier has the following properties:

Analysis:	% W/W
Moisture	4.3
C	71.21
H	5.05
N	1.13
Cl	0.07
S	3.33
O	5.30
Ash	9.61
	100.00
F.S.I.	7
HHV	12,977 Btu/#

Design thruput of specified coal 4.57 tons/hr.

4. Construction:

BCI Drawing No. 3001-M300 Ref. A is an overall view of the gasifier, showing general arrangement and nozzles and this drawing should be used as a reference drawing in conjunction with this specification. The gasifier is composed of the following main components:

Blast Inlet Assembly	Ref. A
Grate Support Base	Ref. B
Grate Support Casing	Ref. C
Water Jacket	Ref. D
Gasifier Shell and Details	Ref. E
Gasifier Lower Cone and Distributor	Ref. F
Gasifier Upper Cone	Ref. G

5. Blast Inlet Assembly (Ref. A on Drawing 3001 - M300):

5.1 Duty: Inlet box for air/steam blast, and to permit removal of any ash which falls thru the grate.

5.2 Operating & Design Conditions:

	Operating	Design
Temperature ^oF	160^o	650
Pressure p.s.i.g.	2.16	4.32

5. Blast Inlet Assembly (Continued):

5.3 Nozzles: The following nozzle sizes are minimums for process requirements. Larger nozzles may be installed if recommended by mechanical department.

1.	Blast inlet	24" O.D.
2.	Thermocouple	2"
3.	Drain	2"
4.	Ash port	8" x 12"
5.	Spare	3"

Connection to gasifier grate to be 24" minimum.

5.4 Material: Carbon steel - to include a 1/4" corrosion allowance.

5.5 Insulation: The blast inlet box will be insulated with 3" calcium silicate.

6. Water Jacket (Ref. D on Drawing 3001 - M300):

6.1 Duty: To generate the steam required for gasification and provide cooling for the gasification reaction.

The water jacket operates in conjunction with the steam drum D201 A to E; they are connected by a thermosyphon. The water jacket, steam drum, and thermosyphon piping must be considered as a complete system for design and coding purposes.

Design production of steam = 3300 #/hr.

Dimensions: Inside height 76 7/8", inside width, 16 5/8". Diameter of inside wall is 141 3/4" (3.6 M).

6.2 Operating & Design Conditions:

	Operating	Proc. Design	Mech. Design
Steam drum temp. °F	267	300	350
Steam drum pressure, psig	25	30 + F.V.	32 + F.V.*
Temp. in water jacket °F	268	300	350
Pressure in water jacket, incl. liquid head, psig	25	40 + F.V.	40 + F.V.
Pressure in gasifier, psig	2.16	4.32	4.32
Temp. of gasification zone	2200	2600	----
Max. furnace wall temp. °F	500	600	700

*F.V. = Full Vacuum

ENG-052-0278)

6. Water Jacket (Continued):

6.3 Nozzles: The following nozzles are the minimum for process requirements. Additional inspection ports or manholes may be added by mechanical department to meet code requirements.

17	Thermosyphon inlet	two x 6"
18	Thermosyphon outlet	two x 8"
19	Nozzle for blowdown	two x 4"
20	Blowdown dip pipe	two x 1 1/2"
21	Drain plug	two x 2"
22	Inspection	eight x 10"

6.4 Material: Carbon steel - to include 1/16" corrosion allowance for the waterside, 3/16" corrosion allowance for the reaction side.

6.5 Insulation: The outside wall of the shell will be insulated with 4" of calcium silicate.

7. Gasifier Shell (Ref. E & F on Drawing 3001 - M300):

7.1 Duty: Shell for refractory lined distillation retort. Total ht. of sections E & F to be 26 ft.

7.2 Operating & Design Conditions:

	Operating	Mech. Design
Temperature ^{o}F	220	300
Pressure p.s.i.g.	2.16	4.32

7.3 Nozzles: The following nozzles are the minimum for process requirements. Additional manholes may be added by mechanical department to facilitate maintenance.

23	Pyrometer port	two x 3"
24	Lower access	one x 1'-10" x 1'-2"
25	Lower rodding ports	fifteen x 3"
26	Inspection port	four x 1'-0" x 1'-0"
27	Access port	five x 1' x 2'6"
28	Clear gas	one x 4'6" O.D.

7. Gasifier Shell (Continued):

7.4 Carbon steel - to include 1/16" corrosion allowance.

7.5 Insulation: No insulation will be provided on the outside of this section of the vessel. A guard may be required around the outside of the vessel for personnel protection.

8. Gasifier Lower Cone & Distributor (Ref. F on Drawing 3001 - M300)

8.1 Duty: To connect the shell with the upper cone, and to provide an even distribution of the coal over the top of the retort.

8.2 Operating & Design Conditions:

	Operating	Mech. Design
Temperature ^{O}F	250	300
Pressure p.s.i.g.	2.16	4.32

8.3 Nozzles: The following nozzles are the minimum for process requirements. Additional manholes may be added by mechanical department to facilitate maintenance.

29	Manhole	one x 30"	
30	Top gas	two x 18" (two used)	1
31	Stirrer shaft port	one x 24"	
32	Coal distributor	five x 24"	
33	Upper rodding ports	five x 3"	

The coal distributor nozzles No. 32 are lined with refractory concrete. The lining has an I.D. of 18" at the top and 20" at the bottom.

8.4 Construction: Carbon steel to include 1/16" corrosion allowance. Distributor to be lined with refractory concrete.

9. Coal Distributor & Level Hopper (Ref. G. on Drawing 3001 - M300):

8.1 Duty: To provide a space for the coal level to fluctuate, and to provide a constant supply of coal to the retort. Unit is sized so that level fluctuages ± 3", equivalent to a coal charge of 1000#.

9. Coal Distributor & Level Hopper (Continued):

9.2 Operating & Design Conditions:

	Operating	Design
Temperature °F	250	400
Pressure p.s.i.g.	2.16	4.32

9.3 Nozzles:

34	Manhole	one - 30"
35	Coal inlet	one - 18"
36	Rodding port	five - 3"
37	Level alarm	one - 6"
38	Stirrer port	one - 24"
39	Level sensor	two - 3"

9.4 Construction:

Carbon steel - to include 1/8" corrosion allowance. Section of hopper below level 6'0" above center discharge of nozzle 32 is to be lined with refractory concrete.

10. Gasifier Grate Castings:

10.1 Duty: To remove ash from the gasifier, and to distribute air/steam blast thru the gasification zone.

10.2 Operating & Design Conditions:

	Operating	Design
Temperature °F	300	650
Pressure p.s.i.g.	2.16	4.32

Grate is to rotate at a maximum speed of one revolution every 2 hours. For details of grate drive unit and hydraulic cylinders, see Spec. W201.

11. Gasifier Refractory:

11.1 Unstirred Gasifiers

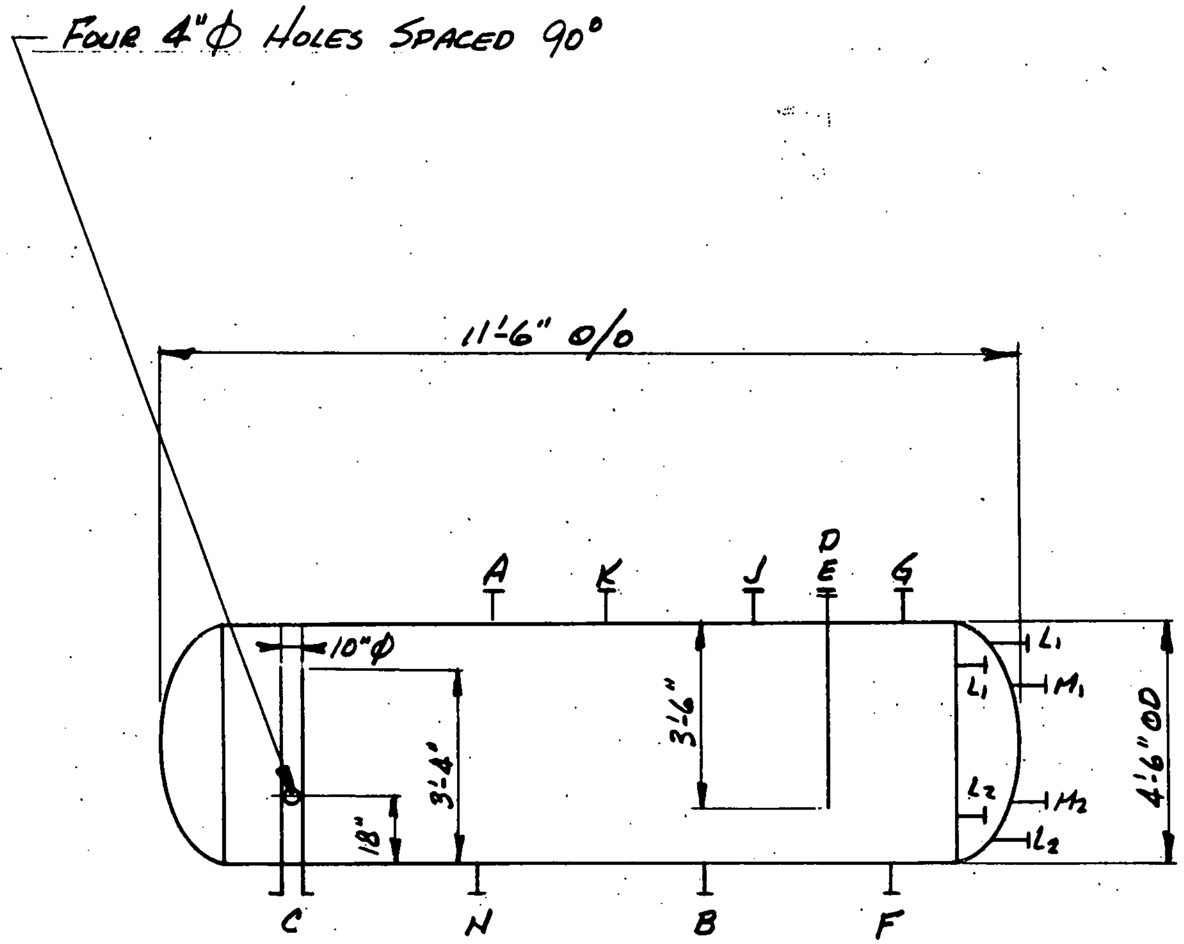
Refractory material Spec.	SP-R201/SR3
Refractory installation Spec.	SP-R201/SR2

11. Gasifier Refractory (Continued):

11.2 Stirred Gasifiers

Refractory material Spec.	SP-R201/SR5
Refractory installation Spec.	SP-R201/SR4

FORM M906



GENERAL NOTES

1. SPECIFICATIONS PER THE BILL OF MATERIAL.
2. THIS DRAWING IS A SCHEMATIC OUTLINE ONLY FOR ELEVATION & ORIENTATION OF ATTACHMENTS. REFER TO
3. FOR ESTIMATING PURPOSES, VESSEL FABRICATOR SHALL INCLUDE THE FOLLOWING CLIPS:
4. Design Basis - One per Gasifier - Five required.
5. Five identical units are required.
6. Capacity each unit: 750 US gallons at normal liquid level.

DESIGN DATA

DESIGN PRESSURE 45psig/F.V. @ °C, °F
OPER. PRESSURE 25psig @ °C, °F
VACUUM DESIGN Full @ °C, °F
OPER. VAC. COND. @ °C, °F
OPER. HYDROSTATIC HEAD
SP. GR. OPER. LIQUID 0.936
CORROSION ALLOWANCE 1/8"
RADIOGRAPHY (FULL) (PARTIAL) (SPOT)
JOINT EFFICIENCY
HEAD TYPE
STRESS RELIEF (REQ'D) (PER CODE)
CODE: ASME SECTION VIII, DIV.
API 650
API 620
X ASME Section I
CODE STAMP (REQ'D) X (NOT REQ'D)
EARTHQUAKE: CODE ZONE
WIND DESIGN BASIS:

MATERIALS OF CONSTRUCTION

SHELL: HEADS:
SUPPORT: EXT. CLIPS:
INTERNALS: BY VESSEL FAB.
TRAYS: BY OTHERS
BOLTS: EXT. INT. NUTS: EXT. INT.
PIPE: EXT. INT.
FORGINGS:
PACKING: BY OTHERS
GASKETS:

REFERENCES

SUPPORT: SKIRT TYPE & __ LEGS __ LUGS
SADDLES X PER STD.
INSUL. SUPP'TS PER STD.
FOR 4" THK. INSULATION Calcium Silicate
FIREPROOFING SUPP'TS PER STD.
REQ'D (I.S) (O.S) OF SKIRT
MANWAY DAVITS/HINGES PER STD.
VESSEL DAVIT PER
STRUCTURAL CLIPS PER SPEC. EXH.
SEE GEN. NOTE 3
PAINT PER SPEC.
LIFTING LUGS (REQ'D) X (NOT REQ'D)

CONTRACT
B/M No. ITEM No.
EQUIP. TAG No. D201A/E No. REQ'D. 5
SERVICE

L. P. STEAM DRUM

DRAWN
CHECKED
DATE
Babcock Contractors Inc.

DWG. NO. D201A/E REV. 1

MARK	No. REQ'D.	SIZE	RATING	SERVICE	REMARKS	MARK	No. REQ'D.	SIZE	RATING	SERVICE	REMARKS
A	1	6"		Steam Outlet		L1L2	4	1-1/2"		Level Gage	
B	1	8"		Circulation-Out		M1M2	2	1-1/2"		Level Control	
C	1	10"		Circulation-Return		N	1	3/4"		Temperature	
D	1	1"		Boiler Feed Water Dip Pipe							
E	1	4"		Nozzle for D							
F	1	1"		Blowdown Drain							
G	1	6"		Relief Valve							
H	1	1"		Pressure Vent							
J	1	3/4"		Pressure Control							
K	1	1-1/2"		Spare							

NOZZLE SCHEDULE

No.	BY	DATE	REVISIONS

CENTRIFUGAL FANS & LOW PRESSURE BLOWERS

Babcock Contractors Inc.

REVISION DATE: 11/29/78 DATE: 5/30/78

SERVICE: Air Supply to Gasifier Plant, One Spare	ITEM NO. B201A,B,C
MFR.: NO. REQ'D. 3 X MOTOR TURBINE	TAG NO. Same
SIZE: MODEL: ARRGT. NO. [ ] SWSI [ ] DWDI	CLASS NO.

POWER TRANSMISSION: [ ] DIRECT [ ] GEAR [ ] HYDRAULIC COUPLING [ ] TYPE BELT [ ] TYPE CHAIN

OUTLET: [ ] CLOCKWISE [ ] COUNTER CLOCKWISE [ ] UP [ ] DOWN [ ] TOP [ ] BOTTOM [ ] ANGLE [ ] HORIZONTAL

INLET BOXES: [ ] UP [ ] DOWN [ ] RIGHT [ ] LEFT [ ] ° ANGLE WITH HORIZONTAL

BLADE FORM: [ ] RADIAL [ ] AIRFOIL [ ] FORWARD CURVED [ ] BACKWARD CURVED [ ] FORWARD INCLINE RADIAL TIP [ ] NON-OVERLOADING

FLUID DATA

FLUID: [X] AIR [ ] GAS

DRY GAS ANALYSIS % BY VOL.

Design Wet Bulb 71°F

MOISTURE CONTENT GR/SCF

SPECIFIC GRAVITY (WET)

MOLECULAR WEIGHT (WET)

DUST CONTENT GR/SCF

PARTICULATE SIZE:

[ ] CORROSIVE [ ] ABRASIVE [ ] TOXIC

[ ] INJURIES [ ]

PROCESS SPECIFICATIONS

	NORMAL	DESIGN
INLET VOL., CFM @ INLET		
, SCFM	22225	24450
,1000 LBS/HR		
INLET TEMP., °F	60	102
INLET PRESS., psig	13.9	13.9
OUTLET PRESS., "WC	80	80
ELEV. ABOVE S.L., FT.	X	1541

CONTROL: [ ] MANUAL [ ] REMOTE MANUAL [ ] AUTOMATIC [ ] OUTLET DAMPER [ ] INLET LOUVER [ ] INLET VANE [ ] HYD. CPLG. [ ]

TURNING GEAR REQ'D. [ ] YES [ ] NO

COOLING WATER PSIG. & °F

MAX. S. P. >/1.15 X DESIGN S. P.

N.A.F.M. NOISE LEVEL < DB

MAX. ALLOWABLE TIP SPEED FPM

1ST CRITICAL SPEED >/ 1.2 X OPER. RPM

RESONANCE SPEED >/ 1.15 X OPER. RPM

RATE OF TEMP. CHANGE >/ °F/MIN.

PERFORMANCE

PERFORMANCE CURVE NO.

STATIC PRESS @ DESIGN VOL. "WC

EXIT VELOCITY FPS

EXIT GAS TEMP. °F

% MECH. EFF. BHP RPM

STATIC PRESSURE @ 1/2 DESIGN VOL. " WC

MAX. RATE TEMP. CHANGE °F/MIN

1ST. CRITICAL SPEED RPM

RESONANCE SPEED RPM

WR^2 LB-FT^2/START. TORQ. FT/LB

COOLING WATER REQ.D. GPM

COMP. AIR REQ.D. PSIG CFM

CONTROL OPER. SHAFT	INLET	OUTLET
DIAM. INCHES		
ANGLE OF ROT. DEG.		
ROTATION TO OPEN		
MAX. TORQUE. IN.- LB		

MATERIALS

	MATERIAL	THICK
SCROLL	C.S.	
SCROLL LINERS		
END LINERS		
INLET BOXES	C.S.	
BLADES	C.S.	
WHEEL END PLATES	C.S.	
WHEEL CENTER PLATE	C.S.	
WHEEL LINER		
CTR & END PLATE LINERS		
HUB		X
SHAFT	C.S.	X

(x) CHECK ITEMS FURNISHED WITH FAN

[ ] INLET LOUVER	[ ] RED. GEAR
[ ] INLET VANES	[ ] HYD. COUPLING
[ ] OUTLET DAMPER	[X] DRIVER
[ ] WEATHER HOOD	[X] COUPLING
[ ] BRG.PED [ ] SOLE PLT.	[ ] TURNING GEAR
[X] FAN 1/2C PLG. [X] MTD.	[ ] BASE PLTS. [ ] DRIVE
[X] DRIVER 1/2C PLG [X] MTD.	[ ] DRIVER [X] COM'N
[ ] EVASE [ ] DES ONLY	Inlet Filter*
[ ] BRG. SUN SHIELD	Silencer*
[ ] BELT/CHAIN GUARD	

CONSTRUCTION DETAILS

GENERAL: [ ] CORROSION RESIST [ ] ABRASION RESIST [ ] HIGH TEMP. [ ] WIDE TEMP. VARIATIONS [ ] GAS TIGHT [ ] NON-SPARK

HOUSING: [ ] FLANGED [ ] SPLIT FOR WHEEL REMOVAL [ ] SOUND TRAP [ ] WEAR LINERS [ ] INLET SCREEN [ ] FIXED INLET VANES [ ] INSULATION CLIPS [ ] ACCESS DOOR [ ] WEATHER PROTECTED; INLET FT^2/OUTLET FT^2

SHAFT SEALS: [X] STD. [ ] CARBON RING [ ] LABYRINTH [ ] PRESSURIZED /Packed Gland

WHEEL: BLADES [ ] SHROUDED [ ] WEAR STRIP [ ] FULL LINER; DIAM. IN. WIDTH @ TIPS IN.

SHAFT: DIAM. @ BEARINGS IN.; DIAM. @ HUB IN.; DISTANCE BETWEEN BRG. ℄ IN.

BEARINGS: [ ] BALL [ ] ROLLER [ ] SLEEVE [ ] THRUST COLLAR [ ] FORCED LUB. [ ] RING OILED [ ] GREASED [ ] AIR COOLED [ ] WATER COOLED [ ] HEAT SLINGER [ ] BRACKETED OFF HOUSING [ ] PEDESTAL [ ] SOLE PLATES [ ] SUN SHIELD

SHAFT CPLG.: MFR.: [ ] RIGID [X] FLEXIBLE [X] CPLG. GUARD

EVASE: [ ] REQ.D. [ ] NOT REQ.D.; RECOVERY, % OF DES. S. P.; LENGTH FT. OUTLET AREA FT^2

INLET LOUVER/VANE: PURPOSE: [ ] REGULATION [ ] SHUT-OFF; BEARINGS: [ ] ANTI-FRICTION [ ] BALL; [ ] OPER. LEVER & LOCKING QUADRANT; [ ] OPER. SHAFT EXT. FOR CONT. LINKAGE

OUTLET DAMPER: PURPOSE: [ ] REGULATION [ ] SHUT-OFF; BEARINGS: [ ] ANTI-FRICTION [ ] BALL; [ ] OPER. LEVER & LOCKING QUADRANT; [ ] OPER. SHAFT EXT. FOR CONT. LINKAGE

WEIGHTS: HOUSING LB.; COMPLETE ROTOR LB.; TOTAL OPERATING LB.; SHIPPING LB.

REMARKS: Design Basis: 10 x 10^9 Btu/Day plus 10% overcapacity. Above capacity is for Two Units (One Unit will be spare).

Vendor to advise thruput at minimum conditions: -40°F, 13.9 psig, inlet: 50"W.C. Outlet.

Motor: 4160V. 60Hz. 3-Phase, Class I, Div. II, Group D

Ambient Temp.: -42°F min. 102°F Max. *Common to all units

MADE BY	CHECKED BY	PAGE	CONT. NO.	ENGINEERING REQUISITION NO.
MJH		1 OF 1	3001	

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PROCESS SPECIFICATION FOR ASH SYSTEM			PS- X205A REVISION 2 PAGE 1 OF 4
ORIGINAL	BY M.J.H.	DATE 6/6/78	APPD.	DATE
REVISION 2	BY M.J.H.	DATE 2/19/79	APPD.	DATE
CLIENT: McKEE				PROJECT NO. 3001

Basis: System - 10 x 10^9 Btu/day, Western Coal, 25% over capacity.

Duty: To collect ash from 6 gasifiers and transport ash to ash collection hopper BN 202.

Also, to collect dust from the dust cyclones, and transport to a collection point.

Capacity: Ash - design average: 6,000#/hr.

Dust - design average: 500#/hr.

Collection Points:

Each gasifier discharges ash at two points - total of 12 discharge points.

Design average rate at each discharge point: 500#/hr.

Dust is discharged at each dust cyclone (6 in total).

Design average rate at each discharge point: 50#/hr.

Ash Characteristics:

Temperature range:	100^oF to 1000^oF
Size range:	50 micron to 6" dia.
Normal size:	1/2" dia. to 1" dia.

Ash may be cooled by water sprays. Provision must be made to observe the size of the ash produced approximately once per hour.

Dust Characteristics:

Temperature range:	100^oF to 1000^oF
Size range:	5 micron to 1/32"
Carbon content:	Approximately 50%

NOTE: Dust must not be cooled by air as it may self ignite. Ash must be cooled by water or inert gas.

NG-050-0278)

System Equipment Items:

B 202	Ash cooling blower
B 203 A/B	Aeration blower
BN 203 A/C	Dust bin
CO 201 A	Drag link conveyor
CO 202 A	Drag link conveyor
CO 203	Drag link conveyor
CO 204	Bucket elevator
MF 203 A/K	Ash lock
MF 207 A/E	Rotary feeder
P 206 A/B	Hydro-ejector pump

Cyclone Ash Disposal:

The cyclone ash will be taken from the five cyclones by means of 8" rotary feeder, (MF 207 A/E), an 8" slide pipe into three sand tanks (BN 203 A/C). The sand tank will be water impounded and will have an overflow louver to eliminate water as the ash displaces it. The ash will be removed from the sand tanks by three 3" x 4" x 45^{o} tangential hydro-ejectors. Each hydro-ejector will require 550 GPM @ 175 psig provided by pump P 206 A/B rated at 700 GPM @ 125 psig.

The sand tanks will require emptying approximately once every six hours. The sequence will be started manually, and then an automatic sequencer will direct the water to each hydro-ejector in sequence. The emptying cycle will take approximately 10 minutes.

Bottom Ash System

The ash will be removed from the gasifier by a drag link conveyor system.

Each gasifier will discharge thru two locking arrangements (MF 203 A/K).

The ash locks will consist of three chambers connected by slide valves. The top chamber will collect the ash discharged from the gasifier, the middle chamber will act as a cooling chamber, where the ash will be cooled by air supplied by the aeration blowers B 203 A/B. Air discharges from the center hopper thru a filter. The third hopper provides a hold up before discharging to the conveyors. Two drag link conveyors, (CO 201 A & 202 A) collect ash from the bottom of the gasifiers. These conveyors are

ENG-052-0278)

Bottom Ash System (Continued)

insulated. A cross conveyor (CO 203) collects the ash from these two conveyors. The ash is further cooled in this conveyor by air from the ash cooling blower, B 202.

The ash is lifted from the cross conveyor to the ash silo by a bucker elevator, CO 204.

The ash silo, (BN 202), has a capacity of 8500 $ft.^3$ (approximately 250 tons or 5 days storage of ash). Ash is discharged from the silo in an ash grinder (MF 204), a silo rotary feeder (MF 205), thru a continuous loader (MF 206) where the ash is conditioned with water to prevent dusting, prior to loading into trucks.

Also provided will be a cooling system for the cross conveyor which will consist of a fan with a motor which will vent to the silo. The purpose of this will be to try to cool the material before it reaches the silo. We propose to introduce ash into the angular space between the top and bottom flight of this conveyor. The velocity of the air will be low enough as not to entrain the ash in the air.

The central control panel for this system for both the bottom ash and the cyclone ash will be of sufficient size and have all controls and programmers mounted within it to facilitate the addition of the other seven gasifiers when and if they are added.

Silo

We propose to furnish an 8500 cubic foot storage silo for holding the bottom ash for the system. The silo is sized for all twelve gasifiers. The silo will be constructed of carbon steel plate with a cone bottom as shown on our drawing.

We will provide for the silo all structural steel supports for truck clearance as shown. Also provided will be the stairway from the grate to the unloader floor, and a ladder and cage to the roof of the silo. On the roof of the silo we will provide an invent filter sufficient for removing the displacement air from the silo of both the cooling system and the displacement ash. Under the silo we will provide a two foot standard cliker grinder which will grind the large pieces which we understand can be 6" in diameter during upset, to an acceptable size to feed into our C-30 unloader. The unloader will be complete with an 18" rotary feeder and a water spray nozzle inside the conditioner.

We will also provide a discharge chute as shown on our drawing for discharge into the customer's truck.

Silo (Continued)

The silo control panel will sequence all operations of the unloading cycle automatically. We have not furnished any water piping to the C-30 unloader, this requires approximately 50 GPM @ 100 psig. This water can be taken from the hydro-ejector pump which we are providing, although no provision has been made at this time for doing so.

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	PROCESS SPECIFICATION FOR TAR CYCLONE			PS- CY 202 A/E REVISION 0 PAGE 1 OF 1
ORIGINAL	BY Hemingway	DATE 6/8/78	APPD.	DATE
REVISION 0 For Estimate	BY	DATE	APPD.	DATE
CLIENT: McKee				PROJECT NO. 3001

Design Basis: 7.4×10^9 Btu/day from four gasifiers, Western coal, 10% overcapacity.

No. Required: Five

Function: To remove tar droplets from top gas.

Duty: (for each unit)

	Normal	Max. Process Design
Gas flow SCFM	6,710	7,381
Gas flow ACFM	9.162	10,078
Gas temperature ^{O}F	250	250
Gas pressure, psia	14.62	14.62
Atmospheric pressure, psia	13.9	13.9
Gas density #/ft.^{3}	0.044	0.044
Gas viscosity Cp	0.0185	0.0185
Gas pressure drop "w.g.	1.5	1.7
Tar loading #/min.	15	70
Tar viscosity @ 250^{O}F Cp		
Tar S.G.	1.01	1.08

Mechanical Design:

Design temperature:	450^{O}F
Design pressure:	5 psig
Material:	C.S.
Corrosion allowance:	1/16"min.
Insulation and tracing:	Cyclone will be steam traced and insulated with 2" insulation by others.

Typical Size: Cyclone will be similar to Fisher Klosterman Model No. XQ36.

Guarantees: Vendor to provide guarantee of pressure drop for the duties listed in this specification.

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROCESS SPECIFICATION FOR DUST CYCLONES		PS - CY201 A/E REVISION 0 PAGE 1 OF 2	
ORIGINAL 0 For Est.	BY I.W.	DATE 6/8/78	APPD. M.J.H.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: McKee			PROJECT NO. 3001	

No. Off: 5 (1 per gasifier)

Duty: Removal of dust (coke and ash particles) from "clear gas".

Gas Analysis:	Vol. %	Range	Typical
Dry Gas	CO	25 - 27	25.61
	CO_2	5.5 - 6.5	6.10
	H_2	19 - 23	19.75
	N_2	43 - 50	47.63
	CH_4	0.06 - 0.12	0.08
	H_2S	0.1 - 0.5	0.38
	COS	0.02 - 0.12	0.09
	NH_3	0.2 - 0.6	0.34
	HCN	100 ppm	0.01
	Cl	200	0.01
			100.00
	Molecular Wt.		23.9
H_2O	lbs./1000 SCF	1.0-1.5	1.07
Dust	grains/100 SCF	approx. 50-100	

Dust Size Range - Vendor shall provide performance curve

Operating Conditions		Normal	Maximum
Temperature:	^{o}F	1202	1250
Pressure:	inches WG.	45	50

Note: Atmospheric pressure = 13.85 psia

		Normal	Maximum
Gas viscosity:	micropoises	380	400

Capacity:

Coal source:		Western	Eastern
Dry Gas:	SCFH	132,100	314,600
H_2O:	SCFH	3,600	7,100
Total:	SCFH	135,700	321,700
Actual flow at operating conditions:	CFH	413,000	979,000

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PROCESS SPECIFICATION FOR DUST CYCLONES	PS - CY201 A/E REVISION 0 PAGE 2 OF 2

Performance Required:

Dust removal: 95%

Pressure drop: Not more than 3 inches WG.

Materials of Construction:

Carbon steel refractory lined

Shell thickness 15/64"

Refractory

Inner layer 3" AP Green Low Abrade 2400F - Vitrified
Backing layer 3" VSL 50 Insulating Castable

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PROCESS SPECIFICATION FOR TAR PRECIPITATOR			PS-~~X~~201 A/B/C REVISION 0 PAGE 1 OF 2
ORIGINAL 0 FOR ESTIMATE	BY I.W.	DATE 6/9/78	APPD. M.J.H.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: McKee				PROJECT NO. 3001

Design Basis: 10 billion Btu/day, 10% overcapacity. No standby.

No. Req'd: 3

Duty: Removal of tar droplets from coal gas (top gas).

Gas Analysis:

Vol. %	Range	Typical
CO	24.5 - 26.0	25.93
CO_2	5.5 - 7.5	7.02
H_2	19 - 23	22.28
N_2	42 - 47	42.96
CH_4	0.8 - 2.0	0.87
C_2+	0.2 - 1.0	0.24
H_2S	0.1 - 1.0	0.18
COS	0.05	0.05
NH_3	0.5	0.46
HCN	0.01	0.01
		100.00
Molecular Wt.		23.2

Tar Content: lbs./1000 SCF of dry gas 1.5 - 10.0

Moisture Content: lbs./1000 SCF of dry gas 3-15

Gas will also contain Phenols and Chlorides.

Operating Conditions:

	Normal	Maximum
Temperature: ^{o}F	250	300
Pressure: inches WG.	29	32

Note: Atmospheric Pressure = 13.85 psia.

Tar Properties:

SG.: 1.01 - 1.08
Viscosity: Approx. 8.6^{o} Engler at 122^{o}F

Tar will be free flowing at operating conditions.

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROCESS SPECIFICATION FOR TAR PRECIPITATOR		PS-X 201 A/B/C REVISION 0 PAGE 2 OF 2	
ORIGINAL 0 FOR ESTIMATE	BY I.W.	DATE 6/9/78	APPD. M.J.H.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: McKee			PROJECT NO. 3001	

Capacity:

Coal Source:		Western	Eastern	Design
Dry Gas:	SCFH	1,733,000	860,000	
Moisture:	SCFH	449,000	89,000	
Total:	SCFH	2,182,000	949,000	2,400,000
Actual flow at operating conditions	CFH	2,946,000	1,281,000	3,240,000

Note: These are the total flowrates through all the precipitators operating in parallel flow.

Performance Required:

Tar removal efficiency: *not less than 99%.

Pressure drop: *not more than 1.0 inches WG.

Vendor is required to specify the performance that will be obtained in items of tar removal efficiency and pressure drop at the design flowrate when one unit is off line.

Power Source: 460 volts 60 Hertz 3 Phase

Area Hazard Classification: Class I, Div. II, Group D

Purge Gas: Vendor to design unit for minimum continuous purge gas at electrodes. Vendor to advise purge requirements.

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	PROCESS SPECIFICATION FOR EXCHANGER	PS-E-201 A to E REVISION 1 PAGE 1 OF 1

ORIGINAL 0 For Estimate	BY I.W.	DATE 6/5/78	APPD. MJH	DATE
REVISION 1	BY MJH	DATE 11/29/78	APPD.	DATE

FUNCTION

Client: McKee | Project: 3001

Process Gas Cooler

Cooling Gas obtained by gasification of coal and generation of 125 psig steam. Design Basis: Eastern Coal; gas in at 1202°F.

OPERATION

Boiler will be fed by thermosyphon recycle from steam drum located approximately 15 ft. above the top end of the boiler.

MATERIALS HANDLED

Gas analysis vol.% Approx.: CO 25.04, CO_2 5.97, H_2 19.31, N_2 46.58
CH_4 0.08, H_2S 0.37, COS 0.09, NH_3 0.33
H_2O 2.21, HCN + Cl Trace

DESIGN DATA

HEAT EXCHANGED (BTU/HR) (East) 4,820,000 (West) 1,807,500 (MAXIMUM) 5,220,000

TRANSFER RATE (BTU/HR-SQ. FT-°F) (SERVICE) (CLEAN)

AREA (FT^2) CORR. LMTD (°F)

TYPE

TUBES NO. OD (IN) 1.5min BWG 10 LENGTH(FT.) PITCH(IN.)

BAFFLES NO. TYPE SHELL I.D. (IN.)

PERFORMANCE OF ONE UNIT (Design)		SHELLSIDE	TUBESIDE
FLUID ENTERING		Boiler Feed Water	Gas
CONDENSABLE VAPORS	LB/HR	-	-
NONCONDENSABLE VAPORS	LB/HR	-	20,170
LIQUID	LB/HR	Approx. 121,000	-
TOTAL FLUID ENTERING	LB/HR	-	20,170
FLUID VAPORIZED	LB/HR	6040	-
SPECIFIC GRAVITY - LIQUID		0.89	
VISCOSITY	CP		In 0.038, Out 0.023
MOLECULAR WEIGHT - VAPORS		18.02	23.72
SPECIFIC HEAT			
LATENT HEAT - VAPORS	BTU/LB	~ 864.5	
THERMAL CONDUCTIVITY	BTU/HR SQ.FT°F/FT		In 0.045, Out 0.026
FOULING RESISTANCE	HR-SQ. FT.°F/ BTU	0.001	0.002
TEMPERATURE IN	°	358	1202
TEMPERATURE OUT	°	358	400
OPERATING PRESSURE	PSIG	130 - 135	~ 1.6
NUMBER OF PASSES		1	1
VELOCITY	FT/SEC.		
PRESSURE DROP	PSI		0.2
DESIGN PRESSURE	PSIG	170	
DESIGN TEMPERATURE		375	

INSULATION

MATERIALS OF CONSTRUCTION: TUBES Refractory lined inlet, CS Tubes
SHELL CS
GASKETS

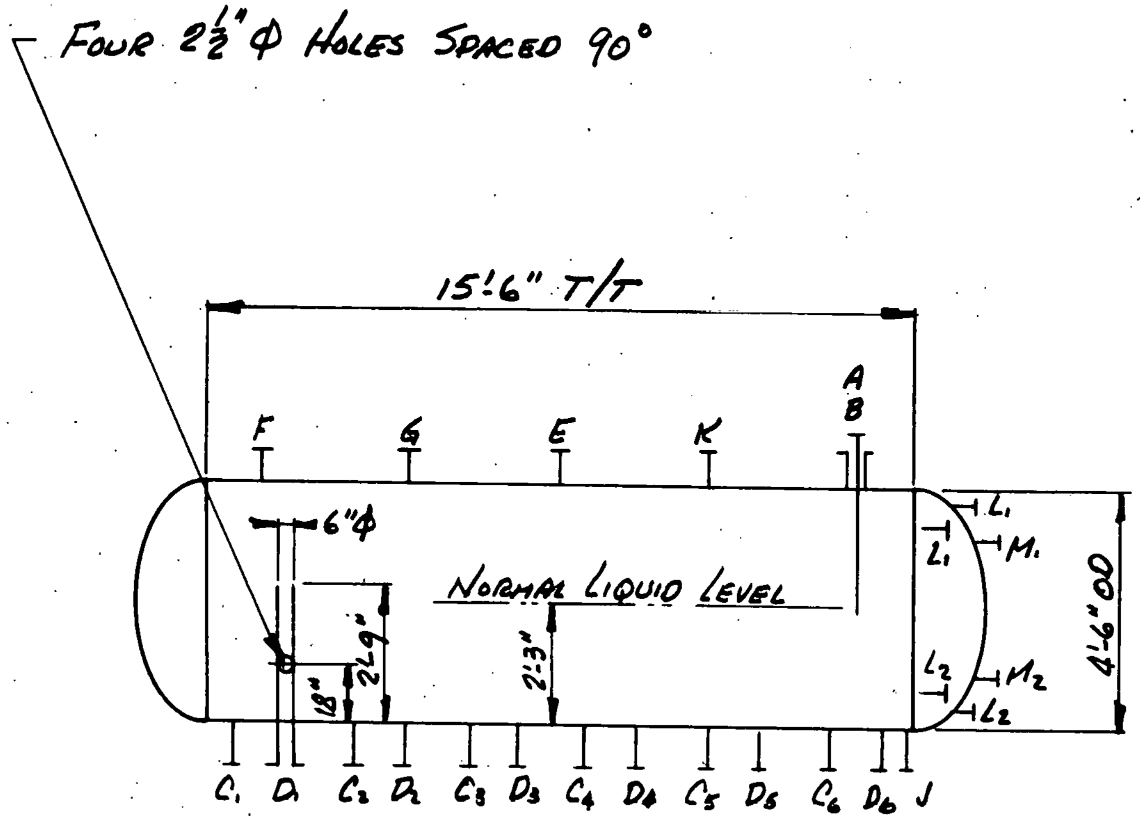
REMARKS:
1. Atmospheric Pressure = 13.85 psia.
2. Boiler will be mounted in an upright position approx. 30° to the vertical gas to flow downward through the tubes.
3. Boiler feed water flow will be by thermosyphon recycle from steam drum located above the boiler.

(ENG-050-0278)

FORM M906

GENERAL NOTES

1. SPECIFICATIONS PER THE BILL OF MATERIAL.
2. THIS DRAWING IS A SCHEMATIC OUTLINE ONLY FOR ELEVATION & ORIENTATION OF ATTACHMENTS. REFER TO
3. FOR ESTIMATING PURPOSES, VESSEL FABRICATOR SHALL INCLUDE THE FOLLOWING CLIPS:
4. Nozzles D_1-D_6 must be on vertical centerline of drum.
5. Nozzles C_1-C_6 may be up to 12" either side of vertical centerline to suit layout.
6. Design Basis - Six gasifiers operating at 1.85×10^9 Btu/Day each - Eastern Coal.
7. One unit required.
8. Capacity: 1100 U.S.Gallons at normal liquid level.



RISER DETAIL SHOWN FOR NOZZLE D_1 ALSO REQ'D FOR NOZZLES D_2 THRU D_6

MARK	NO. REQ'D.	SIZE	RATING	SERVICE	REMARKS	MARK	NO. REQ'D.	SIZE	RATING	SERVICE	REMARKS
A	1	3"		Boiler Feed Water - In		M_1M_2	2	1-1/2"		Level Controller	
B	1	4"		Nozzle for A							
C_1-6	6	4"		Circulation - Out							
D_1-6	6	6"		Circulation-Return							
E	1	6"		Steam-Out							
F	1	6"		Relief Valve							
G	1	3"		Vent							
J	1	1"		Intermittent Blowdown							
K	1	3"		Spare							
L_1L_2	4	1-1/2"		Level Gage							

NOZZLE SCHEDULE

No.	BY	DATE	REVISIONS

DESIGN DATA

DESIGN PRESSURE 150 @ 366 °F
OPER. PRESSURE 125 @ 353 °F
VACUUM DESIGN Full @ -- °C, °F
OPER. VAC. COND. @ °C, °F
OPER. HYDROSTATIC HEAD
SP. GR. OPER. LIQUID 0.89
CORROSION ALLOWANCE 1/8"
RADIOGRAPHY (FULL) (PARTIAL) (SPOT)
JOINT EFFICIENCY
HEAD TYPE
STRESS RELIEF (REQ'D) (PER CODE)

CODE:		
		ASME SECTION VIII, DIV.
		API 650
		API 620
	X	ASME Section I

CODE STAMP (REQ'D) (NOT REQ'D)
EARTHQUAKE: CODE ZONE
WIND DESIGN BASIS:

MATERIALS OF CONSTRUCTION

SHELL: HEADS:
SUPPORT: EXT. CLIPS:
INTERNALS: BY VESSEL FAB.
TRAYS: BY OTHERS
BOLTS: EXT. INT. NUTS: EXT. INT.
PIPE: EXT. INT.
FORGINGS:
PACKING: BY OTHERS
GASKETS:

REFERENCES

SUPPORT: SKIRT TYPE & LEGS LUGS
SADDLES PER STD.
INSUL. SUPP'TS PER STD.
FOR 4 THK. INSULATION Calcium Silicate
FIREPROOFING SUPP'TS PER STD.
REQ'D (I.S) (O.S) OF SKIRT
MANWAY DAVITS/HINGES PER STD.
VESSEL DAVIT PER
STRUCTURAL CLIPS PER SPEC. EXH.
SEE GEN. NOTE 3
PAINT PER SPEC.
LIFTING LUGS (REQ'D) X (NOT REQ'D)

CONTRACT
B/M No. ITEM No.
EQUIP. TAG No. D202A No. REQ'D. 1
SERVICE

High Pressure Steam Drum

DRAWN
CHECKED
DATE

Babcock Contractors Inc.

DWG. NO. D202 REV. 1

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PROCESS SPECIFICATION FOR STEAM DRUM AND PROCESS GAS COOLER PACKAGE		PS-X 204A (System) REVISION 1 PAGE 1 OF 3	
ORIGINAL	BY I.W.	DATE 6/6/78	APPD.	DATE
REVISION	BY M.J.H.	DATE 11/29/78	APPD.	DATE
CLIENT: McKee			PROJECT NO. 3001	

Duty: Cooling of "clear gas" streams from five coal gasifiers by generation of 125 psig saturated steam.

Scope: The package will consist of:

1. 5 waste heat boilers - (Process Spec. E201 A to E).
2. 1 steam drum with appropriate fittings and instrumentation (Process Spec. D202 A).
3. Thermosyphon piping system from steam drum to each waste heat boiler.

Provision is to be made in the design of the steam drum, piping, etc. for the future installation of a sixth waste heat boiler.

Process Data:

1. Waste Heat Boilers: (E201 A to E)

The Design process duty of each waste heat boiler is specified on the attached process data sheet. This design duty is based on Eastern coal, & a gas inlet temperature of 1202 °F. Note that the circulating water flowrate entering each boiler is specified on the basis of a 20/1 ratio of water flow/steam generated. The vendor is free to alter this ratio if he considers a different ratio to be more suitable.

Normal operating condition for Eastern coal will be gas in at 1140 °F, heat exhanged 4.82 MM Btu/lb per exchange. Normal operating condition for Western coal will be gas in at 1060 °F, heat exchanged 1.8. MM Btu/lb per exchange.

2. Steam Drum: (D202 A)

Boiler feed water make-up:

Temperature: 200 °F
Pressure: 150 psig (vendor to advise if this is insufficient)
Quality: to be advised

Steam conditions in drum:

125 psig, 353 °F
Note: atmospheric pressure - 13.85 psia

(ENG-050-0278)

Process Data (Continued):

2. Steam Drum (Continued):

Heat balance:

Steam (saturated) at 353°F	1193.7 Btu/lb.
BFW at 200°F	168.1 Btu/lb.
ΔH	1025.6 Btu/lb.

Waste heat boilers:

Gas cooling duty per boiler	5.22×10^6 Btu/h
For 6 boilers	31.32×10^6 Btu/h

Assume 2% heat loss.

$$\text{Steam generation} = \frac{31.32 \times 10^6}{1025.6 \times 1.02} = 29{,}940 \text{ lb./h}$$

Turndown to 20% required.

i.e. minimum steam generation 6,000 lb./h with 3 boilers operating.

3. Piping System:

The steam drum will be located at an elevation approx. 15 ft. above the top of the waste heat boilers which will be in an upright position, possibly at an angle to the verticle. (Vendor to advise.) A preliminary estimate of the total length of pipe run from the steam drum to the boilers and the number of fittings is as follows:

Steam drum to:

Boilers A, B, E, & F (future)	Pipe length	75'-0"
	Fittings	6-90° Els.
Boilers C, D	Pipe length	45'-0"
	Fittings	4-90° Els.

Each feed water supply and steam return line will also be fitted with 2 shutoff valves so that boilers may be individually isolated from the steam drum if required. Each waste heat boiler should be protected by a relief valve (or valves) in the steam return line. The final determination of elevations, length of pipe runs, numbers of fittings, etc. will be made during the detailed design stage after discussions between the vendor and the purchaser.

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PROCESS SPECIFICATION FOR STEAM DRUM AND PROCESS GAS COOLER PACKAGE			PS-X 204A (System) REVISION 1 PAGE 3 OF 3
ORIGINAL	BY I.W.	DATE 6/6/78	APPD.	DATE
REVISION 1	BY M.J.H.	DATE 11/29/78	APPD.	DATE
CLIENT: McKee				PROJECT NO. 3001

MECHANICAL REQUIREMENTS:

1. The waste heat boilers, steam drum and piping shall be designed to the appropriate ASME code and stamped with maker's name.

2. The steam drum shall be designed to produce steam of a quality suitable for general heating purposes.

3. The steam drum will include as a minimum the following fittings:

   1 boiler feed water nozzle 2"
   1 steam outlet nozzle 8"
   6 circulation outlet nozzles
   6 circulation return nozzles
   Relief valves as required by the code
   1 vent

   1 intermittent blowdown nozzle
   1 spare nozzle 3"
   Level guage
   Level controller and feedwater control valve
   High alarm, low alarm and low low alarm
   Pressure guage

   The vendor should specify any other fittings and internals required to ensure satisfactory operation and steam quality.

4. In the event of a complete failure of boiler feed water supply, the steam drum should provide the following holdup times when generating steam at 29,940 lb./h:

   Normal level to low alarm: 1 minute
   Low alarm to low low alarm: 4 minutes
   Low low alarm to empty: 10 minutes

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROCESS SPECIFICATION FOR EXCHANGER	PS-E202A,B & C REVISION 1 PAGE 1 OF 3

ORIGINAL 0 For Estimate	BY Hemingway	DATE 5/25/78	APPD.	DATE
REVISION 1	BY MJH	DATE 11/29/78	APPD.	DATE

FUNCTION

COMBINED GAS EXCHANGER
(To cool combined top gas and clear gas. - Design Basis is 10 x 10^9 Btu/Day. Western Coal - Three 50% units).

OPERATION

Two operating. One standby. Each unit as specified, consists of two shells. Alternate construction is one shell/unit with 28' long tubes. △1

MATERIALS HANDLED

SHELL SIDE - COMPOSITION OF NON-CONDENSIBLE

CO	26.01% V/V
CO_2	6.79
H_2	22.41
N_2	43.29
CH_4	0.64
C_2+	0.86
	100.00

DESIGN DATA

HEAT EXCHANGED (BTU/HR) 13.56MM (NORMAL) per unit (MAXIMUM)
TRANSFER RATE (BTU/HR-SQ. FT-°F) (SERVICE) (CLEAN)
AREA (FT^2) CORR. LMTD (°F)
TYPE
TUBES NO. OD (IN) 1-1/2" BWG 12 LENGTH (FT.) 14 PITCH (IN.) Square
BAFFLES NO. 10 TYPE Single SHELL I.D. (IN.) 75

PERFORMANCE OF ONE UNIT		Tube Side	Shell Side
FLUID ENTERING		Combined Gas	Cooling Water
CONDENSABLE VAPORS (Water/Oil)	LB/HR	11,131/586	
NONCONDENSABLE VAPORS	LB/HR	74,326	
LIQUID	LB/HR	0	1356 g.p.m.
TOTAL FLUID ENTERING	LB/HR	86 043	
FLUID VAPORIZED OR CONDENSED Water/Oil	LB/HR	7722/586	
SPECIFIC GRAVITY - LIQUID Water/Oil		1.0/0.98	
VISCOSITY Gas In/Out	CP	0.020/0.016	
MOLECULAR WEIGHT - VAPORS (Dry)		23.18	
SPECIFIC HEAT Gas In/Out Btu/#°F		0.316/0.305	
LATENT HEAT - VAPORS Water/Oil	BTU/LB	1025/120	
THERMAL CONDUCTIVITY BTU/HR SQ.FT°F/FT In/Out		0.022/0.018	
FOULING RESISTANCE HR-SQ. FT.°F/BTU		0.003	
TEMPERATURE IN	°F	287	75
TEMPERATURE OUT	°	95	95
OPERATING PRESSURE	PSIG	1.0	
NUMBER OF PASSES			
VELOCITY	FT/SEC.		
PRESSURE DROP	PSI	0.15	
DESIGN PRESSURE	PSIG	5.0	80
DESIGN TEMPERATURE		35	

INSULATION For Personnel Protection Required
MATERIALS OF CONSTRUCTION: TUBES C.S.
SHELL C.S.
GASKETS

REMARKS: 1. See Page 2 for Cooling Curve. △1
2. Unit horizontal - slope 5°

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROCESS SPECIFICATION FOR EXCHANGER	PS-E202 A,B. & C REVISION 1 PAGE 2 OF 3

VENDOR	MANUFACTURER
PROPOSAL NO.	DATE

VENDOR TO PROVIDE EQUIPMENT ITEM(S), PLUS FOLLOWING AUXILIARIES:

COMBINED GAS EXCHANGER - Three Units Required. Each unit will consist of two shells in series. Each Shell specified below.

EQUIPMENT DESCRIPTION

MATERIALS OF CONSTRUCTION:

SHELL Carbon Steel

TUBES Carbon Steel

OUTSIDE AREA PROVIDED

TUBES NO. 1150 O.D. 1-1/2" BWG 12 LENGTH 14' PITCH 1.875" 90°

SHELL I.D. 75" O.D. 76" THICKNESS 1/2"

SHELL COVER

CHANNEL FLOATING HEAD COVER

TUBE SHEETS ☐ STATIONARY CHANNEL COVER

☐ FLOATING

BAFFLES - CROSS NO. 10 TYPE Single 15 % CUT THICKNESS

BAFFLES - LONG NO. No TYPE THICKNESS 0.375"

BAFFLES - IMPINGEMENT

TUBE FASTENING

TUBE SUPPORTS THICKNESS

GASKETS

CONNECTIONS - SHELL IN 8" OUT 8" SERIES

CHANNEL IN 42" OUT 42" SERIES

CORROSION ALLOWANCE SHELLSIDE TUBESIDE

CODE REQUIREMENTS

WEIGHTS EACH SHELL BUNDLE FULL OF WATER

TEST PRESSURE

DESIGN TO TEMA "C"

TEMA TYPE A.E.L.

NOTE: Exchangers to be fitted with 2" nozzle at low point of head for continuous drain of condensate.

(ENG-052-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PROCESS SPECIFICATION FOR EXCHANGER		PS-E202 A,B, & C REVISION 1 PAGE 3 OF 3	
ORIGINAL 0 For Estimate	BY I. Williams	DATE 6/5/78	APPD.	DATE
REVISION 1	BY MJH	DATE 11/29/78	APPD.	DATE

PROJECT NO. 3001

COOLING CURVE DATA

COMBINED GAS COOLER

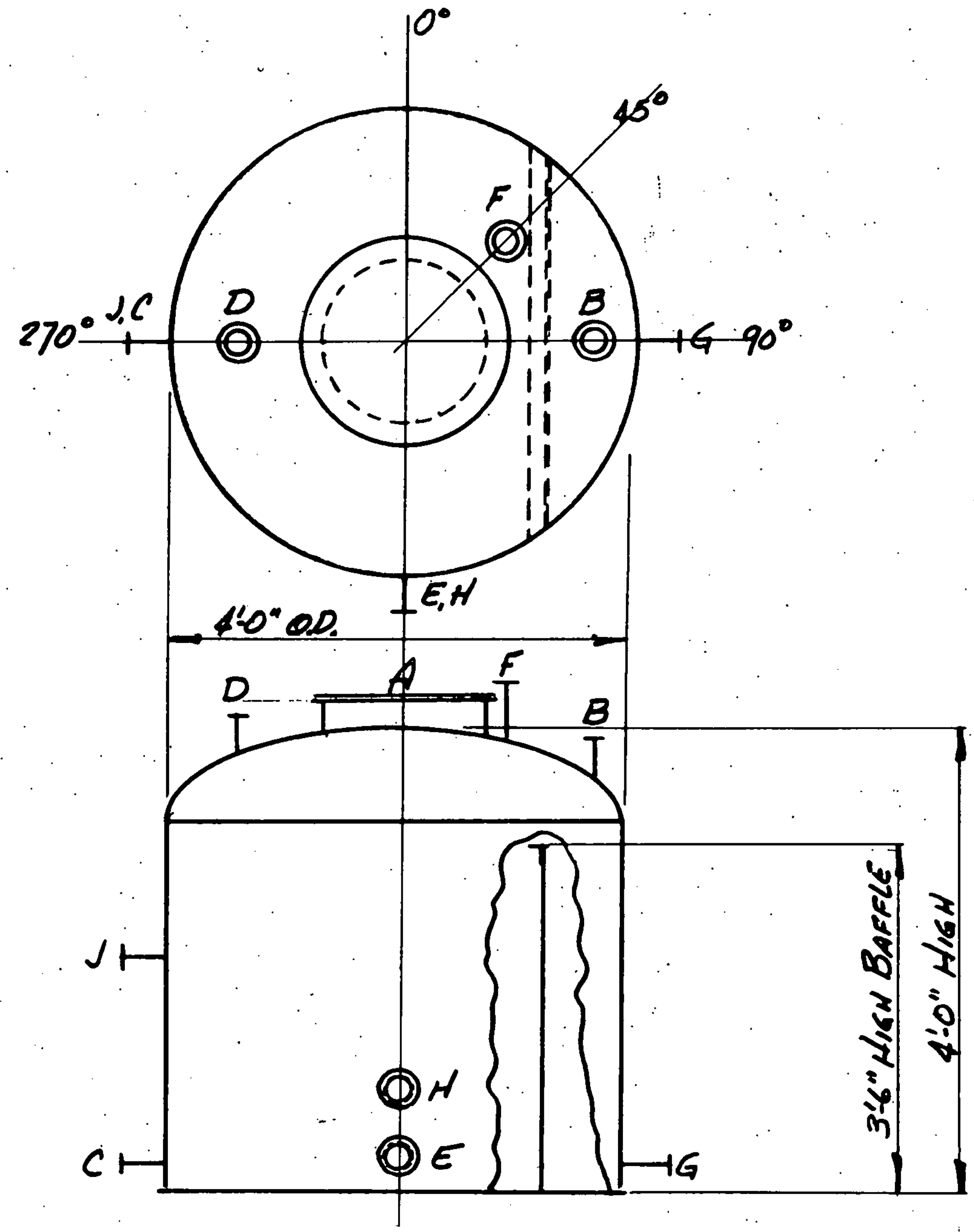
Temp	°F	287	250	200	132	120	110	95
Heat to Be Removed	Btu/hr x 10^{-6}	13.56	12.51	11.05	9.09	5.04	2.64	0
Steam	lb/hr	11,131	11,131	11,131	11,131	7,511	5,484	3,409
Water	lb/hr	-	-	-	-	3,620	5,647	7,722
Oil Vapor	lb/hr	586	586	397	140	95	57	0
Oil Liquid	lb/hr	-	-	189	446	491	529	586

Steam Dew Point 132°F

Oil Dew Point 250°F

(ENG-051-0278)

FORM M906



GENERAL NOTES

1. SPECIFICATIONS PER THE BILL OF MATERIAL.
2. THIS DRAWING IS A SCHEMATIC OUTLINE ONLY FOR ELEVATION & ORIENTATION OF ATTACHMENTS, REFER TO
3. FOR ESTIMATING PURPOSES, VESSEL FABRICATOR SHALL INCLUDE THE FOLLOWING CLIPS:
4. Flow Rate: 4866 lb/hr.

DESIGN DATA

DESIGN PRESSURE Atmos @ 300 °F
OPER. PRESSURE Atmos @ 250 °F
VACUUM DESIGN @ °C, °F
OPER. VAC. COND. @ °C, °F
OPER. HYDROSATIC HEAD
SP. GR. OPER. LIQUID 1.01
CORROSION ALLOWANCE 1/8"
RADIOGRAPHY (FULL) (PARTIAL) (SPOT)
JOINT EFFICIENCY
HEAD TYPE
STRESS RELIEF (REQ'D) (PER CODE)

CODE:
- ASME SECTION VIII, DIV.
- X API 650
- API 620

CODE STAMP (REQ'D) X (NOT REQ'D)
EARTHQUAKE: CODE ZONE
WIND DESIGN BASIS:

MATERIALS OF CONSTRUCTION

SHELL: Carbon Steel HEADS: Carbon Steel
SUPPORT: EXT. CLIPS:
INTERNALS: Carbon Steel BY VESSEL FAB. X
TRAYS: BY OTHERS
BOLTS: EXT. INT. NUTS: EXT. INT.
PIPE: EXT. INT.
FORGINGS:
PACKING: BY OTHERS
GASKETS:

REFERENCES

SUPPORT: SKIRT TYPE & __ LEGS __ LUGS
SADDLES PER STD.
INSUL. SUPP'TS PER STD.
FOR 3" THK. INSULATION Calcium Silicate
FIREPROOFING SUPP'TS PER STD.
REQ'D (I.S) (O.S) OF SKIRT
MANWAY DAVITS/HINGES PER STD.
VESSEL DAVIT PER
STRUCTURAL CLIPS PER SPEC. EXH.
SEE GEN. NOTE 3
PAINT PER SPEC.
LIFTING LUGS (REQ'D) X (NOT REQ'D)

CONTRACT
B/M No. ITEM No.
EQUIP. TAG No. TN 202 No. REQ'D. 1
SERVICE Tar Collection by Gravity

TAR TANK

DRAWN
CHECKED
DATE

Babcock Contractors Inc.

DWG. NO. TK202 REV.

NOZZLE SCHEDULE

MARK	No. REQ'D.	SIZE	RATING	SERVICE	REMARKS	MARK	No. REQ'D.	SIZE	RATING	SERVICE	REMARKS
A	1	24"		Manhole							
B	1	2"		Tar Inlet							
C	1	2"		Tar Outlet (Pump Suction)							
D	1	4"		Vent							
E	1	2"		Drain							
F	1	2"		Level Gage							
G	1	3"		Heater							
H	1	3/4"		Temperature Controller							
J	1	3/4"		Temperature Indicator							

No.	BY	DATE	REVISIONS

POSITIVE DISPLACEMENT PUMP DATA SHEET

Babcock Contractors Inc.

BCI PROJECT 3001, DEMO PLANT
CLIENT: McKee
9/29/78

REVISION BY / DATE	1. JPG 2/2/79	2.	3.	4.	5.	6.	7.	8.

SERVICE Tar Transfer Pump | MOTORS REQ'D Two (2) | TURBINES REQ'D None
NO. REQ'D Two (2) TAG NO. P201 A | TAG NO. 201B | TAG NO.
MFR. | PROVIDED BY | PROVIDED BY
SIZE & TYPE (5) SERIAL NO. | MOUNTED BY | MOUNTED BY

OPERATING CONDITIONS, EACH PUMP

LIQUID Tar — U.S. GPM. at PT. NOR. 4.0 RATED 6.0
DISCH. PRESS., PSIG
PT. F. NOR 250°F MAX 300°F — SUCT. PRESS., PSIG MAX Flooded RATED
SP. GR. at PT 63.24#/ft³ — DIFF. PRESS., PSI
VAP. PRESS. at PT, PSIA <1.0 — DIFF. HEAD, FT 40
VIS. at PT, Ssu (1) CP — NPSHA, FT 25
CORR/EROS. CAUSED BY — HYD. HP

PERFORMANCE

PROPOSAL CURVE NO
RPM — NPSHR (WATER)
EFF. — BHP RATED
MAX. BHP RATED IMP
MAX. HEAD RATED IMP
MIN. CONTINUOUS GPM
ROTATION (VIEWED FROM CPLG END)

CONSTRUCTION

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION				
DISCHARGE				

CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☐ VERT. (TYPE)
-SPLIT: ☐ AXIAL ☐ RAD; TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER
-PRESS ☐ MAX. ALLOW. PSIG °F; ☐ HYDRO TEST PSIG
-CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE
IMPELLER DIA.: ☐ RATED ☐ MAX , ☒ TYPE: Gear
MOUNT: ☐ BETWEEN BRGS ☐ OVERHUNG
BEARINGS-TYPE: ☐ RADIAL ☐ THRUST
LUBE ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ FLINGER ☐ PRESSURE
COUPLING: ☐ MFR ☐ MODEL
DRIVER HALF MTD BY: O PUMP MFG O DRIVER MFR O PURCHASER
PACKING: ☐ MFR & TYPE ☐ SIZE/NO. OF RINGS
MECH. SEAL ☐ MFR & MODEL API CLASS. CODE
☐ MFR CODE

SHOP TESTS

O NON-WIT. PERF O WIT PERF
O NON-WIT. HYDRO O WIT. HYDRO
O NPSH REQ'D. O WIT. NPSH
O SHOP INSPECTION
O DISMANT. & INSP. AFTER TEST
O OTHER

MATERIALS

PUMP: CASE/TRIM CLASS O
BASEPLATE: ☐

AUXILIARY PIPING

O C W PIPE PLAN O CU; O S.S.; O TUBING; O PIPE
☐ TOTAL COOLING WATER REQ'D, GPM O SIGHT F.I. REQ'D
O PACKING COOLING INJECTION REQ'D: ☐ TOTAL GPM ☐ PSIG
O SEAL FLUSH PIPE PLAN O C.S. O S.S. O TUBING O PIPE
O EXTERNAL SEAL FLUSH FLUID ☐ GPM ☐ PSIG
O AUXILIARY SEAL PLAN O C.S. O S.S. O TUBING O PIPE
O AUX SEAL QUENCH FLUID

VERTICAL PUMPS

PIT OR SUMP DEPTH O
MIN. SUBMERGENCE REQ'D ☐
COLUMN PIPE ☐ FLANGED ☐ THREADED
LINE SHAFT: ☐ OPEN ☐ ENCLOSED
BRG. ☐ BOWL ☐ LINE SHAFT
BRG. LUBE ☐ WATER ☐ OIL ☐ GREASE
FLOAT & ROD O C S O S S O BRZ O NONE
FLOAT SWITCH ☐
PUMP THRUST, LB ☐ UP ☐ DOWN

MOTOR DRIVER

HP , RPM FRAME VOLTS/PHASE/CYCLES 440/3/60
MFR BEARINGS LUBE
TYPE INSUL FULL LOAD AMPS
ENC. TEMP RISE, C LOCKED ROTOR AMPS
O VHS O VSS VERT THRUST CAP, LB

APPROX WT, PUMP & BASE
MOTOR TURBINE

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED.

(1) Viscosity equal to #6 fuel oil.
(2) Ambient conditions: -42 to +102°F. 13.9 psia.
(3) No copper, brass, or aluminum pump parts allowed.
(4) Motor for Class 1, Group D, Division 2 use.
(5) Jacketed rotary positive displacement pump.

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROCESS SPECIFICATION FOR OIL/WATER SEPARATOR			PS-TK 201A REVISION 0 PAGE 1 OF 2	
ORIGINAL	BY J. Garvin	DATE 7/20/78	APPD.		DATE
REVISION 0 For Estimate	BY M.J.H.	DATE 8/18/78	APPD.		DATE
CLIENT: McKee				PROJECT NO. 3001	

Number of Units: One (1)

Duty: Separation of Oil and Condensate (water).

Ambient Conditions: Outdoor installation in a heavy industrial environment. Ambient temperature range minus 42^{o} to 102^{o}F. Barometric pressure 13.85 psia.

Service Requirements: Continuous, un-attended operation.

Liquid Flow Rates:

Material	#/hr.		$\#/ft.^3$
Condensate	10,048		62.00
Oil	2,340	(3,000 max.)	60.76
Total flow to separate	12,388		---

Small amounts of fine solids are present.

Liquid Temperature: 95^{o}f (110 max).

Separation Requirements: The unit shall function as a primary separator to remove most of the free oil. Secondary treatment shall be by others.

The separated water stream shall contain 100 ppm oil or less.

Design: The separator shall contain the following functional parts:

1. A gravity separation compartment.
2. An oil skimming device (wier, pipe, etc.).
3. An oil sump, to receive skimmed oil.
4. Two (2) oil pumps, P203 A & B (one operating, one standby). Each pump shall have a capacity of 150% design maximum oil flow at 40 ft. TDH. If the pumps are mounted on the separator, they shall be self priming.
5. A condensate sump to receive oil-free condensate.
6. Two (2) condensate pumps, P202 A & B (one operating, one standby). Each pump shall have a

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROCESS SPECIFICATION FOR OIL/WATER SEPARATOR		PS- TK 201 A REVISION 0 PAGE 2 OF 2	
ORIGINAL	BY J. Garvin	DATE 7/20/78	APPD.	DATE
REVISION 0 For Estimate	BY M.J.H.	DATE 8/18/78	APPD.	DATE
CLIENT: McKee			PROJECT NO. 3001	

Design: (Con't.)

capacity of 150% of design condensate flow at 40 ft. TDH.

7. A solids removal device capable of continuous or intermittent operation. Solids may be removed by a sludge pump P204A.
8. Immersion heaters for freeze protection.
9. Controls - All controls needed for operation.
10. Steel is preferred as a material of construction. Copper, brass or aluminum shall not be used.

Electrical Classification:

1. The area is classified Class I, Group D, Division 2.
2. Motors over 1/2 HP shall be 480V 3 phase, 60 cycle, TEFC.

Installation:

The unit will be installed outdoors, on-grade on a concrete pad. A skid mounted unit shall be furnished. Vendor shall provide access ladders and platforms to top of unit. (Installation by others.)

Data Sheet:

Bidder shall complete attached data sheet.

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PROCESS SPECIFICATION FOR COAL FEEDER			PS- MF 202 A to E REVISION 0 PAGE 1 OF 1
ORIGINAL	BY MJH	DATE 6/8/78	APPD.	DATE
REVISION 0 For Estimate	BY	DATE 8/22/78	APPD.	DATE
CLIENT: McKee				PROJECT NO. 3001

No. Required: Five

Duty: To convey coal from the base of the coal surge hopper BN 201 A to E to the lock hopper MF 201 A to E.

Design Basis: 1.85 x 10^9 Btu/day, Western coal, 25% overcapacity. Fill lock hopper in 15 seconds.

Flow Rate: Design: 690#/15 sec.
165,600 #/hr.
83 tons/hr.

Average Design Rate: 13,805 #/hr.

Material Handled: Coal within the size range 1/2" to 1 1/2".
Max. temperature of coal - 200°F.
Bulk density - 50 #/ft.^{3}.

Dimensions: To suit layout.

Motor: Class II, Div. I, Group F.
Electric supply: 480V, 3 ph, 60 Hz.

Control: Feeder stop/starts in sequence with MF 201 A to E.

TYPE OF FEEDER: May be vibrating or belt type.

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROCESS SPECIFICATION FOR OIL PRECIPITATOR			PS- X 202 A/B/C REVISION 0 PAGE 1 OF 2
ORIGINAL 0 FOR ESTIMATE	BY T.W.	DATE 6/9/78	APPD. M.J.H.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: McKee				PROJECT NO. 3001

Design Basis: 10 billion Btu/day, 10% overcapacity. No standby.

No. Req'd: 3

Duty: Removal of oil droplets and dust from coal gas (combined gas).

Gas Analysis:	Vol. %	Range	Typical
	CO	25.0 - 26.5	25.36
	CO_2	5.5 - 7.5	6.08
	H_2	19.0 - 23.0	19.68
	N_2	42 - 49	47.26
	CH_4	0.5 - 1.0	0.70
	C_2+	0.1 - 0.4	0.29
	H_2S	0.1 - 1.0	0.64
	COS	0.05	
	NH_3	0.5	
	HCN	0.01	
			100.00
	Molecular Wt.		23.83

Oil and Dust Content: lbs./1000 SCF of dry gas expected to be less than 0.15

Moisture Content: lbs./1000 SCF of dry gas 2.3 - 2.81 (i.e. saturated at operating conditions)

Gas will also contain Phenols and Chlorides.

Operating Conditions:	Normal	Maximum
Temperature: $^{\circ}F$	95	105
Pressure: inches WG.	22	25

Note: Atmospheric Pressure = 13.85 psia.

Oil Properties:

SG.: 0.93 - 0.98
Viscosity: Approx. 3.0° Engler at 68°F

Oil will be free flowing at operating conditions.

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROCESS SPECIFICATION FOR OIL PRECIPITATOR			PS- X.202 A/B/C REVISION O PAGE 2 OF 2
ORIGINAL O FOR ESTIMATE	BY I.W.	DATE 6/9/78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: McKee				PROJECT NO. 3001

Capacity:

Coal Source:		Western	Eastern	Design
Dry Gas:	SCFH	2,435,000	2,560,000	
Moisture:	SCFH	144,000	157,000	
Total:	SCFH	2,579,000	2,717,000	2,989,000
Actual flow at operating conditions:	CFH	2,770,000	2,918,000	3,210,000

Note: These are the total flowrates through all the precipitators operating in parallel flow.

Performance Required:

Oil removal efficiency: *not less than 99%.

Pressure drop: *not more than 1.0 inches WG.

Vendor is to specify the performance that will be obtained in terms of tar removal efficiency and pressure drop at the design flowrate when one unit is off line.

Power Source: 460 volts 60 Hertz 3 Phase

Area Hazard Classification: Class I, Div. II, Group D

Purge Gas: Vendor to design unit for minimum continuous purge gas at electrodes. Vendor to advise purge requirements.

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROCESS SPECIFICATION FOR FLARE STACKS			PS-X 206 A to C REVISION 0 PAGE 1 OF 2
ORIGINAL 0 FOR ESTIMATE	BY Hemingway	DATE 6/9/78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: McKee				PROJECT NO. 3001

No. Required: Three

Design Basis: One stack per two gasifiers. Flare to be able to handle total gas production from one gasifier.

Duty: To burn off specification gas produced by a coal gasification unit during start up, shutdown and under emergency conditions.

Type: May be elevated flare stack, or enclosed cabin type ground flare.

Gas Analysis: Vol.%	Max. Range	Typical	Min.
CO	24.5 - 26.0	25.93	0
CO_2	5.5 - 7.5	7.02	21
H_2	19 - 23	22.28	0
N_2	42 - 47	42.96	79
CH_4	0.8 - 2.0	0.87	0
C_2+	0.2 - 1.0	0.24	0
H_2S	0.1 - 1.0	0.18	0
COS	0.05	0.05	0
NH_3	0.5	0.46	0
HCN	0.01	0.01	0
		100.00	
Molecular Wt.		23.2	

Tar Content: lbs./1000 SCF of dry gas 0 - 5

Moisture Content: lbs./1000 SCF of dry gas 3 - 15

Dust Content (coal or ash): lbs./1000 SCF of dry gas 0 - 0.05

Gas will also contain Phenols and Chlorides.

Gas Heating Value:

The maximum heating value on a dry, tar free basis is 170 Btu/dry SCF.

The effective maximum heating value, including tar is 250 Btu/dry SCF.

During start up and shutdown, the HHV of the gas to the flare will vary between 0 Btu/dry SCF and the maximum value.

(ENG-050-0278)

Gas Flow Rate:

The gas flow rate, at any composition between the maximum, and a minimum value equivalent to 50 Btu/SCF can vary between:

	Maximum	Minimum
SCFH dry gas	451,800	112,950
SCFH	86,620	21,655

Supplementary Firing:

Vendor shall include provision for supplementary firing of the flare with natural gas if the gas HHV falls below 50 Btu/SCF. This supplementary firing will be manually initiated.

During supplementary firing, the maximum gas flow rate to the flare will be:

SCFH dry gas	225,900
SCFH water vapor	43,310

Temperature:

For any flow rate or composition given above, the temperature of the gas can vary between 1200°F and 230°F.

Pressure:

Maximum	60" w.g.
Normal	30" w.g.
Minimum	12" w.g.

Vendor is to design flare to operate at maximum flow rate, with 20" w.g. pressure drop.

Ignition & Pilot:

Natural gas or propane will be available for use. Vendor is to recommend if natural gas is required to ensure satisfactory combustion of low heating fuels.

Purging:

Nitrogen or carbon dioxide will be available for purging the line to the burner. Vendor is to include a seal, such as a fluidic seal to minimize the amount of purge gas required. Vendor is to advise BCI of the purge gas required.

Overall Height: The overall height from the base of the flare to the discharge of the stack is to be 70 ft.

VERTICAL PUMP DATA SHEET

Babcock Contractors Inc.

BCI PROJECT 3001, DEMO PLANT
CLIENT: McKee
9/29/78

REVISION BY DATE	1. JPG 2/2/79	2	3.	4.	5.	6.	7.	8.

SERVICE Chemical Sump Pump MOTORS REQ'D Yes TURBINES REQ'D No
NO. REQ'D One (1) TAG NO. P-205 TAG NO. TAG NO
MFR. PROVIDED BY PROVIDED BY
SIZE & TYPE (1) SERIAL NO. MOUNTED BY MOUNTED BY

OPERATING CONDITIONS, EACH PUMP

LIQUID (5) U.S. GPM. at PT. NOR 150 RATED 150
DISCH. PRESS., PSIG 30
PT. F. NOR. 60°F MAX 95°F SUCT. PRESS., PSIG MAX RATED
SP. GR. at PT 8.3 lb/ft^3 DIFF. PRESS., PSI
VAP. PRESS. at PT, PSIA 7.0 DIFF. HEAD, FT
VIS. at PT, Ssu. CP. 20 NPSHA, FT See Sketch
CORR/EROS CAUSED BY Particles Max 1/4" HYD. HP

PERFORMANCE

PROPOSAL CURVE NO
RPM NPSHR (WATER)
EFF BHP RATED
MAX. BHP RATED IMP
MAX. HEAD RATED IMP
MIN. CONTINUOUS GPM
ROTATION (VIEWED FROM CPLG END)

CONSTRUCTION

NOZZLES	SIZE	RATING	FACING	LOCATION
SUCTION				
DISCHARGE				

CASE-MOUNT: ☐ CENTERLINE ☐ FOOT ☐ BRACKET ☒ VERT. (TYPE) Centrifugal
-SPLIT: ☐ AXIAL ☐ RAD; TYPE VOLUTE ☐ SGL ☐ DBL ☐ DIFFUSER
-PRESS ☐ MAX ALLOW PSIG °F; ☐ HYDRO TEST PSIG
-CONNECT: ☐ VENT ☐ DRAIN ☐ GAGE
IMPELLER DIA.: ☐ RATED ☐ MAX , ☐ TYPE:
MOUNT: ☐ BETWEEN BRGS ☐ OVERHUNG
BEARINGS-TYPE: ☐ RADIAL ☐ THRUST
LUBE: ☐ RING OIL ☐ FLOOD ☐ OIL MIST ☐ FLINGER ☐ PRESSURE
COUPLING: ☐ MFR. ☐ MODEL
DRIVER HALF MTD BY: X PUMP MFG O DRIVER MFR O PURCHASER
PACKING: ☐ MFR & TYPE ☐ SIZE/NO. OF RINGS
MECH. SEAL: ☐ MFR & MODEL API CLASS. CODE
☐ MFR CODE

SHOP TESTS

O NON-WIT. PERF O WIT. PERF
O NON-WIT. HYDRO O WIT. HYDRO
O NPSH REQ'D. O WIT. NPSH
O SHOP INSPECTION
O DISMANT. & INSP AFTER TEST
O OTHER

MATERIALS

PUMP: CASE/TRIM CLASS O
BASEPLATE: ☐

AUXILIARY PIPING

O C W PIPE PLAN O CU; O S.S.; O TUBING; O PIPE
[ ] TOTAL COOLING WATER REQ'D, GPM O SIGHT F.I. REQ'D
O PACKING COOLING INJECTION REQ.D ☐ TOTAL GPM ☐ PSIG
O SEAL FLUSH PIPE PLAN O C.S. O S.S. O TUBING O PIPE
O EXTERNAL SEAL FLUSH FLUID ☐ GPM ☐ PSIG
O AUXILIARY SEAL PLAN O C.S. O S.S. O TUBING O PIPE
O AUX. SEAL QUENCH FLUID

VERTICAL PUMPS

PIT OR SUMP DEPTH O See Sketch
MIN. SUBMERGENCE REQ'D ☐
COLUMN PIPE: [ ] FLANGED [ ] THREADED
LINE SHAFT: XX OPEN ☐ ENCLOSED
BRG: ☐ BOWL ☐ LINE SHAFT
BRG. LUBE [ ] WATER [ ] OIL XX GREASE
FLOAT & ROD O C S X S S O BRZ O NONE
FLOAT SWITCH ☒
PUMP THRUST, LB ☐ UP ☐ DOWN

MOTOR DRIVER

HP. , RPM 1800 FRAME VOLTS/PHASE/CYCLES 440/3/60
MFR. BEARINGS LUBE Grease
TYPE INSUL. FULL LOAD AMPS
ENC. TEMP RISE, C. LOCKED ROTOR AMPS
O VHS O VSS VERT THRUST CAP., LB.

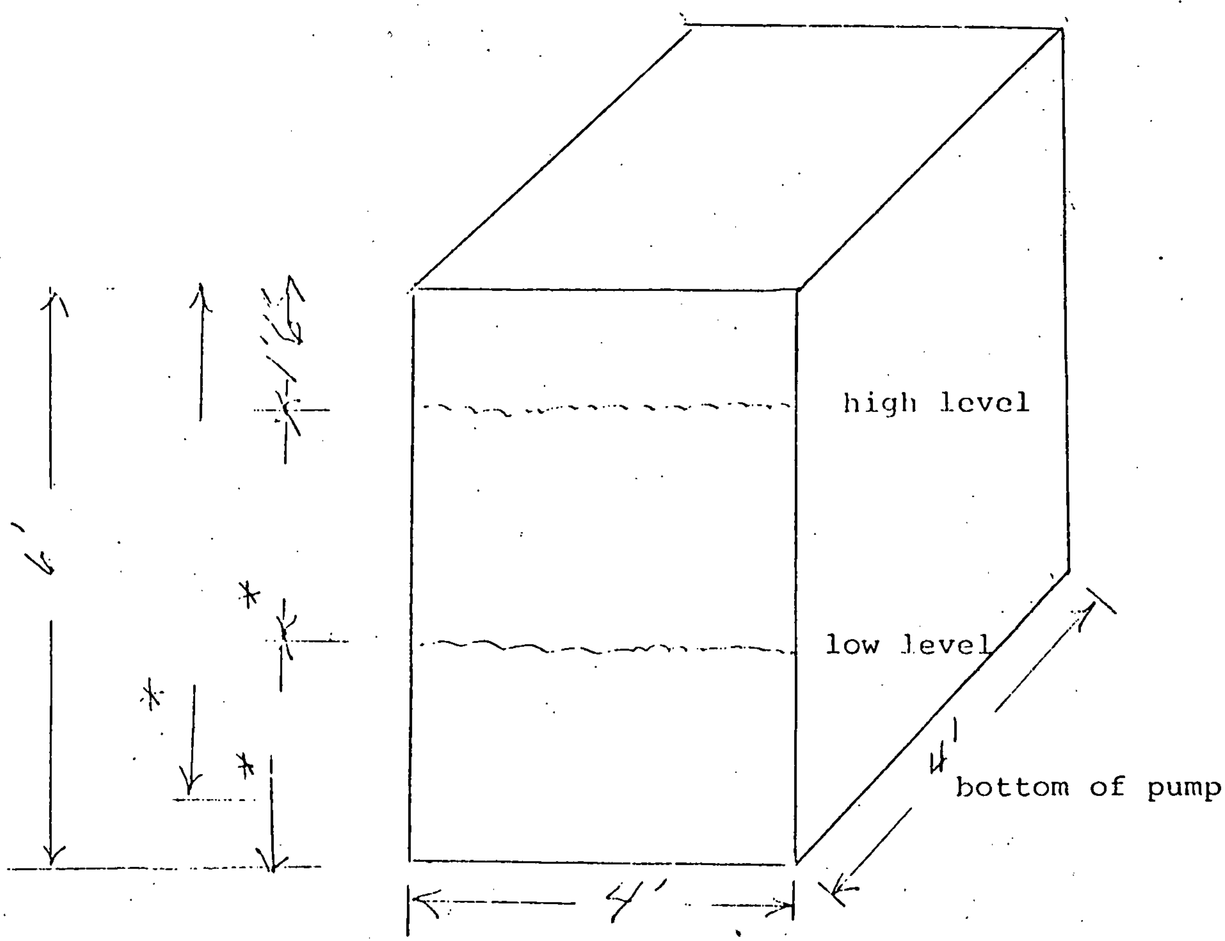
APPROX WT. PUMP & BASE
MOTOR TURBINE

API STANDARD 610 GOVERNS UNLESS OTHERWISE NOTED.

(1) Vertical Sump Pump with base plate and float switch.
(2) Ambient Conditions: -42 to +102°F. 13.9 psia.
(3) No copper, brass, or aluminum pump parts.
(4) Motor for Class 1, Group D, Division 2.
(5) Alkaline Water containing up to 10% tar and oil. Plus ammonia and cyanide.

TK204 sump for P205 Chemical Sump Pump.

Concrete construction.



NOTES:

1. Number of steady bearings *__________

2. Lubricant (prefer water, vendor cyclone)
   *____

3. Bearing material *______________________________

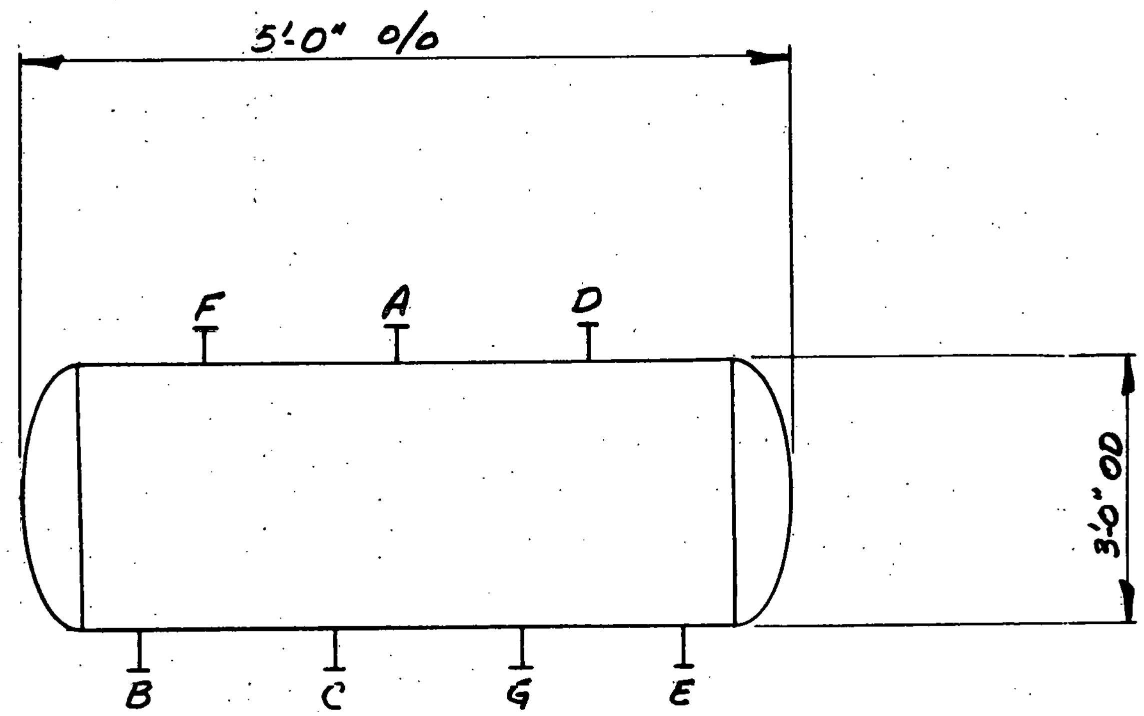
4. Steel pit cover to support pump base plate and with pit access plate. (Not by pump Vendor.) 2" vent to 10' height.

*Information by Vendor.

FORM M906

GENERAL NOTES

1. SPECIFICATIONS PER THE BILL OF MATERIAL.
2. THIS DRAWING IS A SCHEMATIC OUTLINE ONLY FOR ELEVATION & ORIENTATION OF ATTACHMENTS. REFER TO
3. FOR ESTIMATING PURPOSES, VESSEL FABRICATOR SHALL INCLUDE THE FOLLOWING CLIPS:
4. Flow Rate (lb/hr) from 125 psig System
   - Flash Steam: 301
   - Liquid Blowdown: 1709
   - Total: 2010
5. Flow Rate (lb/hr) from 25 psig System
   - Flash Steam: 78
   - Liquid Blowdown: 1242
   - Total: 1320



NOZZLE SCHEDULE

MARK	No. REQ'D.	SIZE	RATING	SERVICE	REMARKS	MARK	No. REQ'D.	SIZE	RATING	SERVICE	REMARKS
A	1	24"	150FF	Manhole							
B	1	3"	150RF	125 psig Blowdown							
C	1	2"	"	25 psig Blowdown							
D	1	6"	"	Vent							
E	1	2"	"	Blowdown Drain							
F	1	2"	"	Spare							
G	1	3"	"	Spare							

No.	BY	DATE	REVISIONS

DESIGN DATA

DESIGN PRESSURE	5 psig @ 400 °C, °F
OPER. PRESSURE	2 psig @ 218 °C, °F
VACUUM DESIGN	Full @ -- °C, °F
OPER. VAC. COND.	@ °C, °F
OPER. HYDROSTATIC HEAD	
SP. GR. OPER. LIQUID	
CORROSION ALLOWANCE	1/8"
RADIOGRAPHY	(FULL) (PARTIAL) (SPOT)
JOINT EFFICIENCY	
HEAD TYPE	
STRESS RELIEF	(REQ'D) (PER CODE)
CODE:	X ASME SECTION VIII, DIV.
	API 650
	API 620
CODE STAMP	(REQ'D) X (NOT REQ'D)
EARTHQUAKE: CODE	ZONE
WIND DESIGN BASIS:	

MATERIALS OF CONSTRUCTION

SHELL:	HEADS:
SUPPORT:	EXT. CLIPS:
INTERNALS:	BY VESSEL FAB.
TRAYS:	BY OTHERS
BOLTS: EXT. INT.	NUTS: EXT. INT.
PIPE: EXT.	INT.
FORGINGS:	
PACKING:	BY OTHERS
GASKETS: 1/8" Compressed Asbestos	

REFERENCES

SUPPORT: SKIRT TYPE & __ LEGS __ LUGS

SADDLES X PER STD.

INSUL. SUPP'TS PER STD.

FOR 3" THK. INSULATION Calcium Silicate

FIREPROOFING SUPP'TS PER STD.

REQ'D (I.S) (O.S) OF SKIRT

MANWAY DAVITS/HINGES PER STD.

VESSEL DAVIT PER

STRUCTURAL CLIPS PER SPEC. EXH.

SEE GEN. NOTE 3

PAINT PER SPEC.

LIFTING LUGS (REQ'D) X (NOT REQ'D)

CONTRACT

B/M No. ITEM No.

EQUIP. TAG No. TN203 No. REQ'D. 1

SERVICE 125 & 25psig Flash Steam

FLASH TANK

DRAWN

CHECKED

DATE

Babcock Contractors Inc.

DWG. NO. TK203 REV. 1

3.3

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 3.0 - EQUIPMENT LIST AND SPECIFICATIONS

3.3 Equipment Specifications (Mechanical)

Spec. No.	Description
R201/SR2	Refractory Installation (Unstirred Gasifier)
R201/SR3	Refractory Materials (Unstirred Gasifier)
R201/SR4	Refractory Installation (Stirred Gasifier)
R201/SR5	Refractory Materials (Stirred Gasifier)
R201/SR6	Refractory Installation - Conversion Unstirred to Stirred
R201/SR7	Refractory Installation - Conversion Stirred to Unstirred
R201/GA	Gasifier Grate Castings
PSW/201	Gasifier Grate Hydraulic System
PSW/202	Gasifier Grate Lubrication System
E202A/B/C	Combined Gas Coolers
CY201	Dust Cyclones
CY202	Tar Cyclones
R201/PV1	Coded Pressure Vessels
R201/PV2	Non-Coded Vessels
B201	Combustion Air Blowers

DOE Contract ET-78-C-01-2578
McKee Contract 2814A/W2
BCI Contract 3001

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	SPECIFICATION FOR REFRACTORY INSTALLATION (UNSTIRRED GASIFIER)			SP- R201/SR2 REVISION 1 PAGE 1 OF 4
ORIGINAL	BY B. RUDDER	DATE 7/14/78	APPD. J. KUSNERUS	DATE 7/20/78
REVISION	BY B. RUDDER	DATE 8/4/78	APPD. J. KUSNERUS	DATE 8/14/78
CLIENT: A. G. McKee & Co., Cleveland, Ohio				PROJECT NO. 3001

1.0 SCOPE

1.1 This specification covers methods and details for installation of refractory brick shapes, castables, insulating castables and high temperature insulation in the lining of a coal gasifier. See Babcock Contractors Inc. (BCI) Dwgs. M-330, M-331, M-334 and M-305.

1.2 The following material specification will be used with this installation specification:

Babcock Contractors Inc. SP-R201/SR3

2.0 GENERAL

2.1 The refractory lining will be installed by the Contractor in accordance with his published standard general practices and in accordance with good and accepted practices of the respective trades, this Specification, and all applicable Codes, Regulations and Ordinances, and BCI instructions.

2.2 The Contractor is totally responsible for the quality of materials and installation workmanship. In addition to the usual brickmason supervision (one supervisor-foreman for each gasifier being worked), the refractory manufacturer will provide full time, experienced technical representation to train installation personnel (craft and supervisors) in the manufacturer's recommended installation techniques and methods, as well as constantly inspecting their work to insure compliance with these techniques and methods and the provisions of paragraph 2.1.

2.3 Babcock Contractors Inc. reserves the right to inspect the installation at all times; to halt and/or reject work; and require replacement of deficient work.

2.4 The Contractor is responsible for safety practices for his work and compliance with OSHA regulations. BCI general job site safety practices are also to be followed.

2.5 The Contractor will make his own bill of materials from BCI design drawings, and include his own allowances for breakage, wastage and extras.

2.6 Gasifier shell will be in place ready for refractory installation. Upper adjacent parts will be installed after completion of refractory work.

2.7 Contractor will perform any welding the refractory installation requires.

2.8 Interior surfaces will not be cleaned and primed with paint.

(ENG-050-0278)

3.0 WORK BY OTHERS

3.1 Furnish and erect gasifier shell.

3.2 Initial drying and firing of gasifier refractory lining.

4.0 INSTALLATION

4.1 In no case will brick shapes be laid, or castable refractory poured, when the materials themselves and/or the mixing water, and/or the ambient air is below freezing temperatures. A 48 hour cure of the in-place refractory is required before exposure to freezing temperatures.

4.2 Mortar Joints

4.2.1 Tight brick-to-brick bed joints, where possible, are most desirable, with a maximum of 1/8" allowable. Vertical joints are to be 1/8" maximum.

4.2.2 "Dipped" or troweled joints may be used where appropriate. "Dipping consistency" is determined by the 1" float test (1" is exposed when 9" straight is gently lowered flat into the mortar).

4.2.3 The natural clearance of 1/8" between the standard 9/16" radius tongue and the 11/16" radius groove allows for tight brick-to-brick joints and a full 1/8" mortar gas seal which is the principal purpose of the tongue and groove shapes.

The 4-1/2" circular tongue and groove inner lining is made up of (at any given elevation) a combination of different lengths of shapes #21, #22, #23 to allow for 1/16" to 1/8" thick vertical joints. This eliminates cutting and provides for a good "gas tight" lining.

A liberal amount of extra shapes #21 and #22 should be shipped to allow for variations in the combinations due to slightly off-size brick since 1/8" joints are maximum permitted.

4.3 Brick Cutting

4.3.1 Saw-cutting of shapes, where required, will be by power saw using wet cutting, diamond edge blades.

4.3.2 The refractory design minimizes cutting to fit. However, the contractor is responsible for all cutting of refractories that is required to properly install the refractory lining. Extras for cutting will not be allowed.

4.3.3 Shape #24 must be cut to size for each course to form the sloping center core.

4.3.4 Shape #26 must be cut to size for each course to form the tapered, spoked partition walls.

4.3.5 Shape #25 must be cut to fit where they notch into or abut the center core wall and the cylindrical lining.

4.3.6 At the five gas outlets into the upper plenum from the spoked partition walls, shapes #21 and #22 are toothed into shape #25 to stabilize the corners. Cross-notches or cross-grooves must be cut into the longitudinal grooves of the overlapping brick shapes to accommodate the notch of the brick shape below. Thus the intersecting courses will be locked together by the cross groove on each course.

4.4 Techniques

4.4.1 Care must be taken to establish a plumb, vertical center line in order to install perfectly centered brick rings of a uniform taper in courses that are level across the entire gasifier at any elevation.

4.4.2 Shape #6 should be centered and set level to the correct I.D. The resultant gap between the back of #6 and the steel shell is to be grouted with high strength castable to insure solid backing.

4.4.3 The proper setting of shapes #7, #8 and #9 are essential to proper contour and support of the upper walls.

4.4.4 The elevation of the arch forms to hold the five partition walls and the tapered center core wall is also critical to insure level courses across the entire furnace. Shapes #32 thru #36 must be cut to fit the course elevations.

4.5 Castable Refractory Installation

4.5.1 It is intended, where practical, to remove all forms for inspection of the formed surfaces.

4.5.2 If the Contractor so chooses, he may install the outside castable wall of the plenum and the distribution udders by the use of a pneumatic gun, rather than conventional casting methods, provided a designed-for-gunning mix is used.

4.5.3 All form surfaces or insulation in contact with wet castable must be water-proofed and as water-tight as possible.

4.5.4 No holes for anchor attachment are to be drilled or burned through gasifier shell. All connections to the shell shall be welded to the shell by the refractory contractor in the field.

4.5.5 All anchorage is to have flexible linkage to gasifier shell so as to provide for differential of thermal expansion between gasifier shell and the supported refractory.

4.5.6 Two 9" x 4-1/2" x 3" sample "bricks" will be cast from each shift's pour with a permanent numbering system that identifies brand name, date of cast, code date of manufacture and exact location in gasifier. These sample bricks will be retained by BCI for future reference and verification of quality.

5.0 DRYING AND FIRING REFRACTORY LINING

5.1 The Contractor will furnish, in writing, detailed instructions for the dry-out and initial firing of the refractory lining, including a specific time-temperature schedule.

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	SPECIFICATION FOR REFRACTORY MATERIALS (UNSTIRRED GASIFIER)			SP- R201/SR3 REVISION 1 PAGE 1 OF 4	
ORIGINAL	BY B. RUDDER	DATE 7/14/78	APPD. J. KUSNERUS	DATE 7/20/78	
REVISION	BY B. RUDDER	DATE 8/4/78	APPD. J. KUSNERUS	DATE 8/14/78	
CLIENT: A. G. McKee & Co., Cleveland, Ohio				PROJECT NO. 3001	

1.0 SCOPE

1.1 This specification covers the refractories and insulating materials for lining an unstirred coal gasifier on Babcock Contractors Inc. (BCI) Dwgs. #M-330, #M-331, #M-334 and #M-305.

1.2 All ASTM Specifications referred to are to be the latest edition.

2.0 OPERATING CONDITIONS

2.1 Analysis of product gas in contact with refractories:

Ingredient	Gas #1	Gas #2
CO	25.397 % Vol.	25.099 % Vol.
CO_2	6.086	5.910
CH_4	0.114	0.079
H_2	22.732	19.399
H_2O	2.683	2.203
H_2S	0.181	0.460
N_2	42.808	46.851
	100	100

2.2 Temperatures of gases in contact with refractory.

2.2.1 1300°F. maximum in wall flues, plenum and outlet nozzle.

2.2.2 The gasifier is filled with coal and gases which vary in temperature from 1300°F. maximum at the bottom to 400°F. maximum (250°F. normal) at the top.

2.3 Pressure of gases varies between 60 and 40 inches water.

3.0 REFRACTORY AND INSULATING MATERIALS

3.1 Firebrick Shapes

3.1.1 All to be High Fired, Super Duty - A. P. Green KX-99, Harbison-Walker Varnon, or approved equal.

(ENG-050-0278)

3.1.2 Brick Shape Size Tolerances

The complexity of design requires close adherence to brick shape dimensions. The total variations on length and width of 95% of all brick shapes in the lining shall not exceed 3/16".

The total variation on thickness of 95% of all brick shapes in the lining shall not exceed 1/8". For all brick shapes which have the "same nominal thickness and/or length", the "same average thickness and/or length" shall be furnished. The "same average thickness" shall be interpreted to be obtained if 95% of ten-high stacks shall fall within the same 1/2" range. Not more than 1/4" wedging in stacks of ten-high is permitted.

All critical surfaces of 95% of all brick shapes shall be within 1/16" total deviation from true plane surfaces.

95% of all brick shapes shall be free of distortions, kiln marks, injurious cracks, internal fissures, cavities, folds, laminations or discolored centers. All critical corners and edges shall be filled out and be sufficiently strong to prevent excessive crumbling or chipping when handled.

All brick shapes will be inspected and approved by BCI at point of manufacture before shipment to job site. Mock lay-ups will be made to insure fit of critical shapes. Quality control documents and test data on all products will be provided to BCI representatives at time of inspection.

Particular Concerns:

a) The 5-13/16" thickness dimension on shapes #21, #22, #23, #24, #25 as each course must be flat and uniform thru height of gasifier.

b) The arc lengths of shapes #21, #22, #23 to insure "no-cutting" and five uniform lining segments.

c) Arc lengths and true, flat, radial surfaces of shape #9, #10, #11 to insure equal flue spacings and a tight self-supporting ring.

d) The arc lengths of shapes #19 and #20 to insure 35 equal flue spaces around circumference.

e) The 3" thickness of shapes #1, #2 and #4; 9" thickness #3 and 4-1/2" width of shape #5 to provide uniform elevation at bottom of shape #6.

3.1.3 Brick Shape Fabrication

The cutting to fit and/or cut-modification of one shape to form another, as is designated on BCI drawings, is to eliminate excessive mold or die fabrication costs. However, for each brick shape the Contractor will determine the most economical method of manufacturing the shape in question. That is, cutting from existing shapes or fabricating a new mold to form the shape. In either case, the shape should be fabricated at the brick plant after BCI approval of the method to be used.

Exceptions may be shapes #32 thru #36, #6A, #6B, #6C, #7A, #7B, #7C, #8A, #8B, #9A, #12, #24, #26, #28 which the contractor may elect to cut all (or some) at the job site using wet cutting, diamond edge saw blades.

3.1.4 Brick Shape Branding

Contractor will use his standard method of branding special shapes designating the shape as "BCI - Item Number" -- Example: "BCI-26".

Cut shapes will be ink stenciled "BCI - (Item Number)" - Examples: "BCI-1A" "BCI-6A"

Shapes #21 and #22 must be ink stenciled BCI-21 and BCI-22 on inner curved face.

3.2 Refractory mortar for laying firebrick to be high temperature, high strength, carbon monoxide resistant, air setting - Harbison Walker Super Harbond, A. P. Green #36 Cement, General Refractories Greflok 3000A, or approved equal.

3.3 Refractory castable #39 and #40 to be high strength, abrasion and carbon monoxide resistant concrete with specifications as follows:

3.3.1 "Unaffected" by carbon monoxide in 60 hour ASTM Test Method C-288 - 1000°F. preheat.

3.3.2 Linear Reheat Change: Less than 0.5% shrinkage after 5 hours at 2000°F. ASTM Method C-269.

3.3.3 Volume Reheat Change: Less than 1.7% shrinkage after 5 hrs. at 2000°F. per ASTM Method C-269.

3.3.4 Modulus of Rupture: At least 750 psi after firing at 500°F. and 1200°F. per ASTM Method C-268.

3.3.5 Materials to be A. P. Green R-2007 stock line castable, General Refractories Brikast XCM-L.I., Harbison-Walker Harcast BF or approved equal.

3.3.6 Quality control test data on the foregoing ASTM Specifications will be provided to BCI representatives at time of brick shape inspection.

3.4 Refractory castable #43 to be high strength, abrasion-resistant concrete, General Refractories H.S. Basicrete, A. P. Green Greencrete ARC, Harbison-Walker HAR Chrome G-W-F, or approved equal.

3.5 Insulating Castable Refractory to be "iron free", carbon monoxide resistant, approximately 50 lbs. per cubic foot - A. P. Green VSL-50, Harbison Walker Light Weight Castable L.I., General Refractories Litecast 50 L.I., or approved equal.

3.6 High Temperature Block Insulation to be "iron free", carbon monoxide resistant, Johns-Manville Super-X 1600, or approved equal.

4.0 ANCHORS/SPACERS

4.1 Refractory anchors/spacers #28 to be same (or better) quality as fire-brick shape with "floating" type alloy linkage to the steel shell.

4.2 Metallic anchors #27 to be 304 S.S. (or higher alloy) rod "V" type with 60° central angle, extending 2/3 the thickness of supported refractory bolted to steel shell. Harbison-Walker H&W 3A, A. P. Green VS Type, General Refractories VC140, or approved equal.

4.3 Metallic anchors #44 to be bent 1/4" dia. carbon steel "V" type with 60° central angle welded directly to shell of distributor extending 2/3 thickness of castable refractory.

5.0 WIRE FIBER REINFORCEMENT

For high strength castable refractory #40 & #43. To be used at a rate of four (4) pounds for each 100 pounds of castable in an alloy recommended by the contractor appropriate to the gas atmosphere and temperatures, as manufactured by Ribtec Corporation, National Standard Corporation, or approved equal.

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	SPECIFICATION FOR REFRACTORY INSTALLATION (STIRRED GASIFIER)			SP- R201/SR4 REVISION 1 PAGE 1 OF 3
ORIGINAL	BY B. RUDDER	DATE 7/14/78	APPD. J. KUSNERUS	DATE 7/20/78
REVISION	BY B. RUDDER	DATE 8/4/78	APPD. J. KUSNERUS	DATE 8/14/78
CLIENT: A. G. McKee & Co., Cleveland, Ohio				PROJECT NO. 3001

1.0 SCOPE

1.1 This specification covers methods and details for installation of refractory brick, castables, insulating castables and high temperature insulation in the lining of a coal gasifier. See Babcock Contractors Inc. (BCI) Drawings M-333, M-334 and M-305.

1.2 The following material specification will be used with this installation specification:

Babcock Contractors Inc. SP - R-201/SR5

2.0 GENERAL

2.1 The refractory lining will be installed by the Contractor in accordance with his published standard general practices and in accordance with good and accepted practices of the respective trades, this Specification, and all applicable Codes, Regulations and Ordinances, and BCI instructions.

2.2 The Contractor is totally responsible for the quality of materials and installation workmanship. In addition to the usual brickmason supervision (one supervisor-foreman for each gasifier being worked), the refractory manufacturer will provide full time, experienced technical representation to train installation personnel (craft and supervisors) in the manufacturer's recommended installation techniques and methods, as well as constantly inspecting their work to insure compliance with these techniques and methods and the provisions of paragraph 2.1.

2.3 Babcock Contractors Inc. reserves the right to inspect the installation at all times; to halt and/or reject work; and require replacement of deficient work.

2.4 The Contractor is responsible for safety practices for his work and compliance with OSHA regulations. BCI general job site safety practices are also to be followed.

2.5 The Contractor will make his own bill of materials from BCI design drawings, and include his own allowances for breakage, wastage and extras.

2.6 Gasifier shell will be in place ready for refractory installation. Upper adjacent parts will be installed after completion of refractory work.

2.7 Contractor will perform any welding the refractory installation requires.

2.8 Interior surfaces will not be cleaned and primed with paint.

(ENG-050-0278)

3.0 WORK BY OTHERS

3.1 Furnish and erect gasifier shell.

3.2 Initial drying and firing of gasifier refractory lining.

4.0 INSTALLATION

4.1 In no case will brick shapes be laid, or castable refractory poured, when the materials themselves and/or the mixing water, and/or the ambient air is below freezing temperatures. A 48 hour cure of the in-place refractory is required before exposure to freezing temperatures.

4.2 Mortar Joints

4.2.1 Tight brick-to-brick bed joints, where possible, are most desirable, with a maximum of 1/8" allowable. Vertical joints are to be 1/8" maximum.

4.2.2 "Dipped" or troweled joints may be used where appropriate. "Dipping consistency" is determined by the 1" float test (1" is exposed when 9" straight is gently lowered flat into the mortar).

4.2.3 The natural clearance of 1/8" between the standard 9/16" radius tongue and the 11/16" radius groove allows for tight brick-to-brick joints and a full 1/8" mortar gas seal which is the principal purpose of the tongue and groove shapes.

The 4-1/2" circular tongue and groove inner lining is made up of (at any given elevation) a combination of different lengths of shapes #21, #22, to allow for 1/16" to 1/8" thick vertical joints. This eliminates cutting and provides for a good "gas tight" lining.

A liberal amount of extra shapes #21 and #22 should be shipped to allow for variations in the combinations due to slightly off-size brick since 1/8" joints are maximum permitted.

4.3 Brick Cutting

4.3.1 Saw-cutting of shapes, where required, will be by power saw using wet cutting, diamond edge blades.

4.3.2 The refractory design minimizes cutting-to-fit. However, the contractor is responsible for all cutting of refractories that is required to properly install the refractory lining. Extras for cutting will not be allowed.

4.4 Techniques

4.4.1 Care must be taken to establish a plumb, vertical center line in order to install perfectly centered brick rings of a uniform taper in courses that are level across the entire gasifier at any elevation.

4.4.2 Shape #6 should be centered and set level to the correct I.D. The resultant gap between the back of #6 and the steel shell is to be grouted with high strength castable to insure solid backing.

4.4.3 The proper setting of shapes #7, #8 and #9 are essential to proper contour and support of the upper walls.

4.5 Castable Refractory Installation

4.5.1 It is intended, where practical, to remove all forms for inspection of the formed surfaces.

4.5.2 If the Contractor so chooses, he may install the outside castable wall of the plenum and the distribution udders by the use of a pneumatic gun, rather than conventional casting methods, provided a designed-for-gunning mix is used.

4.5.3 All form surfaces or insulation in contact with wet castable must be water-proofed and as water-tight as possible.

4.5.4 No holes for anchor attachment are to be drilled or burned through gasifier shell. All connections to the shell shall be welded to the shell by the refractory contractor in the field.

4.5.5 All anchorage is to have flexible linkage to gasifier shell so as to provide for differential of thermal expansion between gasifier shell and the supported refractory.

4.5.6 Two 9" x 4-1/2" x 3" sample "bricks" will be cast from each shift's pour with a permanent numbering system that identifies brand name, date of cast, code date of manufacture and exact location in gasifier. These sample bricks will be retained by BCI for future reference and verification of quality.

5.0 <u>DRYING AND FIRING REFRACTORY LINING</u>

5.1 The Contractor will furnish, in writing, detailed instructions for the dry-out and initial firing of the refractory lining, including a specific time-temperature schedule.

1.0 SCOPE

1.1 This specification covers the refractories and insulating materials for lining a stirred coal gasifier on Babcock Contractors Inc. (BCI) Dwgs. #M-333, #M-334 and #M-305.

1.2 All ASTM Specifications referred to are to be the latest edition.

2.0 OPERATING CONDITIONS

2.1 Analysis of product gas in contact with refractories:

Ingredient	Gas #1	Gas #2
CO	25.397 % Vol.	25.099 % Vol.
CO_2	6.086	5.910
CH_4	0.114	0.079
H_2	22.732	19.399
H_2O	2.683	2.203
H_2S	0.181	0.460
N_2	42.808	46.851
	100	100

2.2 Temperatures of gases in contact with refractory.

2.2.1 1300°F. maximum in wall flues, plenum and outlet nozzle.

2.2.2 The gasifier is filled with coal and gases which vary in temperature from 1300°F. maximum at the bottom to 400°F. maximum (250°F. normal) at the top.

2.3 Pressure of gases varies between 60 and 40 inches water.

3.0 REFRACTORY AND INSULATING MATERIALS

3.1 Firebrick Shapes

3.1.1 All to be High Fired, Super Duty - A. P. Green KX-99, Harbison-Walker Varnon, or approved equal.

3.1.2 Brick Shape Size Tolerances

The complexity of design requires close adherence to brick shape dimensions. The total variations on length and width of 95% of all brick shapes in the lining shall not exceed 3/16".

The total variation on thickness of 95% of all brick shapes in the lining shall not exceed 1/8". For all brick shapes which have the "same nominal thickness and/or length", the "same average thickness" shall be interpreted to be obtained if 95% of ten-high stacks shall fall within the same 1/2" range. Not more than 1/4" wedging in stacks of ten-high is permitted.

All critical surfaces of 95% of all brick shapes shall be within 1/16" total deviation from true plane surfaces.

95% of all brick shapes shall befree of distortions, kiln marks, injurious cracks, internal fissures, cavities, folds, laminations or discolored centers. All critical corners and edges shall be filled out and be sufficiently strong to prevent excessive crumbling or chipping when handled.

All brick shapes will be inspected and approved by BCI at point of manufacture before shipment to job site. Mock lay-ups will be made to insure fit of critical shapes. Quality control documents and test data on all products will be provided to BCI representatives at time of inspection.

Particular Concerns:

a) The 5-13/16" thickness dimension on shapes #21, #22, as each course must be flat and uniform thru height of gasifier.

b) The arc lengths of shapes #21, #22 to insure "no-cutting" and five uniform lining segments.

c) Arc lengths and true, flat, radial surfaces of shape #9, to insure equal flue spacings and a tight self-supporting ring.

d) The arc lengths of shapes #19 and #20 to insure 35 equal flue spaces around circumference.

e) The 3" thickness of shapes #1 thru #2 and #4, 9" thickness #3, and 4-1/2" width of shape #5 to provide uniform elevation at bottom of shape #6 skew.

3.1.3 Brick Shape Fabrication

The cutting to fit and/or cut-modification of one shape to form another, as is designated on BCI drawings, is to eliminate excessive mold or die fabrication costs. However, for each brick shape the contractor will determine the most economical method of manufacturing the shape in question. That is, cutting from existing shapes or fabricating a new mold to form the shape. In either case, the shape should be fabricated at the brick plant ~~after BCI approval of the method to be used~~.

3.1.4 Brick Shape Branding

Contractor will use his standard method of branding special shapes designating the shape as "BCI - Item Number" -- Example: "BCI-21".

Cut shapes will be ink stenciled "BCI - (Item Number)" - Examples: "BCI-1A" "BCI-3"

Shapes #21 and #22 must be ink stenciled BCI-21 and BCI-22 on inner curved face.

3.2 Refractory mortar for laying firebrick to be high temperature, high strength, carbon monoxide resistant, air setting - Harbison Walker Super Harbond, A. P. Green #36 Cement, General Refractories Greflok 3000A, or approved equal.

3.3 Refractory castable #39 and #40 to be high strength, abrasion and carbon monoxide resistant concrete with specifications as follows:

3.3.1 "Unaffected" by carbon monoxide in 60 hour ASTM Test Method C-288 - 1000°F. preheat.

3.3.2 Linear Reheat Change: Less than 0.5% shrinkage after 5 hours at 2000°F. ASTM Method C-269.

3.3.3 Volume Reheat Change: Less than 1.7% shrinkage after 5 hrs. at 2000°F. per ASTM Method C-269.

3.3.4 Modulus of Rupture: At least 750 psi after firing at 500°F. and 1200°F. per ASTM Method C-268.

3.3.5 Materials to be A. P. Green R-2007 stock line castable, General Refractories Brikast XCM-L.I., Harbison-Walker Harcast BF or approved equal.

3.3.6 Quality control test data on the foregoing ASTM Specifications will be provided to BCI representatives at time of brick shape inspection.

ENG-052-0278)

3.4 Refractory castable #43 to be high strength, abrasion-resistant concrete, General Refractories H.S. Basicrete, A. P. Green Greencrete ARC, Harbison-Walker HAR Chrome G-W-F, or approved equal.

3.5 Insulating Castable Refractory to be "iron free", carbon monoxide resistant, approximately 50 lbs. per cubic foot - A. P. Green VSL-50, Harbison Walker Light Weight Castable L.I., General Refractories Litecast 50 L.I., or approved equal.

3.6 High Temperature Block Insulation to be "iron free", carbon monoxide resistant, Johns-Manville Super-X 1600, or approved equal.

4.0 ANCHORS/SPACERS

4.1 Refractory anchors/spacers #28 to be same (or better) quality as fire-brick shape with "floating" type alloy linkage to the steel shell.

4.2 Metallic anchors #27 to be 304 S.S. (or higher alloy) rod "V" type with 60° central angle, extending 2/3 the thickness of supported refractory bolted to steel shell. Harbison-Walker H&W 3A, A. P. Green VS Type, General Refractories VC140, or approved equal.

4.3 Metallic anchors #44 to be bent 1/4" dia. carbon steel "V" type with 60° central angle welded directly to shell of distributor extending 2/3 thickness of castable refractory.

5.0 WIRE FIBER REINFORCEMENT

For high strength castable refractory #40 & #43. To be used at a rate of four (4) pounds for each 100 pounds of castable in an alloy recommended by the contractor appropriate to the gas atmosphere and temperatures, as manufactured by Ribtec Corporation, National Standard Corporation, or approved equal.

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	SPECIFICATION FOR REFRACTORY INSTALLATION CONVERSION OF UNSTIRRED GASIFIER REFRACTORY TO STIRRED GASIFIER REFRACTORY			SP- R201/SR6 REVISION 0 PAGE 1 OF 3
ORIGINAL	BY B. Rudder	DATE 1/12/79	APPD. J. Kusnerus	DATE 1/30/79
REVISION	BY	DATE	APPD.	DATE
CLIENT: A. G. McKee & Co., Cleveland, Ohio				PROJECT NO. 3001

1.0 SCOPE

1.1 This specification covers methods and details for removal of portions of existing unstirred gasifier refractory lining as shown on Babcock Contractors Inc. (BCI) drawings M-330, M-331 and the installation of new refractory brick shapes and castables to effect conversion to a stirred gasifier lining as shown on BCI Dwg. M-333. Also see BCI Dwg. M-334 for brick shape details and material list and BCI Dwg. M-305 for certain castable work.

1.2 BCI installation and material specifications for the stirred gasifier lining, SP-R201/SR4 and SP-R201/SR5 respectively, are to be used with this specification.

1.3 The term Owner as used in this specification refers to the plant owner or his agent. The term Contractor as used in this specification refers to the brick conversion installation contractor.

1.4 BCI Dwgs. M-302 and M-303 show general arrangements of gasifiers and should be used for reference.

2.0 GENERAL

2.1 Portions of the existing refractory lining on BCI Dwgs. M-330 and M-331 will be removed and new refractory installed by the Contractor to make a lining as shown on BCI Dwg. M-333. Work is to be done in accordance with Contractor's published standard general practices and in accordance with good and accepted practices of the respective trades, this specification, all applicable Codes, Regulations and Ordinances, and the Owner's instructions.

2.2 The Contractor is totally responsible for the quality of installation workmanship. Contractor will provide experienced, trained, mason supervisors to insure compliance with paragraph 2.1 above.

2.3 The Owner reserves the right to inspect the installation at all times; to halt and/or reject work; and require replacement of deficient work.

2.4 The Contractor is responsible for safety practices for his work and compliance with OSHA regulations. Owner's plant safety rules and practices will also be followed.

2.5 While the Owner will furnish all materials, the Contractor will inform the Owner of the amount of extras required for breakage and wastage.

2.6 The Contractor will perform any welding that the refractory tear-out or installation of new lining requires.

ENG-050-0278)

2.7 The Contractor will remove refractory and insulation bricks from gasifier shell access openings (9 places) in order to have additional way to get to interior of gasifier.

2.8 The Contractor will place refractory rubble from old lining in Owner's trucks or receptacles adjacent to the gasifier.

3.0 WORK BY OTHERS

3.1 Removal of rubble from job site.

3.2 Installing stirrer in the gasifier.

3.3 Removal and replacement of lower cone and coal distributor and access port metal covers (nozzles 26 and 27) from gasifier.

4.0 SEQUENCE AND EXTENT OF TEAR-OUT AND REMOVAL OF PORTIONS OF EXISTING REFRACTORY-BCI DWGS. M-330 AND M-331.

4.1 Carefully cut out wire fiber reinforced castable refractory #40 caps on top of center core wall and the tops of five spoked partitions, making sure not to disturb the castable cap on the perimeter flue wall.

4.2 Carefully tear out simultaneously, by course from top to bottom, the center core wall and five spoked partitions for courses #38 to #1, and the outside perimeter shapes #21, #22 and #23 for courses #28 to #17. Remove shape #30 at course #17. Do not disturb back-up shapes #19 and #20. Some bracing may be required to stabilize remaining refractories.

4.3 Carefully remove the five partition support arches shapes #13, #14, #15 and #16.

4.4 At this point the entire lining will be inspected by the Owner and the Contractor to determine the suitability of the remaining refractories required to conform to BCI Dwg. M-333 for stirred gasifier.

4.4.1 If found suitable, installation will begin.

4.4.2 If deficiencies are noted, especially with regards to flue support shapes #9, #9A, #8, #8A, #8B, #7, #7A, #7B, #6, #6A and #6B as well as the remainder of the perimeter wall shapes #21, #22 and #23, they will be corrected by repair or removed and replaced entirely.

4.5 Remove abrasion-resistant castable cap #43 over 24" nozzle blind flange in bottom center of lower cone assembly shown on BCI Dwg. M-305.

5.0 INSTALLATION OF CONVERSION REFRACTORIES - BCI DWGS. M-333, M-334 and M-305

5.1 Generally follow entire paragraph 4.0 in BCI Specification SP-R201/SR-4, and this specification.

5.2 If remaining refractories are found suitable by inspection and consultation in Paragraph 4.4 above, the installation will proceed as follows:

5.2.1 The five voids created in the lower perimeter by removal of shape #14 will be filled with #39 castable or an approved phosbonded plastic or ramming mix held with #44 type 304 SS anchors on approximately 6" centers. The anchors will be supported by 3/8" x 3" long 304 SS bolts mortared with #42 mortar into 3/8" x 3" cored holes drilled into the back-up refractory.

5.2.2 Courses #17 to #28 will be replaced in the perimeter wall using shapes #21 and #22, making a tight fit with the old castable perimeter wall cap which was not removed Some cutting or shaving of the bottom of the cap may be required. The seal may be made with #42 mortar or #40 castable, whichever is more appropriate.

5.3 If deficiencies are noted in the remainder of the existing refractories as found in paragraph 4.4.2 above, the affected shapes or portion of the lining will be repaired or replaced in part or in whole as required by the Owner.

5.4 Reinstall refractory #38 and insulation block #31 in access openings 26 and 27 (9 places) at end of work.

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	SPECIFICATION FOR REFRACTORY INSTALLATION CONVERSION OF STIRRED GASIFIER REFRACTORY TO UNSTIRRED GASIFIER REFRACTORY			SP- R201/SR7 REVISION 0 PAGE 1 OF. 3
ORIGINAL	BY B. Rudder	DATE 1/12/79	APPD. J. Kusnerus	DATE 1/30/79
REVISION	BY	DATE	APPD.	DATE
CLIENT: A. G. McKee Co., Cleveland, Ohio				PROJECT NO. 3001

1.0 SCOPE

1.1 This specification covers methods and details for removal of portions of existing stirred gasifier refractory lining as shown on Babcock Contractors Inc. (BCI) Dwg. M-333 and the installation of new refractory brick shapes and castables to effect conversion to an unstirred gasifier lining as shown on BCI Dwgs. M-330 and M-331. Also see BCI Dwg. M-334 for brick shape details and material list and BCI Dwg. M-305 for certain castable work.

1.2 BCI installation and material specifications for the unstirred gasifier lining, SP-R201/SR2 and SP-R201/SR3 respectively, are to be used with this specification.

1.3 The term Owner as used in this specification refers to the plant owner or his agent. The term Contractor as used in this specification refers to the brick conversion installation contractor.

1.4 BCI Dwgs. M-302 and M-303 show general arrangements of gasifiers and should be used as references.

2.0 GENERAL

2.1 Portions of the existing refractory lining on BCI Dwg. M-333 will be removed and new refractory installed by the Contractor to make a lining as shown on BCI Dwgs. M-330 and M-331. Work is to be done in accordance with Contractor's published standard general practices and in accordance with good and accepted practices of the respective trades, this specification, all applicable Codes, REgulations and Ordinances, and the Owner's instructions.

2.2 The Contractor is totally responsible for the quality of installation workmanship. Contractor will provide experienced, trained mason supervisors to insure compliance with paragraph 2.1.

2.3 The Owner reserves the right to inspect the installation at all times; to halt and/or reject work; and require replacement of deficient work.

2.4 The Contractor is responsible for safety practices for his work and compliance with OSHA regulations. Owner's plant safety rules and practices will also be followed.

2.5 While the Owner will furnish all materials, the Contractor will inform the Owner of the amount of extras required for breakage and wastage.

ENG-050-0278)

2.6 The Contractor will perform any welding that the refractory tear-out or installation of new lining requires.

2.7 The Contractor will remove refractory and insulation bricks from gasifier shell access openings (9 places) in order to have additional ways to get to interior of gasifiers.

2.8 The Contractor will place refractory rubble from old lining in Owner's trucks or receptacles adjacent to the gasifier.

3.0 WORK BY OTHERS

3.1 Removal of rubble from job site.

3.2 Removing stirrer from the gasifier.

3.3 Removal and replacement of lower cone and coal distributor and access port metal covers (nozzles 26 and 27) from gasifier.

4.0 SEQUENCE AND EXTENT OF TEAR-OUT AND REMOVAL OF PORTIONS OF EXISTING REFRACTORY - BCI DWG. M-333

4.1 Carefully remove inner lining shapes #21 and #22 from course #28 down to course #1 with a minimum of disturbance or damage to the castable cap and back-up shapes #19 and #20. Some bracing may be required to stabilize remaining refractories.

4.2 Carefully remove flue support shapes #9.

4.3 Locate centerline of five spoked partition support arches as shown on BCI Dwgs. M-330 and M-331. At these points shapes #8, #7 and #6 may be modified in place to approximate the contours of shapes #8A, #8B, #7A and #6A by chisel-cutting. Skew shape #12 sloped contour may be approximated by chisel-cutting the slope on shapes #5 and #4 at these same centerlines.

4.4 If above cannot be done without unduly disturbing the remainder of the rings, then complete tear-out will be required of ring shapes #8, #7 and #6.

4.5 The Owner and the Contractor will inspect the remaining refractories to determine their sutiability to be fitted with the new refractories to conform to BCI Dwgs. M-330 and M-331 for unstirred gasifier.

4.5.1 If found suitable, installation will begin.

4.5.2 If deficiencies are noted, they will be corrected by repair or removed.

5.0 INSTALLATION OF CONVERSION REFRACTORY - BCI DWGS. M-330, M-331, M-334 and M-305

5.1 Generally follow paragraph 4.0 of BCI Installation Specification SP-201/SR2, and this specification.

5.2 If paragraph 4.3 above is accomplished the skew slope for shape #12 will be formed in place by casting a face of #39 castable on the rough cut old refractories at the proper skew angle, as shown for shape #12. Then shapes #14, #15, #16 and #13 may be set using #39 castable or #42 mortar to fill or grout the closure between the tops and sides of shape #14 and the rough cut out shapes #6, #7 and #8.

5.3 If paragraph 4.4 and/or 4.5 above is accomplished, construction will proceed from shape #6 upwards.

5.4 A tight fit is required at the junction of course #28 where shape #22 meets the existing #40 castable perimeter wall cap which may be cut or shaved so the seal may be made with #42 mortar or #40 castable, whichever is more appropriate.

5.5 The existing perimeter wall castable cap will be roughed-up at the junction with the castable caps for the five new spoked partitions so as to provide for at least a friction bond between them.

5.6 Install #43 castable over 24" nozzle blind flange in bottom center of lower cone assembly as shown on BCI Dwg. M-305.

5.7 Reinstall refractory #38 and insulation block #31 in access openings 26 and 27 (9 places) at end of work.

ENG-052-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	SPECIFICATION FOR GASIFIER GRATE CASTINGS			SP- R201/GA REVISION 0 PAGE 1 OF 5	
ORIGINAL	BY H. Raybould	DATE 5/25/78	APPD. J. Liptak	DATE 10/25/78	
REVISION	BY	DATE	APPD.	DATE	
CLIENT: McKee, Cleveland, Ohio				PROJECT NO. 3001	

1.0 SCOPE OF WORK

1.1 Vendor shall supply all labor, materials and equipment required to produce, condition, machine (as required), assemble, test, and ship Gasifier Grate Castings for five (5) Coal Gasification Units as described in the following.

2.0 DRAWINGS AND B/Ms

2.1 Drawings

M-311 (Rev.A) - Lower Part Assembly
M-312 (Rev.A) - Grate Support Base - Sheet 1
M-313 (Rev.A) - Grate Support Base - Sheet 2
M-314 (Rev.A) - Slide Ring and Cover - Details
M-315 (Rev.A) - Ratchet Wheel
M-316 (Rev.A) - Plate Grate
M-317 (Rev.A) - Grate Support Casting
M-318 (Rev.A) - Plow & Deflection Plate
M-319 (Rev.A) - Grate Rings and Breaker
M-320 (Rev.A) - Grate Rings - Sheet #1
M-321 (Rev.A) - Grate Rings - Sheet #2
M-322 (Rev.A) - Slag Wear Ring
M-323 (Rev.A) - Grate Drive Assembly
M-324 (Rev.A) - Grate Drive Details
M-325 (Rev.A) - Grate Lever Indicator
M-342 (Rev.A) - Spring Loaded Port Cover
M-343 (Rev.A) - Inspection Port Cover
M-344 (Rev.A) - Access Port Cover

2.2 Bills of Material

M312/313/314 (3 pages) - Grate Support Base
M314 (1 page) - Slide Ring Detail
M315 (1 page) - Ratchet Wheel Detail
M316 (1 page) - Plate Grate Detail & Assembly
M317 (2 pages) - Grate Support Casting Det. & Assembly
M318 (1 page) - Plow & Deflect Plate Det. & Assembly
M319/320/321 (2 pages) - Grate Rings & Breaker Assembly & Det.
M322 (1 page) - Slag Wear Ring Det.
M323/324 (3 pages) - Grate Drive Assembly & Det.
M325 (1 page) - Grate Lever Indicator

2.3 General

Foregoing drawings and bills of material become an integral part of this specification.

3.0 MATERIALS

3.1 Cast Iron Grades

a. Type 1 Ref. C.I. (1) - General purpose grey cast iron having a minimum tensile strength fo 20,000 lb/in^2.

b. Type 2 Ref. C.I. (2) - General purpose grey cast iron having a minimum tensile strength of 28,000 lb/in^2.

c. Type 3 Ref. C.I. (3) - Grey cast iron for operation in a reducing atmosphere at a temperature range 930 to 1112°F.

3.2 Cast Steel Grades

a. Type 1 Ref. C.S. (1) - General purpose cast steel containing 1-1/2% manganese and having a minimum tensile strength of 70,000 lb/in^2.

- Castings shall be supplied in the normalized condition having a Brinnel hardness not exceeding 207 BHN
- Castings may be repaired by proper welding procedure
- Steel shall contain following percentages of alloying elements;

C	0.18/0.25
Si	0.6
Mn	1.2/1/6
P	0.05
S	0.05

3.3 Cast Bronze Grades

a. Type 1 Ref. C.B (1) - Shall contain following percentages of elements;

Sn	12.0/20.0
Zn	2.0/5.0
Pb	5.0 Max
P	0.15 Max

- Annealing shall not be permitted.
- Note: Alternate materials may be any good commercial quality heavy duty cast bearing bronze.

4.0 GENERAL REQUIREMENTS FOR ALL CASTINGS

4.1 All castings shall have risers runners etc., removed without any break away from the body of the casting and shall be finished clean.

4.2 The workmanship shall be the best of its kind for this class of product.

4.3 All castings shall be sound and free from blow holes, chills, contraction faults or other injurious manufacturing faults.

4.4 Where machining is required, the allowance on the casting surface shall be adequate for a total clean up to a sound surface, having regard for the size of the casting and machine. All bolted components shall be witness marked for dismantling and reassembly.

4.5 The vendor shall provide certification (2 copies) of physical properties and chemical analysis for each type of material required for this order.

4.6 Purchaser and/or his representatives will inspect work periodically in the foundry and machining center.

4.7 Ferrous castings, on completion and after inspection, shall be thoroughly cleaned and given one coat of hot boiled linseed oil.

5.0 OTHER

5.1 Vendor shall assemble each unit in its entirety and demonstrate operability of the assembly in the presence of the Purchaser and/or his representatives.

a. Disassembly for shipment shall be accomplished in such a manner so as to reduce, in-so-far-as possible time required for re-assembly in the field.

5.2 Surfaces requiring machining shall be processed at rates and feeds compatible with 250 micro-inch finish.

5.3 All patterns shall become the property of the Purchaser.

5.4 Purchaser will co-ordinate hydraulic cylinders, supplied by others, for co-ordination with castable and machined parts of grade drive assembly.

6.0 PIECE MARKING FOR SHIPMENT

6.1 All parts, accessories, components, etc., which are to be shipped separately shall be first shop assembled, permanently match marked, and individually identified.

6.2 Each part shall then be properly packed and crated prior to shipping.

6.3 Each shipping package shall be clearly marked to identify every piece which is contained therein or part of a subassembly.

7.0 INSPECTION, TESTING AND ACCEPTANCE

7.1 The Purchaser's Inspector (and/or their client's inspector) will inspect equipment during fabrication and confer acceptance prior to shipment.

7.2 The Vendor shall be responsible for notification, at the proper time, so that tests and inspections may be made without undue inconvenience to either party.

7.3 The Vendor shall afford the Purchaser's Inspector (and/or their client's inspector) access to his shop area and all resonable facilities for accomplishment of his inspection.

7.4 Waiver of any of the foregoing requirements with respect to inspection and testing, at the option of Purchaser's Engineer or Inspector, is binding only if authorized in writing.

8.0 PROPOSAL REQUIREMENTS

8.1 The Vendor shall quote in strict accordance with this specification.

8.2 Any and all exceptions to this proposal shall be clearly stated by the Vendor. Unless exceptions are stated, it will be assumed that the proposal submitted is in accordance with specifications as written.

8.3 Vendor shall submit with proposal the following price breakdown:

8.3.1 Price for material
8.3.2 Price for grate rings and breaker assembly as a separate cost
8.3.3 Price for pattern development and patterns
8.3.4 Price for items indicated on Dwgs. No. M-342, 343, 344
8.3.5 Price for machining surfaces indicated on drawings
8.3.6 Price for shop assembly and test
8.3.7 Price for disassembly into the least number of pieces,

8.0 PROPOSAL REQUIREMENTS (continued)

8.3 (continued)

8.3.7 packaged as required for shipment to Hoyt Lakes, Minnesota.

8.4 Vendor shall submit recommended casting tolerances for machined and non-machined surfaces.

8.5 Vendor shall provide a schedule for delivery to job site each unit. These scheduled deliveries must include assembly, test, and disassembly time periods.

ERIE MINING COMPANY

COAL GASIFICATION PROJECT

HOYT LAKES, MINNESOTA

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

McKEE CONTRACT 4814

BCI PROJECT NO. 3001

SPECIFICATION

FOR

GASIFIER GRATE HYDRAULIC SYSTEM

?

SPECIFICATION NO. 3001-PSW201

FEBRUARY 9, 1979

SPECIFICATION

for

GASIFIER GRATE HYDRAULIC SYSTEM

3001-PSW201

1.0 SCOPE OF WORK

1.1 Supply Hydraulic Power Package, Valve Control Station, and auxiliary components required to actuate gasifier ash grate for six (6) gasifier units basically as shown on the drawing and briefly described in the following:

1.1.1 Hydraulic Power Package Components:

a. Two (2) hydraulic vane pumps - one operating - one spare - each having capacity of 45 gpm at 2000 psig - direct coupled to 40 Hp explosion proof electric motor - 460 volt, 3 phase, 60 Hertz, 1200 rpm - each pump complete with suction filter, flexible coupling and guard.

b. One (1) 100 gallon capacity reservoir having two tank cleanout covers, magnetic drain plug, air breather, filler cap, oil level and temperature gages and conforms to NFPA standards for non-integral industrial oils.

1.1.2 Valve Control Station Components:

a. Six (6) directional control valves - four way, two position, single solenoid (explosion proof), spring offset, 3/4", 115 volt 1 phase 60 Hertz

b. Six (6) sequence valves

c. Four (4) center manifolds

d. Six (6) "A" port throttle checks

e. One (1) front end manifold

f. One (1) rear end manifold

1.0 SCOPE OF WORK

1.1.2 Valve Control Station Components (continued)

g. Three (3) check valves

h. Six (6) flow control valves with checks (adjustable restrictors)

1.1.3 Auxiliary Components:

a. One (1) liquid to liquid heat exchanger

b. One (1) fluid return filter

c. Two (2) pressure switches - one opens at 20 psig and one opens at 2000 psig

d. One (1) relief valve

e. One (1) pressure gage and one (1) gage cock

f. Five (5) limit switches

g. Ten (10) hydraulic cylinders - two per gasifier - 7" bore, 7-7/8" stroke, double acting, non-cushioned.

2.0 DESCRIPTION OF OPERATION

2.1 A single hydraulic power pack will accommodate dual cylinders on each of six (6) gasifier units. Each gasifier ash grate will be continually rotated by two hydraulic cylinders mounted 180° apart around the circumference of the grate drive ring and operate simultaneously. As the temperature of the ash grate drops to a pre-determined low, the strokes per hour of the hydraulic cylinders will be increased until a pre-determined high temperature of the ash grate is reached after which the hydraulic cylinders will be slowed in their operation.

Six (6) gasifiers can be operating at an accelerated rate simultaneously.

3.0 DESIGN CRITERIA

3.1 Thrust Requirement : 120,000 lb. force per pair of cylinders

3.0 DESIGN CRITERIA (continued)

3.2 Cylinder Stroke Rate	:	40 strokes per hour
3.3 Grate Rotation	:	1/2 revolution per hour
3.4 Cylinder Speed	:	20 seconds for stroke and return cycle
3.5 Oil Capacity	:	2-1/2 times maximum usage requirement
3.6 Ambient Air Temperature	:	200°F

4.0 SPECIAL INSTRUCTIONS

4.1 The hydraulic power pack shall be assembled complete with pumps, motors, valve control station and required auxiliaries mounted on the reservoir in such a manner that installation contractor will be required only to place the unit and connect electrical services, cooling water, and cylinder supply and return piping.

5.0 WORK BY OTHERS

5.1 Receive and handle units at construction site

5.2 Furnish and install hydraulic piping and/or tubing from power pack to cylinders

5.3 Furnish and install hydraulic fluid

5.4 Place unit into operation

6.0 DRAWINGS

6.1 M-326 Hydraulic Circuit for Six Grate Drives

SPECIFICATION

for

GASIFIER GRATE LUBRICATION SYSTEMS

3001-PSW202

1.0 SCOPE OF WORK

1.1 Supply grease lubrication systems complete for five (5) gasifier grate drives basically as shown on attached drawings.

1.1.1 Each system shall consist basically of the following components;

a. Four (4) steel body grease reservoirs each having a capacity to contain ten (10) pounds of grease. Reservoirs shall be fitted with low-level switches and fill connectors for replenishing reservoirs.

b. Two (2) Cam-operated, spring return pumps each having capacity to supply 0.095 cu. in. grease per stroke.

c. Two (2) single line manifolds, each manifold having capability of servicing eight (8) lubrication points.

d. Sixteen (16) rupture disc indicators (2700 psi).

e. Four (4) - 3/8" tube to 1/4" pipe straight fittings.

f. Fourteen (14) 1/4" tube to 1/4" pipe 90° elbow fittings.

g. 150 ft. of 1/4" O.D. seamless steel hydraulic tubing.

h. 8 ft. of 3/8" O.D. seamless steel hydraulic tubing.

i. 6 foot of 1/4" I.D. Flexible hose.

j. Two (2) 1/4" hose unions.

k. Two (2) 1/4" hose couplings

1.0 SCOPE OF WORK (continued)

1.1.1 continued

l. Two (2) 1/4" steel elbows

m. Two (2) 1/2 - 3/3 inverted bushings

n. 80 tube clamps, 1/4" single

o. 20 tube clamps, 1/4" double

p. 6 tube clamps, 3/8" single

2.0 DESCRIPTION OF OPERATION

2.1 One Gasifier (Five Required)

2.1.1 Grate lubrication system shall consist of two single line systems. Each single line will serve eight lube points for a total of sixteen lube points for each gasifier. Each single line will be equipped with a cam-operated pump which will be actuated by the forward stroke of a hydraulic cylinder at which time 0 to 0.095 cubic inches of high temperature grease (NLGI #1) to an eight valve metering manifold complete with rupture discs. Each single line system will contain two 10 pound grease reservoirs that will operate in tandem. Those reservoirs will be mounted on the side of the gasifier and each reservoir will be equipped with a low level switch as well as a bottom fill connection. The lines from the reservoirs to the pump will be 3/4" I.D. and located not more than 14" from the pump. Lines from the metering valve manifolds will be 1/4" seamless steel hydraulic tubing.

3.0 DESIGN CRITERIA

3.1 Gasifier grate will be operated at one revolution every two hours by way of two 7" bore cylinders (7-7/8" stroke) spaced 180° apart. Hydraulic oil pressure will be 2000psi.

3.0 DESIGN CRITERIA (continued)

3.2 Ambient air temperature in the vicinity of the grease reservoirs will be 200°F.

3.3 Temperatures at lubrication points will be 400°F to 1000°F.

4.0 DRAWINGS

3001-M327	(rev.)	Common Lubrication System
3001-M328	(rev.)	Lubrication System Details

5.0 REQUIRED WITH PROPOSAL

5.1 Price for one (1) lubrication system described in Section 1.1.1

5.2 Price for five (5) lubrication systems described in Section 1.1.1

5.3 Price for spare parts for five gasifiers for first years operation.

ERIE MINING COMPANY

COAL GASIFICATION PROJECT

HOYT LAKES, MINNESOTA

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

McKEE CONTRACT 4814

BCI PROJECT NO. 3001

SPECIFICATION NO. E202A/BC

FOR

COMBINED GAS COOLERS

OCTOBER 30, 1978

1.0 EQUIPMENT TO BE FURNISHED

1.1 The work to be performed under the terms of this specification shall consist of furnishing all material and labor required to design, detail, fabricate and deliver combined gas coolers for a coal gasification plant. The equipment shall be supplied complete with all appurtenances and accessories as specified herein.

1.2 The Vendor shall provide as the basis of this proposal a Base Price for equipment specified on the attached Data Sheets No. 3006/AD/12920 (five (5) pages).

Number Required	Equipment Number	Description
3 Banks (2 per Bank)	E201A/B/C	Combined Gas Coolers

1.3 The Vendor shall also provide an Alternate Price for equipment specified on the attached Data Sheets No. 3006/AD/12919 (four (4) pages).

Number Required	Equipment Number	Description
3	E201A/B/C	Combined Gas Coolers

2.0 DESIGN CRITERIA

2.1 Combined Gas Cooler shall be capable of performing in accordance with design criteria, and data sheets unique to either the Base or Alternate Cooler System as indicated below:

2.1.1 Equipment to be proposed for Base Price shall be as shown on Data Sheets numbered 3006/AD/12920.

2.1.2 Equipment to be proposed for Alternate Price shall be as shown on Data Sheets numbered 3006/AD/12919.

2.1.3 Any exceptions considered to be relevant by the Vendor shall be brought to the attention of Purchaser prior to submitting proposal.

3.0 WORK BY OTHERS

3.1 Receive, unload, store, and install the equipment as shown on Vendor Drawings.

3.2 Provide and install all Pipe and Duct work to Vendor supplied equipment.

3.3 Provide all foundations and structural supports required as shown on Vendor Drawings.

4.0 DESIGN REQUIREMENTS

4.1 The manufacturer shall be completely responsible for the mechanical design of the equipment as outlined in Paragraph G-5.2 of the latest standards of Tubular Exchanger Manufactuers's Association (TEMA).

4.2 Design, materials, construction welding and testing shall be in accordance with the latest issue and addenda of Section VIII of the ASME Boiler and Pressure Vessel Code and TEMA Class C, unless some local area code governs the design of tubulars,in which case the local code requirements shall be included in the manufacturer's design.

4.3 Mechanical Design shall be in accordance with that described on Data Sheets. Exceptions to the size, arrangement, etc. should be clearly stated in proposal.

4.4 Vessel connections as shown on Data Sheet No. 3006/AD/12920 shall be supplied by Vendor.

5.0 MATERIALS OF CONSTRUCTION

5.1 Materials of construction are, for the most part, contained on attached drawings.

5.1.1 Materials not specified shall be selected by the Vendor in accordance with standard accepted practices for this type equipment.

6.0 INSPECTION, TESTING AND ACCEPTANCE

6.1 Purchaser's inspector (and/or their client's inspector) will inspect equipment during fabrication,

6.0 INSPECTION, TESTING AND ACCEPTANCE (continued)

6.1 continued

witness all hydrostatic tests, inspect weld quality prior to stress-relieving or heat treating, etc.; and confer acceptance prior to shipment.

6.2 The manufacturer will be responsible for notification, at the proper time, so that tests and inspections may be made without undue inconvenience to either party.

6.3 The manufacturer shall afford the purchaser's inspector (and/or their client's inspector) access to his shop area and all reasonable facilities for accomplishment of his inspection.

6.4 When spot x-raying is specified by the Code, this shall consist of a spot x-ray at each junction of longitudinal and circumferential strength welds.

6.5 The shop hydrostatic test pressure shall be 1.5 times the MAP (Maximum Allowable Pressure, new and cold, uncorroded).

6.6 The test pressure shall be held for one hour minimum.

6.7 Waiver of any of the foregoing requirements with respect to inspection and testing, at the option of Purchaser's Engineer or Inspector, is binding only if authorized in writing.

7.0 GUARANTEES

7.1 The Vendor shall assume full responsibility for the mechanical and structural design and construction of the products being furnished.

7.2 The Vendor guarantees the work against defective materials and poor workmanship for a period of one (1) year of operation or eighteen (18) months from date of shipment, whichever occurs first.

7.3 The Vendor shall take all steps and do all things necessary at his own expense and at a time specified by Purchaser to correct all defects in materials and workmanship.

8.0 PAINTING

8.1 Vessel shall have their outside surfaces, supports, etc. prepared and shop painted with one coat of primer.

9.0 SHIPMENT

9.1 All flange faces and other machined surfaces shall be heavily greased and provided with securely fastened protective covers.

9.2 All covers, flanges, gaskets, bolts and nuts furnished by the manufacturer are to be shipped in place. Tapped holes shall be plugged.

9.3 Particular care shall be given to blocking and strapping the equipment to the car or truck, to avoid bent nozzles or other shipping damage.

10.0 PROPOSAL REQUIREMENTS

10.1 Vendor shall submit along with proposal the attached vessel sketch and data sheet completed along with costs.

10.2 The bidder shall quote in strict accordance with this Specification.

10.3 Any and all exceptions to this quote shall be clearly stated by the bidder. Unless specifically stated by the bidder, the Specification is bid upon as written.

10.4 Any alternates to the Specification shall be clearly stated and the price differential quoted.

10.5 All quotes shall be for complete equipment, as specified in this Specification, F.O.B. at plant site. Plant site is Hoyt Lakes, Minnesota. Proposed method of shipment shall be stated.

10.6 Calendar days for receipt of vendor drawings for approval.

10.7 Calendar days for delivery of units after drawing approval.

10.0 PROPOSAL REQUIREMENTS (continued)

10.8 Shipping weight for one (1) unit.

10.9 Operating weight for one (1) unit.

11.0 ATTACHMENTS

11.1 Combined Gas Cooler (Single Shell Design) 3006/AD/12919 Rev.P_1

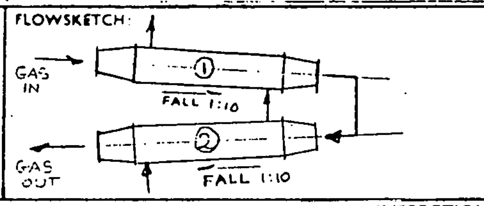
11.2 Combined Gas Cooler (Two Shell Design) 3006/AD/12920 Rev. P_1

Manufacture and construction is to be carried out strictly in accordance with the requirements of this drawing/specification. No changes are to be made without the prior agreement of the Chief Engineer of the originating section within Engineering Department.

LETTERS IN THIS COLUMN INDICATE WHERE CHANGES, ADDITIONS OR DELETIONS HAVE TAKEN PLACE

1	MANUFACTURERS NAME		
2	SERVICE OF UNIT COMBINED GAS COOLER		No. OF UNITS THREE
3	SIZE 75/168 TYPE AEM WITH CONICAL HEADS		SURFACE PER UNIT 12644 ft²
4	SHELLS PER UNIT TWO CONNECTED IN SERIES		SURFACE PER SHELL 6322 ft²
5	THERMAL PERFORMANCE OF ONE UNIT		
6	WESTERN COAL	SHELL SIDE	TUBE SIDE
7	FLUID CIRCULATED	COOLING WATER	COMBINED GAS
8	TOTAL FLUID ENTERING lb/h	678978	86043
9	VAPOUR (OIL) lb/h	—	586
10	LIQUID lb/h	678978	—
11	STEAM lb/h		11131
12	NON-CONDENSABLES lb/h		74326
13	VAPOUR CONDENSED (OIL) lb/h		586
14	LIQUID VAPOURIZED lb/h		—
15	STEAM CONDENSED lb/h		7722
16	GRAVITY - LIQUID ~~H₂O~~ OR sp. gr.	IN / OUT	IN / OUT 1.0
17	MOLECULAR WEIGHT - VAPOUR OR GAS	IN / OUT	IN / OUT
18	MOLECULAR WEIGHT - NON-CONDENSABLES	WATER	23.18
19	VISCOSITY - LIQUID cP.		AS WATER
20	VISCOSITY - VAPOUR OR GAS cP.	AT °F	0.020/0.016 AT 287/95°F
21	THERMAL CONDUCTIVITY - LIQUID Btu/hr ft °F	AT °F	AS WATER AT
22	THERMAL CONDUCTIVITY - VAPOUR OR GAS Btu/hr ft °F	AT °F	0.022/0.018 AT
23	SPECIFIC HEAT - LIQUID Btu/lb °F	AT °F	AS WATER AT
24	SPECIFIC HEAT - VAPOUR OR GAS Btu/lb °F	AT °F	0.316/0.305 AT
25	LATENT HEAT - VAPOUR Btu/lb		STEAM 1025/OIL 120
26	TEMPERATURE IN °F	75	287
27	TEMPERATURE OUT °F	95	95
28	OPERATING PRESSURE psig	30	1.0
29	NUMBER OF PASSES	ONE	ONE
30	VELOCITY ft/sec.	2.17	49.59
31	PRESSURE DROP psi	ALLOW CALC. 5.65	ALLOW 0.15 CALC.
32	FOULING RESISTANCE (Btu/h °F ft²)⁻¹	REQD. 0.002 ACT	REQD. 0.003 ACT.
33	HEAT EXCHANGED Btu/h 13.56×10⁶	M.T.D. (WEIGHTED CORRECTED LMTD)	°F 42.41
34	TRANSFER RATE - SERVICE Btu/h °F ft²	CLEAN 31.63 FOULED 25.94	OVER SURFACE 3.7
35	CONSTRUCTION DATA - EACH SHELL		
36	SHELL INT/NOM DIA. 75" TUBES: No. 1150 O.D. 1.5" B.W.G. 14	LENGTH 168"	PITCH 1.875" □/◇
37	BAFFLES - SEGMENTAL 10 PITCH 15.0"	% CUT 15	FLOW ↔
38	BAFFLES - LONGITUDINAL : TYPE NONE		
39	TUBE SUPPORTS PITCH NONE	FULL/HALF CIRCLES	No. TIE RODS 12
40	CONNECTIONS SHELL IN 8" N/B OUT 8" N/B	SERIES 150 lb	
41	CHANNEL IN 42" N/B OUT 42" N/B	SERIES 150 lb	

42 FLOWSKETCH:



NOTES:
MEAN OPERATING METAL TEMPERATURES
SHELL 1 (HOT)
TUBEWALL 95.3 °F
SHELL 91.3 °F
SHELL 2 (COLD)
TUBEWALL 85.5 °F
SHELL 81.3 °F

43 INSPECTION AND TESTS
44 INSPECTION & TESTS TO THE REQUIREMENTS OF
45 MANUFACTURERS DOCUMENTATION
46 FOR NUMBER OF COPIES OF DRAWINGS AND DOCUMENTS REQUIRED SEE MANUFACTURERS DOCUMENTATION SHEET

				REV.	INITIAL	DATE	DESCRIPTION
DRN	RVT						
CHKD							
APPD S. ENG.							
APPD CO ENG							
APPD CH ENG							
BY	INITIAL	DATE		REVISION			

CONTRACT CJ 3006
UNIT PCI FOR ERIE MINING
EXCHANGER THERMAL DATA SHEET

No. OFF	CLIENTS EQUIP No.	W.D. EQUIP No.
THREE		E-202 A-C

TITLE COMBINED GAS EXCHANGER E202 A- (TWO SHELL DESIGN)

DRG. No 3006/AD/12920 REV P

SF 98 (51)

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, PA 15222

TYPE CODE 12
ORIGIN. SECT.

Manufacture and construction is to be carried out strictly in accordance with the requirements of this drawing/specification. No changes are to be made without the prior agreement of the Chief Engineer of the originating section within Engineering Department.

LETTERS IN THIS COLUMN INDICATE WHERE CHANGES, ADDITIONS OR DELETIONS HAVE TAKEN PLACE

1	MANUFACTURERS NAME			
2	SERVICE OF UNIT		No. OF UNITS	
3	SIZE	TYPE SEE SHT 1	SURFACE PER UNIT	ft^2
4	SHELLS PER UNIT	CONNECTED IN	SURFACE PER SHELL	ft^2
5	THERMAL PERFORMANCE OF ONE UNIT			
6	EASTERN COAL		SHELL SIDE	TUBE SIDE
7	FLUID CIRCULATED		COOLING WATER	COMBINED GAS
8	TOTAL FLUID ENTERING	lb/h	339089	88422
9	VAPOUR (OIL)	lb/h	—	1415
10	LIQUID	lb/h	339089	—
11	STEAM	lb/h	—	—
12	NON-CONDENSABLES	lb/h	—	87007
13	VAPOUR CONDENSED	lb/h	—	1415
14	LIQUID VAPOURIZED	lb/h	—	—
15	STEAM CONDENSED	lb/h	—	—
16	GRAVITY - LIQUID	lb/ft OR sp. gr.	IN OUT	IN OUT
17	MOLECULAR WEIGHT - VAPOUR OR GAS		IN OUT	IN OUT
18	MOLECULAR WEIGHT - NON-CONDENSABLES			
19	VISCOSITY - LIQUID	cP.		
20	VISCOSITY - VAPOUR OR GAS	cP.	AT °F	AT °F
21	THERMAL CONDUCTIVITY - LIQUID	Btu/hr ft °F	AT °F	AT °F
22	THERMAL CONDUCTIVITY - VAPOUR OR GAS	Btu/hr ft °F	AT °F (SEE SHT 1)	AT °F
23	SPECIFIC HEAT - LIQUID	Btu/lb °F	AT °F	AT °F
24	SPECIFIC HEAT - VAPOUR OR GAS	Btu/lb °F	AT °F	AT °F
25	LATENT HEAT - VAPOUR	Btu/lb		
26	TEMPERATURE IN	°F	75	343
27	TEMPERATURE OUT	°F	95	95
28	OPERATING PRESSURE	psig		1.0
29	NUMBER OF PASSES		ONE	ONE
30	VELOCITY	ft/sec.	1.08	51.8
31	PRESSURE DROP	psi	ALLOW CALC. 1.65	ALLOW 0.15 CALC. 0.150
32	FOULING RESISTANCE	(Btu/h °F ft²)⁻¹	REQD. .002 ACT.	REQD. .003 ACT.
33	HEAT EXCHANGED	Btu/h 6.772×10^6	M.T.D. (CORRECTED)	°F 90.055
34	TRANSFER RATE - SERVICE	Btu/h °F ft²	CLEAN 7.94 FOULED 7.51	OVER SURFACE 23.3 %

35 CONSTRUCTION DATA - EACH SHELL (SEE SHT 1)

No.					
36	SHELL: IN / NOM DIA	TUBES: No.	O.D.	B.W.G.	LENGTH / PITCH □◇△
37	BAFFLES - SEGMENTAL	PITCH	% CUT		FLOW
38	BAFFLES - LONGITUDINAL	TYPE			
39	TUBE SUPPORTS	PITCH	FULL / HALF CIRCLES		No. TIE RODS
40	CONNECTIONS	SHELL IN	OUT	SERIES	
41		CHANNEL IN	OUT	SERIES	

42 FLOWSKETCH: SEE SHT 1

NOTES:

MEAN OPERATING METAL TEMPERATURES

SHELL 1 (HOT)
- TUBEWALL 94.7 °F
- SHELL 88.2 °F

SHELL 2 (COLD)
- TUBEWALL 80.4 °F
- SHELL 78.2 °F

43 INSPECTION AND TESTS

44 INSPECTION & TESTS TO THE REQUIREMENTS OF:

45 MANUFACTURERS DOCUMENTATION

46 FOR NUMBER OF COPIES OF DRAWINGS AND DOCUMENTS REQUIRED SEE MANUFACTURERS DOCUMENTATION SHEET

DRN.	RVT	10/8/82		
CHKD.	[illegible]			
		6		FOR ENQUIRY
		REV.	INITIAL DATE	DESCRIPTION
BY	HEAD DATE		REVISION	

CONTRACT SJ 3006
BCI FOR ERIE MINING
UNIT

AREA CODE

EXCHANGER THERMAL DATA SHEET

No. OFF	CLIENTS EQUIP. No.	W.D. EQUIP. No.
THREE		E-202 A, B, C

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, PA 15222

TYPE CODE 12

TITLE COMBINED GAS EXCHANGER E202 A, B, C (TWO SHELL DESIGN)

ORIGIN SECT. | DWG. No. 3006/AD/12920 | REV. D

LETTERS IN THIS COLUMN INDICATE WHERE CHANGES, ADDITIONS, OR DELETIONS HAVE TAKEN PLACE

Manufacture and construction is to be carried out strictly in accordance with the requirements of this drawing/specification. No changes are to be made without the prior agreement of the Chief Engineer of the originating section within Engineering Department.

1	MANUFACTURERS NAME		
2	MECHANICAL DESIGN OF UNIT		
3		SHELL SIDE	TUBE SIDE
4	DESIGN PRESSURE psig	50	5
5	TEST PRESSURE psig	TO CODE	5
6	DESIGN TEMPERATURE °F	110	358
7	CORROSION ALLOWANCE INS.	1/8	1/8

8 STRESS RELIEF: TO BE ADVISED

9 RADIOGRAPHY: SPOT 10% MINIMUM — INSURANCE INSPECTION BY:

10	MATERIALS OF CONSTRUCTION	
11	PART DESCRIPTON	MATERIAL SPECIFICATIONS
12	SHELL & SHELL COVER RING	CS SA285 Gr C
13	SHELL COVER DISH	—
14	CHANNEL CYLINDER	CS SA285 Gr C
15	CHANNEL COVER OR DISH	—
16	CHANNEL FLANGES	CS SA285 Gr C
17	SHELL FLANGES & SHELL COVER FLANGE	—
18	FLOATING HEAD COVER FLANGE	—
19	FLOATING HEAD COVER DISH	—
20	SPLIT-RING	—
21	BACKING-RING	—
22	TUBESHEETS *	CS SA516 Gr 65
23	PARTITION PLATES	—
24	PIPE FOR NOZZLES (IF BUILT UP)	CS SA 106 Gr A or B
25	NOZZLE FLANGES (IF BUILT UP)	CS SA 105
26	LONG FORGED WELDING NECKS	CS SA 105
27	TUBES	CS SA179
28	SPACER SPOOLS	CS
29	TIE-RODS & NUTS	CS
30	BAFFLES & SUPPORT PLATES	CS
31	SADDLE PLATES	CS
32	STUDBOLTS	SA 193 B7
33	NUTS	SA 194 2H
34	GASKETS - SHELL	—
35	GASKETS - CHANNEL	CAF ½" THK.
36	GAS RETURN BEND	CS SA 285 Gr C
37	IMPINGEMENT PLATE (SHELL INLET)	CS
38	TUBE/TUBESHEET ATTACHMENT	EXPANDED
39	NOZZLE FLANGES (GAS IN/OUT)	CS SA 285 Gr C

40 DESIGN CODES

A.S.M.E. U.P.V. SECT. VIII (TUBESIDE FABRICATION ONLY)	✓	~~BS 1500~~	
~~A.S.M.E. POWER BOILER SECT. I~~		~~BS 5500~~	
T.E.M.A. CLASS C	✓	MECHANICAL DESIGN TO COMPLY WITH TEMA 6th EDITION 1978 SECTION 12 'RECOMMENDED GOOD PRACTICE'	

* MATERIAL TO BE ULTRASONICALLY TESTED IN ACCORDANCE WITH ASTM A435

41 INSPECTION AND TESTS

42 INSPECTION & TESTS TO THE REQUIREMENTS OF:

43 MANUFACTURERS DOCUMENTATION

44 FOR NUMBER OF COPIES OF DRAWINGS AND DOCUMENTS REQUIRED SEE MANUFACTURERS DOCUMENTATION SHEET

	BY	INITIAL	DATE
DRN	RJT		10/5/79
CHKD.			
APPD. S. ENG			
APPD. CO. ENG			
APPD. CH. ENG			

REV.	INITIAL	DATE	DESCRIPTION
P	RJT		[illegible]

REVISION

CONTRACT SJ 3006 — BCI FOR ERIE MINING

UNIT

AREA CODE

EXCHANGER MECHANICAL DATA SHEET

No. OFF	CLIENTS EQUIP No.	W.D. EQUIP No.
THREE		E-202 A,B,C

TITLE: COMBINED GAS EXCHANGER E202 A,B,C (TWO SHELL DESIGN)

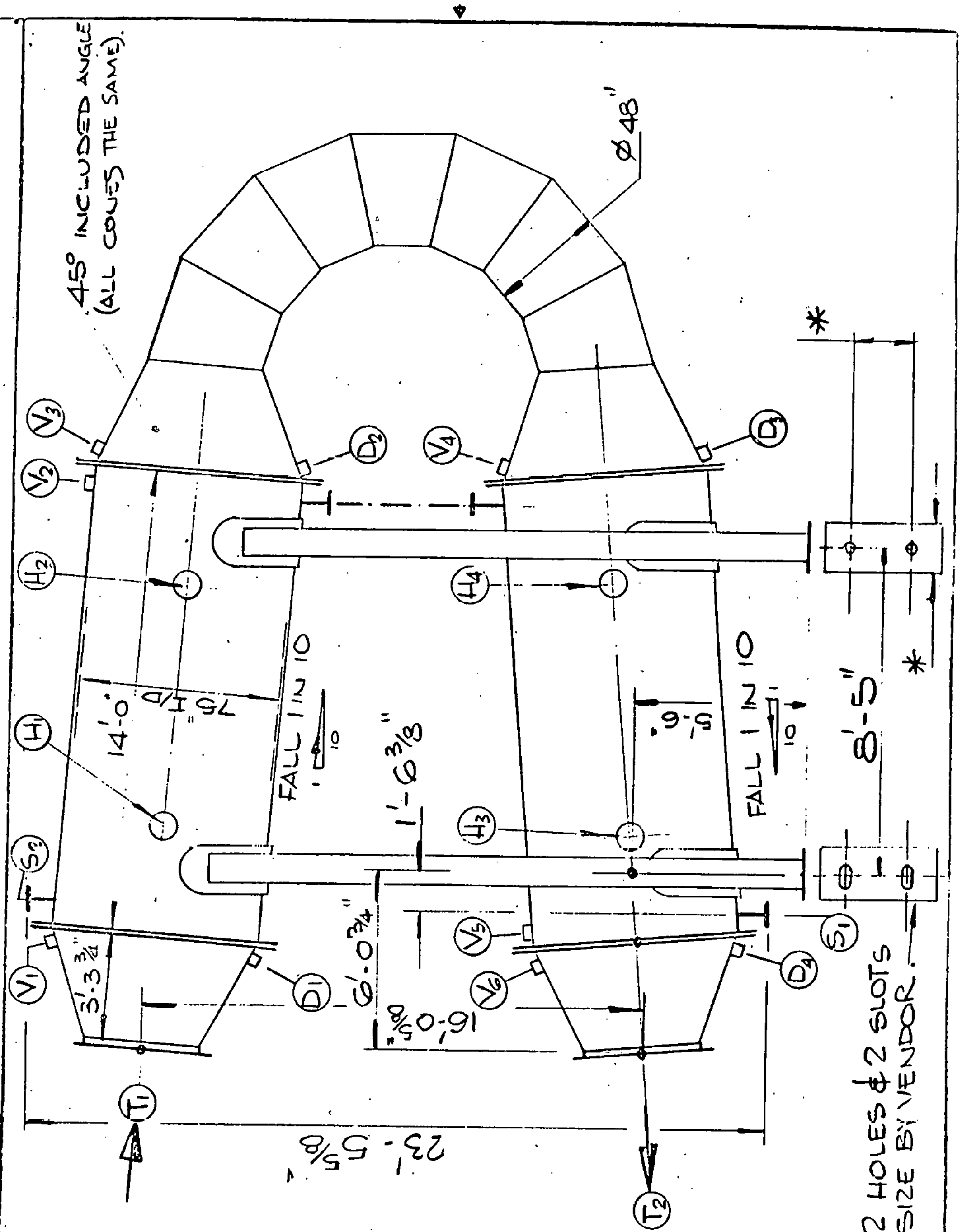
BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, PA 15222

TYPE CODE 12

ORIGIN SECT. E2

DRG. No. 3006/AD/12920 SHEET 3 OF 5 REV. P

Manufacture and construction is to be carried out strictly in accordance with the requirements of this drawing specification. No changes are to be made without the prior agreement of the Chief Engineer of the originating section within Engineering Department.



REV	INIT'L	DATE	REVISIONS	BY	INIT'L	DATE
				DRN.	AJY	
				CHKD.		

ORIGIN. SECT.

CONTRACT 5J 3006

UNIT

AREA CODE

TITLE COMBINED GAS EXCHANGER E202 A,B,C (TWO SHELL DESIGN)

TYPE CODE 12

BABCOCK CONTRACTORS INC.

921 Penn Avenue
Pittsburgh, PA 15222

DRG. No. 4/3006/AD/12920 REV P1

SHEET 4 OF 5

SF 2D (A4)

MARK	NOZZLE	SIZE	RATING	STAND OUT
T1	TUBE INLET	42"	150	–
T2	TUBE OUTLET	42"	150	–
S1	SHELL INLET	8"	150	3'–10"
S2	SHELL OUTLET	8"	150	3'–10"
V1-6	VENT	2"	3000 #	BOSS
D1-4	DRAIN	2"	3000 #	BOSS.
H1-4	HANDHOLE	8"	–	PAD

Manufacture and construction is to be carried out strictly in accordance with the requirements of this drawing specification. No changes are to be made without the prior agreement of the Chief Engineer of the originating section within Engineering Department.

NOTES:-

1/ EXCHANGER VENDOR TO SIZE SADDLES AND GIVE DIMENSIONS MARKED *

2/ SHELL NOZZLE FLANGES TO BE TRULY HORIZONTAL.

3/ ALL STANDOUTS ARE DISTANCE MEASURED FROM CENTRE OF FLANGE NORMAL TO MAINCENTRELINE.

WEIGHTS :- EMPTY — BY VENDOR.
OPERATING — " —
FULL OF WATER — " —

REV	INIT'L	DATE	REVISIONS	BY	INIT'L	DATE
P1	[illegible]	[illegible]	[illegible]			
			DRN.	AJW	[illegible]	
			CHKD.	[illegible]		

ORIGIN. SECT. E2

TYPE CODE 12

CONTRACT SJ 3006
BCI FOR ERIE MINING
UNIT
AREA CODE

TITLE [illegible] GAS
EXCHANGER E202ABC
(TWO SHELL DESIGN)

DRG. No. 4/3006/AD/12020
SHEET 5 OF 5
REV P1

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, PA 15222

2D (A4)

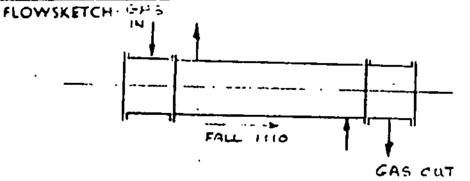
Manufacture and construction is to be carried out strictly in accordance with the requirements of this drawing/specification. No changes are to be made without the prior agreement of the Chief Engineer of the originating section within Engineering Department.

LETTERS IN THIS COLUMN INDICATE WHERE CHANGES, ADDITIONS, OR DELETIONS HAVE TAKEN PLACE

	MANUFACTURERS NAME			
1	SERVICE OF UNIT	COMBINED GAS EXCHANGER		No. OF UNITS THREE
2	SIZE 75/336	TYPE AEL HORIZONTAL		SURFACE PER UNIT $12644 ft^2$
4	SHELLS PER UNIT ONE	CONNECTED IN —		SURFACE PER SHELL $12644 ft^2$
5	THERMAL PERFORMANCE OF ONE UNIT			
6	WESTERN COAL		SHELL SIDE	TUBE SIDE
7	FLUID CIRCULATED		COOLING WATER	COMBINED GAS
8	TOTAL FLUID ENTERING	lb/h	678978	86043
9	VAPOUR (OIL)	lb/h	—	586
10	LIQUID	lb/h	678978	—
11	STEAM	lb/h	—	11131
12	NON-CONDENSABLES	lb/h	—	74326
13	VAPOUR CONDENSED (OIL)	lb/h	—	586
14	LIQUID VAPOURIZED	lb/h	—	—
15	STEAM CONDENSED	lb/h	—	7722
16	GRAVITY - LIQUID ~~API/°F~~	OR sp. gr.	IN OUT	IN OUT 1.0
17	MOLECULAR WEIGHT - VAPOUR OR GAS		IN OUT	IN OUT
18	MOLECULAR WEIGHT - NON-CONDENSABLES		WATER	23.18
19	VISCOSITY - LIQUID	cP.		AS WATER
20	VISCOSITY - VAPOUR OR GAS	cP.	AT °F	0.020/0.016 AT 287/95 °F
21	THERMAL CONDUCTIVITY - LIQUID	Btu/hr ft °F	AT °F	AS WATER AT °F
22	THERMAL CONDUCTIVITY - VAPOUR OR GAS	Btu/hr ft °F	AT °F	0.022/0.018 AT " °F
23	SPECIFIC HEAT - LIQUID	Btu/lb °F	AT °F	AS WATER AT °F
24	SPECIFIC HEAT - VAPOUR OR GAS	Btu/lb °F	AT °F	0.316/0.305 AT " °F
25	LATENT HEAT - VAPOUR	Btu/lb		STEAM 1025/OIL 120
26	TEMPERATURE IN	°F	75	287
27	TEMPERATURE OUT	°F	95	95
28	OPERATING PRESSURE	psig	30	1.0
29	NUMBER OF PASSES		ONE	ONE
30	VELOCITY	ft/sec.	2.17	49.59
31	PRESSURE DROP	psi	ALLOW CALC. 5.64	ALLOW 0.15 CALC. 0.128
32	FOULING RESISTANCE	$(Btu/h\ °F\ ft^2)^{-1}$	REQD. 0.002 ACT.	REQD. 0.003 ACT
33	HEAT EXCHANGED	Btu/h 13.56×10^6	M.T.D. (WEIGHTED CORRECTED LMTD)	°F 42.41
34	TRANSFER RATE - SERVICE	$Btu/h\ °F\ ft^2$	CLEAN 21.45 FOULED 26.81	OVER SURFACE 4.7 %

No.	CONSTRUCTION DATA - EACH SHELL
36	SHELL INT. DIA. 75" — TUBES: No. 1150 O.D. 1.5" B.W.G. 14 (0.083) LENGTH 336" PITCH 1.875" □ ◇
37	BAFFLES - SEGMENTAL 20 PITCH 15" % CUT 15 VERTICAL FLOW →
38	BAFFLES - LONGITUDINAL : TYPE NONE
39	TUBE SUPPORTS PITCH NONE FULL/HALF CIRCLES — No. TIE RODS 12 @ 5/8"
40	CONNECTIONS SHELL IN 8" N/B OUT 8" N/B SERIES 150 lb
41	CHANNEL IN 42" N/B OUT 42" N/B SERIES 150 lb

42 FLOWSKETCH



NOTES.
MEAN OPERATING METAL TEMPERATURES
TUBEWALL 94.5 °F
SHELL 85.0 °F

43 INSPECTION AND TESTS

44 INSPECTION & TESTS TO THE REQUIREMENTS OF: —

45 MANUFACTURERS DOCUMENTATION

46 FOR NUMBER OF COPIES OF DRAWINGS AND DOCUMENTS REQUIRED SEE MANUFACTURERS DOCUMENTATION SHEET

DRN	KJT	10/5/..			
CHKD.					
APPD S. ENG.					
			REV.	DATE	DESCRIPTION
BY	INITIAL	DATE	REVISION		

CONTRACT SJ 3006
BCI FOR ERIE MINING
UNIT

AREA CODE

EXCHANGER THERMAL DATA SHEET

No. OFF	CLIENTS EQUIP. No.	W.D. EQUIP. No.
THREE		E-202 A,B,C

SF 38 (S1)

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, PA 15222

TYPE CODE 12

ORIGIN. SECT. E2

TITLE COMBINED GAS EXCHANGER E202 A,B,C (SINGLE SHELL DESIGN)

DRG. No. 3006 / AD / 12919 REV P

SHEET 1 OF 1

Manufacture and construction is to be carried out strictly in accordance with the requirements of this drawing/specification. No changes are to be made without the prior agreement of the Chief Engineer of the originating section within Engineering Department.

LETTERS IN THIS COLUMN INDICATE WHERE CHANGES, ADDITIONS, OR DELETIONS HAVE TAKEN PLACE

1	MANUFACTURERS NAME		
2	SERVICE OF UNIT	SEE SHT 1	No. OF UNITS
3	SIZE / TYPE		SURFACE PER UNIT ft^2
4	SHELLS PER UNIT / CONNECTED IN		SURFACE PER SHELL ft^2

THERMAL PERFORMANCE OF ONE UNIT

	EASTERN COAL		SHELL SIDE	TUBE SIDE
7	FLUID CIRCULATED		COOLING WATER	COMBINED GAS
8	TOTAL FLUID ENTERING	lb/h	339089	88422
9	VAPOUR	lb/h	—	1415
10	LIQUID	lb/h	339089	—
11	STEAM	lb/h	—	—
12	NON-CONDENSABLES	lb/h	—	87007
13	VAPOUR CONDENSED	lb/h	—	1415
14	LIQUID VAPOURIZED	lb/h	—	—
15	STEAM CONDENSED	lb/h	—	—
16	GRAVITY - LIQUID	lb/ft OR sp. gr.	IN OUT	IN OUT
17	MOLECULAR WEIGHT - VAPOUR OR GAS		IN OUT	IN OUT
18	MOLECULAR WEIGHT - NON-CONDENSABLES		SEE SHT 1	
19	VISCOSITY - LIQUID	cP.		
20	VISCOSITY - VAPOUR OR GAS	cP.	AT °F	AT °F
21	THERMAL CONDUCTIVITY - LIQUID	Btu/hr ft °F	AT °F	AT °F
22	THERMAL CONDUCTIVITY - VAPOUR OR GAS	Btu/hr ft °F	AT °F	AT °F
23	SPECIFIC HEAT - LIQUID	Btu/lb °F	AT °F	AT °F
24	SPECIFIC HEAT - VAPOUR OR GAS	Btu/lb °F	AT °F	AT °F
25	LATENT HEAT - VAPOUR	Btu/lb		
26	TEMPERATURE IN	°F	75	343
27	TEMPERATURE OUT	°F	95	95
28	OPERATING PRESSURE	psig	30	1.0
29	NUMBER OF PASSES		ONE	ONE
30	VELOCITY	ft/sec.	1.03	51.8
31	PRESSURE DROP	psi	ALLOW CALC. 1.228	ALLOW 0.15 CALC. 0.136
32	FOULING RESISTANCE	$(Btu/h\,^oF\,ft^2)^{-1}$	REQD. 0.002 ACT.	REQD. 0.003 ACT
33	HEAT EXCHANGED	Btu/h	M.T.D. (WEIGHTED CORRECTED LMTD) °F	90.06
34	TRANSFER RATE - SERVICE	Btu/h °F ft^2	CLEAN 7.93 FOULED 7.5	OVER SURFACE 24.7%

CONSTRUCTION DATA - EACH SHELL

No.					
36	SHELL: IN-/NON- DIA.	TUBES: No. O.D.	B.W.G.	LENGTH	PITCH □◇△
37	BAFFLES - SEGMENTAL	PITCH	% CUT		FLOW
38	BAFFLES - LONGITUDINAL	TYPE	SEE SHT 1		
39	TUBE SUPPORTS	PITCH	FULL/HALF CIRCLES		No. TIE RODS
40	CONNECTIONS	SHELL IN	OUT	SERIES	
41		CHANNEL IN	OUT	SERIES	

42 FLOWSKETCH: SEE SHT 1

NOTES

MEAN OPERATING METAL TEMPERATURES

TUBEWALL 87.4 °F

SHELL 85.0 °F

43 INSPECTION AND TESTS

44 INSPECTION & TESTS TO THE REQUIREMENTS OF:

45 MANUFACTURERS DOCUMENTATION

46 FOR NUMBER OF COPIES OF DRAWINGS AND DOCUMENTS REQUIRED SEE MANUFACTURERS DOCUMENTATION SHEET

	BY	INITIAL	DATE	REV.	INIT.	DATE	DESCRIPTION
DWN	RVT			P	RVT		FOR ENQUIRY
CHKD.							
APPD S. ENG.							
APPD CO. ENG.							

REVISION

CONTRACT SJ 3006
ECL FOR ERIE MINING
UNIT

AREA CODE

EXCHANGER THERMAL DATA SHEET

No. C.F. | W.D. EQUIP. No. E-202 A,B,C

TITLE COMBINED GAS EXCHANGER E202 A,B,C (SINGLE SHELL DESIGN)

TYPE CODE 12

ORIGIN. SECT. E2

DRG. No. 3006/AD/12919 REV P1

SHEET 2 OF 4

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, PA 15222

Manufacture and construction is to be carried out strictly in accordance with the requirements of this drawing/specification. No changes are to be made without the prior agreement of the Chief Engineer of the originating section within Engineering Department.

LETTERS IN THIS COLUMN INDICATE WHERE CHANGES, ADDITIONS, OR DELETIONS HAVE TAKEN PLACE

1	MANUFACTURERS NAME		
2	MECHANICAL DESIGN OF UNIT		
3		SHELL SIDE	TUBE SIDE
4	DESIGN PRESSURE psig	50	5
5	TEST PRESSURE psig	TO CODE	5
6	DESIGN TEMPERATURE °F	110	358
7	CORROSION ALLOWANCE INS.	1/8	1/8
8	STRESS RELIEF: TO BE ADVISED		
9	RADIOGRAPHY: SPOT 10% MINIMUM		INSURANCE ~~INSPECTION~~ BY

10	MATERIALS OF CONSTRUCTION	
11	PART DESCRIPTON	MATERIAL SPECIFICATIONS
12	SHELL & SHELL COVER RING	C.S SA285 GrC
13	SHELL COVER DISH	—
14	CHANNEL CYLINDER	C.S SA285 GrC
15	CHANNEL COVER OR DISH	C.S SA285 GrC
16	CHANNEL FLANGES	C.S SA285 GrC
17	SHELL FLANGES & SHELL COVER FLANGE	—
18	FLOATING HEAD COVER FLANGE	—
19	FLOATING HEAD COVER DISH	—
20	SPLIT-RING	—
21	BACKING-RING	—
22	TUBESHEETS *	C.S SA516 Gr65
23	PARTITION PLATES	—
24	PIPE FOR NOZZLES (IF BUILT UP) GAS IN/OUT	C.S SA285 GrC
25	NOZZLE FLANGES (IF BUILT UP) " " "	C.S SA285 GrC
26	LONG FORGED WELDING NECKS (TUBESIDE)	C.S SA 105
27	TUBES	C.S SA 179
28	SPACER SPOOLS	C.S
29	TIE-RODS & NUTS	C.S
30	BAFFLES & SUPPORT PLATES	C.S
31	SADDLE PLATES	C.S
32	STUDBOLTS	SA 193 B7
33	NUTS	SA 194 2H
34	GASKETS - SHELL	—
35	GASKETS - CHANNEL	C.A.F 1/8" THK
36	NOZZLE FLANGES OTHER THAN ABOVE	C.S SA 105
37	IMPINGEMENT PLATE (SHELL INLET)	C.S.
38	TUBE/TUBESHEET ATTACHMENT	EXPANDED
39	PIPE FOR BUILT UP NOZZLES EXCEPT ABOVE	C.S SA 106 A or B

40 DESIGN CODES

- A.S.M.E. U.P.V. SECT. VIII (TUBESIDE - FABRICATION ONLY) ✓ — ~~BS 1500~~ ☐
- ~~A.S.M.E. POWER BOILER SECT.~~ ☐ — ~~BS 5500~~ ☐
- T.E.M.A. CLASS C ✓ — MECHANICAL DESIGN TO COMPLY WITH TEMA 6th ED SECTION 12 'RECOMMENDED GOOD PRACTICE'

* MATERIAL TO BE ULTRASONICALLY TESTED IN ACCORDANCE WITH ASTM A435

41 INSPECTION AND TESTS

42 INSPECTION & TESTS TO THE REQUIREMENTS OF:

43 MANUFACTURERS DOCUMENTATION

44 FOR NUMBER OF COPIES OF DRAWINGS AND DOCUMENTS REQUIRED SEE MANUFACTURERS DOCUMENTATION SHEET

BY	INITIAL	DATE	REV.	INITIAL	DATE	DESCRIPTION
DRN	R.V.T	10/3/77				
CHKD.		"				
APPD. S. ENG						
APPD CO ENG			P	R.V.T	10/3/77	FOR ENQUIRY
APPD. CH. ENG						

CONTRACT SJ 3006 BCI FOR ERIE MINING

UNIT

AREA CODE

EXCHANGER MECHANICAL DATA SHEET

No. OFF	CLIENTS EQUIP No.	W.D. EQUIP No
THREE		E-202 A,B,C

TITLE COMBINED GAS EXCHANGER E202A,B,C SINGLE SHELL DESIGN

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, PA 15222

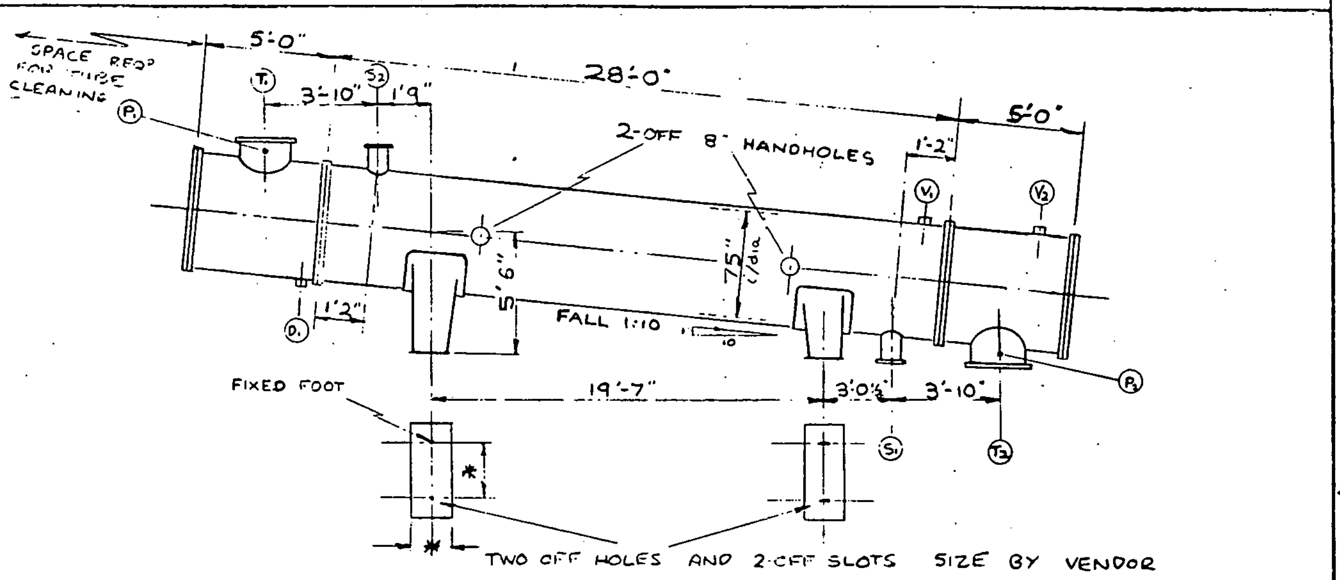
TYPE CODE 12

ORIGIN SECT. E2

DRG. No. 3006/ 4D/12919 REV. P

SHEET 3 OF 4

Manufacture and construction is to be carried out strictly in accordance with the requirements of this drawing specification. No changes are to be made without the prior agreement of the Chief Engineer of the originating section within Engineering Department.



NOTES:-

1) EXCHANGER VENDOR TO SIZE SADDLES AND GIVE DIMENSIONS MARKED *
2) ALL NOZZLE FLANGES TO BE TRULY HORIZONTAL
3) ALL STANDOUTS ARE DISTANCE MEASURED FROM CENTRE OF FLANGE NORMAL TO MAIN CENTRELINE
4) VENDOR TO POSITION SAMPLEPOINTS P_1 AND P_2

WEIGHTS :- EMPTY ------ BY VENDOR
OPERATING ------ " ------ " ------
FULL OF WATER ------ " ------ " ------

NOZZLE	SIZE	MARK	RATING	STAND OUT
SHELL INLET	8"	S_1	150	3'-10"
SHELL OUTLET	8"	S_2	150	3'-10"
TUBE INLET	42"	T_1	150	3'-11"
TUBE OUTLET	42"	T_2	150	3'-11"
VENT SHELLSIDE	2"	V_1	3000	BOSS
VENT TUBESIDE	2"	V_2	3000	BOSS
DRAIN TUBESIDE	2"	D_1	3000	BOSS
SAMPLE POINT	2"	$P_{1,2}$	3000	BOSS
HANDHOLE	8"	$H_{1,2}$	—	PAD

			DRN.			ORIGIN. SECT.
			CHKD.			
REV.	DATE	REVISIONS	BY		DATE	

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, PA 15222

CONTRACT 3026
UNIT
TITLE
(SINGLE SHELL DESIGN
AREA CODE
TYPE CODE 12
DRG. No 3026 / AD / 12919
REV P_1
SHEET 4 OF 4

SF 20 (A4)

ERIE MINING COMPANY

COAL GASIFICATION PROJECT

HOYT LAKES, MINNESOTA

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

McKEE CONTRACT 4814

BCI PROJECT NO. 3001

SPECIFICATION NO. CY 201

FOR

DUST CYCLONES

OCTOBER 10, 1978

1.0 EQUIPMENT TO BE FURNISHED

1.1 The work to be performed under the terms of this specification shall consist of furnishing all materials and labor required to design, detail, fabricate, refractory lining, paint, and deliver five (5) dust cyclones.

Number Required	Equipment Number	Description
5	CY201 A/E	Dust Cyclone

2.0 DESIGN CRITERIA

2.1 Each Cyclone shall be capable of performing under the conditions described in attached copy of Process Specifications for Dust Cyclones - PS-CY201 A/E.

3.0 WORK BY OTHERS

3.1 Receive, unload, store, and install the equipment in accordance with vendor's information.

3.2 Provide and install all supply and discharge piping and valves.

4.0 MATERIALS OF CONSTRUCTION

4.1 Shell Materials - Carbon Steel - ASTM A283 Grade B

4.2 Pipe Nozzles - Carbon Steel - ASTM A 53 Grade B

4.3 Nozzle Flanges - Carbon Steel - ASTM A105 Grade I or II

4.4 Large Flanges - Carbon Steel - ASTM A 36 Struct.Grade

4.5 Flanges shall be 150# equivalent

4.6 Prime Coat 3.0 dry mil thickness inorganic zinc - Carboline Co. Carbozine FD or approved equal (Exterior surfaces only.)

4.7 Surface preparation - SSPC SP6 Commercial Blast Cleaning.

4.8 Refractory Materials

4.8.1 3" thick inner layer APGreen Low Abrade 2400F,

4.0 MATERIALS OF CONSTRUCTION (continued)

4.8.1 (continued)

or approved equal, Vitrified.

4.8.2 3" thick backing layer AFGreen VSL 50 insulating castable.

4.8.3 Refractory anchors shall be specified by refractory supplier.

4.9 Welding - ASME Section IX

5.0 EQUIPMENT CONFIGURATION

5.1 Equipment will be installed conventionally on four (4) saddle supports attached to straight section of cylinder.

5.2 Raw Gas Inlet Size: 30" diameter

5.3 Clean Gas Exit Size: 30" diameter

5.4 Dust Discharge Size: 8" IPS

5.5 Provide handling lugs

5.6 Four saddle supports required

6.0 GUARANTEES

6.1 Vendor shall guarantee the total work to be free from defects in material and workmanship for a period of one (1) year after the equipment has been in regular operation, and shall take all steps and do all things necessary at his own expense and at the time specified by purchaser to remedy completely all such defective materials and workmanship.

7.0 PROPOSAL REQUIREMENTS

7.1 The bidder shall quote in strict compliance with these Specifications.

7.2 Any exceptions shall be noted in detail and submitted as an alternate price.

7.0 PROPOSAL REQUIREMENTS (continued)

7.3 Pricing shall be based on delivery to site at Hoyt Lakes, Minnesota.

7.4 Three (3) copies vendor drawings showing configuration.

7.5 Calendar days for receipt of vendor drawings for approval.

7.6 Calendar days for delivery of unit after approval.

7.7 Total weight of one (1) cyclone.

7.8 Firm lump sum price for five (5) cyclones.

7.9 Additional firm price for thrity-five (35) copies of Installation, Operation, and Maintenance Manuals.

7.10 Alternate firm pricing for exceptions to specifications.

7.0 PROPOSAL REQUIREMENTS (continued)

7.3 Pricing shall be based on delivery to site at Hoyt Lakes, Minnesota.

7.4 Three (3) dopies vendor drawings showing configuration.

7.5 Calendar days for receipt of vendor drawings for approval.

7.6 Calendar days for delivery of unit after approval.

7.7 Total weight of one (1) cyclone.

7.8 Firm lump sum price for five (5) cyclones.

7.9 Additional firm price for thrity-five (35) copies of Installation, Operation, and Maintenance Manuals.

7.10 Alternate firm pricing for exceptions to specifications.

ERIE MINING COMPANY

COAL GASIFICATION PROJECT

HOYT LAKES, MINNESOTA

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

McKEE CONTRACT 4814

BCI PROJECT NO. 3001

SPECIFICATION NO. CY202

FOR

TAR CYCLONES

OCTOBER 10, 1978

1.0 EQUIPMENT TO BE FURNISHED

1.1 The work to be performed under the terms of this specification shall consist of furnishing all materials and labor required to design, detail, fabricate, paint, and deliver five (5) tar cyclones.

Number Required	Equipment Number	Description
5	CY202 A/E	Tar Cyclone

2.0 DESIGN CRITERIA

2.1 Each Cyclone shall be capable of performing under the conditions described in attached copy of Process Specifications for Dust Cyclones - PS-CY202 A/E.

3.0 WORK BY OTHERS

2.1 Receive, unload, store, and install the equipment in accordance with vendor's information.

2.2 Provide and install all supply and discharge piping and valves.

4.0 MATERIALS OF CONSTRUCTION

4.1 Shell materials Carbon Steel ASTM A283 Grade B

4.2 Pipe nozzles Carbon Steel ASTM A 53 Grade B

4.3 Nozzle flanges Carbon Steel ASTM A105 Grade I or II

4.4 Large flanges Carbon Steel ASTM A 36 Struc. Grade

4.5 Flange shall be 150# equivalent

4.6 Prime coat 3.0 dry mil thickness inorganic zinc - Carboline Co. Carbo-Zinc FD or approved equal (Exterior and internal surfaces).

4.7 Surface preparation - SSPC SP6 Commercial Blast Cleaning

4.8 Welding - ASME Section IX

5.0 EQUIPMENT CONFIGURATION

5.1 Equipment will be installed conventionally on four (4) saddle supports attached to straight section of cylinder.

5.2 Raw Gas Inlet Size: 24" diameter

5.3 Clean Gas Exit Size: 24" diameter

5.4 Dust Discharge Size: 2" sch 80 pipe

5.5 Provide handling lugs

5.6 Four saddle supports required

6.0 GUARANTEES

6.1 Vendor shall guarantee the total work to be free from defects in material and workmanship for a period of one (1) year after the equipment has been in regular operation, and shall take all steps and do all things necessary at his own expense and at the time specified by purchaser to remedy completely all such defective materials and workmanship.

7.0 PROPOSAL REQUIREMENTS

7.1 The bidder shall quote in strict compliance with these Specifications.

7.2 Any exceptions shall be noted in detail and submitted as an alternate price.

7.3 Pricing shall be based on delivery to site at Hoyt Lakes, Minnesota.

7.4 Three (3) copies vendor drawings showing configuration.

7.5 Calendar days for receipt of vendor drawings for approval.

7.6 Calendar days for delivery of unit after approval.

7.7 Total weight of one (1) cyclone.

7.0 PROPOSAL REQUIREMENTS

7.8 Firm lump sum price for five (5) cyclones.

7.9 Additional firm price for thirty-five (35) copies of Installation, Operation, and Maintenance Manuals.

7.10 Alternate firm pricing for exception to specifications.

ERIE MINING COMPANY

COAL GASIFICATION PROJECT

HOYT LAKES, MINNESOTA

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

McKEE CONTRACT #4814

BABCOCK CONTRACTORS INC.

PROJECT NO. 3001

SPECIFICATION NO. R201/PV1

FOR

CODED PRESSURE VESSELS

October 13, 1978
Revision 1 - January 16, 1979

1.0 SCOPE

1.1 This specification covers the minimum requirements for the design, fabrication, testing and inspection of the Water Jackets and Steam Drums for five (5) coal gasifiers.

1.2 The term BCI as used in this specification shall mean Babcock Contractors Inc.

2.0 EQUIPMENT TO BE FURNISHED

2.1 The work to be performed under the terms of this specification shall consist of furnishing all materials and labor required to detail, shop fabricate, prime paint, test and deliver coded pressure vessels to be used in an industrial coal gasification plant. The equipment shall be supplied complete with all appurtenances and accessories as specified herein and as shown on BCI design drawings.

2.2 Vessels Required

Number Required	Equipment Number	Description
Five (5)	WT-1/5	Water Jacket
Five (5)	D201-A/E	Gasifier Steam Drum

2.3 Manufacturer shall supply and ship with equipment the following items in accordance with quantity indicated on drawings.

2.3.1 Blind Flanges and Other Covers
2.3.2 Related Bolts and Nuts and Gaskets

3.0 DRAWINGS

The following BCI design drawings become an integral part of this specification:

M-309 Water Jacket Assembly
M-310 Steam Drum
M-338 Code Vessel Details

Revision numbers shall be as stated in inquiry/purchasing documents.

4.0 GENERAL

4.1 Manufacturer's Responsibility

It is the responsibility of the manufacturer:

4.1.1 To read and comply with this specification in conjunction with the inquiry or purchase order and BCI design drawings.

4.1.2 To provide work/materials in accordance with the best modern practice and nothing written or implied in this specification shall relieve the manufacturer of his responsibility for the quality and soundness of the finished work.

4.2 Should deviation from this specification be necessary, the proposed alternative shall be at least equal to this specification and must be approved in writing by BCI prior to commencing fabrication.

4.3 Standards

Reference to Standards and other mandatory documents in this specification relate to their latest issue, current at the time of placing the purchase order.

5.0 DESIGN AND CONSTRUCTION CODES

5.1 Design and construction shall be in accordance with ASME Code Section I "Power Boilers".

5.2 BCI drawings are fully detailed but any areas of design and construction not covered by these drawings shall also be in accordance with the Code. Any additional drawings prepared by manufacturer for his shop work, including calculations, are subject to approval by BCI.

5.3 Requirements of the Statutory Authorities will also apply.

5.4 The manufacturer shall not modify any aspect of the design and construction shown on the drawings listed in Section 3.0 above, without the prior consent of BCI in writing.

6.0 MATERIALS OF CONSTRUCTION

6.1 Materials of construction shall be as specified on BCI design drawings. Alternative materials may be used provided they are at least equivalent to those specified and are approved in writing by BCI.

6.2 All materials used shall be covered by certified Mill Test Reports giving the chemical analysis and physical properties of the material.

7.0 FABRICATION

7.1 Manufacture, workmanship and testing shall be to the standards and requirements of ASME Code Section I.

7.2 The cooling jackets and steam drums shall be completely shop fabricated.

7.3 Longitudinal and circumferential welded seams shall be arranged to avoid nozzles and other attachments. Within fourteen (14) days of BCI placing a purchase order for the cooling jackets and steam drums, the manufacturer shall advise, and agree with BCI the number and location of longitudinal and circumferential seams. These details will then be added to BCI drawings which will then be re-issued to the manufacturer and shall not be modified without approval in writing from BCI.

7.4 Hammering shall not be used to obtain alignment of plate edges.

7.5 Tolerances

7.5.1 Fabrication tolerances shall be as shown in Section 17.0 following, unless indicated otherwise on the design drawings.

7.5.2 The manufacturer's attention is drawn to the need to ensure that the ring welded to the underside of the water jacket Drawing No. M-309 is located within the tolerances stated (i.e., dimension 10-5/8" -0, +1/8 and misalignment of faces 'X' and 'Y' within 1/16").

7.0 FABRICATION (Continued)

7.5 Tolerances (Continued)

7.5.3 The manufacturer is to state at the time of the inquiry if any difficulty is expected in meeting tolerances of this specification.

7.6 Heat Treatment

Preheat for welding and post weld heat treatment shall be carried out in accordance with requirements of ASME Code Section I.

7.7 Repair and Defects

Proposals for and rectification of defects must be submitted to BCI for their approval in writing.

Defective parts and/or materials which cannot be repaired shall be replaced.

8.0 WELDING

8.1 General

All welding shall conform to the requirements of ASME Code Section I and ASME Code Section IX.

8.2 Welding Qualifications

Welding shall only be carried out by welders showing evidence of current qualification tests relevant to the production work involved.

When required by the Code, BCI or the inspecting authority, the manufacturer shall, without extra charge, arrange to test his welders as specified.

8.3 Weld Procedures

The manufacturer shall submit all weld procedures to BCI for approval before manufacture commences.

8.0 WELDING (Continued)

8.4 Welded Joints

All longitudinal and circumferential welded seams shall be full penetration double welded butt joints, unless shown otherwise on BCI drawings; e.g.,

8.4.1 Closing circumferential seams on the water jackets are to be made using a backing strip unless the manufacturer is able to offer an alternative design which complies with ASME Code Section I paragraph PW 9.1.

8.4.2 The closing longitudinal seams on the water jackets shall be single welded full penetration butt joints complying with ASME Section I paragraph PW 9.1. Backing strips shall not be used.

9.0 INSPECTION

9.1 Inspecting Authority

Materials, workmanship and testing shall be subject to inspection by BCI and/or their nominated Inspecting Authority at no additional cost to BCI.

9.2 Facilities for Inspection

BCI and/or their nominated Inspecting Authority, shall have access at all reasonable times to those parts of the works engaged in the manufacture and testing of the equipment being supplied.

The manufacturer shall afford the inspector(s) all reasonable facilities for inspection during progress of the work and on its completion.

9.3 Responsibility

Approval by BCI and/or their nominated Inspecting Authority does not in any way relieve the manufacturer of his responsibility for the materials and/or workmanship.

10.0 TESTING

10.1 Radiographic Examination

100% radiographic examination shall be carried out on all butt welds. Acceptance standards shall be in accordance with the Code.

BCI and/or their nominated Inspecting Authority reserve the right to approve all radiographs.

10.2 Hydrostatic Tests

The water jackets and steam drums shall be subjected to a hydrostatic test in accordance with the Code requirements. The manufacturer shall supply all the necessary blanks and bolts for the tests.

During the hydrostatic test, at no time shall the water temperature fall below 70^{o}F.

11.0 MARKING

11.1 The manufacturer shall supply a nameplate permanently attached to each water jacket and steam drum at a point indicated on BCI drawings.

11.2 Centerlines 0^{o}, 90^{o}, 180^{o} and 270^{o} are to be prominently marked on the exterior of the water jacket.

11.3 Information as indicated on the BCI nameplate shown in Section 18.0 following, is to be stamped on the nameplate by the manufacturer. This nameplate is in addition to any other nameplates regularly furnished by the manufacturer.

11.4 The words "STRESS RELIEVED NO WELDING" are to be stencilled prominently three places on each vessel in characters 4" high.

12.0 CLEANING AND PAINTING

Exterior surfaces to be painted shall be properly cleaned prior to application of vessel manufacturer's standard prime coat. Cleaning shall be as required by the paint supplier.

13.0 PREPARATION FOR SHIPMENT

13.1 All equipment shall be properly marked for erection, identified by BCI purchase order number, project number, and equipment number and protected for shipment.

13.2 Nozzle flanges shall have disposable wooden blanks bolted on for protection.

13.3 All screwed connections shall be plugged with forged steel plugs.

13.4 Machined and threaded surfaces shall be coated with a corrosion preventive and protected from damage.

13.5 Where any loose parts are supplied (e.g., bolts, nuts, gaskets), these shall be properly and robustly packed against damage during transit and clearly labelled as indicated in paragraph 11.1 above.

14.0 MANUFACTURERS' DOCUMENTATION

The manufacturer shall supply prior to shipping, the number of copies of Manufacturers' Data Report Forms, Material and Hydrostatic Test Certificates, Heat Treatment Charts, Radiographic Examination Reports, Weld Procedures, nameplate rubbings and any other documents as called for in BCI purchase order.

15.0 DRAWINGS AND RECORDS

15.1 Upon receipt of purchase order, manufacturer shall promptly prepare and furnish, as required, preliminary shop drawings showing all dimensions, the size and location of every connection, clearance for removing covers, shipping weight, etc., in the quantities requested on purchase order.

15.2 BCI will examine preliminary drawings for general arrangement, dimensions and apparent suitability. One set will be returned to the manufacturer, marked "Approved" or "Approved as Noted".

15.0 DRAWINGS AND RECORDS (Continued)

15.3 The approval, recommendations or suggestions by BCI shall in no way relieve the manufacturer of his responsibilities with respect to the provisions of these specifications or fulfillment of the guarantee.

15.4 Unless authorized by BCI in writing, fabrication of the equipment shall not be started until the preliminary drawings have been approved.

15.5 Final outline and shop fabrication drawings shall be furnished in the quantity specified in the purchase order. Drawings shall be corrected to reflect any alterations or changes beyond those allowed by the prescribed fabrication tolerances.

16.0 PROPOSAL REQUIREMENTS

16.1 The manufacturer shall quote in strict accordance with this specification.

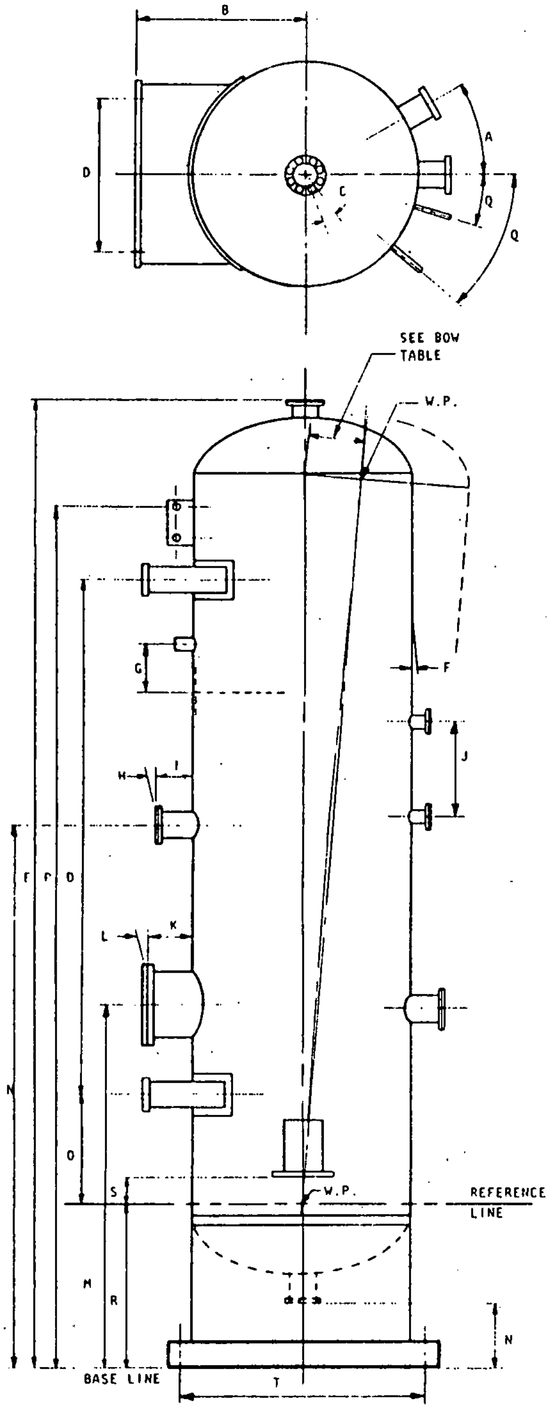
16.2 Any and all exceptions shall be clearly stated in the bid. Unless specifically stated by the manufacturer, the specification is bid upon as written.

16.3 Any alternates to the specification shall be clearly stated, and the price differential quoted.

16.4 All quotes shall be for complete equipment, as specified in this specification, FOB at plant site. Plant site is Hoyt Lakes, Minnesota. Proposed method of shipment shall be stated.

16.5 Weight for each item shall be confirmed by manufacturer.

17.0 EXTERNAL TOLERANCES (Coded Vessels)



NOTES

TOLERANCES SHOWN ON THIS SHEET GOVERN THE FABRICATION OF COLUMNS AND HORIZONTAL OR VERTICAL PRESSURE VESSELS AS THEY APPLY. TOLERANCES GOVERNED BY CODE ARE NOT SHOWN. SPECIAL TOLERANCES WILL BE SHOWN ON VESSEL DESIGN DRAWINGS.

A. ± 1/2° NOZZLE, ± 1° MANHOLE ORIENTATIONS.

B. +0,-1/4" C_L TO BOTTOM OF SUPPORT FOR HORIZONTAL VESSELS.

C. BOLT HOLE ORIENTATION FOR ALL NOZZLES 1/16" MAX. DEVIATION AT BOLT CIRCLE, MANWAYS 3/16" MAX.

D. ± 1/8" C_L TO C_L OF BOLT HOLES ON SUPPORTS FOR HORIZONTAL VESSELS.

E. NOZZLE ELEVATION FROM BASE LINE ± 1/2" MAXIMUM OF 1/64"/LINEAL FT., USE SMALLER. ± 1/8" C_L TO C_L OF ADJACENT NOZZLE OR TRAY SUPPORT WHEN SO DIMENSIONED.

F. 1/8" FOR ANY 10 FEET OF SHELL CURVATURE.

G. ± 1/4" C_L OF COUPLING OR NOZZLE TO TOP OF TRAY WHEN RELATED TO TRAY: I.E.,TI OR SAMPLE CONN.

± 1/2" C_L OF COUPLING TO BASE LINE WHEN NOT RELATED TO INTERNAL EQUIPMENT.

H. NOZZLE TILT MEASURED ACROSS GASKET FACE.

MAX. TILT	NOZZLE SIZE
1/32"	3" & UNDER
1/16"	4" - 10"
1/8"	12" & OVER

I. ± 1/8" NOZZLE PROJECTION.

J. ± 1/16" C_L TO C_L LIQUID-LEVEL AND GAGE GLASS CONNECTIONS.

K. ± 1/2" MANHOLE PROJECTION.

L. MANHOLE TILT MEASURED ACROSS GASKET FACE 1/4" FOR 16" THROUGH 24" SIZES.

M. MANHOLE ELEVATION FROM BASE LINE ± 1/2".

N. ± 1/8" C_L TO BASE LINE, REBOILER NOZZLES OR OTHER NOZZLES WITH RIGID PIPING CONNECTIONS, WHEN SPECIFIED.

O. ± 1/4" DISTANCE FROM REFERENCE LINE TO SADDLE FOR HORIZONTAL VESSELS.

P. ± 1/4" DISTANCE FROM BASE LINE TO CLIP.

Q. ORIENTATION FROM REFERENCE LINE TO CLIP ± 1/2° OR 1/4" ON CIRCUMFERENCE, WHICHEVER IS SMALLER.

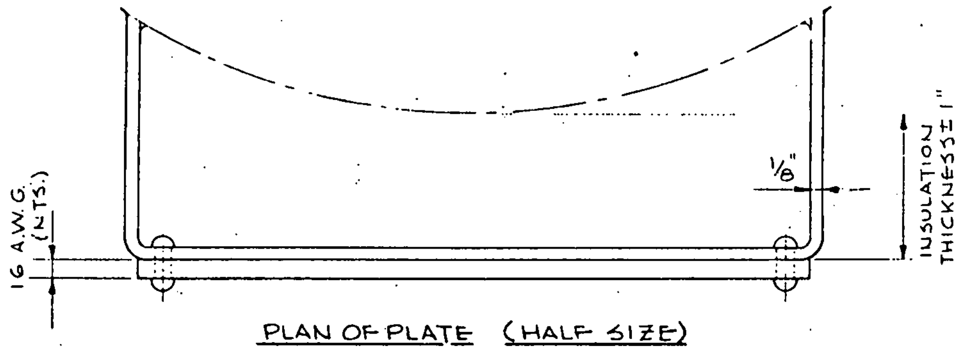
R. +0", -1/4" DISTANCE FROM BASE TO REFERENCE LINE.

S. -0, +1/4" DISTANCE FROM BOTTOM OF SUPPORT TO REFERENCE LINE.

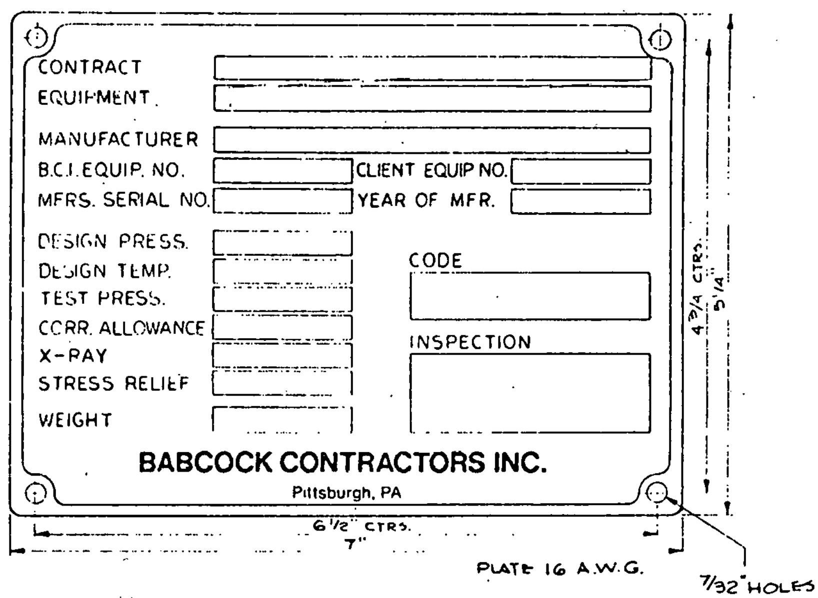
T. ANCHOR BOLT CIRCLE: ± 3/16" ON DIA. ± 3/16" BETWEEN HOLES. THESE TWO TOLERANCES ARE NON-CUMULATIVE.

TOWER MAX. PERMISSIBLE BOW				
HEIGHT	24"to 42"	48"to 66"	73"to 90"	96"& Over
10'-0"	5/32"	3/32"	1/16"	1/16"
20'-0"	5/16"	3/16"	5/32"	3/32"
30'-0"	7/16"	5/16"	7/32"	5/32"
40'-0"	19/32"	13/32"	5/16"	3/16"
50'-0"	3/4"	1/2"	3/8"	1/4"
60'-0"	29/32"	19/32"	7/16"	5/16"
70'-0"	1 1/16"	11/16"	17/32"	11/32"
80'-0"	1 3/16"	13/16"	19/32"	13/32"
90'-0"	1 11/32"	29/32"	11/16"	7/16"
100'-0" & OVER	1-1/2"	1"	3/4"	1/2"

18.0 SPECIAL NAMEPLATE

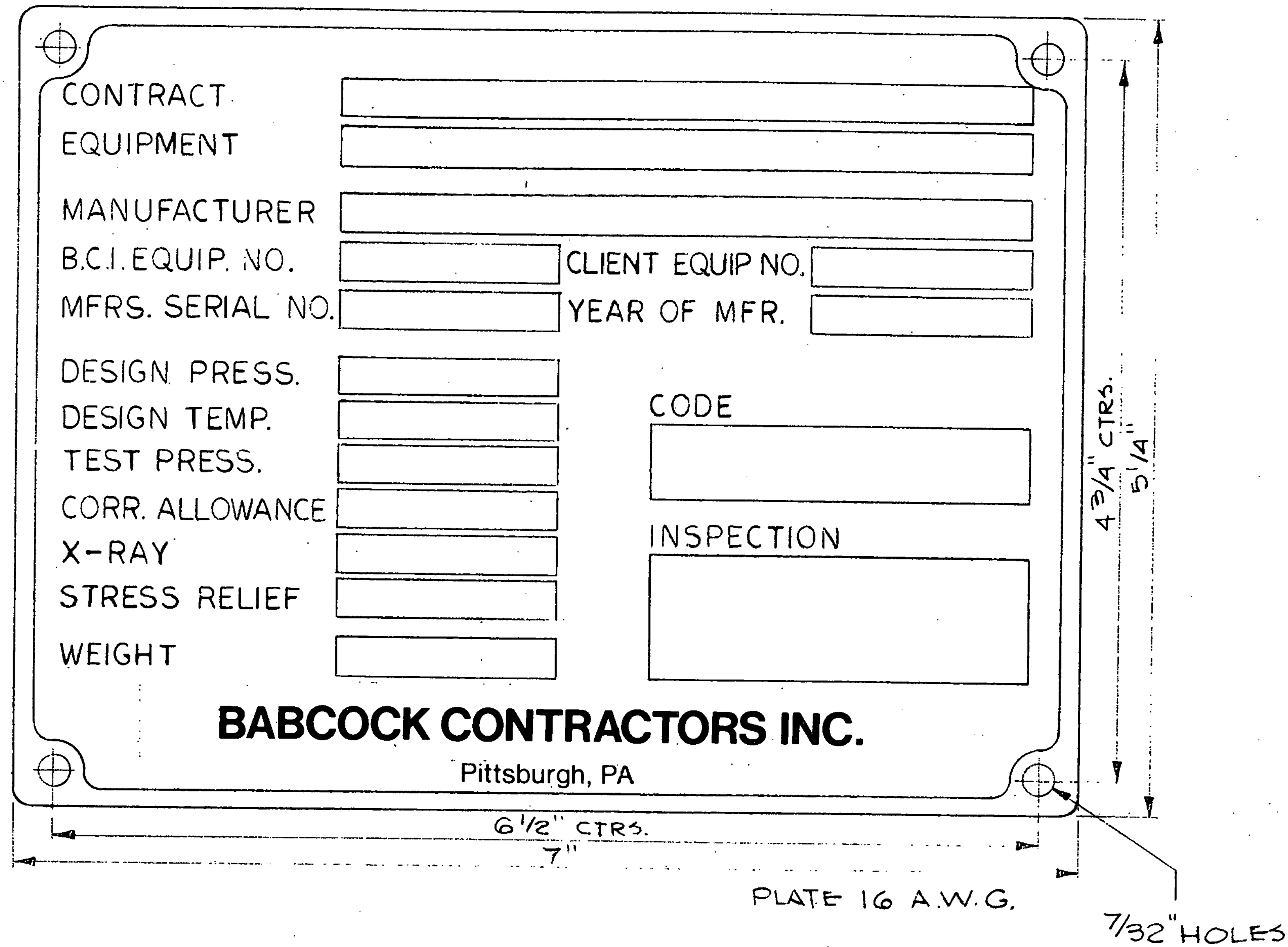


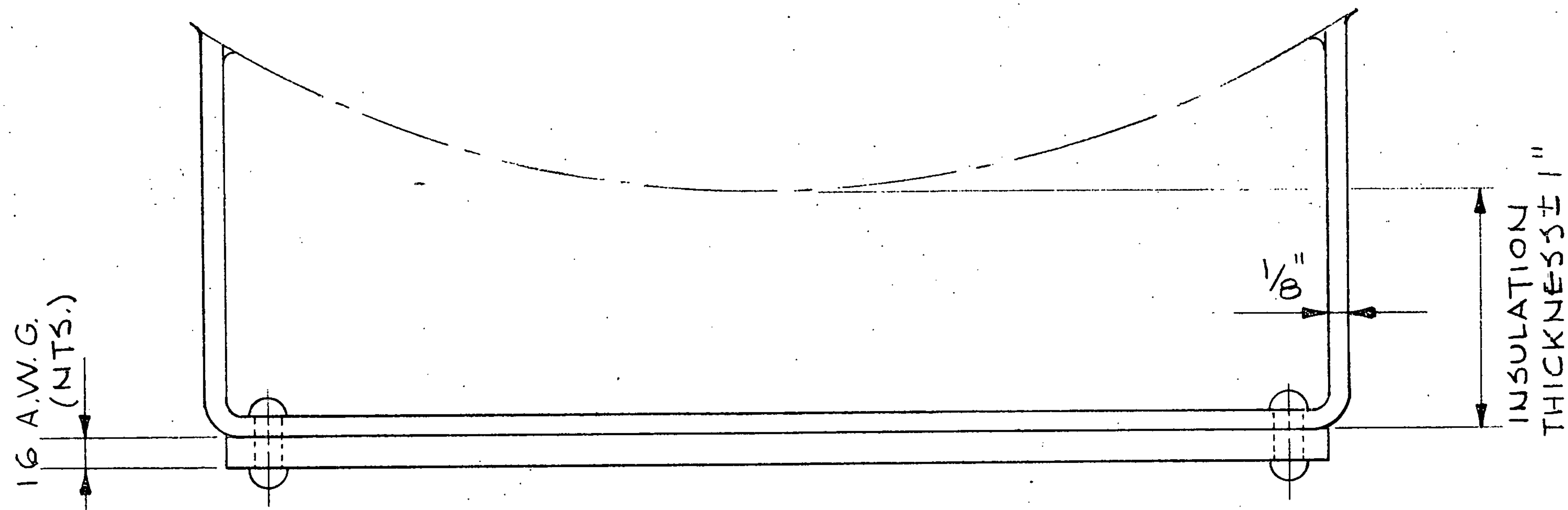
PLAN OF PLATE (HALF SIZE)



NOTES:

MATERIAL: PLATE - ENGRAVED STAINLESS STEEL PLATE
PIERCED FOUR HOLES 7/32"/6mm DIAMETER.
RIVETS - 3/16"/5mm R.H. ALUMINUM x 1/2"/13mm LONG.
NAMEPLATE - SUPPLIED BY BABCOCK CONTRACTORS INC.
STAMPING BY VESSEL MANUFACTURER
BRACKET & RIVETS - SUPPLIED BY VESSEL MANUFACTURER.
METRIC DIMENSIONS ARE NOT DIRECT CONVERSIONS.


CONTRACT
EQUIPMENT
MANUFACTURER
B.C.I. EQUIP. NO.
CLIENT EQUIP NO.
MFRS. SERIAL NO.
YEAR OF MFR.
DESIGN PRESS.
DESIGN TEMP.
TEST PRESS.
CORR. ALLOWANCE
X-RAY
STRESS RELIEF
WEIGHT
CODE
INSPECTION
BABCOCK CONTRACTORS INC.
Pittsburgh, PA
6 1/2" CTRS.
7"
4 3/4" CTRS.
5 1/4"
PLATE 16 A.W.G.
7/32" HOLES



PLAN OF PLATE (HALF SIZE)

ERIE MINING COMPANY

COAL GASIFICATION PROJECT

HOYT LAKES, MINNESOTA

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

McKEE CONTRACT #4814

BABCOCK CONTRACTORS INC.

PROJECT NO. 3001

SPECIFICATION NO. R201/PV2

FOR

NON-CODED VESSELS

October 13, 1978
Revision 1 - January 16, 1979

1.0 SCOPE

1.1 This specification covers the minimum requirements for the design, shop fabrication, testing and inspection of the Shell, Lower Cone, Upper Cone and Blast Inlet assembly for five (5) coal gasifiers.

1.2 The term BCI as used in this specification shall mean Babcock Contractors Inc.

2.0 EQUIPMENT TO BE FURNISHED

2.1 The work to be performed under the terms of this specification shall consist of furnishing all materials and labor required to detail, shop fabricate, prime paint, and deliver the following non-coded vessel parts to be used in an industrial coal gasification plant. The equipment shall be supplied complete with all appurtenances and accessories as specified herein and as shown on BCI design drawings.

2.2 Vessels Required

Number Required	Equipment Number	Description
Five (5)	BI-1/5	Blast Inlet Assembly - Upper Section
Five (5)	BI-1/5	Blast Inlet Assembly - Lower Section
Five (5)	RS-1/5	Gasifier Shell Assembly
Five (5)	CD-1/5	Gasifier Lower Cone
Five (5)	CE-1/5	Gasifier Upper Cone

2.3 Manufacturer shall supply and ship with equipment the following items in accordance with quantity indicated on drawings.

2.3.1 Blind flanges and other covers
2.3.2 Related bolts and nuts and gaskets

3.0 DRAWINGS

The following drawings become an integral part of this specification:

M-300	Common Gasifier - Exterior View
M-304	Gasifier Shell & Details
M-305	Lower Cone Assembly
M-306	Upper Cone Assembly
M-337	Blast inlet Assembly
M-339	Non-Code Vessel Details

Revision numbers shall be as stated in inquiry/purchasing documents.

4.0 GENERAL

4.1 Manufacturer's Responsibility

It is the responsibility of the manufacturer:

4.1.1 To read and comply with this specification in conjunction with the inquiry or order and BCI detail drawings.

4.1.2 To provide work/materials in accordance with the best modern practice and nothing written or implied in this specification shall relieve the manufacturer of his responsibility for the quality and soundness of the finished work.

4.2 Should deviation from this specification be necessary, the proposed alternative shall be at least equal to this specification and must be approved in writing by BCI prior to commencing fabrication.

4.3 Standards

Reference to Standards and other mandatory documents in this specification relate to their latest issue, current at the time of placing the order.

5.0 DESIGN AND CONSTRUCTION

5.1 Design and construction shall be in accordance with the BCI design drawings listed in Section 3.0 above.

5.2 The manufacturer shall not modify any aspect of the design and construction shown on the drawings listed in Section 3.0 above without the prior consent of BCI in writing.

5.3 Any additional drawings prepared by manufacturer for his shop work, including calculations, are subject to approval by BCI.

6.0 FABRICATION

6.1 Manufacture and workmanship shall be in accordance with best modern day practice.

6.0 FABRICATION

6.2 The equipment shall, as far as possible be shop fabricated. The manufacturer shall, at the inquiry stage state the extent of site work involved.

6.3 Longitudinal and circumferential welded seams shall be arranged to avoid nozzles and other attachments.

Within fourteen (14) days of BCI placing an order for the components listed in paragraph 2.0, the manufacturer shall advise, and agree with BCI, the number and location of longitudinal and circumferential seams. These details will then be added to BCI design drawings which will then be reissued to the manufacturer and shall not be modified without approval in writing from BCI.

6.4 Hammering shall not be used to obtain alignment of plate edges.

6.5 Tolerances

Fabrication tolerances shall be in accordance with manufacturer's standard for this type of heavy platework. Statements and drawings showing manufacturer's proposed tolerances shall be submitted to BCI and approved prior to manufacture.

6.6 Repair and Defects

Proposals for and rectification of defects must be submitted to BCI for their approval in writing.

Defective parts and/or materials which cannot be repaired shall be replaced.

7.0 WELDING

7.1 General

All welding shall conform to the requirements of ASME Code Section IX.

7.2 Welding Qualifications

Welding shall only be carried out by welders showing evidence of current qualification tests relevant to the production work involved.

7.0 WELDING (Continued)

7.3 Weld Procedures

The manufacturer shall submit weld procedures to BCI for approval before manufacture commences.

7.4 Welded Joints

All longitudinal and circumferential welded seams shall be full penetration double welded butt joints.

8.0 INSPECTION

8.1 Inspecting Authority

Materials, workmanship and testing shall be subject to inspection by BCI and/or their nominated Inspecting Authority at no additional costs to BCI.

8.2 Facilities for Inspection

BCI and/or their nominated Inspecting Authority, shall have access at all reasonable times to those parts of the works engaged in the manufacture and testing of the equipment being supplied.

The manufacturer shall afford the inspector(s) all reasonable facilities for inspection during progress of the work and on its completion.

8.3 Waiver of any of the foregoing requirements with respect to inspection and testing, at the option of BCI's Engineer or Inspector, is binding only if authorized in writing.

8.4 Responsibility

Approval by BCI and/or their nominated Inspecting Authority does not in any way relieve the manufacturer of his responsibility for the materials and/or workmanship.

9.0 TESTING - RADIOGRAPHIC EXAMINATION

Spot radiographic examination shall be carried out on each of the components listed in paragraph 2.0 of this specification as follows:

One spot shall be examined in the first 50 ft. of welding in each component and one spot shall be examined for each 50 ft. of welding or fraction thereof.

Acceptance standards shall meet ASME Code Section IX requirements.

10.0 CLEANING & PAINTING

Interior and exterior surfaces to be painted shall be properly cleaned prior to application of vessel manufacturer's standard prime coat.

Cleaning shall be as required by the paint supplier.

11.0 PREPARATION FOR SHIPMENT

11.1 All equipment shall be properly marked for erection, identified by BCI purchase order number, project number and equipment number and protected for shipment. Centerlines 0°, 90°, 180° and 270° are to be prominently painted on shell exteriors.

11.2 Nozzle flanges shall have disposable wooden blanks bolted on for protection.

11.3 All screwed connections shall be plugged.

11.4 Machined and threaded surfaces shall be coated with a corrosion preventative and protected from damage.

11.5 Where any loose parts are supplied (e.g., bolts, nuts, gaskets), these shall be properly packed against damage during transit and clearly labelled as indicated in paragraph 11.1 above.

12.0 MANUFACTURERS' DOCUMENTATION

The manufacturer shall supply within the time specified, the number of copies of Material Test Certificates, Radiographic Examination Reports, Weld Procedures, nameplate rubbings and any other documents as called for in BCI purchase order.

13.0 WORK BY OTHERS

Receive, unload, store, and install all equipment at jobsite as indicated in these specifications.

14.0 DRAWINGS AND RECORDS

14.1 Upon receipt of purchase order, manufacturer shall promptly prepare and furnish preliminary shop drawings, as required, showing all dimensions, the size and location of every connection, clearance for removing covers, shipping weight, etc., in the quantities requested on purchase order.

14.2 BCI will examine preliminary drawings for general arrangement, dimensions and apparent suitability. One set will be returned to the Manufacturer marked, "Approved" or "Approved as Noted".

14.3 The approval, recommendations or suggestions by BCI shall in no way relieve the manufacturer of his responsibilities with respect to the provisions of these specifications or fulfillment of the guarantee.

14.4 Unless authorized by BCI in writing, fabrication of the equipment shall not be started until the preliminary drawings have been approved.

15.0 PROPOSAL REQUIREMENTS

15.1 The manufacturer shall quote in strict accordance with this specification.

15.2 Any and all exceptions shall be clearly stated by the manufacturer. Unless specifically stated by the manufacturer, the specification is bid upon as written.

15.3 Any alternates to the specification shall be clearly stated, and the price differential quoted.

15.4 All quotes shall be for complete equipment, as specified in this specification, FOB at plant site. Plant site is Hoyt Lakes, Minnesota.

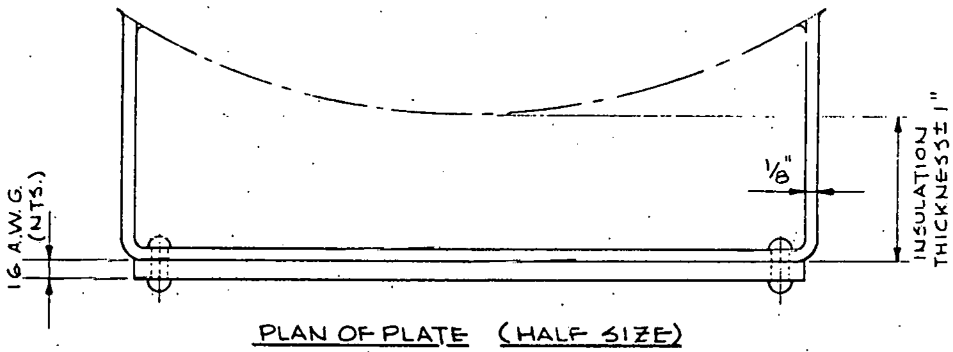
15.5 Weight for each item shall be confirmed by manufacturer.

16.0 SPECIAL NAMEPLATE

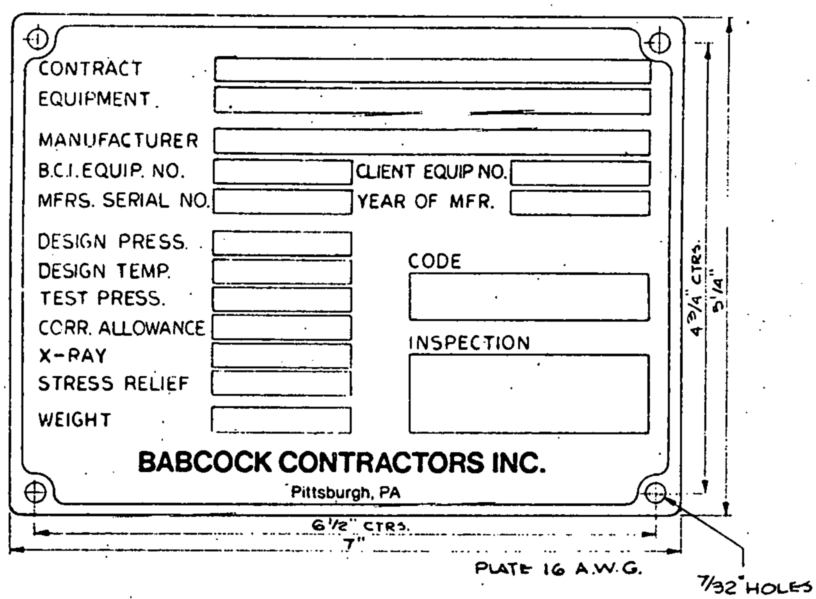
16.1 Information as indicated on the BCI nameplate shown in this Section is to be stamped on the nameplate by the manufacturer. One of these nameplates is to be furnished and attached to the Gasifier Shell Assembly only.

16.2 Other nameplates regularly furnished by the manufacturer are to be attached to each piece of the gasifier.

17.0 SPECIAL NAMEPLATE



PLAN OF PLATE (HALF SIZE)



NOTES:

MATERIAL: PLATE - ENGRAVED STAINLESS STEEL PLATE
PIERCED FOUR HOLES 7/32"/6mm DIAMETER.
RIVETS - 3/16"/5mm R.H. ALUMINUM x 1/2"/13mm LONG.
NAMEPLATE - SUPPLIED BY BABCOCK CONTRACTORS INC.
STAMPING BY VESSEL MANUFACTURER
BRACKET & RIVETS - SUPPLIED BY VESSEL MANUFACTURER.
METRIC DIMENSIONS ARE NOT DIRECT CONVERSIONS.

ERIE MINING COMPANY

COAL GASIFICATION PROJECT

HOYT LAKES, MINNESOTA

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

McKEE CONTRACT 4814

BCI PROJECT NO. 3001

SPECIFICATION NO. B-201

FOR

COMBUSTION AIR BLOWERS

AND

ADJACENT EQUIPMENT

OCTOBER 9, 1978

1.0 EQUIPMENT TO BE FURNISHED

1.1 The work to be performed under the terms of this Specification shall consist of furnishing all materials and labor required to design, detail, fabricate, paint and deliver three (3) centrifugal air blowers to be used in an industrial coal gasification plant for the production of coal gas. The equipment shall be supplied complete with motors and appurtenances all as specified herein and designated as follows:

Number Required	Description
Three (3)	B201A/C Combustion Air Blowers
Three (3)	BM201A/C Electrical Drives
Three (3)	Discharge Silencers
Three (3)	Discharge Dampers
Three (3)	Inlet Flexible Connectors
Three (3)	Outlet Flexible Connectors
One (1)	Inlet Filter Silencer
One (1)	Blowdown Silencer

2.0 WORK BY OTHERS

2.1 Receive, unload, store and install the equipment in accordance with vendor's information.

2.2 Provide and install motor starters, grounding, electrical connections, conduit and wiring in accordance with vendor's instructions.

2.3 Provide and install all connecting piping and valves from equipment discharge flange connection to common discharge plenum.

3.0 DESIGN CRITERIA

3.1 Design and operating criteria are shown on attached copy of Process Specification PS-B201 A, B & C.

3.2 Area Hazard Classification
Class I Division II Group D

3.3 Electrical Characteristics

Power	4160 Volts	3 Phase	60 Hertz
Control	115 volts	1 Phase	60 Hertz

3.4 Attached sketch SK-B201 shows schematic of equipment arrangement.

4.0 EQUIPMENT REQUIREMENTS

4.1 Equipment shall be designed to operate in parallel. Under normal operating conditions, two (2) systems will be in operation, one (1) system will serve as a connected spare. Each system shall be designed identical in performance and auxiliaries.

4.2 Blowers shall be of the centrifugal type.

4.3 Each blower shall be equipped with all appurtenances needed for its performance. This shall include but not be limited to:

a. Flexible Falk coupling

b. OSHA approved coupling guard

c. Inlet filter and silencer with weather hood

d. Discharge silencer shall conform to requirements set forth in Section 3.4

e. Inlet flexible connectors

f. Discharge flexible connectors

g. Flanged butterfly discharge dampers manually operated

4.4 Blowers shall have impellers mounted on a shaft supported by outboard bearings at each end of the casing and directly connected to the drive motor by means of a flexible coupling.

4.0 EQUIPMENT REQUIREMENTS (continued)

4.5 Inlet and outlet connections shall be constructed as integral parts of the inlet and outlet heads. The inlet and outlet connections shall be equipped with 125 lb. flanges.

4.6 The blower supplied shall be mounted on a single, heavy, full length, common steel base, properly reinforced to form a rigid support for the entire unit.

4.7 Equipment furnished shall be designed to allow for expansion between rotating and stationary parts due to the increase in air temperature as the air pressure is increased.

4.8 The rotating assembly shall be statically or dynamically balanced as a unit to insure vibration-free operation.

4.9 Blowers shall have shafts fabricated of high grade steel and ground and polished perfectly true. The shaft shall be of sufficient diameter so that it operates well below its critical speed.

4.10 Bearing shall be splash lubricated of the anti-friction type. The bearings shall be designed for a minimum expected life of five (5) years of continuous service as defined by the AFBMA-10 standards. Heaters shall be supplied as required.

4.11 Equipment will be located outdoors.

4.12 Equipment shall be suitable for continuous industrial service.

4.13 Discharge air shall be free of oil.

4.14 Vendor shall supply, in addition to those specified herein, all items necessary to satisfy the system operation requirements.

5.0 ELECTRICAL

5.1 Electric Motors and Rotating Electrical Equipment

5.1.1 Motors shall not be altered in any way that causes such motors to be non-standard; such as, the addition of brackets, bolts, etc. for the purpose of mounting auxiliary equipment.

5.0 ELECTRICAL (continued)

5.1 Electric Motors and Rotating Electrical Equipment (continued)

5.1.2 Motors shall be mounted where they are readily accessible for maintenance and are not subject to damage.

5.1.3 The motor mounting arrangement shall be such that all anchor bolts can be easily removed and replaced. Ground wires shall be attached to the motor base plate and never to the motor itself.

5.1.4 Oversize fabricated steel connection boxes shall be furnished on all motors.

5.1.5 Specially balanced motors or those having special insulation shall be so indicated on the motor nameplate.

5.1.6 Fans, pumps, gears,etc. should be connected to the drive motor through a coupling and not form an integral part of the motor itself.

5.1.7 Motors driving fans shall have a flexible coupling between the motor and fan which shall be supported by its own bearing pedestals.

5.1.8 Motor will be rated for Class I, Group D, Division II.

5.2 AC Motors

5.2.1 All motors 1/2 horsepower and under shall be single phase, capacitor type, 110 or 220 volt and 60 Hertz.

5.2.2 All motors above 1/4 horsepower and up to 125 horsepower shall be 3 phase, 460 volt and 60 Hertz.

5.2.3 All motors 125 horsepower and above shall be 3 phase, 4160 volt, and 60 Hertz.

5.0 ELECTRICAL (continued)

5.3 All Motors Shall Conform to the Following:

5.3.1 Horsepower - as required by application.

5.3.2 Voltage - 3 phase, 460 volt applications shall be single voltage (460 volt) and 3 leads only.

5.3.3 Frequency - 60 Hertz

5.3.4 Speed - a maximum of 1800 RPM with 3600 RPM application subject to approval of the Electrical Engineer.

5.3.5 NEMA Design - A or B unless application requirement shows need for high torque or high slip Design D.

5.3.6 Enclosure - totally enclosed, fan cooled. Aluminum construction shall not be acceptable.

5.3.7 Service Factor - 1.15 or higher.

5.3.8 Insulation - Class F unless Class H is required by specific application.

5.3.9 Ambient Temperature - 40°C.

6.0 LUBRICATION

6.1 Unit assemblies shall be supplied with all necessary fittings and appurtenances required to satisfy the lubrication requirements specified by vendor.

6.2 Vendor shall specify the make and specifications on lubricant recommended for this service application.

7.0 PAINTING

7.1 Painting of the equipment shall be in accordance with the manufacturer's standard practice for outdoor service.

7.2 Vendor shall, before shipment, coat with a protective material all surfaces that are not painted with a protective material that will prevent rust. Material used shall be readily removed after installation.

8.0 EQUIPMENT MANUALS

8.1 Vendor shall provide thirty-five (35) complete sets of equipment operational and maintenance manuals.

9.0 SERVICES

9.1 Vendor shall provide the services of a competent technical representative to inspect and adjust all items of equipment that are put into service.

9.2 Vendor shall also supervise initial operation of the equipment and instruct the Owner's representative on proper operation and maintenance of equipment.

10.0 LIST OF RECOMMENDED SPARES

10.1 Vendor shall provide a list of recommended spares clearly indicating type, part number, manufacturer's name, size unit price and any other required information for replacement and the recommended number of spares to maintain equipment for a period not less than one (1) year.

11.0 MARKING OF PARTS FOR SHIPMENT

11.1 All pieces of the equipment shall be durably and legibly marked by the manufacturer, giving purchase requisition and order numbers, both Owner and manufacturer and unit numbers.

11.2 A detailed list of the packages being shipped shall be furnished to the Owner to assist in checking completeness of shipment.

12.0 PERFORMANCE

12.1 All equipment furnished under these Specifications shall conform to the applicable provision of the latest revisions of the following standard:

OSHA - Occupational Safety & Health Administration Regulations, including noise regulations.

12.2 Each blower shall have an average overall noise level of 85dBA or less at three feet. Additional steps, if any, to comply with OSHA noise regulations

12.0 PERFORMANCE (continued)

12.2 continued

shall be by others.

13.0 GUARANTEES

13.1 Vendor shall guarantee the total work to be free from defects in material and workmanship for a period of one (1) year after the equipment has been in regular operation, and shall take all steps and do all things necessary at his own expense and at the time specified by purchaser to remedy compeltely all such defective materials and workmanship.

14.0 PROPOSAL REQUIREMENTS

14.1 The bidder shall quote in strict compliance with these Specifications.

14.2 Any exceptions shall be noted in detail.

14.3 Pricing shall be based on delivery to site at Hoyt Lakes, Minnesota.

14.4 Proposals shall include the following:

14.4.1 Dimensional outline diagrams of blower
14.4.2 Performance Curves
14.4.3 Motor outline diagram
14.4.4 List of Spare Parts
14.4.5 Data sheets for all adjacent parts such as couplings, filters, silencers, dampers, flexible connectors, etc.

14.5 Mail proposals, in triplicate, no later than October 31, 1978 to:

Babcock Contractors, Inc.
921 Penn Avenue
Pittsburgh, PA 15222

Attn: Mr. D. W. Barnes
Manager - Purchasing

3.4

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

3.4 PIPING MATERIAL SPECIFICATIONS

CLASS:

B78
C11
C11B
C11D
C11E
C15
C61A
CA1J
G75
G75A
Y89

DOE Contract ET-78-C-01-2578
McKee Contract 2814A/W2
BCI Contract 3001

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PIPING MATERIAL SPECIFICATION	SP- Class B78 REVISION PAGE 1 OF 1

ORIGINAL	BY	DATE	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: Erie Mining Company — PROJECT NO 3001

PRESSURE RATING	125# Solder Joint	SERVICE LIMITS	PSIG	125	100
			°F.	125	150
MATERIAL	Copper	CORROSION ALLOWANCE: Nil			

ITEM	SIZE	DESCRIPTION	REPRESENTATIVE MANUFACTURER (3)	VALVE TAG / ASTM
PIPE	½" thru 1"	Type "K" copper, hard drawn, plain end, 20' lengths		B-88
FITTINGS	½" thru 1"	Wrought copper, solder joint pressure fittings	Chase Brass and Copper Co.	B-63
COUPLING	½" thru 1"	Wrought copper, solder joint, pressure fittings	Chase 401	B-63
REDUCING COUPLING	½" thru 1"	Wrought copper, solder joint, pressure fittings	Chase 401-R	B-63
CAPS	½" thru 1"	Wrought copper, solder joint, pressure fittings	Chase 416-C	B-63
UNION (2)	½" thru 1"	Cast copper, solder joint pressure fittings	Chase 402	B-63
BRANCH CONNS.	Line Size 3/4"& Smaller	Use a tee. Use a tee and reducing coupling on 1" line sizes and smaller.		
GATE VALVE	½" thru 1"	125# Solder joint, cast bronze body.	Powell #1821S	BG78
GLOBE VALVE	½" thru 1"	125# Solder joint, cast bronze body.	Powell #1826	BL78

NOTES:

(1) For solder joints use 50-50 tin-lead, ASTM B-32 Gr 50A with solder flux. Where pipe is subject to external heating use silver solder.
(2) Between dissimilar metals use insulating union, Capitol CS22 thru 77.
(3) Brand names used for convenience only; approved equals are acceptable.

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PIPING MATERIAL SPECIFICATION			SP- Class C11 REVISION PAGE 1 OF 1
ORIGINAL	BY	DATE	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: Erie Mining Company				PROJECT NO. 3001

PRESSURE RATING	150# RF	SERVICE LIMITS	PSIG	275	180	150	120
			°F	100	400	500	650
MATERIAL	Carbon Steel	CORROSION ALLOWANCE: 0.05"					

ITEM	SIZE	DESCRIPTION	ASTM
PIPE (6)	½" thru 1½" 2" thru 10" 12" thru 24"	Sch. 80 (Extra strong) seamless, plain ends. Sch. 40 (Standard weight) seamless, bevel ends 0.375" wall(Standard Weight)seamless, bevel ends	A-106 Gr B A-53 Gr B A-53 Gr B
FITTINGS (1) (6)	½" thru 2" 3" thru 24"	3000# forged steel, socketweld Standard Weight, seamless, buttweld	A-181 Gr II A-234 Gr WPB
PLUGS	½" thru 2"	Solid round head, forged steel, screwed	A-181 Gr II
SWAGE NIPPLES		Sch. 80 (Extra Strong) seamless	A-106 Gr B
FLANGES (2) (4)(6	½" thru 1½" 2" 3" thru 24"	150# RF Socketweld, extra strong bore 150# RF Socketweld, standard weight bore 150# RF Weld Neck, standard weight bore	A-181 Gr IorII A-181 Gr IorII A-181 Gr IorII
BOLTS	Alloy steel stud bolts with two semi-finished heavy hex nuts each		A-193 Gr B7 A-194 Gr 2H
GASKETS	150# type 304 S.S. asbestos spiral-wound. Flexitallic style CG or equal.		

BRANCH CONNS.	Line Size 1½"& Smaller 2" & Smaller 3" & Larger	Use a tee Use a tee and swage on line sizes 2" and smaller. Use a sockolet on line sizes 3" and larger. Stub-in when less than line size. Reinf. per code when req'd	

ITEM	SIZE	DESCRIPTION	REPRESENTATIVE MANUFACTURER(3)	VALVE TAG
GATE VALVE	½" thru 2" 3" thru 24"	150-800# SW, forged steel body. 150# RF flgd. ends, cast steel body	Vogt #SW-12111 Powell #1503-P140	CG86 CG11
GLOBE VALVE	½" thru 2" 3" thru 8"	150-800# SW, forged steel body. 150# RF flgd. ends, cast steel body	Vogt #SW-12141 Powell #1531-P140	CL86 CL11
CHECK VALVE	½" thru 2" 3" thru 16"	150-800# Piston type, SW, forged steel body (horizontal only). 150# Swing type, RF flgd. ends,cast steel body (horizontal or vertical)	Vogt #SW-701 Powell #1561A-P140	CC86H CC11
PLUG VALVES	1" thru 6" 8" thru 12"	150# RF flgd. ends, cast steel body wrench operated. 150# RF flgd. ends, cast steel body Worm gear operated.	Powell #1559 Powell #1559G	CP11 CP11G

NOTES:

(1) Use thredolet for instrument connections and plugged vents.
(2) Use flat face flanges against flat face equipment nozzles.
(3) Brand names used for convenience only; approved equals are acceptable.
(4) Orifice flanges: 300# RF WN. ASTM A-105 Gr II, bore to match pipe.
(5) ASTM A-105 Gr I or II is acceptable for A-181 Gr I or II requirements.
(6) Where pipe is buried, exterior surfaces shall be coated and wrapped to conform to AWWA C-203, Section A1.2 (latest edition.)

ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PIPING MATERIAL SPECIFICATION			SP- Class C11B REVISION PAGE 1 OF 1
ORIGINAL	BY	DATE	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: Erie Mining Company				PROJECT NO. 3001

PRESSURE RATING	150# RF	SERVICE LIMITS	PSIG	275	180	150	120
			°F	100	400	500	650
MATERIAL	Carbon Steel	CORROSION ALLOWANCE: 0.05"					

ITEM	SIZE	DESCRIPTION	REPRESENTATIVE MANUFACTURER(3)	ASTM / VALVE TAG
PIPE	½" thru 1½"	Sch. 80 (extra strong) seamless, plain ends		A-106 Gr B
	2" thru 10"	Sch. 40 (standard weight) seamless, bevel ends		A-53 Gr B
	12" thru 24"	0.375" wall(standard weight)seamless, bevel ends		A-53 Gr B
FITTINGS (1)	½" thru 2"	3000# forged steel, socketweld		A-181 Gr II
	3" thru 24"	Standard Weight, seamless, buttweld		A-234 Gr WPB
PLUGS	½" thru 2"	Solid round head, forged steel, screwed		A-181 Gr II
SWAGE NIPPLES		Sch. 80 (Extra Strong) seamless		A-106 Gr B
FLANGES (2) (4)	½" thru 1½"	150# RF Socketweld, extra strong bore		A-181 Gr IorII
	2"	150# RF Socketweld, standard weight bore		A-181 Gr IorII
	3" thru 24"	150# RF Weld Neck, standard weight bore		A-181 Gr IorII
BOLTS		Alloy steel stud bolts with two semi-finished heavy hex nuts each		A-193 Gr B7 A-194 Gr 2H
GASKETS		150# type 304 S.S. asbestos spiral-wound. Flexitallic style CG or equal.		
BRANCH CONNS.	Line Size	Use a tee.		
	1½"& Smaller	Use a tee and swage on line sizes 2" and smaller		
	2" & Smaller	Use a sockolet on line sizes 3" and larger.		
	3" & Larger	Stub-in when less than line size. Reinf. per code when req'd.		
GATE VALVE	½" thru 2"	150-800# SW, forged steel body	Vogt #SW-12111	CG86
	3" thru 24"	150# RF flgd. ends, cast steel body.	Powell #1503-P140	CG11
GLOBE VALVE	½" thru 2"	150-800# SW, forged steel body	Vogt #SW-12141	CL86
	3" thru 8"	150# RF flgd. ends, cast steel body	Powell #1531-P140	CL11
CHECK VALVE	½" thru 2"	150-800# Piston type, SW, forged steel body (horizontal only).	Vogt #SW-701	CC86H
	3" thru 16"	150# Swing type, RF flgd. ends,cast steel body(horizontal or vertical).	Powell #1561A-P140	CC11

NOTES:

(1) Use thredolet for instrument connections and plugged vents.
(2) Use flat face flanges against flat face equipment nozzles.
(3) Brand names used for convenience only; approved equals are acceptable.
(4) Orifice flanges: 300# RF WN, ASTM A-105 Gr II, bore to match pipe.
(5) ASTM A-105 Gr I or II is acceptable for A-181 Gr I or II requirements.

NG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PIPING MATERIAL SPECIFICATION			SP- Class C11D REVISION PAGE 1 OF: 1
ORIGINAL	BY	DATE	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: Erie Mining Company				PROJECT NO. 3001

PRESSURE RATING	150# RF	SERVICE LIMITS	PSIG	275	180	150	120
			°F	100	400	500	650
MATERIAL	Carbon Steel	CORROSION ALLOWANCE: 0.05"					

ITEM	SIZE	DESCRIPTION	ASTM
PIPE	½" thru 1½" 2" thru 6"	Sch. 80 (Extra strong) seamless, plain ends Sch. 40 (standard weight) seamless, plain ends	A-106 Gr B A-53 Gr B
FITTINGS (1)	½" thru 2" 3" thru 6"	3000# forged steel, socketweld Standard Weight, seamless, buttweld	A-181 Gr II A-234 Gr WPB
PLUGS	½" thru 2"	Solid round head, forged steel, screwed	A-181 Gr II
SWAGE NIPPLES		Sch. 80 (extra strong) seamless	A-106 Gr B
FLANGES (2) (4)	½" thru 1½" 2" 3" thru 6"	150# RF Socketweld, extra strong bore 150# RF Socketweld, standard weight bore 150# RF Weld Neck, standard weight bore	A-181 Gr IorII A-181 Gr IorII A-181 Gr IorII
BOLTS	Alloy steel stud bolts with two semi-finished heavy hex nuts each		A-193 Gr B7 A-194 Gr 2H
GASKETS	1/16" thick asbestos, ring cut type. JM-60 or equal.		
BRANCH CONNS.	Line Size: Use a tee. 1½"& Smaller Use a tee and swage on line sizes 2" and smaller. 2" & Smaller Use a sockolet on line sizes 3" and larger. 3" & Larger Stub-in when less than line size. Reinf. per code when req'd.		

ITEM	SIZE	DESCRIPTION	REPRESENTATIVE MANUFACTURER(3)	VALVE TAG
GATE VALVE	½" thru 2" 3" thru 6"	150-800# SW, forged steel body 150# RF flgd. ends, cast steel body	Vogt #SW-12111 Powell #1503-P140	CG86 CG11
GLOBE VALVE	½" thru 2" 3" thru 6"	150-800# SW, forged steel body 150# RF flgd. ends, cast steel body	Vogt #SW-12141 Powell #1531-P140	CL86 CL11
CHECK VALVE	½" thru 2" 3" thru 6"	150-800# Piston type, SW, forged steel body (horizontal only). 150# Swing type, RF flgd. ends, cast steel body (horizontal or vertical)	Vogt #SW-701 Powell #1561A-P140	CC86H CC11

NOTES:
(1) Use thredolet for instrument connections and plugged vents.
(2) Use flat face flanges against flat face equipment nozzles.
(3) Brand names used for convenience only; approved equals are acceptable.
(4) Orifice flanges: 300# RF WN, ASTM A-105 Gr II, bore to match pipe.
(5) ASTM A-105 Gr I or II is acceptable for A-181 Gr I or II requirements.

G-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PIPING MATERIAL SPECIFICATION	ST- Class C11E REVISION PAGE 1 OF 1

ORIGINAL	BY		DATE		APPD.		DATE	
REVISION	BY		DATE		APPD.		DATE	

PRESSURE RATING	150# RF	SERVICE LIMITS	PSIG	275	255	245
			°F	100	150	175
MATERIAL	Carbon Steel	CORROSION ALLOWANCE	0.05"			

ITEM	SIZE	DESCRIPTION	ASTM
PIPE (6)	½" thru 2"	Sch. 40 (Standard Weight) seamless, threaded & coupled.	A-53 Gr. B
	2½" thru 10"	Sch. 40 (Standard Weight) seamless, bevel end	A-53 Gr. B
	12" thru 24"	0.375" wall (Standard Weight) seamless, bevel ends	A-53 Gr. B
FITTINGS (1) (6)	½" thru 2"	300# malleable iron, screwed ends	A-181 Gr. II
	2½" thru 24"	Standard Weight, seamless, butt weld ends	A-234 Gr. WPB
PLUGS	½" thru 2"	Solid round head, forged steel, screwed	A-181 Gr. II
SWAGE NIPPLES		Sch. 80 (Extra Strong) seamless	A-106 Gr. B
FLANGES (2) (4) (6)	½" thru 2"	150# RF threaded, standard weight bore	A-181 Gr.IorII
	2½" thru 24"	150# RF Weld Neck, standard weight bore	A-181 Gr.IorII
BOLTS	Carbon steel machine bolts with one semi-finished heavy hex nut each.		A-193 Gr. B7 A-194 Gr. 2H
GASKETS	1/16" thick compressed asbestos, flat ring, for raised face flangesassistant		

BRANCH CONNS.	Line Size	Use a tee.
	1½" & Smaller	Use a tee and reducer on line sizes 2" and smaller.
	2" & Smaller	Use a thredolet on line sizes 3" and larger.
	3" & Larger	Stub-in when less than line size. Reinforce per code when required.

ITEM	SIZE	DESCRIPTION	REPRESENTATIVE MANUFACTURER (3)	VALVE TAG
GATE VALVE	½ thru 2"	150-800# SE, forged steel body	Vogt 12111-F8M.	CG85T
	2½" thru 24"	150# RF flgd. ends, cast steel body	Powell #1503-	CG11
GLOBE VALVE	½" thru 2"	150-800# SE, forged steel body.	Vogt 22141-F8M	CL85T
	2½" thru 8"	140# RF flgd. ends, cast steel body	Powell #1531-	CL11
CHECK VALVE	½" thru 2"	150-800# swing type, SE, forged stl. body (horizontal only).	Vogt S-701	CC85H
	2½" thru 16"	150# swing type, RF flgd. ends, cast stl. body (horizontal or vertical)	Powell #1561A-	CC11
PLUG VALVE	1" thru 6"	150# RF flgd. ends, cast steel body wrench operated.	Powell #1559	CP11
	8" thru 12"	150# RF flgd. ends, cast steel body Worm gear operated.	Powell #1559G	CP11G

NOTES:

(1) Use thredolet for instrument connections and plugged vents.
(2) Use flat face flanges against flat face equipment nozzles
(3) Brand names used for convenience only; approved equals are acceptable.
(4) Orifice flanges: 300# RF WN, ASTM A-105 Gr II, bore to match pipe.
(5) ASTM A-105 Gr I or II is acceptable for A-181 Gr I or II Requirements.
(6) Where pipe is buried, exterior surfaces shall be coated and wrapped to conform to AWWA C-203, Section A1.2 (latest edition).

G-051-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PIPING MATERIAL SPECIFICATION	SP Class C15 REVISION PAGE 1 OF 1

ORIGINAL	BY	DATE	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: Erie Mining Company — PROJECT NO. 3001

PRESSURE RATING	150# Screwed	SERVICE LIMITS	PSIG	760	380
			°F	100	400
MATERIAL	Carbon Steel & Copper Tubing	CORROSION ALLOWANCE:	0.05"		

ITEM	SIZE	DESCRIPTION	ASTM
PIPE	½" thru 1½" 2" ½" O.D.	Sch. 80 (Extra Strong) seamless, plain ends Sch. 40 (standard weight) seamless, plain ends 0.032" wall, soft annealed, seamless copper tubing.	A-106 Gr B A-53 Gr B B-42 or B-75
FITTINGS (1)	½" thru 2" ½" O.D.	3000# forged steel, screwed Brass compression, swagelok or equal	A-181 Gr II
PLUGS	½" thru 2"	Solid round head, forged steel, screwed	A-181 Gr II
SWAGE NIPPLES		Sch. 80 (extra strong) seamless	A-106 Gr B
FLANGES (2) (4)			
BOLTS			
GASKETS			
BRANCH CONNS.	Line Size Use a tee. 1½"& Smaller Use a tee and swage.		

			REPRESENTATIVE MANUFACTURER(3)	VALVE TAG
GATE VALVE	½" thru 2"	150#-180# SE, forged steel body	Vogt #12111	CG85V
GLOBE VALVE	½" thru 2"	150#-180# SE, forged steel body.	Vogt #12141	CL85V
CHECK VALVE	½" thru 2"	150#-800# Piston type, SE, forged steel body (horizontal only)	Vogt #701	CC85H

NOTES:

(1) Brand names used for convenience only; approved equals are acceptable.

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	PIPING MATERIAL SPECIFICATION	SP- C61A REVISION PAGE 1 OF: 2

ORIGINAL	BY	DATE	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: Erie Mining Company — PROJECT NO. 3001

PRESSURE RATING	600# RF	SERVICE LIMITS	PSIG °F	SEE PAGE 2
MATERIAL	Carbon Steel	CORROSION ALLOWANCE 0.05"		

ITEM	SIZE	DESCRIPTION	ASTM
PIPE	½" thru 2" 2½" thru 6" 8" thru 14"	Sch. 80 (Extra Strong) seamless, plain end Sch. 40 (Std. weight) seamless, bevel ends 0.500" wall (Std. weight) seamless, bevel ends	A-106, Gr. B A-53, Gr. B A-53, Gr. B
FITTINGS (1)	½" thru 2" 2½" thru 6" 8" thru 14"	3000# forged steel, socketweld Standard weight, seamless, buttweld Extra strong, seamless, buttweld	A-181 Gr. II A-234, Gr.WPB A-234, Gr. WPB
PLUGS	½" thru 2"	Solid round head, forged steel, screwed	A-181, Gr. II
SWAGE NIPPLES		Sch. 80 (extra strong) seamless	A-106, Gr. B
FLANGES (2) (4)	½" thru 2" 2½" thru 6" 8" thru 14"	600# RF socketweld extra strong bore 600# RF weld neck, standard weight bore 600# RF weld neck, extra strong bore	A-105, Gr.IorII A-105 Gr.IorII A-105 Gr.IorII
BOLTS	Alloy steel stud bolts with 2 semi-finished heavy hex nuts each.		
GASKETS	Spiral wound white asbestos filled flat ring w/an 18% Cr-8% Ni Steel winding with carbon steel centering device.		
BRANCH CONNS.	Line Size 1½" & Smaller 2" & Smaller 3" & Larger	Use a tee. Use a tee & reducer on line sizes 2" & smaller. Use a sockolet on line sizes 3" & larger. Stub-in when less than line size. Reinforce per code when required.	

	SIZE	DESCRIPTION	REPRESENTATIVE MANUFACTURER (3)	VALVE TAG
GATE VALVE	½" thru 2" 2½" thru 14"	150-800# SW forged steel body 600# RF flanged ends, cast steel body	Vogt #SW-12111 Powell #6003	CG86 CG61
GLOBE VALVE	½" thru 2" 2½" thru	150-800# SW forged steel body 600# RF flanged ends	Vogt #SW-12141 Powell #6031	CL86 CL61
CHECK VALVE	½" thru 2" 2½" thru 12"	150-800# piston type, SW, forged steel body (horizontal only) 600# swing type, RF flanged ends, cast steel body (horizontal or vertical)	Vogt #SW-701 Powell #6061	CC86H CC61

NOTES:
(1) Use thredolet for instrument connections & plugged vents.
(2) Orifice flanges: 600# RF WN, ASTM A-105 Gr. II; bore to match pipe.
(3) Brand names used for convenience only; approved equals are acceptable.
(4) ASTM A-105 Gr. I or II is acceptable for A-181 Gr. I or II requirements

NG-050-0278)

PRESSURE - TEMPERATURE SERVICE LIMITS

MAXIMUM DESIGN PRESSURES, PSIG								
NOM. PIPE SIZE	Design Temperatures °F							
	-20 to 100°	200	400	650	750	900	1050	1200
3/4"	1440	1400	1330	1030	850			
1	1440	1400	1330	1030	850			
1½	1440	1400	1330	1030	850			
2	1440	1400	1267	1030	850	NOT APPLICABLE	AT THESE	TEMPERATURES
3	1440	1400	1330	1030	850			
4	1439	1374	1241	1030	850			
6	1205	1151	1039	904	780			
8	1440	1400	1330	1030	850			
10	1440	1400	1280	1030	850			
12	1245	1189	1074	934	806			
14	1132	1081	976	849	733			

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PIPING MATERIAL SPECIFICATION			SP- Class CA1J REVISION PAGE 1 OF 2
ORIGINAL	BY	DATE	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: Erie Mining Company		SERVICE	"WC	+25
PRESSURE RATING	125# FF	LIMITS	OF	850

ITEM	SIZE	DESCRIPTION	REPRESENTATIVE MANUFACTURER	ASTM
PIPE	½" thru 1½"	Sch. 80, seamless, plain end		A-106 Gr, B
	2" thru 12"	Sch. 40, seamless, bevel ends		A 106 Gr, B
	14" thru 36"	E.R.W. carbon steel Longitudinal welded Bevel ends, ¼" wall		A-155 Gr, KC65 Class 2
FITTINGS	½" thru 1½"	3000# carbon steel socketweld		A-105 Gr II
	2" thru 12"	standard weight, buttweld		A 234 Gr NPB
	14" thru 36"	fabricated from pipe mitre bends NOTE: Pulled bends preferred up to 6" N.B. radius 3 x N.B. minimum tees 2" and above to be fabricated from pipe.		
FLANGES	½" thru 2"	150# FF slip-on carbon steel		A-105 Gr II
	3" thru 60"	125# FF slip-on light weight pattern		A-285 Gr B
BOLTS	Alloy steel studbolts to ASTM A193 Gr B7 nuts to ASTM A194 grade 2H. UNC threads.			
GASKETS	½ thru 6" C.A.F. full faced to ASA 125# 1/10" thick 8" thru 12" C.A.F. full faced to ASA 125# 1/8" thick 14" thru 36" 1/4" dia. asbestos rope and asbestos putty			

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*		ST Class CA1J REVISION PAGE 2 OF 2

ITEM	SIZE	DESCRIPTION	REPRESENTATIVE MANUFACTURER	
GATE VALVE	½" thru 1½"	800# forged steel body, socket ASTM A 105 weld ends to ASA B16-11, rising stem, louse disc, renewable seat, O.S.SY. bulted cover, 13% chrome trim.		
	2" thru 42"	125# solid sedge F.F. flanged ends. All iron construction to meehanite H.D. type. Bolted bonnet O.S.& Y rising stem	Bryan Dunkin cu. LTD. File No. 994	
CHECK VALVE	½" thru 10"	125# F.F. flanged ends swing type. Cast iron to fit between ASA 125# flanges metal to metal seal	mission style "K"	

(ENG-052-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PIPING MATERIAL SPECIFICATION	SP- Class G75 REVISION PAGE 1 OF 1

ORIGINAL	BY	DATE	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: Erie Mining Company — PROJECT NO. 3001

PRESSURE RATING	125# Screwed	SERVICE LIMITS	PSIG	200	125
			°F	100	350
MATERIAL	Galvanized Carbon Steel	CORROSION ALLOWANCE:	0.05"		

ITEM	SIZE	DESCRIPTION	ASTM
PIPE (5)	½" thru 1½"	Sch. 80 (Extra strong) seamless, galvanized T & C	A-106 Gr. B
	2" thru 6"	Sch. 40 (Standard weight) seamless, galvanized (T & C).	A-53 Gr. B
FITTINGS (1) (5)	½" thru 6"	150# malleable iron, galvanized, screwed	
PLUGS	½" thru 2"	Solid galvanized iron square head, screwed.	
SWAGE NIPPLES		Sch. 80 (Extra strong) seamless, galvanized.	A-106 Gr B
FLANGES (2) (4)(5)	½" thru 6"	150# FF threaded	A-181 Gr IorII
BOLTS	Square head machine bolts with one semi-finish heavy hex nut each		A-307 Gr B A-307
GASKETS	1/16" thick asbestos full face with bolt holes. JM-60 or equal.		
BRANCH CONNS.	Line Size 4" & Smaller	Use a tee. Use a tee and reducer on line sizes 6" and smaller.	

ITEM	SIZE	DESCRIPTION	REPRESENTATIVE MANUFACTURER(3)	VALVE TAG
GATE VALVE	½" thru 2"	125# SE, cast bronze body	Powell #500S	BC75
	3" thru 6"	150# FF flgd ends, cast bronze body	Powell #1414G	BG12
GLOBE VALVE	½" thru 2"	125# SE, cast bronze body	Powell #650	BL75
	3" thru 4"	150# FF flgd. ends, cast bronze body	Powell #1139	BL12
CHECK VALVE	½" thru 2"	125# Swing Type, SE, cast bronze body (horizontal or vertical)	Powell #578	BC75
	3" thru 4"	150# Swing type, FF flgd. ends, cast bronze body (horizontal or vertical)	Powell #2433	BC12

NOTES:

(1) Use Teflon tape on screwed pipe connections.
(2) ASTM A-105 Gr I or II is acceptable for A-181 Gr I or II requirements.
(3) Brand names used for convenience only; approved equals are acceptable.
(4) Use Class C72 for line sizes above 6".
(5) Where pipe is buried, exterior surfaces shall be coated and wrapped to conform to AWWA C-203, Section A1.2 (latest edition).

3-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PIPING MATERIAL SPECIFICATION	SP- Class G75A REVISION PAGE 1 OF 1

ORIGINAL	BY	DATE	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: Erie Mining Company — PROJECT NO. 3001

PRESSURE RATING	125# Screwed	SERVICE LIMITS	PSIG	200	125
			°F	100	350
MATERIAL	Galv. Carbon Steel & Copper Tubing	CORROSION ALLOWANCE:		0.05"	

ITEM	SIZE	DESCRIPTION	ASTM
PIPE	¼" thru 1½"	Sch. 80 (Extra Strong) Galvanized T & C	A-106 Gr. B
	2" thru 6"	Sch. 40 (Standard Weight) Galvanized T & C	A-106 Gr. B
	¼" thru ½"	0.030", 0.032", 0.035" wall respectively, soft annealed copper tubing.	B-75 type DHP
	¼" thru ½"	Same as above with PVC covering.	B-75 type DHP
	¼"	Multi-tube bundle: Copper or PVC w/PVC sheath	
FITTINGS (1)	¼" thru 6"	3000# Forged steel, galvanized, threaded ends	A-181 Gr II
	¼" thru ½"	Brass compression, Swagelok or equal	
PLUGS	¼" thru 2"	Solid round head, forged steel galv., screwed	A-181 Gr II
SWAGE NIPPLES		Sch. 80 (Extra Strong) seamless zinc plated	A-106 Gr B
FLANGES (2) (4)	½" thru 6"	150# FF threaded	A-181 Gr IorII
BOLTS	Square head machine bolts		A-307 Gr B
	with one semi-finished heavy hex nut each		A-307
GASKETS	1/16" thick asbestos full face with bolt holes. JM-60 or equal.		
BRANCH CONNS.	Line Size	Use a tee	
	4" & Smaller	Use a tee and swage on line sizes 6" and smaller.	

			REPRESENTATIVE MANUFACTURER(3)	VALVE TAG
GATE VALVE	¼" thru 2"	125# SE, cast bronze body	Powell #500S	BG75
	3" thru 6"	150# FF flgd. ends, cast bronze body	Powell #1414G	BG12
GLOBE VALVE	¼" thru 2"	125# SE, cast bronze body	Powell #650	BL75
	3" and 4"	150# FF flgd. ends, cast bronze body	Powell #1139	BL12
CHECK VALVE	¼" thru 2"	125# Swing Type, SE, cast bronze body (horizontal or vertical)	Powell #578	BC75
	3" and 4"	150# Swing Type, FF flgd. ends, cast bronze body (horiz. or vert.)	Powell #2433	BC12

NOTES:
(1) Use Teflon tape on screwed pipe connections.
(2) ASTM A-105 Gr I or II is acceptable for A-181 Gr I or II requirements.
(3) Brand names used for convenience only; approved equals are acceptable.
(4) Tubing support for widths 3" and less, use galvanized steel raceway; for widths 6" to 30" use ladder type rigid rack, P & W or equal.

G-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PIPING MATERIAL SPECIFICATION	SP- Class Y89 REVISION PAGE 1 OF 1

ORIGINAL	BY	DATE	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: Erie Mining Company — PROJECT NO. 3001

PRESSURE RATING	Atmospheric	SERVICE	Gravity Oily Water Drain Sewer System
MATERIAL	Cast Iron & Asbestos Cement		

ITEM	SIZE	DESCRIPTION	ASTM
PIPE (1), (2), (3)	4" thru 10"	Extra heavy cast iron pipe, gasketed hub and spigot without a bead. Five and ten foot laying length.	A-74
	6" thru 30"	Non-pressure asbestos cement pipe Standard 13, 10 or 6½ foot laying lengths depending on size or class.	C-428
FITTINGS	4" thru 10"	Extra heavy cast iron, gasketed hub and spigot without a bead.	A-74
	6" thru 30"	Non-pressure asbestos cement, ring-tite.	C-428
JOINT MATERIAL	Cast Iron	Oil resistant rubber ring gasket.	
	Asbestos Cement	Couplings with oil-resistant rubber rings.	

ITEM	SIZE	DESCRIPTION	REPRESENTATIVE MANUFACTURER	
SEAL BOXES	24" to 48" I.D.	Precast concrete with internal ladder and solid manway cover.	Lock Joint Pipe Co.	

NOTES:
(1) Class of asbestos cement pipe and fittings to be determined by installation conditions, such as depth of pipe, soil loading, etc.
(2) Minimum size of laterals to be 4".
(3) Minimum size of headers to be 6".
(4) Other materials may be required for collection point piping (i.e., carbon steel for pump drains, etc.). These specialties will be identified on design drawings.

(ENG-050-0278)

3.5

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

3.5 INSTRUMENTATION SPECIFICATIONS

Specification Index
Instrument Index
Specifications and Data Sheets

DOE Contract ET-78-C-01-2578
McKee Contract 2814A/W2
BCI Contract 3001

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	SPECIFICATION INDEX		SP- 8003 REVISION 1 PAGE 1 OF 2	
ORIGINAL	BY R. Moyta	DATE 8-9-78	APPD.	DATE
REVISION 1	BY ZK	DATE 1-31-79	APPD.	DATE
CLIENT: ERIE MINING COMPANY, HOYT LAKES, MN.			PROJECT NO. 3001 Ø I	

SPECIFICATION NUMBER	DESCRIPTION
8030	Switch-Electronic Signal Monitor
8041	I/P Signal Converter
8021	Signal Converter
8111	Miniature Strip Chart Recorder
8131	Miniature Panel Indicator
8141	Miniature Manual Loading Station
8142	Miniature Indicating Control Station
8149	Miniature Indicating Ratio Control Station
8150	Annunciator
8161	Timer
8180	Main Instrument Panel
8201	Dial Thermometer (Bi-Metal)
8206	Indicating Pyrometer
8216	Thermocouple Assemblies
8236	Temperature Transmitter
8301	Pressure Gage
8311	Pressure Transmitter
8312	Differential Pressure Transmitter
8331	Pressure Switch
8400	Liquid Level Gage Glass
8405	Rotameter
8420	Orifice Plate
8424	Annubar

ENG-090-0278

SPECIFICATION NUMBER	DESCRIPTION
8522	Level Transmitter (Displacement Type)
8527	Level Transmitter (Capacitance Type)
8540	Level Switch (Ball Float Type)
8542	Level Switch (Capacitance Type)
8610	Control Valve (Butterfly)
8612	Control Valve (Globe)
8616	Control Valve (Plug)
8620	Three Port Control Valve
8650	Solenoid Valve
8660	Pressure Regulating Valve
8710	Pressure Safety Relief Valve
8800	Programmable Controller
8820	Weigh System

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT INDEX			SP. 8001 REVISION 1 PAGE 1 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21000 /PI Dwg: Y-11		
	Programmable Controller		
WUC-21000	Programmable Control System		8800
AN-1	Annunciator		8150
	Semi-Graphic - Main Control Panel		
CP-1	MAIN CONTROL PANEL /Dwg. No. K-01		8180

(ENG-650-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT INDEX		SP- 8001 REVISION 1 PAGE 2 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY			PROJECT NO. 3001 Ø 1

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21101/PI Dwg: Y-11		
	Coal Surge Hopper-Level Control		
LE-21101	Probe W/LS-21101		8542
LS-21101	Level Switch (Capacitance Type)		8542
LAL-21101	Annunciator Alarm Point		8150
LH-21101	Panel Lamp		8180
LL-21101	Panel Lamp		8180
	Loop No. 21102/PI Dwg: Y-11		
	Gasifier Coal Charge Control		
LE-21102	Probe W/LIS-21102		8527
LIS-21102	Level Indicating Switch (Cap.Type)		8527
LAH-21102	Annunciator Alarm Point		8150
LAL-21102	Annunciator Alarm Point		8150
FV-21102	Control Valve (Plug)		8616
	w/FY-21102 Solenoid Valve & (2)- ZS-21102 A & B Position Switches		

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	# INSTRUMENT INDEX	SP- 8001 REVISION 1 PAGE 3 A OF

ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE

CLIENT: ERIE MINING COMPANY — PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21103 /PI Dwg: Y-11		
	Gasifier Coal Charge Control		
QE-21103	Weight System		8820
QR-21103	Recorder		8820
PV-21103	Control Valve (Globe)		8612
	w/FY-21103A Solenoid Valve		
FV-21103	Plug Valve w/FY-21103B Solenoid		8616
	Valve & (2)- ZS-21103A & B Position Switches		
HS-21103	Selector Switch		8180
	Loop No. 21104 /PI Dwg: Y-11		
	Low Pressure Boiler-Level Control		
LT-21104	Level Transmitter (Displacement)		8522
LSH-21104	Current Switch		8030
LSL-21104	Current Switch		8030
LAH-21104	Annunciator Alarm Point		8150
LAL-21104	Annunciator Alarm Point		8150
LIC-21104	Controller		8142
I/P-21104	I/P Signal Converter		8041
LV-21104	Control Valve (Globe)		8612

ENG-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT INDEX		SP- 8001 REVISION 1 PAGE 4 A OF
ORIGINAL	BY R. Moyta	DATE 8/31/78	APPD. DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD. DATE
CLIENT: ERIE MINING COMPANY			PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21105 /PI Dwg: Y-11		
	Low Pressure Boiler-Level, Pressure,		
	Temperature Indication		
LG-21105	Gauge Glass		8400
PI-21105	Pressure Gauge		8301
TI-21105	Dial Thermometer (Bi-Metal)w/Well		8201
	Loop No. 21106 /PI Dwg: Y-11		
	Low Pressure Steam Drum - Press		
	& Level Indication		
PT-21106	Pressure Transmitter		8311
PSH-21106	Current Switch		8030
PSL-21106	Current Switch		8030
PAH-21106	Annunciator Alarm Point		8150
PAL-21106	Annunciator Alarm Point		8150
PR-21106	Recorder		8111
LG-21106	Gauge Glass		8400
	Loop No. 21107 /PI Dwg: Y-11		
	Low Pressure Boiler-Pressure		
	Relief		
PSV-21107	Pressure Safety Valve		8710

(ENG-050-C278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	INSTRUMENT INDEX			SP- 8001 REVISION 1 PAGE 5 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21108/PI Dwg: Y-11		
	Low Pressure Boiler-Steam Flow		
	Record		
FE-21108	Annubar		8424
FT-21108	D/P Transmitter		8312
FR-21108	Recorder		8111
	Loop No. 21109/PI Dwg: Y-11		
	Combustion Steam-Flow Ratio		
	Control		
FE-21109	Annubar		8424
FT-21109	D/P Transmitter		8312
FR-21109	Recorder		8111
FFC-21109	Ratio Controller		8149
I/P-21109	I/P Signal Converter		8041
FV-21109	Control Valve (Globe)		8612
RO-21109	Restricting Orifice Plate		8420
PI-21109	Pressure Gauge w/Syphon		8301

ENG-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT INDEX		SP- 8001 REVISION 1 PAGE 6 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY			PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	LOOP NO. 21110 /PI Dwg: Y-11		
	Blast-Temperature & Pressure		
	Record		
TE-21110	Thermocouple Assembly		8216
TT-21110	Temperature Transmitter		8236
PT-21110	Pressure Transmitter		8311
UR-21110	Recorder		8111
PSH-21110	Current Switch		8030
PSL-21110	Current Switch		8030
PAH-21110	Annunciator Alarm Point		8150
PAL-21110	Annunciator Alarm Point		8150
PI-21110	Pressure Gauge w/Siphon		8301
TI-21110	Dial Thermometer (Bi-Metal)		8201
	Loop No. 21111 /PI Dwg: Y-11		
	Combustion Air Flow-Ratio		
	Control		
FE-21111	Annubar		8424
FT-21111	D/P Transmitter		8312
FR-21111	Recorder		8111
FIC-21111	Controller		8142
I/P-21111	I/P Signal Converter		8041
FV-21111	Control Valve (Butterfly)		8610

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT INDEX		SP- 8001 REVISION 1 PAGE 7 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY			PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21112/PI Dwg: Y-11		
	Clean Gas-Temperature & Pressure Indication		
PI-21112	Pressure Gauge		8301
TI-21112	Indicating Pyrometer		8206
	Loop No. 21113/PI Dwg: Y-11		
	Top Gas-Temperature & Pressure Indication		
TI-21113	Dial Thermometer (Bi-Metal)		8201
PI-21113	Pressure Gauge w/Seal		8301
	Loop No. 21114/PI Dwg: Y-11		
	Top Gas-Temperature Control		
TE-21114	Thermocouple Assembly		8216
TT-21114	Temperature Transmitter		8236
TS-21114	Current Switch		8030
TAH-21114	Ann. Alarm Point		8150
TR-21114	Recorder		8111
TIC-21114	Controller		8142
I/P-21114	I/P Signal Converter		8041
TV-21114	Control Valve (Butterfly)		8610
TI-21114	Dial Thermometer (Bi-Metal)		8201

ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	# INSTRUMENT INDEX	SP- 8001 REVISION 1 PAGE 8 A OF

ORIGINAL		BY	R. Moyta	DATE	8/31/78	APPD.	DATE
REVISION	1	BY	ZK	DATE	1/31/79	APPD.	DATE

CLIENT: ERIE MINING COMPANY — PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21116/PI Dwg: Y-11		
	Gas Cooler Feed Water-Pressure Relief		
PSV-21116	Pressure Safety Valve		8710
	Loop No. 21117/PI Dwg: Y-11		
	Purge Gas to Lock Hopper Flow Control		
FI-21117	Rotameter		8405
PRV-21117	Press. Red. Valve		8660
FV-21117	Flow Valve (Solenoid)		8650

(ENG-C50-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	INSTRUMENT INDEX	SP- 8001 REVISION 1 PAGE 9 A OF

ORIGINAL		BY	R. Moyta	DATE	8/31/78	APPD.	DATE
REVISION	1	BY	ZK	DATE	1/31/79	APPD.	DATE
CLIENT:	ERIE MINING COMPANY					PROJECT NO. 3001 Ø I	

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21119/PI Dwg: Y-11		
	Steam to Upper Ring Flow Integration		
PI-21119	Pressure Gauge w/Siphon		8301
	Loop No. 21120/PI Dwg: Y-11		
	Steam to Lower Ring Flow Integration		
PI-21120	Pressure Gauge w/Siphon		8301
PRV-21120	Pressure REgulator		8660

IENG-050-0273

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT INDEX			SP- 8001 REVISION 1 PAGE 10 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	LOOP NO. 21124/PI Dwg: Y-11		
	Gasifier Bed Temperature Record		
	& Grate Speed Control		
TE-21124	Thermocouple Assembly (Dual)		8216
TT-21124 A	Temperature Transmitter		8236
TT-21124 B	Temperature Transmitter		8236
TR-21124	Recorder		8111
HS-21124	Selector Switch		8180
SC-21124	Pulser		8021
SY-21124	Solenoid Valve		By Others
HC-21124	Manual Loading Station		8141
	Loop No. 21125/PI Dwg: Y-11		
	Process Gas Emergency Relief		
HC-21125	Manual Loader		8141
I/P-21125	I/P signal Converter		8041
FV-21125	Control Valve (Butterfly)		8610
	w/FY-21125 Solenoid Valve		
	Loop No. 21126/PI Dwg: Y-11		
	Tar Cyclone Blowdown Control		
HC-21126	Manual Loader		8141
I/P-21126	I/P Signal Converter		8041
FV-21126	Control Valve (Butterfly)		8610
	w/FY-21126 Solenoid Valve		

ENG-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	INSTRUMENT INDEX			SP- 8001 REVISION 1 PAGE 11 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21127 /PI Dwg: Y-11		
	Gasifier Emergency Relief		
HC-21127	Manual Loader		8141
I/P-21127	I/P Signal Converter		8041
FV-21127	Control Valve (Butterfly)		8610
	w/FY-21127 Solenoid Valve		
	Loop No. 21128 /PI Dwg: Y-11		
	Dust Cyclone Level Alarm		
LS-21128	Level Switch (Capacitance Type)		8542
LAH-21128	Ann. Alarm Point		8150
	Loop No. 21129/PI Dwg: Y-11		
	Tar Cyclone Level Alarm		
LS-21129	Level Switch (Capacitance Type)		8542
LAH-21129	Ann. Alarm Point		8150
	Loop No. 21130/PI Dwg: Y-11		
	Emergency Draft Control		
HC-21130	Manual Loader		8141
I/P-21130	I/P Signal Converter		8041
PV-21130	Control Valve (Butterfly)		8610
	w/FY-2130 Solenoid Valve		

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT INDEX			SP- 8001 REVISION 1 PAGE 12 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21131/PI Dwg: Y-11		
	Electric Power Failure System Relief		
KT-21131	Control Timer		8161
HS-21131	SELECTOR SWITCH		8180
	Loop No. 21132/PI Dwg: Y-11		
	Inert Gas to Flare Stack-Flow Indication		
FI-21132	Rotameter		8405

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	INSTRUMENT INDEX		SP- 8001 REVISION 1 PAGE 13 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD. / DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD. / DATE
CLIENT: ERIE MINING COMPANY			PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21701/PI Dwg: Y-25		
	Top Gas Header-Pressure Indication		
PI-21701	Pressure Gauge w/Seal		8301
	Loop No. 21702/PI Dwg: Y-27		
	Combined Gas Header-Pressure Indication		
PI-21702	Pressure Gauge		8301
	Loop No. 21703/PI Dwg: Y-27		
	Tar/Oil Tank-Temperature Control		
TI-21703	Dial Thermometer (Bi-Metal)		8201
TC-21703	Temperature Switch		BY OTHERS
TQ-21703	Heater		By Others
	Loop No. 21704/PY Dwg: Y-27		
	Tar/Oil Tank Discharge Temperature Indication		
TI-21704	Dial Thermometer (Bi-Metal)		8201

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT INDEX		SP- 8001 REVISION 1 PAGE 14 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD. DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD. DATE
CLIENT: ERIE MINING COMPANY			PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21705/PI Dwg: Y-25		
	Tar Header-Temperature Indication		
TI-21705	Dial Thermometer (Bi-Metal)		8201
	Loop No. 21706/PI Dwg: Y-27		
	Tar/Oil Pump Discharge Pressure		
	Indication		
PI-21706	Pressure Gauge w/Seal		8301
	Loop No. 21707/PI Dwg: Y-27		
	Tar/Oil Tank Level Control		
LE-21707	w/LIT-21707		
LIT-21707	Level Indicating Transmitter		8527
	(Cap. Type)		
LAH-21707	Ann. Alarm Point		8150
HS-21707	Selector Switch		8180
I/P-21707	I/P Signal Converter		8041
LV-21707	Control Valve (3-Port)		8620
PI-21707	Pressure Gauge w/Seal		8301

ENG-050-0278

INSTRUMENT INDEX

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT INDEX	SP- 8001 REVISION 1 PAGE 15 A OF

ORIGINAL		BY	R. Moyta	DATE	8/31/78	APPD.	DATE
REVISION	1	BY	ZK	DATE	1/31/79	APPD.	DATE

CLIENT: ERIE MINING COMPANY — PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21710/ PI Dwg: Y-27		
	Mixed Gas to Consumer Pressure Record		
PT-21710	Pressure Transmitter		8311
PR-21710	Recorder		8111
	Loop No. 21711/PI Dwg: Y-29		
	Combined Gas From Cooler		
	Temperature Indication		
TE-21711	Thermocouple Assembly		8216
TT-21711	Temperature Transmitter		8236
TI-21711	Panel Indicator		8131

(ENG-350-278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	# INSTRUMENT INDEX		SP- 8001 REVISION 1 PAGE 16 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY			PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21712/PI Dwg: Y-25		
	Tar Precipitator Level Alarm		
LS-21712	Level Switch (Ball Float)		8540
LAH-21712	Annunciator Alarm Point		8150
	Loop No. 21713/PI Dwg: Y-27		
	Oil Precipitator Level Alarm		
LS-21713	Level Switch (Ball Float)		8540
LAH-21713	Annunciator Alarm Point		8150

EN3-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT INDEX			SP- 8001 REVISION 1 PAGE 17 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21721/PI Dwg: Y-29		
	Combined Gas From Cooler Temp. Indication		
TE-21721	Thermocouple Assembly		8216
TT-21721	Temperature Transmitter		8236
TI-21721	Panel Indicator		8131
	Loop No. 21722/PI Dwg: Y-25		
	Tar Precipitator Level Alarm		
LS-21722	Level Switch (Ball Float)		8540
LAH-21722	Annunciator Alarm Point		8150
	Loop No. 21723/PI Dwg: Y-27		
	Oil Precipitator Level Alarm		
LS-21723	level Switch (Ball Float)		8540
LAH-21723	Annunciator Alarm Point		8150

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT INDEX			SP- 8001 REVISION 1 PAGE 18A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21731 /PI Dwg: Y-29		
	Combined Gas From Cooler		
	Temperature Indication		
TE-21731	Thermocouple Assembly		8216
TT-21731	Temperature Transmitter		8236
TI-21731	Panel Indicator		8131
	Loop No. 21732 /PI Dwg: Y-25		
	Tar Precipitator Level Alarm		
LS-21732	Level Switch (Ball Float)		8540
LAH-21732	Annunciator Alarm Point		8150
	Loop No. 21733 /PI Dwg: Y-27		
	Oil Precipitator Level Alarm		
LS-21733	Level Switch (Ball Float)		8540
LAH-21733	Annunciator Alarm Point		8150

ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	INSTRUMENT INDEX		SP- 8001 REVISION 1 PAGE 19 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY			PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21740/PI Dwg: Y-29		
	Mixed Gas Header Temperature Indication		
TE-21740	Thermocouple Assembly		8216
TT-21740	Temperature Transmitter		8236
TI-21740	Panel Indicator		8131
	Loop No. 21741/PI Dwg: Y-29		
	Mixed Gas From Cooler		
	Temperature Control		
TE-21741	Thermocouple Assembly		8216
TT-21741	Temperature Transmitter		8236
TIC-21741	Controller		8142
I/P -21741	I/P Signal Converter		8041
TV-21741	Control Valve (Butterfly)		8610

ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	# INSTRUMENT INDEX	SP- 8001 REVISION 1 PAGE 20 A OF

ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY			PROJECT NO. 3001 Ø I	

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21800/PI Dwg: Y-29		
	Combustion Air From Blowers-		
	Pressure Control		
PT-21800	Pressure Transmitter		8311
PI-21800	Pressure Gauge		8301
PR-21800	Recorder		8111
PS-21800	Current Switch		8030
PAH-21800	Annunciator Alarm Point		8150
PIC-21800	Controller		8142
I/P-21800	I/P Signal Converter		8041
PV-21800	Control Valve (Butterfly)		8610
	Loop No. 21801/PI Dwg: Y-29		
	Pilot Gas to Flare Stacks-		
	Pressure Control		
PRV-21801	Pressure Regulating Valve		8660
PI-21801	Pressure Gauge		8301

ENG-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT INDEX			SP- 8001 REVISION 1 PAGE 21 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21804/PI Dwg: Y-25		
	High Pressure Steam Drum-Level Control		
LT-21804	Level Transmitter (Displacement Type)		8522
LSH-21804	Current Switch		8030
LSL-21804	Current Switch		8030
LAH-21804	Annunciator Alarm Point		8150
LAL-21804	Annunciator Alarm Point		8150
LIC-21804	Controller		8142
I/P-21804	I/P Signal Converter		8041
LV-21804	control Valve (Globe)		8612
	Loop No. 12805/PI Dwg: Y-25		
	High Pressure Steam Drum Level & Temperature Indication		
LG-21805	Gauge Glass		8400
TI-21805	Dial Thermometer (Bi-Metal)		8201
	Loop No. 21806/PI Dwg: Y-25		
	High Pressure Steam Drum Pressure Record and Alarm		
PT-21806	Pressure Transmitter		8311
PI-21806	Pressure Gauge w/Syphon		8301
PSH-21806	Current Switch		8030
PSL-21806	Current Switch		8030
PAH-21806	Annunciator Alarm Point		8150
PAL-21806	Annunciator alarm Point		8150
PR-21806	Recorder		8111

ENG-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT INDEX			SP- 8001 REVISION 1 PAGE 22 A OF
ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: ERIE MINING COMPANY				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21807/PI Dwg: Y-25		
	High Pressure Steam Drum Pressure Relief		
PSV-21807	Pressure Safety Valve		8710
	Loop No. 21808/PI Dwg: Y-25		
	High Pressure Steam Drum Level		
	Indication		
LG-21808	Gauge Glass		8400
	Loop No. 21809/PI Dwg: Y-29		
	Cooling Water Supply Temperature		
	and Pressure Indication		
TI-21809	Dial Thermometer (Bi-Metal)		8201
PI-21809	Pressure Gauge		8301
	Loop No. 21810 /PI Dwg: Y-29		
	Combustion Air Blowers Pressure Indication/Alarm		
PS-21810	Pressure Switch		8331
PI-21810	Pressure Gauge		8301
PAL-21810	Annunciator Alarm Point		8150
HS-21810	Selector Switch		8180
PL-21810	Panel Lamp		8180

ENG-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT INDEX	SP- 8001 REVISION 1 PAGE 23 A OF

ORIGINAL	BY R. MOYTA	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE

CLIENT: ERIE MINING COMPANY — PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21811/PI Dwg: Y-29		
	Gas Cooler Water Return-Temperature Indication		
TI-21811	Dial Thermometer (Bi-Metal)		8201
	Loop No. 21812/PI Dwg: Y-25		
	Tar Precipitator Purge Gas Flow Indication		
FI-21812	Rotameter		8405
	Loop No. 21814/PI Dwg: Y-27		
	Oil Precipitator Purge Gas-Flow		
	Indication		
FI-21814	Rotameter		8405
	Loop No. 21815/PI Dwg: Y-29		
	Flare Stack Flame Supervision		
	Alarm		
BS-21815	Flame Supervision System		By Others
BA-21815	Annunciator Alarm Point		8150
PRV-21815	Pressure Regulator Valve		8660

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	# INSTRUMENT INDEX		SP- 8001 REVISION 1 PAGE 24 A OF
ORIGINAL	BY R. Moyta	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: Erie Mining Company			PROJECT NO. 3001 Ø I	

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21820/PI Dwg: Y-29		
	Combustion Air Blower Pressure Indication/Alarm		
PS-21820	Pressure Switch		8331
PI-21820	Pressure Gauge		8301
PAL-21820	Annunciator Alarm Point		8150
HS-21820	Selector Switch		8180
PL-21820	Panel Lamp		8180
	Loop No. 21821/PI Dwg: Y-29		
	Gas Cooler Water Return-Temperature		
	Indication		
TI-21821	Dial Thermometer (Bi-Metal)		8201
	Loop No. 21822/PI Dwg: Y-25		
	Tar Precipitator Purge Gas-Flow Indication		
FI-21822	Rotameter		8405
	Loop No. 21824/PI Dwg: Y-27		
	Oil Precipitator Purge Gas Flow Indication		
FI-21824	Rotameter		8405

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT INDEX			SP- 8001 REVISION 1 PAGE 25 A OF
ORIGINAL	BY R. Moyta	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: Erie Mining Company				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21825 /PI Dwg: Y-29		
	Flare Stack Flame Supervision		
	Alarm		
BS-21825	Flame Supervision System		By Others
BA-21825	Annunciator Alarm Point		8150
PRV-21825	Pressure Regulator Valve		8660

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	INSTRUMENT INDEX			SP- 8001 REVISION 1 PAGE 26 A OF
ORIGINAL	BY R. Moyta	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: Erie Mining Company				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21830 /PI Dwg: Y-29		
	Combustion Air Blower Pressure Indication/Alarm		
PS-21830	Pressure Switch		8331
PI-21830	Pressure Gauge		8301
PAL-21830	Annunciator Alarm Point		8150
HS-21830	Selector Switch		8180
PL-21830	Panel Lamp		8180
	Loop No. 21831 /PI Dwg: Y-29		
	Gas Cooler Water Return-Temperature Indication		
TI-21831	Dial Thermometer (Bi-Metal)		8201
	Loop No. 21832 /PI Dwg: Y-25		
	Tar Precipitator Purge Gas Flow		
	Indication		
FI-21832	Rotameter		8405
	Loop No. 21834/PI DWg: Y-27		
	Oil Precipitator Purge Gas Flow Indication		
FI-21834	Rotameter		8405

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	# INSTRUMENT INDEX	SP- 8001 REVISION 1 PAGE 27 A OF

ORIGINAL		BY	R. Moyta	DATE	8/31/78	APPD.	DATE
REVISION	1	BY	ZK	DATE	1/31/79	APPD.	DATE
CLIENT:	Erie Mining Company					PROJECT NO.	3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21835/PI Dwg: Y-29		
	Flare Stack Flame		
	Supervision Alarm		
BS-21835	Flame Supervision System		By Others
BA-21835	Annunciator Alarm Point		8150
PRV-21835	Pressure Regulator Valve		8660

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT INDEX	SP- 8001 REVISION 1 PAGE 28 A OF

ORIGINAL	BY R. Moyta	DATE 8/31/78	APPD.	DATE
REVISION 1	BY ZK	DATE 1/31/79	APPD.	DATE
CLIENT: Erie Mining Company				PROJECT NO. 3001 Ø I

TAG NUMBER	DESCRIPTION	MANUFACTURER AND MODEL NUMBER	SPECIFICATION NUMBER
	Loop No. 21840/PI Dwg: Y-27		
	Purge Gas to Oil Precipitators		
	Pressure Reduction		
PRV-21840	Pressure Regulating Valve		8660
PI-21840	Pressure Gauge		8301
	Loop No. 21841/PI Dwg: Y-25		
	Purge Gas to Tar Precipitators		
	Pressure Reduction		
PRV-21841	Pressure Regulating Valve		8660
PI-21841	Pressure Gauge		8301

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	SIGNAL CONVERTER SPECIFICATION			SP- 8021 REVISION PAGE 1 OF 1
ORIGINAL	BY LMW	DATE 9-25-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.				PROJECT NO. 3001 ΦI

1.0 SCOPE

This specification shall define the physical and performance characteristics of electronic signal converters as further defined in the attached Data Sheets. Documentation requirements will also be defined.

2.0 EQUIPMENT DESCRIPTION

2.1 The case shall be the manufacturer's standard housing for the electrical classification specified on the Data Sheet.

2.2 The input and output signal range shall be as specified in the Data Sheets.

2.3 The units shall be provided with zero and span adjustments.

2.4 Accuracy shall be $\pm$0.5% of span.

2.5 A recessed or covered terminal block shall be provided for electrical connections.

2.6 Each unit shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model and serial number, and the instrument tag number. The instrument tag number shall be as shown on the data sheet.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Electrical ~~and Piping~~ Drawings (schematic and interconnection)
D. Operation and Installation Manuals
E. Maintenance Manual & Parts List
F. Recommended Spare Parts for 2 Years Operation

3.2 Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from data sheet)
E. Exact Instrument Identification as furnished (i.e., detailed model number or list of furnished options)

ENG-250-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	SIGNAL CONVERTER DATA SHEET		SP- 8021 REVISION PAGE 1 OF 1
ORIGINAL	BY LMW	DATE 9-25-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.			PROJECT NO. 3001 ΦI

TAG NO.	SEE NOTE #1		
REVISION			
QUANTITY	5		
MANUFACTURER *			
*			
MODEL NO.			
SERVICE	GRATE SPEED CONTROL		
SIGNAL INPUT - RANGE	4-20mADC		
INPUT IMPEDANCE *			
SIGNAL OUTPUT - TYPE	SEE NOTE #2		
↓ ↓ - RANGE	40 TO 0 PULSES/HR		
(DIRECT/INVERSE) OUTPUT	INVERSE		
POWER	+24 V. DC		
MOUNTING	REAR PNL.		
NEC AREA CLASS.	GEN. PURP.		
ENCLOSURE	↓ ↓		

* BY BIDDER

NOTE #1) SC-21124 SC-21224 SC-21324 SC-21424 SC-21524

NOTE #2) SPDT CONTACT CLOSURE RATED 5A, 115VAC, MINIMUM.

LOCATION			

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	SWITCH - ELECTRONIC SIGNAL MONITOR SPECIFICATION		SP- 8030 REVISION PAGE 1 OF 2	
ORIGINAL	BY LMW	DATE 9-20-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.			PROJECT NO. 3001 ΦI	

1.0 SCOPE

This specification shall define the physical and performance characteristics of adjustable current switches as further described in the attached data sheets. This specification shall also define the documentation requirements of this equipment.

2.0 EQUIPMENT DESCRIPTION

2.1 Case shall be manufacturer's standard general purpose type.

2.2 The units shall be rear panel mounted.

2.3 Each set point shall be conveniently and continuously adjustable over the full mA DC input range.

2.4 Contacts shall be rated at least 2 amps at 110 volts resistive load.

2.5 Reference voltage and amplifier circuitry shall be solid state.

2.6 Operating point drift shall not exceed $\pm 1.0\%$ of range span for an ambient temperature change $\pm 35°F$.

2.7 The unit to be furnished with isolated relay contacts in the arrangement specified on the data sheet. Relay action shall be fail safe, meaning relays shall be energized during normal signal input, unless otherwise specified.

2.8 Each unit shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model and serial number, and the instrument tag number. The instrument tag number shall be as shown on the data sheet.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Electrical ~~& Piping~~ Drawings (schematic and interconnection)
D. Operation and Installation Manuals
E. Maintenance Manual and Parts List
F. Recommended Spare Parts for 2 Years Operation

3.2 Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from Data Sheet)
E. Exact Instrument Identification as furnished (i.e., detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	SWITCH ELECTRONIC SIGNAL MONITOR DATA SHEET			SP- 8030 REVISION PAGE 1 OF 3
ORIGINAL	BY LMW	DATE 8-3-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.				PROJECT NO. 3001 ΦI

ITEM NO.	SEE NOTE #1	SEE NOTE #2	SEE NOTE #3
REVISION			
QUANTITY	10	10	10
MANUFACTURER *			
MODEL NO. *			
SERVICE	L.P. BOILER WATER LEVEL	L.P. BOILER PRESS ALARM	BLAST PRESS. ALARM
MOUNTING	REAR PANEL	→	→
INPUT SIGNAL	4-20mA. DC	→	→
SET POINT - RANGE	4-20mA. DC	→	→
↓ ↓ - SCALE			
ACCURACY	±.5% SPAN	→	→
SWITCH - CONTACT FORM	SPDT	→	→
- RATING	5A. 115VAC	→	→
↓ - DIFFERENTIAL	MINIMUM	→	→
N.E.C. AREA CLASS	GEN. PURP.	→	→
ENCLOSURE	↓	→	→
SET PT. #1 - SIGNAL VALUE	—	—	—
↓ ↓ - ACTION INC.SIG.	SELECTABLE	→	→
SET PT. #2 - SIGNAL VALUE	—	—	—
↓ ↓ - ACTION INC.SIG.	—	—	—
TRIP PT. SETTING VIA	BLIND-SET SCREW	→	→
POWER SUPPLY	24VDC	→	→

NOTE #1) LSH-21104 LSH-21204 LSH-21304 LSH-21404 LSH-21504
LSL-21104 LSL-21204 LSL-21304 LSL-21404 LSL-21504

#2) PSH-21106 PSH-21206 PSH-21306 PSH-21406 PSH-21506
PSL-21106 PSL-21206 PSL-21306 PSL-21406 PSL-21506

#3) PSH-21110 PSH-21210 PSH-21310 PSH-21410 PSH-21510
PSL-21110 PSL-21210 PSL-21310 PSL-21410 PSL-21510

* BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	SWITCH ELECTRONIC SIGNAL MONITOR DATA SHEET			SP- 8030 REVISION PAGE 2 OF 3	
ORIGINAL	BY LMW	DATE 8-4-78	APPD.		DATE
REVISION	BY	DATE	APPD.		DATE
CLIENT:				PROJECT NO. 3001 ΦI	

ITEM NO.	SEE NOTE #1	PS-21800	SEE NOTE #2
REVISION			
QUANTITY	5	1	2
MANUFACTURER *			
MODEL NO. *			
SERVICE	TOP GAS TEMP. ALARM	COMBUSTION AIR PRESS ALARM	H.P. STEAM DRUM H_2O LEVEL ALARM
MOUNTING	REAR PANEL	→	→
INPUT SIGNAL	4-20 mA. DC.	→	→
SET POINT - RANGE	4-20 mA. DC	→	→
↓ ↓ - SCALE	—	—	—
ACCURACY	± .5% SPAN	→	→
SWITCH - CONTACT FORM	SPDT	→	→
↓ - RATING	5A 115 VAC	→	→
↓ - DIFFERENTIAL	MIN.	→	→
N.E.C. AREA CLASS	GEN. PURP.	→	→
ENCLOSURE	↓		
SET PT. #1 - SIGNAL VALUE	—	—	—
↓ ↓ - ACTION INC. SIG.	DE-ENERGIZE	→	SELECTABLE
SET PT. #2 - SIGNAL VALUE	—	—	—
↓ ↓ - ACTION INC. SIG.	—	—	—
TRIP PT. SETTING VIA	BLIND SET SCREW		
POWER SUPPLY	24 VDC	→	→

NOTE #1) TAG NO. TS-21114 TS-21214 TS-21314 TS-21414 TS-21514

#2) TAG NO. LSH-21804 , LSL-21804

* BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	SWITCH ELECTRONIC SIGNAL MONITOR DATA SHEET		SP- 8030 REVISION 1 PAGE 3 OF 3	
ORIGINAL	BY LMW	DATE 8-4-78	APPD.	DATE
REVISION 1	BY LMW	DATE 2-19-79	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.			PROJECT NO. 3001ϕ I	

ITEM NO.	SEE NOTE #1	~~SEE NOTE #2~~	
REVISION		⚠1	
QUANTITY	2	~~5~~	
MANUFACTURER *			
MODEL NO. *			
SERVICE	H.P. STEAM DRUM PRESS ALARM	~~GRATE SPEED CONTROL~~	
MOUNTING	REAR PANEL	→	
INPUT SIGNAL	4-20 mA.DC.	→	
SET POINT - RANGE	4-20mADC	→	
↓ ↓ - SCALE	—	—	
ACCURACY	± .5% SPAN	→	
SWITCH - CONTACT FORM	SPDT	→	
↓ - RATING	5A. 115 VAC	→	
↓ - DIFFERENTIAL	MIN.	→	
N.E.C. AREA CLASS	GEN. PURP.	→	
ENCLOSURE	↓	→	
SET PT. #1 - SIGNAL VALUE	—	—	
↓ ↓ - ACTION INC.SIG.	SELECTABLE	→	
SET PT. #2 - SIGNAL VALUE	—	—	
↓ ↓ - ACTION INC.SIG.	—	—	
TRIP PT. SETTING VIA	BLIND SET SCREW	→	
POWER SUPPLY	24V DC	→	

NOTE #1) PSH-21806, PSL-21806

⚠1 ~~#2) TAG No SY-21124 SY-21224 SY-21324 SY-21424 SY-21524~~

* BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	I/P SIGNAL CONVERTER SPECIFICATION			SP- 8041 REVISION PAGE 1 OF 2
ORIGINAL	BY LMW	DATE 9-25-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.				PROJECT NO. 3001 ΦI

1.0 SCOPE

This specification shall define the physical and performance characteristics of current to pneumatic process signal converters, as further defined in the attached data sheets. Documentation requirements will also be defined.

2.0 EQUIPMENT DESCRIPTION

2.1 The case shall be the manufacturer's standard housing for the electrical classification specified on the Data Sheet. A universal bracket for 2" pipe mounting shall be provided.

2.2 Unless otherwise specified, the output signal range shall be 3 to 15 psig. Except for the mA. DC signal input, no other electrical circuit connections shall be required.

2.3 The transducer shall be provided with zero and span adjustments.

2.4 Accuracy shall be within ± 0.5% of span.

2.5 The output signal shall be directly or inversely proportional to the input signal, as specified on the Data Sheet.

2.6 A recessed or covered terminal block shall be provided for signal circuit connections. Case connections shall be for rigid conduit.

2.7 Pneumatic supply and output connections to be 1/4" NPT.

2.8 When specified, vendor shall furnish a filter-regulator complete with gages. The air set shall be pre-piped to the unit and set at pressure as indicated on data sheet.

2.9 Each unit shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model and serial number, and the instrument tag number. The instrument tag number shall be as shown on the data sheet.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Electrical & Piping Drawings
(schematic and interconnection)
D. Operation and Installation Manuals
E. Maintenance Manual & Parts List
F. Recommended Spare Parts for 2 Years Operation

3.2 Each document shall be marked with the following identifying Data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from Data Sheet)
E. Exact Instrument Identification as furnished
(i.e., detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	I/P SIGNAL CONVERTER DATA SHEET			SP- 8041 REVISION PAGE 1 OF 5
ORIGINAL	BY LMW	DATE 9-25-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001

TAG NO.	SEE NOTE #1		
REVISION			
QUANTITY	10		
MANUFACTURER *			
*			
MODEL NO.			
	VARIOUS		
SERVICE			
INPUT - RANGE	4-20 mA DC		
↓ - IMPEDANCE *			
OUTPUT - RANGE	3-15 PSIG		
PNEUMATIC SUPPLY	20 PSIG		
MOUNTING	2" PIPE		
N.E.C. AREA CLASS	CL.I DIV.II G. D		
ENCLOSURE	EXPLOSION PROOF		
AIR SET WITH GAUGES	REQ'D		

* BY BIDDER

NOTE #1) I/P-21104, I/P-21204, I/P-21304, I/P-21404, I/P-21504

I/P-21109, I/P-21209, I/P-21309, I/P-21409, I/P-21509,

LOCATION			

VG-053-(2/76)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	I/P SIGNAL CONVERTER DATA SHEET			SP. 3041 REVISION PAGE 2 OF 5	
ORIGINAL	BY LMW	DATE 9-25-78	APPD.		DATE
REVISION	BY	DATE	APPD.		DATE
CLIENT: ERIE MINING CO				PROJECT NO. 3001 Φ I	

TAG NO.	SEE NOTE #1		
REVISION			
QUANTITY	10		
MANUFACTURER *			
*			
MODEL NO.			
	VARIOUS		
SERVICE			
INPUT - RANGE	4-20 mA DC		
↓ - IMPEDANCE *			
OUTPUT - RANGE	3-15 PSIG		
PNEUMATIC SUPPLY	20 PSIG		
MOUNTING	2" PIPE		
N.E.C. AREA CLASS	CL.I DIV II G. D		
ENCLOSURE	EXPLOSIONPROOF		
AIR SET WITH GAUGES	REQ'D		

* BY BIDDER

NOTE #1) I/P-21111 I/P-21211 I/P-21311 I/P-21411 I/P-21511

I/P-21114 I/P-21214 I/P-21314 I/P-21414 I/P-21514

LOCATION			

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	I/P SIGNAL CONVERTER DATA SHEET		SP- 8041 REVISION PAGE 3 OF 5
ORIGINAL	BY LMW	DATE 9-25-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. PROJECT NO. 3001ΦI

TAG NO.	SEE NOTE #1		
REVISION			
QUANTITY	10		
MANUFACTURER *			
*			
MODEL NO.			
	VARIOUS		
SERVICE			
INPUT - RANGE	4-20 mA DC		
↓ - IMPEDANCE *			
OUTPUT - RANGE	3-15 PSIG		
PNEUMATIC SUPPLY	20 PSIG		
MOUNTING	2" PIPE		
N.E.C. AREA CLASS	CL. I DIV. II G. D		
ENCLOSURE	EXPLOSIONPROOF		
AIR SET WITH GAUGES	REQ'D		

* BY BIDDER

NOTE #1) I/P-21125 I/P-21225 I/P-21325 I/P-21425 I/P-21525

I/P-21126 I/P-21226 I/P-21326 I/P-21426 I/P-21526

LOCATION

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	I/P SIGNAL CONVERTER DATA SHEET			SP. 3041 REVISION PAGE 4 OF 5
ORIGINAL	BY LMW	DATE 9-25-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001 Φ I

TAG NO.	SEE NOTE #1		
REVISION			
QUANTITY	10		
MANUFACTURER *			
*			
MODEL NO.			
SERVICE	VARIOUS		
INPUT - RANGE	4-20mA D.C.		
- IMPEDANCE *			
OUTPUT - RANGE	3-15 PSIG		
PNEUMATIC SUPPLY	20 PSIG		
MOUNTING	2" PIPE		
N.E.C. AREA CLASS	CL I DIV II G. D		
ENCLOSURE	EXPLOSIONPROOF		
AIR SET WITH GAUGE	REQ'D		

* BY BIDDER

NOTE #1) I/P-21127, I/P-21227, I/P-21327, I/P-21427, I/P-21527

I/P-21130 I/P-21230 I/P-21330 I/P-21430 I/P-21530

LOCATION			

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	I/P SIGNAL CONVERTER DATA SHEET			SP- 3041 REVISION PAGE 5 OF 5
ORIGINAL	BY LMW	DATE 9-25-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001 ΦI

TAG NO.	SEE NOTE #1		
REVISION			
QUANTITY	4		
MANUFACTURER *			
*			
MODEL NO.			
	VARIOUS		
SERVICE			
INPUT - RANGE	4-20 mA DC		
↓ - IMPEDANCE *			
OUTPUT - RANGE	3-15 PSIG		
PNEUMATIC SUPPLY	20 PSIG		
MOUNTING	2" PIPE		
N.E.C. AREA CLASS	CL. I DIV II G.D		
ENCLOSURE	EXPLOSIONPROOF		
AIR SET WITH GAUGES	REQ'D		

*BY BIDDER

NOTE #1) I/P-21707
I/P - 21741
I/P - 21800
I/P - 21804

LOCATION			

VG-053 (3/76)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	MINIATURE STRIP CHART RECORDER SPECIFICATION			SP- 8111 REVISION PAGE 1 OF 2
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.				PROJECT NO. 3001Φ I

1.0 SCOPE

This specification defines the physical and preformance characteristics of flush panel mounting, electronic or pneumatic, miniature strip chart recorders as further described in the attached data sheets. This specification also defines the documentation required with this equipment.

2.0 EQUIPMENT DESCRIPTION

2.1 The miniature strip chart recorders shall be manufacturers standard complying this Specification and the accompanying Data Sheet.

2.2 Case shall be manufacturers standard 3x6, 6 x 6, or 9 x 6 nominal size as specified on Data Sheet. Case shall be suitable for flush panel mounting complete with all required brackets, shelves or other mounting hardware.

2.3 Recorder shall have a minimum chart and scale length of four inches. A chart tear-off mechanism shall be provided.

2.4 Terminals for external wiring shall be by screw type barrier strip.

2.5 Recorder pens shall be capillary type with reservoir mounted within recorder case or felt tip pen. Reservoir or felt tip pen shall provide a minimum of fifteen days of continuous service.

2.6 Chart drive speed shall be either 3/4 inch/hour or one (1) inch /hour. Chart drive shall be electric 115 volt, 60 Hz hermetically sealed synchronous motor, unless otherwise specified on accompanying Data Sheet.

2.7 Roll charts shall be a minimum of 720 inches long and fan fold charts shall be a mimimum of 360 inches long. One month's supply of chart shall be furnished recorder.

2.8 Recorder shall be supplied with an engraved nameplate, clearly readable from the front of the recorder with the door closed. Nameplate shall indicate on top line pen tag number and pen color, middle line shall indicate pen function, and bottom line shall indicate pen chart factor and engineering units.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical ~~& Piping~~ Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare parts 2 Years Operation.

3.2 Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument identification as furnished. (i.e. detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	MINATURE STRIP CHART RECORDER DATA SHEET		SP- 8111 REVISION PAGE 1 OF 5
ORIGINAL	BY LMW	DATE 8-2-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. HOYT LAKES, MN. PROJECT NO. 3001 ΦI

TAG NO.	SEE NOTE #1	SEE NOTE #2	SEE NOTE #3
REVISION			
QUANTITY	5	5	5
MANUFACTURER *			
*			
MODEL NO.			
SERVICE	WEIGHT OF COAL TO GASIFIER	L.P. BOILER PRESS.	L.P. BOILER STEAM LB/HR
NOMINAL SIZE	6" X 6"	6" x 6"	→
CHART - DRIVE	ELECT.	ELECT.	→
↓ - SPEED	3/4"/HR	3/4"/HR	→
↓ - RANGE	0 - 100	0 - 100	→
SCALE - RANGE			
INPUT SIGNAL	4-20 MA DC	4-20 mA DC	→
POWER SUPPLY	24 VDC	24 VDC	→
PEN 1 - FUNCTION	WEIGHT	PRESSURE	FLOW RATE
↓ - COLOR	BLUE	BLUE	→
PEN 2 - FUNCTION	–	–	–
↓ - COLOR	–	–	–
PEN 3 - FUNCTION	–	–	–
↓ - COLOR	–	–	–
FACE PLATE LEGEND			
↓ ↓ ↓			
INTEGRAL 24 VDC TRANS. SUPPLY	–	REQ'D	REQ'D
INSTRUMENT SHELF	INDIVIDUAL	INDIV.	→
CORD SET	REQ'D	REQ'D	→

NOTE ~~#1) TAG NO. QR-21103 QR-21203 QR-21303 QR-21403 QR-21503~~

#2) TAG No. PR-21106 PR-21206 PR-21306 PR-21406 PR-21506

#3) TAG No. FR-21108 FR-21208 FR-21308 FR-21408 FR-21508

* BY BIDDER

LOCATION	CP-1	→	→

ENG-050 (2/78)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	MINATURE STRIP CHART RECORDER DATA SHEET	SP- 8111 REVISION PAGE 2 OF 5

ORIGINAL	BY LMW	DATE 8-2-78	APPD.	DATE	
REVISION	BY	DATE	APPD.	DATE	
CLIENT: ERIE MINING CO. HOYT LAKES, MN.				PROJECT NO. 3001 ΦI	

TAG NO.	SEE NOTE #1	SEE NOTE #2	SEE NOTE #3
REVISION			
QUANTITY	5	5	5
MANUFACTURER *			
*			
MODEL NO.			
SERVICE	STEAM FLOW TO EDUCTOR	BLAST TEMP/PRESS	COMBUSTION AIR TO EDUCTOR-FLOW
NOMINAL SIZE	6"x6"	→	→
CHART - DRIVE	ELECT.	→	→
- SPEED	3/4 "/HR	→	→
- RANGE	0-100	→	→
SCALE - RANGE			
INPUT SIGNAL	4-20mA.DC	→	→
POWER SUPPLY	24VDC	→	→
PEN 1 - FUNCTION	STEAM FLOW RATE	TEMP.	FLOW RATE
- COLOR	BLUE	BLUE	BLUE
PEN 2 - FUNCTION	—	PRESS.	—
- COLOR	—	RED	—
PEN 3 - FUNCTION	—	SPARE	—
- COLOR	—	GREEN	—
FACE PLATE LEGEND #1		TR-21110	
#2		PR-21110	
#3			
INTEGRAL +24v.DC TRANS. SUPPLY	—	ONE PER PEN	—
INSTRUMENT SHELF	INDIVIDUAL	→	→
CORD SET	REQ'D	→	→

NOTE #1) TAG NO. FR-21109, FR-21209, FR-21309, FR-21409, FR-21509
#2) TAG NO. UR-21110, UR-21210, UR-21310, UR-21410, UR-21510
#3) TAG NO. FR-21111, FR-21211, FR-21311, FR-21411, FR-21511

*BY BIDDER

LOCATION	CP-1	CP-1	CP-1

ENG-0559

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	MINATURE STRIP CHART RECORDER DATA SHEET			SP. 8111 REVISION PAGE 3 OF 5
ORIGINAL	BY LMW	DATE 8-3-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.				PROJECT NO. 3001 ΦI

TAG NO.	SEE NOTE #1	~~SEE NOTE #2~~	~~SEE NOTE #3~~
REVISION			
QUANTITY	5	~~5~~	~~5~~
MANUFACTURER *			
*			
MODEL NO.			
SERVICE	TOP GAS TEMP.	~~CLEAN GAS FLOW RATE~~	~~TOP GAS FLOW RATE~~
NOMINAL SIZE	6" x 6"	~~→~~	~~→~~
CHART - DRIVE	ELECT	~~→~~	~~→~~
- SPEED	3/4 "/HR	~~→~~	~~→~~
- RANGE	0 - 100	~~→~~	~~→~~
SCALE - RANGE	LATER		
INPUT SIGNAL	4-20 MA.DC	~~→~~	~~→~~
POWER SUPPLY	24VDC	~~→~~	~~→~~
PEN 1 - FUNCTION	TEMP	~~FLOW RATE~~	~~FLOW RATE~~
- COLOR	BLUE	~~BLUE~~	~~BLUE~~
PEN 2 - FUNCTION	—	~~—~~	~~—~~
- COLOR	—	~~—~~	~~—~~
PEN 3 - FUNCTION	—	~~—~~	~~—~~
- COLOR	—	~~—~~	~~—~~
FACE PLATE LEGEND			
INTEGRAL +24V. TRANS. SUPPLY	—	~~REQ'D~~	~~REQ'D~~
INSTRUMENT SHELF	INDIVIDUAL	~~→~~	~~→~~
CORD SET	REQ'D	~~→~~	~~→~~

NOTE #1) TAG NO. TR-21114, TR-21214, TR-21314, TR-21414, TR-21514

~~#2) TAG NO. FR-21115, FR-21215, FR-21315, FR-21415, FR-21515~~

~~#3) TAG NO. FR-21121, FR-21221, FR-21321, FR-21421, FR-21521~~

*BY BIDDER

LOCATION	CP-1	CP-1	CP-1

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	MINATURE STRIP CHART RECORDER DATA SHEET			SP- 8111 REVISION PAGE 4 OF 5
ORIGINAL	BY LMW	DATE 8-3-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.	HOYT LAKES, MN.			PROJECT NO. 3001 ΦI

TAG NO.	SEE NOTE #1	FR-21708	FR-21709
REVISION			
QUANTITY	5	1	1
MANUFACTURER *			
* MODEL NO.			
SERVICE	GASIFIER BED TEMP	TOP GAS FLOW	CLEAN GAS FLOW
NOMINAL SIZE	6" x 6"	→	→
CHART - DRIVE	ELECT.	→	→
- SPEED	3/4"/HR.	→	→
- RANGE	0 - 100	→	→
SCALE - RANGE	400-550°F		
INPUT SIGNAL	4-20 MA. DC	→	→
POWER SUPPLY	24VDC	→	→
PEN 1 - FUNCTION	TEMP	FLOW RATE	FLOW RATE
- COLOR	BLUE	→	→
PEN 2 - FUNCTION	—	—	—
- COLOR	—	—	—
PEN 3 - FUNCTION	—	—	—
- COLOR	—	—	—
FACE PLATE LEGEND			
INTEGRAL +24V. TRANS. SUPPLY	REQ'D	→	→
INSTRUMENT SHELF	INDIVIDUAL	→	→
CORD SET	REQ'D	→	→

NOTE #1) TAG No. TR-21124, TR-21224, TR-21324, TR-21424, TR-21524

* BY BIDDER

LOCATION	CP-1	CP-1	CP-1

ENG-050

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	MINATURE STRIP CHART RECORDER DATA SHEET			SP- 8111 REVISION PAGE 5 OF 5
ORIGINAL	BY LMW	DATE 8-3-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO HOYT LAKES, MN.				PROJECT NO. 3001 Φ I

TAG NO.	PR-21710	PR-21800	PR-21806
REVISION			
QUANTITY	1	1	1
MANUFACTURER *			
*			
MODEL NO.			
SERVICE	MIXED GAS PRESS	COMBUSTION AIR PRESS	H.P. STEAM DRUM-PRESS
NOMINAL SIZE	6"x6"	→	→
CHART - DRIVE	ELECT.	→	→
↓ - SPEED	3/4"/HR	→	→
↓ - RANGE	0-100	→	→
SCALE - RANGE			
INPUT SIGNAL	4-20 mA. DC	→	→
POWER SUPPLY	24 VDC	→	→
PEN 1 - FUNCTION	PRESS.	→	→
↓ - COLOR	BLUE	→	→
PEN 2 - FUNCTION	—	—	—
↓ - COLOR	—	—	—
PEN 3 - FUNCTION	—	—	—
↓ - COLOR	—	—	—
FACE PLATE LEGEND			
↓ ↓ ↓			
INTEGRAL +24V. TRANS. SUPPLY	REQ'D.	—	REQ'D.
INSTRUMENT SHELF	INDIVIDUAL	→	→
CORD SET	REQ'D	→	→

* BY BIDDER

LOCATION	CP-1	CP-1	CP-1

ENG-652-0774

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	MINIATURE PANEL INDICATOR SPECIFICATION			SP- 8131 REVISION PAGE 1 OF 2
ORIGINAL	BY LMW	DATE 8-8-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.				PROJECT NO. 3001ΦI

1.0 SCOPE

1.1 This specification defines the physical and preformance characteristics of electronic or pneumatic miniature indicators suitable for flush panel mounting, as further specified in the accompaning data sheets. This specification also defines the documentation required with these indicators.

2.0 EQUIPMENT DESCRIPTION

2.1 The Miniature Panel Indicator shall be Manufacturer's standard assembly conforming to this specification and the accompanying data sheet.

2.2 The case shall be sturdy sheet steel, general purpose construction. Case shall be flush panel mounting, suitable for multiple side-by-side mounting, complete with all brackets, shelves or other mounting hardware.

2.3 Internal illumination, when required, shall utilize a 24 volt DC bulb, readily changeable without removing gage from panel.

2.4 Zero and range calibration shall be adjustable without removing gage from panel.

2.5 Scales shall be white with black figures and a minimum of four (4) inches long.

2.6 Adjustable alarm set points shall be provided when specified. One (1) or two (2) individual set points shall be available and shall be readily adjustable from the front of the panel with no special tools. Each alarm set point value shall be indicated by a distinctive pointer on the scale plate. Alarm set points shall be SPDT rated for a minimum of 1 amp., 115 volt inductive load.

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	MINIATURE PANEL INDICATOR SPECIFICATION		SP- SP-8131 REVISION PAGE 2 OF 2	
ORIGINAL	BY R. MOYTA	DATE 8-8-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 3001ΦI	

2.7 Each miniature Panel Indicator shall be supplied with an engraved nameplate, clearly readable from the front of the indicator when the indicator is mounted in the panel in operating position. The nameplate shall indicate the instrument tag number, scale factors, and the process function as shown on the data sheet.

2.8 Each indicator shall be supplied with a permanently attached corrosion resistant tage showing the manufacturer's name, model number, serial number and the instrument tag number as shown on the data sheet.

3.0 <u>DOCUMENTATION</u>

3.1 The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for ______ Years Operation

3.2 Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	MINIATURE PANEL INDICATOR DATA SHEET			SP- 8131 REVISION PAGE 1 OF 1
ORIGINAL	BY LMW	DATE 8-8-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO	HOYT LAKES, MN.			PROJECT NO. 3001 Φ I

TAG NO.	SEE NOTE #1	TI-21740	
REVISION			
QUANTITY	3	1	
MANUFACTURER *			
*			
MODED NO.			
SERVICE	GAS COOLER OUTLET TEMP	GAS COOLER INLET TEMP.	
SCALE - TYPE	VERTICAL	→	
- RANGE	Later		
- LENGTH	4"	→	
ACCURACY - % RANGE	± 2%	→	
INPUT SIGNAL	4-20 mA. DC	→	
ILLUMINATION	—	—	
ALARM	—	—	
FACEPLATE LEGEND			
POWER SUPPLY	24 VDC	→	
INTEGRAL TRANS. PWR. SUPPLY	+24V REQ'D	→	
INSTRUMENT SHELF	REQ'D	→	
CORD SET	REQ'D	→	

NOTE #1) TI-21711, TI-21721, TI-21731

* BY BIDDER

LOCATION	CP-1	→	

ENG-650-0778

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	MINIATURE MANUAL LOADING STATION SPECIFICATION			SP- 8141 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ØI

DESIGN CRITERIA FOR MINIATURE MANUAL LOADING STATION

Case shall be manufacturer's standard dust and moisture resistant, suitable for flush panel mounting. Mounting brackets shall be provided.

Indicator shall preferably be vertical scale with minimum visible scale length of 3".

Chassis shall plug in and pull out from front of case. Field connections shall be integral with case.

Loading stations shall at all times indicate the output or final control element position.

The set-point adjustment for all control stations shall be manual, unless otherwise specified and readily accessible from the front of the case.

Accuracy shall be within 0.5% range span.

Unit shall be furnished with a durable tag or label marked with the tag number as listed on the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Operation and Installation Manuals
D. Maintenance Manual & Parts List
E. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from data sheet)
E. Exact Instrument Identification as furnished (i.e., detailed model number or list of furnished options).

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	MANUAL LOADER DATA SHEET			SP- 8141 REVISION PAGE 1 OF 2
ORIGINAL	BY LMW	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ØI

TAG NO.	SEE NOTE #1	SEE NOTE #2	SEE NOTE #3
REVISION			
QUANTITY	5	5	5
MANUFACTURER *			
MODEL NO. *			
SERVICE	DUST CYCLONE EMER. RELIEF	TAR CYCLONE BLOW DOWN CONTROL	EMERGENCY DRAFT VENT
NOMINAL SIZE	3"x6"	→	→
INPUT - SOURCE	MANUAL KNOB	→	→
↓ - RANGE	0-100	→	→
↓ - GAUGE	—	—	—
OUTPUT - RANGE	4-20mA	→	→
↓ - GAUGE	0-100	→	→
SET POINT	MANUAL	→	→
SWITCH - TYPE	—	—	—
↓ - NAMEPLATE	—	—	—
SUPPLY	+24V D.C.	→	→
MOUNTING	FLUSH PANEL	→	→
N.E.C. AREA CLASS	GEN PURP.	→	→
ENCLOSURE	↓ ↓	→	→

NOTE #1) FOR TAG NO. HC-21125, HC-21225, HC-21325, HC-21425, HC-21525

#2) FOR TAG NO. HC-21126, HC-21226, HC-21326, HC-21426, HC-21526

#3) FOR TAG NO. HC-21130, HC-21230, HC-21330, HC-21430, HC-21530

*BY BIDDER

LOCATION	CP-1	CP-1	CP-1

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT DATA SHEET MANUAL LOADER		SP- 8141 REVISION 1 PAGE 2 OF 2	
ORIGINAL	BY R. MOYTA	DATE 8-10-78	APPD.	DATE
REVISION 1	BY LMW	DATE 2-19-79	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 30001ΦI	

TAG NO.	#1 BELOW	#2 BELOW ⚠	
REVISION		⚠	
QUANTITY	5	5	
MANUFACTURER *			
MODEL NO. *			
SERVICE	AIR INTAKE TO EDUCTOR	GASIFIER BED TEMP CONTROL	
NOMINAL SIZE	3" X 6"	→	
INPUT - SOURCE	MANUAL KNOB	→	
↓ - RANGE	0-100	→	
- GAUGE	—	–	
OUTPUT - RANGE	4-20mA	→	
↓ - GAUGE	0-100	→	
SET POINT	MANUAL	→	
SWITCH - TYPE	—	–	
↓ - NAMEPLATE	—	–	
SUPPLY	+ 24VDC	→	
MOUNTING	FLUSH PANEL	→	
N.E.C. AREA CLASS	GEN PURPOSE	→	
ENCLOSURE	↓ ↓	→	

#1) HC-21127, HC-21227, HC-21327, HC-21427, HC-21527

⚠ #2) HC-21124 HC-21224 HC-21324 HC-21424 HC-21524

* BY BIDDER

LOCATION	CP-1	CP-1	

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	MINATURE INDICATING CONTROL STATION SPECIFICATION		SP- 8142 REVISION PAGE 1 OF 2
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.			PROJECT NO. 3001ϕI

1.0 SCOPE

This specification defines the physical and preformance characteristics of electronic or pneumatic miniature indicating control stations suitable for flush panel mounting, as further described in the attached data sheets. This specification also defines the documentation required with these control stations.

2.0 EQUIPMENT DESCRIPTION

2.1 The Miniature Indicating Control Station shall be Manufacturer's standard assembly conforming to this Specification and the accompany Data Sheet.

2.2 The case shall be of sturdy sheet steel, general purpose construction. Case shall be suitable for flush panel mounting complete with all required brackets, shelves or other mounting hardware.

2.3 The indicator scale shall be vertical, mounted on a plug-in front pull-out chassis. The measurement receiver units and automatic controls shall be integral with the chassis.

2.4 The control station shall be complete with a bumpless Auto-manual Transfer Switch, manual loading knob, control set-point knob and chassis release lever, readily accessible from the front of the case. Removal of the chassis shall not interfere with manual control.

2.5 The control station shall at all times indicate: 1) measured process variable signal, 2) control setpoint, 3) either controller output or manual loading pressure.

2.6 Control modes shall be non-interacting and shall be adjustable against a calibrated scale, over the full range without use of special tools. Direct and reverse action shall be reversable without use of special tools.

ENG-050-0278

ORIGINAL	BY R. MOTTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 30010I	

2.7 Each control station shall be supplied with an engraved nameplate, clearly readable from the front of the control station, when the station is mounted in the panel in operating position. The nameplate shall indicate the instrument tag number, as shown on the data sheet, and the process function indentified as "Faceplate Legend" on the data sheet.

2.8 Each indicator shall be supplied with a permanently attached corosion resistant tag showing the manufacturer's name, model number, serial number and the instrument tag number as shown on the data sheet.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical ~~& Piping~~ Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

3.2 Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	MINIATURE INDICATING CONTROL STATION DATA SHEET	SP- 8142 REVISION PAGE 1 OF 2

ORIGINAL	BY LMW	DATE 8-3-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. HOYT LAKES, MN. PROJECT NO. 3001 ΦI

TAG NO.	SEE NOTE #1	SEE NOTE #2	SEE NOTE #3
REVISION			
QUANTITY	5	5	5
MANUFACTURER *			
* MODEL NO.			
SERVICE	L.P. BOILER LEVEL	COMBUSTION AIR FLOW	CLEAR GAS TO COOLERS
TYPE	FLUSH PANEL	→	→
NOMINAL SIZE	3"x 6"	→	→
SIGNAL - INPUT	4-20mA. DC	→	→
↓ - OUTPUT	4-20mA. DC	→	→
SCALE RANGE			
SET POINT	REMOTE	LOCAL	→
PROPORTIONAL BAND	REQ'D	→	REQ'D
RESET	REQ'D	→	REQ'D
DERIVATIVE	—	—	REQ'D
ACTION			
POWER SUPPLY	24 VDC	→	→
FACEPLATE LEGEND			
INSTR. SHELF	INDIVIDUAL	→	→
CORD SET	REQ'D	→	→

NOTE #1) TAG NO. LIC-21104, LIC-21204, LIC-21304, LIC-21404, LIC-21504
#2) TAG NO. FIC-21111, FIC-21211, FIC-21311, FIC-21411, FIC-21511
#3) TAG No. TIC-21114, TIC-21214, TIC-21314, TIC-21414, TIC-21514

* BY BIDDER

LOCATION	CP-1	CP-1	CP-1

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	MINIATURE INDICATING CONTROL STATION DATA SHEET	SP- 8142 REVISION PAGE 2 OF 2		
ORIGINAL	BY LMW	DATE 8-3-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. HOYT LAKES, MN. PROJECT NO. 3001 ØI

TAG NO.	TIC-21741	PIC-21800	LIC-21804
REVISION			
QUANTITY	1	1	1
MANUFACTURER *			
* MODEL NO.			
SERVICE	MIXED GAS FROM COOLERS	COMBUSTION AIR HEADER	H.P. STEAM DRUM
TYPE	FLUSH PANEL	→	→
NOMINAL SIZE	3" x 6"	→	→
SIGNAL - INPUT	4-20 mA. DC	→	→
↓ - OUTPUT	4-20 mA. DC	→	
SCALE RANGE			
SET POINT	LOCAL	→	→
PROPORTIONAL BAND	REQ'D	→	→
RESET	REQ'D	→	→
DERIVATIVE	REQ'D	—	—
ACTION			
POWER SUPPLY	24VDC	→	→
FACEPLATE LEGEND			
INSTR SHELF	INDIVIDUAL	→	→
CORD SET	REQ'D	→	→

* BY BIDDER

LOCATION	CP-1	CP-1	CP-1

ENG-050 (3/78)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	MINIATURE INDICATING RATIO CONTROL STATION SPECIFICATION		SP- 8149 REVISION PAGE 1 OF 2
ORIGINAL	BY LMW	DATE 9-22-78	APPD. / DATE
REVISION	BY	DATE	APPD. / DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.			PROJECT NO. 3001 ΦI

1.0 SCOPE

This specification defines the physical and performance characteristics of electronic or pneumatic miniature indicating ratio control stations suitable for flush panel mounting, as further described in the attached data sheets. This specification also defines the documentation required with these control stations.

2.0 EQUIPMENT DESCRIPTION

2.1 The Miniature Indicating Ratio Control Station shall be manufacturer's standard assembly conforming to this specification and the accompanying Data Sheet.

2.2 The case shall be of sturdy sheet steel, general purpose construction. Case shall be suitable for flush panel mounting complete with all required brackets, shelves or other mounting hardware.

2.3 The ratio control station shall accept two process variables and control the secondary process variable at some preset ratio to an uncontrolled primary process variable.

2.4 The indicator scale shall be vertical, mounted on a plug-in front pull-out chassis. The measurement receiver units and automatic controls shall be integral with the chassis.

2.5 The control station shall be complete with a bumpless Auto-manual Transfer Switch, manual loading knob, control set-point knob and chassis release lever, readily accessible from the front of the case. Removal of the chassis shall not interfere with manual control.

2.6 The control station shall at all times indicate: 1) controlled process variable; 2) uncontrolled process variable; 3) ratio set point; 4) either controller output or manual loading pressure.

2.7 Control modes shall be non-interacting and shall be adjustable against a calibrated scale, over the full range without use of special tools. Direct and reverse action shall be reversable without use of special tools.

2.8 Each control station shall be supplied with an engraved nameplate, clearly readable from the front of the control station, when the station is mounted in the panel in operating position. The nameplate shall indicate the instrument tag number, as shown on the Data Sheet, and the process function identified as "Faceplate Legend" on the Data Sheet.

2.9 Each indicator shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model number, serial number and the instrument tag number as shown on the data sheet.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Electrical ~~& Piping~~ Drawings
(schematic and interconnection)
D. Operation and Installation Manuals
E. Maintenance Manual & Parts List
F. Recommended Spare Parts for 2 Years Operation

3.2 Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from Data Sheet)
E. Exact Instrument Identification as furnished
(i.e., detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	MINIATURE INDICATING RATIO CONTROL STATION SPECIFICATION	SP- 8149 REVISION PAGE 1 OF 1

ORIGINAL	BY LMW	DATE 9-22-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. HOYT LAKES, MN. PROJECT NO. 3001 Φ I

TAG NO.	SEE NOTE No. 1		
REVISION			
QUANTITY	5		
MANUFACTURER *			
*			
MODEL NO.			
SERVICE	EDUCTOR AIR/STEAM CTL.		
NOMINAL SIZE	3" X 6"		
SIGNAL - INPUT	4-20 mA DC		
- OUTPUT	4-20 mA DC		
RATIO RANGE			
VARIABLE RANGE	0-100		
SET POINT			
FORMULA			
PROPORTIONAL BAND	REQ'D		
RESET	REQ'D		
DERIVATIVE	—		
ACTION			
POWER SUPPLY	+24 VDC		
FACEPLATE LEGEND	AIR/STEAM RATIO		

NOTE #1) FFC-21109 FFC-21209 FFC-21309 FFC-21409 FFC-21509

* BY BIDDER

3-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	ANNUNCIATOR SPECIFICATION		SP- 8150 REVISION PAGE 1 OF. 2	
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO			PROJECT NO. 30010I	

DESIGN CRITERIA FOR PANEL ALARM ANNUNCIATORS

Panel alarm annunciators housing shall be suitable for control panel mounting. Unit shall be complete with plug-in sequence alarm modules, auxiliary modules, as required, completely pre-wired to annunciator housing terminal block.

Annunciator circuitry shall be suitable for either normally open or normally closed field contacts by wiring to proper terminals.

The alarm sequences shall be as follows:

Malfunction	- Audible and light "Flashing"
Acknowledge	- Audible "OFF" light "On Steady"
Return to Normal	- Audible "OFF" light "OFF"
Test	- Audible "ON", all lights flashing

Annunciator circuitry shall be suitable for operation on nominal 24 VDC power supply and shall have complete immunity to any transient signals.

Annunciator shall be furnished complete and suitable to supply 0.5 amps, 24 volt DC to a remote panel mounted audible alarm "Howler" unit.

Plug-in sequence alarm modules shall be provided for all annunciator points, whether active or inactive. Design shall be such that auxiliary modules do not eliminate any alarm point in the cabinet.

Annunciator shall be furnished complete with flasher unit. Test and acknowledge pushbuttons shall be furnished.

Unit shall be furnished with a durable tag or label marked with the tag number as listed on the data sheet.

ENG-050-0276

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	ANNUNCIATOR POINT LIST		SP- 8150 REVISION 1 PAGE 1 OF 4	
ORIGINAL	BY R MOYTA	DATE 8-10-78	APPD.	DATE
REVISION 1	BY LMW	DATE 2-19-79	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 30010I	

TAG	DESCRIPTION
1	COAL SURGE HOPPER LEVEL HI BN 201 A
LAL-21101	↓ ↓ ↓ ↓ LO ↓ ↓ ↓
LAH-21102	GASIFIER COAL LEVEL HI A 201 A
LAL-21102	↓ ↓ ↓ LO ↓ ↓ ↓
LAH-21104	STEAM DRUM WATER LEVEL HI D 201 A
LAL-21104	↓ ↓ LO ↓ ↓ ↓
PAH-21106	PRESSURE HI D 201 A
PAL-21106	↓ ↓ ↓ LO ↓ ↓ ↓
PAH-21110	STEAM/AIR BLAST PRESSURE HI
PAL-21110	↓ ↓ ↓ ↓ LO
TAH-21114	TOP GAS TEMPERATURE HI
LAH-21128	DUST CYCLONE LEVEL HI CY 201 A
LAH-21129	TAR CYCLONE ↓ ↓ CY 202 A
1	COAL SURGE HOPPER LEVEL HI BN 201 B
LAL-21201	↓ ↓ ↓ ↓ LO ↓ ↓ ↓
LAH-21202	GASIFIER COAL LEVEL HI A 201 B
LAL-21202	↓ ↓ ↓ LO ↓ ↓ ↓
LAH-21204	STEAM DRUM WATER LEVEL HI D 201 B
LAL-21204	↓ ↓ LO ↓ ↓ ↓
PAH-21206	PRESSURE HI D 201 B
PAL-21206	↓ ↓ ↓ LO ↓ ↓ ↓
PAH-21210	STEAM/AIR BLAST PRESSURE HI
PAL-21210	↓ ↓ ↓ ↓ LO
TAH-21214	TOP GAS TEMPERATURE HI
LAH-21228	DUST CYCLONE LEVEL HI CY 201 B
LAH-21229	TAR CYCLONE ↓ ↓ CY 202 B

(ENG-050-2275)

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of
Babcock International Inc.

ANNUNCIATOR POINT LIST

SP- 8150
REVISION 1
PAGE 2 OF 4

ORIGINAL	BY R MOYTA	DATE 8-10-78	APPD.	DATE
REVISION 1	BY LMW	DATE 2-19-79	APPD.	DATE

CLIENT: ERIE MINING CO. PROJECT NO. 30010I

TAG	DESCRIPTION
1	COAL SURGE HOPPER LEVEL HI BN 201 C
LAL-21301	↓ ↓ ↓ ↓ LO ↓ ↓ ↓
LAH-21302	GASIFIER COAL LEVEL HI A 201 C
LAL-21302	↓ ↓ ↓ LO ↓ ↓ ↓
LAH-21304	STEAM DRUM WATER LEVEL HI D 201 C
LAL-21304	↓ ↓ LO ↓ ↓ ↓
PAH-21306	PRESSURE HI D 201 C
PAL-21306	↓ ↓ LO ↓ ↓ ↓
PAH-21310	STEAM/AIR BLAST PRESSURE HI
PAL-21310	↓ ↓ ↓ ↓ LO
TAH-21314	TOP GAS TEMPERATURE HI
LAH-21328	DUST CYCLONE LEVEL HI CY 201 C
LAH-21329	TAR CYCLONE ↓ ↓ CY 202 C
1	COAL SURGE HOPPER LEVEL HI BN 201 D
LAL-21401	↓ ↓ ↓ ↓ LO ↓ ↓ ↓
LAH-21402	GASIFIER COAL LEVEL HI A 201 D
LAL-21402	↓ ↓ ↓ LO ↓ ↓ ↓
LAH-21404	STEAM DRUM WATER LEVEL HI D 201 D
LAL-21404	↓ ↓ LO
PAH-21406	PRESSURE HI
PAL-21406	↓ ↓ LO ↓ ↓ ↓
PAH-21410	STEAM/AIR BLAST PRESSURE HI
PAL-21410	↓ ↓ ↓ ↓ LO
TAH-21414	TOP GAS TEMPERATURE HI
LAH-21428	DUST CYCLONE LEVEL HI CY 201 D
LAH-21429	TAR CYCLONE ↓ ↓ CY 202 D

(ENG-C50-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	ANNUNCIATOR POINT LIST	SP- 8150 REVISION 1 PAGE 3 OF 4

ORIGINAL	BY R MOYTA	DATE 8-10-78	APPD.	DATE
REVISION 1	BY LMW	DATE 2-19-79	APPD.	DATE

CLIENT: ERIE MINING CO | PROJECT NO. 30010I

TAG	DESCRIPTION
1	COAL SURGE HOPPER LEVEL HI BN 201 E
LAL-21501	↓ ↓ ↓ ↓ LO ↓ ↓ ↓
LAH-21502	GASIFIER COAL LEVEL HI A 201E
LAL-21502	↓ ↓ ↓ LO ↓ ↓ ↓
LAH-21504	STEAM DRUM WATER LEVEL HI D 201 E
LAL-21504	↓ ↓ LO ↓ ↓ ↓
PAH-21506	PRESSURE HI D 201 E
PAL-21506	↓ ↓ ↓ LO ↓ ↓ ↓
PAH-21510	STEAM/AIR BLAST PRESSURE HI
PAL-21510	↓ ↓ ↓ ↓ LO
TAH-21514	TOP GAS TEMPERATURE HI
LAH-21528	DUST CYCLONE LEVEL HI CY 201 E
LAH-21529	TAR CYCLONE ↓ ↓ CY 202E

ENG-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	ANNUNCIATOR POINT LIST	SP- 8150 REVISION 1 PAGE 4 OF. 4

	BY	DATE	APPD.	DATE
ORIGINAL	R. MOYTA	8-10-78		
REVISION 1	LMW	2-19-79		

CLIENT: ERIE MINING CO. — PROJECT NO. 3001ϕI

	TAG	DESCRIPTION
	LAH-21712	TAR PRECIPITATOR LEVEL HI M 201 A
	LAH-21722	B
	LAH-21732	C
	LAH-21713	OIL M 202 A
	LAH-21723	B
	LAH-21733	C
1	PAL-21810	COMBUSTION AIR BLOWER PRESS. LO B 201 A
	PAL-21820	B
	PAL-21830	C
	BA-21815	FLARE STACK PILOT FLAME OFF J 201 A
	BA-21825	B
	BA-21835	C
	PAH-21800	COMBUSTION AIR HEADER PRESSURE HI
	LAH-21804	H.P. STEAM DRUM LEVEL HI D 202
	LAL-21804	LO
	PAH-21806	PRESSURE HI D 202
	PAL-21806	LO
	LAH-21707	TAR/OIL TANK LEVEL HIGH TN-202

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	TIMER SPECIFICATION			SP- 8161 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO				PROJECT NO. 3001ϕI

DESIGN CRITERIA FOR TIMER

Timer shall be manufacturer's standard assembly complying to this specification and the accompanying Data Sheet.

Timer shall provide dial or digital adjustable timed interval. Interval time shall be displayed on timer face.

Each timer shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model and serial number, and the instrument tag number. The instrument tag number shall be as shown on the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Operation and Installation Manuals
D. Maintenance Manual & Parts List
E. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from data sheet)
E. Exact Instrument Identification as furnished (i.e., detailed model number or list of furnished options).

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	TIMER DATA SHEET		SP- 8161 REVISION PAGE 1 OF 1
ORIGINAL	BY LMW	DATE 9-6-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.			PROJECT NO. 3001ΦI

TAG NO.	SEE NOTE #1	NOTE #2	
REVISION			
QUANTITY	5	5	
MANUFACTURER *			
*			
MODEL NO.			
SERVICE		SYS. RELIEF ON PWR. FAILURE	
TYPE		RELAY	
TYPE DELAY		OFF DELAY	
COIL VOLTAGE		24 VDC	
CONTACT - FORM		SPDT	
↓ - RATING		5A. - 115V AC	
MOUNTING		SURFACE	
TIME RANGE ADJ.		2.5 TO 50 SEC.	

NOTE #1) ~~SC-21124, SC-21224, SC-21324, SC-21424, SC-21524~~

NOTE #2) KT-21131, KT-21231, KT-21331, KT-21431, KT-21531

*BY BIDDER

LOCATION	CP-1	→	

NG-020-0276)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	MAIN INSTRUMENT PANEL SPECIFICATION			SP- 8180 REVISION PAGE 1 OF 8
ORIGINAL	BY LMW	DATE 2-19-79	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001 ΦI

1.0 SCOPE

The work to be performed under the terms of this Specification shall consist of furnishing all materials and labor required to design, detail, fabricate, paint, test, and deliver by vendor to the buyer one (1) main control panel, specified herein and designated as follows:

Number Required	Equipment Number	Description
1	CP-1	Main Control Panel

2.0 WORK BY OTHERS

2.1 Receive, unload, store and install the assembled unit.

2.2 All instruments will be supplied to the vendor by others.

2.3 Panel layout, instrument loop, elementary drawings, terminal drawings and nameplate list for annunciator will be by others.

2.4 Wiring, piping and tubing external to the control panel board.

2.5 Control panel foundation.

2.6 Installation, calibration and start-up operations.

3.0 EQUIPMENT AND SERVICE REQUIREMENTS

3.1 Vendor shall furnish control panel boards as described herein and in the quantities and as detailed in the accompanying design drawings, Data Sheets, and elementary drawings.

3.2 Vendor shall furnish all pushbuttons, selector switches, solenoid valves, indication lights, relays and timers unless specifically excluded in the next section of this specification.

3.3 Vendor shall furnish all items that are required to make a complete and operational control panel board unless specifically excluded in the next section of this Specification.

3.4 Vendor shall submit prior to start of fabrication and hardware purchase, for approval by the Buyer the following drawings:

3.4.1 Fully dimensioned drawings showing panel cutouts, structural details, junction boxes and lighting.

3.4.2 Anchor layout.

3.4.3 Layout of all conduit and tubing inside panel, one (1) print showing combined routing is desired.

4.0 GENERAL

4.1 The control panels shall be complete and ready for field installation including instruments, accessories, attachments and interconnecting tubing, piping and wiring. Construction to be in accordance with the details outlined. Panel piping and tubing shall be leak tested and wiring "checked out" prior to shipment. The instrument Vendor shall submit a detailed description of "check out" procedure for the Owner's approval. The instrument vendor shall further advise when "Check out" will be performed with sufficient notice for representative(s) to be present at the Buyer's option.

4.2 The Buyer or a designated representative, reserves the right to visit the Vendor's plant for purpose of panel board inspection.

4.3 Instrument vendor shall design back of panel arrangement so that all instrumentation items mounted thereon are positioned and located so as to be readily accessible for inspection, trouble shooting and maintenance. All electrical items (relays, etc.) shall be located so as to be conveniently available for trouble shooting and maintenance, yet shall not impede accessibility of above mentioned instrumentation items.

5.0 DESIGN CRITERIA

5.1 Mechanical

5.1.1 Panel fronts shall be 1/4" steel plate.

5.1.2 Other parts of panels shall be 3/16" steel plate.

5.1.3 Panel shall be free standing.

5.1.4 Control panels shall be constructed in accordance with the Vendor's construction standards to yield a heavy gage steel panel braced to develop a rigid assembly.

5.1.5 Provision shall be made for bolting the panels to a curb and for bolting the panels together as required. Complete bolting for joining panel sections to be furnished by panel Vendor.

5.1.6 Additional internal panels shall be provided for mounting of required auxiliary equipment and shall be arranged so as not to interfere with the service and maintenance of any equipment or components.

5.1.7 Lifting angle shall be of suitable size to prevent panel from buckling. Furnish and install removable eye bolt lifting lugs with nuts welded to inside panel.

5.1.8 Make all instrument cut outs and drillings straight and true. Round all sharp edges.

5.1.9 Clean thoroughly to remove all grease, oil and foreign matter. Sand all flat surfaces to remove any irregularities.

5.1.10 Apply one (1) coat of rust proofing compound.

5.1.11 Apply one or more coats of metal primer and sand smooth.

5.1.12 Apply surfacer, sand and fill indentations, scratches, etc., with filler compound. Sand smooth and apply two (2) additional coats of primer surfacer. Sand and apply two (2) finish coats of semi-gloss Sherwin-Williams Enamel, F1A 2109 Code M light gray, or equal.

5.1.13 <u>Nameplates</u>

All front mounted instruments shall be identified by a laminated plastic nameplate showing service. All lights, switches, etc., shall be identified on the front panel by a laminated plastic nameplate showing service.

All nameplates shall be 1/16" thick beveled edge white Lamicoid, Gravoply or equal with black center. They will be fastened to the board with adhesive backing. They shall be approximately 1" by 3" included with 1/4" high characters of uniform size.

All components on the inside of the panel shall be identified by durable labels located for easy visibility.

5.2 Electrical

5.2.1 All panel wiring shall terminate at terminal blocks located as specified and numbered per Buyer's terminal drawing.

5.2.2 All panel wiring shall be neatly done and shall conform with all applicable codes.

5.2.3 All panel wiring, as far as practical, shall be run in ducts with the wires tagged at each end.

5.2.4 Terminal blocks for field wiring connections shall be pressure type for at least #12 AWG field wire or equal and shall be labeled with the appropriate terminal numbers. Terminals shall be arranged so that terminals for each circuit are grouped together. Two (2) spare terminals shall be provided for each ten (10) active terminals.

5.2.5 All instrument and control power wiring shall be routed through a single multi-circuit breaker panel, Square D Type "QO" or equal.

5.2.6 Thermocouple, resistant thermometer, and other low power signal wiring shall be separated from, or magnetically shielded from, 115 volt power wiring, and be neatly arranged in conduit or wiring duct.

5.2.7 Selector switches, pushbuttons, and lights shall be General Electric miniature oil tight, or equal. Indicating lights shall be transformer type for AC applications and resistor type for DC applications.

5.2.8 All electrical control items (relays, timers, etc.) shall be wired and identified per Buyer Elementary Diagrams and/or loop diagrams.

5.2.9 Control relays shall be Allen Bradley Type 700-N or equal. Contacts shall be 300 volt, rated, machine tool open type with convertible contacts. Number of contacts on each relay shall be per Buyer's Elementary Drawing plus one extra set of contacts.

5.2.10 Rear of panel shall be suitable lighted and provided with a 3 way switch adjacent to the access door. R & S fixture type No. 6334A or equal. Exposed fluorescent tubes not acceptable. Convenience outlets in front and rear shall be provided on each panel section.

5.2.11 Power wiring to instruments consuming 150 volt amperes or less shall be 3-wire, 3-prong, polarized plug to "plug mold" or "plug-in strips" without switches. This strip is to be suitably fused.

5.2.12 Wiring shall be of No. 14 gauge flexible copper wire with 600 volt polyvinyl insulation. Color code as follows: black wires - ground, white wires - neutral, red wires - hot, green wires - control. When wiring miniature type indicating lights, use No. 18 gauge wire.

5.3 Piping & Tubing

5.3.1 An instrument air supply system shall be provided as detailed in the following paragraphs only if specified in the Panel Data Sheets.

5.3.2 All instruments shall be connected by necessary piping or tubing, valving, test connections, etc., to bulkhead fittings conveniently located. Bulkhead fittings shall be rigidly supported and grouped in an orderly manner so as to simplify field connections. Each tube shall be clearly identified by an affixed label presented on loop drawings.

5.3.3 Tube fittins shall be Swagelok or equal.

5.3.4 All tubing shall be rigidly supported and clipped either to the panel or to a supporting brace. Tubing shall be 1/4" O.D. x .032 wall thickness copper tube from field. A minimum of 10% spare bulkhead connections shall be provided per panel section but in no case less than one (1) spare. All piping and tubing shall be routed so as to permit future instrument additions without making changes to existing installation and also to permit easy access to all instruments for maintenance and adjustments.

5.3.5 Tee handle valves shall be used on the air manifold for each air consuming instrument.

5.3.6 There shall be the three spare valved connections on air manifold for every twelve (12) in service, equally spaced on a minimum of 2-1/2" centers.

5.3.7 Unless otherwise noted, the panel Vendor shall provide dual air filter regulators with isolating valves, each station sized for full load capacity. All fittings downstream of the filters to be copper or brass. Air supply connections shall be valved off with a "packless" valve. A suitable line mounted output pressure gage shall be furnished for each regulator.

6.0 SUPERVISION

6.1 Testing

6.1.1 All tubing connections will be tested for leaks and shall conform to ISA RP 7.1.

6.1.2 Test shall be conducted at maximum operating pressures.

6.1.3 All piping installations shall conform to Code ANSI-334.1.

8.0 MISCELLANEOUS

8.1 Deviations

In case of differences in information submitted, detailed data presented on Buyer's or by Buyer approved drawings shall take precendence over others where discrepancies occur.

8.2 Quotation

Quote unit price for the following additional instrumentation (installed, piped and wired) which may be added at a later date:

- Indicating lights
- Pushbuttons
- Relays
- Timers

9.0 INFORMATION REQUIRED FROM VENDOR

In addition to his standard proposal, the Vendor shall furnish the following information:

9.1 Vendor shall state each exception taken to this Specification by a list "Exceptions to Specification".

9.2 An 8" x 10" glossy color print of each front panel section shall be provided on completion of the panel.

DRAWING LIST FOR PANEL BUILDER

Drawing No.	Title
ϕI	Loop Diagrams
	El. Elementary
SPEC 8150 ϕI	Annunciator System
	Name Plates List
4814-K-02-01-2	Panel Drawing

1.0 SCOPE

This specification defines the physical and performance characteristics of bi-metal element actuated dial thermometers as further described on the attached Data Sheets. This specification also defines the documentation to be supplied with this equipment.

2.0 EQUIPMENT DESCRIPTION

2.1 Dial thermometers shall be manufacturer's standard assembly complying with this specification and the accompanying Data Sheet.

2.2 Thermometer shall be constructed so that both range and zero calibration may be adjusted, conveniently, with simple common hand tools.

2.3 Case shall be manufacturer's standard dust and moisture proof.

2.4 Accuracy shall be within 1% of full scale value.

2.5 Neither accuracy nor calibration shall be affected by a temperature of 150% of full scale value.

2.6 Thermometer movement shall be protected from error or damage due to vibration.

2.7 Stem shall be stainless steel. Connection nut shall have 1/2 inch NPT male thread.

2.8 The thermometer movement shall be mounted directly to a metallic block which shall include the wrench flats or hex head and the process connection.

2.9 Unless otherwise specified, separable well shall be furnished with thermometer.

2.10 Separable well shall be hex head, bar stock, with 1 inch NPT process connection unless otherwise specified. Well bore shall not be more than 0.015 inch greater than the thermometer stem outside diameter.

2.11 Each thermometer shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model and serial number and the instrument tag number as shown on the data sheet.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Operation & Installation Manuals
D. Maintenance Manual & Parts List
E. Recommended Spare Parts 2 Years Operation

3.2 Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from data sheet)
E. Exact instrument identification as furnished (i.e., detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	DIAL THERMOMETER BI-METAL SPECIFICATION	SP- 8201 REVISION PAGE 1 OF 2

ORIGINAL	BY R MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO — PROJECT NO. 30010I

THERMOMETER

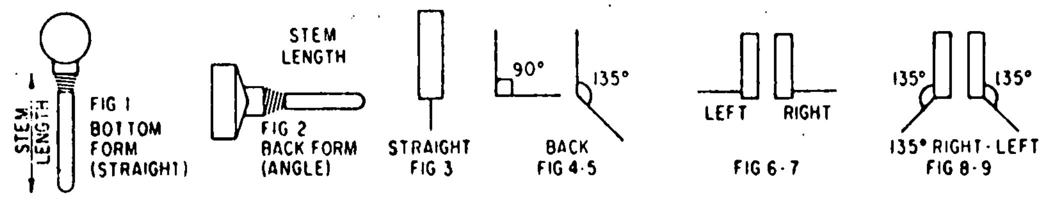
1. Stem: Threaded X Plain ☐ Union ☐
   Material: ______
2. Stem or Union Thread: ½ in. X ¾ in. ☐
3. Stem Diameter: STD ☐ .250 in. X .375 in. ☐
4. Case Material: STD X Other ______
5. Dial Size 5" Color BLACK ON WHITE
6. Scale length ______ Color ______
7. Form: Fig. No. ______ Adjustable X
8. External Calibrator ☐ Herm Sealed Case X

* 9. MFR. & Model No. ______

WELL

10. None ☐ Included X By Others ☐
11. Material: 304SS ☐ 316SS X
    Other: ______
12. Construction: Drilled X Built-Up ☐
    Other: ______

Well Length Must Suit Stem Length.



Rev.	Tag No.	Range	Operating Temp	Stem Length	Well Conn.	Lag Ext.	Service	Notes
	TI-21105	50/300	267°F	9"	3/4" NPT	3"	D 201 A STEAMDRUM	
	TI-21205						B	
	TI-21305						C	
	TI-21405						D	
	TI-21505						E	
	TI-21113	50/300	250°F				TOP GAS TO CYCLONE	
	TI-21213							
	TI-21313							
	TI-21413							
	TI-21513							
	~~TI-21113B~~							
	~~TI-21213B~~							
	~~TI-21313B~~							
	~~TI-21413B~~							
	~~TI-21513B~~							
	TI-21114	50/550	400°F				COOL CLEAN GAS	
	TI-21214							
	TI-21314							
	TI-21414							
	TI-21514							
	TI-21703	50/300	250°F	9"			TAR OIL TANK	
	TI-21704	50/300	250°F	6"				
	TI-21705	50/300	250°F	6"			TO TANK	

Notes:
* BY BIDDER

(ENG-050-0278)

ISA FORM S20.14

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	DIAL THERMOMETER BI-METAL SPECIFICATION	SP- 8201 REVISION PAGE 2 OF. 2

ORIGINAL	BY R MOYTA	DATE 8-2-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. PROJECT NO. 3001ΦI

THERMOMETER

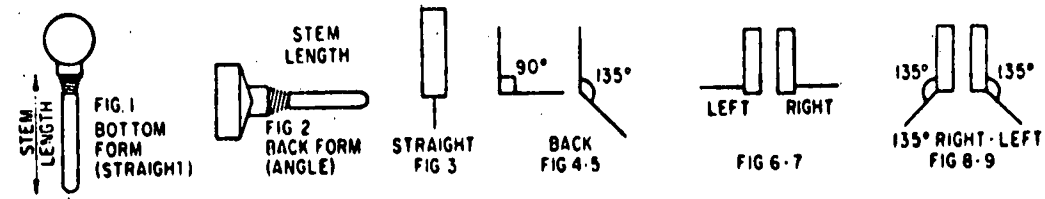
1. Stem: Threaded ☒ Plain ☐ Union ☐
   Material ________
2. Stem or Union Thread: ½ in. ☒ ¾ in. ☐
3. Stem Diameter: STD ☐ .250 in. ☒ .375 in. ☐
4. Case Material: STD ☒ Other ________
5. Dial Size 5" Color BLACK ON WHITE
6. Scale length ______ Color ________
7. Form: Fig. No. ______ Adjustable ☒
8. External Calibrator ☐ Herm Sealed Case ☒

* 9. MFR. & Model No. ________

WELL

10. None ☐ Included ☒ By Others ☐
11. Material: 304SS ☐ 316SS ☒
    Other: ________
12. Construction: Drilled ☒ Built-Up ☐
    Other: ________

Well Length Must Suit Stem Length.



Rev.	Tag No.	Range	Operating Temp	Stem Length	Well Conn.	Lag Ext.	Service	Notes
	TI-21805	50/400	352°F	9"	3/4" NPT	3"	D 202 STEAM DRUM	
	TI-21809			↓	↓	↓	COOL WATER TO COOLERS	
	TI-21811						FROM	
	TI-21821						↓	
	TI-21831							
	TI-21110	0/250	150°F	9"	3/4"	3"	BLAST TO GASIFIER	
	TI-21210	↓	↓	↓	↓	↓	↓	
	TI-21310							
	TI-21410							
	TI-21510							

Notes:

* BY BIDDER

ENG-253-(2/78)

ISA FORM S20.14

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INDICATING PYROMETER SPECIFICATION	SP- 8206 REVISION PAGE 1 OF 1

ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. | PROJECT NO. 30010I

DESIGN CRITERIA FOR INDICATING PYROMETER

This item shall be an integral combination of thermocouple, thermowell, and millivoltmeter, designed to indicate temperatures up to 2000°F.

The unit shall be completely self contained, with no external power requirements.

The housing shall be the manufacturers standard to meet data sheet requirements.

The thermocouple shall be spring loaded against the bottom of the well.

Each unit shall be supplied with a permanently attached corrosion resistant tag showing the manufacturers name, model, serial number, and the instrument tag number as shown on the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Operation and Installation Manuals
D. Maintenance Manual & Parts List
E. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from data sheet)
E. Exact Instrument Identification as furnished (i.e., detailed model number or list of furnished options).

ENG-053-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INDICATING PYROMETER			SP- 8206 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MOYTA	DATE 8-2-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ΦI

TAG NO.	#1 BELOW		
REVISION			
QUANTITY	5		
MANUFACTURER *			
*			
MODEL NO.			
SERVICE	GASIFIER CLEAR GAS		
PROCESS - FLUID	COAL GAS		
- TEMP	1202°F		
- PRESS	45" WC		
DIAL SIZE	3"		
HOUSING	ALUMINUM		
SCALE RANGE	0-2000°F		
WELL - MATERAL	INCONEL 601		
- LENGTH	14"		
- CONNECTION	3/4" NPT		
- CONNECTION TYPE	BUSHING		
NEC CLASS	CLASS I DIV II GROPE D		
LOCATION	FIELD		

#1) TI-21112, TI-21212, TI-21312, TI-21412, TI-21512

* BY BIDDER

ENG-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	THERMOCOUPLE ASSEMBLIES SPECIFICATION			SP-8216 REVISION PAGE 1 OF 2
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ϕI

DESIGN CRITERIA FOR THERMOCOUPLE ASSEMBLIES

Thermocouple assemblies shall be complete including terminal block, thermocouple element with insulators, extension, head and protecting well or tube, as required.

Recommended practice as described in ISA-RP1, as approved September, 1958, shall be met for calibration accuracy and color coding.

Heads shall be universal type, cast iron, complete with threaded chained, gasketed cover, integral single pair screw type terminal block with polarity indicated, a 1/2" NPT well, and 3/4" NPT conduit connection unless otherwise specified.

Extensions, when required, shall be of 1/2" steel pipe with length as specified on data sheets.

When required, protective wells shall be solid bored type with process connection and length as specified on data sheets.

Protective tubes shall be straight type, single or double construction, complete with pressure-tight mounting bushing or pressure-tight mounting flange, as specified.

Thermocouple wire shall be ISA standard types. Wire gage shall be as recommended in ISA recommended practice RP1.3.

The unit shall be identified by a metal tag attached with corrosion resistance wire, and stamped with the tag number from the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT DATA SHEET THERMOCOUPLE ASSEMBLIES			SP-8216 REVISION 1 PAGE 1 OF 2	
ORIGINAL	BY LMW	DATE 8-7-78	APPD.	DATE	
REVISION 1	BY ZK	DATE 1-31-79	APPD.	DATE	
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ØI	

TAG NO.	SEE NOTE #2	SEE NOTE #3	SEE NOTE #4
REVISION			1
QUANTITY	5	5	5
MANUFACTURER *			HONEYWELL
MODEL NO. *			
SERVICE	BLAST TEMP.	DUST CYCLONE OUTLET TEMP.	GASIFIER GRATE TEMP.
PROCESS FLUID	AIR	COAL GASIFIER TOP GAS	STEAM & AIR
THERMOCOUPLE TYPE	"J"	→	DUAL "J"
WIRE GAGE	14 AWG	→	8 AWG
ELEMENT LENGTH	SEE NOTE #1	→	11 FT.
ELEMENT DIAMETER			—
SHEATH	316 ST. ST.	→	—
GROUNDING	REQ'D	→	—
HEAD - TYPE	WEATHERPROOF	→	→
HEAD - PROCESS CONNECTION	1/2" NPT	→	1" NPT
HEAD - EXTENSION	3"	→	NONE
WELL - MATERIAL	316 ST. ST.	→	—
WELL - BORE *			NOT REQ'D
WELL - "U" DIMENSION	9"	→	—
WELL - PROCESS CONNECTION	3/4"	→	—
WELL - WALL THICKNESS-MIN. *			—
WELL - LAG LENGTH	3"	→	—
ELEMENT INSULATION	—	—	SEE NOTE #5

NOTE #1) SPRING LOADED TO CONTACT WELL BOTTOM.
#2) TAG No. TE-21110, TE-21210, TE-21310, TE-21410, TE-21510
#3) TAG No TE-21114, TE-21214, TE-21314, TE-21414, TE-21514
#4) TAG NO TE-21124, TE-21224, TE-21324, TE-21424, TE-21524

#5) WELD TIPS OF BOTH ELEMENTS TOGETHER AND FURNISH 2-HOLE CERAMIC INSULATORS FOR ENTIRE LENGTH OF EACH ELEMENT.

* INFO BY BIDDER

LOCATION	FIELD	→	→

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT DATA SHEET THERMOCOUPLE ASSEMBLIES		SP. 8216 REVISION PAGE 2 OF 2	
ORIGINAL	BY LMW	DATE 8-7-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.			PROJECT NO. 3001 ϕ I	

TAG NO.	SEE NOTE #2	TE-21740	TE-21741
REVISION			
QUANTITY	3	1	1
MANUFACTURER *			
MODEL NO. *			
SERVICE	GAS COOLER OUTPUT	MIXED GAS TO COOLERS	MIXED GAS OUT OF COOLERS
PROCESS FLUID	COAL GAS	→	→
THERMOCOUPLE TYPE	"J"	→	→
WIRE GAGE	14 AWG	→	→
ELEMENT LENGTH	SEE NOTE #1	→	→
ELEMENT DIAMETER *			
SHEATH	316 ST. ST.	→	→
GROUNDING	REQ'D	→	→
HEAD - TYPE	WEATHERPROOF	→	→
HEAD - PROCESS CONNECTION	1/2" NPT	→	→
HEAD - EXTENSION	3"	→	→
WELL - MATERIAL	316 ST. ST.	→	→
WELL - BORE *			
WELL - "U" DIMENSION	9"	→	→
WELL - PROCESS CONNECTION	3/4"	→	→
WELL - WALL THICKNESS-MIN.*			
WELL LAG LENGTH	3"	→	→

NOTE #1) SPRING LOADED TO CONTACT WELL BOTTOM.

#2) TAG NO. TE-21711, TE-21721, TE-21731

* INFO BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	TEMPERATURE TRANSMITTER SPECIFICATION		SP- 8236 REVISION PAGE 1 OF 2	
ORIGINAL	BY RMOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 30016I	

DESIGN CRITERIA FOR TEMPERATURE TRANSMITTERS

Transmitter shall be enclosed in gasketed dust-tight and moisture-proof case, unless otherwise specified on the data sheet.

Transmitter shall be compensated for ambient temperature limits of -20°F to +150°F.

Accuracy and repeatability shall be within 0.5% of span.

Transmitter shall be equipped with a universal bracket for 2" pipe mounting.

Transmitters with thermocouple inputs shall have automatic reference junction temperature compensation.

Span and zero shall be field adjustable.

When specified, vendor shall furnish a filter-regulator complete with gage. The air set shall be pre-piped to the unit and set at pressure as indicated on data sheet.

The transmitter shall be complete with direct reading, integral indicator when specified.

The unit shall be identified by a metal tag attached with corrosion resistance wire, and stamped with the tag number as indicated on the data sheet.

(ENG-050-0278)

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT DATA SHEET Mv/I TRANSMITTER		SP- 8236 REVISION PAGE 1 OF 2	
ORIGINAL	BY LMW	DATE 8-7-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO HOYT LAKES, MN.			PROJECT NO. 3001 ΦI	

TAG NO.	SEE NOTE #1	SEE NOTE #2	SEE NOTE #3
REVISION			
QUANTITY	5	5	3
MANUFACTURER *			
MODEL NO. *			
SERVICE	BLAST TO GASIFIER TEMP.	DUST CYCLONE OUTLET TEMP	GAS COOLERS OUTLET TEMP
INPUT - TYPE	THERMOCOUPLE	→	→
- Mv RANGE	FOR TYPE "J" T/C	→	→
- PROCESS RANGE	0-250°F	0-500°F	0-200°F
OUTPUT - TYPE	CURRENT	→	→
- RANGE	4-20 MA. DC	→	→
- BURNOUT	UP SCALE	→	→
MOUNTING	2" PIPE	→	→
SUPPLY	12.5 TO 50 V. DC.	→	→
AREA CLASS	CLASS I GR. D DIV. 2	→	→
HOUSING	EXPLOSIONPROOF	→	→

NOTE #1) TT-21110, TT-21210, TT-21310, TT-21410, TT-21510
#2) TT-21114, TT-21214, TT-21314, TT-21414, TT-21514
#3) TT-21711, TT-21721, TT-21731

*BY BIDDER

LOCATION	FIELD	FIELD	FIELD

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT DATA SHEET Mv/I TRANSMITTER	SP. 8236 REVISION PAGE 2 OF 2	
ORIGINAL	BY LMW	DATE 8-8-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 3001ϕI	

TAG NO.	TT-21740	TT-21741	SEE NOTE #1
REVISION			
QUANTITY	1	1	10
MANUFACTURER *			
MODEL NO. *			
SERVICE	MIXED GAS TO COOLERS	MIXED GAS OUT OF COOLERS	GASIFIER BED TEMP
INPUT - TYPE	THERMOCOUPLE	→	→
- Mv RANGE	FOR TYPE "J" T/C	→	12.57 – 12.65 mV
- PROCESS RANGE	0 – 500 °F	0 – 200 °F	450 – 550 °F
OUTPUT - TYPE	CURRENT	→	→
- RANGE	4-20 MA. DC.	→	→
- BURNOUT	UP SCALE	→	→
MOUNTING	2" PIPE	→	→
SUPPLY	12.5 TO 50 V. DC	→	→
AREA CLASS	CLASS I GR. D DIV. 2	→	→
HOUSING	EXPLOSIONPROOF	→	→

NOTE #1) TAG NO. TT-21124A, TT-21224A, TT-21324A, TT-21424A, TT-21524A
TT-21124B TT-21224B TT-21324B TT-21424B TT-21524B

* BY BIDDER

LOCATION	FIELD	→	→

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PRESSURE GAGE SPECIFICATIONS		SP- 8301 REVISION PAGE 1 OF 2	
ORIGINAL	BY R MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.			PROJECT NO. 3001ΦI	

1.0 SCOPE

This specification defines the physical and preformance requirements for pressure gages as further defined in the attached data sheets. The documentation required for this equipment is also defined.

2.0 EQUIPMENT DESCRIPTION

2.1 Pressure Gages shall be manufacturers' standard complying with this specification and the accompanying Date Sheet.

2.2 Surface and local mounted gages shall be weathertight and dustproof.

2.3 All gages with ranges above 20 PSIG shall be furnished with solid front and blow-out back.

2.4 Gage window shall be clear and shatterproof.

2.5 Gage indicator movement shall be rotary geared, insensitive to normal vibration, pressure pulsations and ambient temperature fluctuations.

2.6 Movement zero calibration shall be adjustable from front of case without removal of point.

2.7 Movement range calibration shall be adjustable without the use of special tools or parts.

2.8 Gage shall be accurate to within 1/2 of 1% of the full scale span.

2.9 Gage accuracy and zero calibration shall be unaffected by pressures to 150 percent of maximum calibrated range.

2.10 Scale shall have uniform indications over the range of the gage, unless otherwise specified on the accompanying Date Sheet.

2.11 Process connection shall be an integral part of the measuring element-mounting block.

2.12 Process connections shall extend from the case and be equipped with wrench flats.

2.13 Each gage shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model and serial number and the instrument tag number as shown on the data sheet.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

3.2 Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	PRESSURE GAGE DATA SHEET	SP- 8301 REVISION PAGE 1 OF 4

ORIGINAL	BY R. MOYTA	DATE 7-31-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. PROJECT NO. 30010I

1. Type: Direct Rdg [X] 3-15 lb Receiver ☐
   Other
2. Mounting: Surface ☐ Local [X] Flush ☐
3. Dial: Diameter 4 1/2" Color BLACK ON WHITE
4. Case: Cast Iron ☐ Aluminum [X] Phenol ☐
   Other
5. Ring: Screwed [X] Hinged ☐ Slip ☐ Std ☐
   Other
6. Blow-out Protection None ☐ Back [X] Disc ☐
   Solid Front ☐ Other
7. Lens: Glass [X] Plastic ☐
8. Options: Sylphon [X] Material STEEL
   Snubber ☐
   Pressure Limit Valve ☐
   Movement Damping ☐
9. Nominal Accuracy Required ± 1 % OF SCALE

*10. MFR. & Model No.
11. Press. Element: Bourdon [X] Bellows ☐
    Other
12. Element Mtl: Bronze [X] Steel ☐ SS
    Other
13. Socket Mtl: Bronze [X] Steel ☐ SS
    Other
14. Connection NPT: ¼ in. ☐ ½ in. [X] Other
    Bottom [X] Back ☐
15. Movement: Bronze ☐ SS [X] Nylon ☐
    Other
16. Diaphragm Seal
    MFG. Type
    Wetted Part Mtl. Other Mtl.
    Fill Fluid
    Process Conn. Gage Conn.

Rev.	Quan.	Tag No.	Range	Operating Pressure	Service
	1	PI-21105	0-30	25 PSI	D 201 A STEAM DRUM
	1	PI-21205	↓	↓	B
	1	PI-21305	↓	↓	C
	1	PI-21405	↓	↓	D
	1	PI-21505	↓	↓	E
	1	PI-21109	↓	↓	STEAM TO EDUCTOR
	1	PI-21209	↓	↓	↓
	1	PI-21309	↓	↓	↓
	1	PI-21409	↓	↓	↓
	1	PI-21509	↓	↓	↓
Δ	1	PI-21110	0-80"	60" H_2O	LOW PRESS STEAM TO GASIFIER
Δ	1	PI-21210	↓	↓	↓
Δ	1	PI-21310	↓	↓	↓
Δ	1	PI-21410	↓	↓	↓
Δ	1	PI-21510	↓	↓	↓
	~~1~~	~~PI-21118~~	0-30	25 PSI	BALANCE STEAM
	~~1~~	~~PI-21218~~	↓	↓	↓
	~~1~~	~~PI-21318~~	↓	↓	↓
	~~1~~	~~PI-21418~~	↓	↓	↓
	~~1~~	~~PI-21518~~	↓	↓	↓
	1	PI-21119	0-160	125 PSI	PURGE STEAM (UPPER)
	1	PI-21219	↓	↓	↓
	1	PI-21319	↓	↓	↓
	1	PI-21419	↓	↓	↓
	1	PI-21519	↓	↓	↓

Notes:

Δ SIPHON NOT REQ'D

* BY BIDDER

ENG-050-0275

Per ISA S20.41a

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PRESSURE GAGE DATA SHEET			SP- 8301 REVISION PAGE 2 OF 4
ORIGINAL	BY R. MOYTA	DATE 7-31-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 30010I

1. Type: Direct Rdg ☒ 3-15 lb Receiver ☐
   Other
2. Mounting: Surface ☐ Local ☒ Flush ☐
3. Dial: Diameter 4 1/2" Color BLACK ON WHITE
4. Case: Cast Iron ☐ Aluminum ☒ Phenol ☐
   Other
5. Ring: Screwed ☒ Hinged ☐ Slip ☐ Std ☐
   Other
6. Blow-out Protection None ☐ Back ☒ Disc ☐
   Solid Front ☐ Other
7. Lens: Glass ☒ Plastic ☐
8. Options: Syphon ☒ Material STEEL
   Snubber ☐
   Pressure Limit Valve ☐
   Movement Damping ☐
9. Nominal Accuracy Required ± 1 % OF SCALE

* 10. MFR. & Model No.
11. Press. Element: Bourdon ☒ Bellows ☐
    Other
12. Element Mtl: Bronze ☒ Steel ☐ ____ SS
    Other
13. Socket Mtl: Bronze ☒ Steel ☐ ____ SS
    Other
14. Connection-NPT: ¼ in. ☐ ½ in. ☒ Other
    Bottom ☒ Back ☐
15. Movement: Bronze ☐ SS ☒ Nylon ☐
    Other
16. Diaphragm Seal
    MFG. Type
    Wetted Part Mtl. Other Mtl.
    Fill Fluid
    Process Conn. Gage Conn.

Rev. Quan.	Tag No.	Range	Operating Pressure	Service
1	PI-21120	0-160	125 PSI	PURGE STEAM (LOWER)
1	PI-21220	↓	↓	↓
1	PI-21320	↓	↓	↓
1	PI-21420	↓	↓	↓
1	PI-21520	↓	↓	↓
1	PI-21806	0-160	125 PSI	D 202 STEAM DRUM

Notes

* BY BIDDER

ENG-050-2275

Per ISA S20.41a

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PRESSURE GAGE DATA SHEET	SP- 8301 REVISION PAGE 3 OF. 4

ORIGINAL	BY R. MOYTA	DATE 7-31-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. PROJECT NO. 30010I

1. Type: Direct Rdg ☒ 3-15 lb Receiver ☐
 Other
2. Mounting: Surface ☐ Local ☒ Flush ☐
3. Dial: Diameter 4 1/2" Color BLACK ON WHITE
4. Case: Cast Iron ☐ Aluminum ☒ Phenol ☐
 Other
5. Ring: Screwed ☒ Hinged ☐ Slip ☐ Std ☐
 Other
6. Blow-out Protection None ☐ Back ☒ Disc ☐
 Solid Front ☐ Other
7. Lens: Glass ☒ Plastic ☐
8. Options: Sylphon ☐ Material
 Snubber ☐
 Pressure Limit Valve ☐
 Movement Damping ☐
9. Nominal Accuracy Required ± 1 % OF SCALE

*10. MFR. & Model No.
11. Press. Element: Bourdon ☒ Bellows ☐
 Other
12. Element Mtl: Bronze ☒ Steel ☐ SS
 Other
13. Socket Mtl: Bronze ☒ Steel ☐ SS
 Other
14. Connection-NPT: ¼ in. ☐ ½ in. ☒ Other
 Bottom ☒ Back ☐
15. Movement: Bronze ☐ SS ☒ Nylon ☐
 Other
16. Diaphragm Seal
 MFG. Type
 Wetted Part Mtl. Other Mtl.
 Fill Fluid
 Process Conn. Gage Conn.

Rev. Quan.	Tag No.	Range	Operating Pressure	Service
1	PI-21841			INERT GAS TO TAR PRECIPITATORS
1	PI-21703	0-60"	40"	COMBINED GAS TO PRECIPITATORS
1	PI-21800	0-80"	60"	COMBUSTION AIR
1	PI-21801			PILOT GAS TO FLARE STACK
1	PI-21809			COOLING WATER TO GAS COOLERS
1	PI-21810	0-80"	60"	COMBUSTION AIR BLOWER B-201 A
1	PI-21820	0-80"	60"	↓ B-201 B
1	PI-21830	0-80"	60"	↓ B-201 C
1	PI-21840			INERT GAS TO OIL PRECIPITATORS
1	PI-21112	0-60"	45"	CLEAR GAS TO CYCLONE
1	PI-21212	↓	↓	↓
1	PI-21312	↓	↓	↓
1	PI-21412	↓	↓	↓
1	PI-21512	↓	↓	↓

Notes:

* BY BIDDER

ENG-050-0275

Per ISA S20.41a

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PRESSURE GAGE DATA SHEET	SP- 8301 REVISION PAGE 4 OF 4

ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. PROJECT NO. 3001ΦI

1. Type: Direct Rdg ☒ 3-15 lb Receiver ☐ Other
2. Mounting: Surface ☐ Local ☒ Flush ☐
3. Dial: Diameter 4 1/2 Color BLACK ON WHITE
4. Case: Cast Iron ☐ Aluminum ☒ Phenol ☐ Other
5. Ring: Screwed ☒ Hinged ☐ Slip ☐ Std ☐ Other
6. Blow-out Protection None ☐ Back ☒ Disc ☐ Solid Front ☐ Other
7. Lens: Glass ☒ Plastic ☐
8. Options: Sylphon ☐ Material; Snubber ☐; Pressure Limit Valve ☐; Movement Damping ☐
9. Nominal Accuracy Required ± 1% OF SCALE

* 10. MFR. & Model No.
11. Press. Element: Bourdon ☒ Bellows ☐ Other
12. Element Mtl: Bronze ☒ Steel ☐ SS Other
13. Socket Mtl: Bronze ☒ Steel ☐ SS Other
14. Connection-NPT: ¼ in. ☐ ½ in. ☒ Other; Bottom ☒ Back ☐
15. Movement: Bronze ☐ SS ☒ Nylon ☐ Other
16. Diaphragm Seal: MFG. Type; Wetted Part Mtl. SS Other Mtl.; Fill Fluid GLYCERINE; Process Conn. 1/2" Gage Conn. 1/2"

Rev.	Quan.	Tag No.	Range	Operating Pressure	Service
	1	PI-21706	0-30PSI	25PSI	TAR/OIL TRANSFER PUMP
	1	PI-21707	0-30PSI	25PSI	↓
	1	PI-21701	0-50"	30"	TOP GAS HEADER
	1	PI-21113	0-50"	30"	TOP GAS TO CYCLONE
	1	PI-21213	↓	↓	↓
	1	PI-21313	↓	↓	↓
	1	PI-21413	↓	↓	↓
	1	PI-21513	↓	↓	↓

Notes:

* BY BIDDER

(ENG-C50-C278)

Per ISA S20.41a

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	PRESSURE TRANSMITTER SPECIFICATION		SP- 8311 REVISION PAGE 1 OF 2	
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.			PROJECT NO 3001ϕI	

1.0 SCOPE

This specification shall define the physical and performance characteristics of field mounted, electric or pneumatic output, force balance type pressure transmitters as further described in the attached data sheets. The required documentation for this equipment is also defined.

2.0 EQUIPMENT DESCRIPTION

2.1 Transmitter shall be enclosed in gasketed dust-tight and moisture-proof case, unless otherwise specified on the data sheet.

2.2 Pressure transmitter shall be complete with integral direct reading indicator or an output meter, when specified.

2.3 Accuracy and repeatability shall be within 0.5% of span.

2.4 Overrange protection shall be provided so that neither accuracy nor zero calibration will be affected by a pressure of 150% of scale span.

2.5 Chemical seals shall be provided only when specified on the data sheets.

2.6 Transmitter shall be equipped with a universal bracket for 2" pipe mounting.

2.7 When specified, vendor shall furnish a filter-regulator complete with gage. The air set shall be pre-piped to the unit and set at pressure as indicated on data sheet.

2.8 Each transmitter shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model and serial number, and the instrument tag number. The instrument tag number shall be as shown on the data sheet.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (Schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

3.2 Each document shall be marked with the following indentifying date:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	PRESSURE TRANSMITTER DATA SHEET	SP- 8311 REVISION PAGE 1 OF 2

ORIGINAL	BY R. MOYTA	DATE 8-2-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. PROJECT NO. 3001ϕI

TAG NO.	#1 BELOW	#2 BELOW	PT-21710
REVISION			
QUANTITY	5	5	1
MANUFACTURER *			
*			
MODEL NO.			
SERVICE	D201 A THRU E STEAM DRUM	BLAST FROM EDUCTOR	COMBINED GAS TO BAT. LIMITS
PROCESS FLUID	STEAM	STEAM & AIR	COOL GAS
FLUID - PRESSURE - MAX.			
- - OPER.	25 PSI	60" H_2O	20" H_2O
- TEMPERATURE	267°F	147°F	95°F
ELEMENT - TYPE *			
- MATERIAL *			
- RANGE LIMITS	15-60 PSI	25"-100" WC	7.5-30" WC
- CALIBRATION	15-60 PSI	25"-100" WC	7.5-30" WC
BODY - MATERIAL	C. STEEL	→	→
- RATING	150#	→	→
- CONNECTION	1/2" NPT	→	→
OUTPUT SIGNAL	4-20 MA	→	→
SUPPLY	24 VDC	→	→
AREA CLASS	CLASS I DIV II GROUP D	→	→
MOUNTING	2" PIPE BRKT	→	→

#1) PT-21106, PT-21206, PT-21306, PT-21406, PT-21506

#2) PT-21110, PT-21210, PT-21310, PT-21410, PT-21510

* BY BIDDER

LOCATION	FIELD	→	→

ENG-550 (2/74)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PRESSURE TRANSMITTER DATA SHEET	SP- 8311 REVISION PAGE 2 OF 2

ORIGINAL	BY R. MOYTA	DATE 8-2-78	APPD.		DATE		
REVISION	BY	DATE	APPD.		DATE		
CLIENT: ERIE MINING CO.					PROJECT NO. 3001ϕI		

TAG NO.	PT-21800	PT-21806	
REVISION			
QUANTITY	1	1	
MANUFACTURER *			
MODEL NO. *			
SERVICE	COMBUSTION AIR BLOWERS	D202 H.P. STEAM DRUM	
PROCESS FLUID	AIR	STEAM	
FLUID - PRESSURE - MAX.			
- ↓ - OPER.	60" H_2O	125 PSI	
↓ - TEMPERATURE	100 °F	352 °F	
ELEMENT - TYPE *			
- MATERIAL *			
- RANGE LIMITS	25"-100"WC	75-300 PSI	
↓ - CALIBRATION	25"-100"WC	75-300 PSI	
BODY - MATERIAL	C. STEEL	→	
- RATING	150#	→	
↓ - CONNECTION	1/2" NPT	→	
OUTPUT SIGNAL	4-20MA	→	
SUPPLY	24VDC	→	
AREA CLASS	CLASS I DIV II GROUP D	→	
MOUNTING	2" PIPE BRKT	→	

* BY BIDDER

LOCATION	FIELD	→	

(ENG-150 0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	DIFFERENTIAL PRESSURE TRANSMITTER SPECIFICATION			SP- 8312 REVISION PAGE 1 OF 2	
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.		DATE
REVISION	BY	DATE	APPD.		DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.				PROJECT NO. 3001ΦI	

1.0 SCOPE

This specification defines the physical and perform characteristics of differential pressure transmitters as further described in the attached data sheets. This specification shall include both electronic and pneumatic type transmitters. Documentation required with this equipment is also defined.

2.0 EQUIPMENT DESCRIPTION

2.1 Differential pressure transmitters shall preferably be force balance type.

2.2 Transmitter shall be enclosed in gasketed dust-tight and moisture-proof case, unless otherwise specified on the data sheet.

2.3 Body shall be provided with drain ports at bottom and vent ports at top. Both drain and vent ports shall be minimum 1/4" NPT.

2.4 The differential pressure range span shall be adjustable to permit elevation or suppression of a minimum of 50% of range span when specified. This adjustment shall be made within the transmitter housing without a change of parts.

2.5 Process connections shall be 1/2" NPT, minimum.

2.6 Transmitter shall be capable to sustaining differential pressure in either direction, up to body rating, without damage to meter, a loss of accuracy, or a zero shift.

2.7 The differential pressure transmitter shall be fully compensated for both process and ambient temperature variations.

2.8 Accuracy and repeatability shall be within 0.5% of range span.

2.9 Transmitter shall be equipped with a universal bracket for 2" pipe mounting.

2.10 Unit shall be available with adjustable dampening, when specified.

2.11 Transmitter shall be complete with an output meter, when specified on the data sheet.

2.12 When specified, vendor shall furnish a filter-regulator complete with gage. The air set shall be pre-piped to the unit and set at pressure as indicated on data sheet.

ENG-053-0272

2.13 Each transmitter shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model and serial number, and the instrument tag number. The instrument tag number shall be as shown on the data sheet.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

3.2 Each document shall be marked with the following indentifying data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options.)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	DIFFERENTIAL PRESSURE TRANSMITTER DATA SHEET			SP- 8312 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MOYTA	DATE 8-2-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO				PROJECT NO. 30010I

TAG NO.	#1 BELOW	#2 BELOW	#3 BELOW
REVISION			
QUANTITY	5	5	5
MANUFACTURER *			
MODEL NO. *			
SERVICE	STEAM FROM STEAM DRUM	STEAM TO EDUCTOR	AIR TO EDUCTOR
PROCESS FLUID	STEAM	STEAM	AIR
FLUID - PRESSURE	25 PSI	→	60" H2O
- TEMPERATURE	267 °F	→	100 °F
ELEMENT - TYPE	DIAPHRAGM	→	→
- MATERIAL	316 SS.	→	→
- RANGE LIMITS	0 - 30" WC	→	→
- CALIBRATION			
BODY - MATERIAL	C. STEEL	→	→
- CONNECTION	1/2" NPT	→	→
- RATING	125 #	→	→
OUTPUT SIGNAL	4-20 MA	→	→
SUPPLY	24 VDC	→	→
AREA CLASS	CLASS I GROUP D DIV II	→	→
MOUNTING	2" PIPE BRKT	→	→
3 VALVE MANIFOLD	REQ'D	→	→

#1) FT-21108, FT-21208, FT-21308, FT-21408, FT-21508
#2) FT-21109, FT-21209, FT-21309, FT-21409, FT-21509
#3) FT-21111, FT-21211, FT-21311, FT-21411, FT-21511

* BY BIDDER

LOCATION	FIELD	→	→

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	PRESSURE SWITCH SPECIFICATION		SP- 8331 REVISION PAGE 1 OF 2	
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.			PROJECT NO. 300 1ϕI	

1.0 SCOPE

This specification defines the physical and performance characteristics of pressure actuated switches for process and pneumatic line applications as further described in the attached data sheets. Documentation required with this equipment is also defined.

2.0 EQUIPMENT DESCRIPTION

2.1 The case shall be manufacturer's standard, complete with process and electrical connections.

2.2 Case housing shall be weather proof unless otherwise indicated on the data sheet.

2.3 Pressure setting shall be conveniently adjustable over full range.

2.4 Pressure setting shall be indicated on a calibrated scale.

2.5 Switch shall be snap action type unless otherwise specified and rated for a minimum of five (5) amp at 120 V.A.C., 60 Hz inductive load.

2.6 Switch operation shall not be affected by vibration.

2.7 Neither accuracy nor calibration shall be affected by a momentary over pressure of 120% of range.

2.8 Each switch shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model and serial number, and the instrument tag number. The instrument tag number shall be as shown on the data sheet.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and Interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation.

(ENG-050-0278)

3.2 Each document shall be marked with the following indentifying data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	PRESSURE SWITCH DATA SHEET	SP- 8331 REVISION PAGE 1 OF 1

ORIGINAL	BY LMW	DATE 8-4-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. PROJECT NO. 3001 Φ I

TAG NO.	SEE NOTE #1		
REVISION			
QUANTITY	3		
MANUFACTURER *			
*			
MODEL NO.			
	COMBUSTION AIR		
SERVICE	BLOWER DISCH		
PROCESS FLUID	AIR		
FLUID - PRESS - OPER/MAX.	80" WC		
- TEMP. - MAX.	100°F		
ELEMENT - TYPE	DIAPHRAM		
- MATERIAL	BUNA N		
- RANGE LIMITS	0-80" W.C.		
CONNECTION - SIZE & TYPE	1/4" NPT		
- LOCATION	BOTTOM		
SWITCH - TYPE	SNAP		
- CONTACT FORM	SPDT		
- RATING	5 AMP @115AC		
N.E.C. AREA CLASS	CLASS I GRD DIV II		
ENCLOSURE	EXPLOSIONPROOF		
SETTING - TYPE	EXTERNAL		
- SET POINT	ADJUSTABLE		
- DIFFERENTIAL	MIN.		

NOTE #1) TAG No PS-21810, PS-21820, PS-21830

* BY BIDDER

LOCATION	FIELD		

ENG-050-(27M)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	LIQUID LEVEL GAGE GLASS SPECIFICATION		SP- 8400 REVISION PAGE 1 OF 1	
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 30010I	

DESIGN CRITERIA FOR LIQUID LEVEL GAUGE GLASS

The Liquid Level Gauge Glass shall be the manufacturer's standard assembly conforming to this Specification and the accompanying data sheet.

The Gauge Glass shall be high quality Pyrex Tubing suitable for the working conditions specified on the data sheet.

Valves shall be furnished for top and bottom shut off and shall have vent and drain connections for cleaning the glass.

The unit shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's Name, Model and Serial Number, and the Instrument Tag Number. The instrument tag number shall be as shown on the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Operation and Installation Manuals
D. Maintenance Manual & Parts List
E. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from data sheet)
E. Exact Instrument Identification as furnished (i.e., detailed model number or list of furnished options).

ENG-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT DATA SHEET LIQUID LEVEL GAUGE GLASS		SP- 8400 REVISION PAGE 1 OF 1
ORIGINAL	BY LMW	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 3001ϕI

TAG NO.	SEE NOTE #1	LG-21805 LG-21808	
REVISION			
QUANTITY	10	2	
MANUFACTURER *			
MODEL NO. *			
SERVICE	LOW PRESSURE BOILER	HIGH PRESS. BOILER	
PROCESS FLUID	WATER/STEAM	→	
PRESSURE	25 PSIG	125 PSIG	
TEMPERATURE	270°F	355°F	
SPECIFIC GRAVITY	—	—	
GAUGE-TYPE	BRONZE	→	
-MOUNTING LENGTH	18"	18"	
-VISIBLE LENGTH *			
-VISIBLE WIDTH	5/8"	5/8"	
-RATING	125 PSIG	200 PSIG	
VALVE- TYPE	OFFSET	→	
- CONNECTION	1/2" NPT	→	
- VENT/DRAIN	3/8" DRAIN WITH VENT	→	

*INFO. BY BIDDER

NOTE NO. 1) FOR TAG NO. LG-21105 LG-21205 LG-21305 LG-21405 LG-21505
LG-21106 LG-21206 LG-21306 LG-21406 LG-21506

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	ROTAMETER SPECIFICATION		SP- 8405 REVISION PAGE 1 OF 1	
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 30010I	

DESIGN CRITERIA FOR ROTAMETERS

Rotameter shall be complete, direct reading device with glass or plastic metering tube, as specified in data sheet.

Rotameter assemblies shall be direct mounting unless otherwise specified in data sheet.

Accuracy shall be $\pm 2\%$ full scale.

Rotameter shall be furnished with direct reading scales, etched directly on the tube, referred to standard conditions of temperature and pressure.

Rotameter body shall be constructed as to relieve the glass tube of any piping stress.

A calibrating curve should be supplied with each rotameter.

The unit shall be identified by a metal tag attached with corrosion resistance wire.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Operation and Installation Manuals
D. Maintenance Manual & Parts List
E. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from data sheet)
E. Exact Instrument Identification as furnished (i.e., detailed model number or list of furnished options).

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	INSTRUMENT DATA SHT. ROTAMETERS		SP. 8405 REVISION PAGE 1 OF 2	
ORIGINAL	BY R. MOYTA	DATE 8-3-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO			PROJECT NO. 30010I	

TAG NO.	#1 BELOW	#2 BELOW	#3 BELOW
REVISION			
QUANTITY	5	5	3
MANUFACTURER			
MODEL NO.			
SERVICE	I.G. TO GASIFIER LOCK HOPPER	I.G. TO FLARE STACK	I.G. TO TAR PRECIPITATOR
FLUID - TEMP. - OPER.	125 °F	→	→
FLUID - PRESS. - OPER./MAX.	100 PSIG	→	→
FLUID - SP. GR. @ F.T.	1.08 @ F.T.	→	→
FLUID - VISCOSITY cs @ F.T.			
FLOW RATE - OPER./MAX.			
SCALE LENGTH	5"	→	→
LINE SIZE	1" NPT	→	2" NPT
METER SIZE			
METER CONN. SIZE	1" NPT	→	2" NPT
METER CONN. BOT. LOC.			
METER CONN. TOP LOC.			
MATERIAL TUBE	GLASS	→	→
MATERIAL FLOAT			
MATERIAL END FITTINGS			
SCALE CALIBRATION			
PRESS RATING			
MOUNTING	IN-LINE	→	→
TUBE MODEL NO.			
FLOAT MODEL NO.			

#1) FI-21117, FI-21217, FI-21317, FI-21417, FI-21517
#2) FI-21132, FI-21232, FI-21332, FI-21432, FI-21532
#3) FI-21812, FI-21822, FI-21832

* BY BIDDER

LOCATION	FIELD	→	→

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	INSTRUMENT DATA SHT. ROTAMETERS			SP- 8405 REVISION PAGE 2 OF 2
ORIGINAL	BY R. MOYTA	DATE 8-4-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT:				PROJECT NO. 3001ΦI

TAG NO.	#1 BELOW		
REVISION			
QUANTITY	3		
MANUFACTURER *			
MODEL NO. *			
SERVICE	I.G. TO OIL PRECIPITATOR		
FLUID - TEMP. - OPER.	125°F		
FLUID - PRESS. - OPER./MAX.	100 PSIG		
FLUID - SP. GR. @ F.T.	1.08 @ F.T.		
FLUID - VISCOSITY cs @ F.T.			
FLOW RATE - OPER./MAX.			
SCALE LENGTH	5"		
LINE SIZE	2" NPT		
METER SIZE			
METER CONN. SIZE	2" NPT		
METER CONN. BOT. LOC.			
METER CONN. TOP LOC.			
MATERIAL TUBE	GLASS		
MATERIAL FLOAT			
MATERIAL END FITTINGS			
SCALE CALIBRATION			
PRESS RATING			
MOUNTING	IN LINE		
TUBE MODEL NO.			
FLOAT MODEL NO.			

1) FI-21814, FI-21824, FI-21834

* BY BIDDER

LOCATION	FIELD		

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	ORIFICE PLATE SPECIFICATION	SP- 8420 REVISION PAGE 1 OF 1	
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.			PROJECT NO. 30010I

1.0 SCOPE

This specification defines the physical and performance characteristics of orifice plates for fluid flow metering applications, further specified in the attached data sheets. Documentation required with these orifice plates is also defined.

2.0 EQUIPMENT DESCRIPTION

2.1 Orifice Plate shall be, unless otherwise specified on Data Sheet, paddle type, concentric, flat plat, sharp edge per ISA-RP 3.2 or latest revision.

2.2 Orifice calculation shall be provided by Orifice Plate supplier. The specific orifice calculation for each orifice shall be supplied within two weeks of order placement.

2.3 The calculation shall include and indicate correction factors for: thermal expansion of plate, flowing fluid viscosity, and compressibility. It shall determine and indicate the exact beta ratio, orifice bore, upstream and downstream tap location, plate thickness, bore diameter, drain or vent hole diameter.

2.4 In addition to the "Identifying Information" specified in paragraph 7 of ISA-RP 3.2; the "Tag Number", shown on the Data Sheet, shall be permanently marked on the inlet face of the handle in a position outside the diameter of the flange.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Orifice Calculation

3.2 Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished
   (i.e. detailed model number or list of furnished options)

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	RESTRICTING ORIFICE PLATE DATA SHEET		SP- 8420 REVISION PAGE 1 OF 1	
ORIGINAL	BY R MOYTA	DATE 8-3-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING			PROJECT NO. 3001ΦI	

TAG NO.	#1 BELOW		
REVISION			
QUANTITY	5		
MANUFACTURER *			
* MODEL NO.			
SERVICE	BY PASS TO EDUCTOR		
PROCESS FLUID	SAT. STEAM		
FLUID TEMPERATURE	267°F		
PRESSURE	25 PSI		
SPECIFIC GRAVITY	1.25		
VISCOSITY			
SUPERHEAT			
BASE TEMP./PRESS.	60°F / 14.7 PSIA		
FLOW RATE - OPERATING	700#/HR		
- SIZING			
METER DIFFERENTIAL (DRY)	100" WC		
LINE - SIZE/SCHEDULE	2" / 40		
- I.D.	2.067		
TAPS - UP/DOWN	—		
- ORIENTATION	—		
VENT/DRAIN	NOT REQ'D		
FLANGE - SIZE/RATING	2" / 150#		
- FACE	R.F.		
PLATE - MATERIAL	316 SS		
- BETA RATIO *			
- BORE *			

#1) RO-21109, RO-21209, RO-21309, RO-21409, RO-21509

* BY BIDDER

LOCATION	FIELD		

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	ANNUBAR SPECIFICATION			SP- 8424 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ΦI

DESIGN CRITERIA FOR ANNUBARS

This primary flow rate sensing element shall be a combined reverse pitot tube design based on the Manufacturer's standard design.

The output of this flow element shall be a differential pressure proportional to average flow velocity squared.

When installed with the straight run requirement specified on the data sheets, accuracy shall be ±1.5% or better.

A calculation report confirming maximum flow rate differential pressure shall be furnished, based on data sheet specified conditions.

The unit shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model and serial number, and the instrument tag number. The instrument tag number shall be as shown on the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Operation and Installation Manuals
D. Maintenance Manual & Parts List
E. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from data sheet)
E. Exact Instrument Identification as furnished (i.e., detailed model number or list of furnished options).

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	ANNUBAR DATA SHEET	SP. 8424 REVISION PAGE 1 OF 1

ORIGINAL	BY LMW	DATE 8-9-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. HOYT LAKES, MN. PROJECT NO. 3001ΦI

TAG NO.	SEE NOTE #1	SEE NOTE #2	SEE NOTE #3
REVISION			
QUANTITY	5	5	5
MANUFACTURER *			
*			
MODEL NO.			
SERVICE	STEAM FLOW FROM L.P. BOILER	STEAM FLOW TO EDUCTOR	COMBUSTION AIR TO EDUCTOR
PROCESS FLUID	SAT. STEAM	→	AIR
FLUID TEMP	267°F	→	80°F
PRESS	25 PSIG	→	80" W.C.
SP. GRAVITY @ OPER COND	1.29	→	
VISCOSITY	—	—	—
SUPERHEAT	—	—	—
BASE TEMP./PRESS.	—	—	60°F | 14.7 PSIA
FLOW RATE - OPER.	2640 LB/HR	2600 LB/HR	4200 SCFM
- SIZING	3000 LB/HR	3000 LB/HR	6000 SCFM
METER DIFFERENTIAL (DRY) *			
LINE SIZE / SCHEDULE	6" SCH. 40	6" SCH. 40	14" STD. WT.
LINE I.D.	6.07"	6.07"	
METER MAT'L.	316 ST. ST.	→	316 ST. ST.
COUPLING SIZE/MAT'L. *			
PRESS. CONNECTIONS	1/2" NPT	→	→
HOT TAP FITTINGS	REQ'D	→	NOT REQ'D
STRAIGHT RUN APPROACH			
STRAIGHT RUN DEPART			

NOTE #1) TAG. No. FE-21108, FE-21208, FE-21308, FE-21408, FE-21508

#2) TAG No FE-21109, FE-21209, FE-21309, FE-21409, FE-21509

#3) TAG No. FE-21111, FE-21211, FE-21311, FE-21411, FE-21511

* BY BIDDER

LOCATION	FIELD	→	→

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	LEVEL TRANSMITTER (DISPLACEMENT TYPE) SPECIFICATION			SP-8522 REVISION PAGE 1 OF 1	
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.		DATE
REVISION	BY	DATE	APPD.		DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ΦI	

DESIGN CRITERIA FOR LEVEL TRANSMITTER (Displacer Type)

Transmitter shall operate on the principle of force sensing on a variable displacement displacer suspended in the liquid to be monitored.

The displacer and fluid shall be completely isolated from the transmitter mechanism by a torque tube or equivalent packless seal.

The output signals shall be standard pneumatic or electronic as specified on the data sheet.

A float chamber shall mount to the vessel with the configuration and connection specified on the data sheets.

The unit shall be furnished with a metal tag fastened with corrosion resistant wire and stamped with the tag number as specified on the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options.)

ENG-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT DATA SHEET LEVEL TRANSMITTER - DISPLACEMENT		SP- 8522 REVISION PAGE 1 OF 1
ORIGINAL	BY R MOYTA	DATE 8-4-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO			PROJECT NO. 3001ΦI

TAC NO.	#1 BELOW		LT-21804		
REVISION					
QUANTITY	5		1		
MANUFACTURER *					
MODEL NO. *					
SERVICE	LOW PRESS. STEAM DRUM		HI PRESS. STEAM DRUM		
UPPER FLUID	STEAM		STEAM		
LOWER FLUID	WATER		WATER		
FLUID - PRESS. MAX/OPER.	/25PSI		/125PSI		
- SP. G. UP/LOW	1.25	1.0	4.0	1.0	
- TEMP. MAX/OPER.		267°F		352°F	
CHAMBER - TYPE	C. STEEL		→		
CONNECTION - TYPE & SIZE	2" NPT		→		
TOP CONNECTION - LOCATION	SIDE		→		
BOTTOM CONNECTION -	END		→		
DISPLACER - DIA/LENGTH *		14"		14"	
- MATERIAL	ST. STEEL		ST. STEEL		
SEAL - TYPE *					
- MATERIAL *					
OUTPUT	4-20MA		→		
SUPPLY	24VDC		→		

#1) LT-21104, LT-21204, LT-21304, LT-21404, LT-21504

* BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	LEVEL TRANSMITTER (CAPACITANCE TYPE) SPECIFICATION			SP- 8527 REVISION PAGE 1 OF 2
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 30010I

DESIGN CRITERIA FOR LEVEL TRANSMITTER - CAPACITANCE TYPE

Level Transmitter - Capacitance Type shall be manufacturer's standard assembly complying with this specification and the accompanying data sheet.

The transmitter shall measure the level of the process media by sensing the capacitave coupling between a sensing probe and an adjacent grounded surface.

The transmitter output shall be continuous of the type and range shown on the data sheet. The magnitude of the output shall vary in direct proportion to the measured level.

The transmitter shall be complete with sensing element, interconnecting cable, connectors and suitable enclosure.

The transmitter shall be suitable for service in industrial plant and outdoor environment with temperature range of -20 to 150^{o} F.

Each transmitter shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model and serial number, and the instrument tag number. The instrument tag number shall be as shown on the data sheet.

(ENG-050-278)

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options)

-052-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT DATA SHEET LEVEL TRANSMITTER - CAPACITANCE TYPE	SP- 8527 REVISION PAGE 1 OF 1		
ORIGINAL	BY R. MOYTA	DATE 8-4-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO			PROJECT NO. 30014I	

TAG NO.	#1 BELOW	LIT-21707	
REVISION			
QUANTITY	5	1	
MANUFACTURER *			
MODEL NO. *			
SERVICE	COAL FEED	TN 202 TAR/OIL TANK	
PROCESS FLUID	COAL	TAR/OIL	
FLUID - PRESS/TEMP.	80" W.C. / 1200°F	0/250°F	
- VISCOSITY	—	—	
ELEMENT - TYPE	ROD	→	
- MATERIAL	316 ST. ST.	→	
- SHIELD *			
- DIA. & LENGTH	1/2" / 8 FT.	1/2" /	
- CONNECTION	6" FLANGE	→	
TRANSMITTER	INDICATING WITH 4 SWITCHES		
OUTPUT	4-20 MA	4-20 MA	
FLOW RANGE - MIN/MAX	—	—	
WATER LEVEL - MIN/MAX	—	—	
LOCATION	VESSEL TOP	→	
POWER SUPPLY	24VDC	24VDC	
CABLE LENGTH (HEAD-TRANSM.)	Later	Later	
INDICATIOR	REQ'D	→	
N.E.C AREA CLASS	CLASS I DIV II GROUP D	→	
ENCLOSURE	NEMA 4	→	
AMBIENT TEMPERATURE	150 °F	125 °F	

#1) LS-21102, LS-21202, LS-21302, LS-21402, LS-21502

* BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	LEVEL SWITCH (BALL FLOAT TYPE) SPECIFICATION			SP- 8540 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 30010I

DESIGN CRITERIA FOR BALL FLOAT TYPE LEVEL SWITCH

Switch shall detect liquid level via a float movement and linkage which has no physical connection to the switch mechanism. The switches shall be actuated by the sensing system through a sealed chamber.

The switch housing shall be of weather proof construction unless otherwise specified on the data sheets.

Housing shall be designed to allow top, side or exterior cage mounting as specified on the data sheets.

Electrical switch construction shall be an SPDT snap action type and have a minimum rating of five (5) amps at 120 V.A.C., 60 Hz, unless otherwise specified on the data sheet.

The unit shall be identified by a metal tag attached with corrosion resistance wire, and stamped with the tag number as indicated on the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options.)

(ENG-C50-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT DATA SHEET SWITCH - BALL FLOAT	SP- 8540 REVISION PAGE 1 OF 1

ORIGINAL	BY R. MOYTA	DATE 8-4-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 30019I

TAG NO.	#1 BELOW	#2 BELOW	
REVISION			
QUANTITY	3	3	
MANUFACTURER *			
MODEL NO. *			
SERVICE	TAR PRECIPITATOR	OIL PRECIPITATOR	
PROCESS FLUID	TAR	OIL	
FLUID - PRESS/TEMP.	0 / 250°F	0/95°F	
↓ - SPECIFIC GRAVITY	1.01	0.99	
FLOAT - MATERIAL	304 S.S.	→	
↓ - DIAMETER	2.5"	→	
CONNECTION - SIZE & TYPE	2 1/2" NPT	→	
MOUNTING POSITION	SIDE	→	
SHAFT - DIA. & LENGTH *	* / 12"	→	
↓ - MATERIAL	S. STEEL	→	
SEAL - TYPE *		→	
↓ - MATERIAL *		→	
SWITCH - TYPE	MERCURY	→	
- CONTACT FORM	SPDT	→	
↓ - RATING	13 AMP	→	
N.E.C. AREA CLASS	CLASS I DIV II GROUP D	→	
ENCLOSURE	NEMA 4	→	
SETTING - TYPE			
↓ - DIFFERENTIAL			

#1) LS-21712, LS-21722, LS-21732
#2) LS-21713, LS-21723, LS-21733

* BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	LEVEL SWITCH (CAPACITANCE TYPE) SPECIFICATION			SP- 8542 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ϕI

DESIGN CRITERIA FOR CAPACITANCE TYPE LEVEL SWITCH

Switch shall detect level by sensing the change of capacitance between probe and either or both the liquid and tank.

The sensing probe shall not have any moving parts and it shall be constructed of materials satisfactory for the service conditions specified on the data sheets.

The electronics and probe shall be in weather proof housings unless specified otherwise on the data sheets.

Operation shall be satisfactory over the ambient temperature range of -20°F to 160°F.

Electrical switch construction shall be SPDT snap action type. Minimum contact rating shall be five (5) amps at 120 V.A.C., 60 Hz, unless otherwise indicated on the data sheet.

The unit shall be identified by a metal tag attached with corrosion resistance wire, and stamped with the tag number from the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options.)

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT DATA SHEET LEVEL SWITCH - CAPACITANCE TYPE			SP- 8542 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MOYTA	DATE 8-4-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ΦI

TAG NO.	#1 BELOW	#2 BELOW	#3 BELOW
REVISION			
QUANTITY	5	5	5
MANUFACTURER *			
MODEL NO. *			
SERVICE	COAL SURGE HOPPER	DUST CYCLONE	TAR CYCLONE
PROCESS FLUID	COAL	DUST/GAS	TAR/GAS
FLUID - PRESS/TEMP.	0 / 80°F	0 / 1202°F	0 / 250°F
- VISCOSITY	—	—	—
ELEMENT - TYPE	ROD	→	→
- MATERIAL	ST. ST.	→	→
- SHIELD *			
- DIA. & LENGTH	1/2" 5 FT.	1/2" 2 FT.	1/2" 2 FT.
- CONNECTION	FLANGE	→	→
SWITCH - CONTACT FORM	(2) SPDT	(1) SPDT	(1) SPDT
- RATING	5 AMP @ 115VAC	→	→
SETTING - TYPE			
- SET PT/DIFF.	ADJUSTABLE	MIN.	→
ELECTRONICS - LOCATION	IN HEAD	→	→
- POWER	24VDC	→	→
CABLE - TYPE			
- LENGTH	Later		
N.E.C. AREA CLASS	CLASS I DIV II GROUP D	→	→
ENCLOSURE	NEMA 4	→	→

#1) LS-21101, LS-21201, LS-21301, LS-21401, LS-21501
#2) LS-21128, LS-21228, LS-21328, LS-21428, LS-21528
#3) LS-21129, LS-21229, LS-21329, LS-21429, LS-21529

* BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	CONTROL VALVE DIAPHRAGM OPERATED SPECIFICATION			SP- 8610 REVISION PAGE 1 OF 2
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ΦI

DESIGN CRITERIA FOR DIAPHRAGM OPERATED CONTROL VALVES

Control valve shall be manufacturer's standard complying with this specification and accompanying data sheets.

The vendor shall determine required Cv, considering service data on the data sheet and limiting errosion, cavitation, and noise to reasonable values. The vendor shall show the required Cv, the actual full open Cv, design and maximum noise (Db) level of the valve bid in his proposal.

The valve body shall be marked to show direction of flow.

Diaphragm operators shall provide a linear travel versus loading pressure and give a high degree of dynamic stability and frequency response.

When positioners are called for on the data sheets, they shall have convenient adjustments for zero and span. The positioner shall be capable of easy reversibility in the field, preferably with no additional parts required.

When specified on the data sheet, a pre-piped filter regulator shall be furnished.

Vendor shall specify the maximum steady state air consumption of his furnished positioner.

The unit shall be identified by a metal tag attached with corrosion resistance wire, and stamped with the tag number from the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT DATA SHEET CONTROL VALVE - BUTTERFLY	SP- 8610 REVISION 1 PAGE 1 OF 3
ORIGINAL	BY R. MOYTA · DATE 8-7-78 · APPD.	DATE
REVISION 1	BY LMW · DATE 2-19-79 · APPD.	DATE
CLIENT: ERIE MINING CO.		PROJECT NO. 30010I

TAG NO.	#1 BELOW	#2 BELOW	#3 BELOW
REVISION			△1
QUANTITY	5	5	5
MANUFACTURER *			
MODEL NO. *			
SERVICE	COMBUSTION AIR TO EDUCTOR	CLEAR GAS TO COOLER	CLEAR GAS TO FLARE STACK
PROCESS FLUID	AIR	GAS	GAS
FLUID - FLOW-OPERATING	4200 SCFM	4800 SCFM	2400 SCFM
- FLOW-MAX/MIN.	5250 / 0	6000 / 0	3000 / 0
- PRESSURE IN	80" H_2O	45" H_2O	45" H_2O
- ΔP OPER/MAX. *			
- TEMP./VISC.	100°F / —	1202°F / —	1202°F / —
- SPECIFIC GRAVITY	1.0	.02#/FT³ @ 1200°F 45" H_2O	→
LINE SIZE & RATING	14" 150#	30" 125#	16" 125#
BODY - TYPE	WAFER	→	→
- MATERIAL	CARB. ST.	316 ST. ST.	→
- RATING	150 #	125 #	→
- END CONNECTION	150#RF	125# F.F. FLANGE	→
- SIZE	14"	30"	16"
- LINER/SEAT *	— /	— /	— /
- BORE *			
DISC - TYPE	SWING THRU	→	TIGHT SHUT OFF
- MATERIAL	CARB. ST.	316 ST. ST.	→
- LINER/SEAT *	/	NONE /	NONE /
ACTUATOR - TYPE	DIAPHRAGM	→	→
- SIZE/RANGE *	/ 3-15 PSIG	/ 3-15 PSIG	/ 3-15 PSIG
- ACTION/FAIL	ATO / CLOSE 75%	ATC / OPEN	ATO / CLOSE
POSITIONER - MFG/MODEL	NONE / —	NONE / —	NONE / —
- POWER	—	—	—
3-WAY SOL. VALVE △1	—	—	115 VAC, X-PROOF
CV - REQUIRED/ACTUAL *	/	/	/
HAND WHEEL	REQ'D	→	→

#1) FV-21111, FV-21211, FV-21311, FV-21411, FV-21511
#2) TV-21114, TV-21214, TV-21314, TV-21414, TV-21514
#3) FV-21125, FV-21225, FV-21325, FV-21425, FV-21525

*BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT DATA SHEET CONTROL VALVE - BUTTERFLY	SP-8610 REVISION 1 PAGE 2 OF 3

ORIGINAL		BY R MOYTA	DATE 8-7-78	APPD.		DATE	
REVISION	1	BY LMW	DATE 2-19-79	APPD.		DATE	
CLIENT: ERIE MINING CO.				PROJECT NO.	30010I		

	#1 BELOW		#2 BELOW		#3 BELOW	
TAG NO.	#1 BELOW		#2 BELOW		#3 BELOW	
REVISION	△1		△1		△1	
QUANTITY	5		5		5	
MANUFACTURER *						
MODEL NO. *						
SERVICE	TOP GAS TO FLARE STACK		AIR INTAKE TO EDUCTOR		VENT TO ATMOSPHERE	
PROCESS FLUID	TOP GAS		AIR		GAS	
FLUID - FLOW-OPERATING	2700 SCFM		1500 SCFM		2700 SCFM	
- FLOW-MAX/MIN.	3500	0	2000	0	3500	0
- PRESSURE IN	30" H_2O		ATMOS.		45" H_2O	
- ΔP OPER/MAX. *		30" H_2O	-5" H_2O			45" H_2O
- TEMP./VISC.	250°F	—	100°F	—	1202°F	—
- SPECIFIC GRAVITY	.044#/FT^3 @ 250°F 30" H_2O		1.0		.02#/FT^3 @ 1200°F 45" H_2O	
LINE SIZE & RATING	16" 125#		12" 150#		16" 125#	
BODY - TYPE	WAFER		→		→	
- MATERIAL	CARB. ST.		→		316 ST. ST.	
- RATING	125 #		150 #		125 #	
- END CONNECTION	125 # FF		150 # RF		125 # FF	
- SIZE	16"		12"		16"	
- LINER/SEAT *						
- BORE *						
DISC - TYPE	TIGHT SHUT OFF		→		→	
- MATERIAL	CARB ST.		→		316 ST. ST.	
- LINER/SEAT *						
ACTUATOR - TYPE	DIAPHRAGM		→		→	
- SIZE/RANGE		3-15 PSIG		3-15 PSIG		3-15 PSIG
- ACTION/FAIL	ATC	OPEN				
POSITIONER - MFG/MODEL	NONE		NONE		NONE	
- POWER	—		—		—	
3-WAY SOL. VALVE △1	115 VAC, X-PROOF		→		→	
CV - REQUIRED/ACTUAL *						
HAND WHEEL	REQ'D		→		→	

#1) FV-21126, FV-21226, FV-21326, FV-21426, FV-21526
#2) FV-21127, FV-21227, FV-21327, FV-21427, FV-21527
#3) PV-21130, PV-21230, PV-21330, PV-21430, PV-21530

*BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT DATA SHEET CONTROL VALVE - BUTTERFLY	SP- 8610 REVISION PAGE 3 OF 3	
ORIGINAL	BY R. MOYTA	DATE 8-7-78	APPD. / DATE
REVISION	BY	DATE	APPD. / DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 3001 ΦI

TAG NO.	TV-21741	PV-21800	
REVISION			
QUANTITY	1	1	
MANUFACTURER *			
MODEL NO. *			
SERVICE	COOLING WATER TO GAS COOLERS	COMBUSTION AIR TO ATMOS.	
PROCESS FLUID	WATER	AIR	
FLUID - FLOW-OPERATING	4100 GPM	11050 SCFM	
- FLOW-MAX/MIN.	4100 / 0	14000 / 0	
- PRESSURE IN	75 PSI	80" H_2O	
- ΔP OPER/MAX.	/	/ 80" H_2O	
- TEMP./VISC.	75°F / —	100°F / —	
- SPECIFIC GRAVITY	1.0	1.0	
LINE SIZE & RATING	18"/150#	30"/150#	
BODY - TYPE	WAFER	→	
- MATERIAL	CARB. ST	→	
- RATING	150#	→	
- END CONNECTION	RF FLANGE	→	
- SIZE	18"	30"	
- LINER/SEAT *	/	/	
- BORE *			
DISC - TYPE	SWING THRU	→	
- MATERIAL	CARB. ST.	→	
- LINER/SEAT	— / —	— / —	
ACTUATOR - TYPE	DIAPHRAGM	→	
- SIZE/RANGE *	/ 3-15 PSIG	/ 3-15 PSIG	
- ACTION/FAIL			
POSITIONER - MFG/MODEL	NONE / —	NONE / —	
- POWER	—	—	
- SIGNAL/ACTION	—	—	
CV - REQUIRED/ACTUAL *	/	/	
HAND WHEEL	REQ'D	→	

*BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	CONTROL VALVE DIAPHRAGM OPERATED SPECIFICATION			SP- 8612 REVISION PAGE 1 OF 2
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ΦI

DESIGN CRITERIA FOR DIAPHRAGM OPERATED CONTROL VALVES

Control valve shall be manufacturer's standard complying with this specification and accompanying data sheets.

The vendor shall determine required Cv, considering service data on the data sheet and limiting errosion, cavitation, and noise to reasonable values. The vendor shall show the required Cv, the actual full open Cv, design and maximum noise (Db) level of the valve bid in his proposal.

The valve body shall be marked to show direction of flow.

Diaphragm operators shall provide a linear travel versus loading pressure and give a high degree of dynamic stability and frequency response.

When positioners are called for on the data sheets, they shall have convenient adjustments for zero and span. The positioner shall be capable of easy reversibility in the field, preferably with no additional parts required.

When specified on the data sheet, a pre-piped filter regulator shall be furnished.

Vendor shall specify the maximum steady state air consumption of his furnished positioner.

The unit shall be identified by a metal tag attached with corrosion resistance wire, and stamped with the tag number from the data sheet.

ENG-550-0278

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of* *Babcock International Inc.*	INSTRUMENT DATA SHEET CONTROL VALVE - GLOBE BODY	SP- 8612 REVISION 1 PAGE 1 OF 2

ORIGINAL	BY R. MOYTA	DATE 8-7-78	APPD.	DATE
REVISION 1	BY LMW	DATE 2-19-79	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ΦI

TAG NO.	#1 BELOW	#2 BELOW	#3 BELOW
REVISION	⚠		
QUANTITY	5	5	5
MANUFACTURER *			
MODEL NO. *			
SERVICE	PURGE GAS TO ATMOS.	BOILER WATER TO STEAM DRUM	STEAM TO EDUCTOR
PROCESS FLUID	GAS	WATER	STEAM
FLUID - FLOW OPERATING		2900# HR	2600# HR
- FLOW MAX./MIN.		3600 | 0	3000 | 0
- PRESSURE IN.	3 PSI	25 PSI	25 PSI
- ΔP - OPER./MAX.			
- SPECIFIC GRAVITY	1.08	1	—
- VISCOSITY/TEMP.	| 125 °F	| 270 °F	| 270 °F
BODY - TYPE	2- PORT	→	→
- MATERIAL	CARB. STL.	→	→
- RATING	150 #	150#	→
- END CONNECTION	NPT	RF FLANGE	→
- SIZE	2"	1"	6"
PIPE - SIZE/RATING	2" 150#	1" 150# SCH 80	6"-150#
TRIM - TYPE	PLUG	→	→
- SIZE/CHARACTER. *	FULL | =%	| LIN.	| =%
- SEAT MATERIAL	ST. ST.	→	→
- PLUG MATERIAL	ST. ST.	→	→
ACTUATOR - TYPE	DIAPHRAGM	→	→
- SIZE/RANGE *	| 3-15 PSIG	| 3-15 PSIG	| 3-15 PSIG
- ACTION/FAIL	ATC | OPEN	|	|
POSITIONER - MFG.	—	—	—
- MODEL	—	—	—
- POWER	—	—	—
4-WAY SOL. VALVE ⚠	115 VAC X-PROOF	—	—
Cv - REQUIRED/ACTUAL *			
NOISE - MAX. @ 3' DBA *			

#1) PV-21103, PV-21203, PV-21303, PV-21403, PV-21503
#2) LV-21104, LV-21204, LV-21304, LV-21404, LV-21504
#3) FV-21109, FV-21209, FV-21309, FV-21409, FV-21509

* BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT DATA SHEET CONTROL VALVE - GLOBE BODY			SP- 8612 REVISION PAGE 2 OF 2
ORIGINAL	BY R. MOYTA	DATE 8-7-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 3001ΦI

TAG NO.	LV-21804		
REVISION			
QUANTITY	1		
MANUFACTURER *			
MODEL NO. *			
SERVICE	BOILER WATER TO H.P. STEAM DRUM		
PROCESS FLUID	STEAM		
FLUID - FLOW OPERATING	27000 #/H.R.		
- FLOW MAX./MIN.	30000 | 0		
- PRESSURE IN.	150 PSI		
- ΔP - OPER./MAX.			
- SPECIFIC GRAVITY	1		
- VISCOSITY	—		
BODY - TYPE	2-PORT		
- MATERIAL	CARB. ST.		
- RATING	150 #		
- END CONNECTION	RF FLANGE		
- SIZE	3"		
PIPE - SIZE/RATING	3" 150 #		
TRIM - TYPE	PLUG		
- SIZE/CHARACTER. *	| =%		
- SEAT MATERIAL	ST. ST.		
- PLUG MATERIAL	ST. ST.		
ACTUATOR - TYPE	DIAPHRAGM		
- SIZE/RANGE *	| 3-15 PSIG		
- ACTION/FAIL	Later		
POSITIONER - MFG.	—		
- MODEL	—		
- POWER	—		
- SIGNAL/ACTION	—		
Cv - REQUIRED/ACTUAL *			
NOISE - MAX. @ 3' DBA *			

* BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	CONTROL VALVE - PLUG SPECIFICATION	SP- 8616 REVISION PAGE 1 OF 2

ORIGINAL	BY LMW	DATE 9-25-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. HOYT LAKES, MN. PROJECT NO. 3001 ΦI

1.0 SCOPE

This specification defines the physical and performance requirements of plug type control valves as further defined in the attached data sheets. The documentation for this equipment is also defined.

2.0 EQUIPMENT DESCRIPTION

2.1 Plug valves shall be the manufacturer's standard assembly complying with this specification and accompanying data sheet.

2.2 The material shall be as specified on the data sheet.

2.3 The vendor shall calculate the maximum ΔP using the service data shown on the accompanying data sheet and limiting erosion, cavitation, and noise to acceptable values.

2.4 Each valve shall be delivered with two (2) identification tags:

a) A permanent corrosion resistant metal tag, riveted or screwed to the valve with the following information lettered in physical relief:

Tag Number
Manufacturer
Model No.
Body & Trim Material
Trim Size
Manufacturer's Serial Number

b) A temporary weatherproof tag at least 2" x 4" wired to the top works, showing the valve tag number in bold, readable lettering on both sides of the tag.

(ENG-050-0278)

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Electrical & Piping Drawings
(Schematic & Interconnection)
D. Operation & Installation Manuals
E. Maintenance Manual & Parts List
F. Recommended Spare Parts 2 Years Operation.

3.2 Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from Data Sheet)
E. Exact Instrument Identification as furnished)
(i.e., detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	CONTROL VALVE - PLUG DATA SHEET	SP- 8616 REVISION 1 PAGE 1 OF 1

ORIGINAL	BY LMW	DATE 9-25-78	APPD.	DATE	
REVISION 1	BY LMW	DATE 2-19-79	APPD.	DATE	
CLIENT: ERIE MINING CO.	HOYT LAKES, MN.			PROJECT NO. 3001 Φ I	

TAG NO.	SEE NOTE #1	SEE NOTE #2	
REVISION			
QUANTITY	5	5	
MANUFACTURER *			
MODEL NO. *			
SERVICE	GASIFIER LOCK HOPPER (TOP)	→ HOPPER (BOT.)	
PROCESS FLUID	1/2" TO 1 1/2" LUMP COAL	→	
FLUID - FLOW OPERATING	ON/OFF SERVICE	→	
- FLOW MAX./~~MIN.~~	1400 LB/MIN	→	
- PRESSURE IN.	ATMOS.	≈ 5 PSIG	
- ΔP - MAX.	≈ 5 PSIG	≈ 5 PSIG	
- SPECIFIC GRAVITY	50 LB/FT³	→	
- ~~VISCOSITY~~ TEMP.	250°F	400°F NORM 1000°F MAX	
BODY - TYPE	2-PORT	→	
- MATERIAL	HARD FACED C.S.	→	
- RATING	150 PSIG	→	
- END CONNECTION	18" R.F. FLANGE	→	
- SEAT MATERIAL	*	*	
PIPE - SIZE/RATING	18"	→	
PLUG MATERIAL	HARD FACED C.S.	→	
SEAL - TYPE	*	*	
- MATERIAL	*	*	
% OPENING	90°	→	
ACTUATOR - TYPE	PNEUMATIC	→	
- SIZE/RANGE	*	*	
- ACTION/FAIL	—	—	
AIR SUPPLY	100 PSIG	→	
LIMIT SWITCHES (EACH END)	DPDT	→	
AUTO. LUBE SYSTEM	REQ'D	→	
DUTY CYCLE	A 1 MIN CYCLE EVERY 3 MIN	→	

*BY BIDDER

NOTE #1) FV-21103 FV-21203 FV-21303 FV-21403 FV-21503

#2) FV-21102 FV-21202 FV-21302 FV-21402 FV-21502

⚠ #3) FURNISH 115VAC, X-PROOF, 4-WAY, SOL. VALVE WITH EACH ACTUATOR

LOCATION			

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	3 PORT CONTROL VALVE SPECIFICATION		SP-8620 REVISION PAGE 1 OF 2
ORIGINAL	BY R MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 3001ΦI	

DESIGN CRITERIA FOR 3 PORT CONTROL VALVES

1. The control valve shall be manufacturer's standard three port valve complying with this Specification and the accompanying Data Sheet.

2. Vendor shall determine the required Cv; considering the service data shown on the Data Sheet and limiting errosion, cavitation and noise to reasonable values.

3. Vendor shall state the required Cv and the actual Cv of the valve as bid in the proposal.

4. Control valves shall be sized so that the maximum flow shall not require more than eighty percent of valve stem travel for controlled flow.

5. The valve body shall be marked to show direction of flow for each port.

6. Each valve shall be delivered with identification tags:

   (a) A permanent metal tag, riveted or screwed to the valve with the following information lettered in physical relief:

   Tag Number
   Manufacturer
   Model Number
   Body and Trim Material
   Trim Size for each port
   Cv for each flow direction

   (b) A temporary weatherproof tag at least 2" x 4", wired to the top works, showing the valve tag number in bold, readable lettering on both sides of the tag.

(ENG-050-0278)

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. Electrical & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying Data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	INSTRUMENT DATA SHEET 3 PORT CONTROL VALVE		SP-8620 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MOYTA	DATE 8-7-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 3001ΦI

TAG NO.	LV-21707	TRIM	
FUNCTION	RECIRCULATE	TYPE	BALL
QUANTITY	1	CHARACTERISTICS	*
MANUFACTURER *		BALL MAT.	316 ST. ST.
MODEL NO. *		SEAT "	TFE
SERVICE	TAR/OIL TANK RETURN	STEM MAT.	316 ST. ST.
		GUIDING MAT. *	
PROCESS FLUID	TAR/OIL	PACKING *	
UPSTREAM PRESSURE	25 PSI	LUBRICATOR *	
TEMPERATURE	250°F		
SIZING SPEC GRAVITY	0.9		
SIZING VISCOSITY			
CONTROLLED FLOW DIFF. PRESS	5 PSI	ACTUATOR	PNEUMATIC
RECIRCULATED FLOW DIFF. "	21 PSI	TYPE	DIAPHRAGM
CONTROL SIZING FLOW	40 GPM	SIZE *	
RECIRCUL. SIZING FLOW	50 GPM	ACTION	ATC. REC. PORT
MAXIMUM PRESSURE	25 PSIG	FAILURE	OPEN REC. PORT
" DIFF. PRESSURE	20 PSI	SUPPLY	100/20 PSIG
MAXIMUM TEMPERATURE	250 °F	SIGNAL	3-15 PSIG
LINE SIZE	2"		
REQUIRED Cv *		POSITIONER	NOT REQ'D
ACTUAL Cv *		MANUFACTURER	
% OPEN @ SIZING CONTR FLOW		MODEL	
" " @ MAXIMUM " "		ACTION	
" " @ SIZING RECIRC. "		SIGNAL IN	
" " @ MAXIMUM " FLOW		SIGNAL OUT	
BODY			
TYPE/RATING	3-PORT 150#	ACCESSORIES	
MATERIAL	CARB. ST.	AIR SET	REQ'D
SIZE	2"		
END CONNECTION	RF FLANGE		
RATING	150#		

NOTES: 15 PSI CONTROL PRESS. CLOSES RECIRC. SIDE & OPEN DISCHARGE LINE 100%
3 ↓ ↓ ↓ OPENS ↓ ↓ ↓ CLOSES ↓ ↓

* BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	SOLENOID VALVES SPECIFICATION		SP-8650 REVISION PAGE 1 OF 1	
ORIGINAL	BY LMW	DATE 1-31-79	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 3001 ΦI	

DESIGN CRITERIA FOR SOLENOID VALVES

Valves shall be two state control devices where the state is selected based on the application of electrical power to an integrally attached solenoid.

The solenoid coil shall be housed in manufacturer's standard enclosure and be isolated from the flowing fluid. Coil shall be rated to allow continuous operation at the fluid and ambient temperatures specified on the data sheets.

For solenoid valves requiring a minimum operating differential pressure for dependable operation, this valve shall be specified clearly by the vendor.

The unit shall be identified by a metal tag attached with corrosion resistance wire and stamped with the tag number from the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order:

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Electrical & Piping Drawings
(Schematic & Interconnection)
D. Operation & Installation Manuals
E. Maintenance Manual & Parts List
F. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from Data Sheet)
E. Exact Instrument Identification as furnished
(i.e., detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	SOLENOID VALVES INSTRUMENT DATA SHEET		SP- 8650 REVISION PAGE 1 OF 1	
ORIGINAL	BY LMW	DATE 1-31-79	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 3001 ΦI	

TAG NO.	SEE NOTE #1		
REVISION			
QUANTITY	5		
MANUFACTURER			
MODEL NO.			
SERVICE	PURGE GAS TO LOCK HOPPER		
PROCESS FLUID	INERT GAS		
FLUID-FLOW OPERATING			
FLUID-FLOW MAX/MIN			
FLUID- P MAX/MIN	100 / 5 PSIG		
FLUID-SPECIFIC GRAVITY	1.08		
FLUID-TEMPERATURE	125 °F		
BODY-TYPE	2-WAY		
BODY-MATERIAL	BRASS		
BODY-RATING	150 PSIG		
BODY-SIZE	1" NPT		
ORIFICE-SIZE	1"		
COIL-TYPE	MOLDED		
COIL-HOUSING	CLASS I DIV. II GROUP D		
COIL-RATING	*		
COIL-VOLTAGE	115V 60 HZ		
ACTION-TYPE-DE-ENERGIZED	OPEN		

NOTE #1) FV-21117, FV-21217, FV-21317, FV-21417, FV-21517

* BY BIDDER

LOCATION	FIELD		

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	PRESSURE REGULATING VALVE SPECIFICATION			SP- 8660 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MOYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 30010I

DESIGN CRITERIA FOR PRESSURE REGULATING VALVES

Self-acting pressure regulators (reducing or back pressure) shall be manually adjustable and spring actuated.

Pressure fall-off or build-up shall not exceed 15% of set pressure at rated flow rate.

Reducing regulators shall be provided with integral relief valves when specified on data sheets.

Vendor shall specify the maximum capacity of regulators quoted, under failure conditions.

The diaphragm material shall be compatible with the process fluid at maximum operating conditions of temperature and pressure.

The unit shall be identified by a metal tag attached with corrosion resistance wire, and stamped with the tag number from the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. ~~Electrical~~ & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options.)

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT DATA SHEET REGULATOR-PRESSURE-SELF OPERATED			SP- 8660 REVISION PAGE 1 OF 2
ORIGINAL	BY R MOYTA	DATE 8-7-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.				PROJECT NO. 30014I

TAG NO.	PRV-21801	#1 BELOW	PRV-21840
REVISION			
QUANTITY	1	3	1
MANUFACTURER *			
MODEL NO. *			
SERVICE	PILOT GAS TO FLARE STACK	→	I.G. PURGE TO OIL PRECIPITATORS
PROCESS FLUID	N. GAS	N. GAS	GAS
TEMPERATURE	100°F	→	→
SPECIFIC GRAVITY	0.56	0.56	1.08
SIZING FLOW			
INLET PRESSURE-MAX/MIN			100 / 80 PSIG
OUTLET PRESSURE			5 PSIG
SPRING RANGE *			
Cv-REQUIRED/MAX *			
PIPE CONNECTIONS	2" NPT	1" NPT	2" NPT
BODY MATERIAL	CARB. ST.	→	→
PLUG MATERIAL	ST. ST.	→	→
SEAT MATERIAL	ST. ST.	→	→
DIAPHRAGM MATERIAL *			
PROCESS SENSING	N. GAS	→	→
PILOT	NOT REQ'D	→	→

#1) PRV-21815, PRV-21825, PRV-21835

* BY BIDDER

LOCATION	FIELD	→	→

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT DATA SHEET REGULATOR-PRESSURE-SELF OPERATED		SP-8660 REVISION 1 PAGE 2 OF 2
ORIGINAL	BY R MOYTA	DATE 9-5-78	APPD.	DATE
REVISION 1	BY LMW	DATE 2-19-79	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 30010I

TAG NO.	PRV-21841	SEE NOTE #1	SEE NOTE #2 ⚠
REVISION			⚠
QUANTITY	1	5	5
MANUFACTURER *			
MODEL NO. *			
SERVICE	I.G. TO TAR PRECIPITATORS	I.G. TO FLARE STACKS	STEAM TO LOWER RING
PROCESS FLUID	INERT GAS	→	SAT. STEAM
TEMPERATURE	100 °F	→	355 °F
SPECIFIC GRAVITY	1.08	→	—
SIZING FLOW			
INLET PRESSURE-MAX/MIN	100 / 80 PSIG	→	125 PSIG
OUTLET PRESSURE	5 PSIG	→	ADJ.
SPRING RANGE *			25-100 PSIG
Cv-REQUIRED/MAX *			
PIPE CONNECTIONS	2" NPT	1" NPT	2" NPT
BODY MATERIAL	CARB ST.	→	BRONZE
PLUG MATERIAL			ST. ST.
SEAT MATERIAL			HARDENED ST. ST.
DIAPHRAGM MATERIAL			ST. ST.
PROCESS SENSING	GAS	→	INTERNAL
PILOT			INTERNAL

NOTE #1) PRV-21117 PRV-21217 PRV-21317 PRV-21417 PRV-21517

⚠ #2) PRV-21120, PRV-21220, PRV-21320, PRV-21420, PRV-21520

* BY BIDDER

LOCATION	FIELD	FIELD	FIELD

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	PRESSURE SAFETY RELIEF VALVE SPECIFICATION		SP- 8710 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MDYTA	DATE 8-1-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 30010I

DESIGN CRITERIA FOR PRESSURE SAFETY RELIEF VALVES

These valves shall be spring loaded direct acting types suitable for applications covered by the latest published edition of the ASME Unfired Pressure Vessel Code or Power Boiler Code.

Nameplates and valves shall be marked according to the applicable code as indicated on the data sheets.

Allowable overpressure shall be as indicated on the data sheet but in no case shall exceed 10% for steam or gases and 25% for liquids.

Specific gravity is given as follows:

Liquids: At relieving temperature, referred to water at 60°F.

Gases: At accumulated relieving pressure and temperature referred to air at 14.7 psia and 60°F.

The unit shall be identified by a metal tag attached with corrosion resistance wire, and stamped with the tag number from the data sheet.

DOCUMENTATION

The following certified documents shall be submitted to the buyer in quanties and terms as specified in the purchase order.

1. Drawing and Manual Index
2. General Arrangement Drawings
3. ~~Electrical~~ & Piping Drawings (schematic and interconnection)
4. Operation & Installation Manuals
5. Maintenance Manual & Parts List
6. Recommended Spare Parts for 2 Years Operation

Each document shall be marked with the following indentifying data:

1. BCI Job Number
2. Customer Job Number
3. BCI Instrument Specification Number
4. Instrument Tag No. (from data sheet)
5. Exact Instrument Identification as furnished (i.e. detailed model number or list of furnished options.)

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	INSTRUMENT DATA SHEET PRESSURE SAFETY RELIEF VALVE		SP-8710 REVISION PAGE 1 OF 1
ORIGINAL	BY R. MOYTA	DATE 8-8-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.			PROJECT NO. 3001ΦI

TAG NO.	#1 BELOW	#2 BELOW	PSV-21807
REVISION			
QUANTITY	5	5	1
MANUFACTURER *			
MODEL NO. *			
SERVICE	LOW PRESS STEAM DRUM	GAS COOLER COOLENT	HI PRESS STEAM DRUM
PROCESS FLUID	STEAM	STEAM	STEAM
FLUID - FLOW (CAPACITY)	13200 #/HR	20104 #/HR	20104 #/HR
- PRESSURE-NORMAL	25 PSIG	125 PSIG	125 PSIG
- -RELIEVING	30 PSIG	135 PSIG	135 PSIG
- TEMP. - NORMAL	267°F	352 °F	352°F
- RELIEVING			
- Sp.G.	—	—	—
- VISCOSITY	—	—	—
PRESSURE - SPRING/SET *	30 PSIG	135 PSIG	135 PSIG
BACK PRESSURE	—	—	—
OVER PRESSURE (%)	3 %	10 %	3 %
BASIS OF SELECTION	ASME SEC. I	ASME SEC VIII	ASME SEC. I
PILOT	—	—	—
BODY - MATERIAL	BRONZE	→	→
CONNECTION - IN *	150#RF	150#RF	150#RF
- OUT *	150#RF	150#RF	150#RF
SEAT & DISC MATERIAL *			
ORIFICE AREA - CALCULATED *			
- ACTUAL *			

#1) PSV-21107, PSV-21207, PSV-21307, PSV-21407, PSV-21507
#2) PSV-21116, PSV-21216, PSV-21316, PSV-21416, PSV-21516

* BY BIDDER

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROGRAMMABLE CONTROLLER SPECIFICATION			SP- 8800 REVISION PAGE 1 OF 2	
ORIGINAL	BY LMW	DATE 10-3-78	APPD.		DATE
REVISION	BY	DATE	APPD.		DATE
CLIENT: ERIE MINING CO. HOYT LAKES, MN.				PROJECT NO. 3001 ΦI	

1.0 SCOPE

This specification shall describe the physical and performance characteristics of programmable controllers as further described in the attached data sheets. Documentation requirements are also described.

2.0 DESCRIPTION OF EQUIPMENT

2.1 The equipment shall be a solid state design suitable for an industrial control room environment.

2.2 The system shall be supplied complete with central processor, power supply, input/output module, module housings, and all interconnecting cables and connectors.

2.3 The central processor memory shall be a non-volatile type which is not erased by a sustained power failure.

2.4 Input/output modules shall have recessed or protected terminal strips capable of accepting two AWG No. 14 wires.

2.5 A portable programming and trouble shooting instrument shall be provided when specified in the Data Sheet.

2.6 The vendor shall provide programming to execute the logic detailed on the referenced drawings unless stated otherwise in the Data Sheet.

2.7 The vendor shall furnish clear and complete information on the programming language and instructions necessary to write and implement a program.

2.8 This equipment shall be provided with a permanently attached corrosion resistant tag or tags showing the manufacturer's name, model number, serial number, and the instrument tag number as shown on the Data Sheet.

2.9 The equipment shall have 25% spare I/O's available after required connections are made. The system shall be designed for easy 25% future capacity expansion.

3.0 REFERENCE DRAWINGS (ATTACHMENTS)

(ENG-050-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROGRAMMABLE CONTROLLER SPECIFICATION	SP - 8800 REVISION PAGE 2 OF 2

4.0 DOCUMENTATION

4.1 The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Electrical & Piping Drawings (Schematic & Interconnection)
D. Operation & Installation Manuals
E. Maintenance Manual & Parts List
F. Recommended Spare Parts for 2 Years Operation

4.2 Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from Data Sheet)
E. Exact Instrument Identification as furnished
(i.e., detailed model number or list of furnished options)

(ENG-052-0278)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROGRAMMABLE CONTROLLER DATA SHEET		SP- 8800 REVISION PAGE 1 OF 1
ORIGINAL	BY LMW	DATE 10-3-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. HOYT LAKES, MN. — PROJECT NO. 3001 ΦI

TAG NO.	WUC-21000		
REVISION			
QUANTITY	1		
MANUFACTURER *			
*			
MODEL NO.			
SERVICE	CTL. GASIFIER OPERATION		
CENTRAL PROCESSOR			
LOGIC LINES - REQ'D.	200		
- MAX.	*		
INPUT LINES - REQ'D.	200		
- MAX.	*		
OUTPUT LINES - REQ'D.	200		
- MAX.	*		
POWER SUPPLY	115V. 1PH. 60 HZ.		
INPUT MODULES - NO. INPUTS	85		
- INPUTS/MODULE	*		
- CKT. V./I.	24 VDC		
OUTPUT MODULES - NO. OUTPUTS	85		
- OUTPUTS/MOD.	*		
- CKT. V./I.	24VDC		
INPUT/OUTPUT MODULE HOUSINGS	REQ'D		
MOUNTING RACK	REQ'D		
NEC AREA CLASS	GEN. PURP.		
ENCLOSURES	↓ ↓		
PROGRAMMING PANEL	REQ'D		
FIELD CHECK AND START-UP SERV.	2 WEEKS		
CIRCUIT STATUS LIGHTS	REQ'D		

*BY BIDDER

LOCATION			

ENG-050-0278

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	WEIGH SYSTEM SPECIFICATION			SP- 8820 REVISION PAGE 1 OF 2
ORIGINAL	BY LMW	DATE 9-27-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE
CLIENT: ERIE MINING CO.	HOYT LAKES, MN.			PROJECT NO. 3001ΦI

1.0 SCOPE

This specification shall define the physical and performance characteristics of an automatic batch weighing system for use with a small coal hopper. Documentation requirements are also specified.

2.0 EQUIPMENT DESCRIPTION

2.1 Load cells shall be the electronic type with strain gage force sensors. The material of construction shall be stainless steel or as specified in the Data Sheet.

2.2 Load cells shall be temperature compensated over a range of 0 to 150°F.

2.3 Linearity of the load cell shall be ±.05% of full scale or better.

2.4 Load cells shall be fully protected against humidity and water and shall be suitable for the NEC classification specified in the Data Sheets.

2.5 The weight indicator/controller shall be compatible with the load cells and shall provide the readouts and control features as specified in the Data Sheet.

2.6 The weigh system shall include all hardware required to provide a working system, including signal cable, connectors, and any required signal summers or signal conditioners.

2.7 Each load cell and receiver instrument shall be supplied with a permanently attached corrosion resistant tag showing the manufacturer's name, model number, serial number and the instrument tag number as shown on the Data Sheet.

3.0 DOCUMENTATION

3.1 The following certified documents shall be submitted to the buyer in quantities and terms as specified in the purchase order.

A. Drawing and Manual Index
B. General Arrangement Drawings
C. Electrical & Piping Drawings (schematic and interconnection)
D. Operation and Installation Manuals
E. Maintenance Manual & Parts List
F. Recommended Spare Parts for 2 Years Operation

(ENG-050-0278)

3.2 Each document shall be marked with the following identifying data:

A. BCI Job Number
B. Customer Job Number
C. BCI Instrument Specification Number
D. Instrument Tag No. (from Data Sheet)
E. Exact Instrument Identification as furnished
(i.e., detailed model number or list of furnished options)

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. A Subsidiary of Babcock International Inc.	WEIGH SYSTEM DATA SHEET		SP- 8820 REVISION PAGE 1 OF 1
ORIGINAL	BY LMW	DATE 9-27-78	APPD.	DATE
REVISION	BY	DATE	APPD.	DATE

CLIENT: ERIE MINING CO. HOYT LAKES, MN. PROJECT NO. 3001ΦI

TAG NO.	SEE NOTE #1		
REVISION			
QUANTITY	5		
MANUFACTURER *			
* MODEL NO.			
SERVICE	LOCK HOPPER		
LOAD CELL - TYPE	ELECTRONIC		
- NUMBER	4		
- MATERIAL	ST. STEEL		
- CAPACITY (EACH)	2000 LB.		
- RESISTANCE	*		
NEC CLASSIFICATION	CL I DIV II G. D		
ENCLOSURE	EXPLOSIONPROOF		
HOPPER WEIGHT - EMPTY	5800 LB.		
- FULL	6700 LB.		
WEIGHT PROCESSOR			
APPLICATION	AUTO. BATCH CTL.		
READOUT - UNITS	TOTAL NET TONS		
- DIGITS	6		
- RESOLUTION	.1 TON		
CONTROL - INPUTS	RESET		
- OUTPUTS	TWO SPOT SET POINTS		
POWER SUPPLY	+24 V. DC		
MOUNTING	FLUSH PANEL		
NEC CLASSIFICATION	GEN. PURP.		
ENCLOSURE			
SIGNAL CABLE LENGTH	200 FT		

* INFO BY BIDDER

NOTE #1) PROCESSOR: QR-21103, QR-21203, QR-21303, QR-21403, QR-21503

LOAD CELL: QE-21103 QE-21203 QE-21303 QE-21403 QE-21503

LOCATION			

ENG-050-02(9)

4.0

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 4.0 - DRAWINGS

4.1 Non-Proprietary Drawings

4.1.1 General Arrangement
4.1.2 Process Flow Diagrams (Non-proprietary)
4.1.3 Piping and Instrumentation Diagrams
4.1.4 External Gasifier Drawings (Non-proprietary)
4.1.5 Instrumentation Loop Diagrams
4.1.6 Electrical Classification Drawings
4.1.7 Single Line Diagrams
4.1.8 Structural Steel Loading Diagrams

4.2 Proprietary Drawings

4.2.1 Process Flow Diagrams
4.2.2 Internal Gasifier Arrangement Drawings
4.2.3 Gasifier Temperature Profiles

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

4.1.1

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

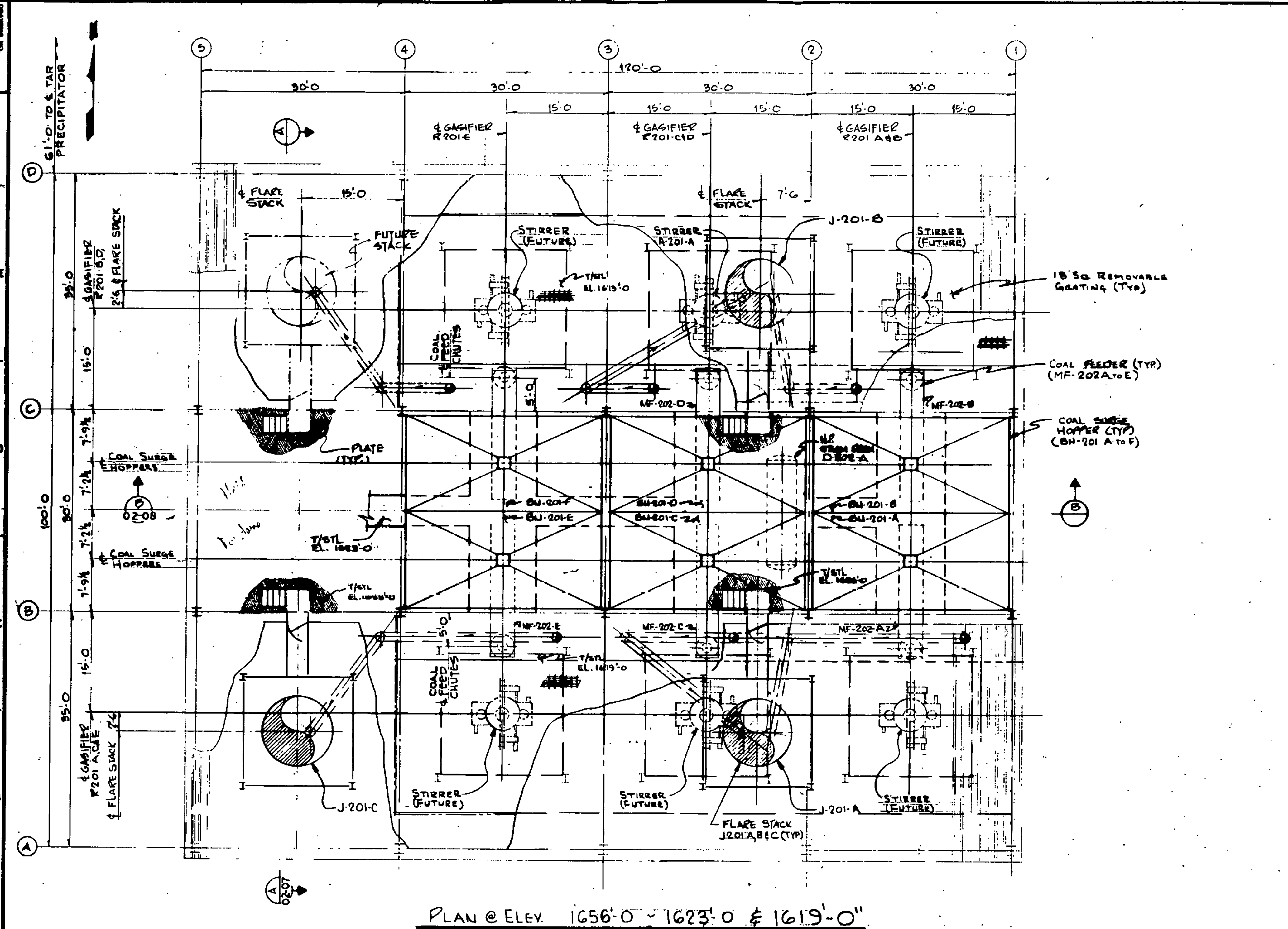
SECTION 4.0 - DRAWINGS

4.1 Non-Proprietary Drawings

4.1.1 General Arrangement

4814-X-02-02-2	Gen.Arrg't. Plan - Sheet No. 1
4814-X-02-03-2	Gen.Arrg't. Plan - Sheet No. 2
4814-X-02-04-2	Gen.Arrg't. Plan - Sheet No. 3
4814-X-02-05-2	Gen.Arrg't. Plan - Sheet No. 4
4814-X-02-06-2	Gen.Arrg't. Plan - Sheet No. 5
4814-X-02-07-2	Gen.Arrg't. Sect.- "A-A"
4814-X-02-08-2	Gen.Arrg't. Sect.- "B-B"
4814-X-02-09-2	Gas Cleaning Plant - Plan and Elevation

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001



PLAN @ ELEV. 1656'-0 ~ 1623'-0 & 1619'-0"

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. M-100 ISSUE NO. 1
FOR DES. MAN SIGNED DATE 2/16/79

REVISIONS	DATE	BY	CHK	DESCRIPTION	APP.
1	4/20/80	JL	DS	FINAL REVIEW	
0	2/16/79			ISSUED FOR DESIGN MANUAL	

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

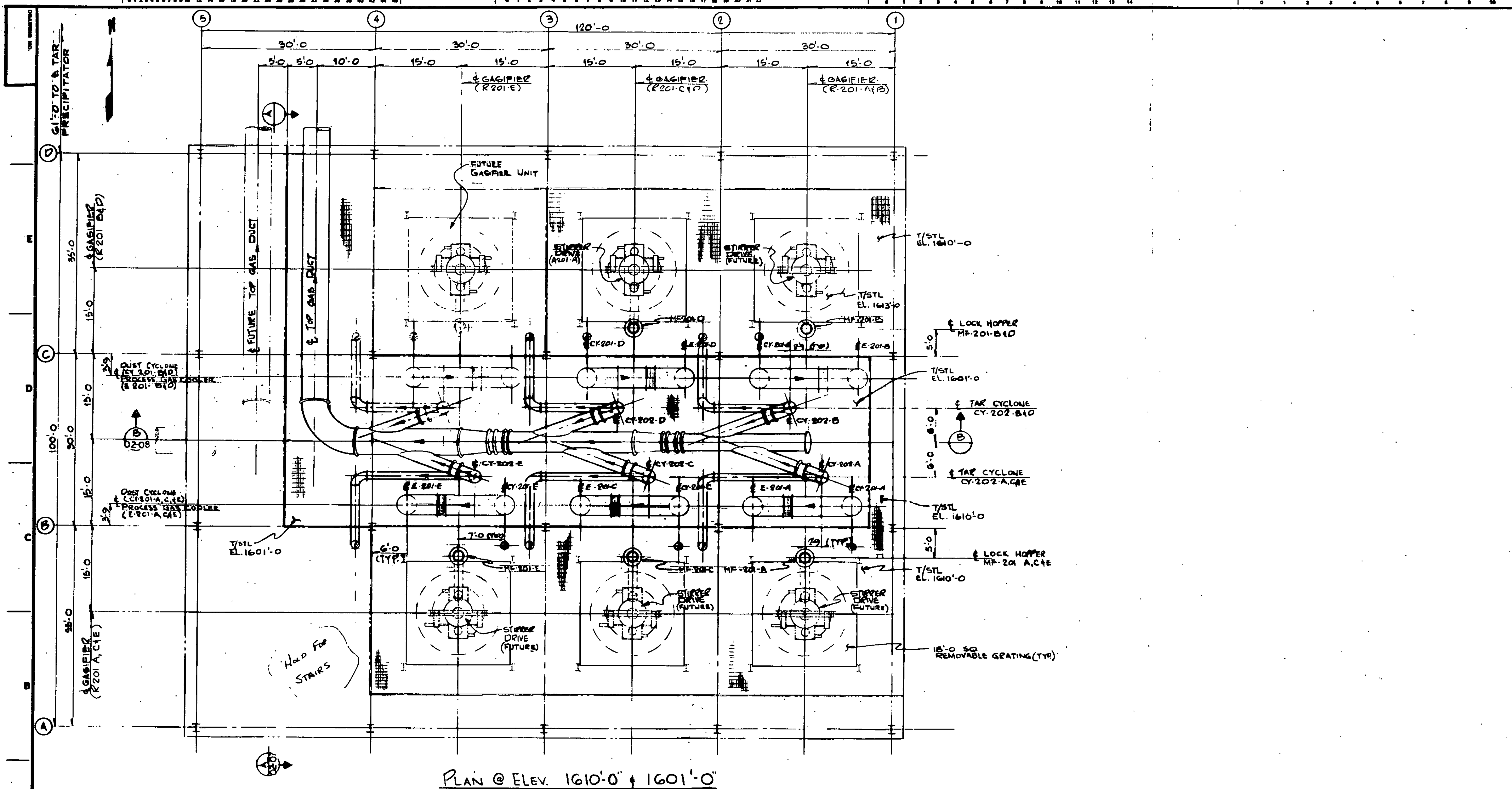
PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

4814-X-02-02-2

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

GASIFICATION
COMMERCIAL UNIT–STAGE 1 (DEMO)
GEN. ARRGT. PLAN~SHEET Nº 1

SCALE 1/8" = 1'-0
REVISION 1



PLAN @ ELEV. 1610'-0" & 1601'-0"

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. M-101 ISSUE NO 1
FOR DES. MAN. SIGNED DATE 2/16/79

DATE	BY	CHK	DESCRIPTION	APP.
11/20/78	JL	DC	FINAL REVIEW	
2/16/79			ISSUED FOR DESIGN MANUAL	

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT-CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

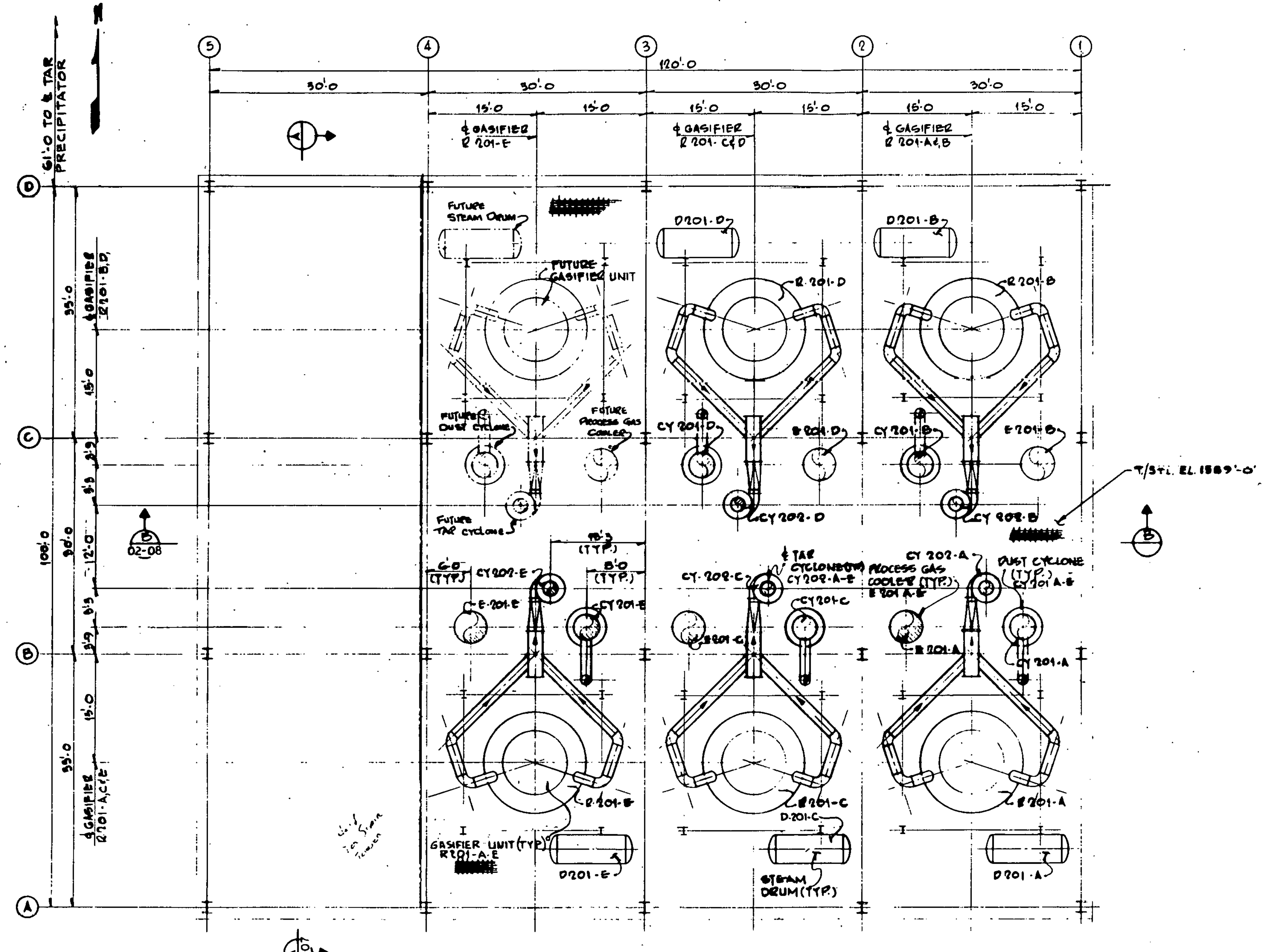
4814-X-02-03-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

GASIFICATION
COMMERCIAL UNIT-STAGE 1 (DEMO)
GEN. ARRGT. PLAN~SHEET Nº 2

SCALE 1/8" = 1'-0

REVISION 1



PLAN @ ELEV. 1589'-0

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA
A Subsidiary of Babcock International Inc.
PROJECT NO 3001 DRAWING NO M-107 ISSUE NO 1
FOR DES MAN. SIGNED DATE 2/16/79

DATE	BY	CHK	DESCRIPTION	APP.
11/20/78	JL	DS	FINAL REVIEW	
2/16/79			ISSUED FOR DESIGN MANUAL	

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT–CONTRACT NO. ET-78-C-01-2578

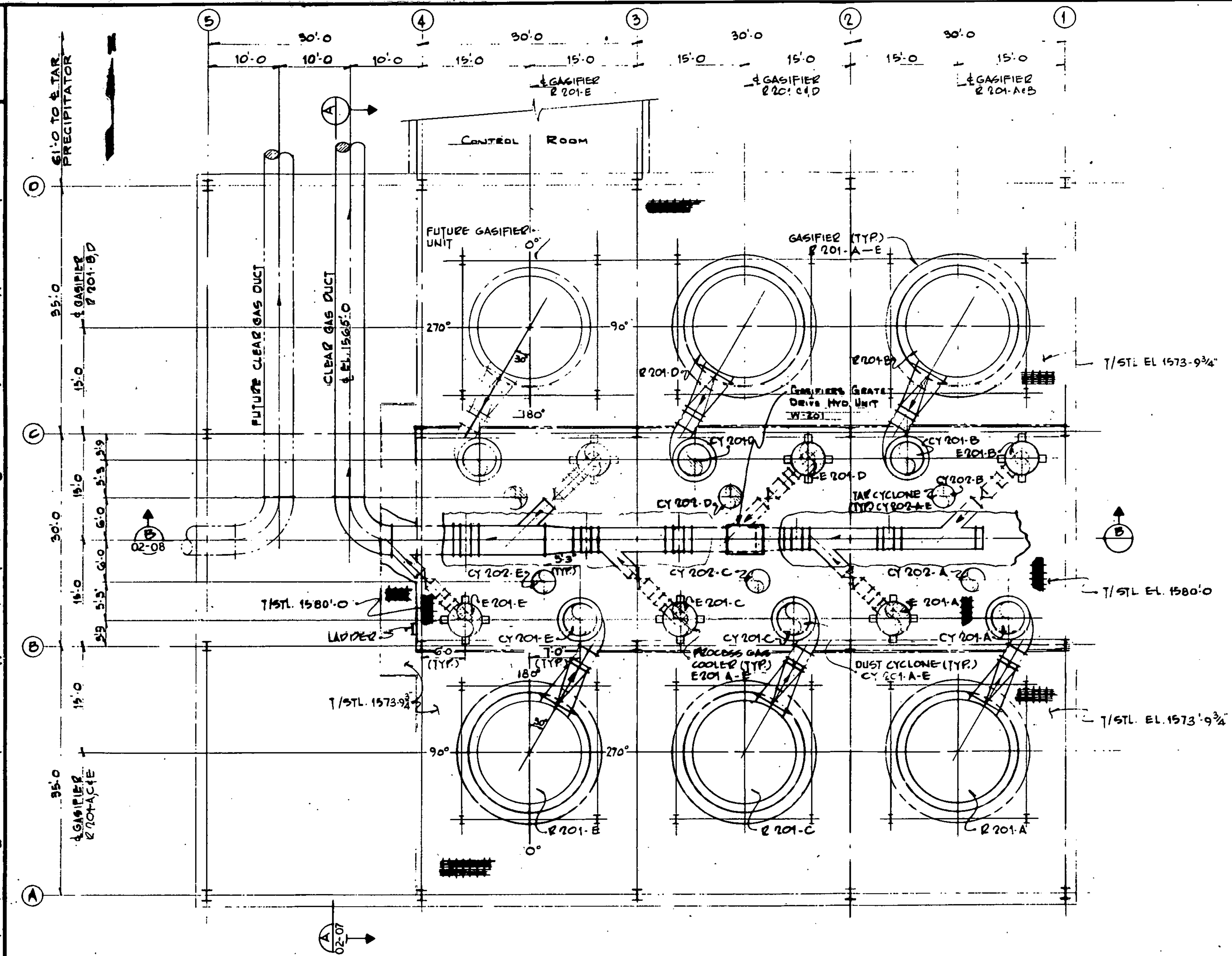
PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

4814-X-02-04-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

GASIFICATION
COMMERCIAL UNIT - STAGE 1 (DEMO)
GEN. ARRGT. PLAN SHEET-NO. 3

SCALE 1/8" = 1'-0
REVISION 1



PLAN @ EL. 1573'-9¾" & 1580'-0"

BABCOCK CONTRACTORS INC.
PITTSBURGH PA
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. M-102 ISSUE NO. 1
FOR DES MAN SIGNED DATE 2/16/79

DATE	BY	CHK	DESCRIPTION	APP.
11/20/78	JL	DS	FINAL REVIEW	
2/16/79			ISSUED FOR DESIGN MANUAL	

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT–CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

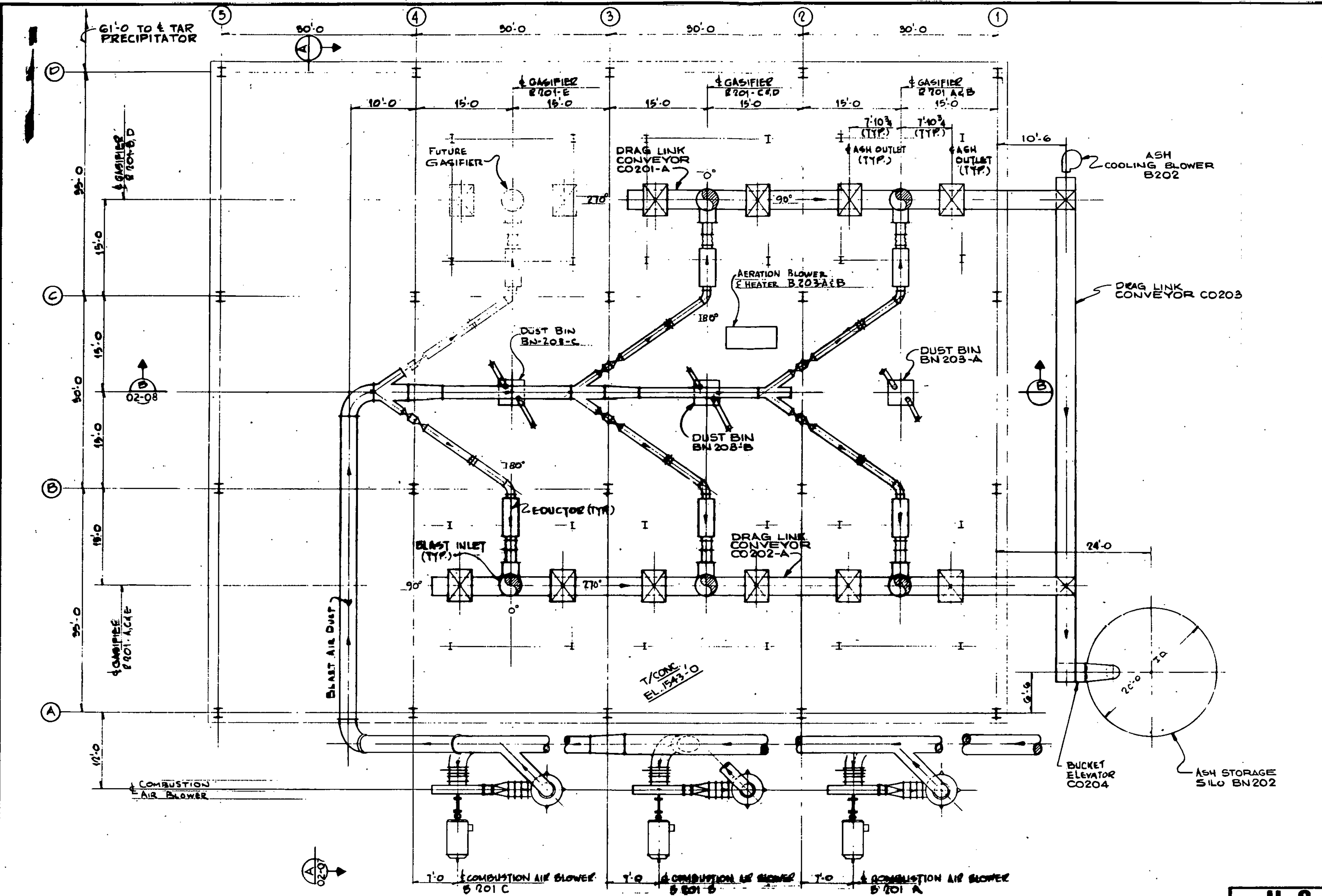
4814-X-02-05-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

SCALE 1/8" = 1'-0"

GASIFICATION
COMMERCIAL UNIT - STAGE 1 (DEMO)
GEN. ARRGT. PLAN~SHEET NO. 4

REVISION 1



PLAN @ EL. 1543'-0

This drawing, including the information it contains, is the property of Erie Mining Company, Pickands Mather & Co., Managing Agent. It is submitted only in connection with a project under contract between Erie and The United States Department of Energy and must not be used in any manner detrimental to the interests of Erie or the Department of Energy. The drawing is not to be copied and must be returned upon request.

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. M-103 ISSUE NO. 1
FOR DES. MAN. SIGNED DATE 2/16/79

DATE	BY	CHK	DESCRIPTION
1 4/20/79	JL	DS	FINAL REVIEW
2/16/79			ISSUED FOR DESIGN MANUAL

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT–CONTRACT NO. ET-78-C-01-2578

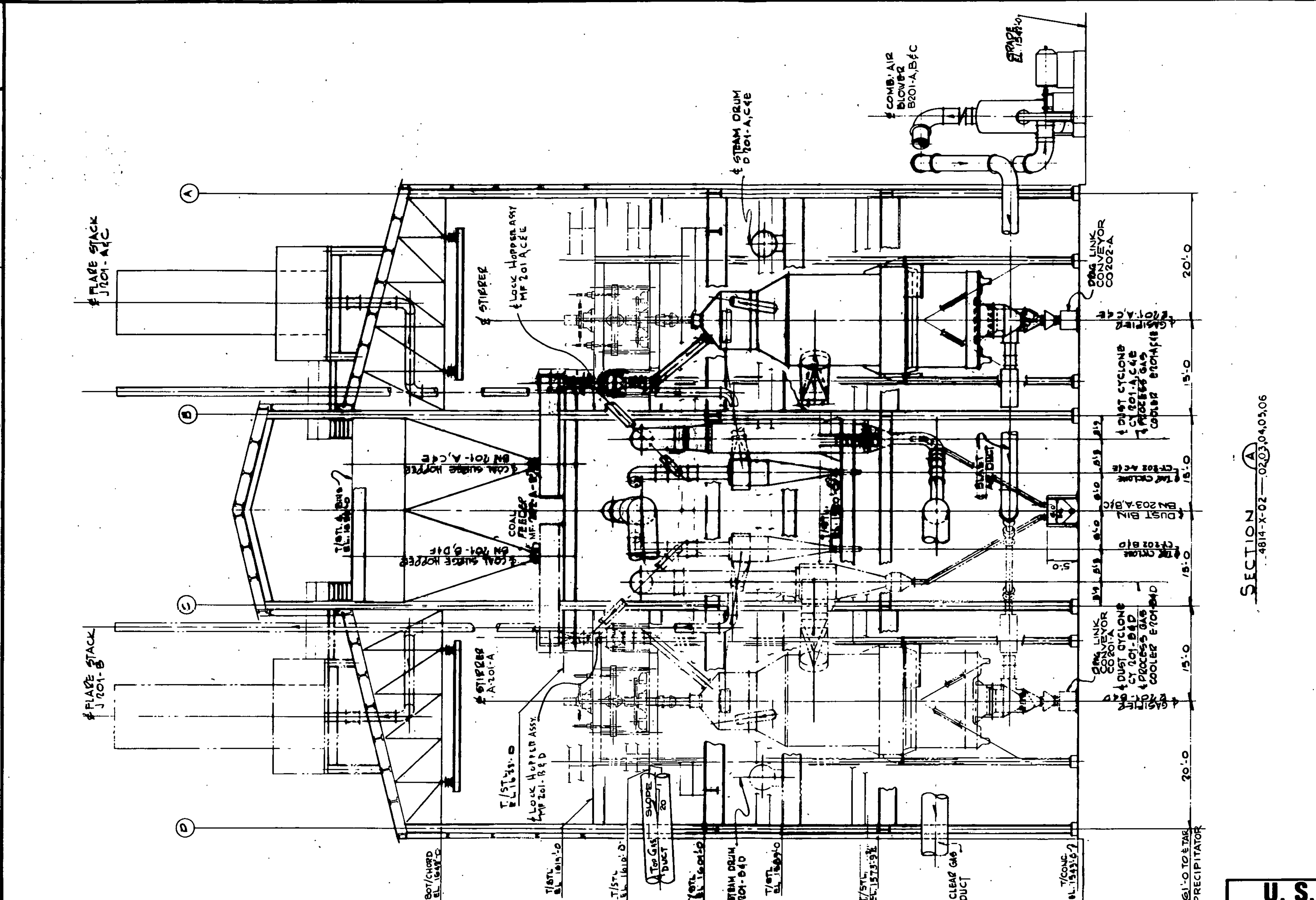
PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

4814-X-02-06-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

GASIFICATION
COMMERCIAL UNIT - STAGE 1 (DEMO)
GEN. ARRG'T. PLAN-SHEET NO. 5

SCALE 1/8" = 1'-0
REVISION 1



This drawing, including the information it contains, is the property of Erie Mining Company, Pickands Mather & Co., Managing Agent. It is submitted only in connection with a project under contract between Erie and The United States Department of Energy and must not be used in any manner detrimental to the interests of Erie or the Department of Energy. The drawing is not to be copied and must be returned upon request.

BABCOCK CONTRACTORS INC.
PITTSBURGH PA
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO M-104 ISSUE NO 1
FOR DES. MAN. SIGNED DATE 2/16/79

DATE	BY	CHK	DESCRIPTION	APP.
1 11/20/78	JN	DS	FINAL REVIEW	
2/16/79			ISSUED FOR DESIGN MANUAL	

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

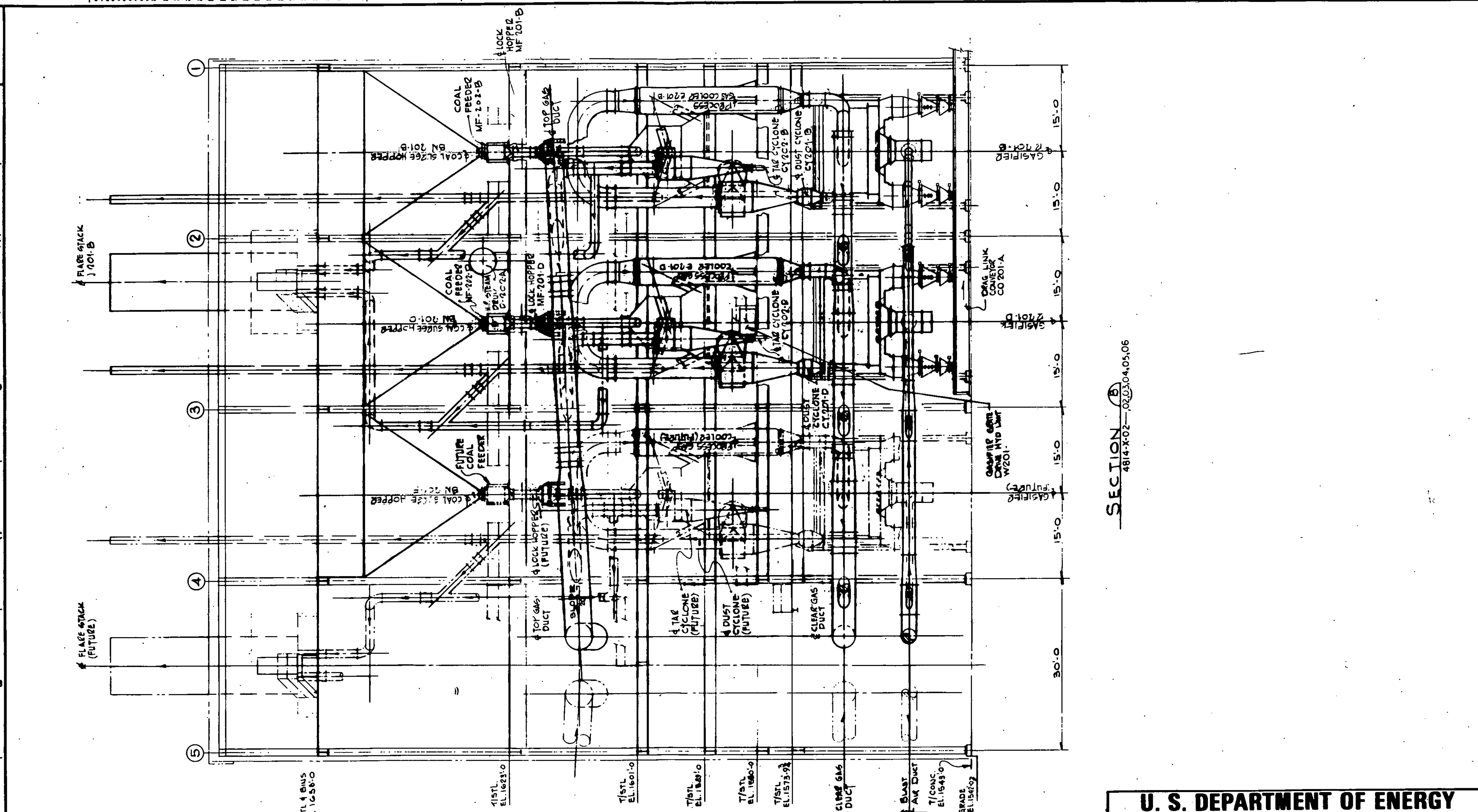
4814-X-02-07-2

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT.
HOYT LAKES MINNESOTA

GASIFICATION
COMMERCIAL UNIT - STAGE 1 (DEMO)
GEN. ARRGT. SECT. "A-A"

SCALE 1/8" = 1'-0"

REVISION 1



This drawing, including the information it contains, is the property of Erie Mining Company, Pickands Mather & Co., Managing Agent. It is submitted only in connection with a project under contract between Erie and The United States Department of Energy and must not be used in any manner detrimental to the interests of Erie or the Department of Energy. The drawing is not to be copied and must be returned upon request.

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.
PROJECT NO 3001 DRAWING NO. M-105 ISSUE NO 1
FOR DES MAN. SIGNED DATE 2/16/79

REVISIONS	DATE	BY	CHK	DESCRIPTION	APP.
1	11/20/78	JN	DS	FINAL REVIEW	
1	2/16/79			ISSUED FOR DESIGN MANUAL	

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKEE ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

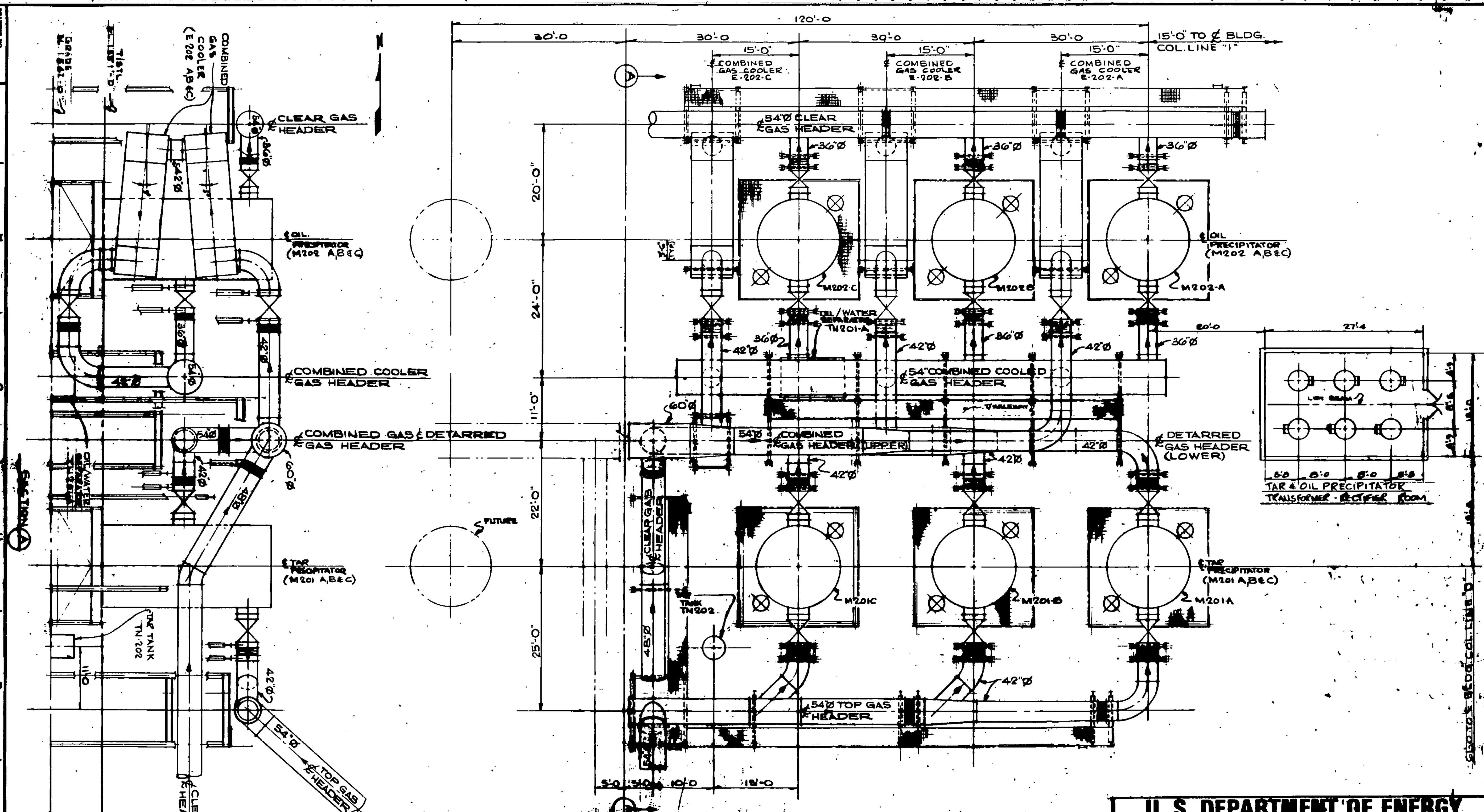
4814-X-02-08-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

PROJECT NO. | P.E. NO.
SCALE 1/8" = 1'-0"

GASIFICATION
COMMERCIAL UNIT - STAGE 1 (DEMO)
GEN. ARRGT. SECTION "B-B"

REVISION 1



This drawing, including the information it contains, is the property of Erie Mining Company, Pickands Mather & Co., Managing Agent. It is submitted only in connection with a project under contract between Erie and The United States Department of Energy and must not be used in any manner detrimental to the interests of Erie or the Department of Energy. The drawing is not to be copied and must be returned upon request.

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. M-106
FOR DES. MAN. DATE 2/16/79

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT-CONTRACT NO. ET-78-C-01-2578
PREPARED BY McKee ENGINEERS AND CONSTRUCTORS CLEVELAND OHIO
4814-X-02-09-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA
GASIFICATION
COMMERCIAL UNIT - STAGE 1 (DEMO)
GAS CLEANING PLANT ~ PLAN & ELEV
SCALE 1/8" = 1'-0"
REVISION 1

DATE	BY	CHK	DESCRIPTION	APP.
11/16/79	J.L.	DS	FINAL REVIEW	
2/16/79			ISSUED FOR DESIGN MANUAL	

4.1.2

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 4.0 - DRAWINGS

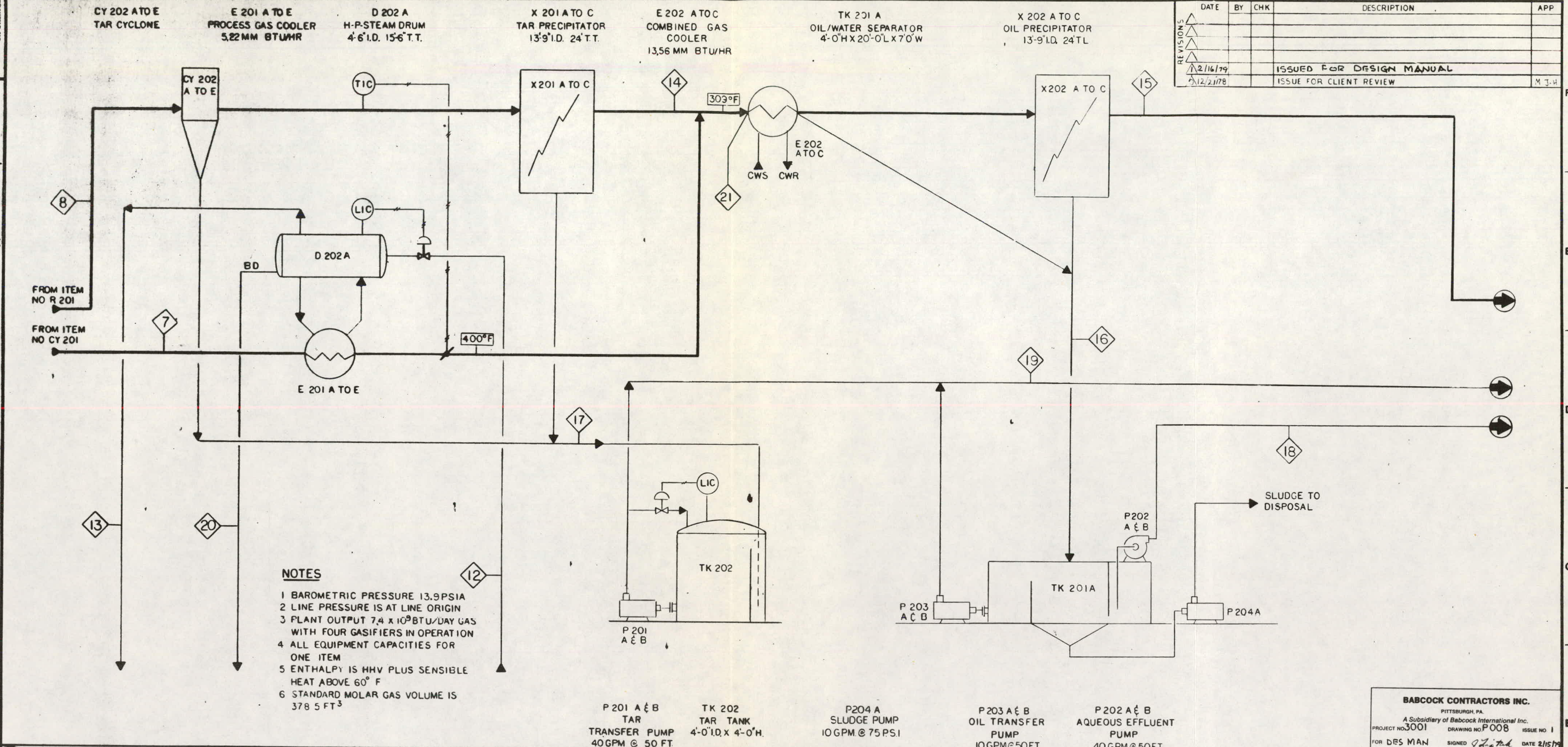
4.1 Non-Proprietary Drawings

4.1.2 Process Flow Diagrams (Non-Proprietary)

4814-Y-02-05-2	PFD West Coal (1 of 2)
4814-Y-02-06-2	PFD West Coal (2 of 2)
4814-Y-02-07-2	PFD East Coal (1 of 2)
4814-Y-02-08-2	PFD East Coal (2 of 2)

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

REVISIONS	DATE	BY	CHK	DESCRIPTION	APP
1	2/16/79			ISSUED FOR DESIGN MANUAL	
0	12/21/78			ISSUE FOR CLIENT REVIEW	M J H



NOTES

1. BAROMETRIC PRESSURE 13.9 PSIA
2. LINE PRESSURE IS AT LINE ORIGIN
3. PLANT OUTPUT 7.4 x 10^9 BTU/DAY GAS WITH FOUR GASIFIERS IN OPERATION
4. ALL EQUIPMENT CAPACITIES FOR ONE ITEM
5. ENTHALPY IS HHV PLUS SENSIBLE HEAT ABOVE 60° F
6. STANDARD MOLAR GAS VOLUME IS 378.5 FT^3

CRITERIA ↓ / STREAM IDENTIFICATION →	7 CLEAR GAS		8 TOP GAS		12 H.P. B.F.W.		13 H.P. STEAM		14 DETARRED GAS		15 COOLED GAS		16 OIL/WATER		17 TAR		18 AQUEOUS EFFLUENT		19 TAR/OIL		20 H P BLOW DOWN		21 SPRAY WATER	
	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR
MOISTURE FREE COAL																								
ASH/CHAR/DUST															7				7					
TAR/OIL											20	0.2	2062	20.6	4859	48.6	0.4	0.0	6920.6	69.2				
CARBON MONOXIDE											35477	1266.8												
CARBON DIOXIDE											13400	304.5	6	0.13			6	0.13						
HYDROGEN											1984	984.4												
NITROGEN											66169	2363.1												
METHANE											564	35.2												
C_2 TO C_5											650	14.8												
HYDROGEN SULFIDE											918	26.9	9	0.27			9	0.27						
CARBONYL SULFIDE											279	4.6												
AMMONIA											39	2.3	17	1.00			17	1.0						
HYDROGEN CYANIDE											4	0.16	5	0.19			5	0.19						
OXYGEN																								
CHLORIDE													26	0.74			26	0.74						
WATER					20262	1125.6	18420	1023.3			5355	297.3	1114	61.91			1113.4	61.87	0.6	0.04	1842	102.3	2000	111.11
TOTAL					20262	1125.6	18420	1023.3			124859	5300.3	3239	84.84	4866	48.6	1177	64.2	6928	69.24	1842	102.3	2000	111.11
MM SCFD / USGPM	30.88		17.47			42.8	9.30		17.03		48.15			6.48		9.61		2.35		13.9		3.68		4.0
PRESSURE PSIG OR " H_2O G		40"		30"	150 PSIG		125 PSIG			25"		20" (BL)					25 PSIG				125 PSIG			
TEMPERATURE °F	1140		250		210		352		250		95		95		250		95		204		352		60	
DENSITY LB/FT^3	0.0219		0.0485		59		0.308		0.0464		0.0581		61.74		63.24		62.0		62.1		55.6		62	
ENTHALPY MM BTU/HR	217.3		246.4		3.04		21.44		161.3		314.54		35.50		65.12		0.01		120.62		0.6		0	

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. P008 ISSUE NO. 1
FOR DES MAN SIGNED [signature] DATE 2/15/79

U. S. DEPARTMENT OF ENERGY

FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

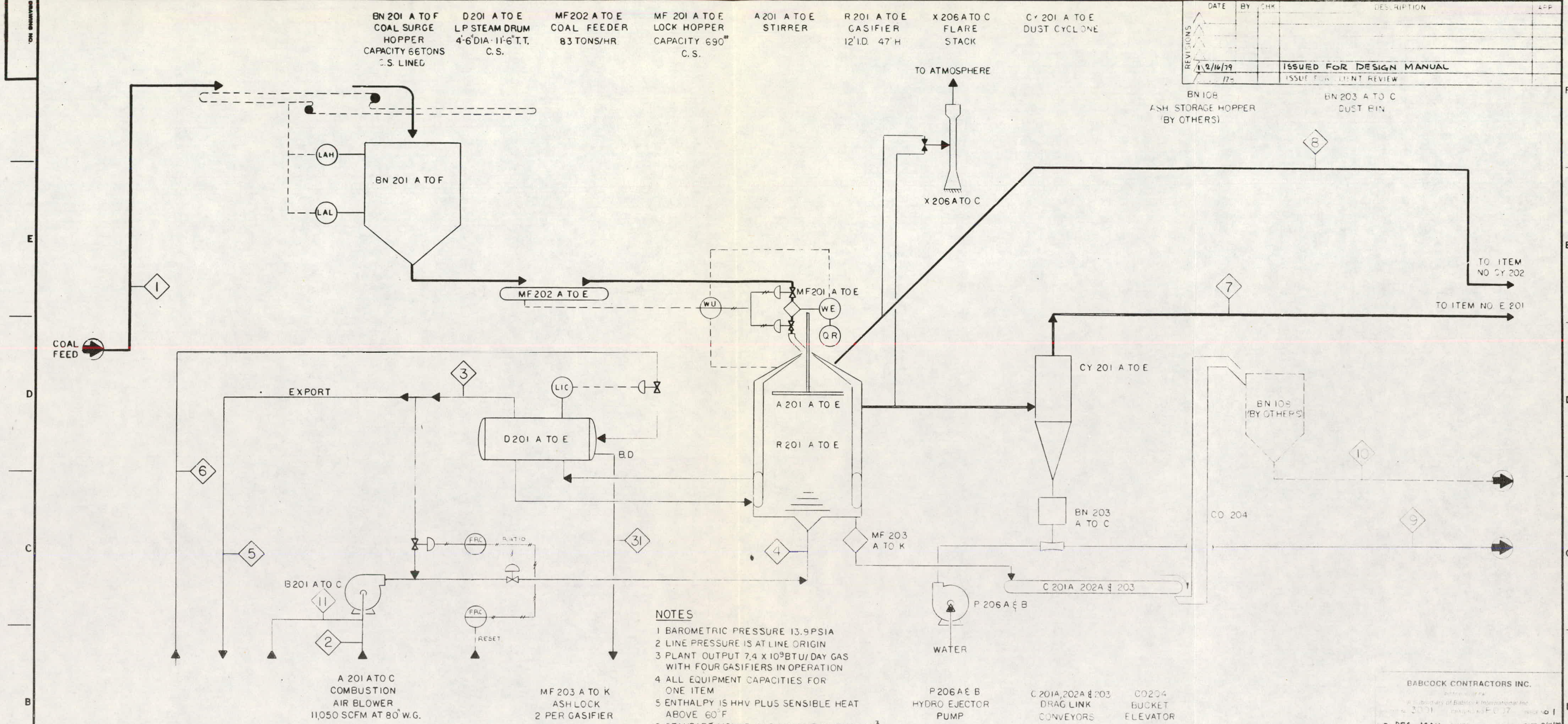
4814-Y-02-08-2
SHEET 2 OF 2

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

PROJECT NO. 3001 P.E. NO.
PROCESS ENGINEERING APPROVAL
BY M. J. H. DATE 12/21/78

GASIFICATION
DEMONSTRATION UNIT
P.F.D. EAST COAL

REVISION 1



NOTES
1 BAROMETRIC PRESSURE 13.9 PSIA
2 LINE PRESSURE IS AT LINE ORIGIN
3 PLANT OUTPUT 7.4 X 10⁹ BTU/DAY GAS WITH FOUR GASIFIERS IN OPERATION
4 ALL EQUIPMENT CAPACITIES FOR ONE ITEM
5 ENTHALPY IS HHV PLUS SENSIBLE HEAT ABOVE 60°F
6 STANDARD MOLAR GAS VOLUME IS 378.5 FT^3

CRITERIA / STREAM IDENTIFICATION	1 COAL FEED		2 AIR		3 STM PRODUCED		4 BLAST		5 BALANCE STM.		6 L.P. B.F.W		7 CLEAR GAS		8 TOP GAS		9 DUST		10 ASH		11 STRETFORD REC		31 LP BLOW DOWN	
	#/HR		#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR
MOISTURE FREE COAL	35024																							
ASH/CHAR/DUST																	84		3818					
TAR/OIL																								
CARBON MONOXIDE							11.7	0.42													11.7	0.42		
CARBON DIOXIDE							102	2.32													102	2.32		
HYDROGEN							0.7	0.37													0.7	0.37		
NITROGEN			56042	2001.4			65873	2352.5													9831	351.1		
METHANE																								
C_2 TO C_5																								
HYDROGEN SULFIDE																								
CARBONYL SULFIDE																								
AMMONIA																								
HYDROGEN CYANIDE																								
OXYGEN			17025	532.0		—	19487	609.0													2462	77		
CHLORIDE																								
WATER	1574		731	40.6	13200	733	12794	710.4	1740	96.7	14520	807.0					842				603	33.5	1320	73.5
TOTAL	36598		73798	2575.0	13200	733	98269	3675.0	1740	96.7	14520	807.0					926		3818		13010	464.7	1320	73.5
MM SCFD / US GPM			23.38		6.65		33.53		.38			30.25	30.88		17.47						4.22			2.8
PRESSURE PSIG OR "H_2O G	0		0		25PSIG			60"	25PSIG		25PSIG			40"		30"					80"		25PSIG	
TEMPERATURE °F	60		60		267		140		267		210		1140		250		1202		140		60		267	
DENSITY LB/FT^3			0.0718		0.0719		0.0788		0.0719		59		0.0219		0.0485						0.0885		58.8	
ENTHALPY MM BTU/HR	474.9		0.768		150		16.3		0.20		2.80		217.3		246.4		0.57		4.61				0.3	

COAL FEED ANALYSIS

MOISTURE	4.3
C	71.21
H	5.05
N	1.13
Cl	0.07
S	3.33
O	5.30
ASH	9.61
	100.00
HHV	12977

TAR/OIL ANALYSIS

C	84.11
H	9.38
N	0.95
Cl	0.00
S	2.64
O	2.92
	100.00

REVISIONS	DATE	BY	CHK	DESCRIPTION	APP
1	2/16/79			ISSUED FOR DESIGN MANUAL	
	1/7-			ISSUED FOR CLIENT REVIEW	

BABCOCK CONTRACTORS INC.
DES. MAN. DATE 2/16/79

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT-CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

GASIFICATION
DEMONSTRATION UNIT
RED - EAST COAL

SHEET 1 OF 2
PROCESS ENGINEERING APPROVAL
BY DATE
REVISION 1

DATE	BY	CHK	DESCRIPTION	APP
△				
△				
△				
△				
△1 2/16/79			ISSUED FOR DESIGN MANUAL	
△0 12/21/78			ISSUE FOR CLIENT REVIEW	

REVISIONS

CY 202 A TO E
TAR CYCLONE

E 201 A TO E
PROCESS GAS COOLER
5.22 MM BTU/HR

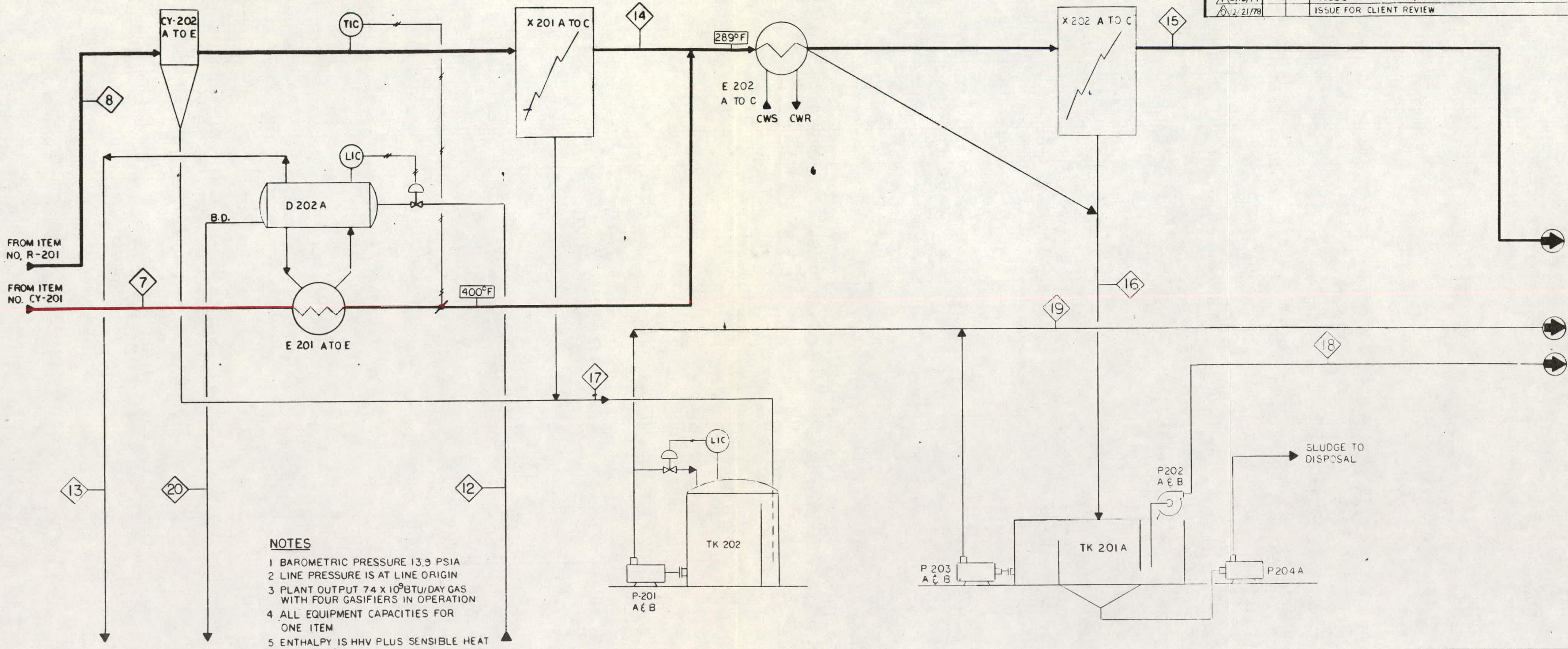
D202 A
H-P-STEAM DRUM
4'6" I.D. 15'6" T.T.

X 201 A TO C
TAR PRECIPITATOR
13'9" I.D. 24' T.T.

E 202 A TO C
COMBINED GAS COOLER
13.56 MM BTU/HR

TK 201 A
OIL/WATER SEPARATOR
4'0" H x 20'0" L x 7'0" W

X 202 A TO C
OIL PRECIPITATOR
13'9" I.D. 24' T.L.



NOTES

1. BAROMETRIC PRESSURE 13.9 PSIA
2. LINE PRESSURE IS AT LINE ORIGIN
3. PLANT OUTPUT 7.4×10^9 BTU/DAY GAS WITH FOUR GASIFIERS IN OPERATION
4. ALL EQUIPMENT CAPACITIES FOR ONE ITEM
5. ENTHALPY IS HHV PLUS SENSIBLE HEAT ABOVE 60°F
6. STANDARD MOLAR GAS VOLUME IS 378.5 FT^3

P201 A & B
TAR TRANSFER PUMP
40 GPM AT 50 FT

TK 202
TAR TANK
4'0" I.D. x 4'0" H.

P 204 A
SLUDGE PUMP
10 GPM AT 75 PSI

P 203 A & B
OIL TRANSFER PUMP
10 GPM AT 50 FT.

P 202 A & B
AQUEOUS EFFLUENT PUMP
40 GPM AT 50 FT.

CRITERIA / STREAM IDENTIFICATION	7 CLEAR GAS		8 TOP GAS		12 H.P. B.F.W.		13 H.P. STEAM		14 DETARRED GAS		15 COOLED GAS		16 OIL/WATER		17 TAR		18 AQUEOUS EFFLUENT		19 TAR/OIL		20 H.P. BLOW DOWN	
	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR
MOISTURE FREE COAL																						
ASH/CHAR/DUST													9.0						9			
TAR/OIL											9	0.09	858	8.6	2022	20.2	4	0.04	2876	28.76		
CARBON MONOXIDE											34610	1236.0										
CARBON DIOXIDE											14205	322.8	44	0.99			44	0.99				
HYDROGEN											2180	1089.5										
NITROGEN											57666	2059.2										
METHANE											487	30.43										
C_2 TO C_6											380	[illegible].50										
HYDROGEN SULFIDE											271	7.94	2	0.08			2	0.08				
CARBONYL SULFIDE											140	2.33										
AMMONIA											65	3.80	9	0.55			9	0.55				
HYDROGEN CYANIDE											4	0.12	3	0.12			3	0.12				
OXYGEN																						
CHLORIDE													4	0.12			4	0.12				
WATER					7645	424.7	6950	385.8			5062	281.2	11429	634.9			11429	634.9	0.3	0.02	695	38.6
TOTAL					7645	424.7	6950	385.8			115079	5042.9	12358	645.4	2022	20.2	11495	636.8	2885	28.8	695	38.6
MM SCFD / USGPM	13.01		38.76			16.2	3.51		38.58		45.81			24.7		4.0		23.0		5.7		1.6
PRESSURE PSIG OR " H_2O G		40"		30"	150PSIG		125PSIG			25"		20"	0		0		25PSIG		25PSIG		125PSIG	
TEMPERATURE °F	1060		250		210		352		250		95		95		250		95		204		352	
DENSITY LB/FT^3	0.0200		0.0439		59		0.308		0.0452		0.0535		62		63.24		62.0		63		55.6	
ENTHALPY MM BTU/HR	92.4		285.0		1.14		8.09		250.57		320.9		14.88		34.44		0.07		49.25		0.25	

BABCOCK CONTRACTORS INC.
PITTSBURGH PA
A Subsidiary of Babcock International Inc.
PROJECT NO 3001 DRAWING NO P006 ISSUE NO 1
FOR DES MAN SIGNED DATE 2/16/79

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT-CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

4810-Y-02-06-2
SHEET 2 OF 2

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

PROCESS ENGINEERING APPROVAL
BY — DATE

GASIFICATION
DEMONSTRATION UNIT
P.F.D. - WEST COAL

REVISION 1

BN 201 A TO F COAL SURGE HOPPER CAPACITY 66 TONS C.S. LINED

D201 A TO E L.P. STEAM DRUM 4'-6" I.D. × 11'-6" T.T. C.S.

MF202 A TO E COAL FEEDER 83 TONS/HR.

MF201 A TO E LOCK HOPPER CAPACITY 690# C.S.

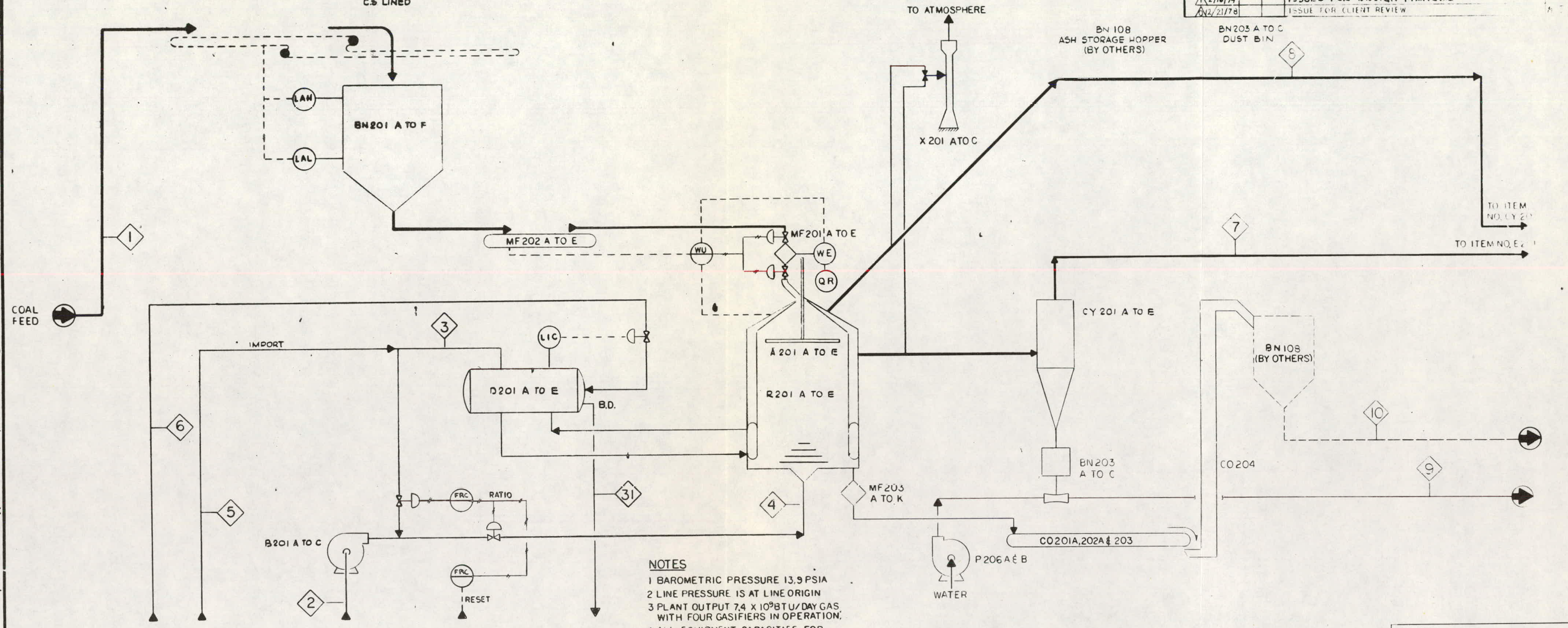
A201 A TO E STIRRER

R201 A TO E GASIFIER 12'-0" I.D. × 47' HT.

X206 A TO C FLARE STACK

CY 201 A TO E DUST CYCLONE

REVISIONS	DATE	BY	CHK	DESCRIPTION
1	2/16/79			ISSUED FOR DESIGN MANUAL
0	2/21/78			ISSUE FOR CLIENT REVIEW



NOTES

1 BAROMETRIC PRESSURE 13.9 PSIA
2 LINE PRESSURE IS AT LINE ORIGIN
3 PLANT OUTPUT 7.4 × 10⁹ BTU/DAY GAS WITH FOUR GASIFIERS IN OPERATION.
4. ALL EQUIPMENT CAPACITIES FOR ONE ITEM
5 ENTHALPY IS HHV PLUS SENSIBLE HEAT ABOVE 60°F
6. STANDARD MOLAR GAS VOLUME IS 378.5 FT^3

B201 A TO C COMBUSTION AIR BLOWER 11,050 SCFM AT 80" W.G.

MF 203 A TO K ASH LOCK 2 PER GASIFIER

P206 A & B HYDRO EJECTOR PUMP

CO201A, 202A & 203 DRAG LINK CONVEYORS

CO204 BUCKET ELEVATOR

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.
PROJECT NO 3001 DRAWING NO P005 ISSUE NO 1
FOR DES MAN. SIGNED [signature] DATE 2/16/79

CRITERIA ↓ / STREAM IDENTIFICATION →	1 COAL FEED		2 AIR		3 STM. PRODUCED		4 BLAST		5 BALANCE STM		6 L.P. B.F.W.		7 CLEAR GAS		8 TOP GAS		9 DUST		10 ASH		31 LP BLOW DOWN			
	#/HR		#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR	#/HR	MOL/HR				
MOISTURE FREE COAL	32868																							
ASH/CHAR/DUST																	101		3975					
TAR/OIL																								
CARBON MONOXIDE																								
CARBON DIOXIDE																								
HYDROGEN																								
NITROGEN			57 330	2 048			57 330	2 048																
METHANE																								
C_2 TO C_6																								
HYDROGEN SULFIDE																								
CARBONYL SULFIDE																								
AMMONIA																								
HYDROGEN CYANIDE																								
OXYGEN			17 435	545			17435	545																
CHLORIDE																								
WATER	11310		747	41.5	13200	733	14 592	810	647	35.9	14 920	806 7					1010				1320	73.5		
TOTAL	44178		75512	2634.5	13 200	733	89 357	3403	647	35.9	14520	806 7					1111		3975		1320	73.5		
MM SCFD / USGPM			23.8		6.65		30.9		0.326			30.25	13.01		38.76							2.8		
PRESSURE PSIG OR " H_2O G.	0		0		25PSIG			60	25 PSIG		25 PSIG			40		30"					25 PSIG			
TEMPERATURE °F	60		60		267		147		267		210		1060		250		1202		147		267			
DENSITY LB/FT.^{3}			0.0718		0.0952		0.0692		0.0952		59		0.0200		0.0439						58.8			
ENTHALPY MM BTU/HR.	388.0		0		15.0		17.6		0.735		2.17		92.4		285		0.71		2.91		0.3			

COAL FEED ANALYSIS	
MOISTURE	25.60
C	50.74
H	3.53
N	0.87
Cl	0.01
S	0.87
O	10.11
ASH	8.27
	100.00
HHV	8775 BTU

TAR/OIL ANALYSIS	
C	88.23
H	6.72
N	0.61
Cl	0.00
S	1.38
O	3.06
	100.00

U. S. DEPARTMENT OF ENERGY

FUEL GAS DEMONSTRATION PLANT PROGRAM

SMALL SCALE INDUSTRIAL PROJECT–CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKEE ENGINEERS AND CONSTRUCTORS CLEVELAND OHIO

4814-Y-02-05-2
SHEET 1 OF 2

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

PROJECT NO 3001 P.E. NO

PROCESS ENGINEERING APPROVAL
BY [signature] DATE [illegible]

GASIFICATION DEMONSTRATION UNIT
P.F.D. WEST COAL

REVISION 1

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 4.0 - DRAWINGS

4.1 Non-Proprietary Drawings

4.1.3 Piping and Instrumentation Drawings

4814-Y-02-09-2	Symbols and Legends
4814-Y-02-11-2	Gasifier R201A
4814-Y-02-12-2	Gasifier R201B
4814-Y-02-13-2	Gasifier R201C
4814-Y-02-14-2	Gasifier R201D
4814-Y-02-15-2	Gasifier R201E
4814-Y-02-23-2	Process Interconnecting
4814-Y-02-25-2	Detarring
4814-Y-02-27-2	Deoiling
4814-Y-02-29-2	Gas Cooling
4814-Y-02-31-2	Utility (Water & Gas)
4814-Y-02-33-2	Utility (Steam & Condensate)
4814-Y-02-35-2	Ash Handling
4814-Y-02-37-2	Ash Handling

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

4.1.3

SCALING RULES 1/8" 1/4" 3/8" 1/2"

INSTRUMENT IDENTIFICATION

I.S.A. STANDARD S5.1 - REV. 1973 SHALL APPLY FOR SYMBOLS AND IDENTIFICATION NOT PRESENTED ON THIS SHEET

	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED/ INITIATING VARIABLE	MODIFIER	READOUT/ PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER FLAME				
C	CONDUCTIVITY (ELECTRICAL)			CONTROL	
D	DENSITY (MASS) /SPEC GRAVITY	DIFFERENTIAL			
E	VOLTAGE (EMF)		PRIMARY ELEMENT		
F	FLOW RATE	RATIO (FRACTION)			
G	GAGING (DIMENSIONAL)		GLASS		
H	HAND (MANUALLY INITIATED)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME / TIME SCHEDULE			CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	MOISTURE/ HUMIDITY				MIDDLE INTERMEDIATE
N					
O			ORIFICE (RESTRICTION)		
P	PRESSURE/ VACUUM		POINT (TEST CONNECTION)		
Q	QUANTITY/ EVENT	INTEGRATE/ TOTALIZE			
R	RADIOACTIVITY		RECORD/PRINT		
S	SPEED/ FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VISCOSITY			VALVE DAMPER/ LOUVER	
W	WEIGHT/FORCE		WELL		
X					
Y				RELAY/COMPUTE	
Z	POSITION			DRIVE ACTUATE/ UNCLASSIFIED FINAL CONTROL ELEMENT	

LINE IDENTIFICATION

LINE SIZE	UNIT DESIGNATION	SERVICE CODE	LINE NUMBER	LINE SPECIFICATION	INSULATION CODE
XX	X	X	XXXX	XXX	XXX

SERVICE	LINE NO.	SPEC	CODE	SERVICE	LINE NO.	SPEC	CODE
COMBUSTION AIR	100-199	C11E	CA	BLOWDOWN	1500-1599	C11B	BD
ASH BLOWER AIR	200-299	C11E	AA	AQUEOUS EFF.	1600-1699	C11E	AE
INERT GAS	300-399	C11E	IG	INST. AIR	1700-1799	G75A	IA
BOILER FEED LOW BOILER FEED HIGH	400-599	C11B	BFL BFH	DOMESTIC WATER	1800 1899	B78 & G75	DW
SLUDGE		C11F	SL				
L.P. STEAM	600-799	C11B	LS	THERMOSYPHON	1900-1999	CA1J	TS
H.P. STEAM	800-899	C11B	HS	COMBINED GAS	2000-2099	CA1J	MG
TOP GAS	900-999	CA1J	TG	GREASE	2100-2199		GR
CLEAR GAS	1000-1099		CG	FLARE STACK GAS	2200-2299	CA1J	FG
OIL	1100-1199	C11E	OL	UTILITY AIR	2300-2399	C11E	UA
TAR	1200-1299	C11D	TR	CHEMICAL DRAIN	2400-2499	C11E	CD
HYDRAULICS	1300-1399	C61A	HY	PILOT GAS	2500-2599	C11	PC
COOLING W. SUP	1400-1499	C11E	CWS	CONDENSATE	2600-2699	C11B	CO
COOLING W. RET	1400 1499	C11E	CWR				

PIPING & INSTRUMENT DIAGRAM ABBREVIATIONS

GENERAL

ATM ATMOSPHERE
AVG AVERAGE
BTU BRITISH THERMAL UNIT
COND CONDENSATE
CU.FT. CUBIC FEET
CFH CUBIC FEET PER HOUR
CFM CUBIC FEET PER MINUTE
CFS CUBIC FEET PER SECOND
CU IN CUBIC INCH
CYL CYLINDER
(°)DEG DEGREE
EL ELEVATION
EXT EXTERNAL
F FAHRENHEIT DEGREES
FPM FEET PER MINUTE
FPS FEET PER SECOND
(')FT. FOOT-FEET
GAL GALLONS
GPD GALLONS PER DAY
GPH GALLONS PER HOUR
GPM GALLONS PER MINUTE
GPS GALLONS PER SECOND
HP HIGH PRESSURE
HP HORSEPOWER
HR HOUR
(")IN INCH
ID INSIDE DIAMETER
INT INTERNAL
KW KILOWATT
KWH KILOWATT HOUR
LIQ. LIQUID
LP LOW PRESSURE
MAX MAXIMUM
MM MILLION
M THOUSAND
MOL MOLES
NO NUMBER
% PERCENT
LB POUND
PCF POUNDS PER CUBIC FOOT
LB/GAL POUNDS PER GALLON
#/HR POUNDS PER HOUR
PSF POUNDS PER SQUARE FOOT
PSI POUNDS PER SQUARE INCH
PSIA POUNDS PER SQUARE INCH-ABSOLUTE
PSIG POUNDS PER SQUARE INCH GAUGE
SCFD STANDARD CUBIC FEET PER DAY
SEC SECOND
SG SPECIFIC GRAVITY
STD STANDARD
SCFH STANDARD CUBIC FEET PER HOUR (60°F) AT 1 ATMOSPHERE AT SEA LEVEL
ST STEAM TRAP
STR STRAINER
TEMP TEMPERATURE
T TEMPORARY SERVICE
VISC VISCOSITY
VI VISCOSITY INDEX
W WATT
WT WEIGHT

SAFETY

ATM TO ATMOSPHERE
FLARE TO FLARE
STACK TO STACK

LOCALLY MOUNTED INSTR.
PANEL MOUNTED INSTR. (X-PANEL I.D.)
BACK PANEL MOUNTET INSTR. (X-PANEL I.D.)
DUAL VARIABLE INSTR.

UTILITIES

BFL BOILER FEED LOW
BFH BOILER FEED HIGH
COND CONDENSATE
CWS COOLING WATER SUPPLY
CWR COOLING WATER RETURN
DW DOMESTIC WATER
IW INDUSTRIAL WATER
UA INDUSTRIAL AIR
IA INSTRUMENT AIR
NITROGEN-XXX NITROGEN (PRESSURE)
STM XXX STEAM (PRESSURE)

LINE & PIPING SYMBOLS IDENTIFICATION

TO OR FROM (UAL) UNIT AREA LIMIT
MAIN PROCESS LINE
SECONDARY PROCESS LINE
ELECTRICAL LINE
PNEUMATIC LINE
CAPILLARY TUBING
HYDRAULIC SIGNAL
ELECTROMAGNETIC &/OR SONIC SIGNAL
INSULATION
STEAM TRACED
LINE SPECIFICATION CHANGE
FURNISHED PIPING
FUTURE PIPING
ELECTRIC TRACED
* INDICATES FURNISHED WITH ASSOCIATED EQUIPMENT

VALVES

GATE VALVE
BALL VALVE
GLOBE VALVE
NEEDLE VALVE
PLUG VALVE
CHECK VALVE
BUTTERFLY VALVE
BUTTERFLY CONTROL VALVE
CONTROL VALVE WITH HANDWHEEL
HAND OPERATED CONTROL VALVE
SAFETY VALVE
FLUSH BOTTOM VALVE
PISTON OPERATED BALL VALVE HIGH TEMP (HT)
PISTON OPERATED CONTROL VALVE
DIAPHRAGM OPERATED CONTROL VALVE
FC VALVE CLOSES ON ACTUATING MEDIUM FAILURE
FO VALVE OPENS ON ACTUATING MEDIUM FAILURE
FCL-FC VALVE LOCKS IN LAST POSITION ON ACTUATING MEDIUM FAILURE
BACK PRESSURE CONTROL VALVE
PRESSURE REDUCING CONTROL VALVE
THREE WAY VALVE
DIAPHRAGM OPERATED THREE WAY CONTROL VALVE
PISTON OPERATED SLIDE VALVE
CSC CAR SEAL CLOSED
ANGLE VALVE

MISCELLANEOUS SYMBOLS

Y-TYPE STRAINER
BASKET STRAINER
FIGURE 8 BLIND (SPECTACLE BLIND)
TEMPORARY STRAINER
RO RESTRICTION ORIFICE
FE FLOW ELEMENT
BLIND FLANGE
REDUCER
HOSE CONNECTION
EXPANSION JOINT
PIPE CAP (THREADED)
PIPE CAP (WELDED)
FI ROTAMETER, FLOW INDICATOR
FE VENTURI
TRAP
OPEN DRAIN
EC-CLEAN WATER
EO-OILY WATER
ES-SANITARY WATER
LOCATION FOR BLIND FLANGE
PO - PUMP OUT
SO - STEAM OUT
SC - SAMPLE CONN.
FLEXIBLE HOSE

EQUIPMENT SYMBOLS

CENTRIFUGAL PUMP (MOTOR DRIVEN)
SUMP PUMP (MOTOR DRIVEN)
POSITIVE DISPLACEMENT PUMP (MOTOR DRIVEN)
BLOWER (MOTOR DRIVEN)
CENTRIFUGAL COMPRESSOR (MOTOR DRIVEN)
SHELL AND TUBE HEAT EXCHANGER
HORIZONTAL DRUM
HOPPER
EDUCTOR
CONVEYOR (BELT TYPE)
AGITATOR
SILENCER
SCALES

PROCESS ENGINEERING APPROVAL BY [illegible] DATE 11/18/78

3001 DES. MAN. P-009 2 2/16/79

REVISIONS	DATE	BY	CHK	DESCRIPTION	APP.
2	2/16/79			ISSUED FOR DESIGN MANUAL	
1	11/11/78			REVISED PER McKEE COMMENTS	
0	11/6/78			ISSUE FOR CLIENT REVIEW	

U. S. DEPARTMENT OF ENERGY

FUEL GAS DEMONSTRATION PLANT PROGRAM

SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS CLEVELAND — OHIO

4814-Y-02-09-2

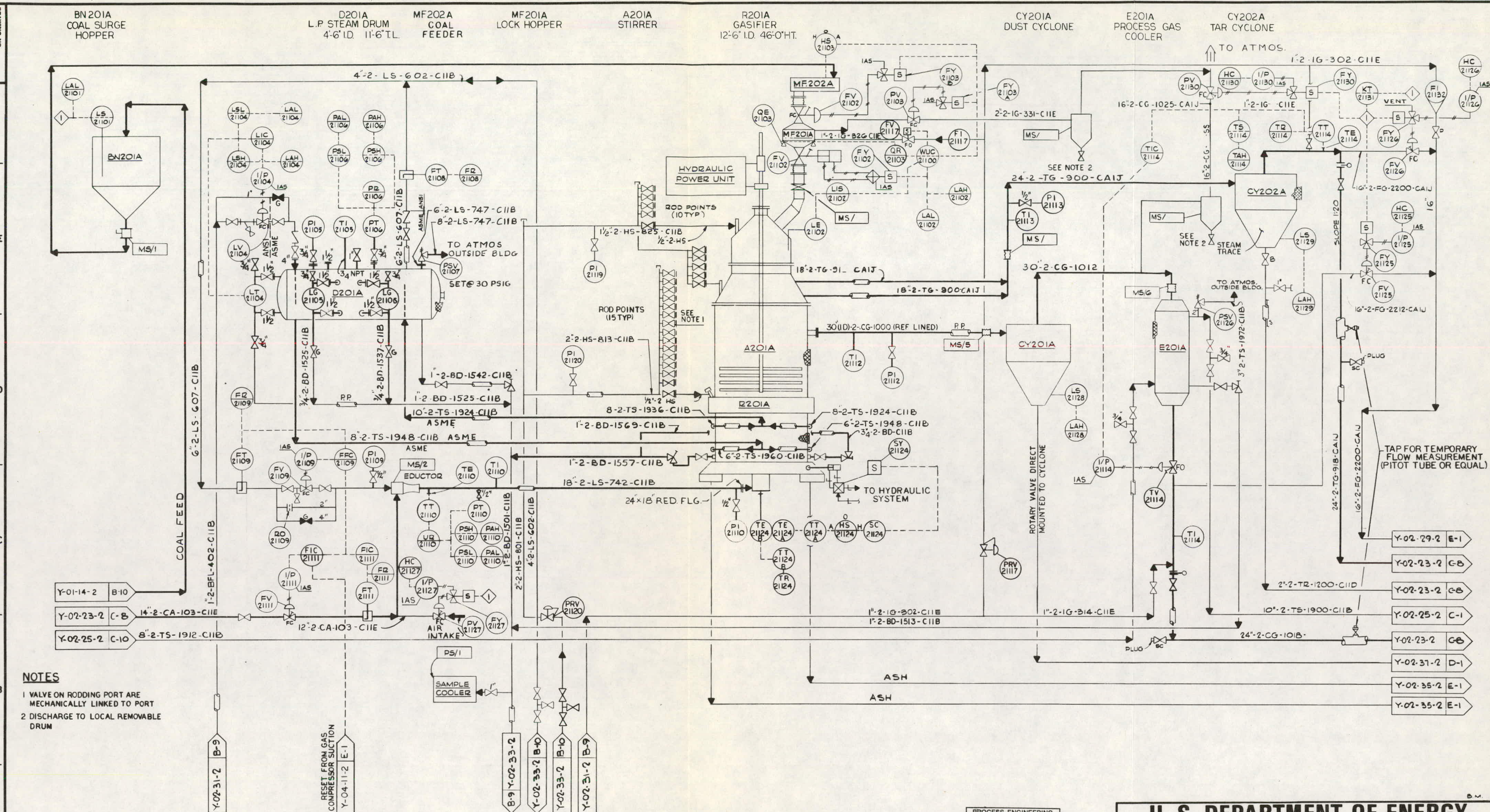
FOR ERIE MINING COMPANY

PICKANDS MATHER AND CO. MANAGING AGENT

HOYT LAKES — MINNESOTA

GASIFICATION
COMMERCIAL UNIT STAGE I & II
SYMBOLS AND LEGEND

PROJECT NO. 3001 P.E. NO.
SCALE NONE
REVISION 2



NOTES

1. VALVE ON RODDING PORT ARE MECHANICALLY LINKED TO PORT
2. DISCHARGE TO LOCAL REMOVABLE DRUM

PROCESS ENGINEERING APPROVAL
BY [signature] DATE 11/15/78

BABCOCK CONTRACTORS INC.
PITTSBURGH PA
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. P-011 ISSUE NO. 2

U. S. DEPARTMENT OF ENERGY

FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT-CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKEE ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

4814-Y-02-11-2

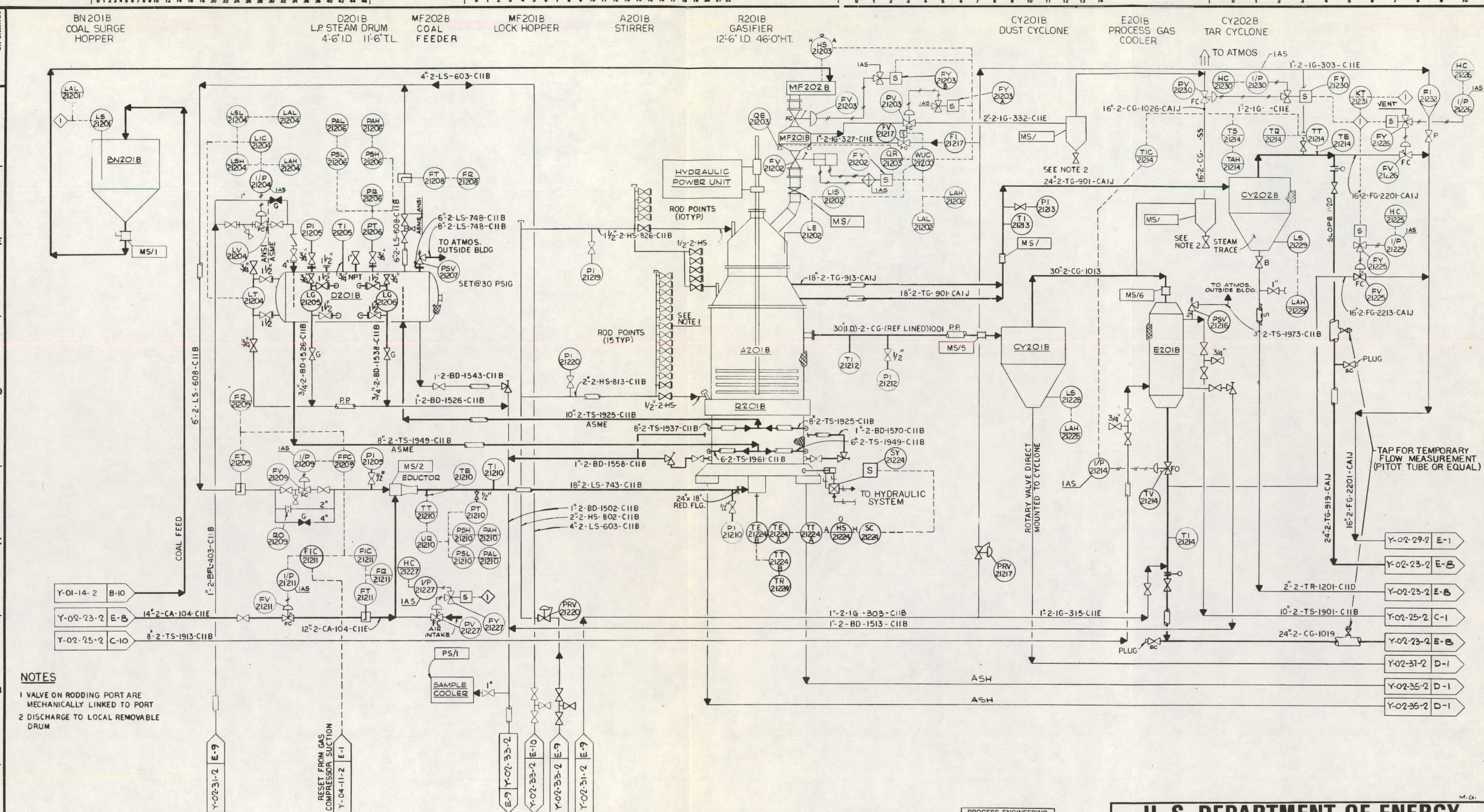
FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

PROJECT NO. 3001
SCALE NONE

GASIFICATION
COMMERCIAL UNIT - STAGE I (DEMO)
P& I.D. GASIFIER R201A

REVISION 2

REVISIONS	DATE	BY	CHK	DESCRIPTION	APP.
2	2/16/79			ISSUED FOR DESIGN MANUAL	
1	11/11/78			REVISED PER McKEE COMMENTS	
0	11/6/78			ISSUE FOR CLIENT REVIEW	



NOTES

1. VALVE ON RODDING PORT ARE MECHANICALLY LINKED TO PORT
2. DISCHARGE TO LOCAL REMOVABLE DRUM

PROCESS ENGINEERING APPROVAL BY ______ DATE 11/18/78

BABCOCK CONTRACTORS INC.
PITTSBURGH PA
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. P-012 ISSUE NO. __
FOR DES. MAN. SIGNED ______ DATE 2/16/79

U. S. DEPARTMENT OF ENERGY

FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

4814-Y-02-12-2

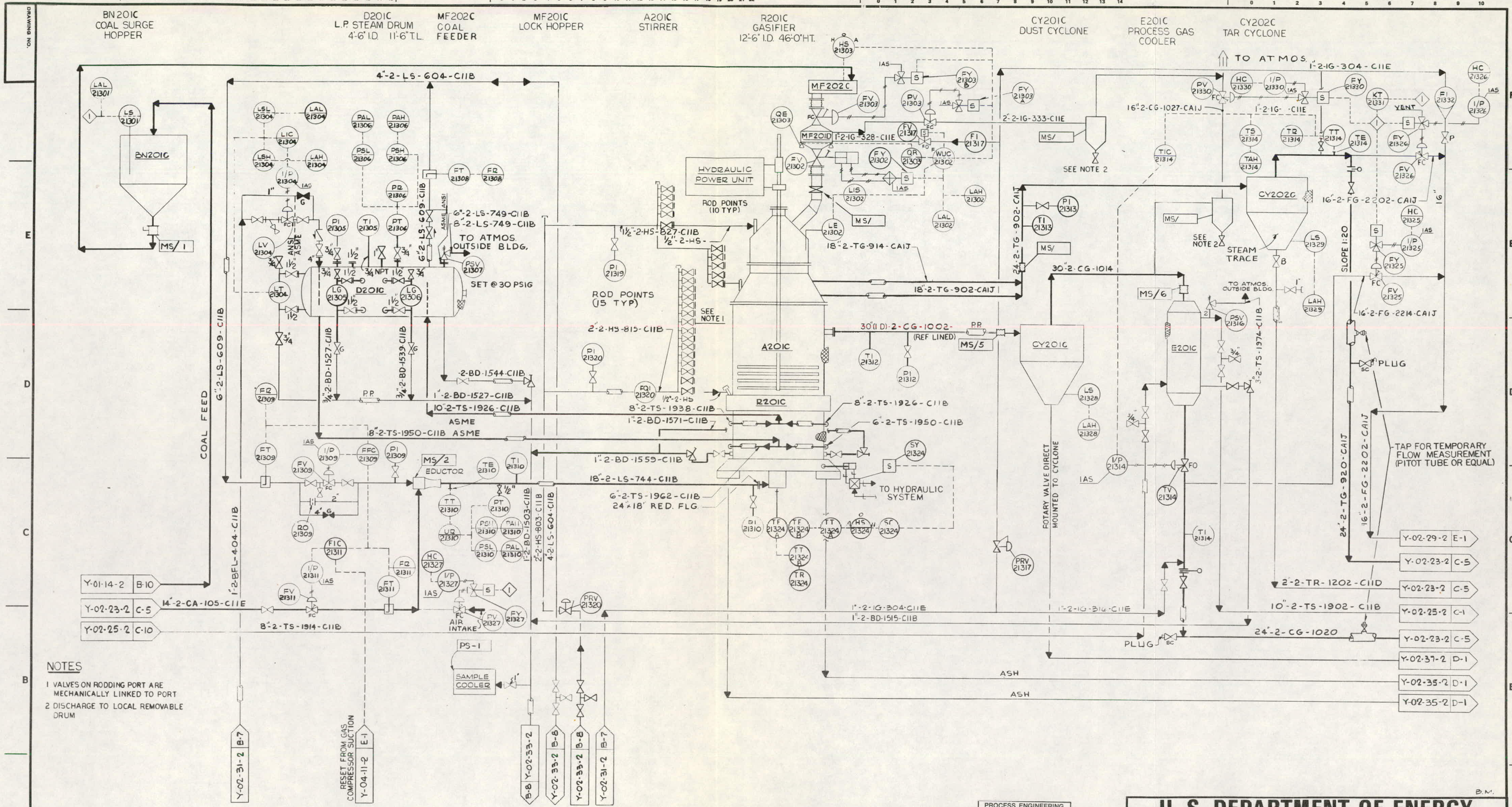
FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

PROJECT NO. 3001 P.E. NO.
SCALE NONE

GASIFICATION
COMMERCIAL UNIT - STAGE I (DEMO)
P & I.D. GASIFIER R201B

REVISION 2

REV	DATE	BY	CHK	DESCRIPTION	APP.
2	2/16/79			ISSUED FOR DESIGN MANUAL	
1	11/11/78			REVISED PER McKEE COMMENTS	
0	11/6/78			ISSUE FOR CLIENT REVIEW	



NOTES

1. VALVES ON RODDING PORT ARE MECHANICALLY LINKED TO PORT
2. DISCHARGE TO LOCAL REMOVABLE DRUM

PROCESS ENGINEERING APPROVAL
BY ___ DATE 11/18/78

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. P-013 ISSUE NO. 2

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT–CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKEE ENGINEERS AND CONSTRUCTORS
CLEVELAND, OHIO

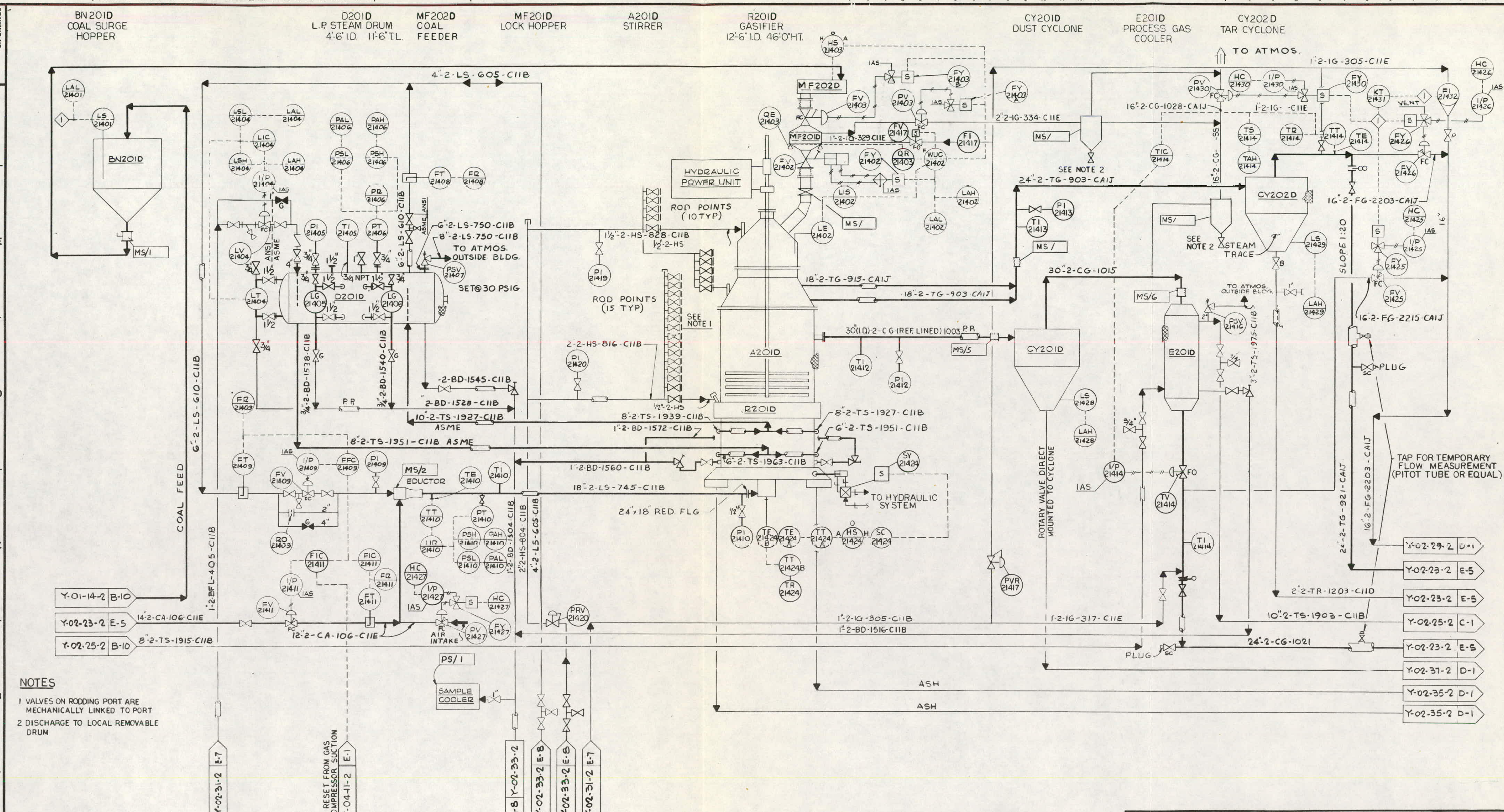
4814-Y-02-13-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

GASIFICATION
COMMERCIAL UNIT - STAGE I (DEMO)
P & I.D. GASIFIER R201C

PROJECT NO. 3001
SCALE NONE
REVISION 2

REV.	DATE	BY	CHK	DESCRIPTION	APP.
2	2/16/79			ISSUED FOR DESIGN MANUAL	
1	11/11/78			REVISED PER McKEE COMMENTS	
0	11/6/78			ISSUE FOR CLIENT REVIEW	



NOTES

1 VALVES ON RODDING PORT ARE MECHANICALLY LINKED TO PORT

2 DISCHARGE TO LOCAL REMOVABLE DRUM

This drawing, including the information it contains, is the property of Erie Mining Company, Pickands Mather & Co., Managing Agent. It is submitted only in connection with a project under contract between Erie and The United States Department of Energy and must not be used in any manner detrimental to the interests of Erie or the Department of Energy. The drawing is not to be copied and must be returned upon request.

PROCESS ENGINEERING APPROVAL

BABCOCK CONTRACTORS INC.
PITTSBURGH PA
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. P-014 ISSUE NO. 2

U. S. DEPARTMENT OF ENERGY

FUEL GAS DEMONSTRATION PLANT PROGRAM

SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS

CLEVELAND — OHIO

4814-Y-02-14-2

FOR ERIE MINING COMPANY

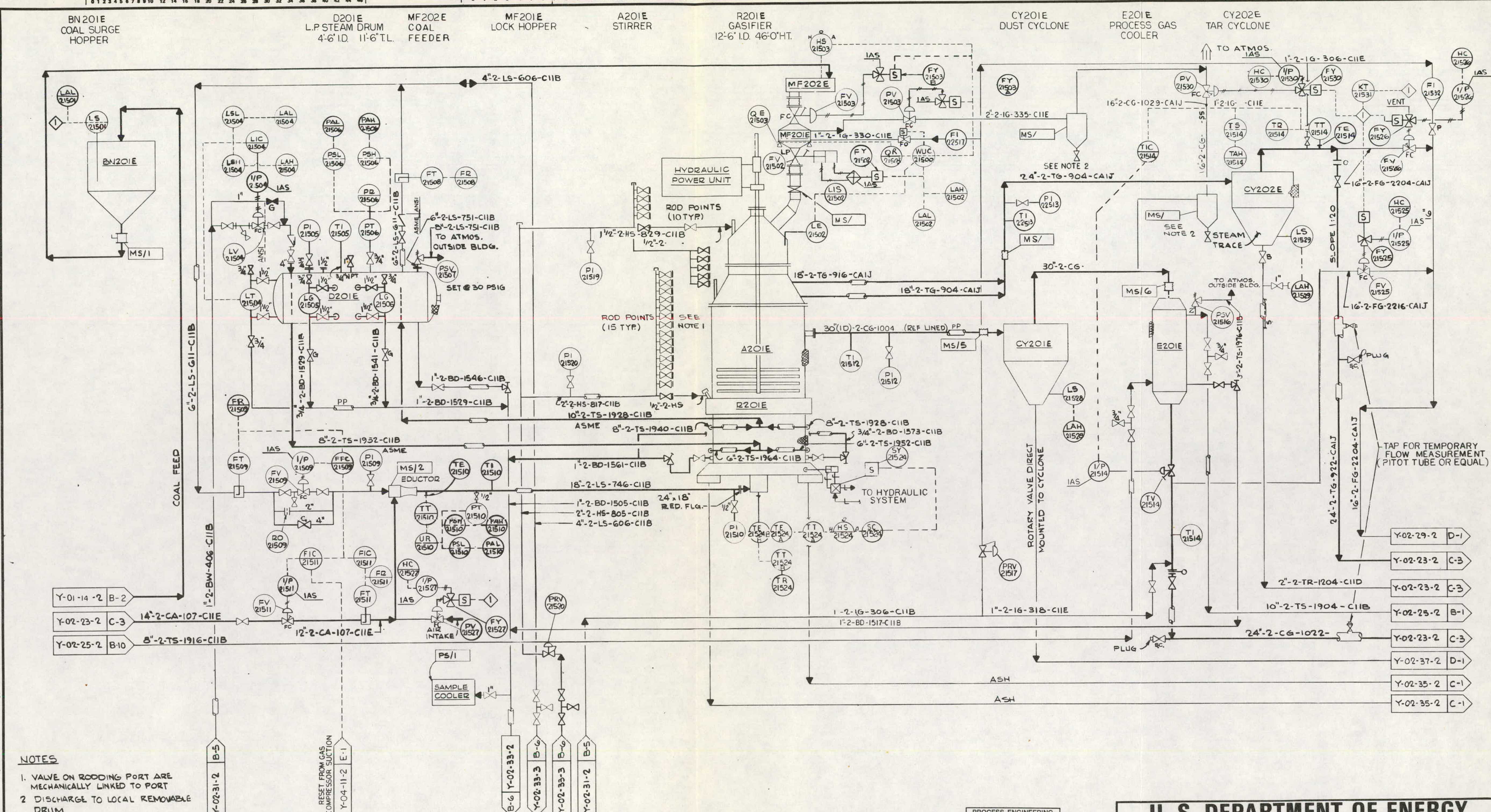
PICKANDS MATHER AND CO. — MANAGING AGENT

HOYT LAKES — MINNESOTA

GASIFICATION
COMMERCIAL UNIT - STAGE I (DEMO)
P& I.D. GASIFIER R201D

PROJECT NO. 3001 | SCALE NONE | REVISION 2

REV	DATE	DESCRIPTION
2	2/15/79	ISSUED FOR DESIGN MANUAL
1	11 78	REVISED PER McKEE COMMENTS
0	11-6-78	ISSUE FOR CLIENT REVIEW



NOTES

1. VALVE ON RODDING PORT ARE MECHANICALLY LINKED TO PORT
2. DISCHARGE TO LOCAL REMOVABLE DRUM

PROCESS ENGINEERING APPROVAL
BY [signature] DATE 11/18/78

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. P-015 ISSUE NO. 2
FOR DFS MAN SIGNED [signature] DATE 2/16/79

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

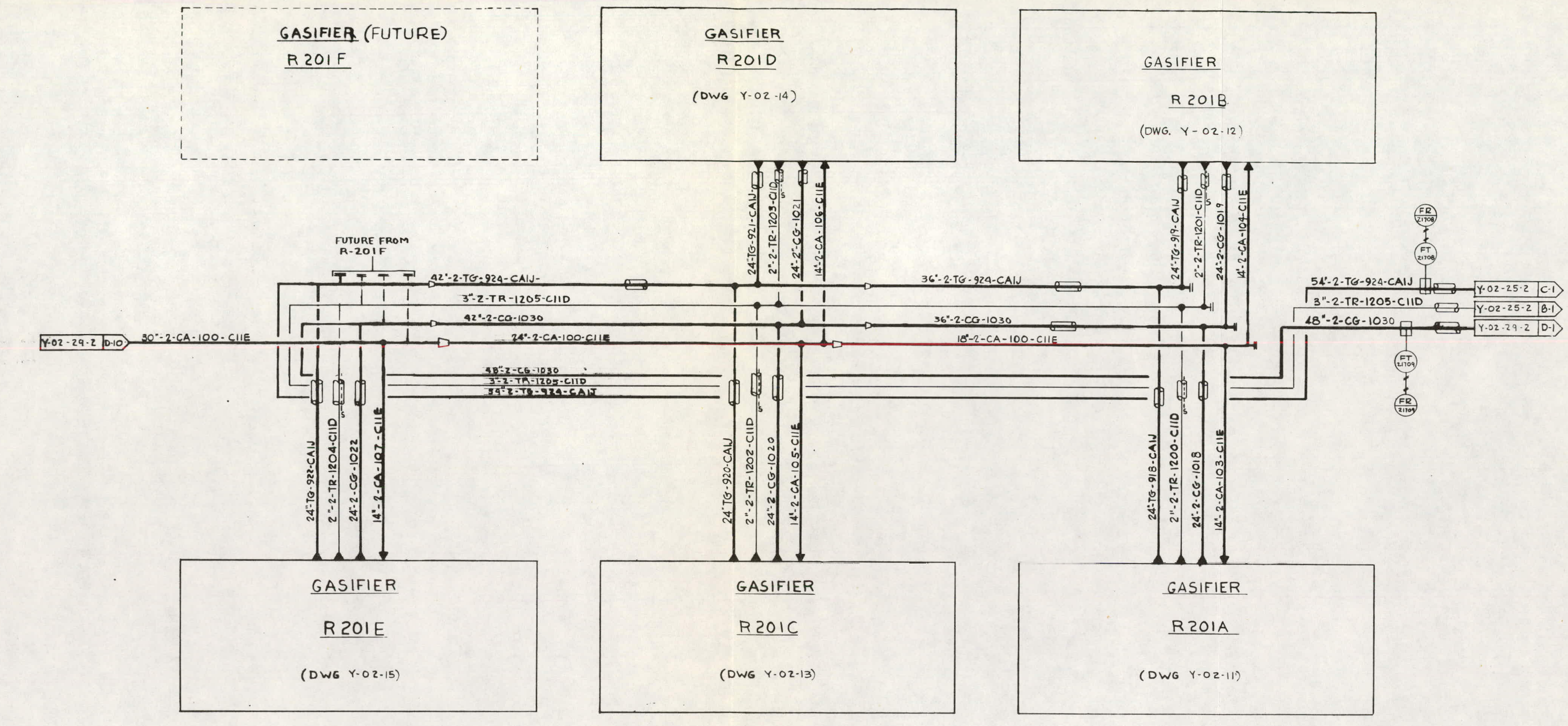
4814-Y-02-15-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

GASIFICATION
COMMERCIAL UNIT - STAGE I (DEMO)
P & I.D. GASIFIER R201E

PROJECT NO. 3001
SCALE NONE
REVISION 2

REV	DATE	BY	CHK	DESCRIPTION	APP.
2	2/16/79			ISSUED FOR DESIGN MANUAL	
	11/11/78			REVISED PER McKEE COMMENTS	
0	11/6/78			ISSUE FOR CLIENT REVIEW	



NOTE

1. ALL GAS DUCTS ARE TO SLOPE 1:100 IN THE DIRECTION OF GAS FLOW UNLESS NOTED OTHERWISE ON THESE DIAGRAMS

PROCESS ENGINEERING APPROVAL
BY: [illegible] DATE 11/8/79

BABCOCK CONTRACTORS INC.
3001 R-023 2
DES MAN 2/16/79

DATE	BY	CHK	DESCRIPTION	APP.
2/16/79			ISSUED FOR DESIGN MANUAL	
11/1/79	JM		REVISED PER McKEE COMMENTS	
11/6/78	JM		ISSUE FOR CLIENT REVIEW	

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT-CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

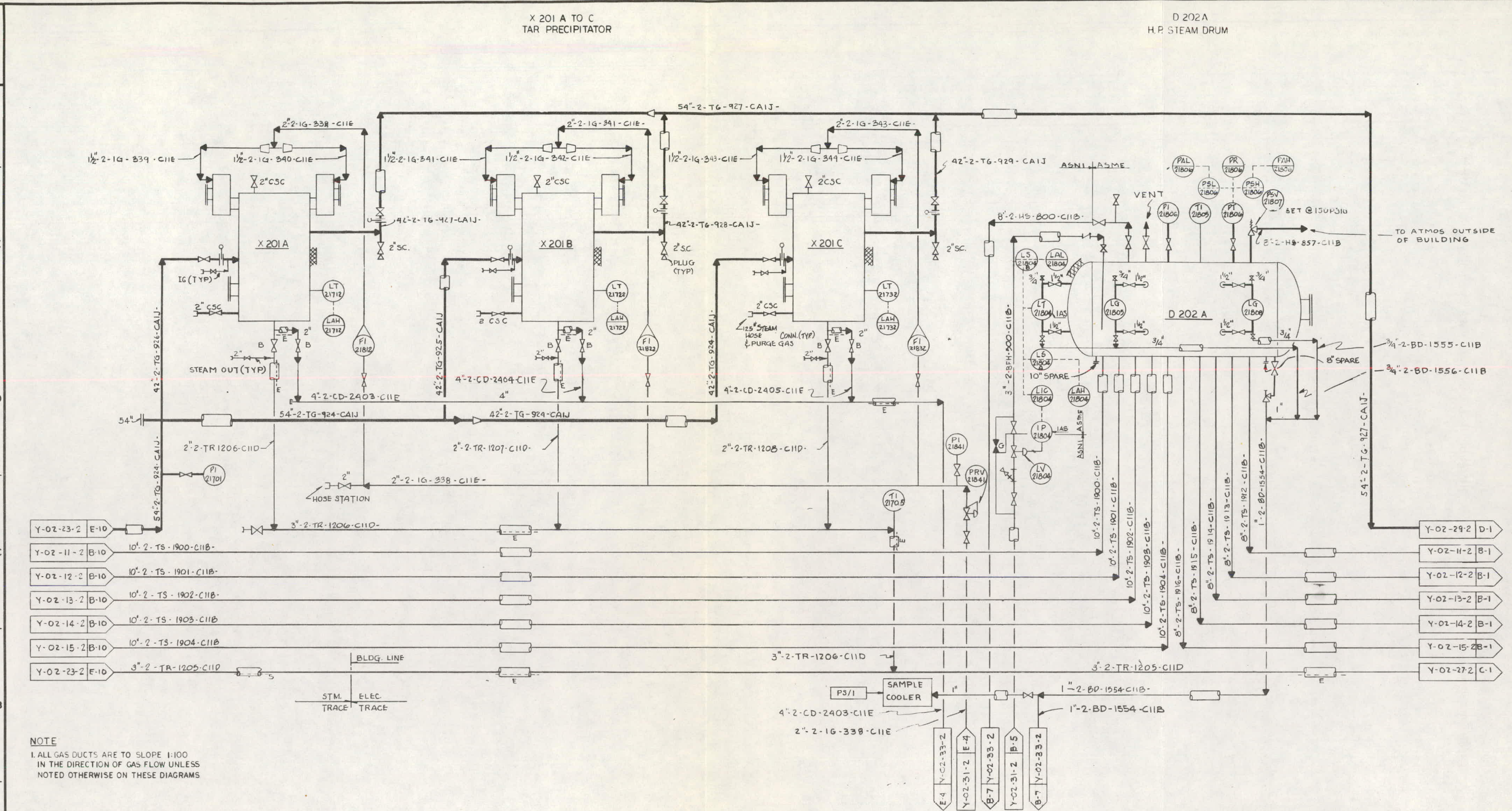
4814-Y-02-23-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

PROJECT NO. 3001
SCALE NONE

GASIFICATION
COMMERCIAL UNIT STAGE I (DEMO)
P & I.D. PROCESS INTERCONNECTING

REVISION 2



PROCESS ENGINEERING APPROVAL
BY: DATE: 11/8/78

3001 P-025

DATE	BY	CHK	DESCRIPTION	APP.
2/16/79			ISSUED FOR DESIGN MANUAL	
11/11/78	JM		REVISED PER McKEE COMMENTS	
11/6/78	JM		ISSUED FOR CLIENT REVIEW	

U. S. DEPARTMENT OF ENERGY

FUEL GAS DEMONSTRATION PLANT PROGRAM

SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS

CLEVELAND — OHIO

4814-Y-02-25-2

FOR **ERIE MINING COMPANY**

PICKANDS MATHER AND CO. MANAGING AGENT

HOYT LAKES — MINNESOTA

PROJECT NO. 3001

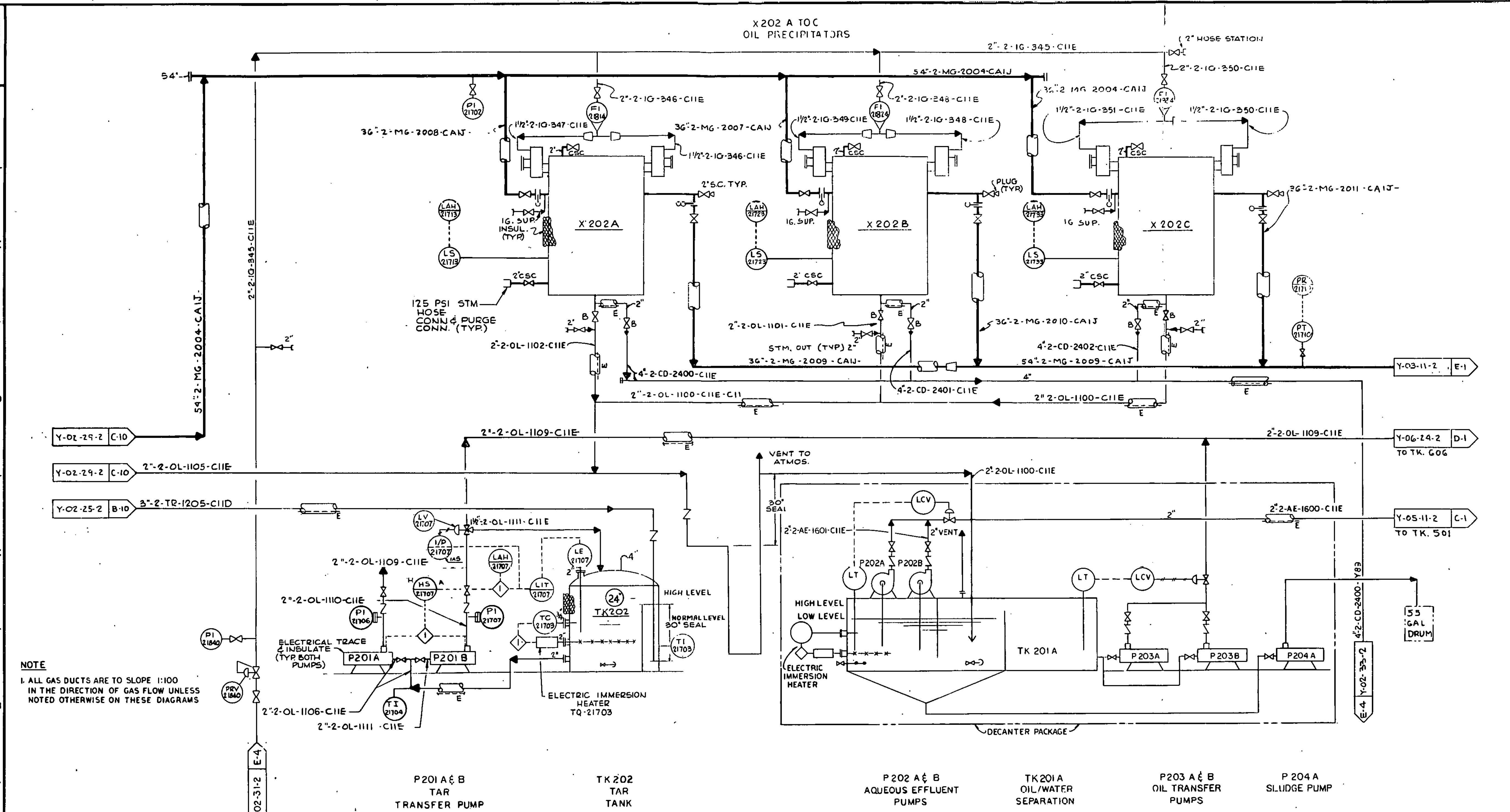
SCALE NONE

GASIFICATION

COMMERCIAL UNIT STAGE I (DEMO)

P&I.D. DETARRING

REVISION 2



PROCESS ENGINEERING APPROVAL
BY ... DATE 11/18/78

3001 P-027 2
GES MAN. 4/16/79

DATE	BY	CHK	DESCRIPTION	APP.
2/16/79			ISSUED FOR DESIGN MANUAL	
11/11/78	JM		REVISED PER McKEE COMMENTS	
11/6/78	JM		ISSUE FOR CLIENT REVIEW	

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

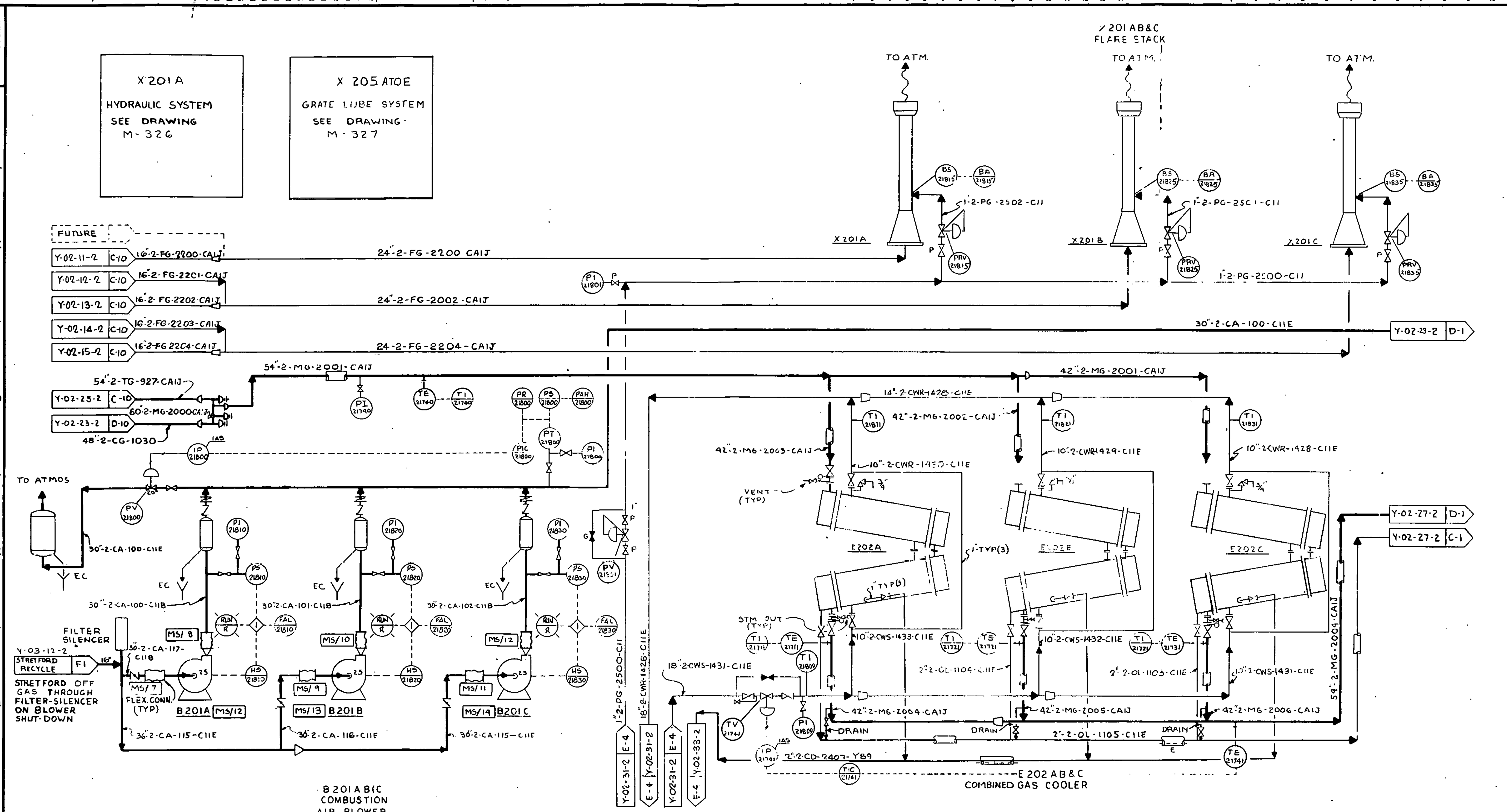
4811-Y-...-27-2

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

PROJECT NO. 3001
SCALE NONE

GASIFICATION
COMMERCIAL UNIT STAGE I (DEMO)
P & I.D. DECOILING

REVISION 2



PROCESS ENGINEERING APPROVAL
BY [illegible] DATE 11/16/78

3001 P-029 2

DATE	BY	CHK	DESCRIPTION	APP.
[illegible]			ISSUED FOR DESIGN MANUAL	
11/11/79	JM		REVISED PER McKEE COMMENTS	
11/6/78	[illegible]		ISSUE FOR CLIENT REVIEW	

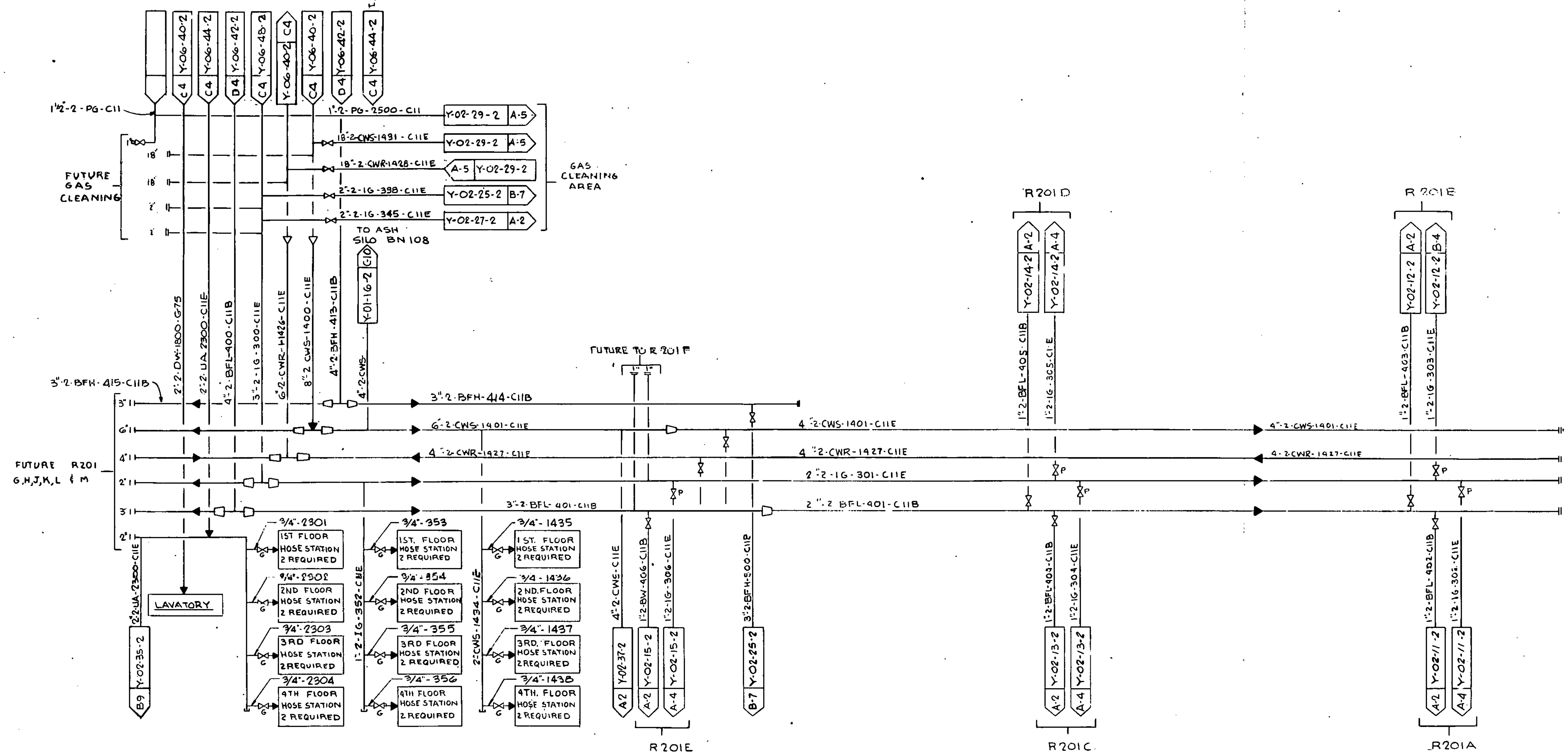
U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

GASIFICATION
COMMERCIAL UNIT STAGE I (DEMO)
P&I.D. GAS COOLING

PROJECT NO. 300
SCALE NONE
REVISION 4



PROCESS ENGINEERING APPROVAL

DATE	BY	CHK	DESCRIPTION	APP.
2			ISSUED FOR DESIGN MANUAL	
1 11/11/78			REVISED PER McKEE COMMENTS	
0 11/6/78			ISSUE FOR CLIENT REVIEW	

3001 P031 2

U. S. DEPARTMENT OF ENERGY

FUEL GAS DEMONSTRATION PLANT PROGRAM

SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS

CLEVELAND — OHIO

4814-Y-02-31-2

FOR **ERIE MINING COMPANY**

PICKANDS MATHER AND CO. MANAGING AGENT

HOYT LAKES — MINNESOTA

PROJECT NO. 3001 | P.E. NO.

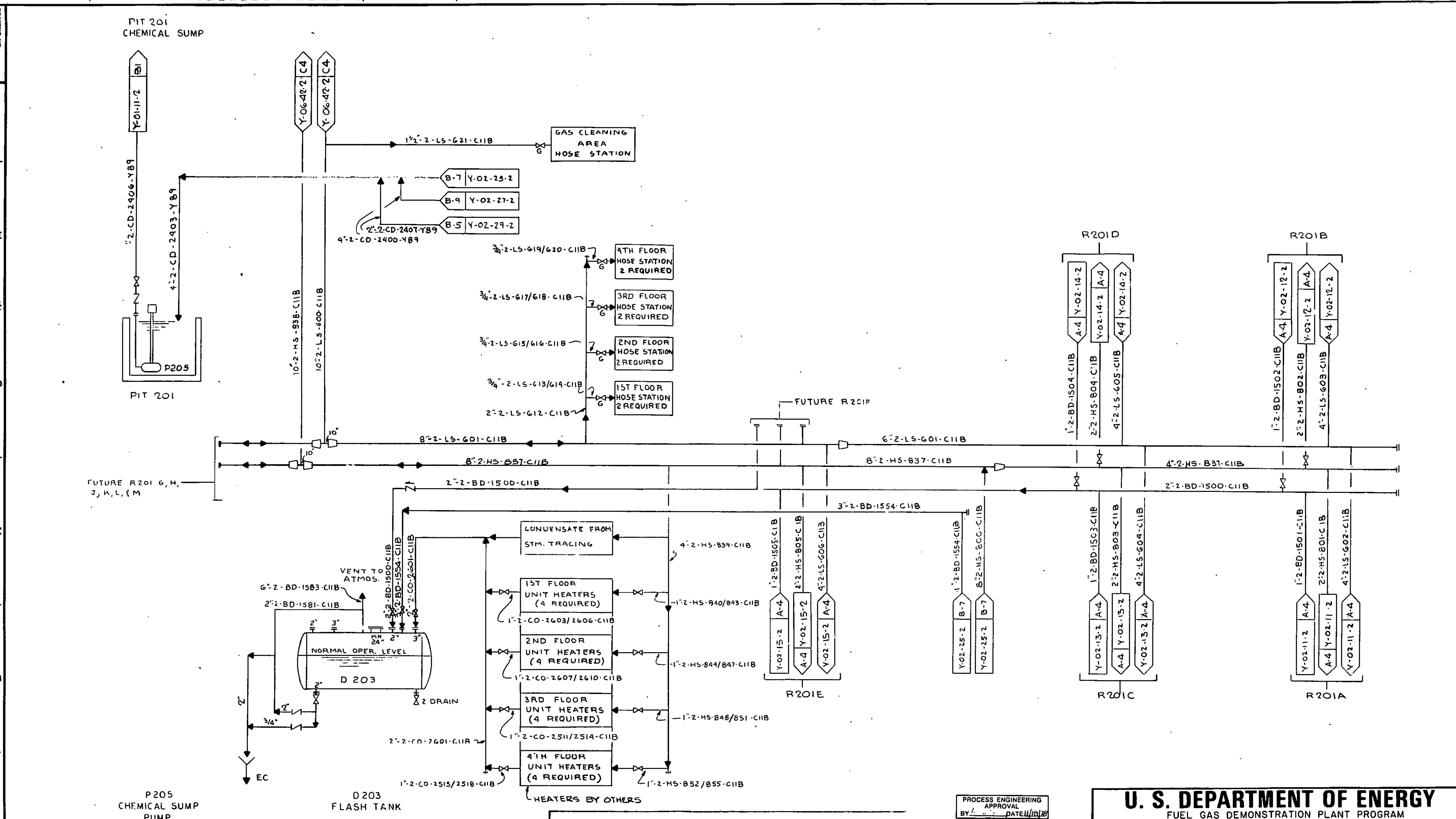
SCALE NONE

REVISION 2

GASIFICATION

COMMERCIAL UNIT STAGE I (DEMO.)

P.&I.D. UTILITY (WATER & GAS)



U. S. DEPARTMENT OF ENERGY

FUEL GAS DEMONSTRATION PLANT PROGRAM

SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS

CLEVELAND — OHIO

4814-Y-02-33-2

FOR ERIE MINING COMPANY

PICKANDS MATHER AND CO. MANAGING AGENT

HOYT LAKES — MINNESOTA

GASIFICATION

COMMERCIAL UNIT STAGE I (DEMO)

P.& I.D. UTILITY (STEAM & CONDENSATE)

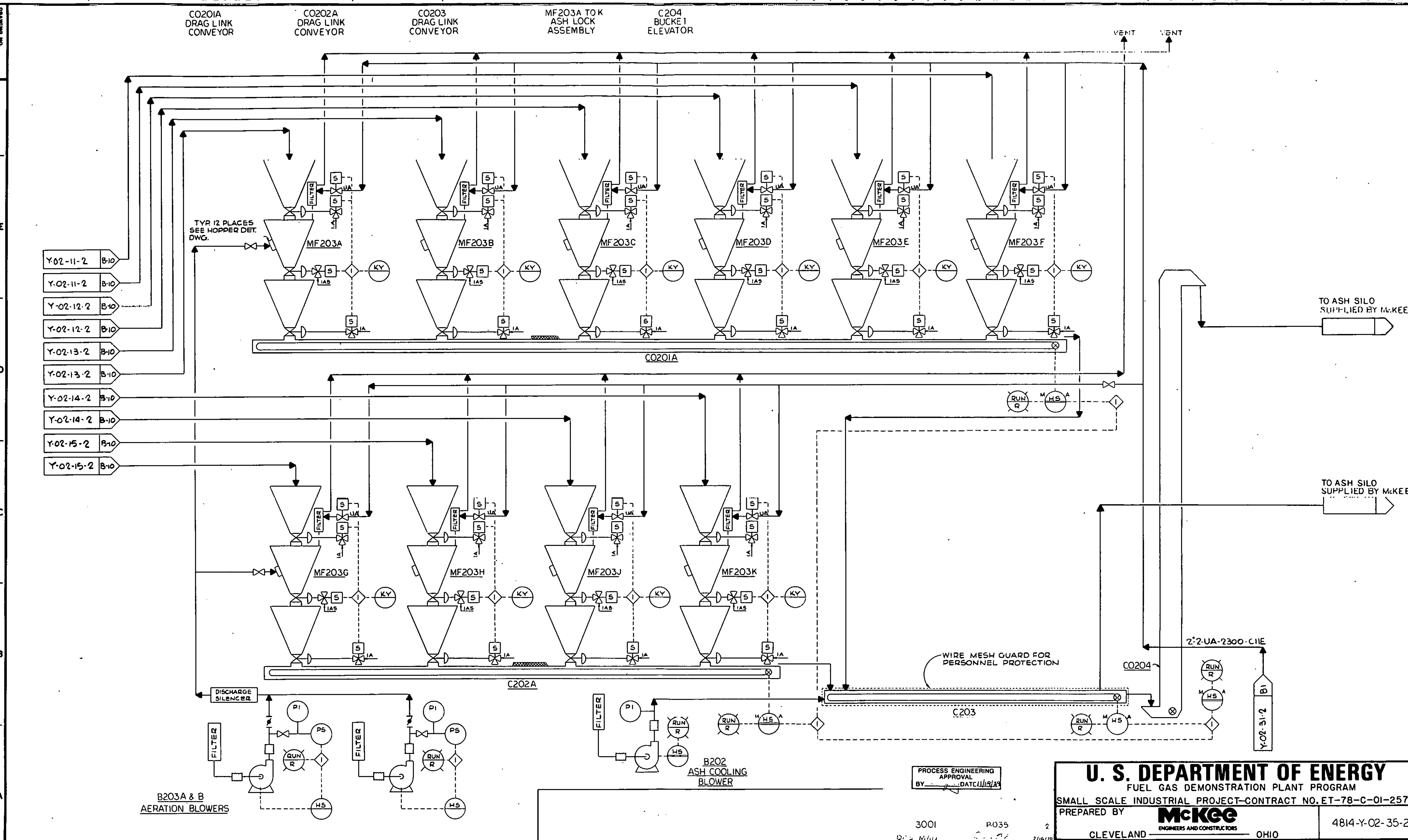
PROJECT NO. 3001

SCALE NONE

REVISION 2

3001 P-033 2

REVISIONS	DATE	BY	CHK	DESCRIPTION	APP.
2	2/16/79			ISSUED FOR [illegible]	
1	11/11/78			REVISED PER McKEE COMMENTS	
0	11/6/78			ISSUED FOR CLIENT REVIEW	



PROCESS ENGINEERING APPROVAL
BY ______ DATE 11/8/78

3001 R035 2

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT–CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

4814-Y-02-35-2

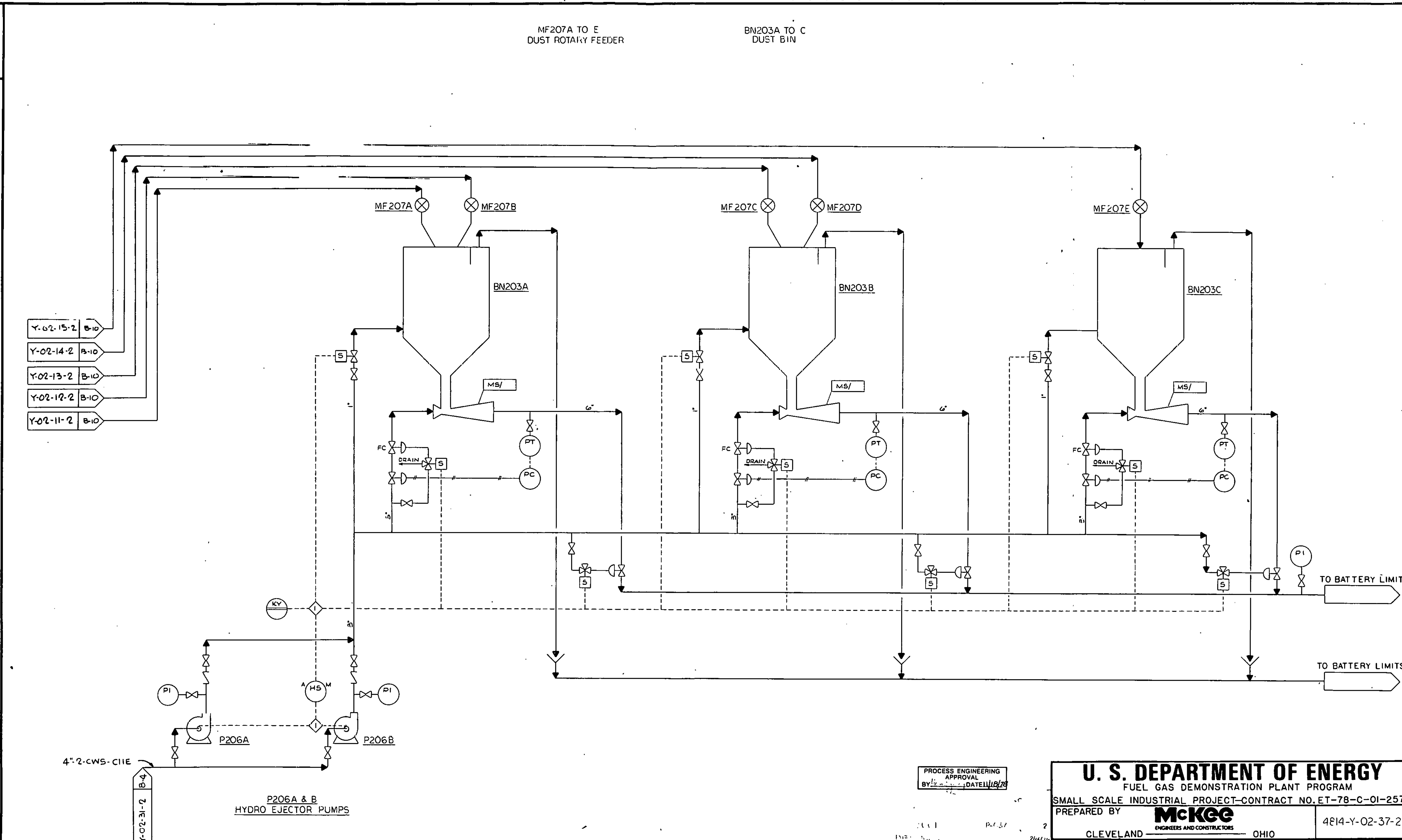
FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

PROJECT NO. 3001
SCALE NONE

GASIFICATION
COMMERCIAL UNIT-STAGE I (DEMO)
P& I.D. ASH HANDLING

REVISION 2

REVISIONS	DATE	BY	CHK	DESCRIPTION	APP.
2	2/16/79			ISSUED FOR DESIGN MANUAL	
1	11/11/78			REVISED PER McKEE COMMENTS	
0	11/6/78			ISSUE FOR CLIENT REVIEW	



PROCESS ENGINEERING APPROVAL
BY ______ DATE 11/8/78

U. S. DEPARTMENT OF ENERGY

FUEL GAS DEMONSTRATION PLANT PROGRAM

SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS

CLEVELAND — OHIO

4814-Y-02-37-2

FOR **ERIE MINING COMPANY**

PICKANDS MATHER AND CO. MANAGING AGENT

HOYT LAKES — MINNESOTA

PROJECT NO. 3001

P.E. NO.

SCALE NONE

GASIFICATION

COMMERCIAL UNIT - STAGE I (DEMO)

P.& I.D. ASH HANDLING

REVISION 2

REVISIONS

	DATE	BY	CHK	DESCRIPTION	APP.
2	2/16/79			ISSUED FOR DESIGN MANUAL	
1	11/11/78			REVISED PER McKEE COMMENTS	
0	11/6/78			ISSUE FOR CLIENT REVIEW	

1 2 3 4 5 6 7 8 9 10

4.1.4

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

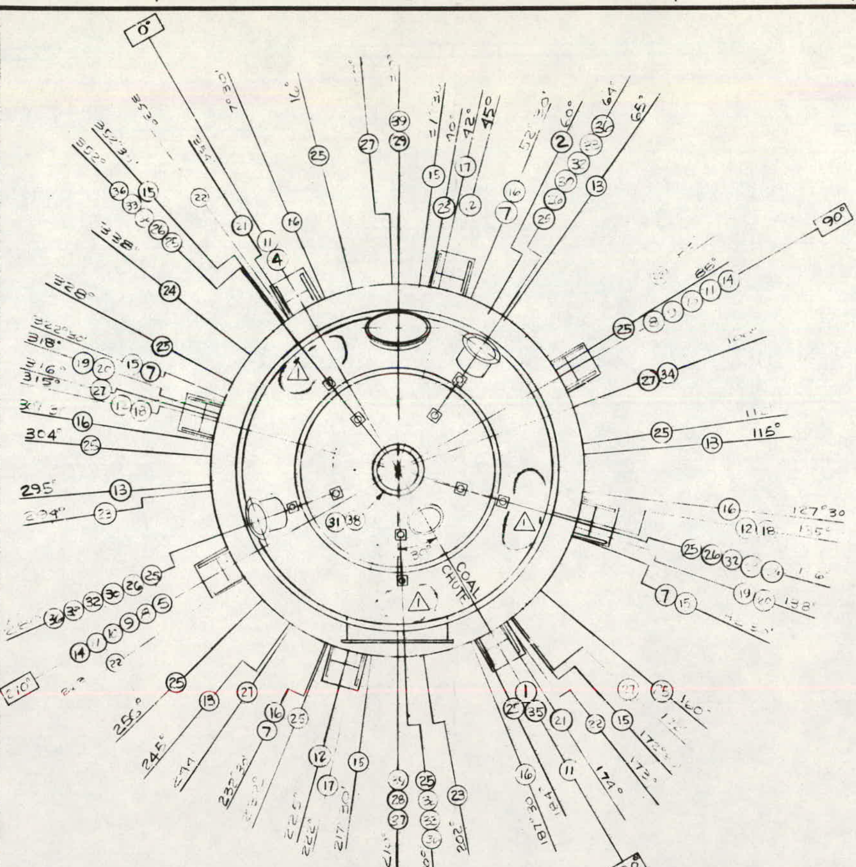
SECTION 4.1.4

External Gasifier Drawings

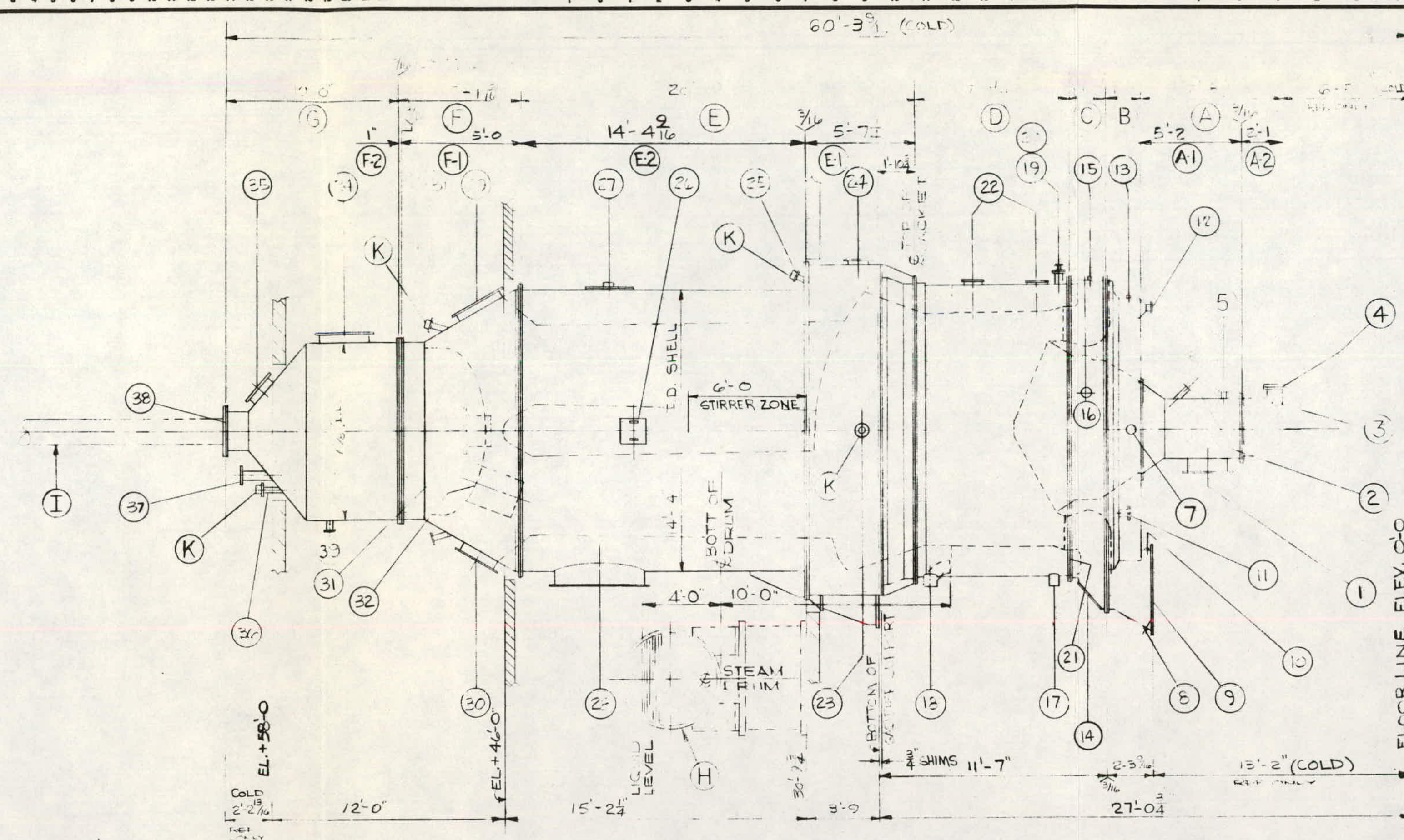
Dwg. 4814-D-02-01-2 Exterior View

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

SCALING RULES



ORIENTATION PLAN



NOZZLE SCHEDULE

REF.	SIZE	QTY.	SERVICE	FLANGES
Ⓐ	BLAST INLET		ASSEMBLY	DWG. M-337
1	24 ϕ X.S.	1	BLAST INLET	24" 125 # S.O.
2	2" ϕ SCH 40	1	THERMOCOUPLE	150# R.F. S.O.
3	2" ϕ SCH 40	1	DRAIN	2" F.S. SCREWED CAP
4	8" X 1'-0"	1	ASH CLEAN OUT	1'-1 1/2 x 1'-5 1/2
5	3" ϕ SCH. 40	1	SPARE	150# RF, S.O.
Ⓑ	GRATE SUPPORT BASE			DWGS. M-312 & M-313
7	6" Ø	4	INSPECTION PORT	
8	3/4" ϕ SCH 40	2	WATER INJECTION CONNECTION	3/4"-150#
9	3'-9 1/16" x 4'-11"	2	ASH DISCHARGE	
10	3/4" ϕ SCH. 40	2	WATER INJECTION CONNECTION	3/4"-150#
11	4" ϕ	4	DRAIN - ASH	4"-125#
12	4" ϕ	4	DRAIN - ASH	4"-125#
13	1/2" ϕ	4	PLUG	
Ⓒ	GRATE		SUPPORT CASING	DWG. M-317
14	1'-1 3/4 x 1'-9 5/8"	2	ACCESS PORT	
15	1/2" ϕ	6	PLUG	
16	6" ϕ	6	ACCESS PORT	
Ⓓ	WATER		JACKET	DWG. M-309
17	6" ϕ SCH 40	2	FEED WATER INLET	
18	8" Ø XXS 90° ELL.	2	HOT WATER OUTLET	
19	4" ϕ SCH. 40	2	STOOL FOR 20	150# R.F. S.O.

REF.	SIZE	QTY.	SERVICE	FLANGES
20	1 1/2" ϕ SCH 40	2	BLOW DOWN	150# SUP-ON
21	2" ϕ	2	DRAIN	2" ϕ SQ. HD. PLUG
22	10" R.F. FLANGE	5	INSPECTION PORTS	
Ⓔ	GASIFIER		SHELL ASSEMBLY	DWG. M-304
23	3" ϕ SCH 40	2	PYROMETER PORT	0'-6 1/8" SQ.
24	1'-2 x 1'-10	1	ACCESS PORT	1'-6 3/4 x 2'-2 1/2
25	3" ϕ SCH 40	15	RODDING PORT	0'-6 1/8" SQ.
26	1'-0 SQ.	4	ACCESS PORT	1'-4 SQ.
27	1'-0 x 2'-6	5	ACCESS PORT	1'-4 x 2'-10
28	4'-6 ϕ	1	CLEAR GAS	5'-0 O.D.
Ⓕ	GASIFIER	LOWER	CONE AND DISTRIBUTOR	DWG. M-305
29	30" Ø STD.	1	MAN HOLE	3'-0 O.D.
30	18" ϕ STD.	2 ⚠1	TOP GAS	125# FF. S.O.
31	24 ϕ X.S.	1	STIRRER PORT	2'-4 O.D.
32	24 ϕ	5	COAL DISTRIBUTION	
33	3" ϕ SCH 40	5	RODDING PORT	0'-6 1/8 SQ.
Ⓖ	GASIFIER	UPPER	CONE	DWG. M-306
34	30" STD.	1	MAN HOLE	3'-0 O.D.
35	18 SCH. 40	1	COAL INLET	150# R.F. S.O.
36	3" ϕ SCH. 40	5	RODDING PORT	0'-6 1/8" SQ.
37	6" ϕ SCH. 40	1	COAL LEVEL ALARM	150# R.F. S.O.
38	24" ϕ X.S.	1	STIRRER SHAFT PORT	2'-4 O.D.

REF.	SIZE	QTY	SERVICE	FLANGES
39	3" Ø SCH. 40	2	LEVEL SENSOR	150# R.F. S.O.
Ⓗ	GASIFIER STEAM DRUM			DWG. M-310
Ⓘ	GASIFIER STIRRER			DWG. M 315
Ⓚ	GASIFIER RODDING PORT COVER			DWG. M-336

UNSTIRRED GASIFIER MAXIMUM OPERATING WT. = 264 TONS
STIRRED GASIFIER MAXIMUM OPERATING WT. = 252 TONS ⚠1

FOR GASIFIER GENERAL ARRANGEMENT SEE DRAWINGS:
M-302 UNSTIRRED
M-303 STIRRED

M300 2

REVISIONS	DATE	BY	CHK	DESCRIPTION	APP.
B	9-27-78		L.S.	FOR BIDDING	J.C.M.
C	11/21/78	J.L.	L.S.	FINAL REVIEW	
1	1/5/79			RELEASED FOR CONSTRUCTION	D.L.S.
2	2/16/79			ISSUED FOR DESIGN MANUAL	D.L.S.

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

4814-D 02 01-2

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

PROJECT NO. | P.E. NO.

SCALE 1/4" = 1'-0

COAL GASIFICATION
GASIFIER - COMMON
EXTERIOR VIEW

REVISION ⚠2

4.1.5

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 4.1.5

Instrument Loop Diagrams

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

XXXXX LOOP NUMBER

INDIVIDUAL LOOP IDENTIFICATION

1 GASSIFIER A OR G
2 B H
3 C J
4 D K
5 E L
6 F M
7 TAR & OIL HANDLING
8 UTILITIES
9 MISC

1 GASSIFIER A THRU F
2 GASSIFIER G THRU M

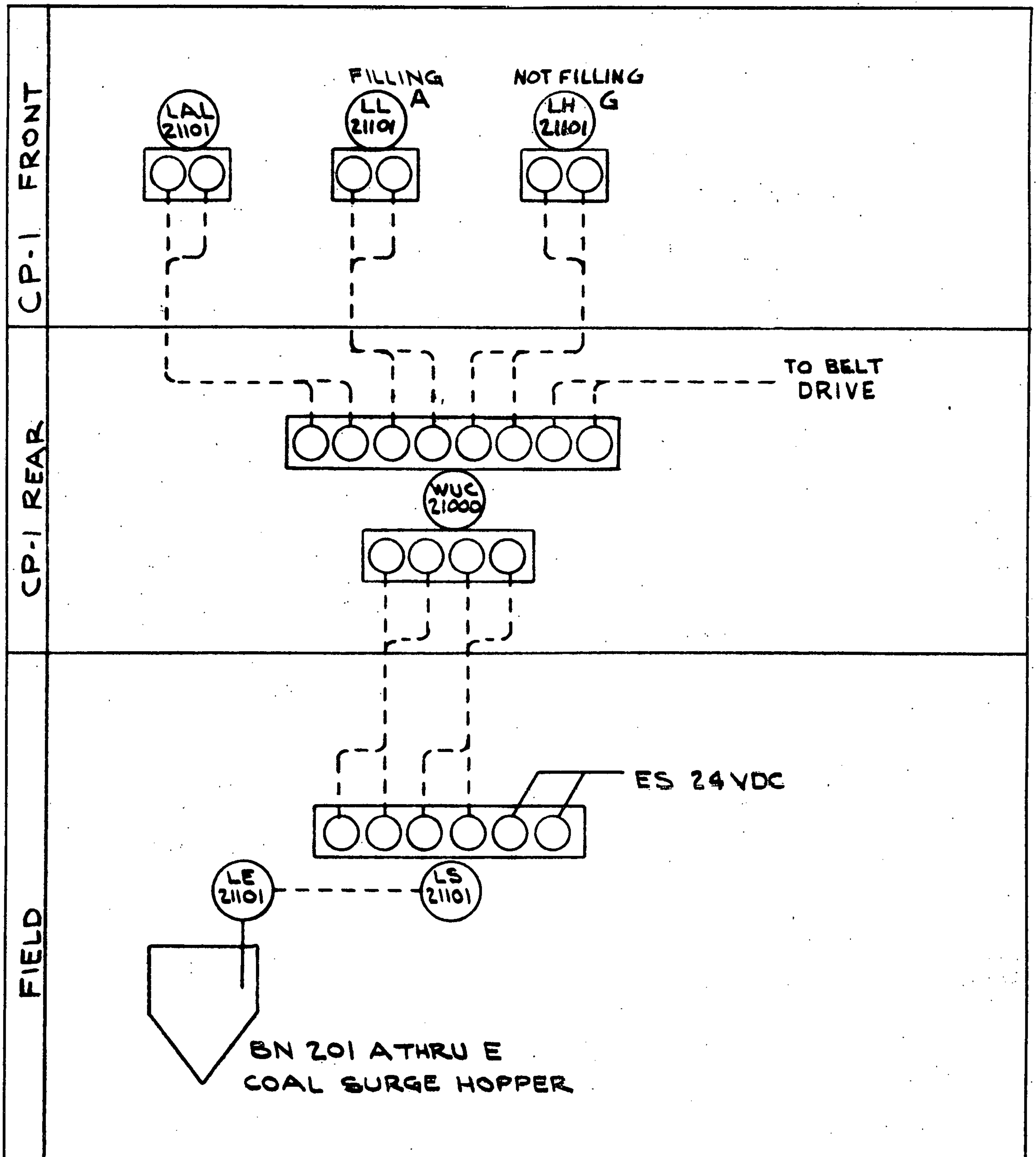
2 COAL GASIFICATION PLANT

LOOP NUMBERING SYSTEM

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. Ø I 3001	SKETCH NO. O	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



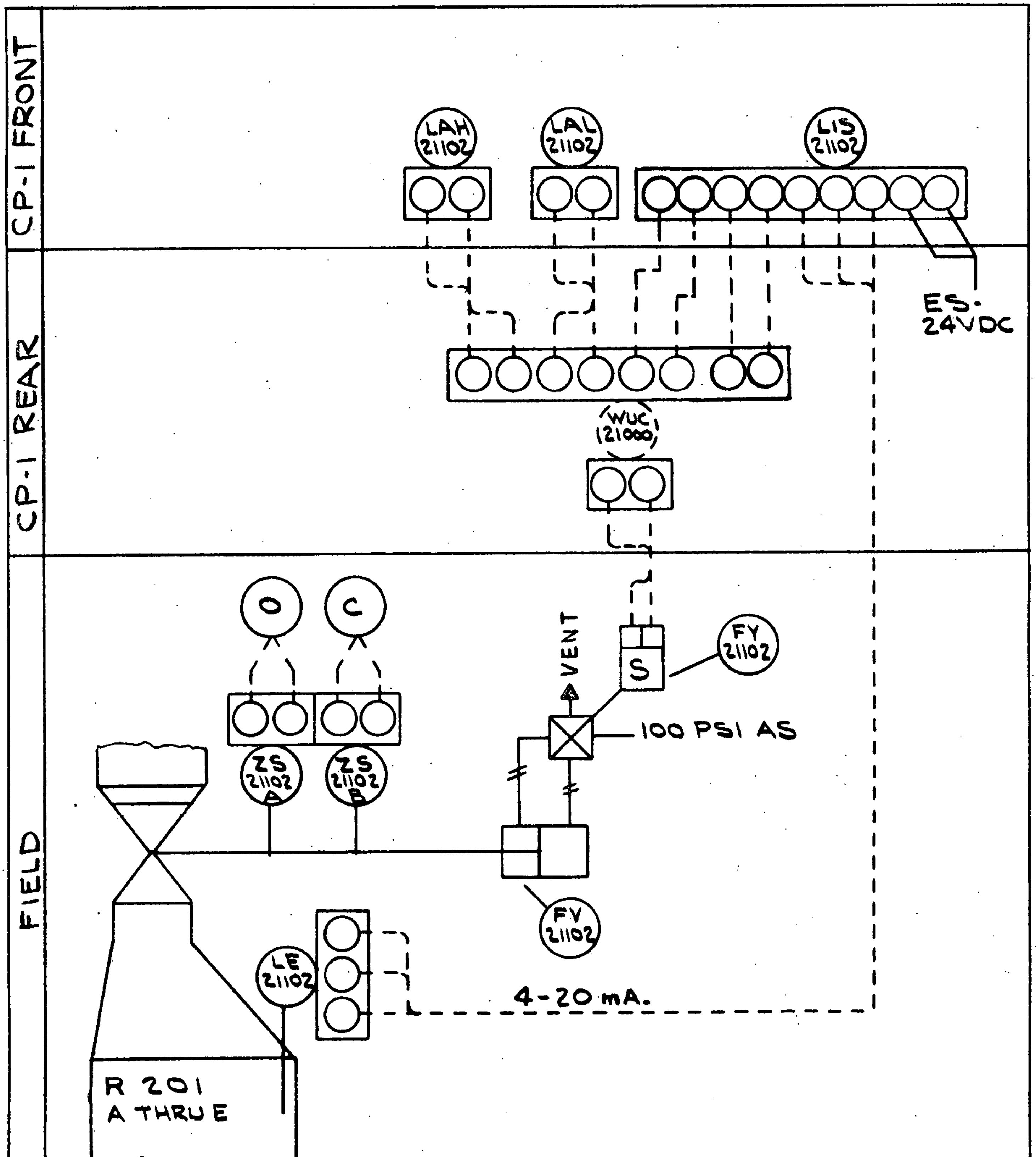
COAL SURGE HOPPER - LEVEL CONTROL

LOOP 21101 THRU 21501

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-15-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. Φ I 3001	SKETCH NO. 1	REV. 1
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



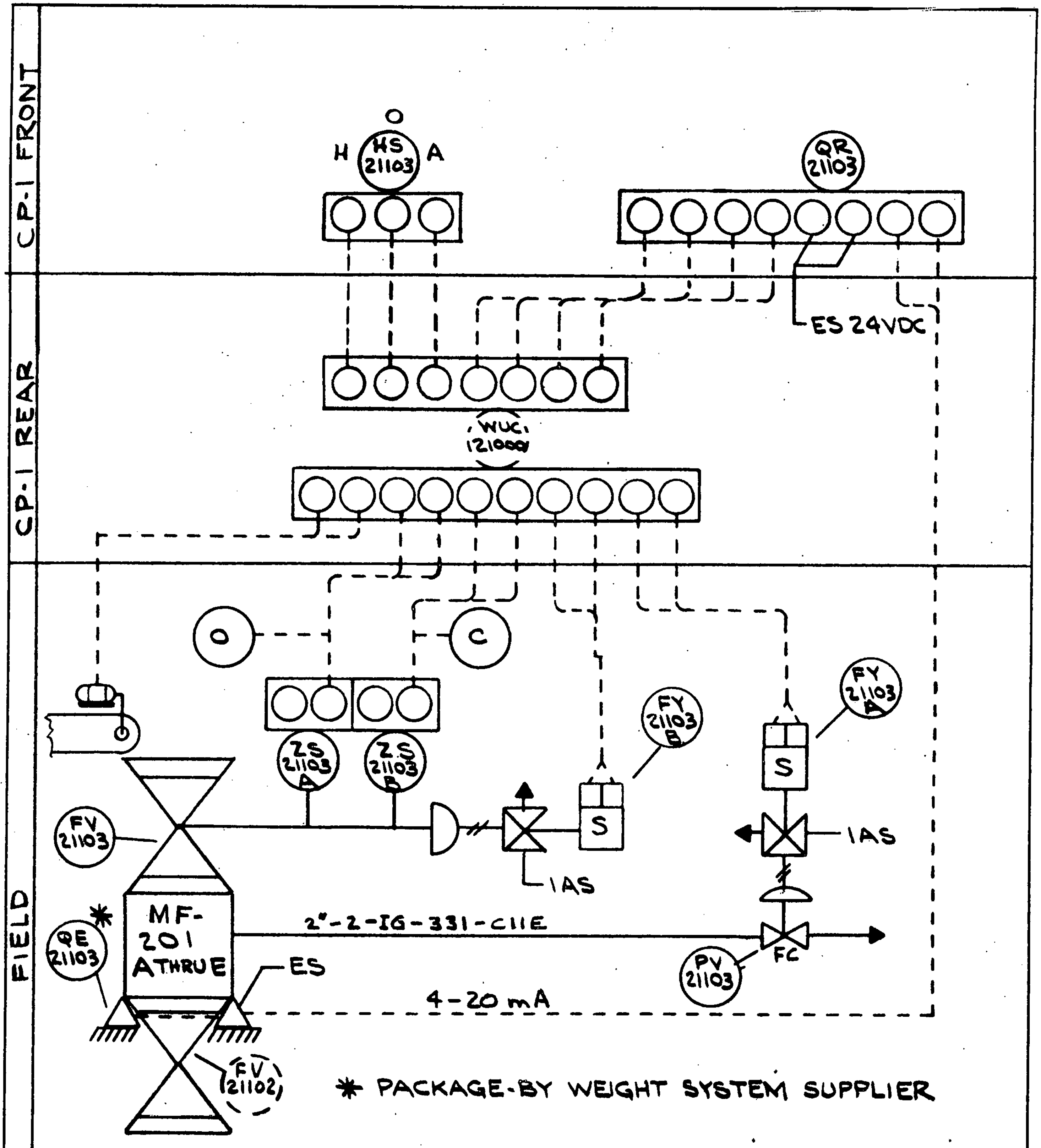
GASIFIER COAL CHARGE CONTROL

LOOP 21102 THRU 21502

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-15-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 2	REV 1 1-25-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



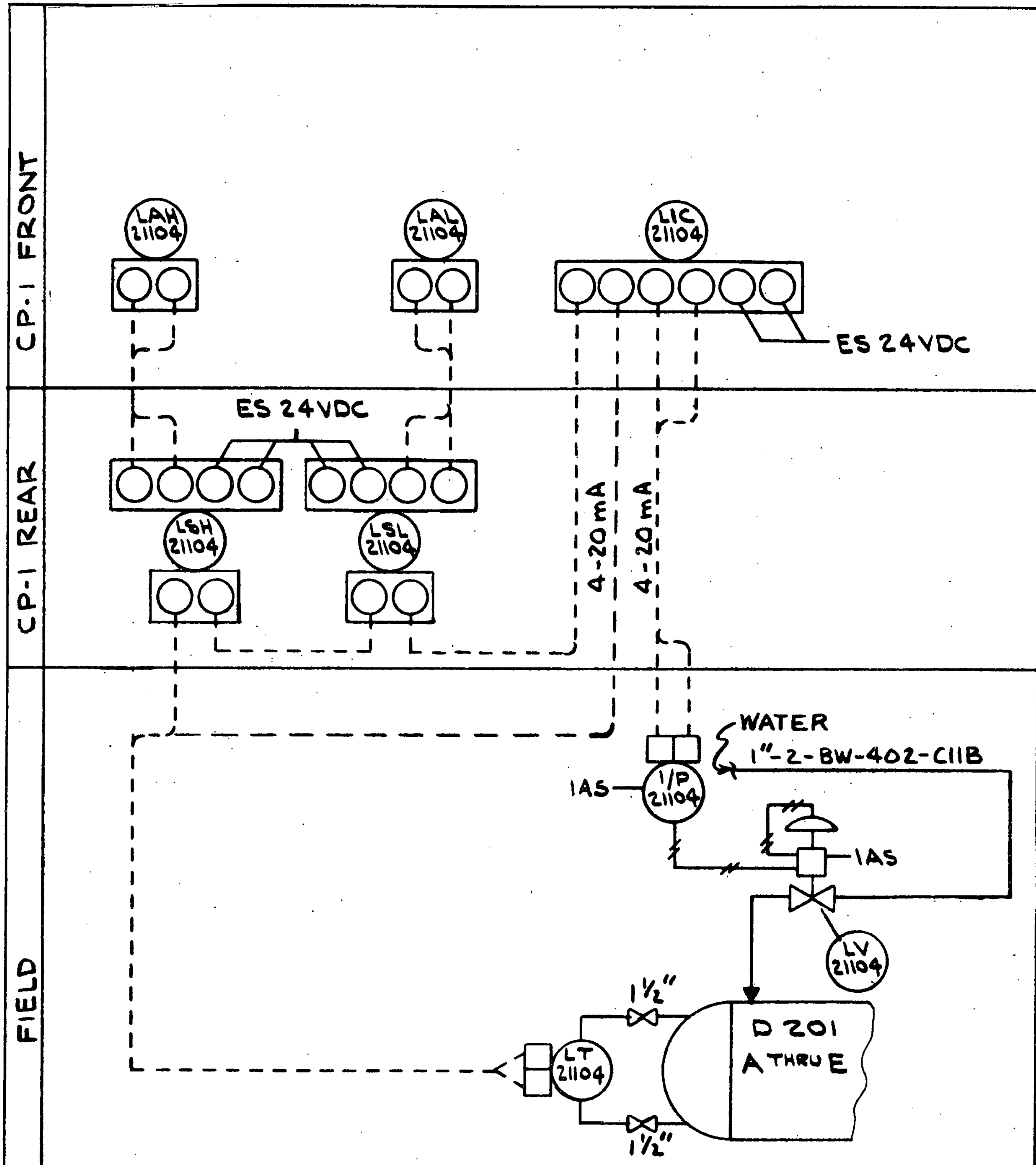
LOOP 21103
THRU 21503

GASIFIER COAL CHARGE CONTROL

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-15-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 3	REV. 1 1-25-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



LOW PRESSURE BOILER LEVEL CONTROL

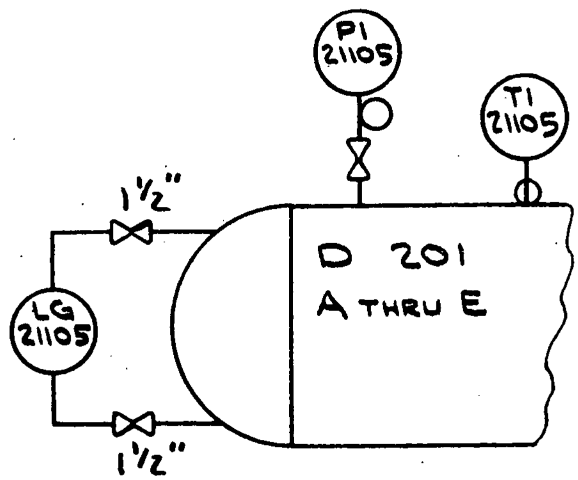
LOOP 21104
THRU 21504

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-16-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 4	REV. 1
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



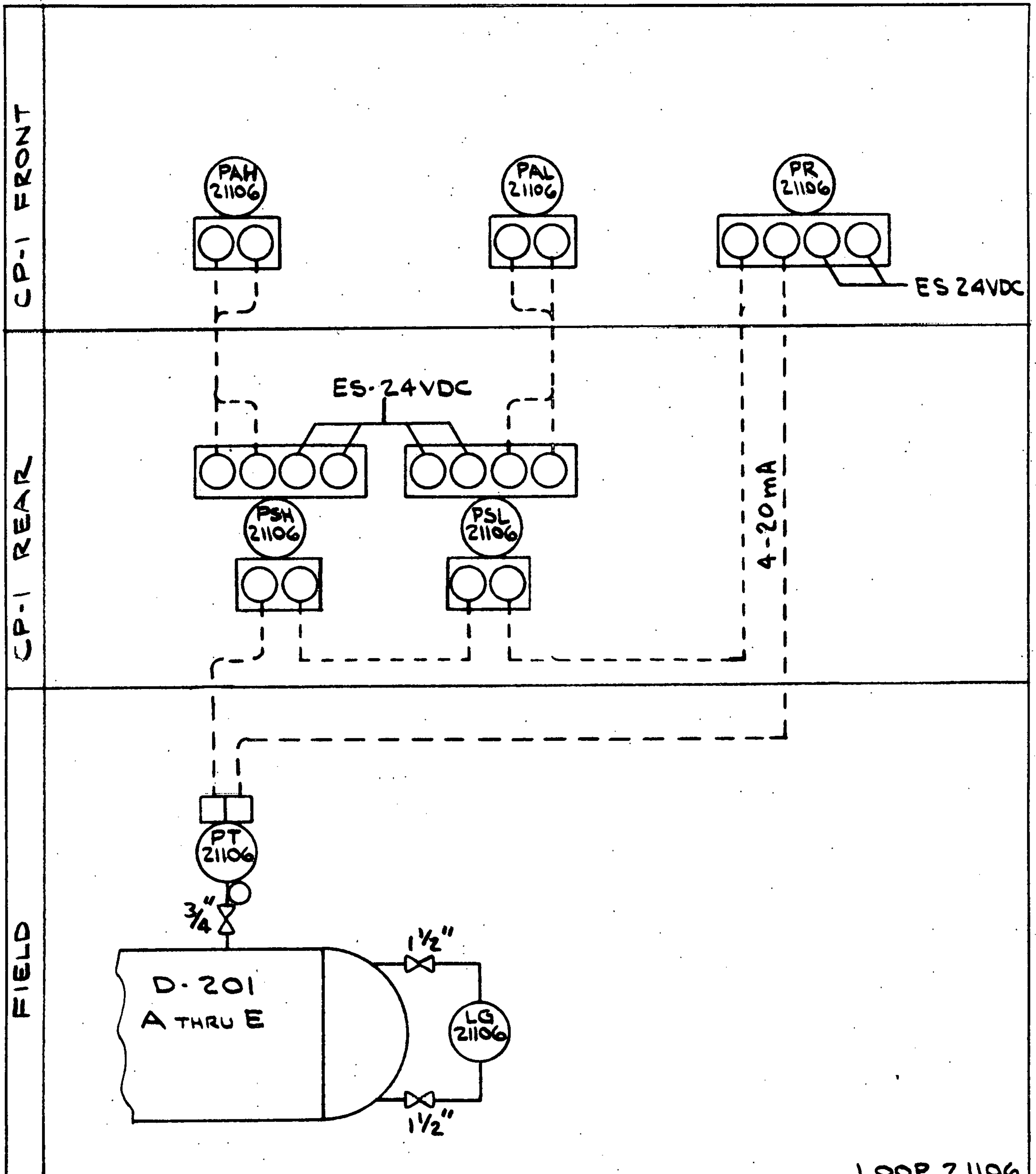
LOW PRESSURE BOILER-LEVEL, PRESS., TEMP. INDIC.

LOOP 21105
THRU 21505

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8·15·78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 5	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



LOOP 21106 THRU 21506

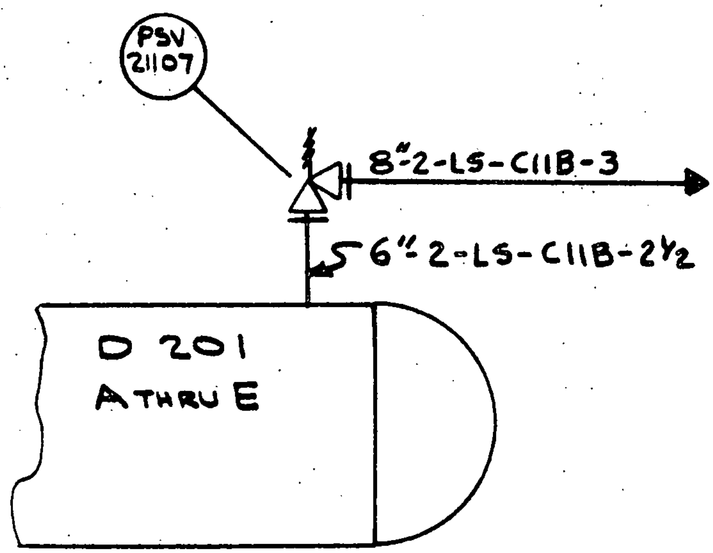
LOW PRESSURE STEAM DRUM-PRESS & LEVEL INDIC

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-15-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 6	REV 1 1-26-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



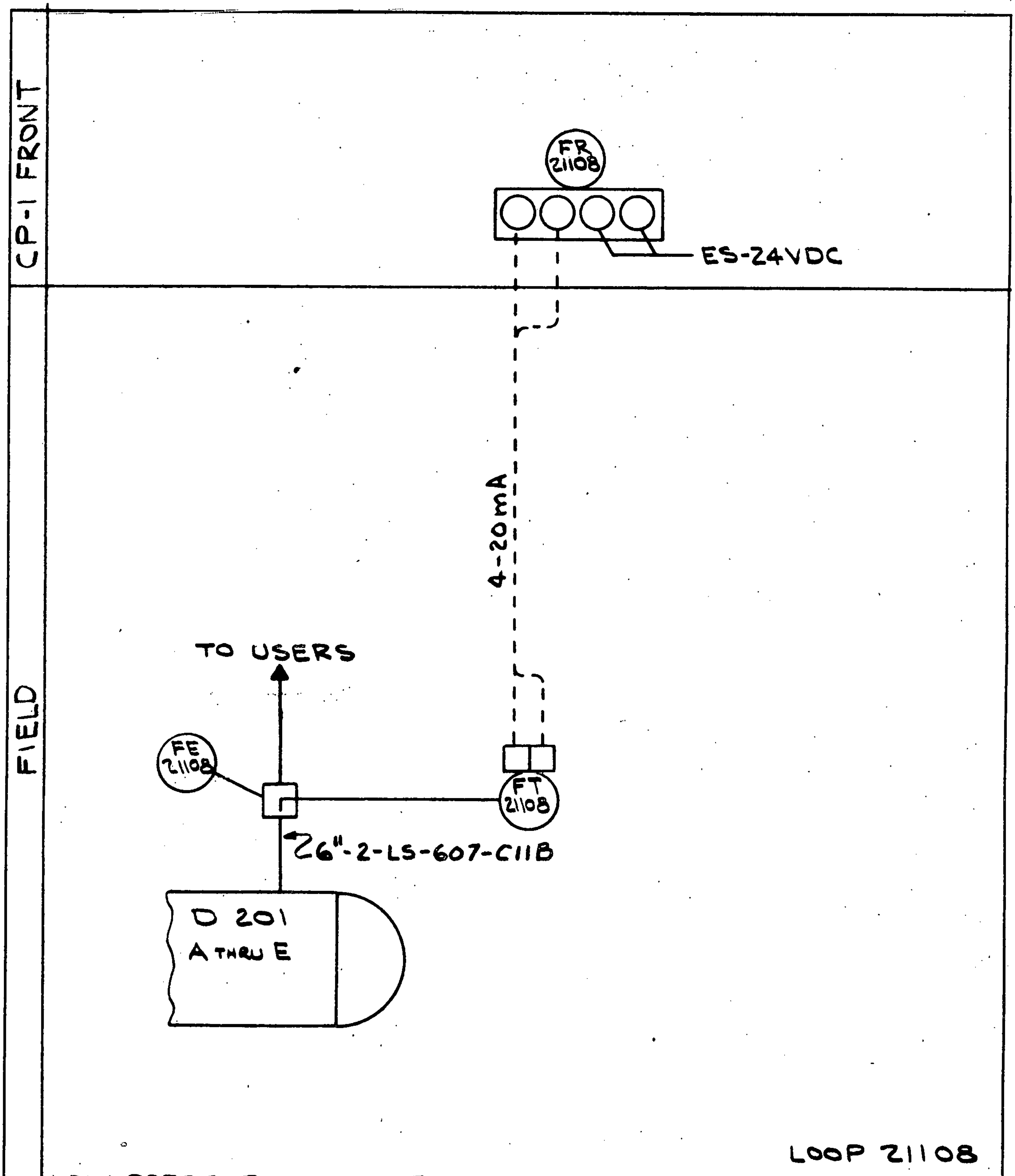
LOW PRESS. BOILER PRESS. RELIEF

LOOP 21107
THRU 21507

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-15-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. Φ I 3001	SKETCH NO. 7	REV. 1 1-26-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



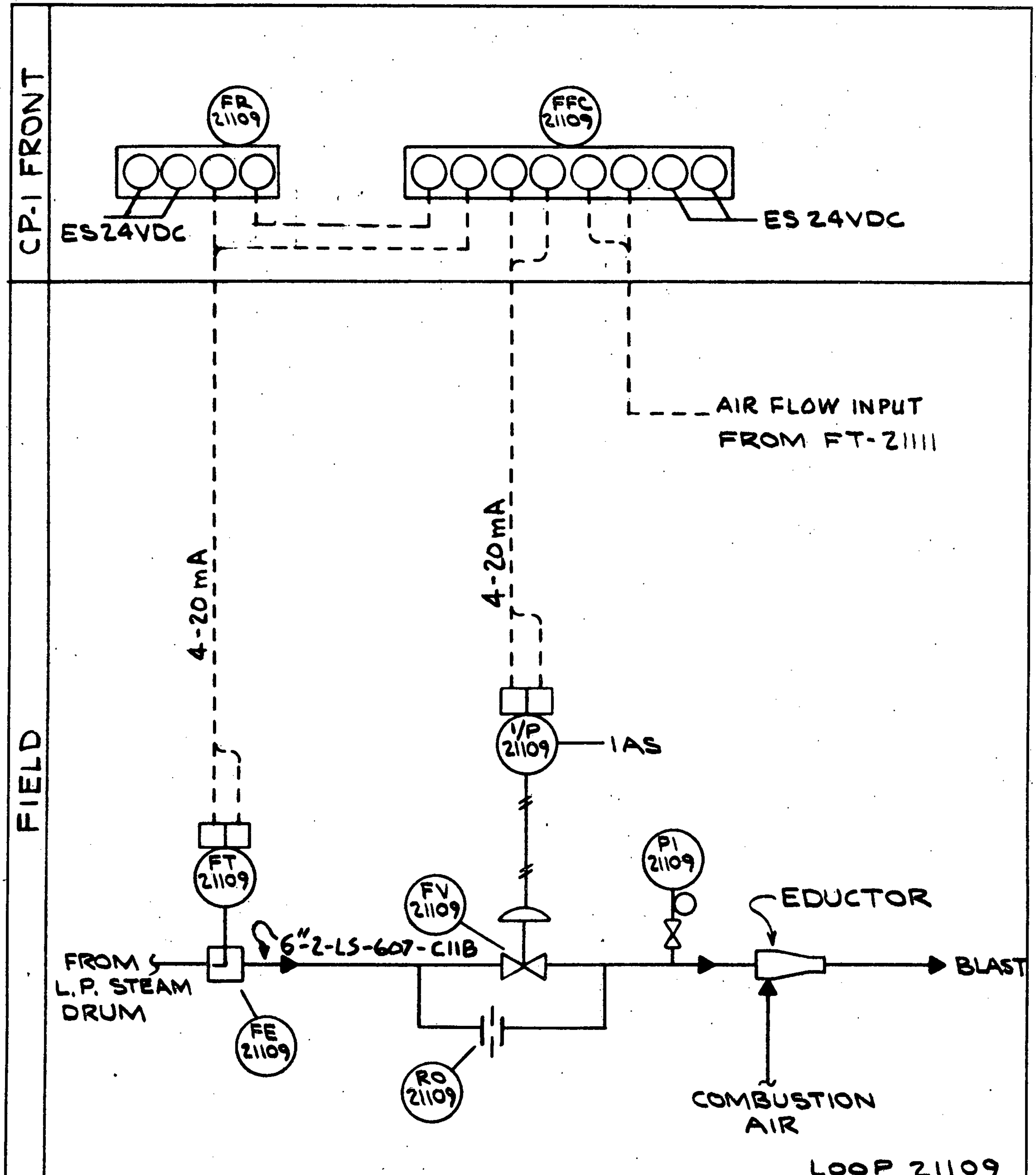
LOW PRESS. BOILER STEAM FLOW RECORD

LOOP 21108
THRU 21508

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-15-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 8	REV. 1 1-26-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



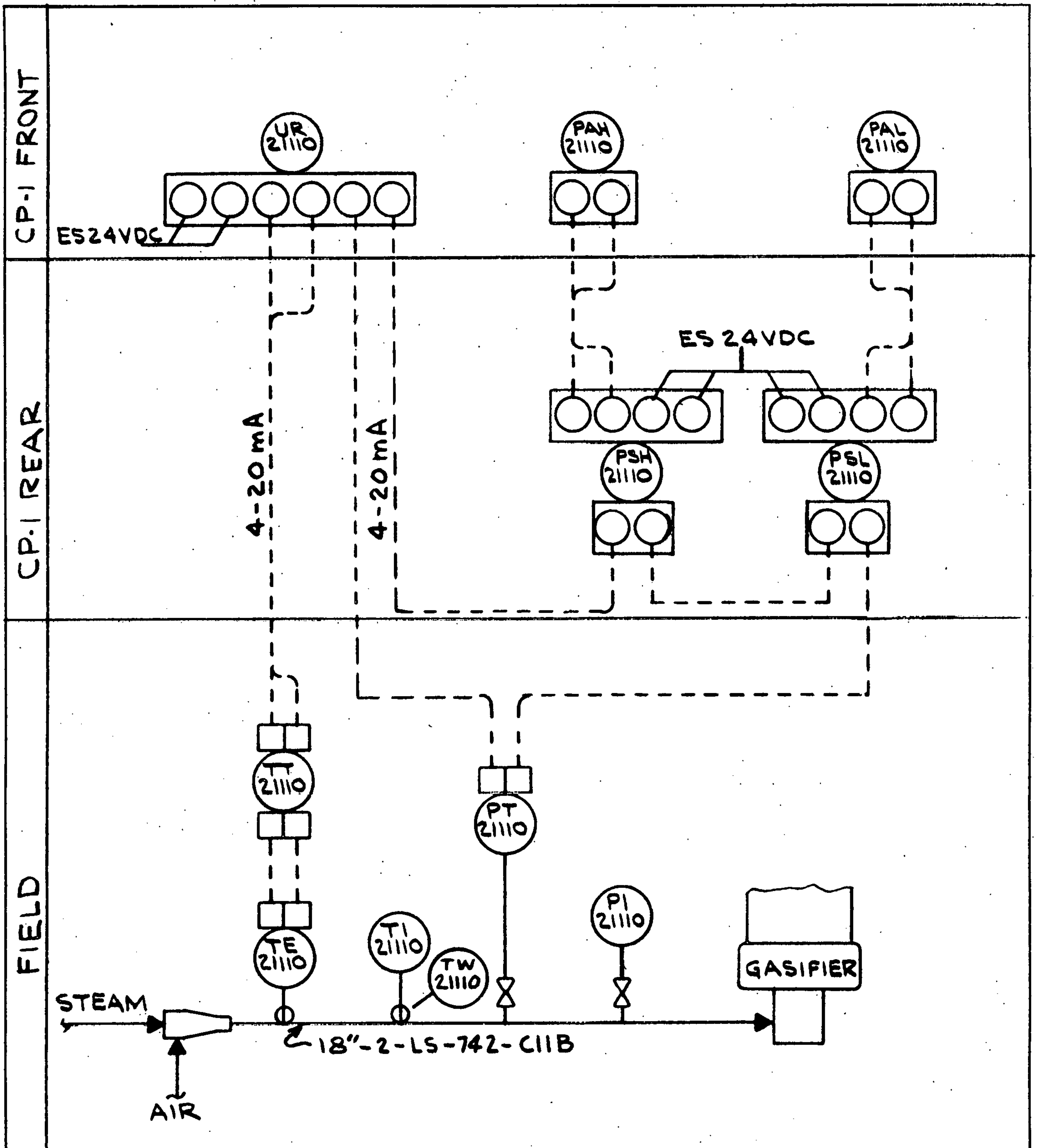
COMBUSTION STEAM FLOW RATIO CONTROL

LOOP 21109 THRU 21509

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-16-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. Φ I 3001	SKETCH NO. 9	REV. 1-26-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



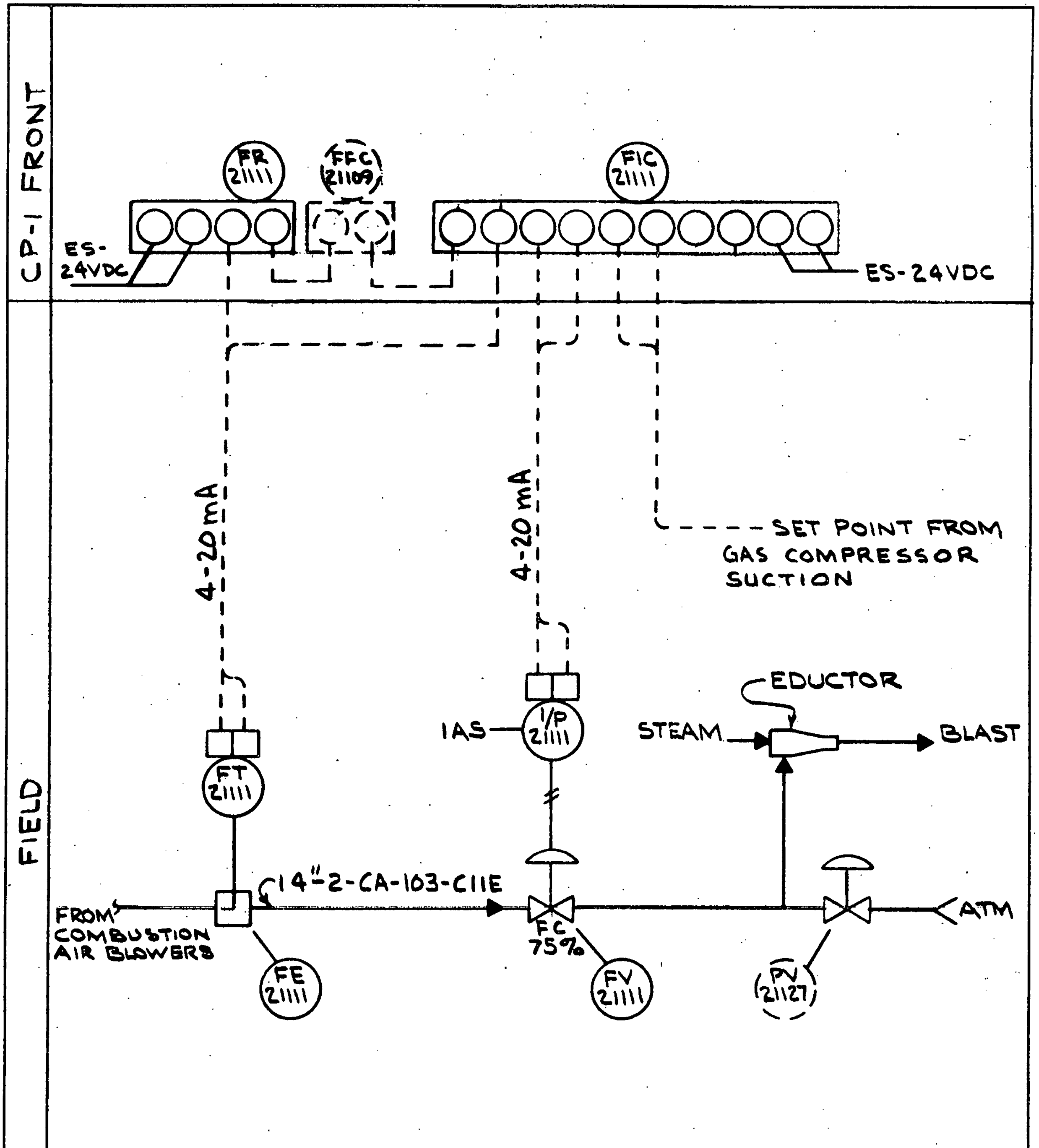
BLAST TEMP & PRESS. RECORD

LOOP 21110
THRU 21510

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-16-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 10	REV. 1 1-26-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



COMBUSTION AIR FLOW RATIO CONTROL

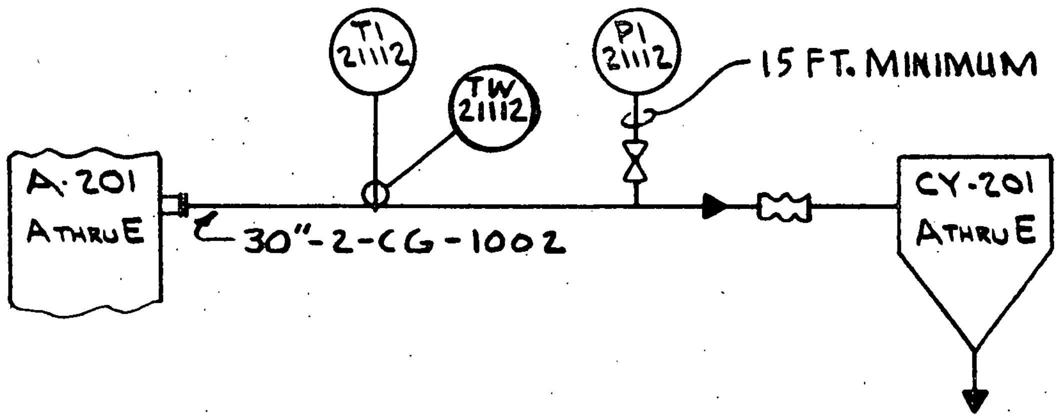
LOOP 21111
THRU 21511

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-17-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 11	REV. 1 1-26-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278)

FIELD



CLEAN GAS TEMP. & PRESS. INDICATION

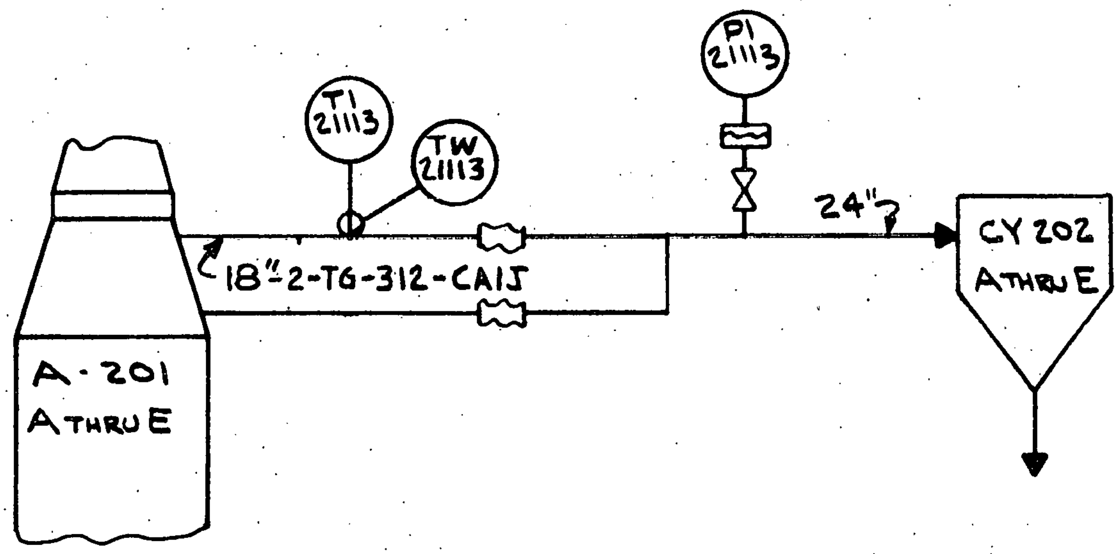
LOOP 21112 THRU 21512

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-17-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 12	REV 1 1-26-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



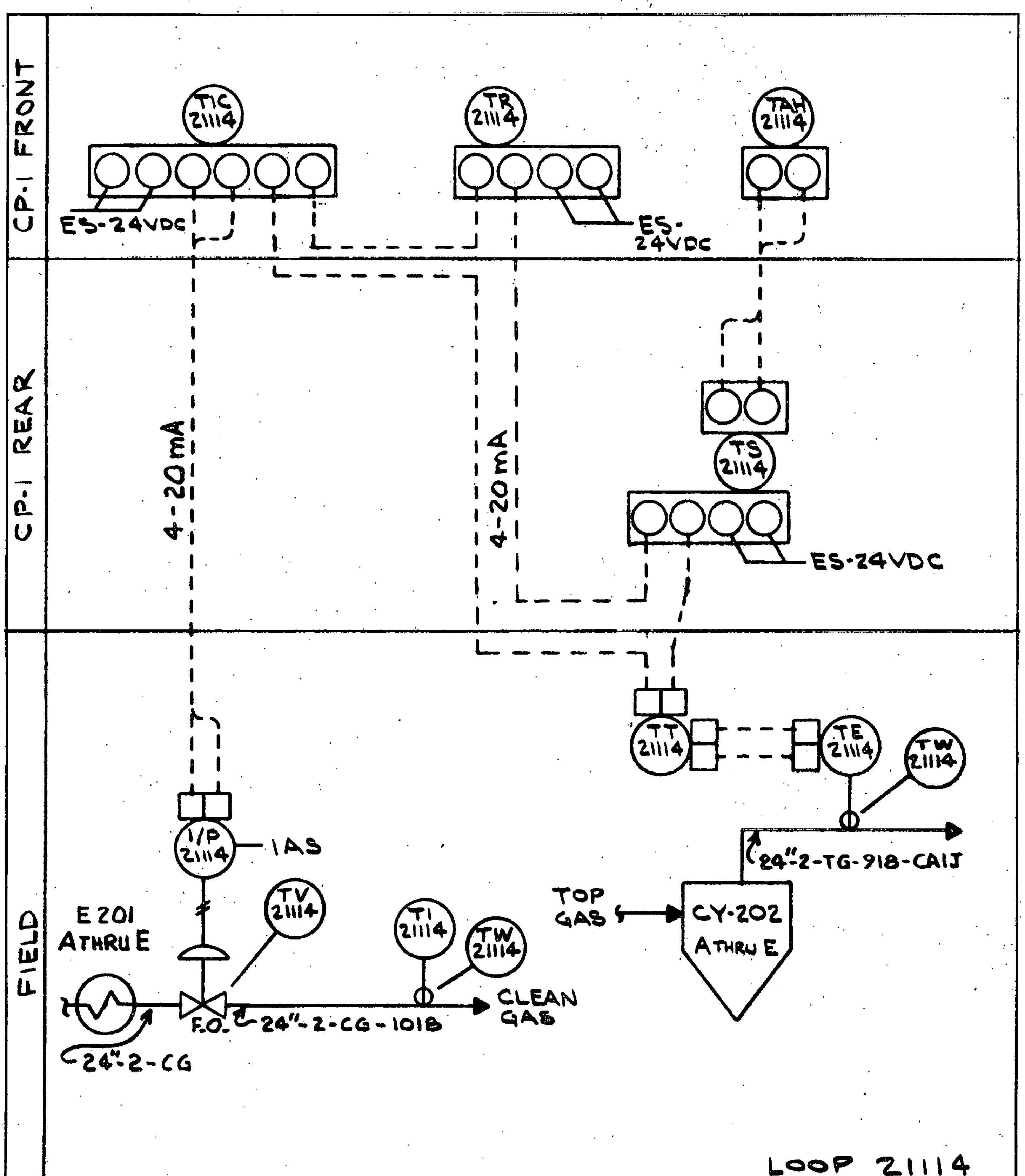
TOP GAS TEMP. & PRESS. INDICATION

LOOP 21113
THRU 21513

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-17-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 13	REV. 1 1-26-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



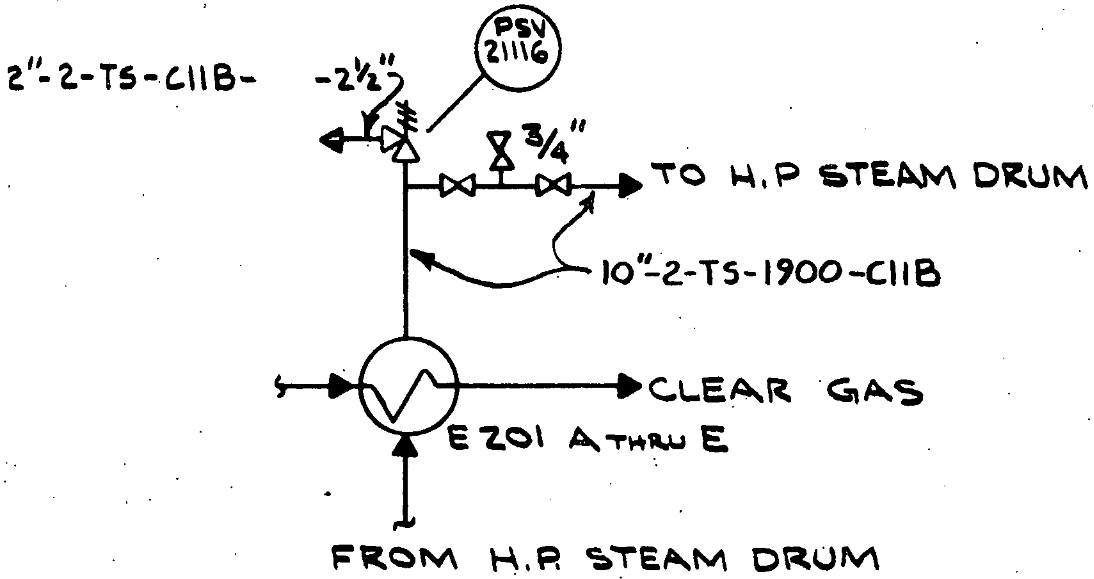
TOP GAS TEMP. CONTROL

LOOP 21114
THRU 21514

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-17-78	SECT. MGR. APPD.	DATE	SCALE:	PROJECT NO.	SKETCH NO.	REV
CH.	DATE	PROJ. MGR. APPD.	DATE	NONE	Φ I 3001	14	1

(ENG-106-0278)



FIELD

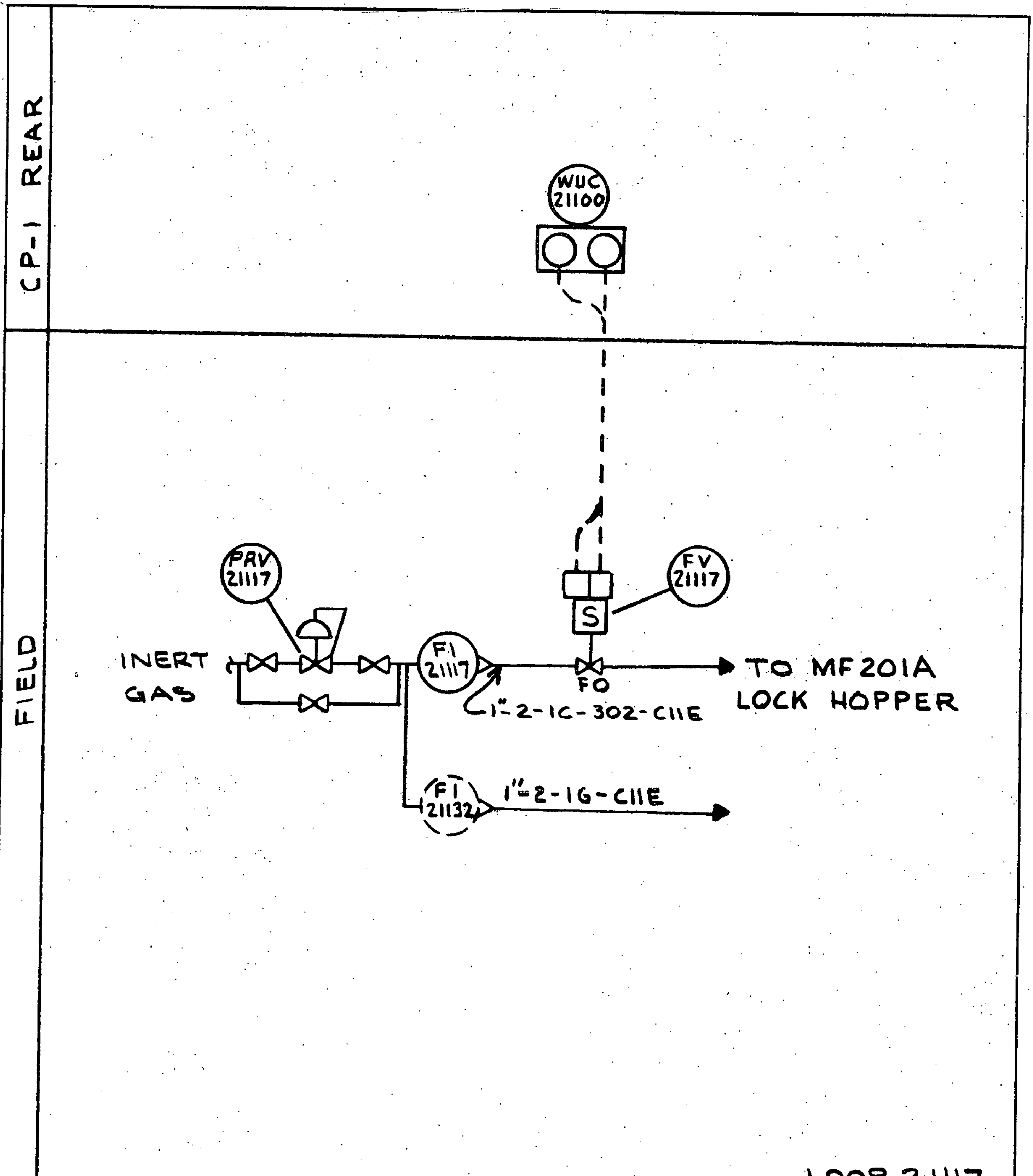
LOOP 21116
THRU 21516

GAS COOLER FEED WATER PRESS. RELIEF

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-17-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 16	REV. 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



PURGE GAS TO LOCK HOPPER CONTROL

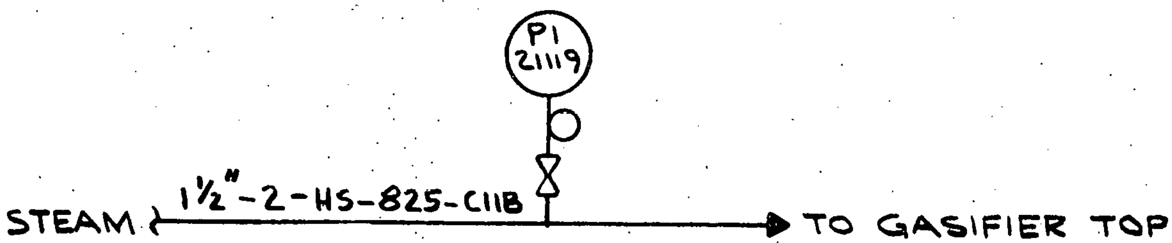
LOOP 21117
THRU 21517

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-17-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 17	REV 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



STEAM TO UPPER RING FLOW INTEGRATION

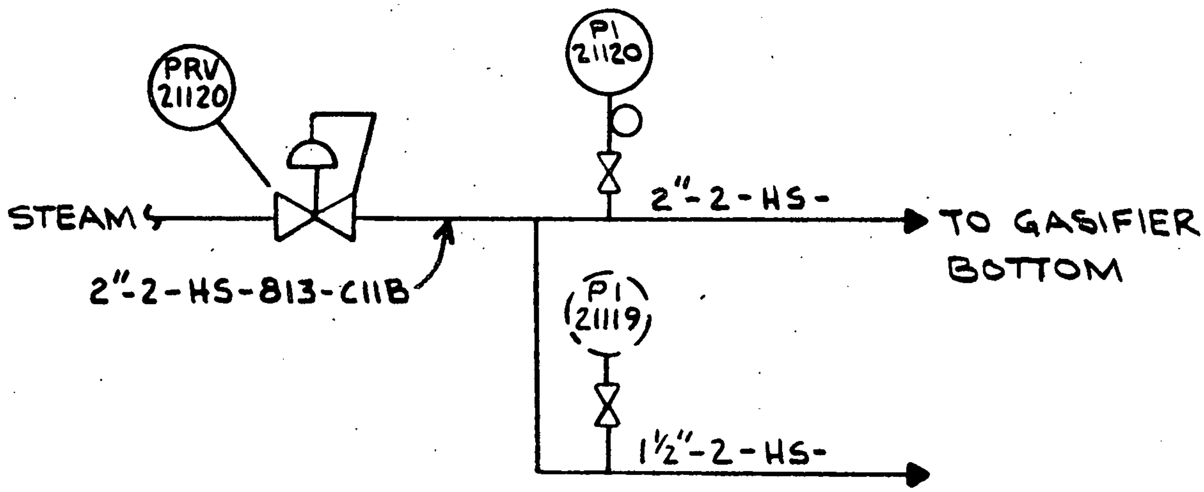
LOOP 21119
THRU 21519

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-17-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 19	REV. 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



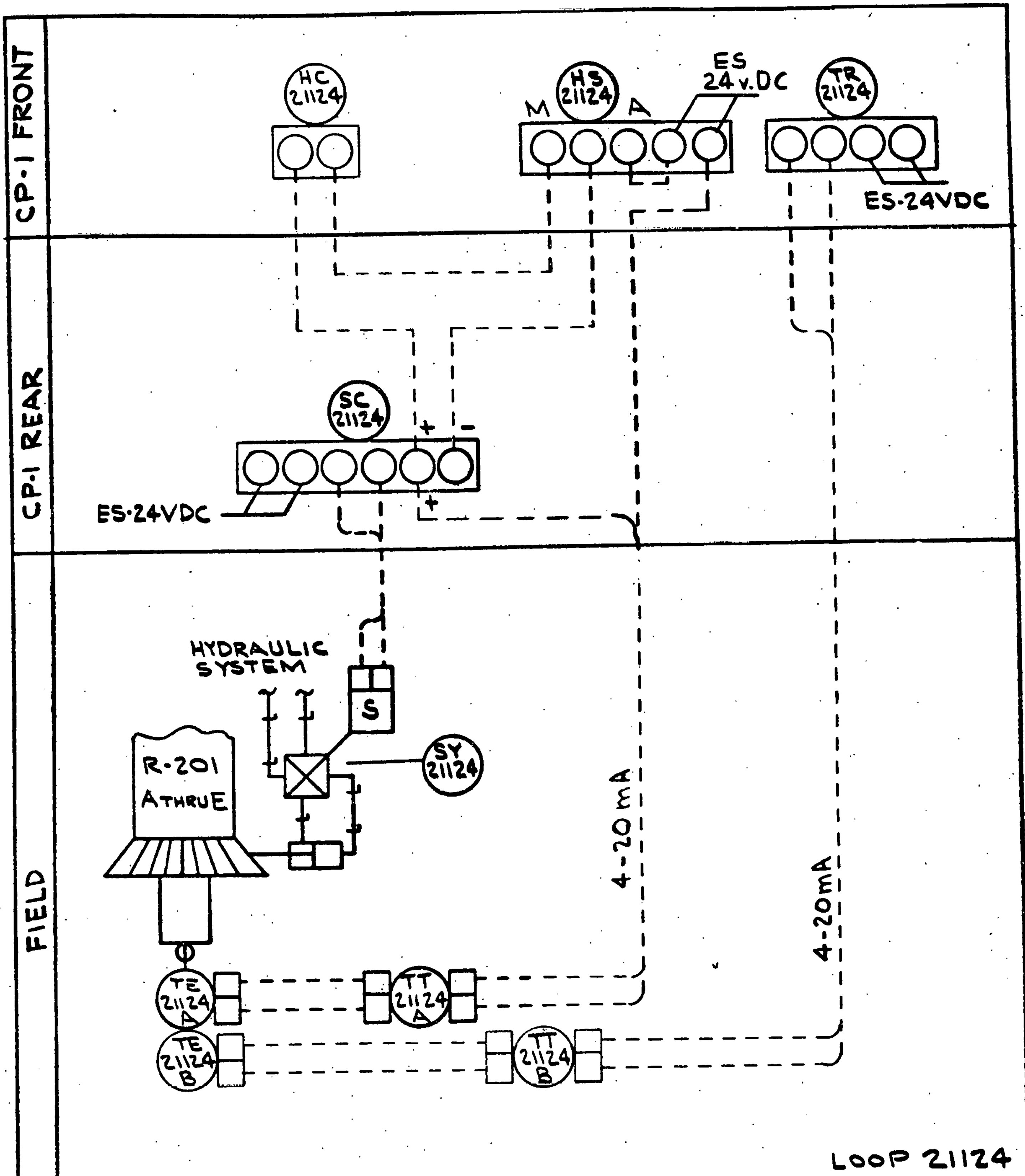
STEAM TO LOWER RING FLOW INTEGRATION

LOOP 21120
THRU 21520

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-17-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO. 20	REV. 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



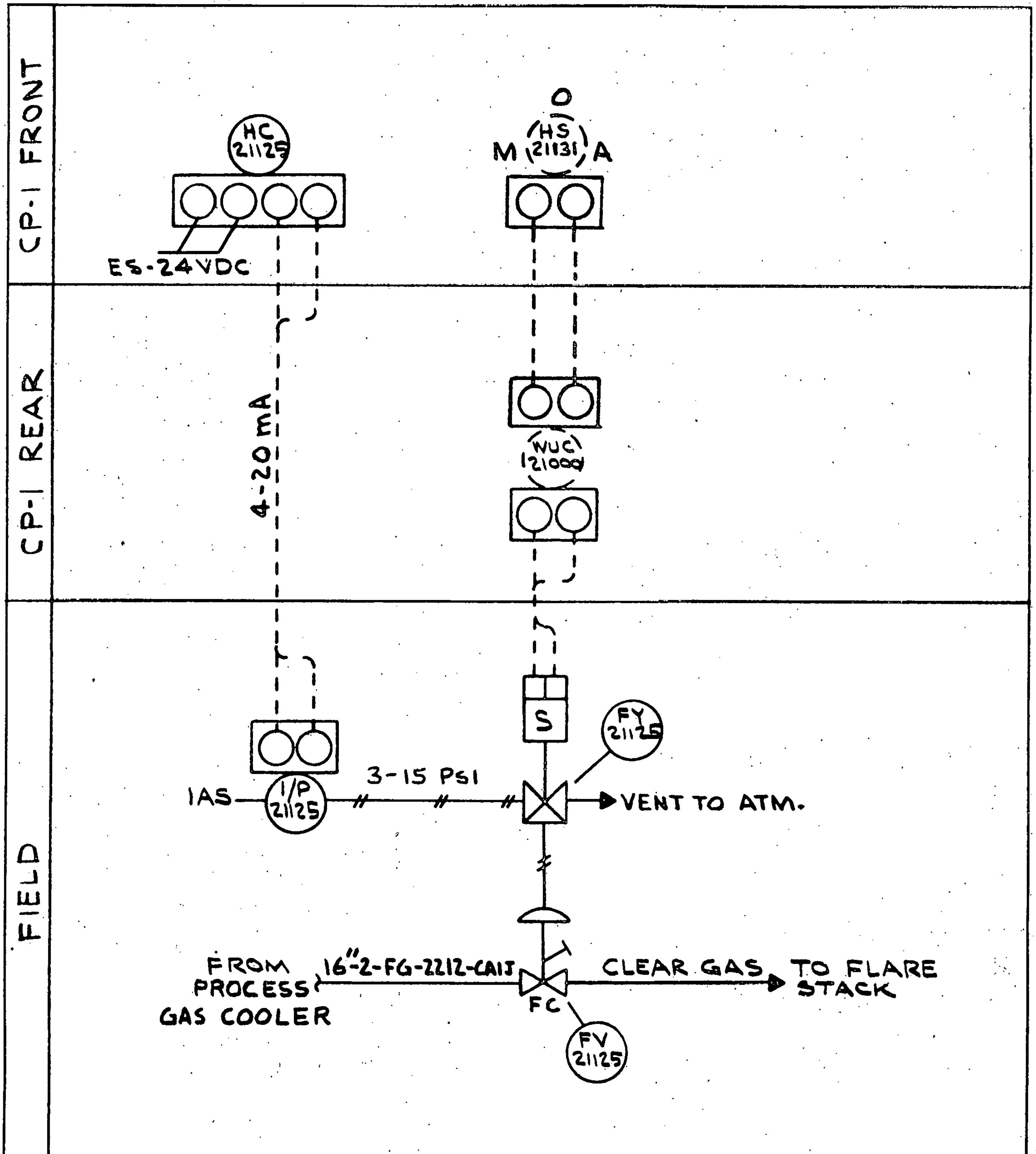
GASIFIER BED TEMP RECORD & GRATE SPEED CONTROL

LOOP 21124 THRU 21524

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-18-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. Φ I 3001	SKETCH NO.	REV 1 1-29-79
CH.	DATE	PROJ. MGR. APPD	DATE				

(ENG-106-0278)



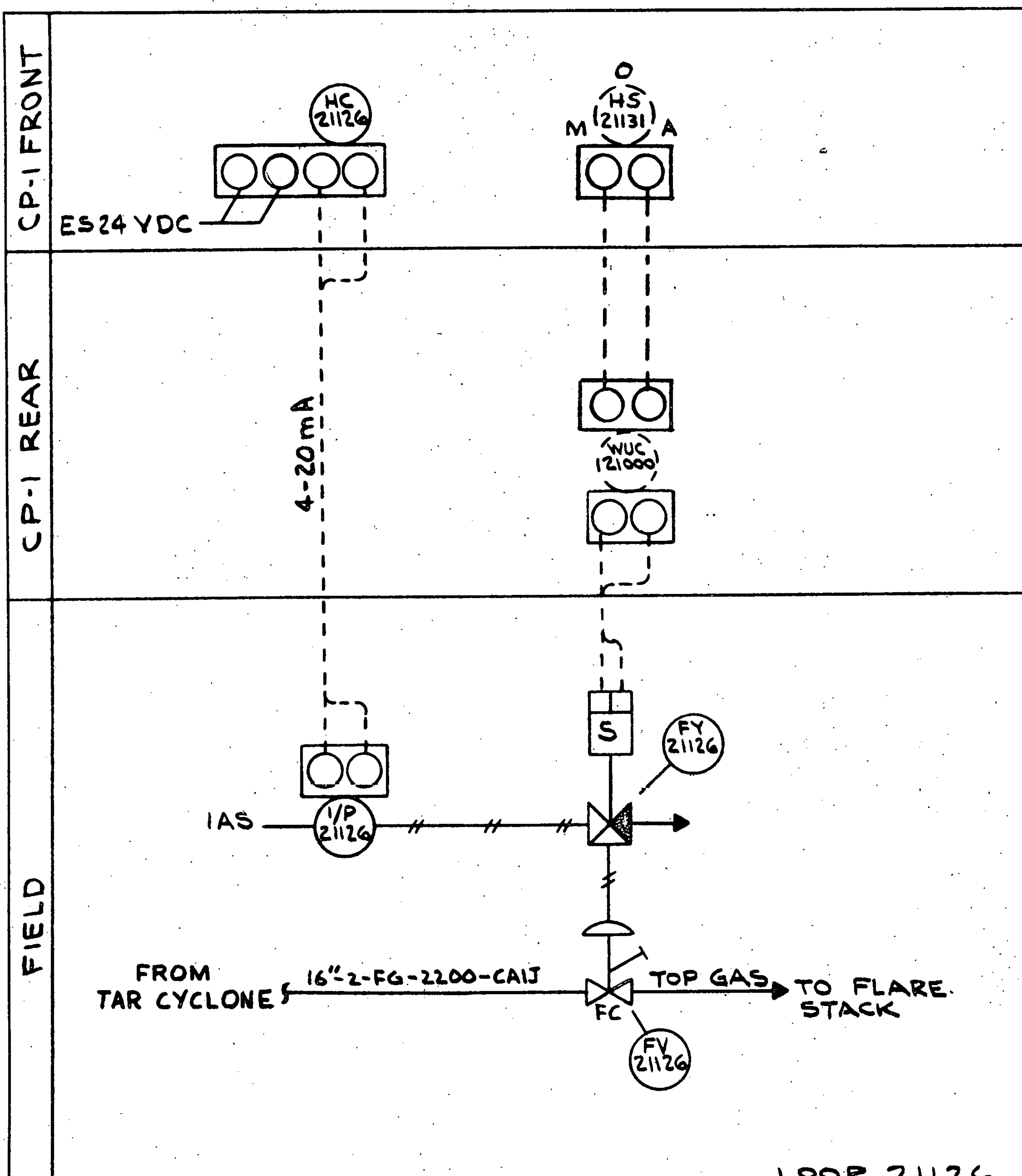
PROCESS GAS EMERGENCY RELIEF

LOOP 21125
THRU 21525

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-18-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



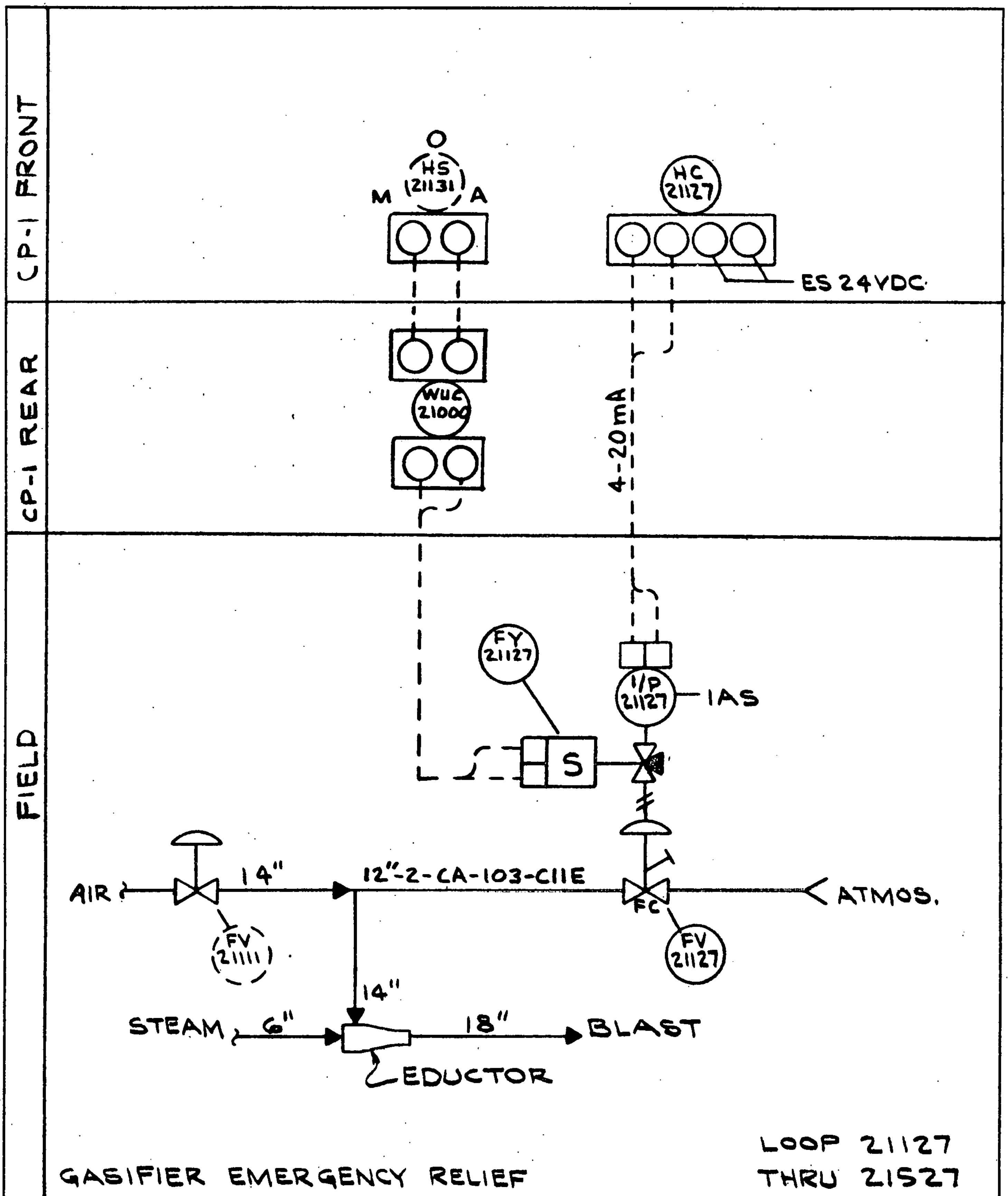
TAR CYCLONE BLOWDOWN CONTROL

LOOP 21126
THRU 21526

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-18-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV. 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

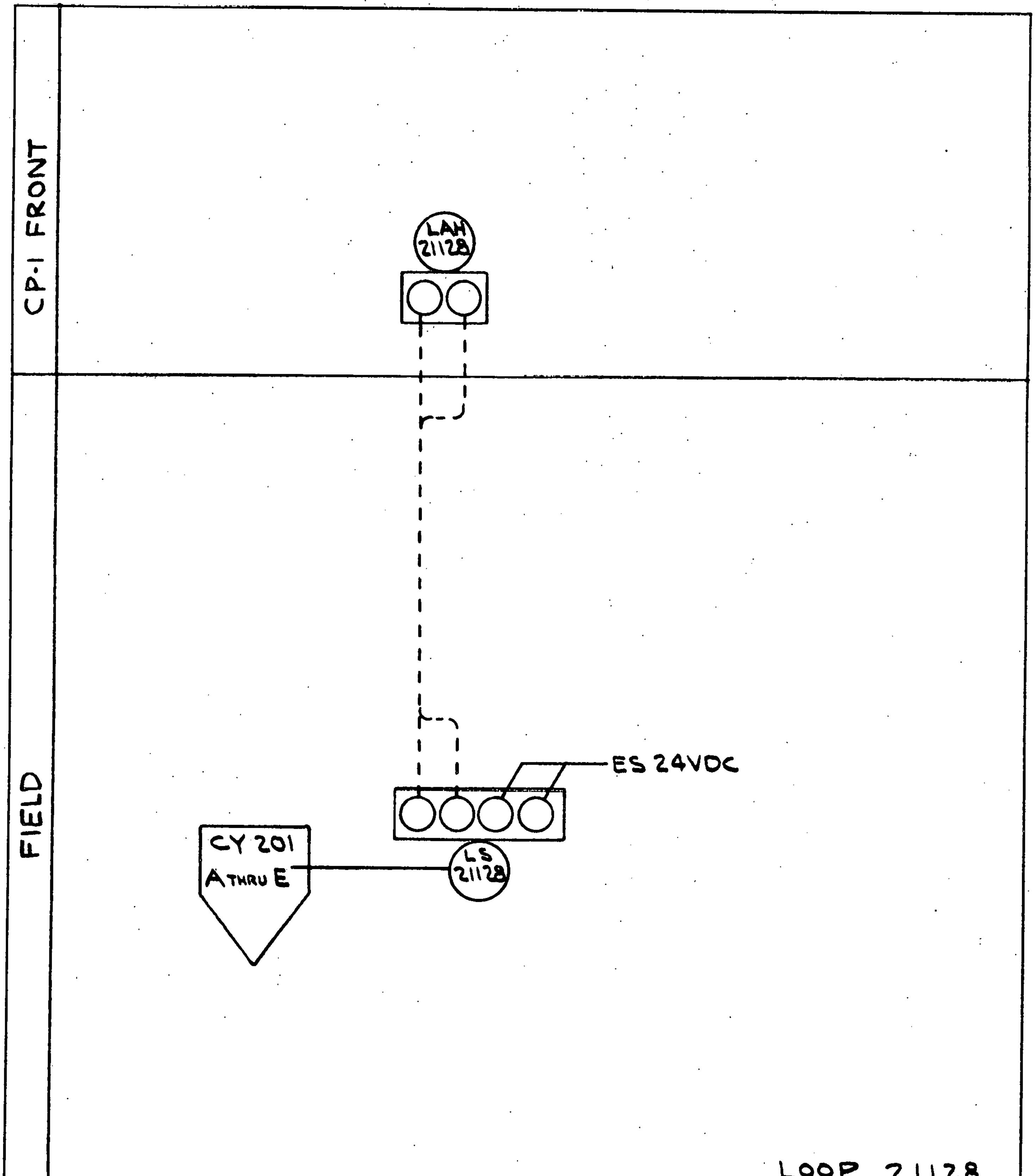
(ENG-106-0278)



BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-21-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278)



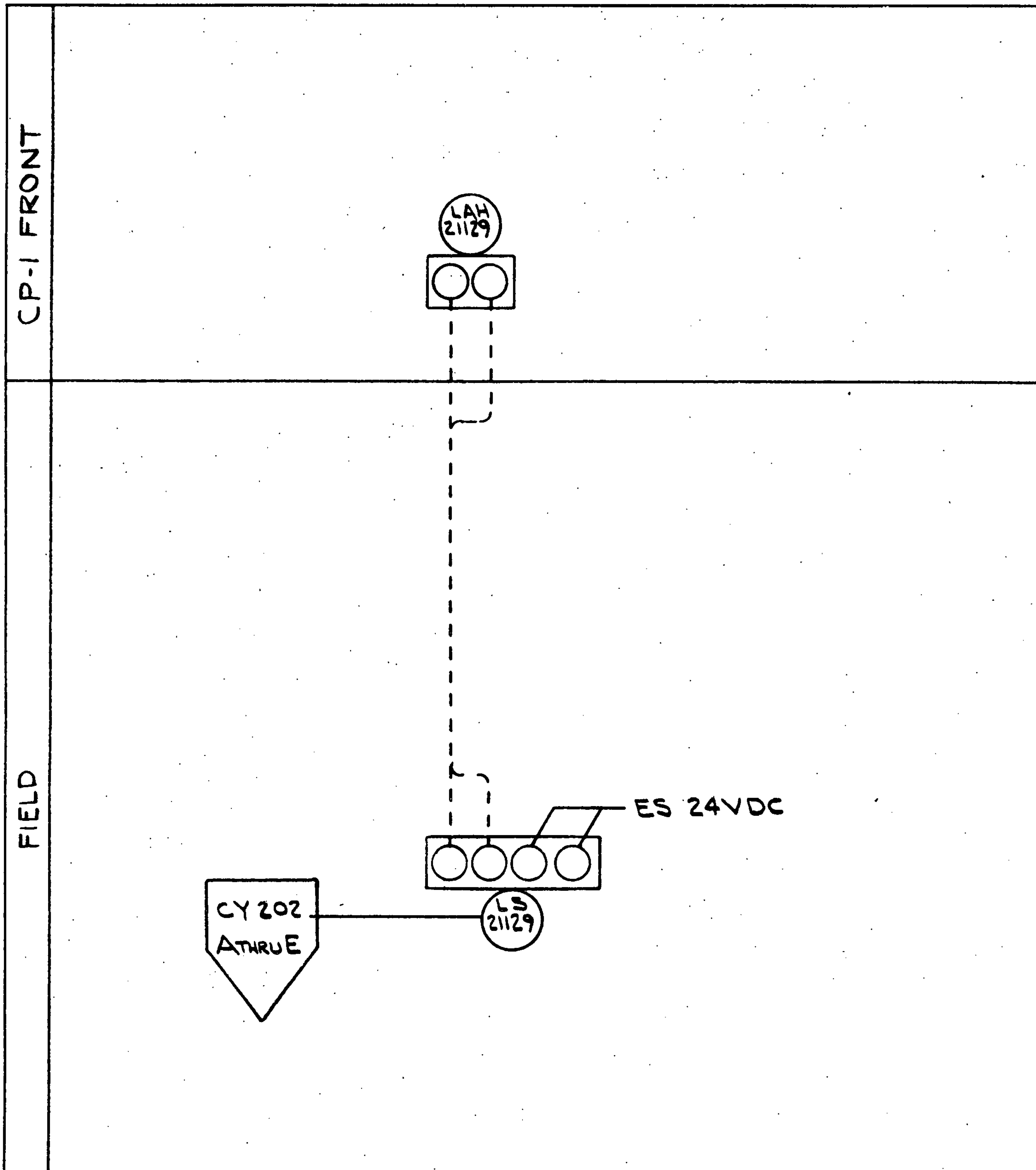
DUST CYCLONE LEVEL ALARM

LOOP 21128
THRU 21528

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-22-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



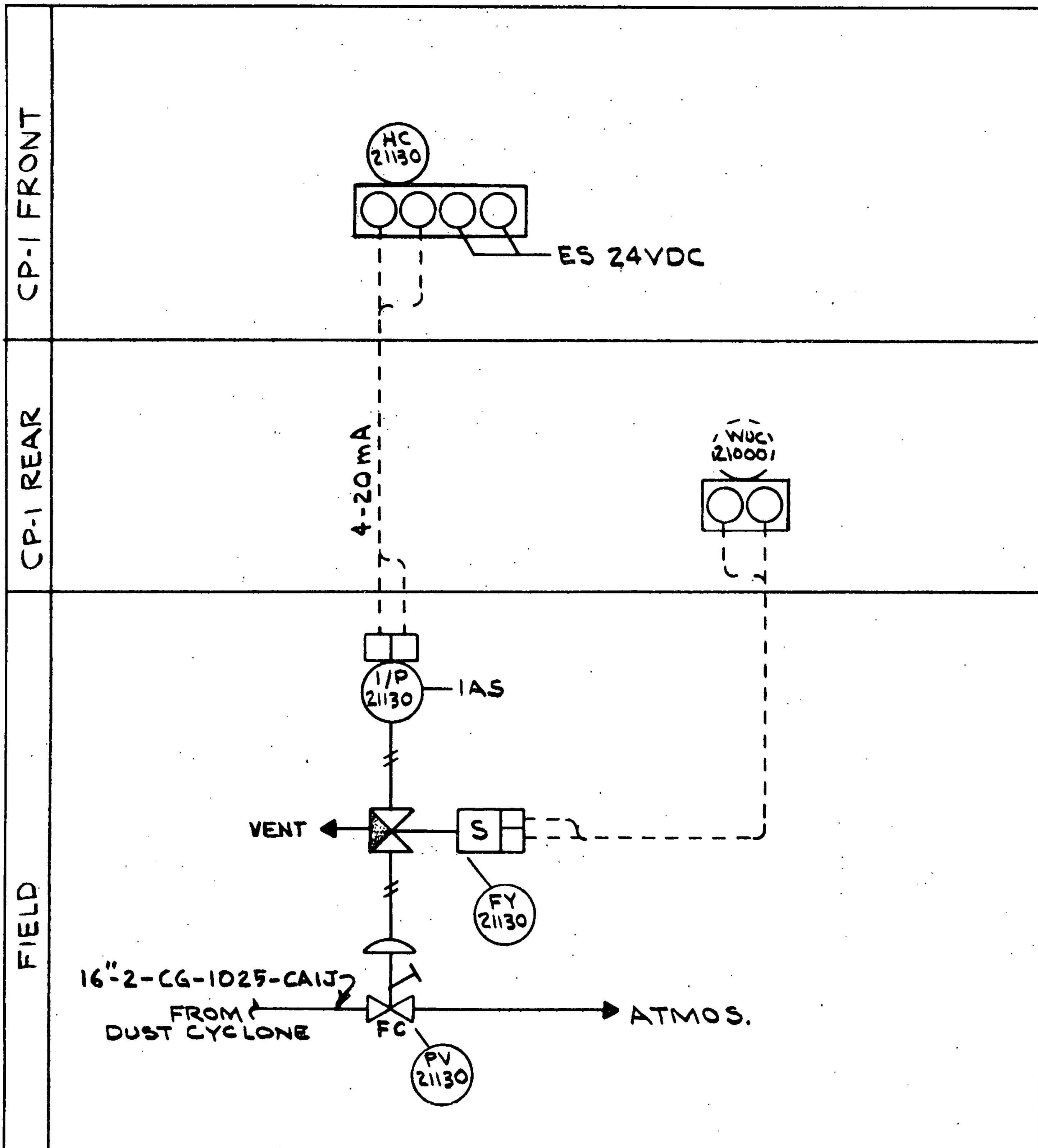
TAR CYCLONE LEVEL ALARM

LOOP 21129
THRU 21529

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-22-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ØI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



EMERGENCY DRAFT CONTROL

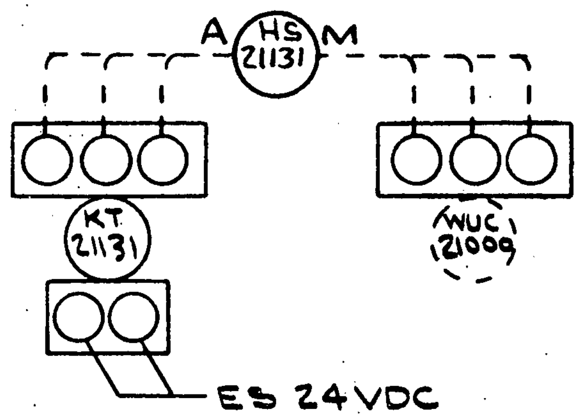
LOOP 21130
THRU 21530

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-23-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

CP-1 REAR



ELECTRIC POWER FAILURE-SYSTEM RELIEF

LOOP 21131
THRU 21531

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-23-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD

INERT GAS TO FLARE STACK - FLOW INDICATION

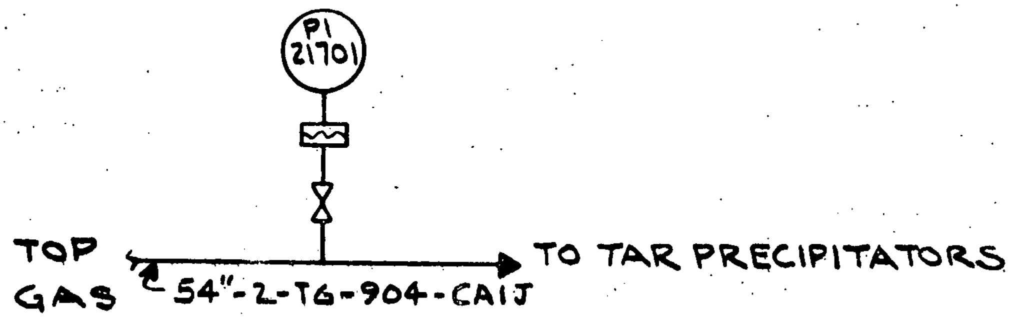
LOOP 21132
THRU 21532

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-23-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ØI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278)

FIELD



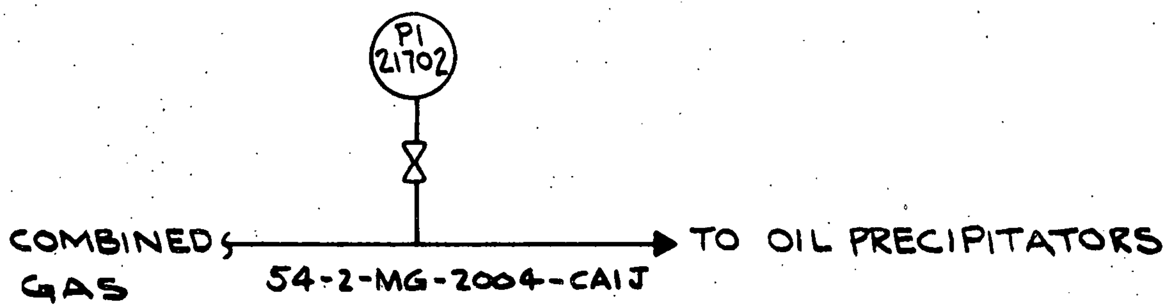
TOP GAS HEADER PRESSURE INDICATION LOOP 21701

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-23-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ØI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



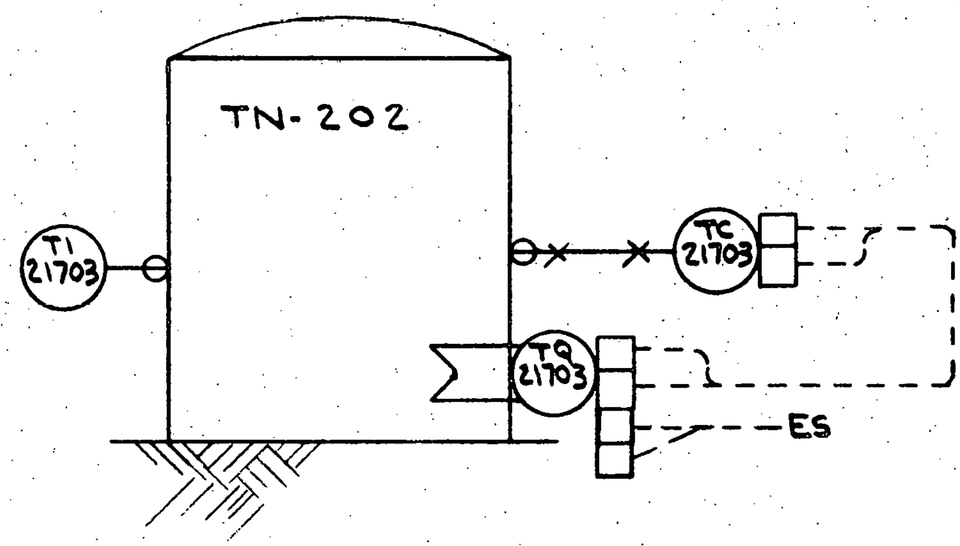
COMBINED GAS HEADER-PRESSURE INDICATION LOOP 21702

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-23-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278)

FIELD



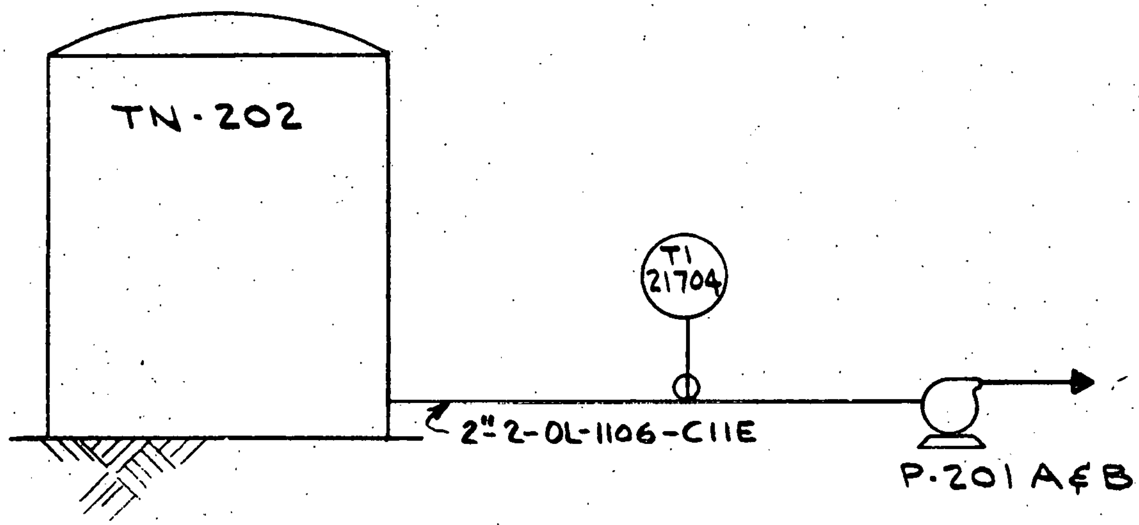
TAR/OIL TANK-TEMPERATURE CONTROL LOOP 21703

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-24-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



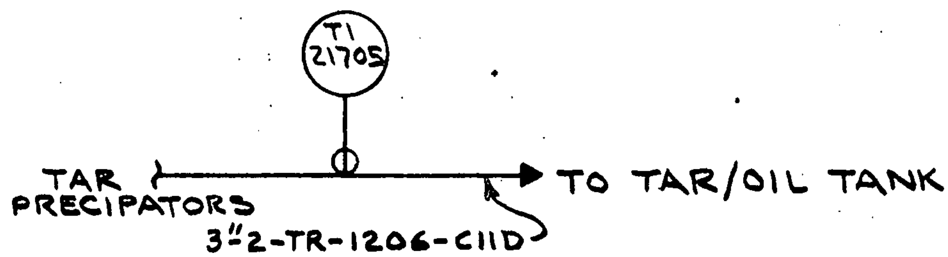
TAR/OIL TANK DISCHARGE-TEMP. INDIC. LOOP 21704

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-24-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ØI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278

FIELD



TAR HEADER - TEMP. INDICATION

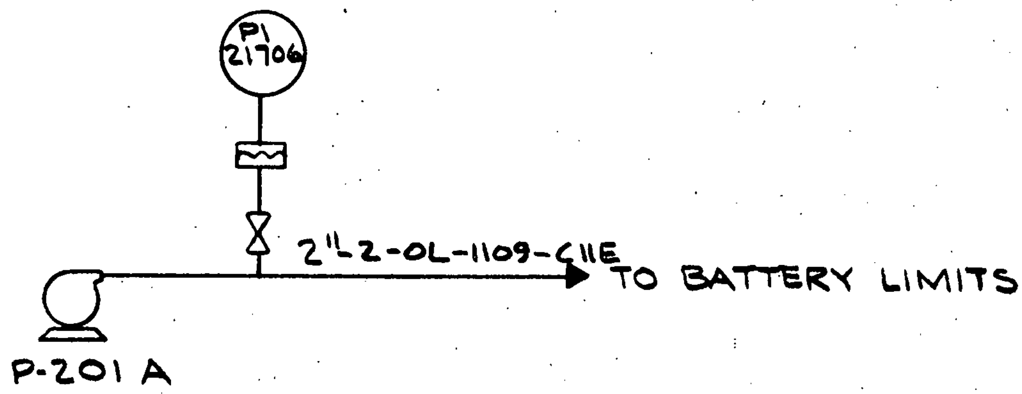
LOOP 21705

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-24-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD

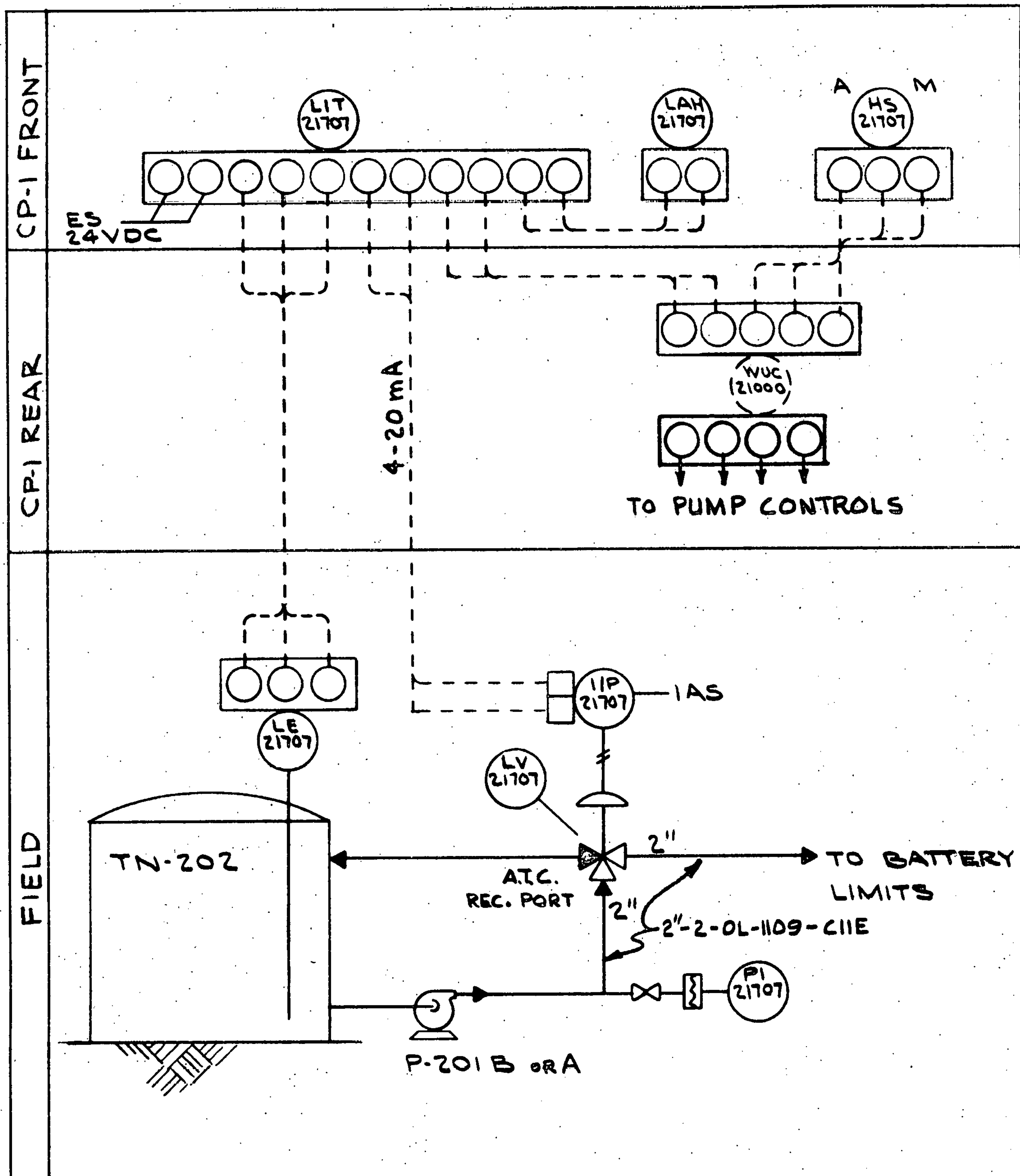


TAR/OIL PUMP DISCHARGE-PRESS INDIC LOOP 21706

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-24-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



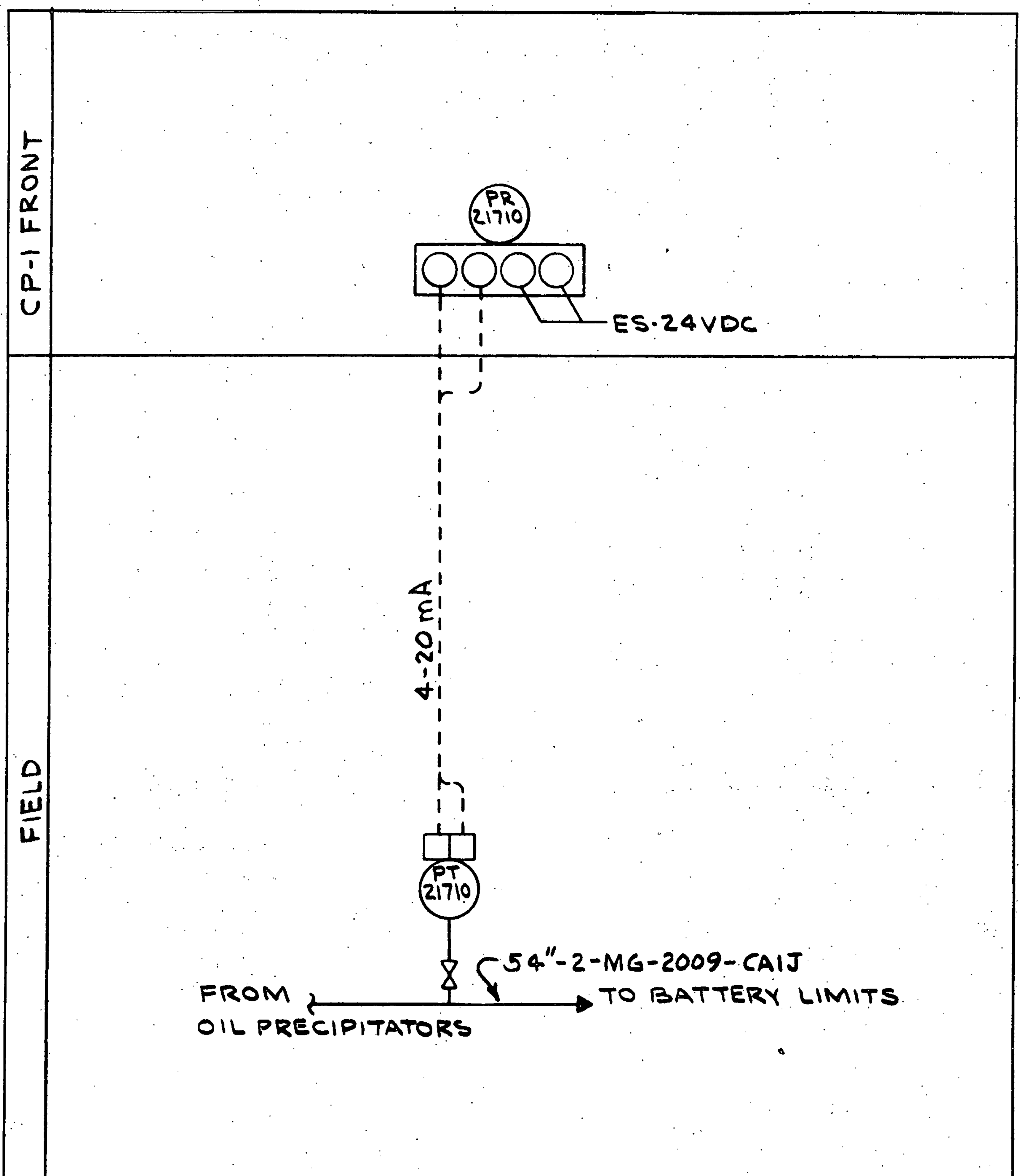
TAR / OIL TANK-LEVEL CONTROL

LOOP 21707

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-24-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV. 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

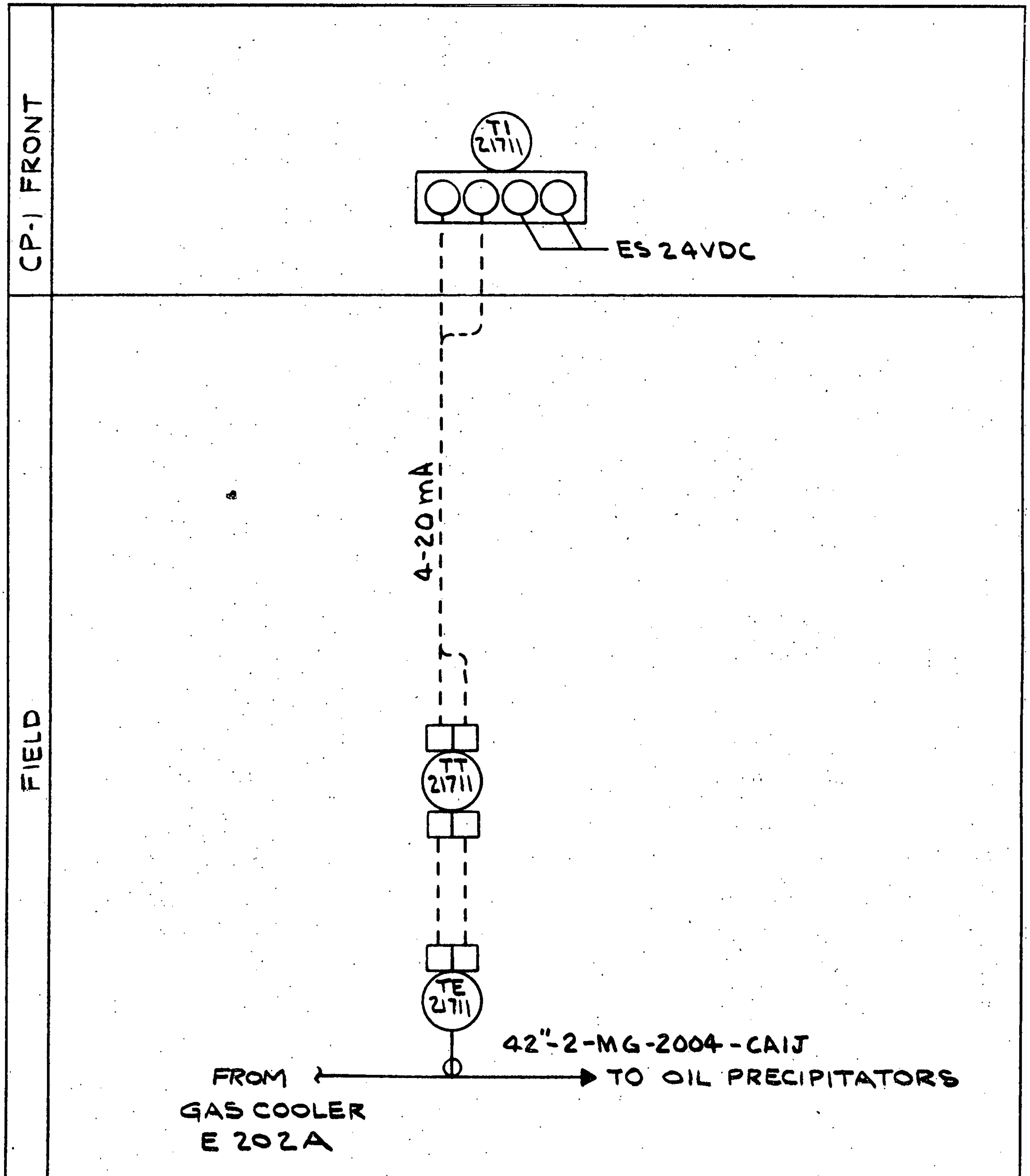


MIXED GAS TO CONSUMER PRESS RECORD LOOP 21710

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-24-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

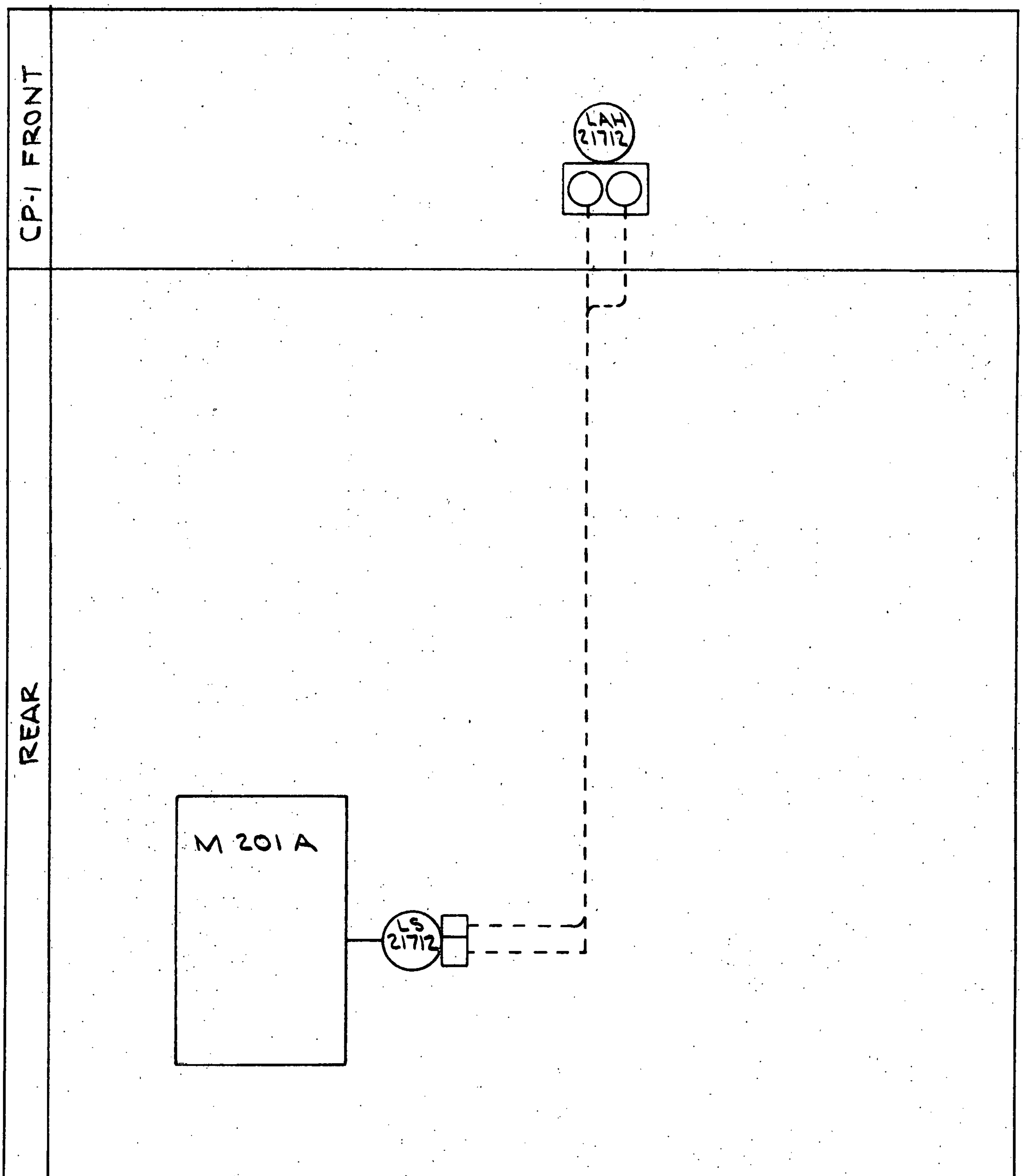


COMBINED GAS FROM COOLER TEMP. INDICATION LOOP 21711

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

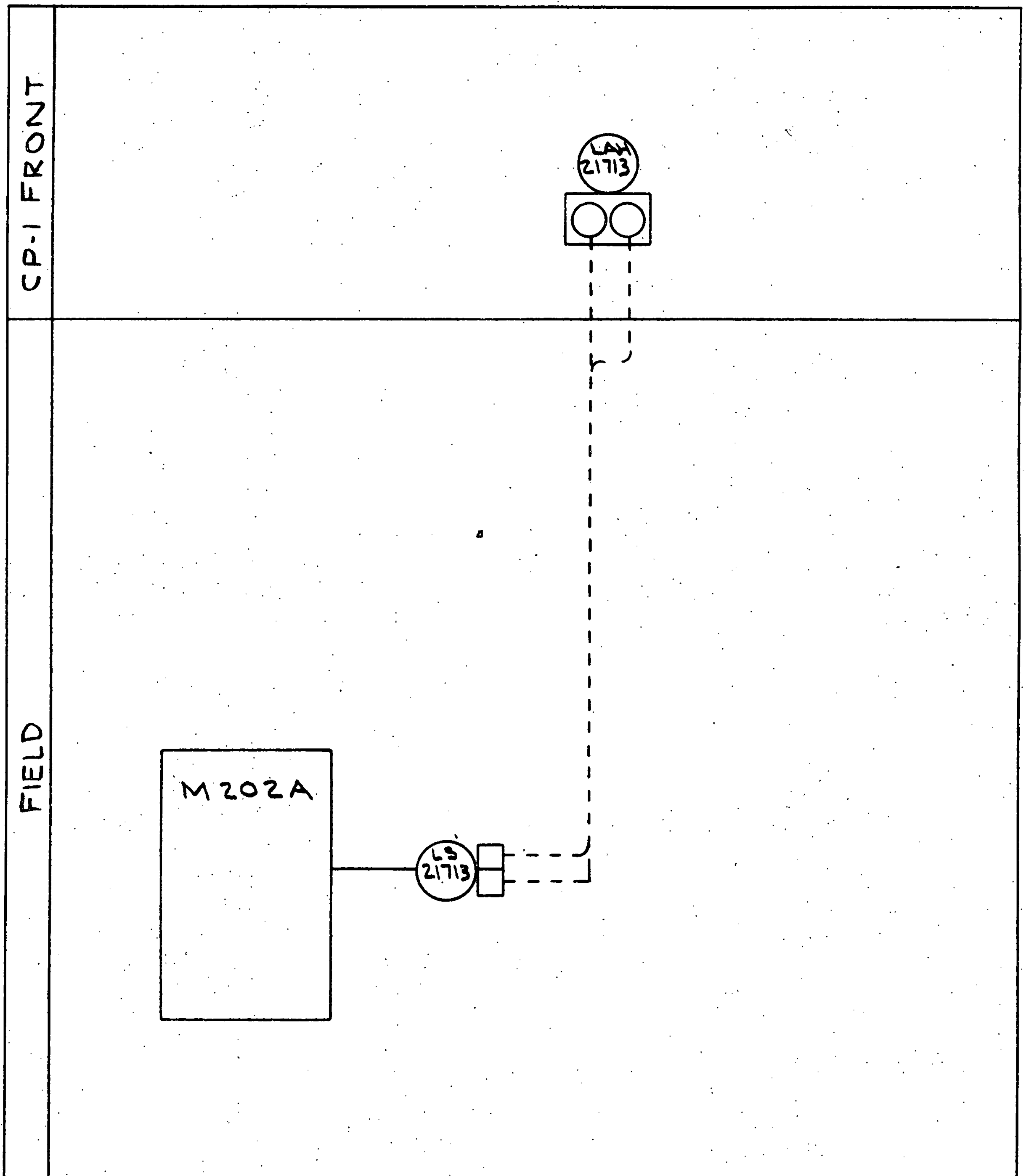


TAR PRECIPITATOR-LEVEL ALARM LOOP 21712

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ØI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

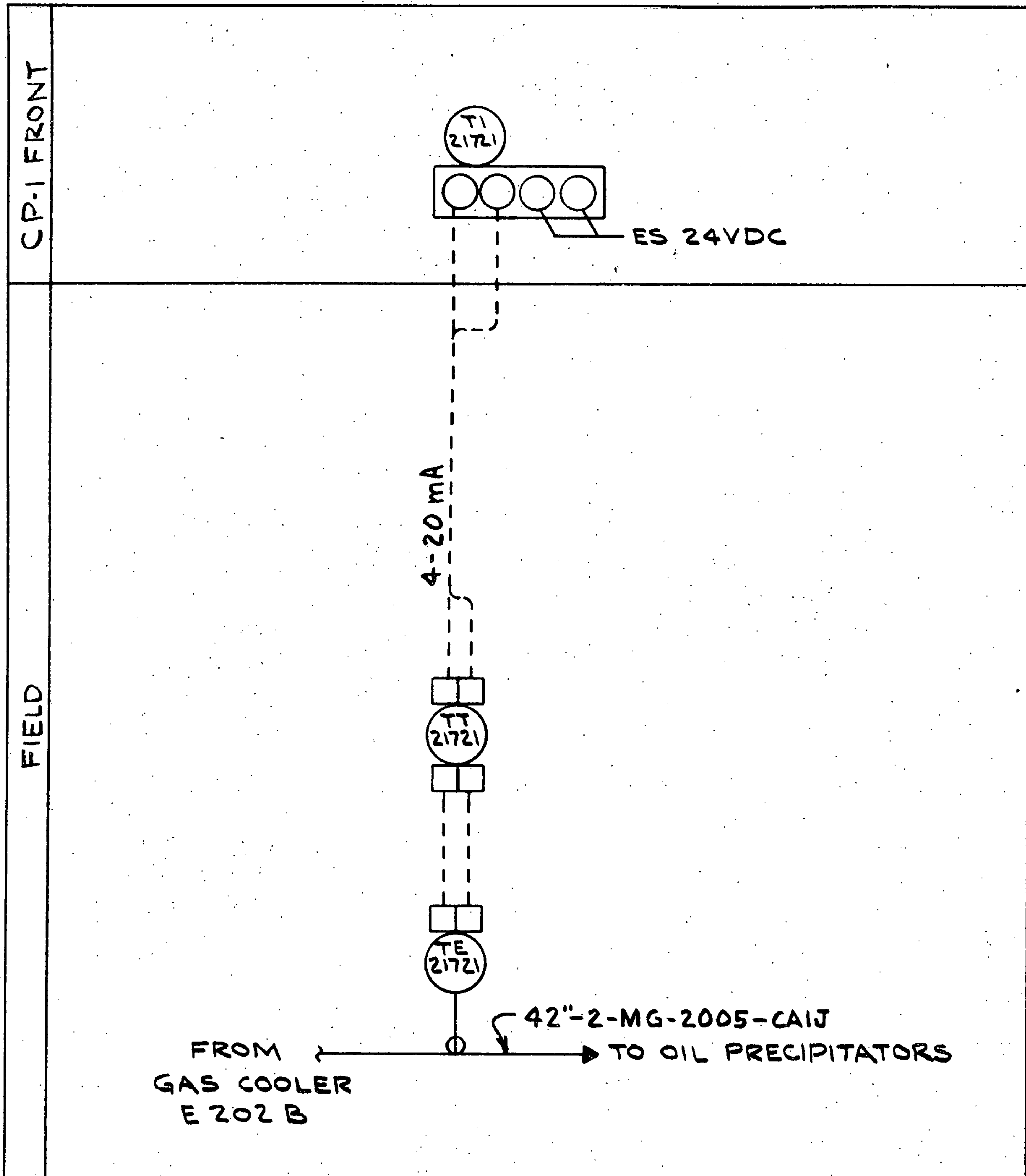


OIL PRECIPITATOR - LEVEL ALARM LOOP 21713

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

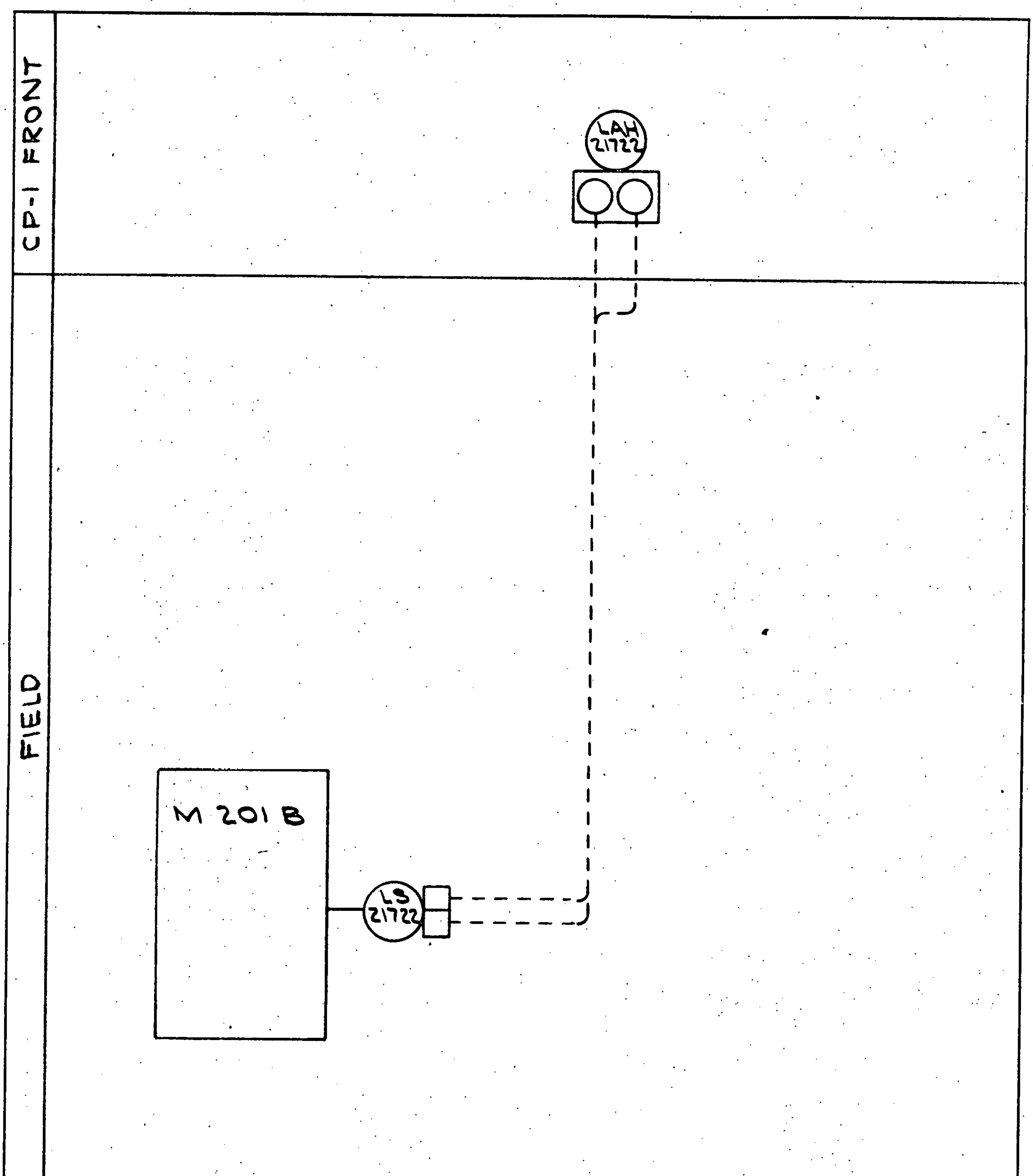


COMBINE GAS FROM COOLER-TEMP INDICATION LOOP 21721

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278)



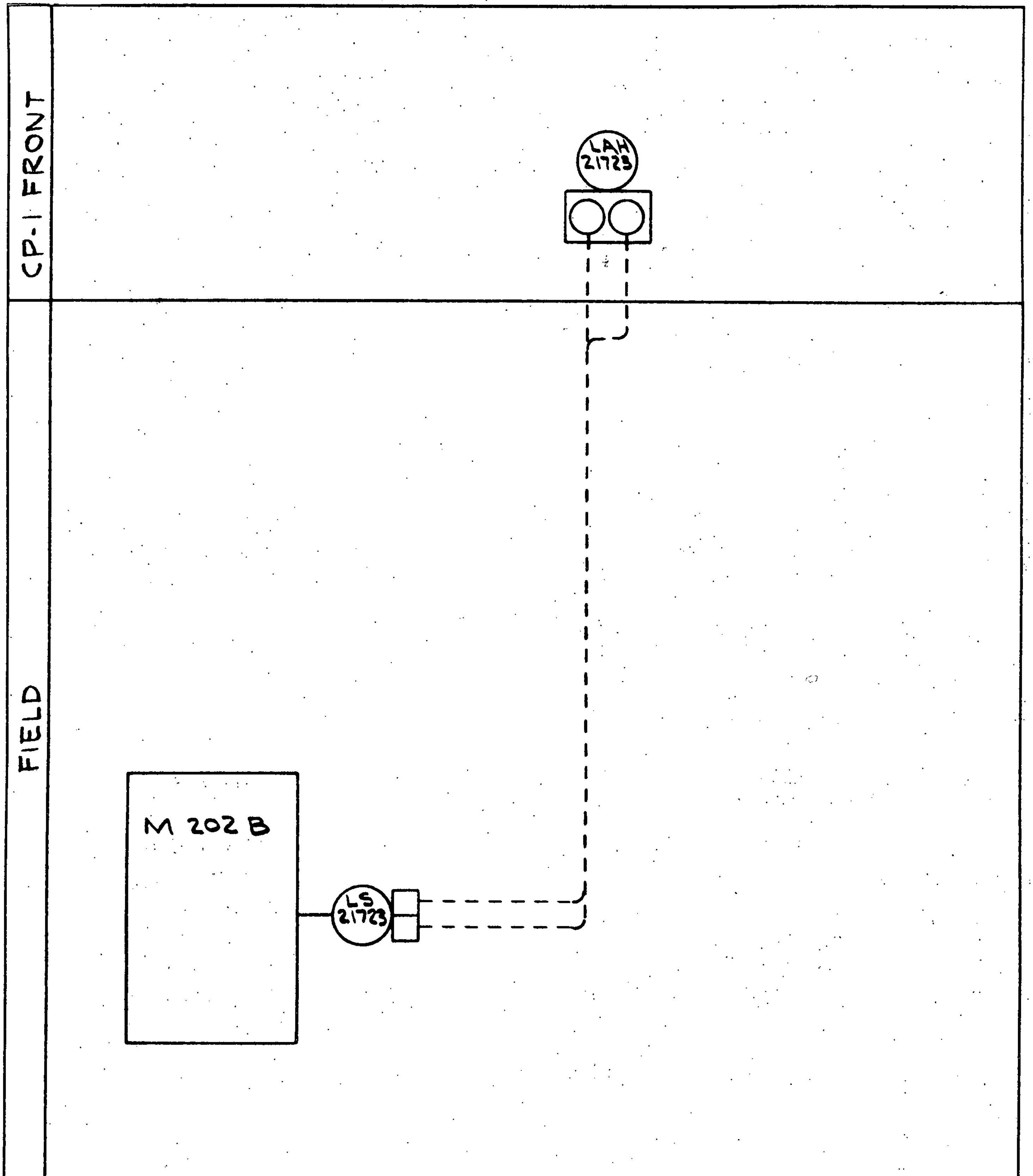
TAR PRECIPITATOR-LEVEL ALARM

LOOP 21722

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8·25·78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278)

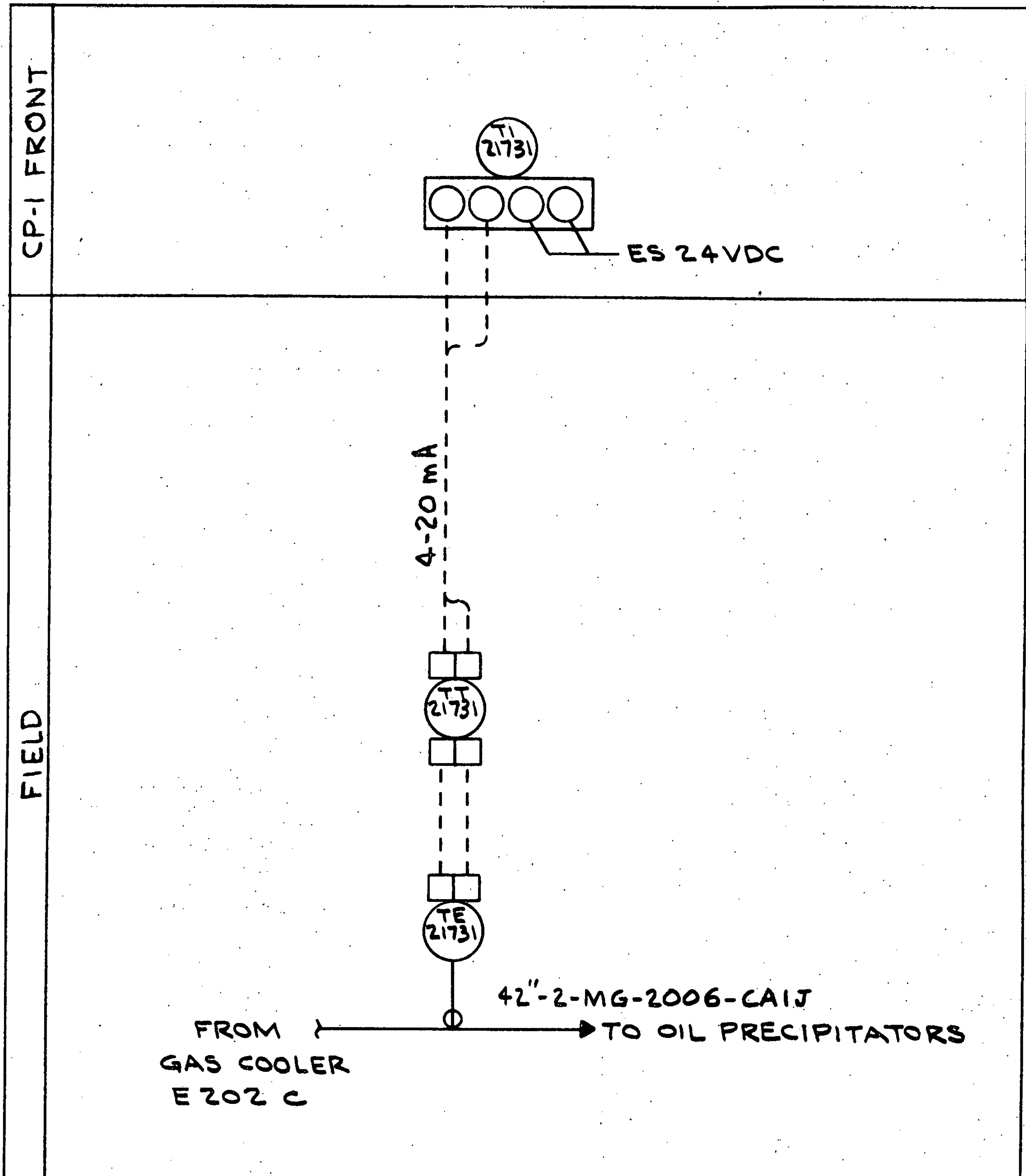


OIL PRECIPITATOR - LEVEL ALARM   LOOP 21723

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

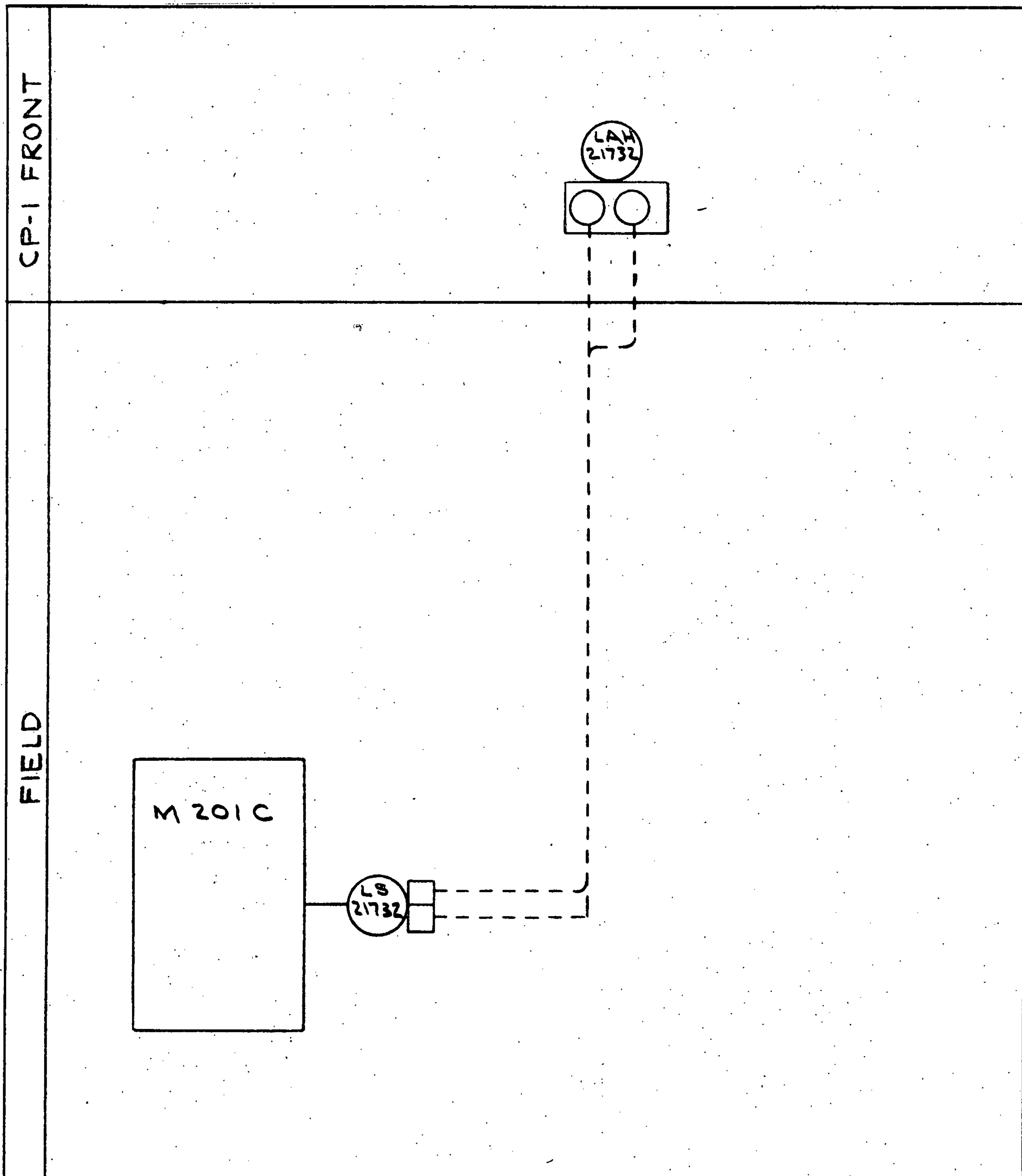


COMBINED GAS FROM COOLER - TEMP INDICATION LOOP. 21731

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ØI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

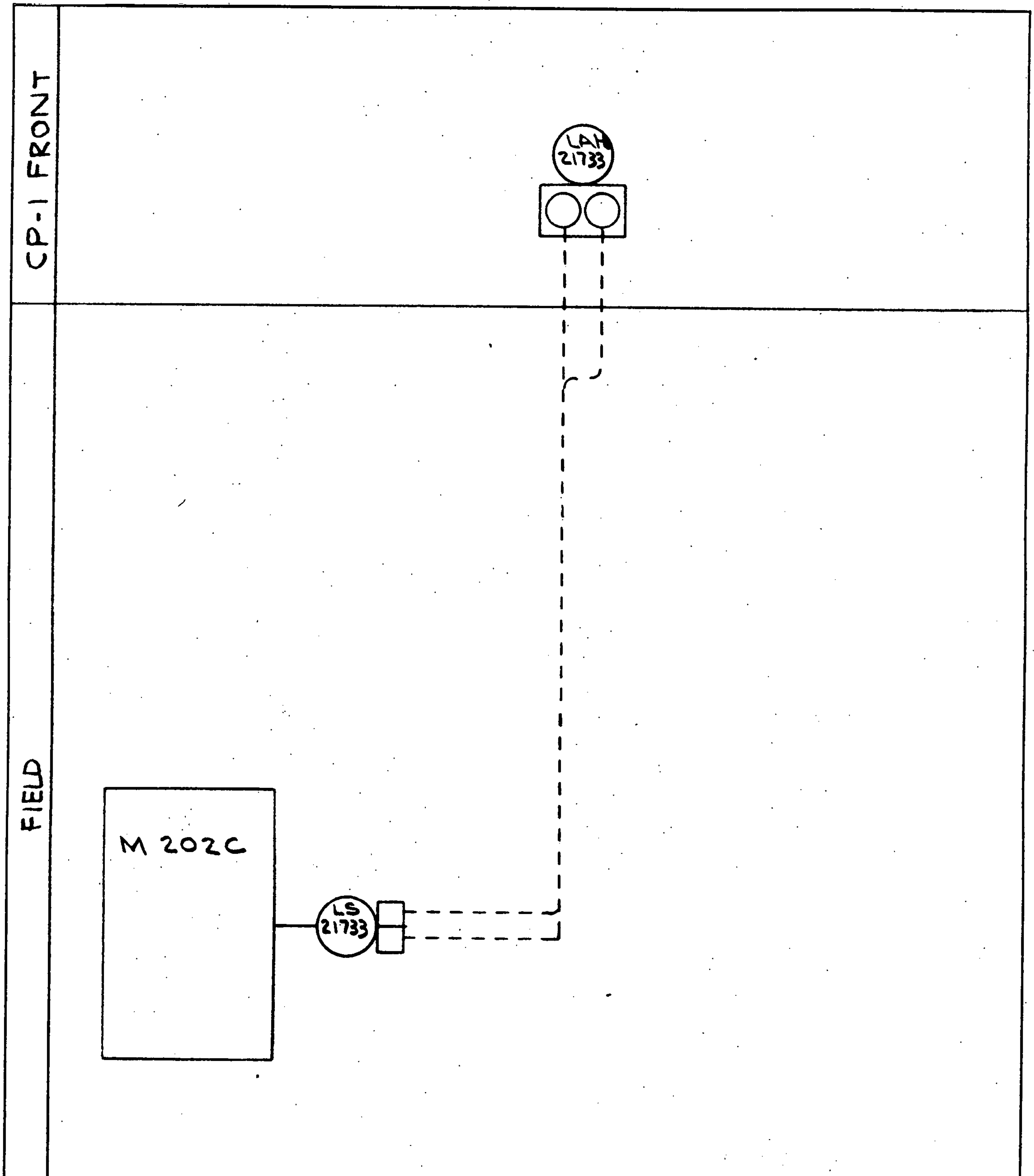


TAR PRECIPITATOR LEVEL ALARM LOOP 21732

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

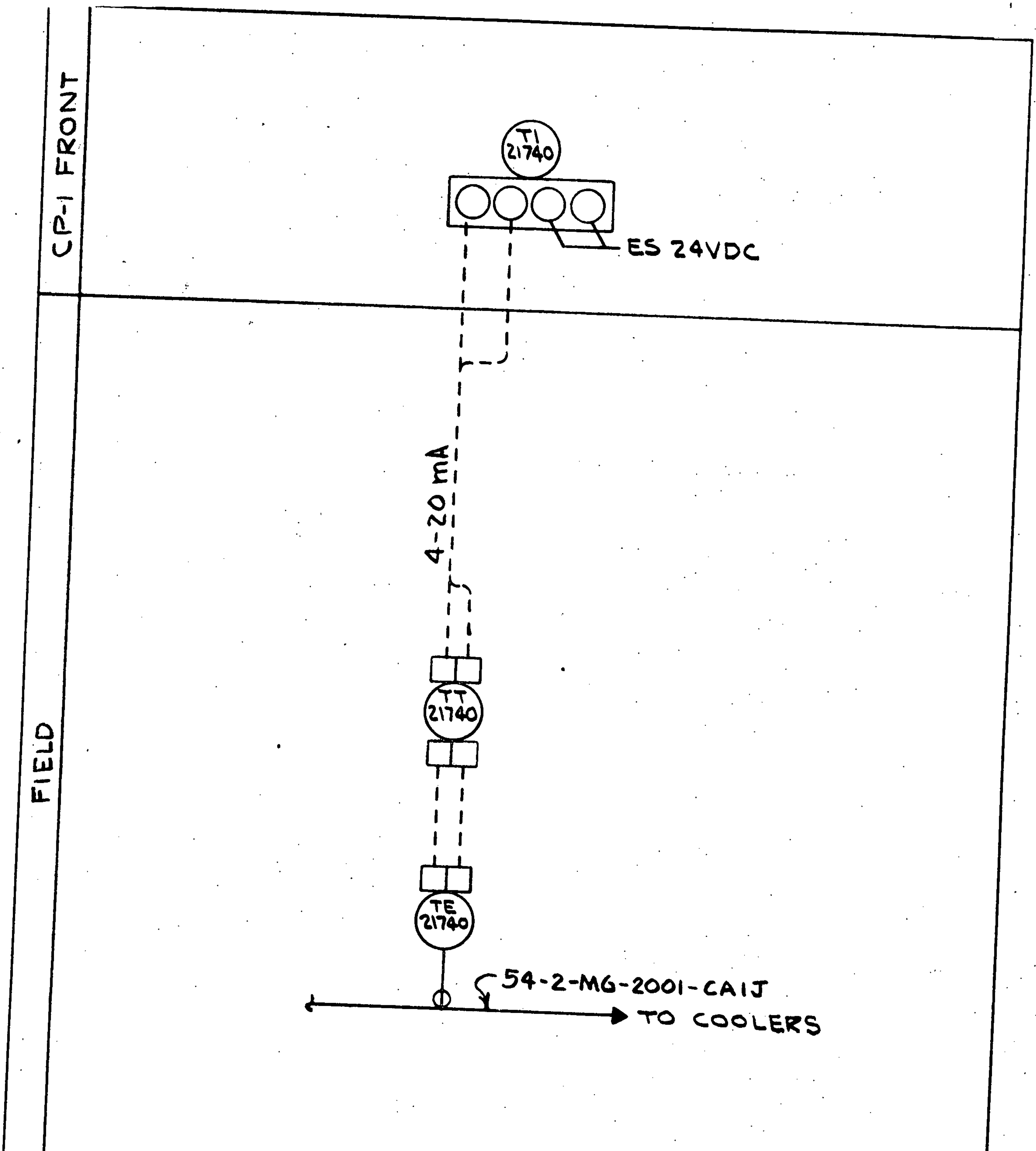


OIL PRECIPITATORS LEVEL ALARM LOOP 21733

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ØI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



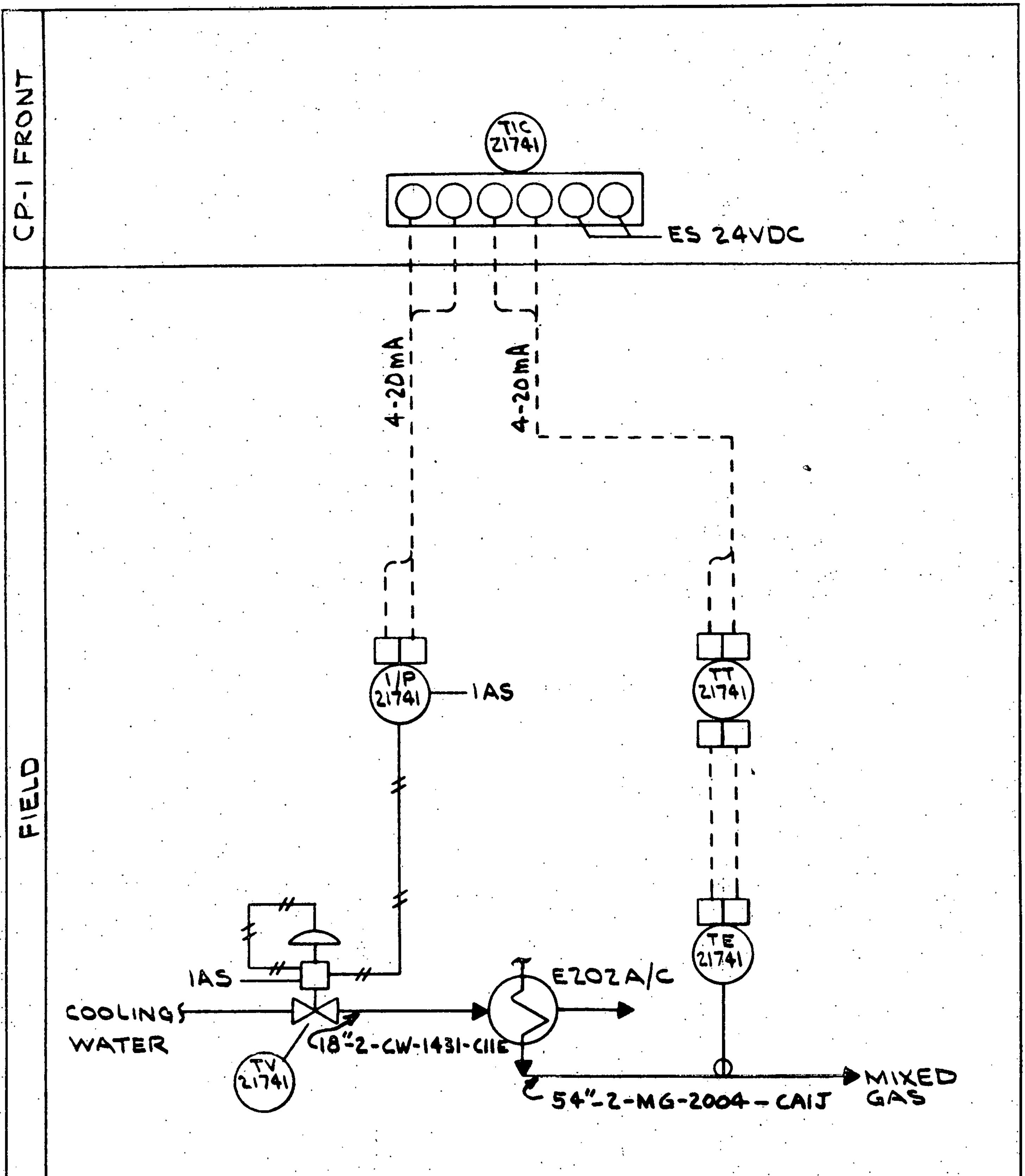
MIXED GAS HEADER - TEMP. INDICATION

LOOP 21740

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

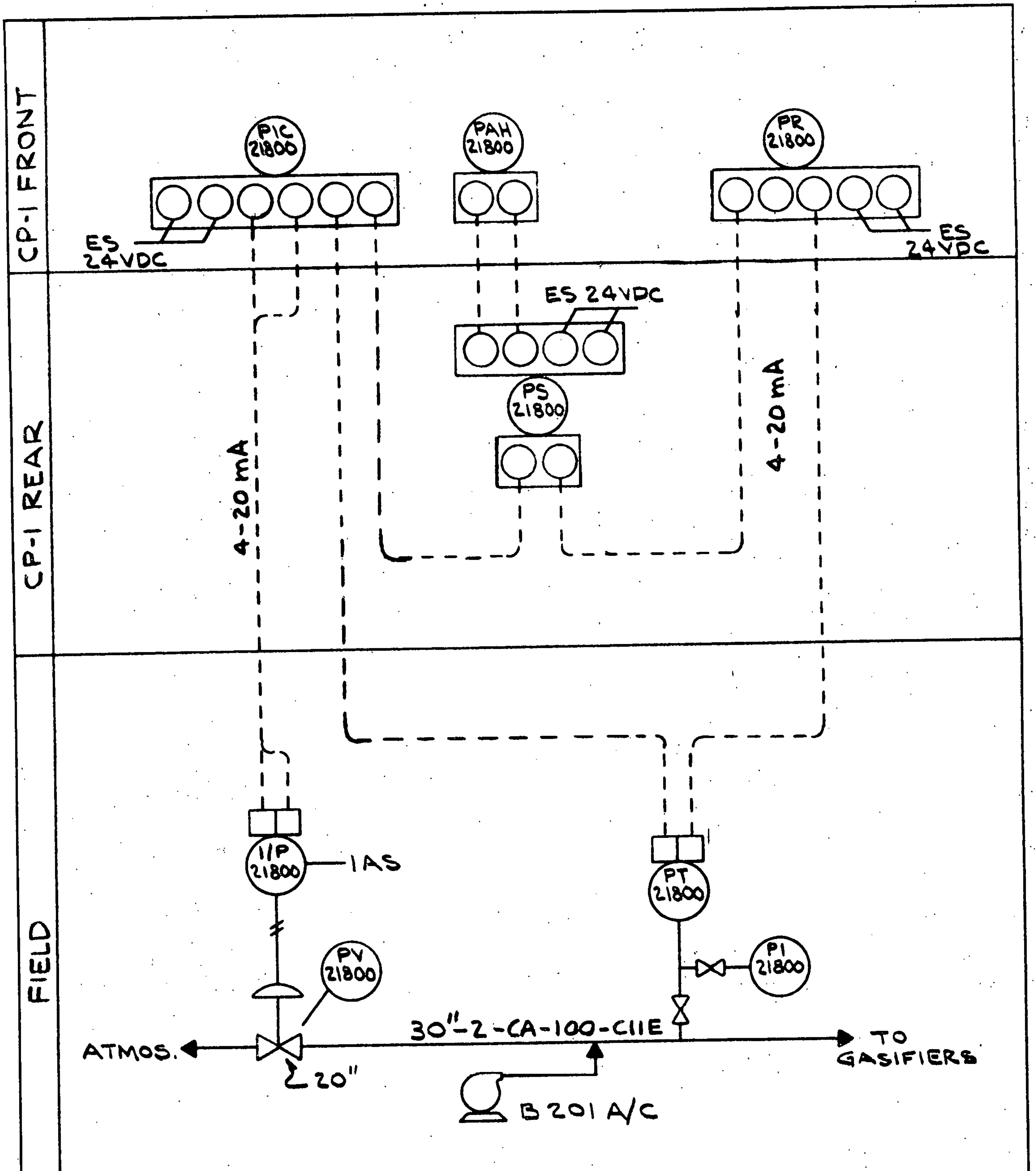


MIXED GAS FROM COOLERS - TEMP. CONTROL LOOP 21741

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ØI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



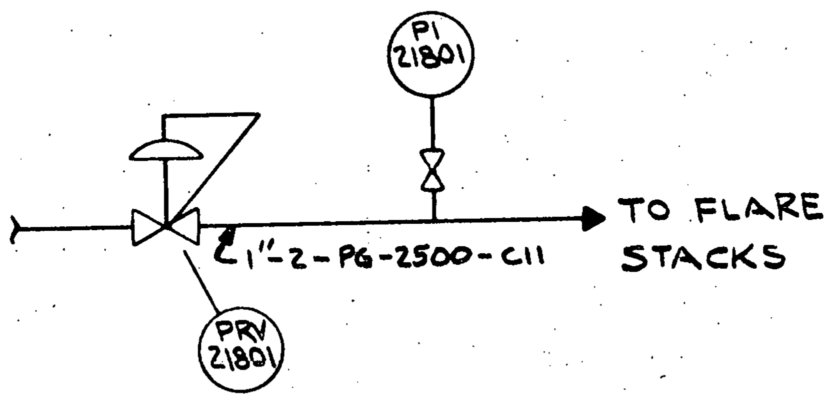
COMBUSTION AIR FROM BLOWERS PRESS CONTROL LOOP 21800

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ØI 3001	SKETCH NO.	REV 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

NG-106-0278)

FIELD

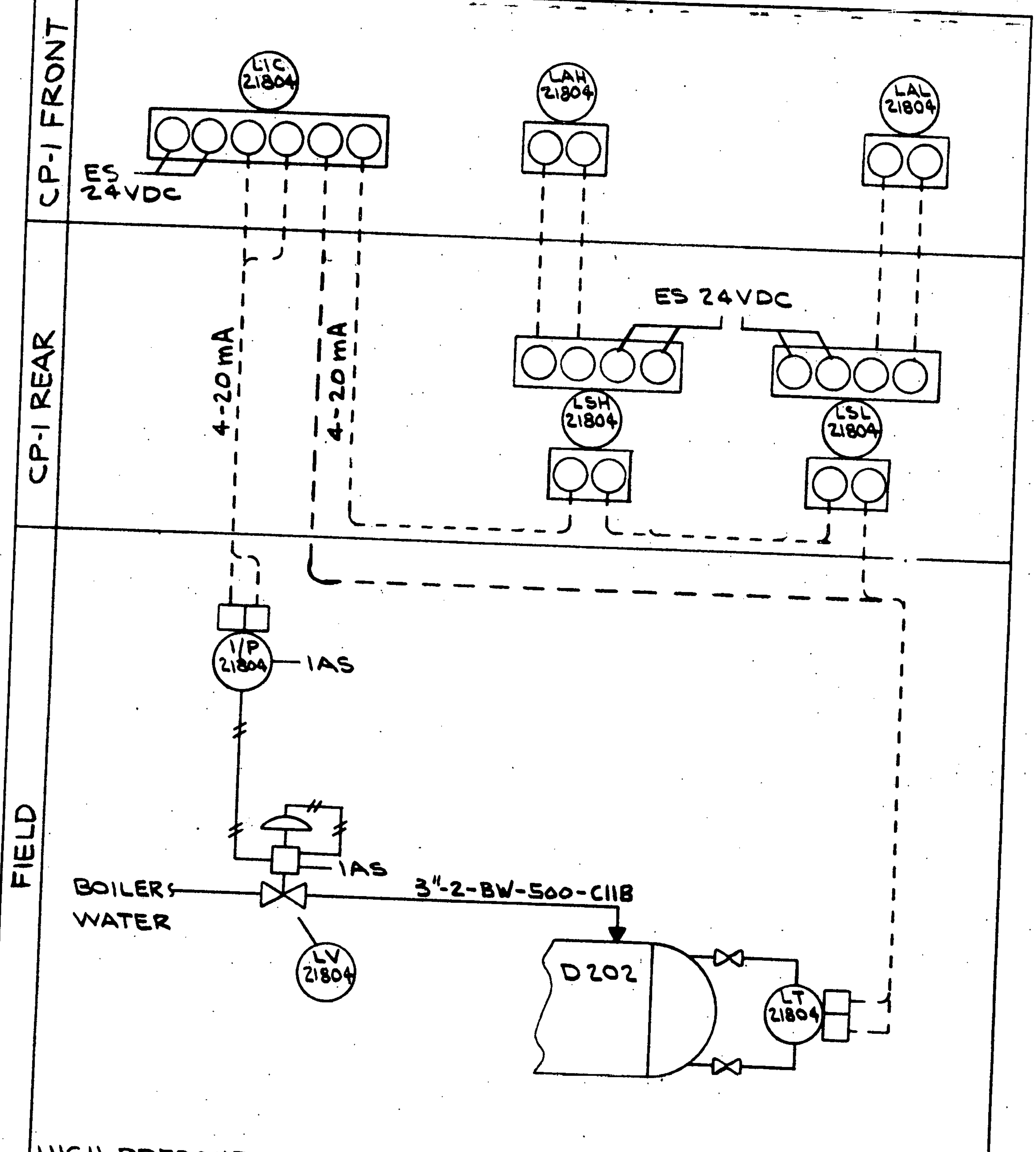


PILOT GAS TO FLARE STACKS PRESS CONTROL LOOP 21801

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

VG-106-0278)



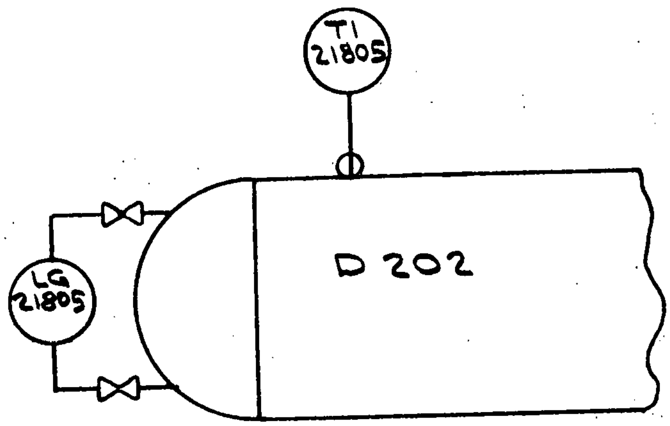
HIGH PRESSURE STEAM DRUM-LEVEL CONTROL LOOP 21804

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-027

FIELD

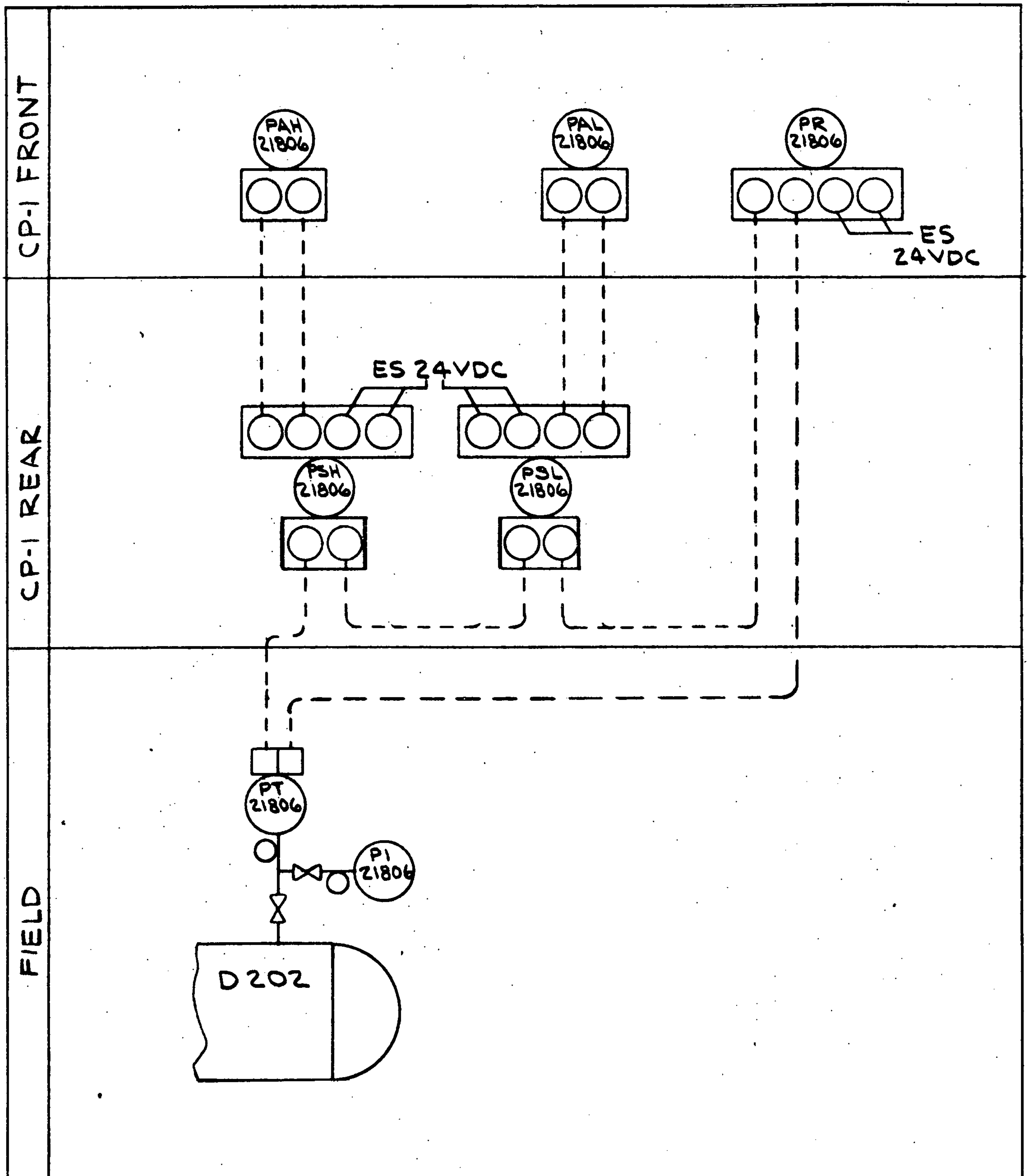


H. P. STEAM DRUM - LEVEL & TEMP INDICATION LOOP 21805

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ØI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278)



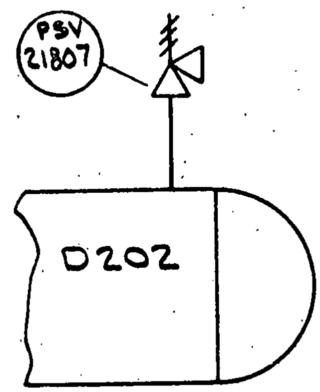
H.P. STEAM DRUM PRESS. RECORD & ALARM   LOOP 21806

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



H.P. STEAM DRUM PRESS. RELIEF

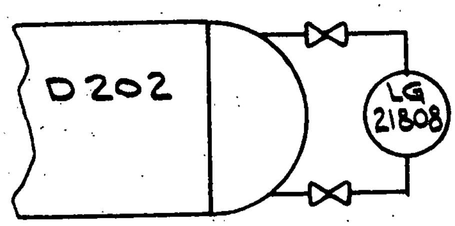
LOOP 21807

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-25-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



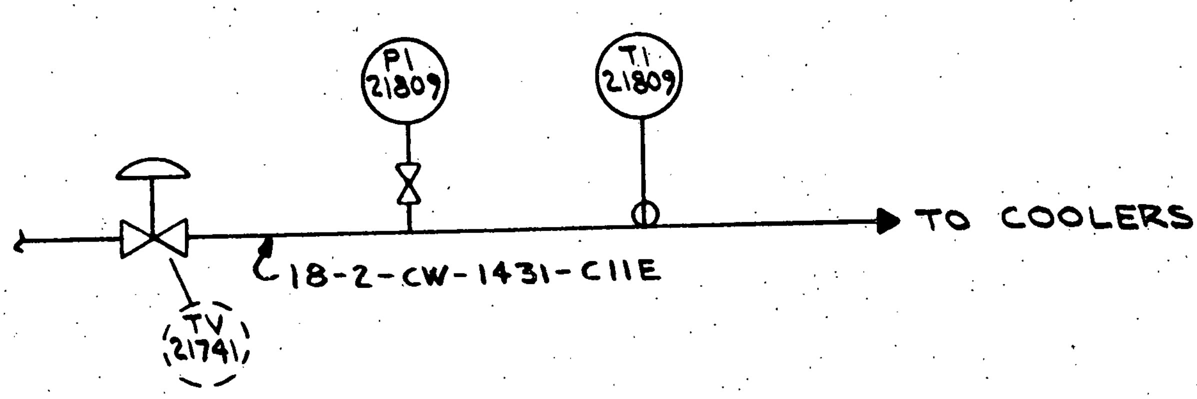
H.P. STEAM DRUM - LEVEL INDICATION LOOP 21808

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278)

FIELD

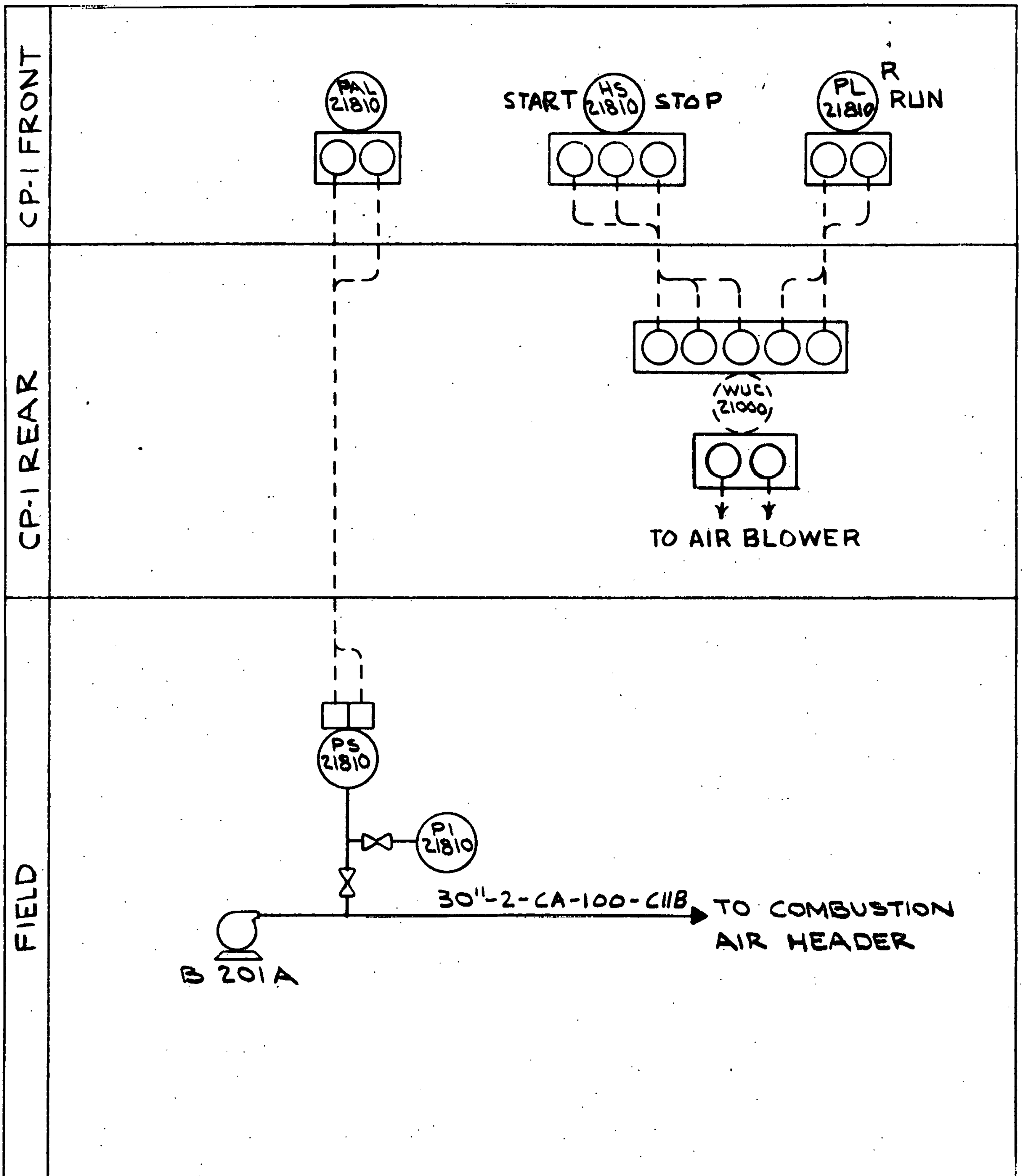


COOLER WATER SUPPLY TEMP & PRESS INDICATION LOOP 21809

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



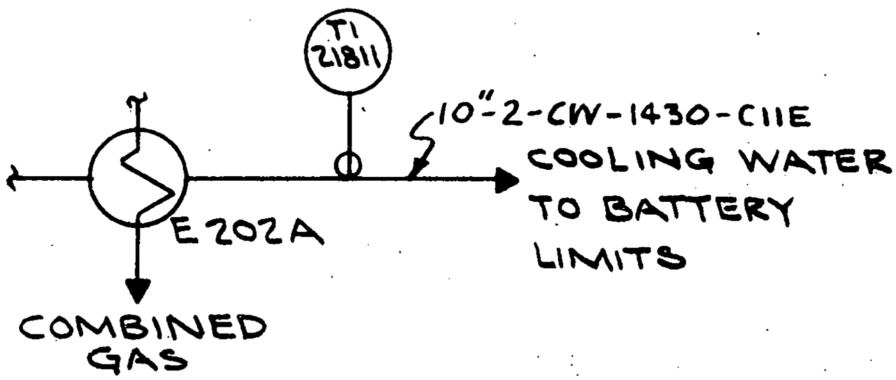
COMBUSTION AIR BLOWER-PRESS. INDICATE/ALARM LOOP 21810

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV. 1
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



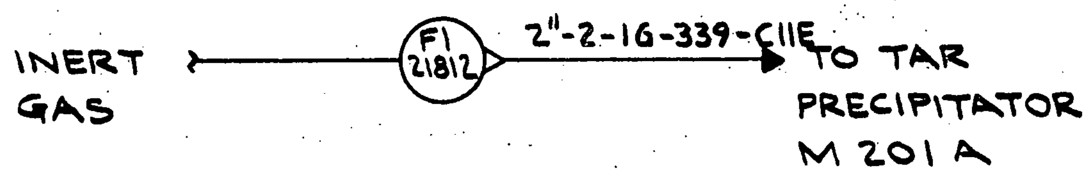
GAS COOLER WATER RETURN-TEMP INDICATE. LOOP 21811

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. Φ I 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



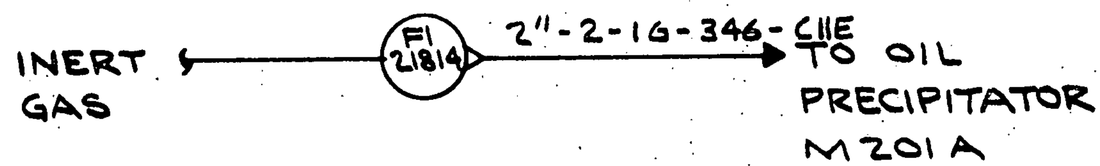
TAR PRECIPITATOR PURGE GAS FLOW INDICATION LOOP 21812

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD

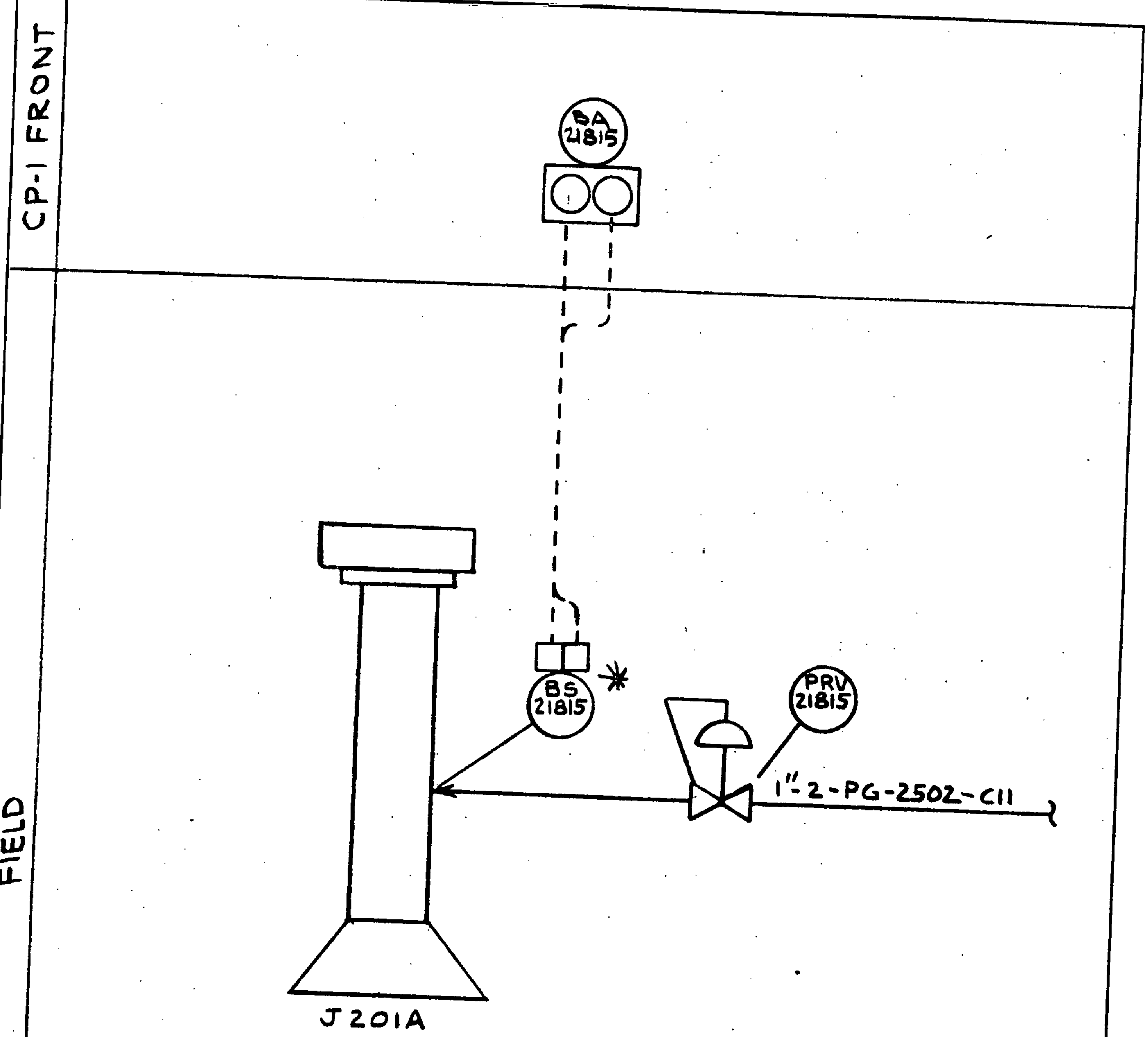


OIL PRECIPITATOR PURGE GAS-FLOW INDICATION LOOP 21814

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278)



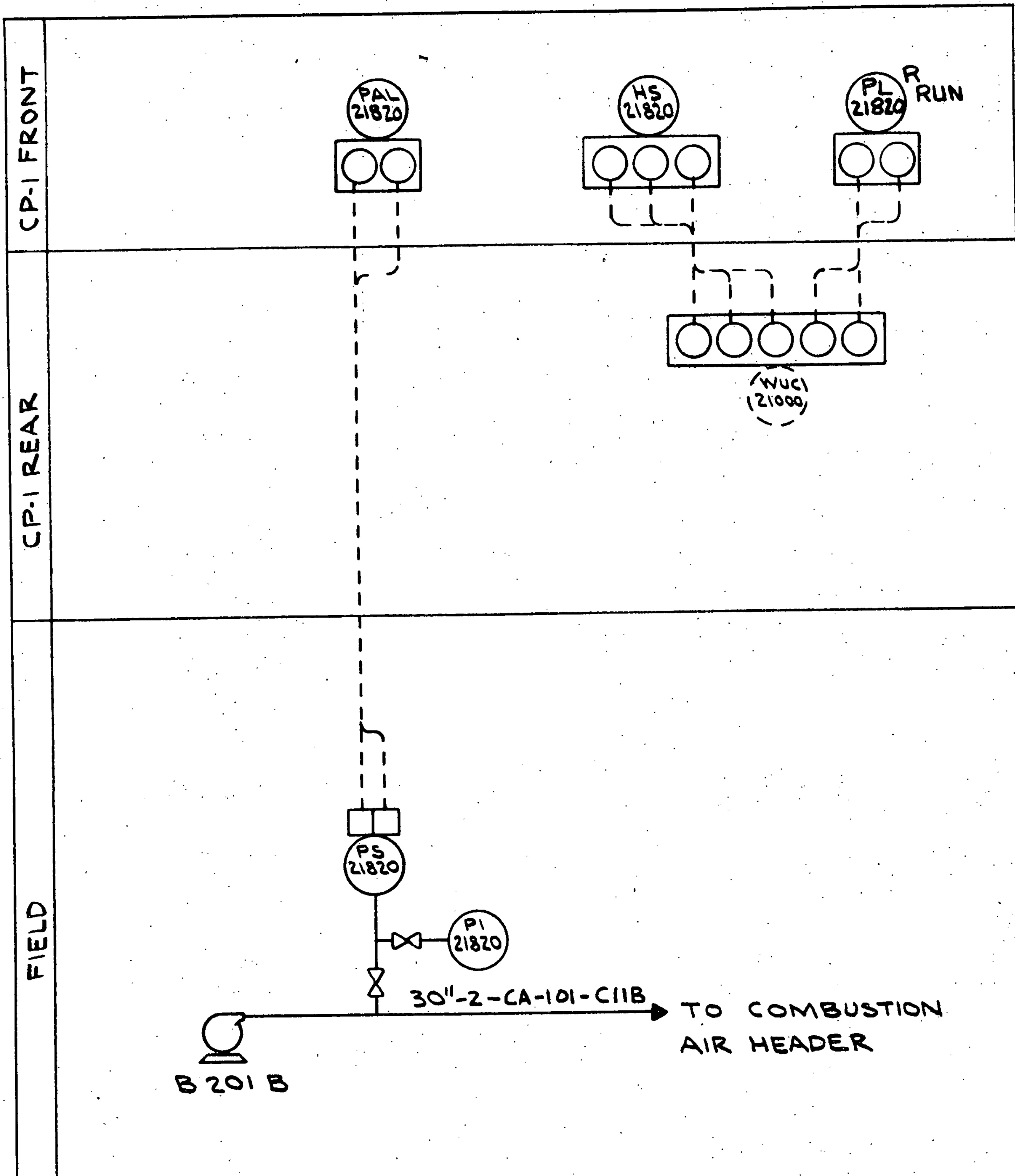
* FURNISHED WITH STACK

FLARE STACK FLAME SUPERVISION ALARM LOOP 21815

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-18-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV. 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



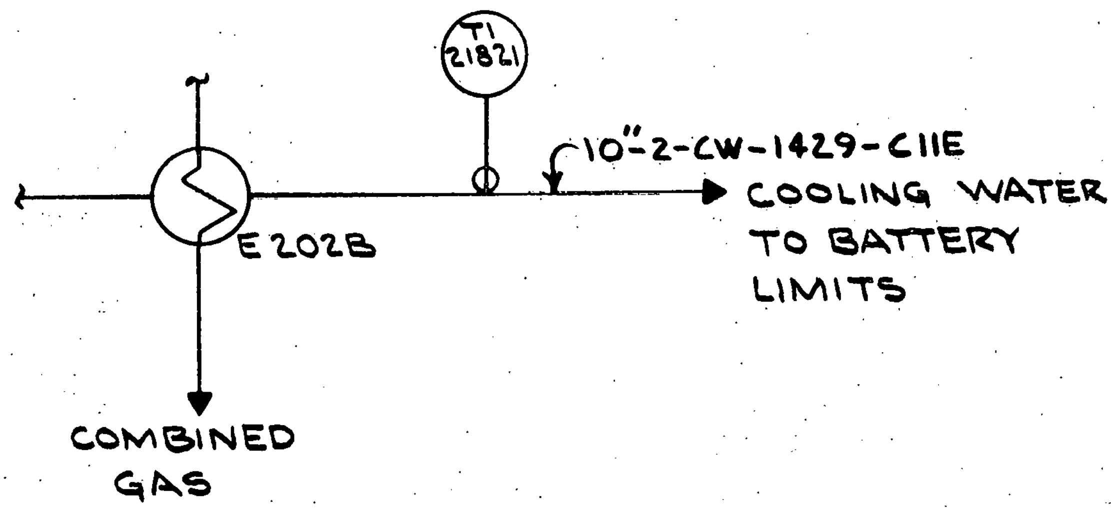
COMBUSTION AIR BLOWER-PRESS INDICATE/ALARM LOOP 21820

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(G-106-0278)

FIELD



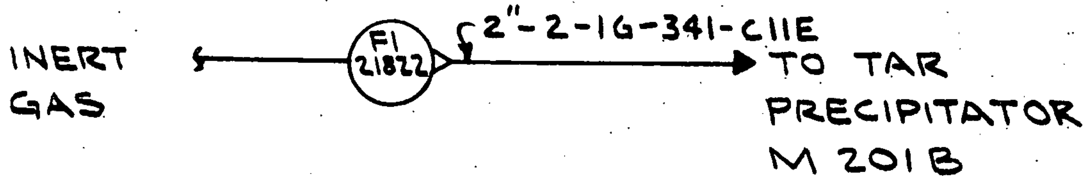
GAS COOLER WATER RETURN-TEMP. INDICATION LOOP 21821

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



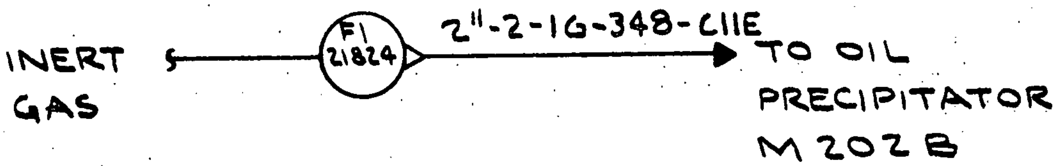
TAR PRECIPITATOR PURGE GAS FLOW INDICATION LOOP 21822

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR.	DATE	SECT. MGR. APPD.	DATE	SCALE:	PROJECT NO.	SKETCH NO.	REV.
MOYTA	8-28-78			NONE	ΦI 3001		
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD

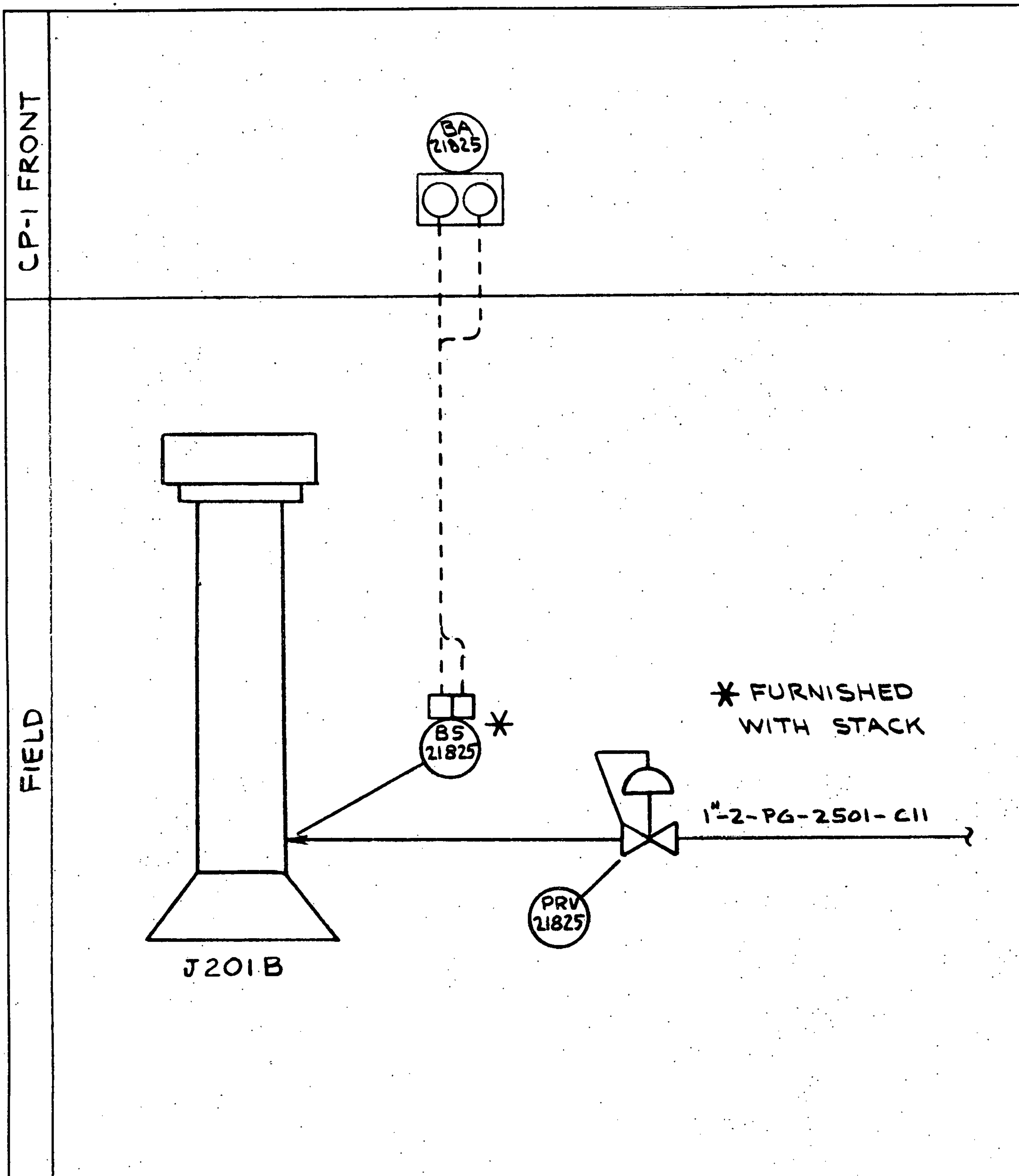


OIL PRECIPITATOR PURGE GAS FLOW INDICATION LOOP 21824

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

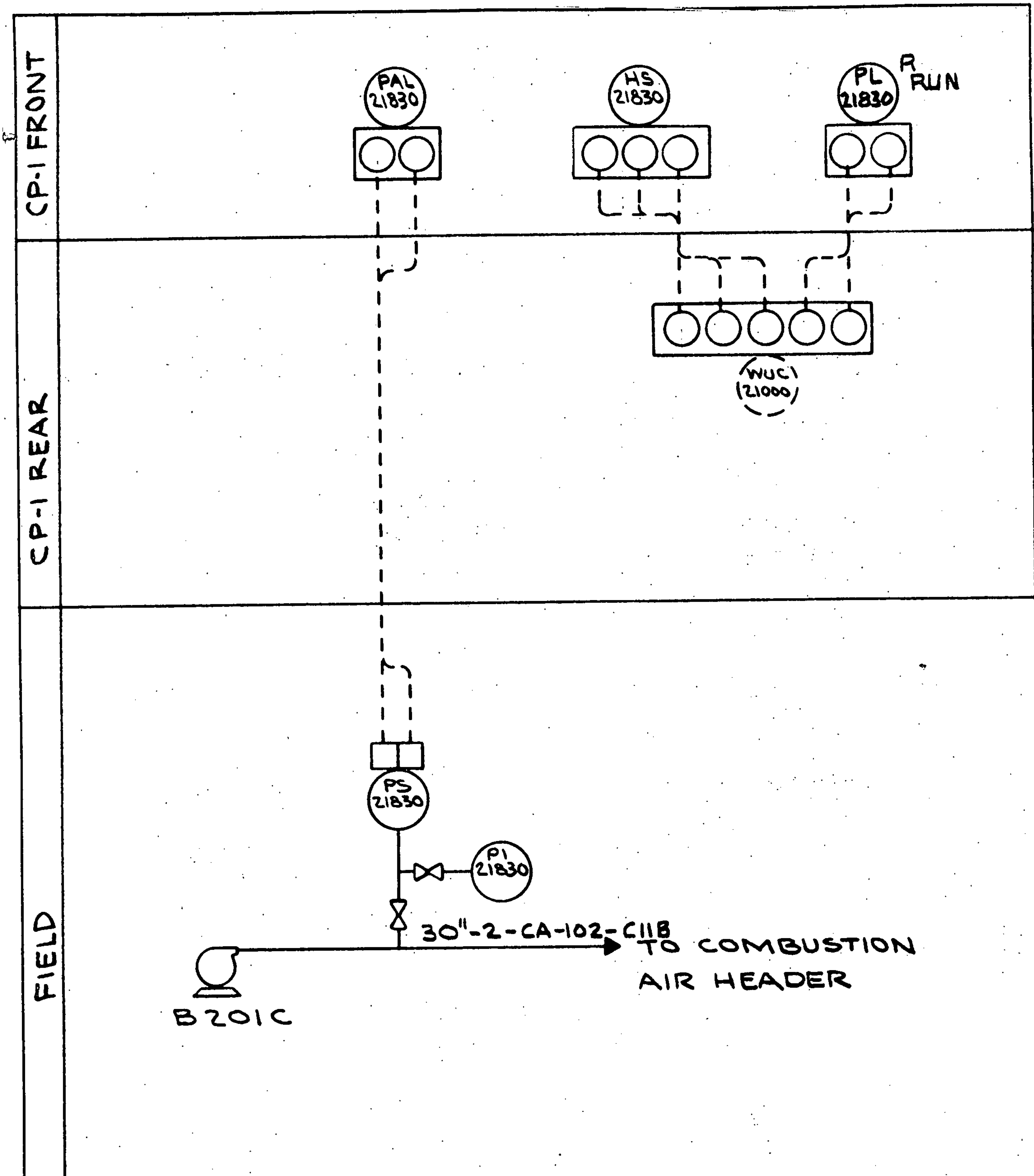


FLARE STACK FLAME SUPERVISION ALARM LOOP 21825

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV. 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



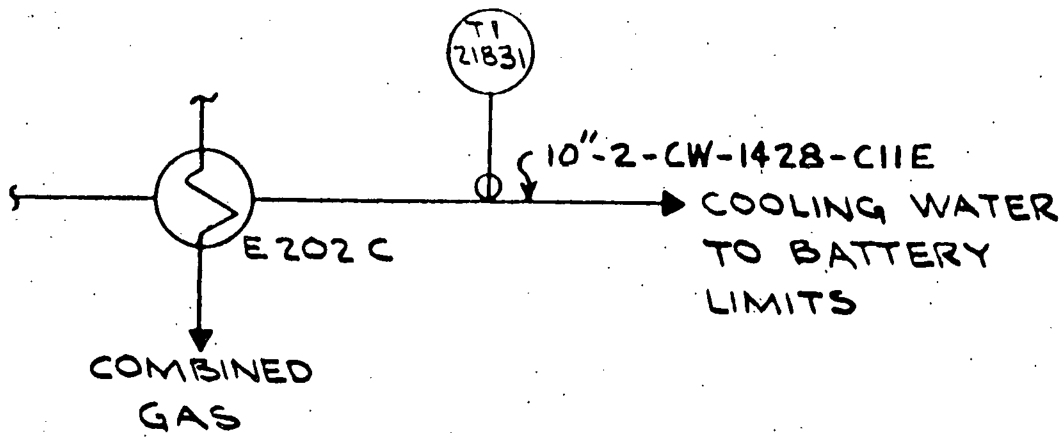
COMBUSTION AIR BLOWER·PRESS. INDICATE/ALARM LOOP 21830

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8·28·78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278)

FIELD



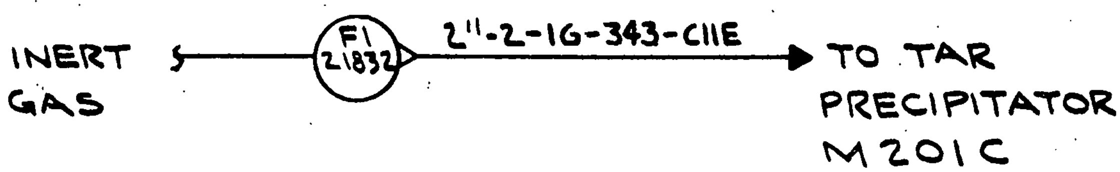
GAS COOLER WATER RETURN-TEMP INDICATION LOOP 21831

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV
CH.	DATE	PROJ MGR APPD.	DATE				

(ENG-106-0278)

FIELD



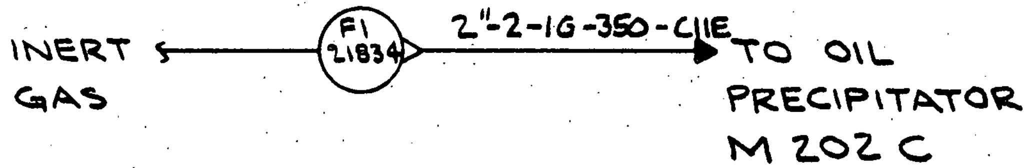
TAR PRECIPITATOR PURGE GAS FLOW INDICAT. LOOP 21832

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

NG-106-0278)

FIELD

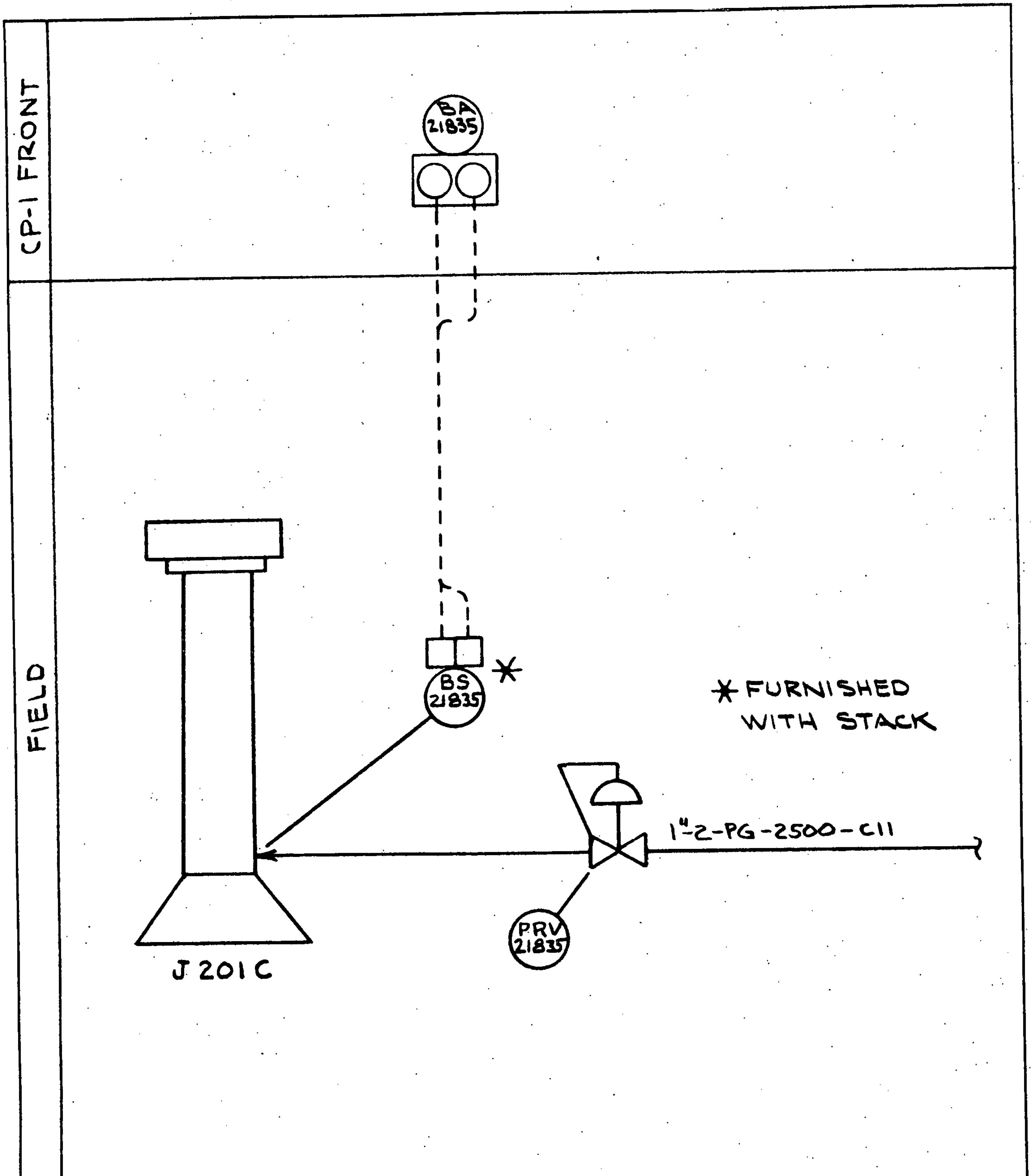


OIL PRECIPITATOR PURGE GAS FLOW INDICATION LOOP 21834

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)



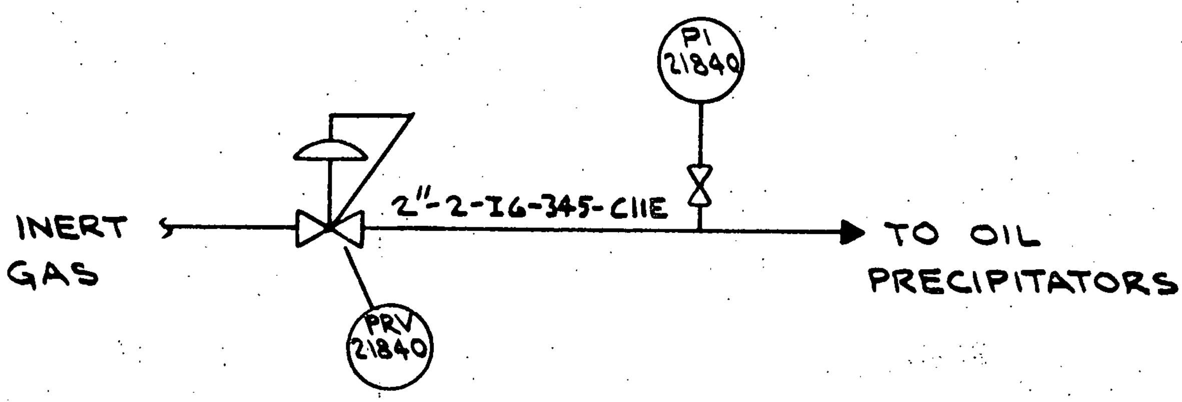
FLARE STACK FLAME SUPERVISION ALARM LOOP 21835

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV 1 1-29-79
CH.	DATE	PROJ. MGR. APPD.	DATE				

ENG-106-0278)

FIELD



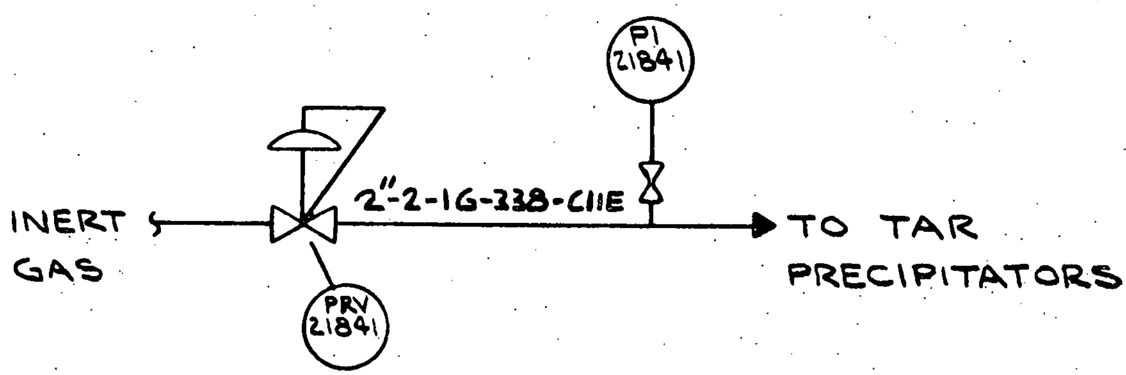
PURGE GAS TO OIL PRECIPITATORS PRESS. REDUC. LOOP 21840

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

FIELD



PURGE GAS TO TAR PRECIPITATORS PRESS REDUC LOOP 21841

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA.
A Subsidiary of Babcock International Inc.

DR. MOYTA	DATE 8-28-78	SECT. MGR. APPD.	DATE	SCALE: NONE	PROJECT NO. ΦI 3001	SKETCH NO.	REV.
CH.	DATE	PROJ. MGR. APPD.	DATE				

(ENG-106-0278)

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

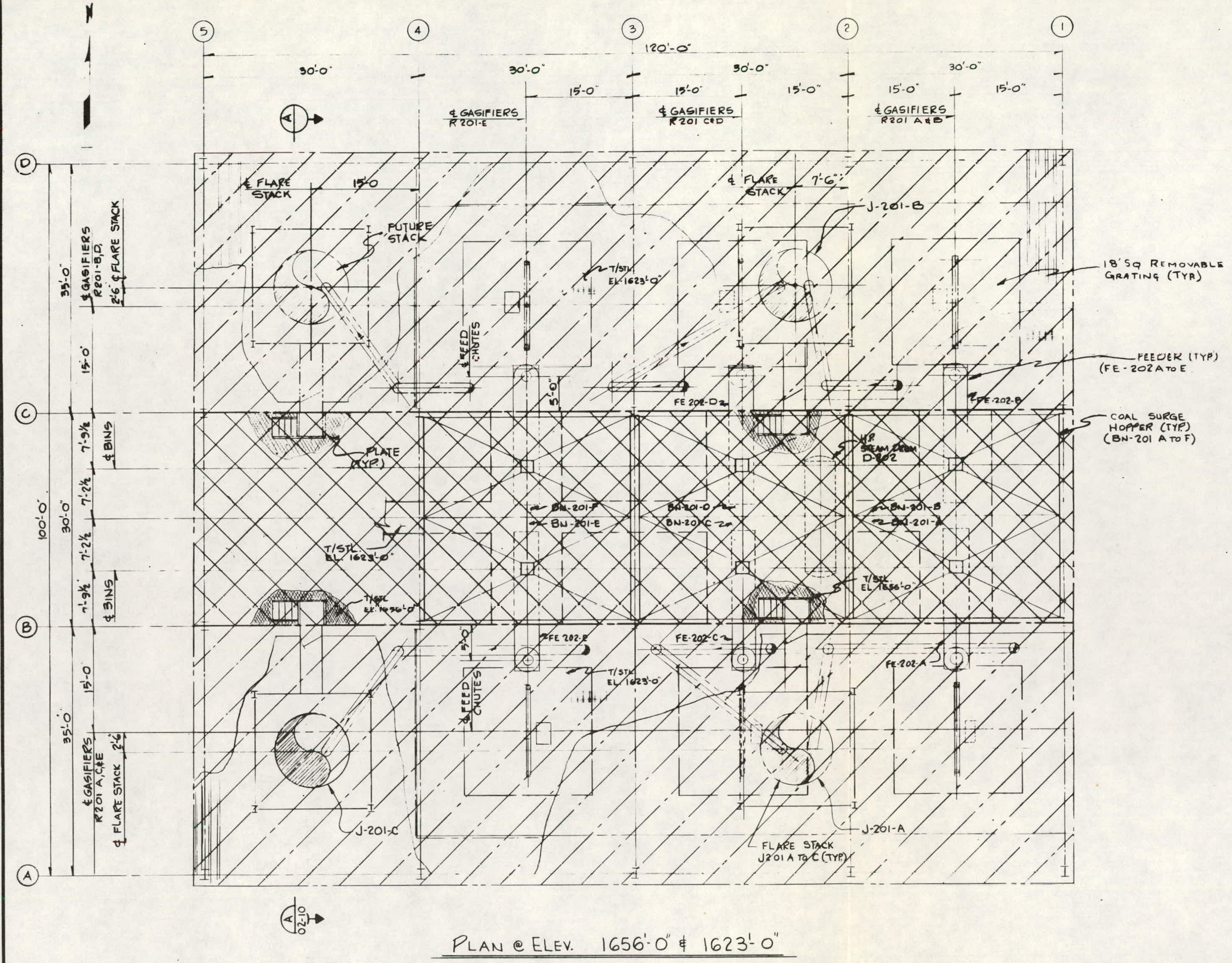
SECTION 4.1.6

Electrical Classification Drawings

4814-N-02-04-2	Area Classification - Sheet No. 1
4814-N-02-05-2	Area Classification - Sheet No. 2
4814-N-02-06-2	Area Classification - Sheet No. 3
4814-N-02-07-2	Area Classification - Sheet No. 4
4814-N-02-08-2	Area Classification - Sheet No. 5
4814-N-02-09-2	Area Classification - Sheet No. 6
4814-N-02-10-2	Area Classification - Sheet No. 7

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

4.1.6



PLAN @ ELEV. 1656'-0" & 1623'-0"

LEGEND:

AREA ABOVE EL. 1656'-0" (COAL HANDLING) TO BE CLASSIFIED CLASS II, GROUP F, DIVISION I.

AREA ABOVE EL. 1623'-0" TO UNDERSIDE OF EL. 1656'-0" TO BE CLASSIFIED CLASS I, GROUP D, DIVISION II.

This drawing including the information it contains is the property of Erie Mining Company Pickands Mather & Co Managing Agent. It is submitted only in connection with a project under contract between Erie and The United States Department of Energy and must not be used in any manner detrimental to the interests of Erie or the Department of Energy. The drawing is not to be copied and must be returned upon request.

BABCOCK CONTRACTORS INC.
PITTSBURGH PA
A Subsidiary of Babcock International Inc
PROJECT NO. 3001 DRAWING NO. E-004 ISSUE NO. 1
FOR DESIGN MANUAL SIGNED DATE 2-16-79

DATE	BY	CHK	DESCRIPTION	APP.
0 11/20/78	D.C.	H.B.	FINAL REVIEW	B.A.
1 2-16-79	S.K.	B.A.	ISSUED FOR DESIGN MANUAL	B.A.

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT–CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKEE ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

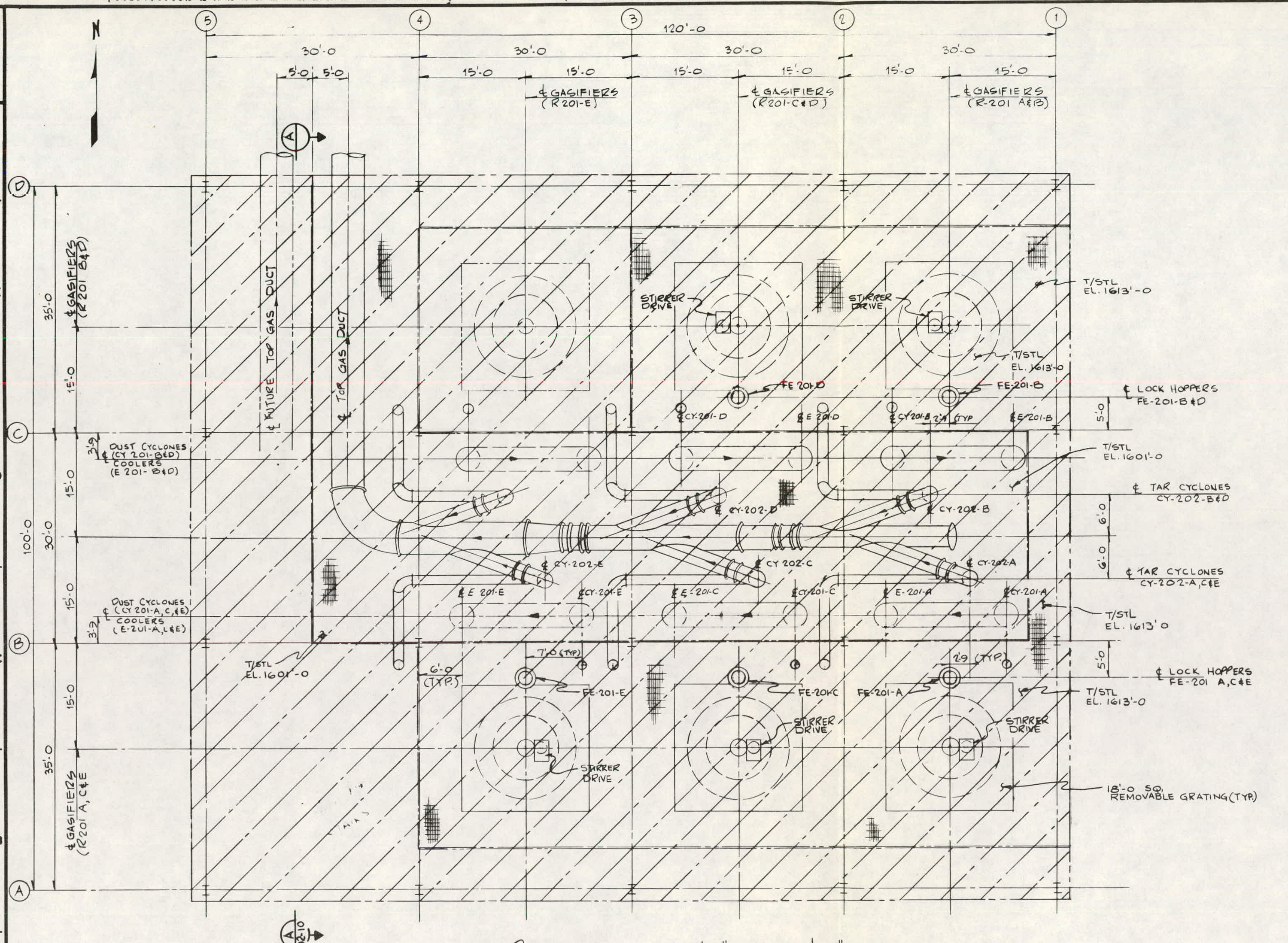
4814-N-02-04-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

PROJECT NO. 3001
SCALE 1/8" = 1'-0

GASIFICATION
COMMERCIAL UNIT-STAGE I (DEMO)
AREA CLASSIFICATION - SHEET NO. 1

REVISION 1



PLAN @ ELEV. 1613'-0" & 1601'-0"

LEGEND:

AREA ABOVE EL. 1601'-0" TO UNDERSIDE OF EL. 1623'-0" TO BE CLASSIFIED CLASS I, GROUP D, DIVISION II.

BABCOCK CONTRACTORS INC.
PITTSBURGH PA
A Subsidiary of Babcock International Inc.
PROJECT NO 3001 DRAWING NO E-005 ISSUE NO 1
FOR DESIGN MANUAL SIGNED DATE 2-16-79

DATE	BY	CHK	DESCRIPTION	APP.
11/20/78	D.C.	H.B.	FINAL REVIEW	B.A.
2-16-79	S.K.	B.A.	ISSUED FOR DESIGN MANUAL	B.A.

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKEE ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

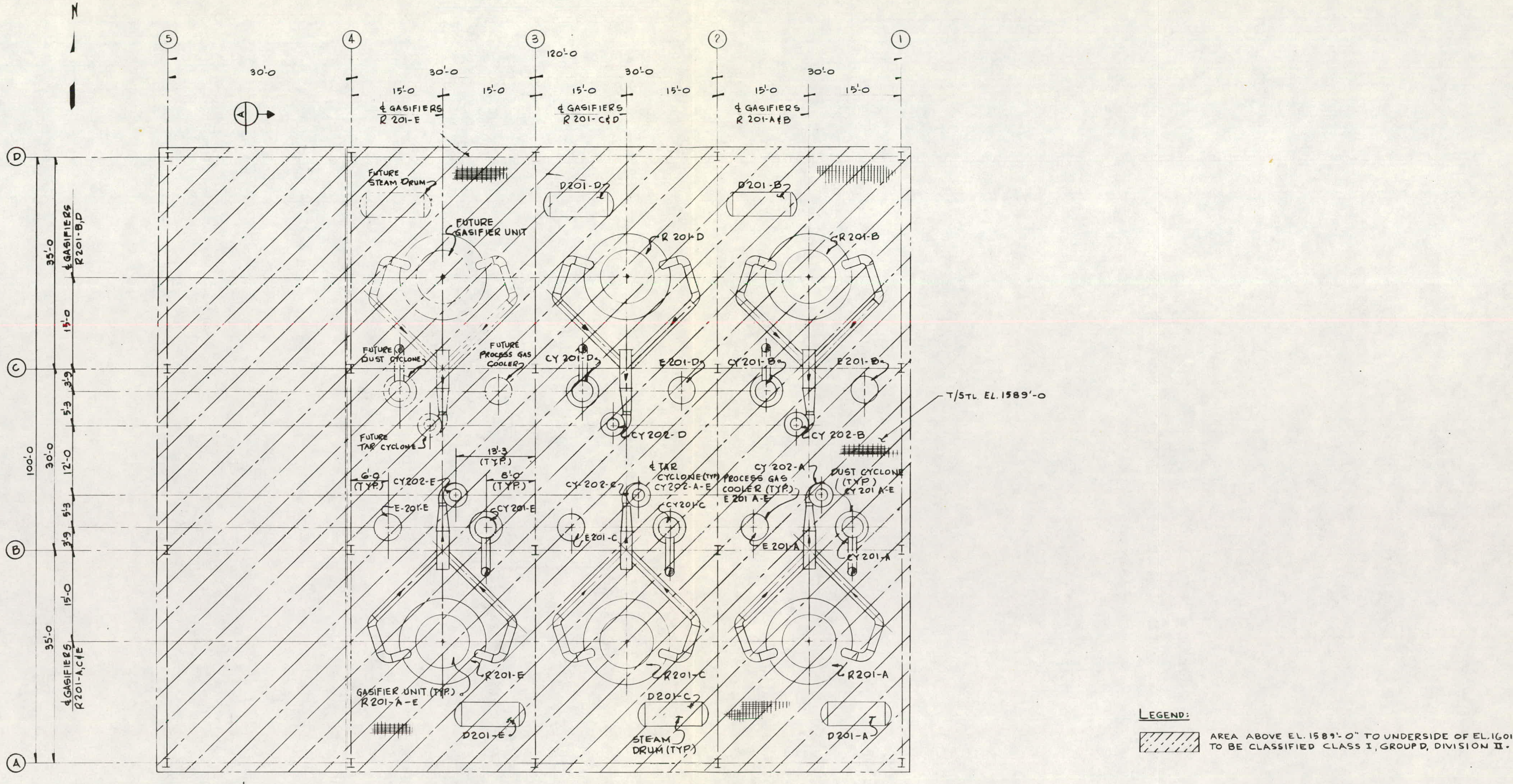
4814-N-02-05-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

PROJECT NO. 3001
SCALE 1/8" = 1'-0

GASIFICATION
COMMERCIAL UNIT-STAGE I (DEMO)
AREA CLASSIFICATION - SHEET NO. 2

REVISION 1



PLAN @ ELEV. 1589'-0

BABCOCK CONTRACTORS INC.
PITTSBURGH PA
A Subsidiary of Babcock International Inc.,
PROJECT NO 3001 DRAWING NO E-006 ISSUE NO 1
FOR DESIGN MANUAL SIGNED [signature] DATE 2-16-79

REV.	DATE	BY	CHK	DESCRIPTION	APP.
0	11/20/78	D.C.	H.B.	FINAL REVIEW	B.A.
1	2-16-79	S.K.	B.A.	ISSUED FOR DESIGN MANUAL	B.A.

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT–CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKEE ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

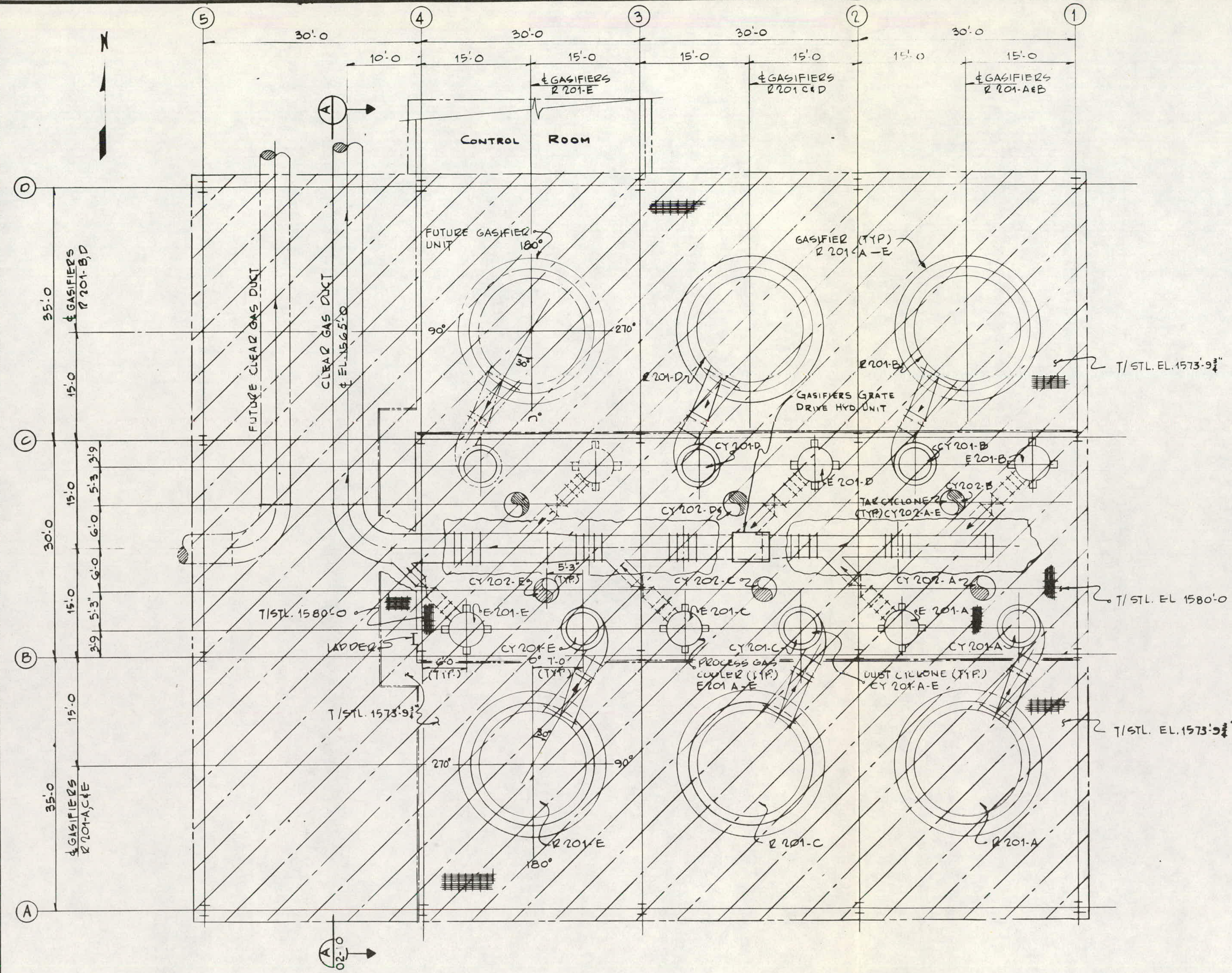
4814-N-02-06-2

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

PROJECT NO. 3001
SCALE 1/8" = 1'-0

GASIFICATION
COMMERCIAL UNIT-STAGE I (DEMO)
AREA CLASSIFICATION - SHEET NO. 3

REVISION 1



PLAN @ EL. 1573'-9¾" & 1580'-0

LEGEND:

CONTROL ROOM TO BE CLASSIFIED "NON-CLASSIFIED"

AREA ABOVE EL. 1570'-0" TO UNDERSIDE OF EL. 1580'-0" TO BE CLASSIFIED CLASS I, GROUP D, DIVISION II.

BABCOCK CONTRACTORS INC.
PITTSBURGH PA
A Subsidiary of Babcock International Inc.
PROJECT NO 3001 DRAWING NO E-007 ISSUE NO 1
FOR DESIGN MANUAL SIGNED J Lipteh DATE 2-16-79

REV	DATE	BY	CHK	DESCRIPTION	APP.
0	11/20/78	D.C.	H.B.	FINAL REVIEW	B.A.
1	2-16-79	S.K.	B.A.	ISSUED FOR DESIGN MANUAL	B.A.

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT–CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKEE ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

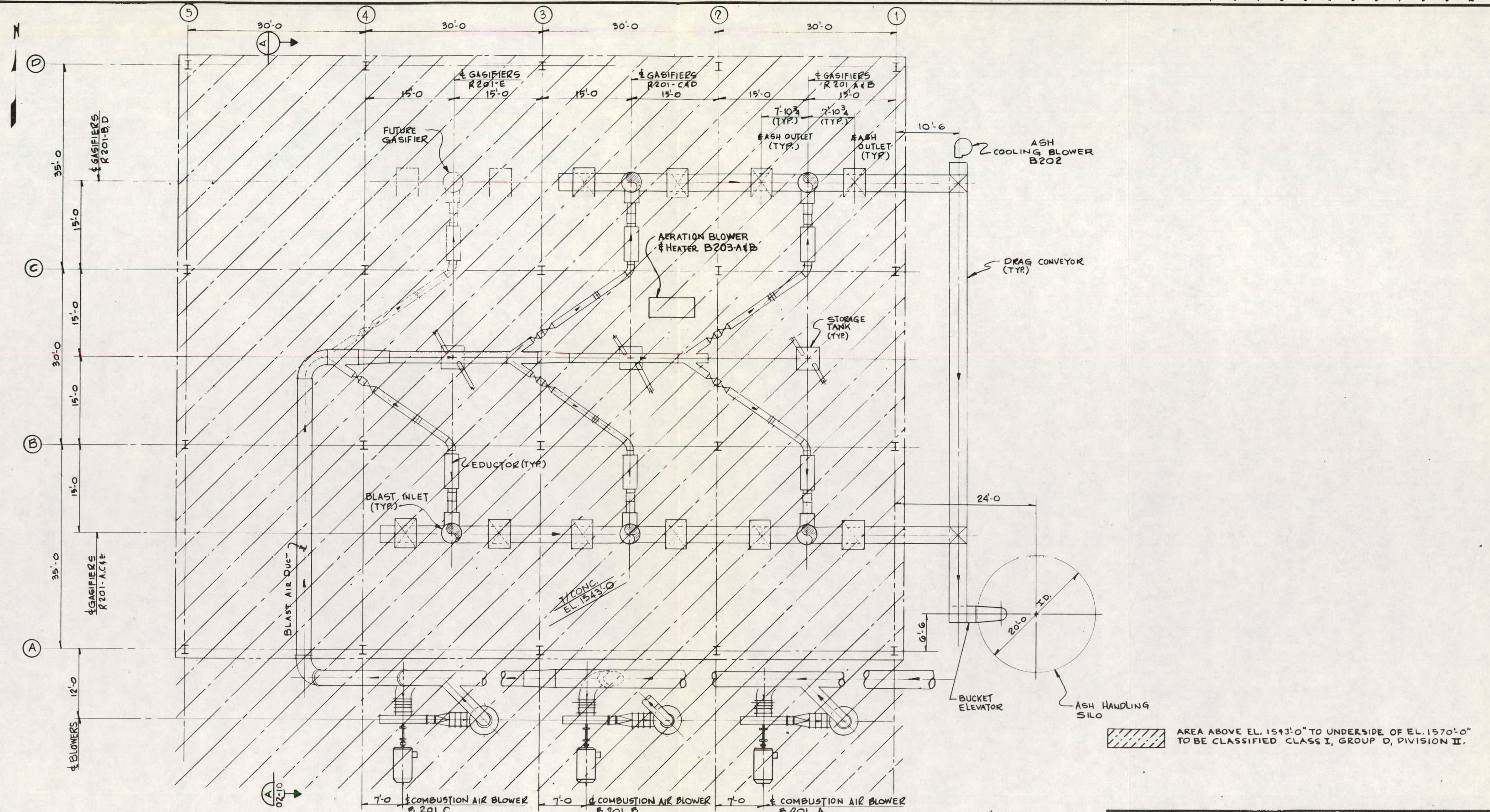
4814-N-02-07-2

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

GASIFICATION
COMMERCIAL UNIT-STAGE I (DEMO)
AREA CLASSIFICATION-SHEET NO.4

SCALE 1/8" = 1'-0"

REVISION 1



PLAN @ EL. 1543'-0

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA
A Subsidiary of Babcock International Inc.
PROJECT NO. 3001 DRAWING NO. E-008 ISSUE NO. 1
FOR DESIGN MANUAL SIGNED [signature] DATE 2.16.79

DATE	BY	CHK	DESCRIPTION	APP.
0 11/20/78	D.C.	H.B.	FINAL REVIEW	B.A.
1 2-16-79	S.K.	B.A.	ISSUED FOR DESIGN MANUAL	B.A.

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

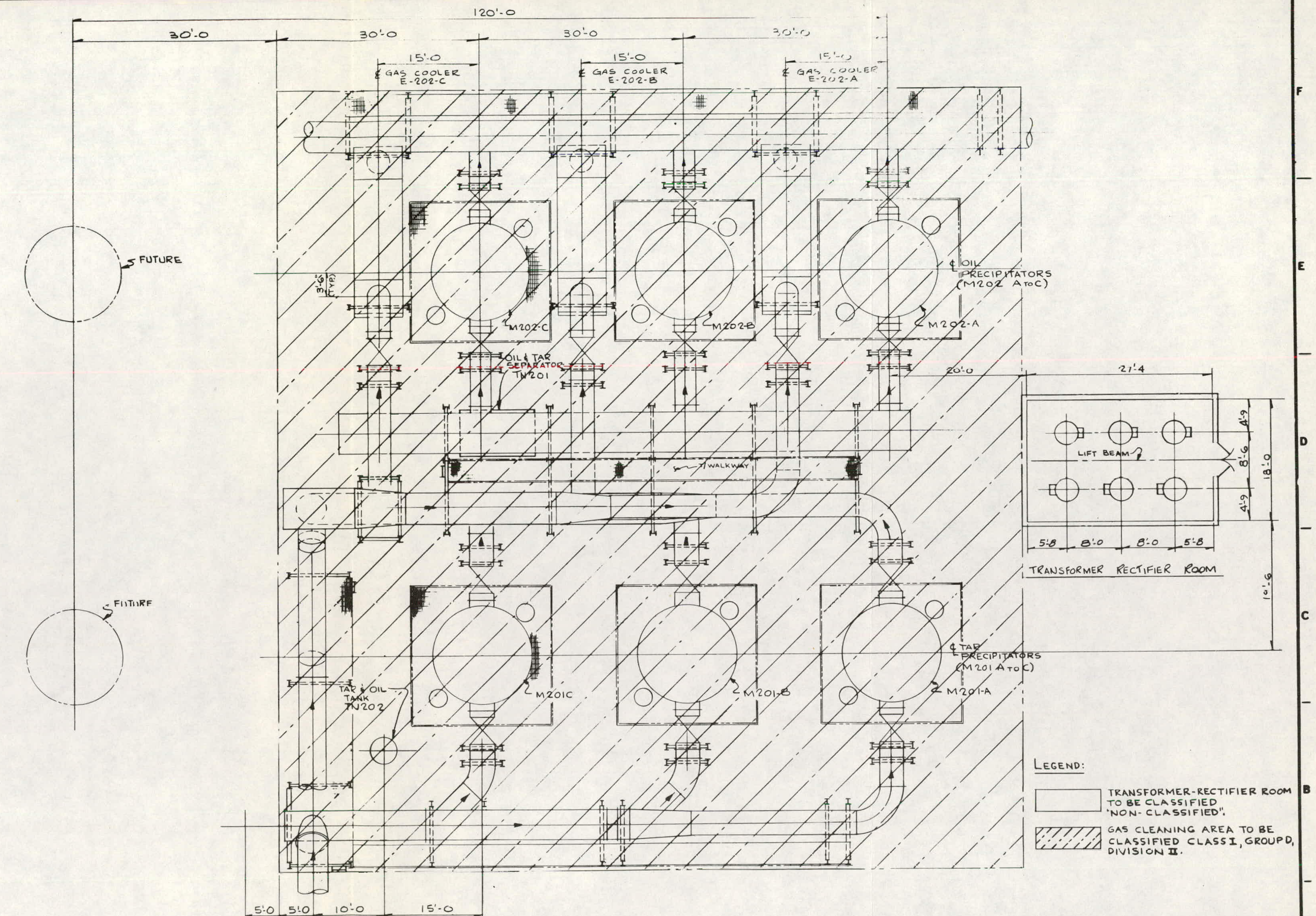
PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

4814-N-02-08-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

GASIFICATION
COMMERCIAL UNIT-STAGE I (DEMO)
AREA CLASSIFICATION-SHEET NO. 5

PROJECT NO. 3001
SCALE 1/8" = 1'-0
REVISION 1



BABCOCK CONTRACTORS INC.
PITTSBURGH PA
A Subsidiary of Babcock International Inc
PROJECT NO 3001 DRAWING NO E-009 ISSUE NO 1
FOR DESIGN MANUAL SIGNED [signature] DATE 2-16-79

DATE	BY	CHK	DESCRIPTION	APP.
0 11/20/78	D.C.	H.B.	FINAL REVIEW	B.A.
1 2-16-79	S.K.	B.A.	ISSUED FOR DESIGN MANUAL	B.A.

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT-CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

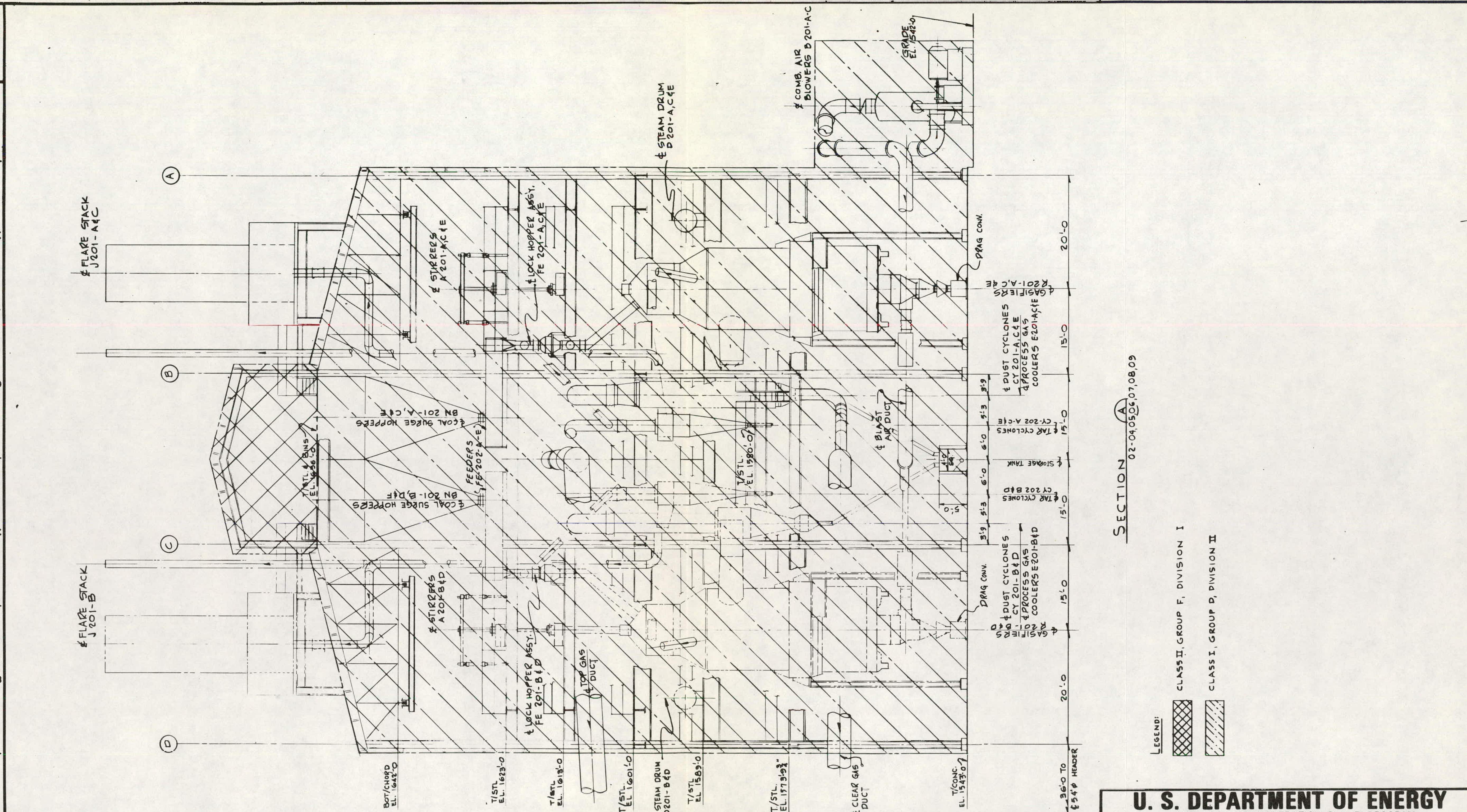
4814-N-02-09-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

PROJECT NO. 3001
SCALE 1/8" = 1'-0"

GASIFICATION
COMMERCIAL UNIT - STAGE I (DEMO)
AREA CLASSIFICATION - SHEET NO. 6

REVISION 1



This drawing, including the information it contains, is the property of Erie Mining Company, Pickands Mather & Co., Managing Agent. It is submitted only in connection with a project under contract between Erie and The United States Department of Energy and must not be used in any manner detrimental to the interests of Erie or the Department of Energy. The drawing is not to be copied and must be returned upon request.

HOLLEY, KENNEY, SCHOTT, INC. PITTSBURGH, PA. BECKLEY, W. VA.

CONTRACT NO. 3001 DRAWING NO. E-010 ISSUE NO. 1
FOR DESIGN MANUAL SIGNED DATE 2-16-79

DATE	BY	CHK	DESCRIPTION	APP.
0 11/20/78	D.C.	H.B.	FINAL REVIEW	B.A.
1 2-16-79	S.K.	B.A.	ISSUED FOR DESIGN MANUAL	B.A.

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO

4814-N-02-10-2

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

GASIFICATION
COMMERCIAL UNIT-STAGE I (DEMO)
AREA CLASSIFICATION - SHEET NO.7

PROJECT NO. 3001
SCALE 1/16" = 1'-0"
REVISION 1

4.1.7

COAL GASIFICATION DEMONSTRATION PLANT

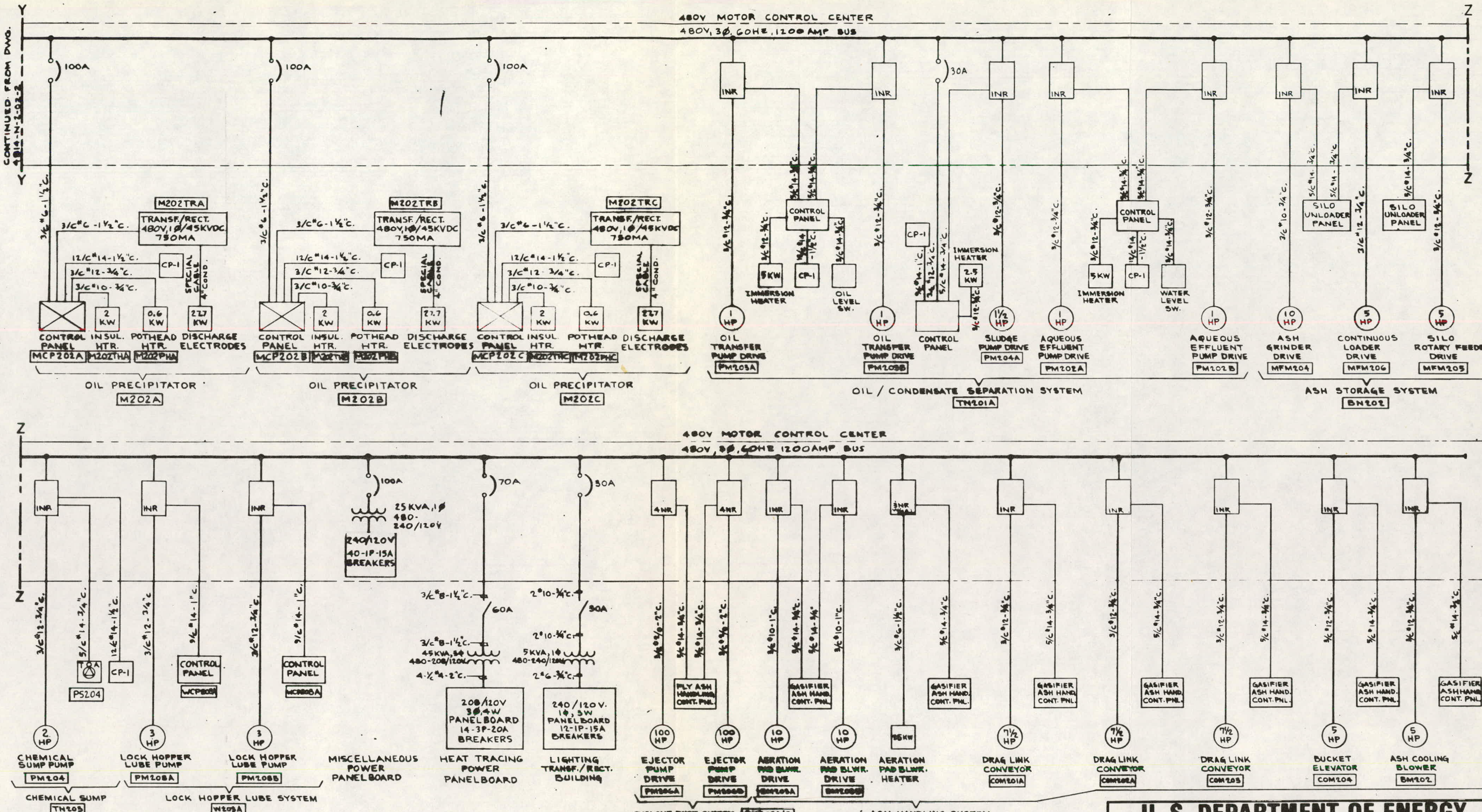
HOYT LAKES, MINNESOTA

SECTION 4.1.7

Electrical Single Line Drawings

4814-N-02-01-2	Single Line Diagram - Sheet 1	
4814-N-02-02-2	Single Line Diagram - Sheet 2	
4814-N-02-03-2	Single Line Diagram - Sheet 3	

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001



NOTES:
FOR LEGEND SEE DWG. 4814-N-2-01-2

[redacted]

DESIGN MANUAL

DATE	BY	CHK.	DESCRIPTION	APP.
			FINAL REVIEW	B.A.
		S.K. B.A.	ISSUED FOR DESIGN MANUAL	B.A.

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT–CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

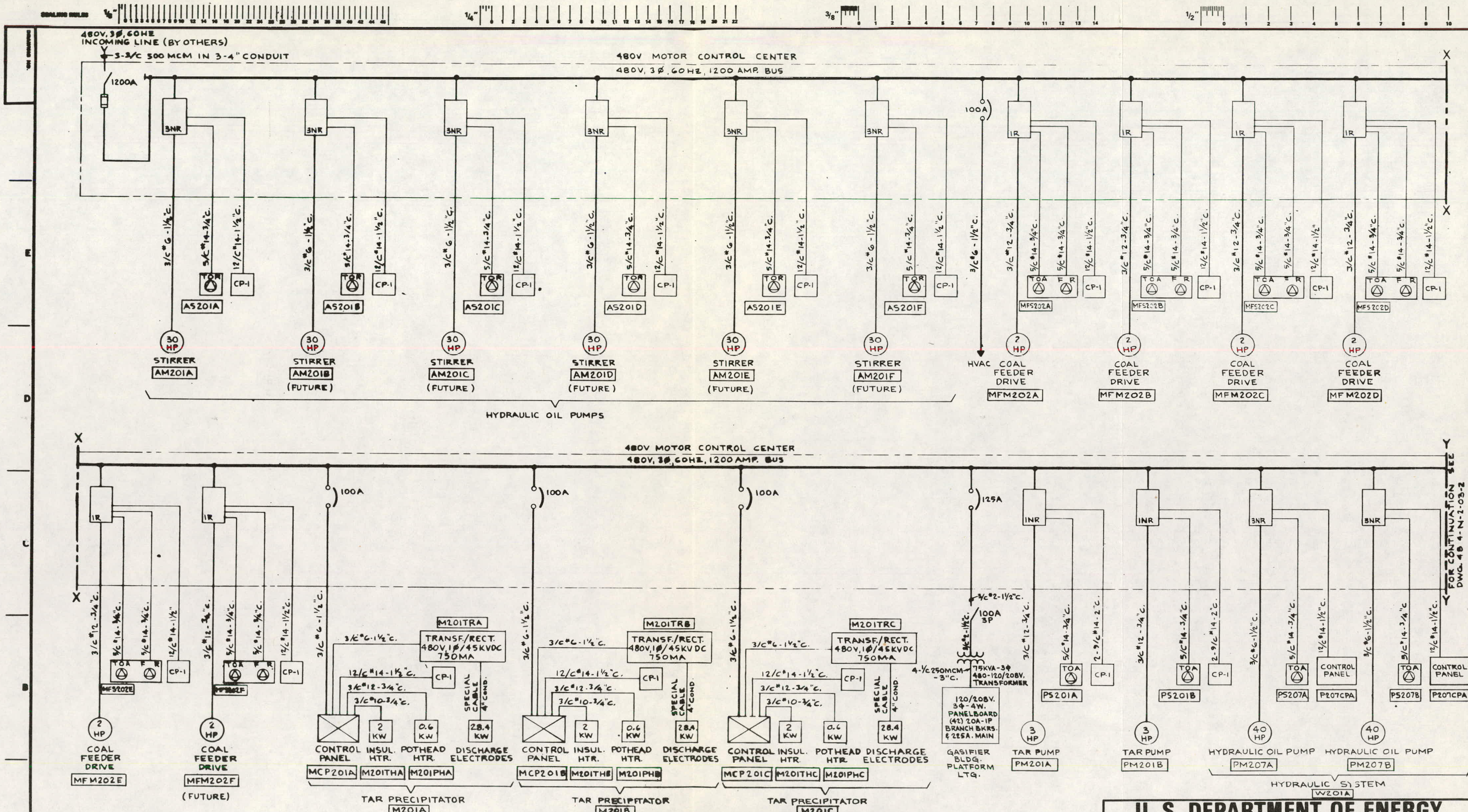
4814-N-02-03-2

FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

PROJECT NO. 3001
SCALE NONE

GASIFICATION
COMMERCIAL UNIT-STAGE I (DEMO)
SINGLE LINE DIAGRAM SH. 3

REVISION 1



NOTES:
FOR LEGEND SEE DWG. 4814-N-2-01-2

[redacted]

BABCOCK CONTRACTORS INC.
E-008
DESIGN MANUAL 2-16-79

U. S. DEPARTMENT OF ENERGY

FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT–CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND OHIO

4814-N-02-02-2

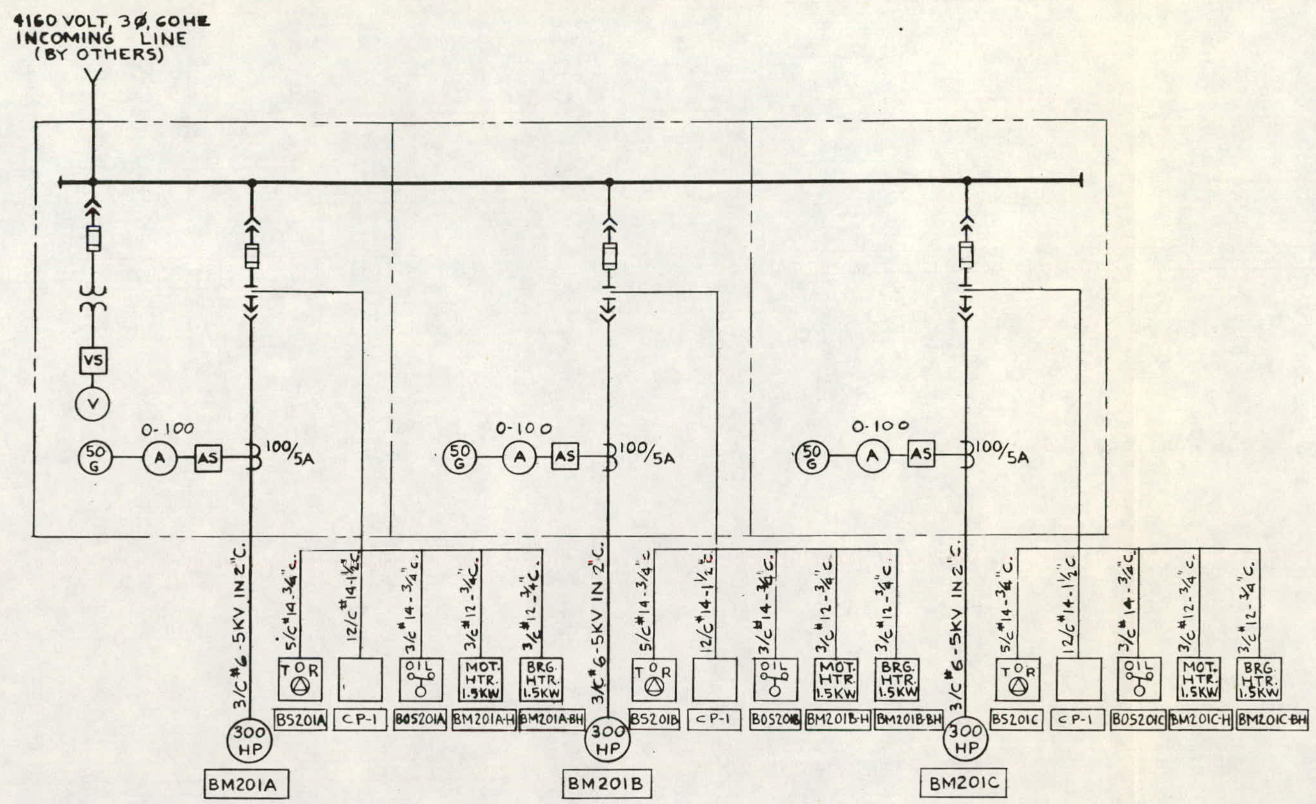
FOR **ERIE MINING COMPANY**
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES MINNESOTA

PROJECT NO. 3001
SCALE NONE

GASIFICATION
COMMERCIAL UNIT-STAGE I (DEMO)
SINGLE LINE DIAGRAM SH. 2

REVISION 1

	DATE	BY	CHK	DESCRIPTION	APP.
0	11/20/78	D.C.	H.E.	FINAL REVIEW	B.A.
1	2-16-79	S.K.	B.A.	ISSUED FOR DESIGN MANUAL	B.A.



COMBUSTION AIR BLOWERS

LEGEND:

- CP-1 MAIN CONTROL PANEL
- START-STOP SWITCH
- TEST-OFF-AUTO SWITCH
- TEST-OFF-REMOTE SWITCH
- FORWARD-REVERSE SWITCH

BABCOCK CONTRACTORS INC.
3001 E-001 SHEET NO. 1
DESIGN MANUAL 2-16-79

DATE	BY	CHK	DESCRIPTION	APP.
11/20/78	D.C.	H.B.	FINAL REVIEW	B.A.
2-16-79	S.K.	B.A.	ISSUED FOR DESIGN MANUAL	B.A.

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578

PREPARED BY McKEE ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO
4814-N-02-01-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

PROJECT NO. 3001
SCALE NONE

GASIFICATION
COMMERCIAL UNIT - STAGE I (DEMO)
SINGLE LINE DIAGRAM SH. 1

REVISION 1

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 4.1.8

Structural Steel Loading Diagram

3001-C-001 Column Load Schedule

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

COLUMN LOADINGS

LOCATION	TYPE	A-1	A-2	A-3	A-4	A-5	STACK SUPPORT COL		B-1	B-2	B-3	B-4	B-5	C-1	C-2	C-3	C-4	C-5	D-1	D-2	D-3	D-4	D-5
ELEV. 1658'-6	D.L.						5	TYP FOR (16) COLS.															
	L.L.						4																
	WIND N/S & E/W																						
	VERT.						6 ↕																
	HORIZ.						3 ↔																
(a) ELEV. 1655'-0	D.L.								10	20	20	10	—	10	20	20	10	—					
	L.L.								103	206	206	103	—	103	206	206	103	—					
(b) ELEV. 1622'-0	D.L.	11	20	20	11	—			18	36	37	18	—	18	36	37	15	—	11	20	20	11	—
	L.L.	23	46	46	23	—			52	100	97	52	—	52	.00	97	41	—	23	46	46	23	—
(b) ELEV. 1612'-0	D.L.	6	11	11	6	—			8	16	16	8	—	8	16	16	8	—	6	11	11	6	—
	L.L.	20	39	39	20	—			31	52	52	26	—	31	52	52	26	—	20	39	39	20	—
ELEV. 1600'-0	D.L.	7	12	12	7	—			11	22	22	19	4	11	22	22	25	6	7	12	12	16	4
	L.L.	31	62	62	31	—			49	98	98	72	14	49	98	98	99	20	31	62	62	67	6
ELEV. 1588'-0	D.L.	19	26	26	13	—			12	22	22	12	—	12	22	22	12	—	13	26	26	19	—
	L.L.	31	62	62	31	—			49	89	89	49	—	49	89	89	49	—	31	62	62	31	—
EL. 1579-0	D.L.	—	—	—	—	—			23	68	68	46	—	26	68	68	23	—	—	—	—	—	—
	L.L.	—	—	—	—	—			32	75	75	43	—	43	75	75	32	—	—	—	—	—	—
EL. 1569'-0	D.L.	3	5	5	3	—			7	14	14	10		7	14	14	11	—	3	5	6	5	—
	L.L.	13	19	19	13	—			34	66	66	43		34	66	66	48	—	13	19	19	21	—

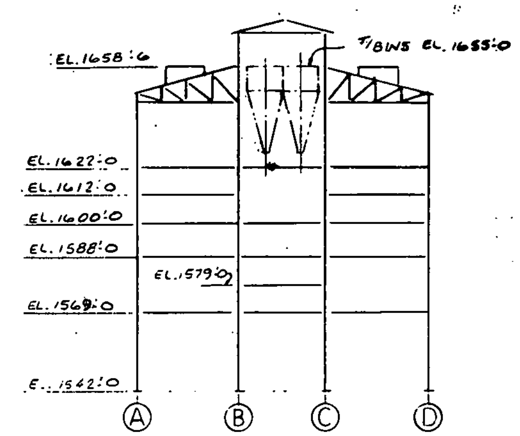
NOTES

1. ALL LOADS ARE VERTICAL UNLESS OTHERWISE NOTED.
2. LOADS ARE IN KIPS.
3. LOADS DUE TO A 10 TON CRANE AT EL. 1641'-0 ARE NOT INCLUDED.
4. LOADS DUE TO FUTURE GASIFIER IS INCLUDED, BUT SUPPORT STEEL IS NOT INCLUDED IN MATERIAL ESTIMATE.
5. LOADS DUE TO PLATFORM AT EL. 1655'-0, CONTROL ROOM & STAIRWELL ARE NOT INCLUDED.

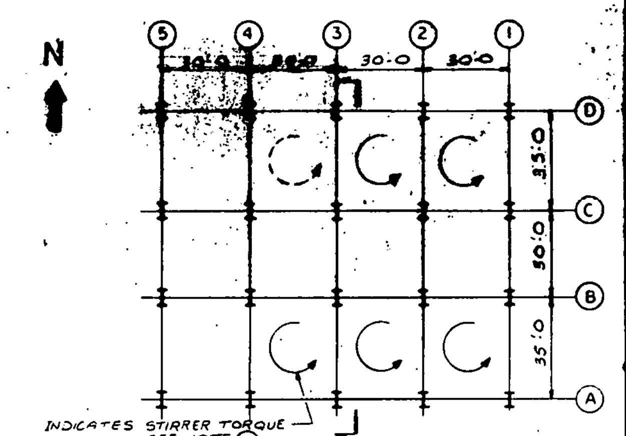
(a) BIN LOADS

(b) A TORQUE OF ___ PER STIRRER IS ANTICIPATED AT THIS ELEV.

BABCOCK CONTRACTORS INC.
3001 C-001
DESIGN MANUAL 10/1/78



TYPICAL SECTION



COLUMN PLAN

ISSUES & REVISIONS		
11	ISSUED FOR DESIGN MANUAL	
10	FINAL REVIEW	

ERIE MINING CO.

BABCOCK CONTRACTORS INC.
PITTSBURGH, PA
A Subsidiary of Babcock International Inc.

COAL GASIFICATION
DEMO UNIT
COLUMN LOAD SCHEDULE

3001 | 3001-C-001

4.2.1

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 4.0 - DRAWINGS

4.2 Proprietary Drawings

4.2.1 Process Flow Diagrams

4814-Y-02-01-2	West Coal (1 of 2)
4814-Y-02-02-2	West Coal (2 of 2)
4814-Y-02-03-2	East Coal (1 of 2)
4814-Y-02-04-2	West Coal (2 of 2)

DELETED FROM THIS PACKAGE

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

4.2.2

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

DELETED FROM THIS PACKAGE

SECTION 4.0 - DRAWINGS

4.2 Proprietary Drawings

4.2.2 Internal Gasifier Arrangement Drawings (Size 22" x 34") - Page One

M-302	G/A Unstirred Gasifier
M-303	G/A Stirred Gasifier
M-304	Gasifier Shelf & Details
M-311	Gasifier Lower Port Assembly
M-312	Gasifier Grate Support Base - Sheet #1
M-314	Gasifier Slide Ring & Cover - Details
M-315	Gasifier Ratchet Wheel
M-316	Gasifier Plate Grate
M-317	Gasifier Grate Support Casting
M-319	Gasifier Grate Rings & Breakers
M-320	Gasifier Grate Rings - Sheet #1
M-322	Gasifier Slag Wear Ring
M-323	Gasifier Grate Drive Assembly
M-324	Gasifier Grate Drive Details
M-330	Gasifier Unstirred Refractory Assembly - Sheet 1
M-331	Gasifier Unstirred Refractory Assembly - Sheet 2
M-333	Gasifier Stirred Refractory Assembly
M-334	Gasifier Brick Details

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

DELETED FROM THIS PACKAGE

SECTION 4.0 - DRAWINGS

4.2 Proprietary Drawings (continued)

4.2.2 Internal Gasifier Arrangement Drawings (Size 11" x 17") - Page Two

4814-Y-02-05-2	PFD West Coal
4814-Y-02-06-2	PFD West Coal
4814-Y-02-07-2	PFD East Coal
4814-Y-02-08-2	PFD East Coal
M-305	Gasifier - Lower Cone Assembly
M-306	Gasifier - Upper Cone Assembly
M-309	Gasifier Water Jacket Assembly
M-310	Gasifier Steam Drum
M-313	Gasifier Grate Support Base Sheet 2
M-318	Gasifier Plow & Deflection Plate
M-321	Gasifier Grate Ring - Sheet 2
M-325	Gasifier Grate Lever Indicator
M-326	Hydraulic Circuit for Six Grate Drives
M-327	Gasifier - Lubrication System
M-328	Gasifier Lubrication System Details
M-329	Hydraulic Circuit for One Grate Drive
M-336	Rodding Port Cover - Style 1
M-337	Gasifier - Blast Inlet Assembly
M-338	Gasifier Code Vessel Details
M-339	Gasifier Non-Code Vessel Details
M-342	Gasifier Spring Loaded Port Cover
M-343	Gasifier Inspection Port Cover
M-344	Gasifier Access Port Cover

4.2.3

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

DELETED FROM THIS PACKAGE

<u>SECTION 4.0 - DRAWINGS</u>

4.2 <u>Proprietary Drawings</u>

4.2.3 Gasifier Temperature Profiles

3001-M-341 Gasifier Temperature Profile

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W
BCI Contract 3001

5.0

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 5.0 - APPENDIX

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

5.1

5.0 APPENDIX

5.1 Evaluation of Pneumatic Ash Handling System

5.1.1 Introduction

In an effort to comply with our contractural commitment, and the requirement to review both the economic and technical feasibility of handling gasifier produced ash pneumatically, BCI conducted an investigation to evaluate the availability of commercially proven technology and transport hardware that could be applied successfully to handle our project needs. The systems design approach which was established emphasized specific attention to the probable variability of the ash material consistency due to a process up-set condition. Collection and distribution hardware was evaluated on the basis of the following operating conditions:

a. Ash Temperature Variations (100°F to 1000°F)

b. Particle Size Variations (50 microns to 6 inch)

Based on the above considerations, and the original request by Erie Mining to sluice and transfer cyclone ash to the pelletizing area, the BCI base estimate provides for a conventional air cooled drag conveyor system for the gasifier bottom ash and a conventional sluicing system for the cyclone ash. The purpose of this report is to present a pneumatic system which will process gasifier bottom ash as specified in Section 5.1.2 with the understanding that further design investigation will be required during Phase II Development to resolve specific details of operation.

5.1.2 Design Criteria

a. Gasifier Bottom Ash Production

Design Average per Gasifier	1000 lbs/hr
Total Ash Produced-Five (5) Gasifiers	5000 lbs/hr

b. Operating Conditions

Temperature Range	100°F to 1000°F
Particle Size Range	50 microns to 6 inch Diameter
Normal Operating Size Range	1/2 to 1 inch Diameter

5.0 APPENDIX

5.1 Evaluation of Pneumatic Ash Handling System

5.1.2 Design Criteria (continued)

c. Gasifier Bottom Ash Cooling will be required to reduce the ash temperature to approximately 600°F which is the normal collection hardware operating temperature. It is proposed that this will be achieved through the use of controlled water sprays.

d. Cyclone Ash Produced

Design Average per Cyclone	50 lbs/hr
Total Ash Produced	300 lbs/hr

e. Operating Conditions

Temperature Range	100°F to 1000°F
Particle Size Range	5 microns to 1/32 inch Diameter
Carbon Content	Approximately 50%

f. Cyclone Ash can not be cooled using an external air source due to the self igniting potential of ash containing a high percentage of carbon.

5.1.3 Pneumatic Systems Review

Conventionally, the systems design approach for handling the products of combustion of solid fuels pneumatically within a pipe or duct has been achieved by means of a high-velocity, vacuum recovery air system. This type of system was best suited for materials of low specific gravity which were substantially free flowing. A high degree of success was achieved in this type of application because much was known of the materials consistency, specific weight, temperature, particle size distribution, etc. The major design consideration that was followed was to insure that vertical runs were short in proportion to horizontal runs, and if vertical lines had to be long, sufficient lifting power was added to the system by increasing air velocity and suction power.

In order to rationalize a sensible pneumatic handling system for a gasifier plant which is designed to

5.0 APPENDIX

5.1 Evaluation of Pneumatic Ash Handling System

5.1.3 Pneumatic Systems Review (continued)

manufacture a producer gas using a wide variety of coals, BCI found it necessary to evaluate a system designed to handle not only a potential process upset condition, but one that would be flexible enough to operate effectively over a range of material size and temperature variations. This would eliminate the need for operator assistance and lower operating costs.

Since it was evident that these conditions could exist during normal operations, BCI decided that a vacuum recovery system presented too many intangible design features for this application. Subsequently, BCI concluded that a pressure recovery system would provide the additional reliability that is necessary for an application of this type.

The two basic types of pressure recovery systems reviewed were:

a. Lean Phase Collection

b. Dense Phase Collection

A lean phase system operates at reasonably low pressure, but requires high air velocities to maintain material suspension in a continuous air stream. Systems of this type could have fluidizing air velocities as high as 4400 ft. per minute and air to material ratio of 300:1. Since the ash produced is somewhat abrasive, BCI did not feel a system designed in accordance with the above criteria would be reliable. Further, if this design approach was adopted, an extensive materials of construction research program would have to be conducted.

A dense phase system operates at high pressure and low air velocities and essentially pushes a batch of material to a receiving station. The transferring of material does not require fluidization. Systems of this type would have air velocities of 400 ft. per minute and an air to material ratio of 25:1. This type of system could handle materials up to 1-1/2 inch in diameter as well as smaller particles which will

5.0 APPENDIX

5.1 Evaluation of Pneumatic Ash Handling System

5.1.3 Pneumatic Systems Review (continued)

be produced. The ash discharged from the gasifiers would be cooled to 600°F by means of a controlled water spray system. A double roll clinker grinder would be required to crush and feed ash at a guaranteed rate during up-set conditions, should they occur.

This type of an alternate system would be our choice if pneumatic conveying of ash is required for this project. However, additional investigation would be necessary to resolve specific details of operation during Phase II Development.

5.1.4 Alternate System Requirements

The system described below was proposed by the Detroit Stoker Company, who have commercially proven hardware for conveying solids utilizing dense phase technology. Based on our experience with this application, the system proposed for handling gasifier ash pneumatically provides the flexibility and control which we consider important for maintaining a reliable operation.

a. Ash Cooling

As shown on BCI Sketch No. SK-4301, ash will be discharged from each gasifier outlet into a quenching chamber. This chamber will be equipped with a level control probe, temperature sensor, access door and spray header. The spray system will be actuated if the ash temperature exceeds 500°F. The ash temperature will be reduced by automatically controlling the cooling water flow rate.

b. Material Sizing Control

Material leaving the quenching chamber will pass through a double roll clinker breaker. Grinder will ensure the feeding of ash at a guaranteed rate and size consistency. The breaker assembly will be fabricated steel unit consisting of two (2) contra-rotating breaker wheels driven by a

5.0 APPENDIX

5.1 Evaluation of Pneumatic Ash Handling System

5.1.4 Alternate System Requirements (continued)

b. Material Sizing Control

totally enclosed 3 HP gear motor. The breaker section will consist of cast iron breaker wheels mounted on steel shafts suitable for operating at temperatures for up to approximately 900°F.

Accumulation and Ash Breaking Mode

When ash is not being conveyed from a recovery station, fine material entering the cooling chamber from the gasifier will fall through the stationary breakers while the larger lumps will be retained above. When an adequate amount of ash has accumulated, a level signal will actuate the inlet dome valve on the dense-a-matic ash receiver, and the breakers will begin to operate, discharging crushed ash into the receiver.

c. Ash Recovery System

Each gasifier discharge point will be equipped with a dense-a-matic ash receiver and pneumatic cylinder operated dome valve. The ash receiver is a fabricated mild steel unit, designed to meet ASME, Division 1 code. The unit is self-contained and equipped with all electro-mechanical controls.

Operation

The ash breaker will continue preparing material until the receiver becomes full. At this time a level signal will close the dome valve and correspondingly initiate the conveying cycle. High pressure air enters the conveying chamber in a controlled manner, producing the dense phase conveying action. Each ash leg is independently and automatically controlled.

d. Cyclone Ash Disposal

An alternate design consideration for collecting cyclone ash would be to merely collect the ash from each cyclone via a rotary valve feeder and

5.0 APPENDIX

5.1 Evaluation of Pneumatic Ash Handling System

5.1.4 Ash Recovery System (continued)

d. Cyclone Ash Disposal

discharge shute into an enclosed collection container. Manual removal of containers would be required periodically.

5.1.5 Control System Design Philosophy

In general, it is anticipated that the control system will function automatically with the inherent features of limited operator supervision and adjustment capability. The physical layout is such that both gasifier outlets will be connected to the same discharge line. This feature enables the discharge of ash from only one (1) of two (2) recovery stations per gasifier simultaneously. Essentially, one (1) set of five (5) independently operated recovery stations can discharge ash to the silo during the same time period. It is intended that the ash recovery stations for each gasifier will be sequenced automatically. Each station will be actuated independently and will be on-line for a controlled period of time. Prior to activating the second station, the preceding sequence will have been completed. This follows the general philosophy that only one recovery station per discharge line can be activated which will reduce the possibility of line blockage and the level of wear in the lines by controlling the correct air to material ratio immediately as the material leaves the dense-a-matic receiver.

5.1.6 Comparative System Costs

Description	A.S.H.		Detroit Stoker	
	Equip. ($)	Labor ($)	Equip. ($)	Labor ($)
Gasifier Bottom Ash Including pre-processing, transport hardware and controls	678,000	67,620	818,774	56,238
TOTAL SYSTEM PRICE	$745,620.		$875,012.	

5.0 APPENDIX

5.1 Evaluation of Pneumatic Ash Handling System

5.1.6 Comparative System Costs (continued)

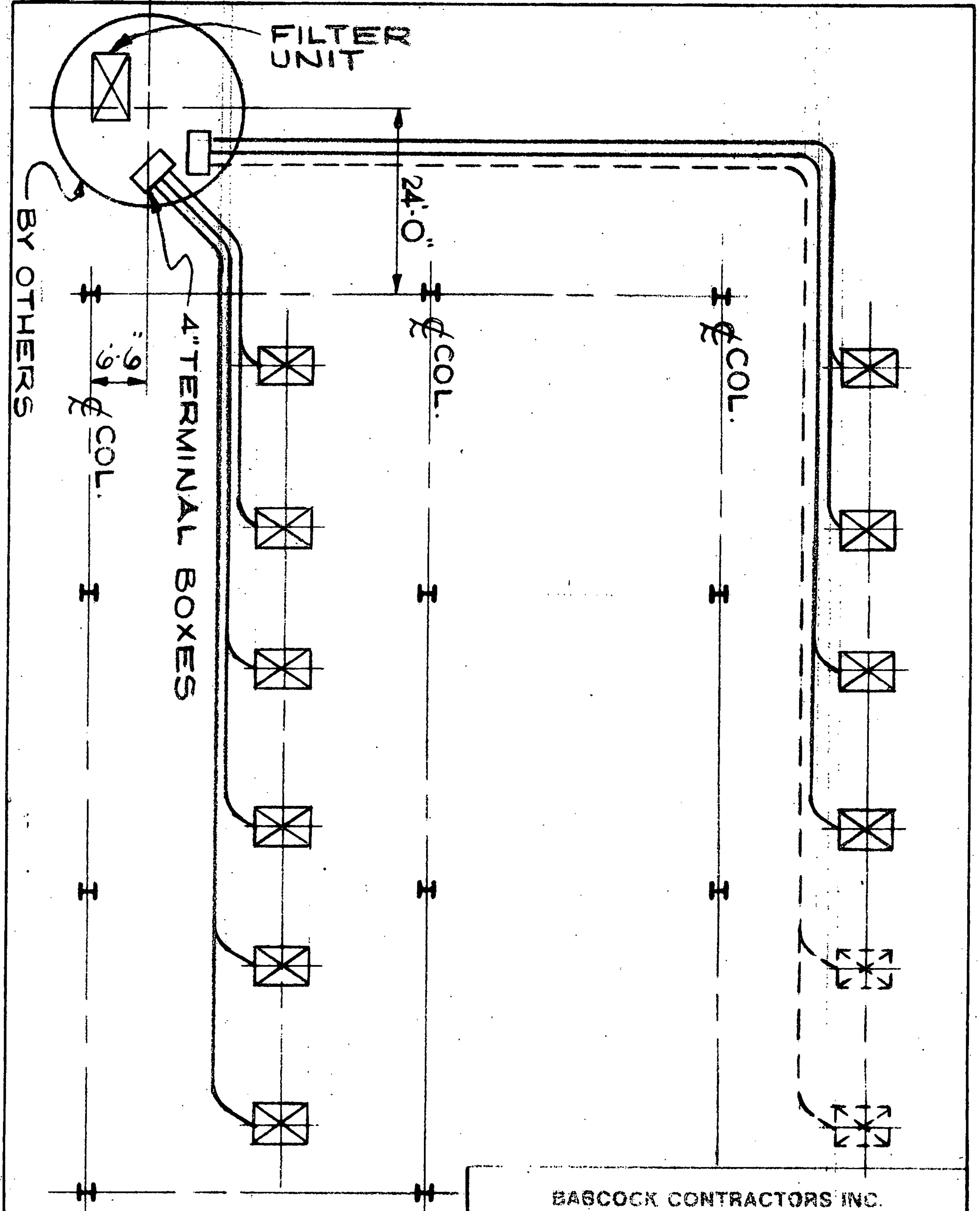
The system totals above do not include hardware or labor costs for recovering cyclone ash. As originally anticipated, the overall system costs for a pneumatic system exceed those for the conventional conveyor system. The basic difference, is the addition of two (2) clinker breaker per gasifier. Hardware prices for the Detroit Stoker system are based on five (5) gasifiers. However, the total system has sufficient capacity to handle one (1) additional gasifier system.

5.1.7 Suggested Phase II Design Considerations

a. Additional investingation will be required to resolve the specific details of operation and materials fo construction.

b. In order to confirm the on-line time requirements for the overall system and to ensure sufficient system stability, it will be necessary to develop a sensible material balance which will take into account the expected mean flow design rates and ash cooling variations.

BCI Contract 3001



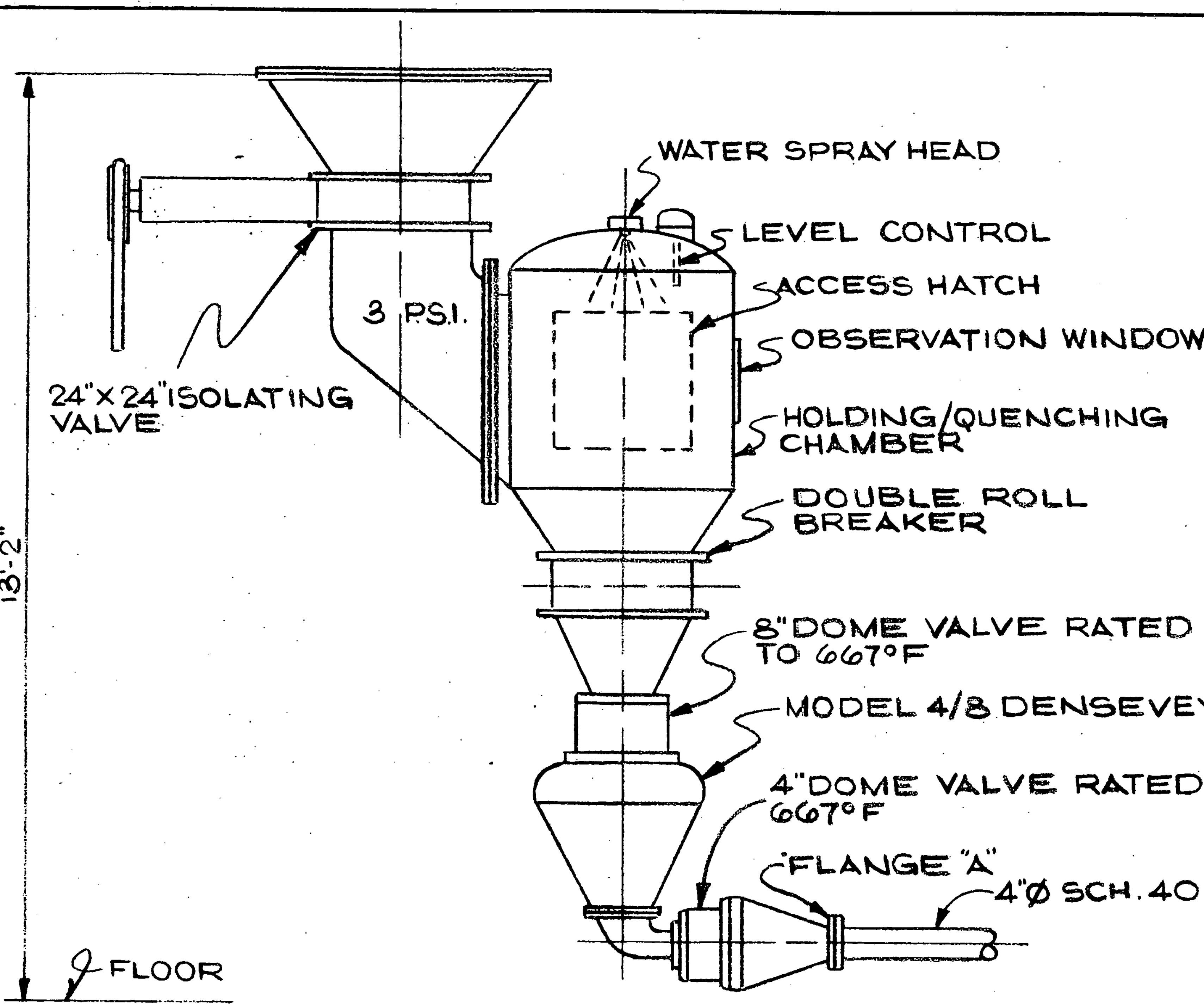
BABCOCK CONTRACTORS INC.

PITTSBURGH PA

A Subsidiary of Babcock International Inc

PROJECT NO. 3001 DRAWING NO. SK4302 ISSUE NO. A

ALT. SYSTEM PROPOSAL
PNEUMATIC ASH HANDLING



BABCOCK CONTRACTORS INC.

PITTSBURGH, PA

A Subsidiary of Babcock International Inc

PROJECT NO. 3001 DRAWING NO. SK4301 ISSUE NO. A

GASIFIER PRE-PROCESSING ASH COLLECTOR HARDWARE

5.2

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

<u>SECTION 5.0 - APPENDIX</u>

5.2 Laboratory Coal Test Results

a. <u>Analysis Report for Sample No. 3001-1</u>
<u>Dated May 3, 1978 and Revised May 31, 1978</u>

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

WESTERN DIVISION MANAGER
LLOYD W. TAYLOR, JR.

SINCE 1908

PLEASE ADDRESS ALL CORRESPONDENCE TO:
10775 EAST 51st AVE., DENVER, COLO. 80239
OFFICE TEL. (303) 373-4772

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, Pennsylvania 15222

May 3, 1978

Sample Identification
by

Babcock Contractors Inc.

Sample No. 3001-1
"For Babcock Contractors as discussed with Mr. Morlock"
P. O. No. 3001-2

Kind of sample reported to us	Coal
Sample taken at	xxxxx
Sample taken by	Babcock Contractors Inc.
Date Sampled	xxxxx
Date Received	4-17-78

Analysis report no. 72-69714 Page 1

PROXIMATE ANALYSIS

	As received	Dry basis
% Moisture	22.80	xxxxx
% Ash	8.58	11.12
% Volatile	33.82	43.81
% Fixed Carbon	34.80	45.07
	100.00	100.00
Btu	9106	11795
% Sulfur	0.90	1.17

ULTIMATE ANALYSIS

	As received	Dry basis
% Moisture	22.80	xxxxx
% Carbon	52.65	68.20
% Hydrogen	3.66	4.74
% Nitrogen	0.90	1.17
% Chlorine	0.01	0.01
% Sulfur	0.90	1.17
% Ash	8.58	11.12
% Oxygen (diff)	10.50	13.59
	100.00	100.00

SULFUR FORMS

	As received	Dry basis
% Pyritic Sulfur	xxxxx	xxxxx
% Sulfate Sulfur	xxxxx	xxxxx
% Organic Sulfur (Diff)	xxxxx	xxxxx
% Total Sulfur	xxxxx	xxxxx

FUSION TEMPERATURE OF ASH

	Reducing	Oxidizing
Initial Deformation	2140°F	2250°F
Softening (H=W)	2150°F	2280°F
Softening (H=1/2W)	2165°F	2330°F
Fluid	2175°F	2335°F

HARDGROVE GRINDABILITY INDEX = 50.0 at 20.32% Moisture

% EQUILIBRIUM MOISTURE = xxxxx

FREE SWELLING INDEX = 0-N.A.

GDP/md/pm

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. PALMER, Manager, Denver Laboratory

AMERICAN COUNCIL OF INDEPENDENT LABORATORIES, INC. Charter Member

BCI Contract 3001

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 5.0 - APPENDIX (continued)

5.2 Laboratory Coal Test Results

a. Analysis Report for Sample No. 3001-1
Dated May 3, 1978 and Revised May 31,1978

b. Analysis Report for Sample No. 3001-1
Dated May 22, 1978

c. Analysis Report for Sample No. 3001-2
Dated May 3, 1978

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

WESTERN DIVISION MANAGER
LLOYD W. TAYLOR, JR.

PLEASE ADDRESS ALL CORRESPONDENCE TO:
10775 EAST 51st AVE., DENVER, COLO. 80239
OFFICE TEL. (303) 373-4772

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, Pennsylvania 15222

May 4, 1978

Sample Identification
by

Babcock Contractors Inc.

Sample No. 3001-1
"Fischer Assay Residue from
Sample No. 3001-1"
"For Babcock Contractors as
discussed with Mr. Morlock"
P. O. No. 3001-2

Kind of sample reported to us	Char
Sample taken at	xxxxx
Sample taken by	Babcock Contractors Inc.
Date Sampled	xxxxx
Date Received	4-24-78

Analysis report no. 72-69859

ULTIMATE ANALYSIS

	As Received	Dry Basis
% Moisture	0.50	xxxxx
% Carbon	73.97	74.34
% Hydrogen	2.95	2.96
% Nitrogen	1.28	1.29
% Chlorine	0.00	0.00
% Sulfur	1.12	1.13
% Ash	14.73	14.80
% Oxygen	5.45	5.48
(diff)	100.00	100.00

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. PALMER, Manager, Denver Laboratory

CDP/pm

BCI Contract 3001

Charter Member

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

WESTERN DIVISION MANAGER
LLOYD W. TAYLOR, JR.

SINCE 1928

PLEASE ADDRESS ALL CORRESPONDENCE TO:
10775 EAST 51st AVE., DENVER, COLO. 80239
OFFICE TEL. (303) 373-4772

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, Pennsylvania 15222

May 4, 1978

Sample Identification by

Kind of sample reported to us	Tar
Sample taken at	xxxxx
Sample taken by	Babcock Contractors Inc.
Date Sampled	xxxxx
Date Received	4-24-78

Babcock Contractors Inc.

Sample No. 3001-1
"Tar from Fischer Assay"
"For Babcock Contractors as discussed with Mr. Morlock"
P. O. No. 3001-2

Analysis report no. 72-69860

ULTIMATE ANALYSIS

	As Received
% Moisture	xxxxx
% Carbon	83.56
% Hydrogen	4.88
% Nitrogen	0.53
% Chlorine	0.00
% Sulfur	0.30
% Ash	0.03
% Oxygen (diff)	10.70
	100.00

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. PALMER, Manager, Denver Laboratory

GDP/pm

Charter Member

BCI Contract 3001

V ✓

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

SINCE 1908

Reply to
10775 East 51st Ave.
Denver, CO 80239

Phone: 303-373-4772

Mr. John Hemingway
BABCOCK CONTRACTORS, INC.
921 Penn Avenue
Pittsburgh, Pennsylvania 15222

May 31, 1978

Dear Mr. Hemingway:

Enclosed please find corrected copies of our Certificate Of Analysis No. 72-69860, your sample no. 3001-1, tar from Fischer Assay.

Due to a calculation error, the % Hydrogen was originally reported in error. The correct value now appears on these enclosed copies.

We hope this has not caused you or Babcock Contractors any problems or inconvenience.

Should you have any questions or comments, please feel free to contact us.

Sincerely yours,
COMMERCIAL TESTING & ENGINEERING COMPANY

Gail Palmer

Gail D. Palmer
Manager, Denver Laboratory

GDP/ct

AMERICAN COUNCIL OF INDEPENDENT LABORATORIES, INC.

BCI Contract 3001

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

WESTERN DIVISION MANAGER
LLOYD W. TAYLOR, JR.

PLEASE ADDRESS ALL CORRESPONDENCE TO:
10775 EAST 51st AVE., DENVER, COLO. 80239
OFFICE TEL. (303) 373-4772

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, Pennsylvania 15222

May 31, 1978

Sample Identification
by

Babcock Contractors Inc.

Sample No. 3001-1
"Tar from Fischer Assay"
"For Babcock Contractors as discussed with Mr. Morlock"
P. O. No. 3001-2

Kind of sample reported to us	Tar
Sample taken at	xxxxx
Sample taken by	Babcock Contractors Inc.
Date Sampled	xxxxx
Date Received	4-24-78

Analysis report no. 72-69860 Corrected

ULTIMATE ANALYSIS

	As Received
% Moisture	xxxxx
% Carbon	83.56
% Hydrogen	9.70
% Nitrogen	0.53
% Chlorine	0.00
% Sulfur	0.30
% Ash	0.03
% Oxygen (diff)	5.88
	100.00

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. PALMER, Manager, Denver Laboratory

GDP/pm

Charter Member

BCI Contract 3001

SAMPLE NUMBER 3001-1 72-69714 Page 2
SAMPLE DESCRIPTION "For Babcock Contractors as discussed with Mr. Morlock"
TERMINAL TEMP 932 DEG. F
FISCHER ASSAY NO. FB1542

	AS MINED	MOISTURE FREE	MOISTURE AND ASH FREE
FISCHER ASSAY YIELDS			
TAR (LB/TON)	139.3	185.7	208.9
(GAL/TON)	16.9	22.5	25.3
API GRAVITY	11.3	11.3	11.3
GAS (LB/TON)	124.4	165.8	186.6
(SCF/TON)	1584.3	2112.4	2376.7
WATER (LB/TON)	630.5	174.0	195.8
(GAL/TON)	75.6	20.9	23.5
CHAR (LB/TON)	1100.4	1467.3	1400.6
TOTAL (LB/TON)	1994.6	1992.8	1991.8
VARIANCE (PC)	-.3	-.4	-.4
GAS (LB/TON)			
H2	0.50	0.67	0.75
CO	19.19	25.59	28.79
CO2	63.24	84.32	94.89
H2S	3.30	4.40	4.95
C1	19.42	25.89	29.13
C2	6.75	8.99	10.12
C2-	2.36	3.15	3.55
C3	2.63	3.51	3.95
C3-	2.62	3.49	3.93
I-C4	0.08	0.11	0.12
N-C4	0.58	0.78	0.87
C4-	1.39	1.86	2.09
C5	1.19	1.59	1.78
C6	0.90	1.20	1.35
C7	0.20	0.26	0.30
C8	0.00	0.00	0.00
C9	0.00	0.00	0.00
ADJUSTED YIELDS			
C3 AND LIGHTER (LB/TON)	120.0	160.0	180.0
(SCF/TON)	1559.4	2079.2	2339.4
NET (1000 BTU/TON)	838.1	1117.5	1257.3
NET (BTU/SCF)	537.5	537.5	537.5
C4 AND HEAVIER (LB/TON)	143.6	191.5	215.4
(GAL/TON)	17.7	23.6	26.5
API GRAVITY	13.9	13.9	13.9
TOTAL HYDROCARBONS (INCL. H2 & CO, LB/TON)	197.1	262.8	295.7

COMMERCIAL TESTING & ENGINEERING CO.

BABCOCK CONTRACTORS INC.

FISCHER ASSAY GAS ANALYSIS

SAMPLE NUMBER	3001-1 72-69714 Page 3
SAMPLE DESCRIPTION	"For Babcock Contractors as disussed with Mr. Morlock"
FISCHER ASSAY NO.	PB1542
TERMINAL TEMP. DEG. F	932

COMPONENT	MOLE PERCENT
H2	6.00
CO	16.40
CO2	34.39
H2S	2.31
C1	29.04
C2	5.36
C2-	2.02
C3	1.43
C3-	1.49
I-C4	0.03
N-C4	0.24
C4-	0.59
C5	0.40
C6	0.25
C7	0.05
C8	0.00
C9	0.00
SUM	100.00

AVERAGE MOLE WT	29.75
LBS C IN GAS/TON COAL	74.01
PERCENT CARBON	44.64
BTU VALUE OF GAS (CALC.)	
BTU/SCF (GROSS)	634.65
BTU/SCF (NET)	582.35

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 5.0 - APPENDIX

5.2 Laboratory Coal Test Results

b. Analysis Report for Sample No. 3001-1 Dated May 22, 1978

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

CABLE ADDRESS COMTECO

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

ESTERN DIVISION MANAGER
LLOYD W. TAYLOR, JR.

SINCE 1908

PLEASE ADDRESS ALL CORRESPONDENCE TO:
10775 EAST 51st AVE., DENVER, COLO. 80239
OFFICE TEL. (303) 373-4772

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, Pennsylvania 15222

May 22, 1978

Sample Identification
by

Babcock Contractors Inc.

Sample No. 3001-1
"For Babcock Contractors as Discussed with Mr. Morlock"
P.O. NO. 3001-2

Kind of sample reported to us	Coal
Sample taken at	xxxxx
Sample taken by	Babcock Contractors Inc.
Date Sampled	xxxxx
Date Received	4-17-78

Analysis report no. 72-69714 Page 1

PROXIMATE ANALYSIS

	As received	Dry basis
% Moisture	22.80	xxxxx
% Ash	8.58	11.12
% Volatile	33.82	43.81
% Fixed Carbon	34.80	45.07
	100.00	100.00
Btu	9106	11795
% Sulfur	0.90	1.17

ULTIMATE ANALYSIS

	As received	Dry basis
% Moisture	22.80	xxxxx
% Carbon	52.65	68.20
% Hydrogen	3.66	4.74
% Nitrogen	0.90	1.17
% Chlorine	0.01	0.01
% Sulfur	0.90	1.17
% Ash	8.58	11.12
% Oxygen (diff)	10.50	13.59
	100.00	100.00

SULFUR FORMS

	As received	Dry basis
% Pyritic Sulfur	0.50	0.65
% Sulfate Sulfur	0.02	0.03
% Organic Sulfur (Diff)	0.38	0.49
% Total Sulfur	0.90	1.17

FUSION TEMPERATURE OF ASH

	Reducing	Oxidizing
Initial Deformation	2140°F	2250°F
Softening (H=W)	2150°F	2280°F
Softening (H=1/2W)	2165°F	2330°F
Fluid	2175°F	2335°F

% Sulfur (Ignited Ash Basis) = 6.16

HARDGROVE GRINDABILITY INDEX = 50.0 at 20.32% Moisture

% EQUILIBRIUM MOISTURE = xxxxx

FREE SWELLING INDEX = xxxxx

GDP/md /ct

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Gail D Palmer

G. D. PALMER, Manager, Denver Laboratory

Charter Member

BCI Contract 3001

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

WESTERN DIVISION MANAGER
LLOYD W. TAYLOR, JR.

PLEASE ADDRESS ALL CORRESPONDENCE TO:
10775 EAST 51st AVE., DENVER, COLO. 80239
OFFICE TEL. (303) 373-4772

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, Pennsylvania 15222

May 22, 1978

Sample Identification
by

Kind of sample reported to us	Tar	Babcock Contractors Inc.
Sample taken at	xxxxx	Sample No. 3001-1
Sample taken by	Babcock Contractors Inc.	"Second Fischer Assay For CT&E #69714"
Date Sampled	xxxxx	"For Babcock Contractors as discussed with Mr. Morlock" P.O. No. 3001-2
Date Received	5-12-78	

Analysis report no. 72-70190

ULTIMATE ANALYSIS

	As Received
% Moisture	xxxxx
% Carbon	82.18
% Hydrogen	9.37
% Nitrogen	0.46
% Chlorine	0.00
% Sulfur	0.40
% Ash	0.19
% Oxygen (Diff)	7.40
	100.00

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. PALMER, Manager, Denver Laboratory

Charter Member

GDP/ct

BCI Contract 3001

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

WESTERN DIVISION MANAGER
LLOYD W. TAYLOR, JR.

PLEASE ADDRESS ALL CORRESPONDENCE TO:
10775 EAST 51st AVE., DENVER, COLO. 80239
OFFICE TEL. (303) 373-4772

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, Pennsylvania 15222

May 22, 1978

Kind of sample reported to us	Char	Sample Identification by
Sample taken at	xxxxx	Babcock Contractors Inc.
Sample taken by	Babcock Contractors Inc.	Sample No. 3001-1 "Second Fischer Assay from CT&E #69714" "For Babcock Contractors as discussed with Mr. Morlock" P.O. No.3001-2
Date Sampled	xxxxx	
Date Received	5-12-78	

Analysis report no. 72-70191

ULTIMATE ANALYSIS

	Dry Basis
% Moisture	xxxxx
% Carbon	74.29
% Hydrogen	3.09
% Nitrogen	0.95
% Chlorine	0.01
% Sulfur	1.07
% Ash	14.81
% Oxygen (diff)	5.78
	100.00

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. PALMER, Manager, Denver Laboratory

Charter Member

GDP/ct

BCI Contract 3001

BILLINGS, MT. • BIRMINGHAM, AL. • CHARLESTON, W.V. • CLARKSBURG, W.V. • CLEVELAND, OH. • DENVER, CO. • GOLDEN, CO. • HENDERSON, KY. • MIDDLESBORO, KY. • NORFOLK, VA. • SOUTH HOLLAND, IL. • VANCOUVER, B.C. CAN.

1

SAMPLE NUMBER	3001-1 72-69714	Page 2
SAMPLE DESCRIPTION	"For Babcock Contractors as discussed with Mr. Morlock"	
TERMINAL TEMP	932 DEG. F	
FISCHER ASSAY NO.	1546	

*As Mined Moisture Result Calculated on estimated Equilibrium Moisture of 25.00%	*AS MINED	MOISTURE FREE	MOISTURE AND ASH FREE
FISCHER ASSAY YIELDS			
TAR (LB/TON)	124.9	166.6	187.4
(GAL/TON)	15.3	20.4	22.9
API GRAVITY	12.6	12.6	12.6
GAS (LB/TON)	116.6	155.5	175.0
(SCF/TON)	1454.7	1939.6	2182.2
WATER (LB/TON)	621.5	162.0	182.2
(GAL/TON)	74.5	19.4	21.9
CHAR (LB/TON)	1115.5	1487.4	1423.2
TOTAL (LB/TON)	1978.6	1971.4	1967.9
VARIANCE (PC)	-1.1	-1.4	-1.6
GAS (LB/TON)			
H2	0.34	0.45	0.51
CO	17.83	23.77	26.75
CO2	58.71	78.28	88.07
H2S	1.82	2.43	2.73
C1	17.88	23.85	26.83
C2	7.35	9.80	11.03
C2-	2.13	2.84	3.20
C3	3.25	4.33	4.87
C3-	2.56	3.41	3.84
I-C4	0.14	0.19	0.22
N-C4	0.80	1.07	1.21
C4-	1.30	1.74	1.96
C5	1.23	1.64	1.85
C6	1.09	1.46	1.64
C7	0.20	0.26	0.29
C8	0.00	0.00	0.00
C9	0.00	0.00	0.00
ADJUSTED YIELDS			
C3 AND LIGHTER (LB/TON)	111.9	149.2	167.8
(SCF/TON)	1427.5	1903.4	2141.5
NET (1000 BTU/TON)	799.9	1066.5	1200.0
NET (BTU/SCF)	560.3	560.3	560.3
C4 AND HEAVIER (LB/TON)	129.7	172.9	194.6
(GAL/TON)	16.2	21.6	24.3
API GRAVITY	15.8	15.8	15.8
TOTAL HYDROCARBONS (INCL. H2 & CO, LB/TON)	181.1	241.4	271.6

1

FISCHER ASSAY GAS ANALYSIS

SAMPLE NUMBER	3001-1 72-69714 Page 3
SAMPLE DESCRIPTION	"For Babcock Contractors as discussed with Mr. Morlock"
FISCHER ASSAY NO.	1546
TERMINAL TEMP. DEG. F	932

COMPONENT	MOLE PERCENT
H2	4.42
CO	16.59
CO2	34.76
H2S	1.39
C1	29.12
C2	6.36
C2-	1.98
C3	1.92
C3-	1.58
I-C4	0.06
N-C4	0.36
C4-	0.61
C5	0.45
C6	0.33
C7	0.05
C8	0.00
C9	0.00
SUM	100.00

AVERAGE MOLE WT	30.39
LBS C IN GAS/TON COAL	71.50
PERCENT CARBON	45.97
BTU VALUE OF GAS (CALC.)	
BTU/SCF (GROSS)	668.21
BTU/SCF (NET)	613.64

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 5.0 - APPENDIX

5.2 Laboratory Coal Test Results

c. Analysis Report for Sample No. 3001-2
Dated May 3, 1978

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

WESTERN DIVISION MANAGER
LLOYD W. TAYLOR, JR.

CTE SINCE 1908

PLEASE ADDRESS ALL CORRESPONDENCE TO:
10775 EAST 51st AVE., DENVER, COLO. 80239
OFFICE TEL. (303) 373-4772

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, Pennsylvania 15222

May 3, 1978

Sample Identification by

Babcock Contractors Inc.

Sample No. 3001-2
"For Babcock Contractors as discussed with Mr. Morlock"
P. O. No. 3001-2

Kind of sample reported to us	Coal
Sample taken at	xxxxx
Sample taken by	Babcock Contractors Inc.
Date Sampled	xxxxx
Date Received	4-17-78

Analysis report no. 72-69715 Page 1

PROXIMATE ANALYSIS

	As received	Dry basis
% Moisture	5.50	xxxxx
% Ash	9.49	10.04
% Volatile	38.90	41.16
% Fixed Carbon	46.11	48.80
	100.00	100.00
Btu	12814	13560
% Sulfur	3.29	3.48

ULTIMATE ANALYSIS

	As received	Dry basis
% Moisture	5.50	xxxxx
% Carbon	70.32	74.41
% Hydrogen	4.99	5.28
% Nitrogen	1.12	1.18
% Chlorine	0.07	0.07
% Sulfur	3.29	3.48
% Ash	9.49	10.04
% Oxygen (diff)	5.22	5.54
	100.00	100.00

SULFUR FORMS

	As received	Dry basis
% Pyritic Sulfur	xxxxx	xxxxx
% Sulfate Sulfur	xxxxx	xxxxx
% Organic Sulfur (Diff)	xxxxx	xxxxx
% Total Sulfur	xxxxx	xxxxx

FUSION TEMPERATURE OF ASH

	Reducing	Oxidizing
Initial Deformation	2000°F	2530°F
Softening (H=W)	2080°F	2550°F
Softening (H=1/2W)	2310°F	2570°F
Fluid	2490°F	2580°F

HARDGROVE GRINDABILITY INDEX = 46.8 at 1.33% Moisture

% EQUILIBRIUM MOISTURE = xxxxx

FREE SWELLING INDEX = 7

GDP/md/pm

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. Palmer

G. D. PALMER, Manager, Denver Laboratory

BCI Contract 3001

AMERICAN COUNCIL OF INDEPENDENT LABORATORIES, INC. Charter Member

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

WESTERN DIVISION MANAGER
LLOYD W. TAYLOR, JR.

PLEASE ADDRESS ALL CORRESPONDENCE TO:
10775 EAST 51st AVE., DENVER, COLO. 80239
OFFICE TEL. (303) 373-4772

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, Pennsylvania 15222

May 12, 1978

Sample Identification
by

Babcock Contractors Inc.

Char from Fischer Assay on
C.T. & E. sample 72-69715
Sample No. 3001-2
P. O. No. 3001-2

Kind of sample reported to us	Char
Sample taken at	xxxxx
Sample taken by	Babcock Contractors Inc.
Date Sampled	xxxxx
Date Received	5-5-78

Analysis report no. 72-70057

ULTIMATE ANALYSIS
Dry Basis

% Moisture	xxxxx
% Carbon	74.83
% Hydrogen	3.00
% Nitrogen	0.93
% Chlorine	0.08
% Sulfur	3.37
% Ash	15.04
% Oxygen (diff)	2.75
	100.00

Btu 12582

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. PALMER, Manager, Denver Laboratory

GDP/pm

Charter Member

BCI Contract 3001

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 228 NORTH LA SALLE STREET, CHICAGO, ILLINOIS 60601 · AREA CODE 312 726-8434

WESTERN DIVISION MANAGER
LLOYD W. TAYLOR, JR.

PLEASE ADDRESS ALL CORRESPONDENCE TO:
10775 EAST 51st AVE., DENVER, COLO. 80239
OFFICE TEL. (303) 373-4772

BABCOCK CONTRACTORS INC.
921 Penn Avenue
Pittsburgh, Pennsylvania 15222

May 22, 1978

		Sample Identification by
Kind of sample reported to us	Tar	Babcock Contractors Inc.
Sample taken at	xxxxx	Sample No. 3001-2 "Tar from Fischer Assay" "For Babcock Contractors as discussed with Mr. Morlock" P.O. No. 3001-2
Sample taken by	Babcock Contractors Inc.	
Date Sampled	xxxxx	
Date Received	5-5-78	

Analysis report no. 72-70058

ULTIMATE ANALYSIS

	As Received
% Moisture	xxxxx
% Carbon	85.41
% Hydrogen	9.40
% Nitrogen	1.06
% Chlorine	0.00
% Sulfur	1.06
% Ash	0.11
% Oxygen (diff)	2.96
	100.00

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

G. D. PALMER, Manager, Denver Laboratory

GDP/ct

BCI Contract 3001

Charter Member

BABCOCK CONTRACTORS INC.

SAMPLE NUMBER	3001- 72-69715 Page 2
SAMPLE DESCRIPTION	"For Babcock Contractors as discussed with Mr. Morlock"
TERMINAL TEMP	932 DEG. F
FISCHER ASSAY NO.	RF1544

*As Mined Moisture Result Calculated on estimated Equilibrium Moisture of 5.00%

	*AS MINED	MOISTURE FREE	MOISTURE AND ASH FREE
FISCHER ASSAY YIELDS			
TAR (LB/TON)	362.2	383.3	426.6
(GAL/TON)	42.0	44.5	49.5
API GRAVITY	5.4	5.4	5.4
GAS (LB/TON)	95.8	101.3	112.8
(SCF/TON)	1502.1	1589.5	1769.0
WATER (LB/TON)	158.2	51.1	56.8
(GAL/TON)	19.0	6.1	6.8
CHAR (LB/TON)	1355.2	1434.0	1370.1
TOTAL (LB/TON)	1971.4	1969.8	1966.3
VARIANCE (PC)	-1.4	-1.5	-1.7
GAS (LB/TON)			
H2	0.75	0.80	0.88
CO	5.32	5.63	6.27
CO2	10.53	11.14	12.40
H2S	16.79	17.77	19.77
C1	28.39	30.05	33.44
C2	14.12	14.94	16.63
C2-	1.95	2.06	2.29
C3	6.72	7.11	7.92
C3-	3.38	3.57	3.98
I-C4	0.27	0.29	0.32
N-C4	1.89	2.00	2.22
C4-	1.75	1.85	2.06
C5	2.50	2.64	2.94
C6	1.35	1.43	1.59
C7	0.07	0.07	0.08
C8	0.00	0.00	0.00
C9	0.00	0.00	0.00
ADJUSTED YIELDS			
C3 AND LIGHTER (LB/TON)	88.0	93.1	103.6
(SCF/TON)	1456.6	1541.4	1715.5
NET (1000 BTU/TON)	1310.7	1387.0	1543.6
NET (BTU/SCF)	899.8	899.8	899.8
C4 AND HEAVIER (LB/TON)	370.1	391.6	435.8
(GAL/TON)	43.6	46.1	51.3
API GRAVITY	7.4	7.4	7.4
TOTAL HYDROCARBONS (INCL. H2 & CO, LB/TON)	430.7	455.8	507.2

BABCOCK CONTRACTORS INC.

FISCHER ASSAY GAS ANALYSIS

SAMPLE NUMBER	3001-2 72-69715	Page 3
SAMPLE DESCRIPTION	"For Babcock Contractors as discussed with Mr. Morlock"	
FISCHER ASSAY NO.	RF1544	
TERMINAL TEMP. DEG. F	932	

COMPONENT	MOLE PERCENT
H2	9.48
CO	4.80
CO2	6.04
H2S	12.42
C1	44.77
C2	11.84
C2-	1.76
C3	3.85
C3-	2.02
I-C4	0.12
N-C4	0.82
C4-	0.79
C5	0.89
C6	0.40
C7	0.02
C8	0.00
C9	0.00
SUM	100.00

AVERAGE MOLE WT	24.16
LBS C IN GAS/TON COAL	57.50
PERCENT CARBON	56.74
BTU VALUE OF GAS (CALC.)	
BTU/SCF (GROSS)	1067.61
BTU/SCF (NET)	973.98

5.3

5.0 APPENDIX

5.3 Suggestions for Waste Stream Clean-up

5.3.1 Waste Streams

The waste streams generated by the gasification unit are:

1. Aqueous Effluent
2. Boiler Blowdown
3. Gasifier Off-Gas
4. Ash
5. Oil/Water Separator Sludge

5.3.2 Treatment of Aqueous Effluent

a. Nature of Waste Stream

Aqueous effluent is formed in the combined gas cooler. Gross amounts of tar, oil and solids are separated from the water phase in an on-site gravity separator.

The amount of the water stream depends chiefly on the water content of the coal. This coal contains 25.6% moisture. The design Eastern coal contains 4.3% moisture and forms none of this stream. If water is sprayed into the combined gas produced from Eastern coal, aqueous effluent will, of course, result.

The aqueous effluent which is produced by the unit will contain a variety of impurities which will include the following: ammonia, chloride, cyanide, flouride, hydrogen sulfide, oil phenol, thiocyanate and carbonate. The liquid will be dark in color and have a slightly alkaline pH.

References (1) and (2) offer a general background into the nature of the aqueous effluent.

5.3

5.0 APPENDIX

5.3 Suggestions for Waste Stream Clean-up

5.3.1 Waste Streams

The waste streams generated by the gasification unit are:

1. Aqueous Effluent
2. Boiler Blowdown
3. Gasifier Off-Gas
4. Ash
5. Oil/Water Separator Sludge

5.3.2 Treatment of Aqueous Effluent

a. Nature of Waste Stream

Aqueous effluent is formed in the combined gas cooler. Gross amounts of tar, oil and solids are separated from the water phase in an on-site gravity separator.

The amount of the water stream depends chiefly on the water content of the coal. This coal contains 25.6% moisture. The design Eastern coal contains 4.3% moisture and forms none of this stream. If water is sprayed into the combined gas produced from Eastern coal, aqueous effluent will, of course, result.

The aqueous effluent which is produced by the unit will contain a variety of impurities which will include the following: ammonia, chloride, cyanide, flouride, hydrogen sulfide, oil phenol, thiocyanate and carbonate. The liquid will be dark in color and have a slightly alkaline pH.

References (1) and (2) offer a general background into the nature of the aqueous effluent.

5.0 APPENDIX (continued)

5.3 Suggestions for Waste Stream Clean-Up (continued)

5.3.2 Treatment of Aqueous Effluent (continued)

b. Goals of Wastewater Treatment

BCI is not aware of the specific Federal guidelines which apply to this project. EPA guidelines (3), (4) for coke plant effluent may be considered instead, since coke wastewater is generated from coal in a somewhat similar manner.

Current regulations for coke wastewater call for the control of six parameters: ammonia, cyanide, oil and grease, phenol, suspended solide and pH. 1983 guidelines can be expected to stricter and to include limits for carcinogens and other toxic substances.

c. Biological Treatment

In the context of this report, biological treatment is a series of process steps, one of which is a bio-oxidation step, to purify aqueous effluent. The process, if used, should be adapted from the one used to treat coke wastewater. Descriptions of this process, or aspects of it, may be found in references (5), (6), & (7). Biological treatment of gasification wastewater has been studied by Luthy & Tallon (8).

Biological treatment as applied to coal gasification is shown in Figure 1. This represents an application of the patented Bethlehem Steel process (4). The stream is first equalized by at least one days storage to reduce variation in the waste concentration. After equalization; lime is added to free ammonia for distillation and to entrap dispensed oil in the lime solids. An oily sludge is produced. In the second step, ammonia is distilled from the liquor. The still bottoms are cooled and biologically treated. After clarification, the effluent is discharged.

THIS PAGE

WAS INTENTIONALLY

LEFT BLANK

5.0 APPENDIX (continued)

5.3 Suggestions for Waste Stream Clean-Up (continued)

5.3.2 Treatment of Aqueous Effluent (continued)

f. Re-Injection of Wastewater into the Gasifier or Gas Main (continued)

which produces or transports the gas, as well as in equipment treating wastewater.

Therefore, we suggest any re-injection scheme be inculded only as an option, to be studied in service. Also the injection of a partially purified stream may be more feasible than injection of the entire waste. For example, the overhead from the ammonia still (bio process) could be injected into the gas main.

5.3.3 Boiler Blowdown

a. Nature of Waste Stream

Boiler Blowdown is alkaline and is high in dissolved solids. It has an oxygen demand due to the presence of sulfite. It contains phosphate which may be objectionable in some cases. Offsetting these factors is its fairly low volume.

b. Treatment of Boiler Blowdown

If the aqueous effluent will be treated biologically, boiler blowdown and aqueous effluent should be combined for treatment. Referring to Figure 1, the blowdown will serve as a beneficial source of alkalinity in the lining step and as a beneficial source of phosphate in the biological step. Carbon dioxide generated in the biological step will neutralize alkalinity. If the aqueous effluent is not treated biologically, the boiler blowdown should be treated separately and discharged.

5.0 APPENDIX (continued)

5.3 Suggestions for Waste Stream Clean-Up (continued)

5.3.2 Treatment of Aqueous Effluent (continued)

c. Biological Treatment (continued)

Biological treatment offers several advantages as a process for use in purifying the aqueous effluent stream. It is a well developed process in the coke industry. Licensed processes are available and existing plants may be inspected. Energy use and operating costs are relatively low; compared to incineration.

Biological treatment also has several disadvantages in this application. Capital costs are high compared to incineration. The advantage of low operating cost will be offset by the small amount of wastewater to be treated compared to the typical large coke plant. Operation of this plant in the severe winter conditions of Northern Minnesota will require excellent operating practices, due to the many outdoor water lines. In the future, add-on steps may be required to remove nitrogen compounds and toxic substances.

d. Incineration of Aqueous Effluent

A possible incineration scheme for aqueous effluent is shown in Figure 2. After equalization, the waste is partially evaporated. This partially evaporated liquor is then incinerated.

We feel that the incineration process offers advantages for this application and should be vigorously pursued. It at least appears simple and will create no liquid or solid effluent. Capital cost may be lower.

Incineration also poses several potential problems which must be considered. Simple incineration may produce both $S0_3$ and $N0_x$ air pollution. It is desireable that combustion products be limited to $S0_2$, Co_2, H_20, HCl and H_20. Formation of $S0_3$ and $N0_x$ may be reduced by using a patented burner system developed by Firma Carl Still (9) and described

5.0 APPENDIX (continued)

5.3 Suggestions for Waste Stream Clean-Up (continued)

5.3.2 Treatment of Aqueous Effluent (continued)

d. Incineration of Aqueous Effluent (continued)

by Ferguson (10). Essentially, this process involves the double incineration of the waste, first under reducing conditions and then under oxidizing conditions.

Incineration is less energy-efficient than biological treatment and may involve higher operating costs. The partial evaporation step shown in Figure 2 is intended to reduce fuel costs. The difficulty is that NH_3, phenol, H_2S and HCL may also evaporate. pH adjustments which fix ammonia in the liquid phase make the weak acids more volatile and vice versa. This step requires further pilot work before an answer is found.

e. Carbon Adsorption

Carbon adsorption has been discussed as a means of purifying coke plant wastewater (11). One or two plants have been built. Referring to Figure 1, carbon adsorption would presumably replace the biological step. A possible advantage of carbon is the removal of biorefractory organic compounds. A disadvantage is that carbon regeneration is costly and requires energy. In our opinion, carbon adsorption is not a process to be considered at this time.

f. Re-Injection of Wastewater into the Gasifier or Gas Main

Some sort of re-injection method would seem a natural way to dispose of all or part of the wastewater. Although such schemes are tempting, we urge caution in this application. Re-injection may cause problems such as corrosion or fouling, which could not have been foreseen. These problems may occur in the equipment

5.0 APPENDIX (continued)

5.3 Suggestions for Waste Stream Clean-Up (continued)

5.3.4 Gasifier Off-Gas

A gas stream is vented from the gasifier during certain phases of start-up, normal shutdown and emergency shut-down. Treatment of this stream is provided by flare stacks (ground-flares) provided in the design.

5.3.5 Ash

a. Ash Handling

Ash produced in the gasifiers is conveyed to a storage bin or hopper for disposal by truck. Air used to cool the ash is filtered to remove particulate matter. Since the ash is handled dry, no water stream is produced.

b. Disposal of Ash

Because of its large volume, disposal of ash must be considered a problem to be given serious consideration in this application. Background material on ash disposal is given by Edwards et. al.(12).

If the ash from the gasifiers is buried, studies will be needed regarding the fate of constituent trace elements. Some studies have suggested that toxic trace metals can be leached from disposal sites (13). Research has been conducted on using ash as a beneficial by-product rather than disposing of it as a waste. For example, ash has been used in revegetating mined-out areas (surface coal mining). Spoil and refuse piles can be neutralized by ash, which raises the pH to about 5, making it possible to grow vegetation on coal refuse materials without the use of topsoil. Such growth has not been proven to last for long periods of time, but with the use of fertilizers and limestone, grass has been started and weathered well for one year on certain test plots (14). Application of these ideas to iron mining might be considered.

5.0 APPENDIX (continued)

5.3 Suggestions for Waste Stream Clean-Up (continued)

5.3.5 Ash (continued)

b. Disposal of Ash (continued)

The National Ash Association and other commercial interests have found still other uses for ash, for example in paving of highways, in fast drying concrete for continuous slip forming systems, as impervious fill for storage areas, and in lightweight concrete block aggregate.

5.3.6 Oil/Water Separator Sludge

A small amount of solids will be produced at the oil/water separator. This will consist of dust plus entrained oil and water. This may be land filled with the ash.

5.3.7 DOE Environmental Assessment Program for High-BTU Coal Gasification

In July of 1976, the Department of Energy initiated a comprehensive program for environmental assessment of its high-BTU coal gasification pilot plant installations. The overall objective of the program is to develop the methodology and data base necessary for meaningful assessment of the environmental impact of the coal gasification processes. The environmental characterization efforts at each pilot plant are focused on scaleable process units, with the goal of establishing rules and strategy for scaleup to commercial-size installations.

Carnegie-Mellon University has been given the role of assistance, coordination and evaluation contractor for the DOE program. Carnegie-Mellon has prepared a series of technical documents in support of program objectives and activities. This resource should be utilized in determing the methods of waste stream clean-up to be used.

5.0 APPENDIX (continued)

REFERENCES

1) Massey, M.J., R.W. Dunlap, F.C. McMichael & D.D. Nakles, "Characterization of Effluents from the Hygas and CO_2 Acceptor Plants" NTIS No. FE-2496-1, ERDA Nov. 1976.

2) Nakles, D.V. "Significance of Process Variables on Liquid Effluent Production in Coal Gasification" Ph.D Thesis Depart. of Chemical Engineering/Engineering & Public Policy. Carnegie Mellon University, 1977.

3) EPA Effluent Guidelines & Standards for Iron & Steel Manufacture Title 40. Chapter 1. Subchapter N. Part 420. Iron & Steel Manufacture. Point Source Category. Sub parts By-Product Coke Subcategory. June 28, 1974. Environment Reporter 1974.

4) Train, R.E. et. Al. "Development Document for Effluent Limitation Guidelines & New Source Performance Standards for Iron & Steel Making Segment of the Iron & Steel Making Point Source Category, 1974.

5) Rudzki, E.M., K.R. Barcaw & R.J. Horst "An Improved Process for the Removal of Ammonia from Coke Plant Weak Ammonia Liquor" I & SM June 1977.

6) Glassman, D. "USS Cyam System - An Improved Process for Ammonia & Cyanide Removal from Coke Plant Waste Water" U.S. Steel Corporation. Research, Monroeville, PA.

7) Cousins & Mindler "Tertiary Treatment of Weak Ammonia Liquor" J. WPCF Vol. 44 No. 4 April, 1972.

8) Luthy, R.G. & J. T. Tallon " Experimental Analysis of the Biological Oxidation Characteristics of Hygas Coal Gasification Wastewater" Carnegie Mellon University. Dept. of Civil Engineering. May, 1978, DOE contract E (49-18) 2496.

9) U.S. Patent 3,661,507. May 9, 1972. F. Breitbach and G. Choulat. Assigned to Firma Carl Still.

10) Ferguson, Paul A. "Hydrogen Sulfide Remobal from Gases, Air and Liquids" Noyes Data Corporation, Park Ridge, NJ.

5.0 APPENDIX (continued)

REFERENCES (continued)

11) Schroeder, J.W. and C. Naso "A New Method of Treating Coke Plant Wastewater." Iron & Steel Engineer, December, 1976.

12) Edward, R. G., D. Broderson & W.P. Houser "Social, Economic & Environmental Impacts of Gasification and Liquifaction Plants" April 1976. Institute for Mining & Minerals Research. University of Kentucky. Lexington. NTIS NO. PB 253-747.

13) Hargis, W. F., A. W. Andren, and G. S. Henderson "Environmental Assessment of SO_2 and Trace Element Emissions from Coal Utilization" Oak Ridge National Laboratory.

14) First Symposium on Mine and Preparation Plant Refuse Disposal, Papers Presented Before the Coal and the Environment Technical Conference, Louisville, Kentucky, Oct. 22-23-24, 1974.

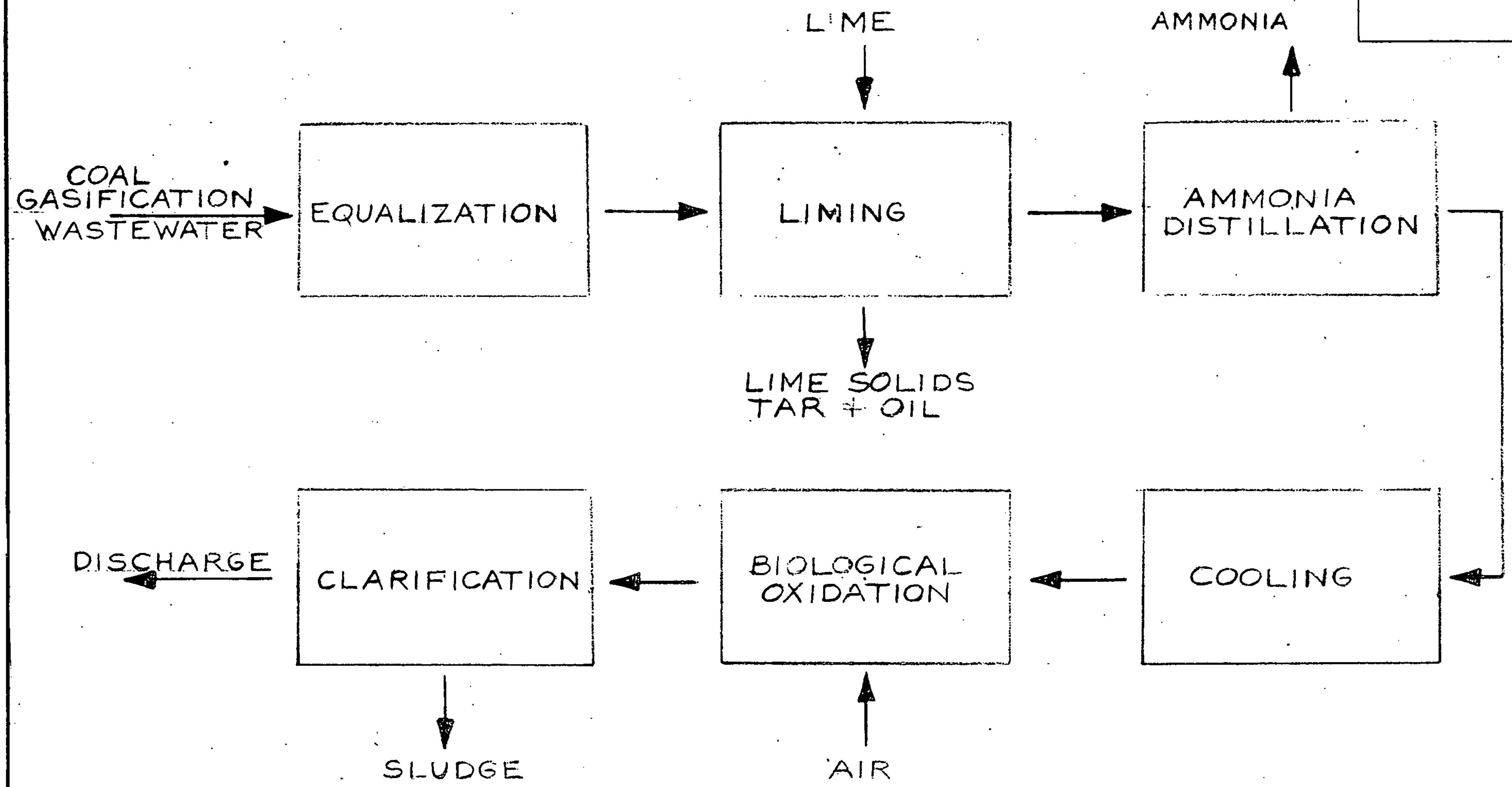


FIGURE #1

BIOLOGICAL OXIDATION AQUEOUS EFFLUENT

SCALE:	APPROVED BY	DRAWN BY PJA
DATE: 12/28/78		

BCI PROJECT #3001

DRAWING NUMBER

BCI Contract 3001

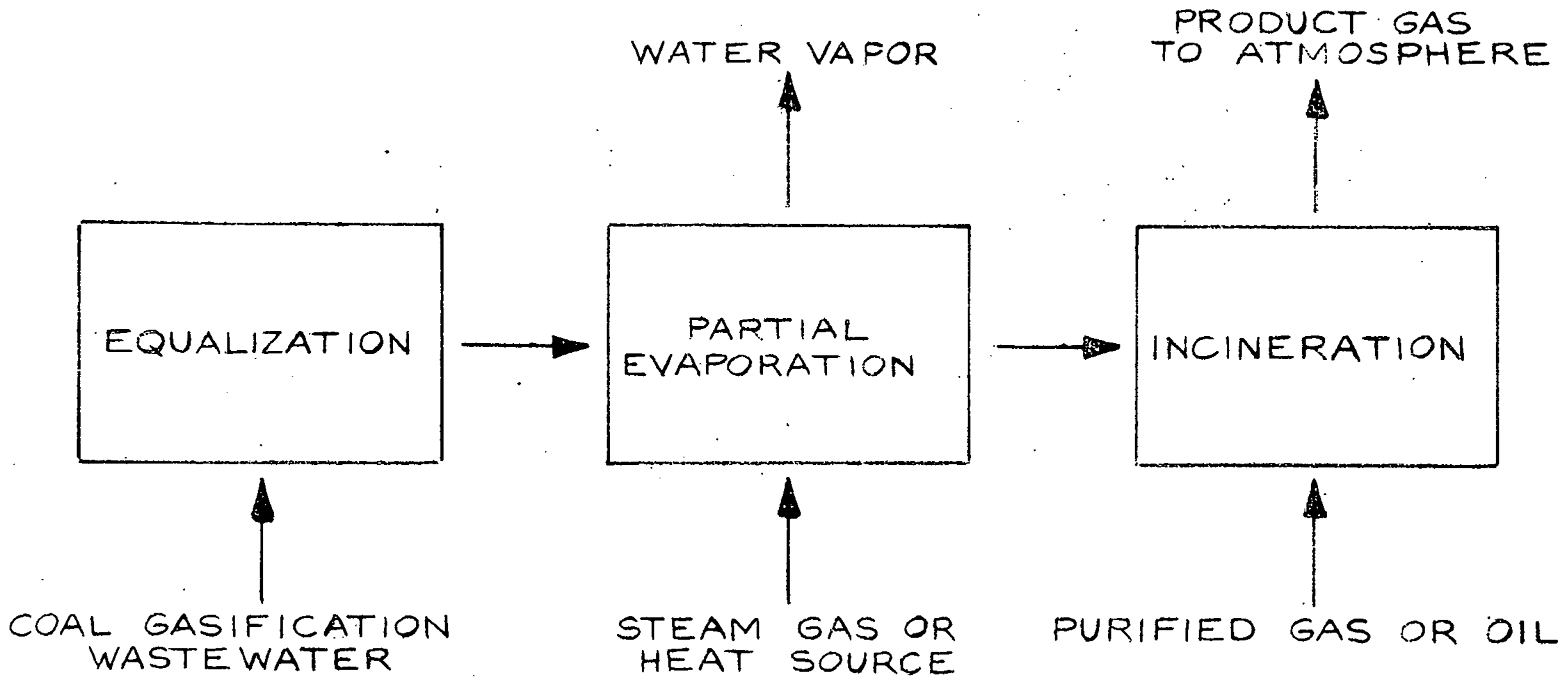


FIGURE #2
INCINERATION OF AQUEOUS EFFLUENT

SCALE:	APPROVED BY	DRAWN BY PJA
DATE: 12/28/78		

BCI PROJECT # 3001

DRAWING NUMBER

BCI Contract 3001

5.4

COAL GASIFICATION DEMONSTRATION PLANT

HOYT LAKES, MINNESOTA

SECTION 5.0 - Appendix

5.4 Project Calculations

Contents

Rev. 1 - 3/6/79: Rewrote Cooling Water Jacket and Steam Drum Calculation Sheets on Vacuum Design

DOE Contract ET-78-C-01-2578
McKee Contract 4814A/W2
BCI Contract 3001

PART 1

BABCOCK CONTRACTORS INC. PITTSBURGH, PA. *A Subsidiary of Babcock International Inc.*	PROCESS SPECIFICATION FOR REACTOR			PS-R201 A to E REVISION 2 PAGE 1 OF 7
ORIGINAL	BY MJH	DATE 7/12/78	APPD.	DATE 7/10/78
REVISION	BY MJH	DATE 2/19/79	APPD.	DATE
CLIENT: McKee				PROJECT NO. 3001

1. Type:

Two stage, dry grate gasifier.

The gasifiers are to be capable of modification so they can operate in either of two modes:

1.1 As a conventional two stage gasifier.

1.2 As a developmental two stage gasifier, fitted with a stirrer (Item No. A 201).

1.3 The two types of gasifier will be identical, except for the refractory lining (see Section and the stirrer. The stirrer is covered under a separate specification.

1.4 The demonstration plant will consist of four conventional gasifiers, and one stirred gasifier.

2. Nominal Size: 12 ft. I.D. or 3.6 M.

3. Duty:

To gasify coal to a low Btu gas leaving an ash residue. The gasifier produces two product gas streams - a top gas at approximately 250^{o}F, and a clear gas at approximately 1200^{o}F.

3.1 The design basis coal feed to the conventional gasifiers has the following properties:

Analysis:	% W/W
Moisture	25.60
C	50.74
H	3.53
N	0.87
Cl	0.01
S	0.87
O	10.11
Ash	8.27
	100.00

F.S.I.	Non-agglomerating
HHV	8775 Btu/#

Design thruput of specified coal 5.52 tons/hr.

ENG-050-0278

3. Duty (Continued):

3.2 The design basis coal feed to the stirred gasifier has the following properties:

Analysis:	% W/W
Moisture	4.3
C	71.21
H	5.05
N	1.13
Cl	0.07
S	3.33
O	5.30
Ash	9.61
	100.00
F.S.I.	7
HHV	12,977 Btu/#

Design thruput of specified coal 4.57 tons/hr.

4. Construction:

BCI Drawing No. 3001-M300 Ref. A is an overall view of the gasifier, showing general arrangement and nozzles and this drawing should be used as a reference drawing in conjunction with this specification. The gasifier is composed of the following main components:

Blast Inlet Assembly	Ref. A
Grate Support Base	Ref. B
Grate Support Casing	Ref. C
Water Jacket	Ref. D
Gasifier Shell and Details	Ref. E
Gasifier Lower Cone and Distributor	Ref. F
Gasifier Upper Cone	Ref. G

5. Blast Inlet Assembly (Ref. A on Drawing 3001 - M300):

5.1 Duty: Inlet box for air/steam blast, and to permit removal of any ash which falls thru the grate.

5.2 Operating & Design Conditions:

	Operating	Design
Temperature ^{o}F	160^{o}	650
Pressure p.s.i.g.	2.16	4.32

5. Blast Inlet Assembly (Continued):

5.3 Nozzles: The following nozzle sizes are minimums for process requirements. Larger nozzles may be installed if recommended by mechanical department.

1.	Blast inlet	24" O.D.
2.	Thermocouple	2"
3.	Drain	2"
4.	Ash port	8" x 12"
5.	Spare	3"

Connection to gasifier grate to be 24" minimum.

5.4 Material: Carbon steel - to include a 1/4" corrosion allowance.

5.5 Insulation: The blast inlet box will be insulated with 3" calcium silicate.

6. Water Jacket (Ref. D on Drawing 3001 - M300):

6.1 Duty: To generate the steam required for gasification and provide cooling for the gasification reaction.

The water jacket operates in conjunction with the steam drum D201 A to E; they are connected by a thermosyphon. The water jacket, steam drum, and thermosyphon piping must be considered as a complete system for design and coding purposes.

Design production of steam = 3300 #/hr.

Dimensions: Inside height 76 7/8", inside width, 16 5/8". Diameter of inside wall is 141 3/4" (3.6 M).

6.2 Operating & Design Conditions:

	Operating	Proc. Design	Mech. Design
Steam drum temp. ^{o}F	267	300	350
Steam drum pressure, psig	25	30 + F.V.	32 + F.V. *
Temp. in water jacket ^{o}F	268	300	350
Pressure in water jacket, incl. liquid head, psig	25	40 + F.V.	40 + F.V.
Pressure in gasifier, psig	2.16	4.32	4.32
Temp. of gasification zone	2200	2600	----
Max. furnace wall temp. ^{o}F	500	600	700

*F.V. = Full Vacuum

6. Water Jacket (Continued):

6.3 Nozzles: The following nozzles are the minimum for process requirements. Additional inspection ports or manholes may be added by mechanical department to meet code requirements.

17	Thermosyphon inlet	two x 6"
18	Thermosyphon outlet	two x 8"
19	Nozzle for blowdown	two x 4"
20	Blowdown dip pipe	two x 1 1/2"
21	Drain plug	two x 2"
22	Inspection	eight x 10"

6.4 Material: Carbon steel - to include 1/16" corrosion allowance for the waterside, 3/16" corrosion allowance for the reaction side.

6.5 Insulation: The outside wall of the shell will be insulated with 4" of calcium silicate.

7. Gasifier Shell (Ref. E & F on Drawing 3001 - M300):

7.1 Duty: Shell for refractory lined distillation retort. Total ht. of sections E & F to be 26 ft.

7.2 Operating & Design Conditions:

	Operating	Mech. Design
Temperature ^{o}F	220	300
Pressure p.s.i.g.	2.16	4.32

7.3 Nozzles: The following nozzles are the minimum for process requirements. Additional manholes may be added by mechanical department to facilitate maintenance.

23	Pyrometer port	two x 3"
24	Lower access	one x 1'-10" x 1'-2"
25	Lower rodding ports	fifteen x 3"
26	Inspection port	four x 1'-0" x 1'-0"
27	Access port	five x 1' x 2'6"
28	Clear gas	one x 4'6" O.D.

7. Gasifier Shell (Continued):

7.4 Carbon steel - to include 1/16" corrosion allowance.

7.5 Insulation: No insulation will be provided on the outside of this section of the vessel. A guard may be required around the outside of the vessel for personnel protection.

8. Gasifier Lower Cone & Distributor (Ref. F on Drawing 3001 - M300)

8.1 Duty: To connect the shell with the upper cone, and to provide an even distribution of the coal over the top of the retort.

8.2 Operating & Design Conditions:

	Operating	Mech. Design
Temperature ^{o}F	250	300
Pressure p.s.i.g.	2.16	4.32

8.3 Nozzles: The following nozzles are the minimum for process requirements. Additional manholes may be added by mechanical department to facilitate maintenance.

(29)	Manhole	one x 30"
(30)	Top gas	two x 18" (two used)
(31)	Stirrer shaft port	one x 24"
(32)	Coal distributor	five x 24"
(33)	Upper rodding ports	five x 3"

The coal distributor nozzles No. 32 are lined with refractory concrete. The lining has an I.D. of 18" at the top and 20" at the bottom.

8.4 Construction: Carbon steel to include 1/16" corrosion allowance. Distributor to be lined with refractory concrete.

9. Coal Distributor & Level Hopper (Ref. G. on Drawing 3001 - M300):

8.1 Duty: To provide a space for the coal level to fluctuate, and to provide a constant supply of coal to the retort. Unit is sized so that level fluctuages $\pm 3"$, equivalent to a coal charge of 1000#.

ENG-052-2275

9. Coal Distributor & Level Hopper (Continued):

9.2 Operating & Design Conditions:

	Operating	Design
Temperature ^{o}F	250	400
Pressure p.s.i.g.	2.16	4.32

9.3 Nozzles:

34	Manhole	one - 30"
35	Coal inlet	one - 18"
36	Rodding port	five - 3"
37	Level alarm	one - 6"
38	Stirrer port	one - 24"
39	Level sensor	two - 3"

9.4 Construction:

Carbon steel - to include 1/8" corrosion allowance. Section of hopper below level 6'0" above center discharge of nozzle 32 is to be lined with refractory concrete.

10. Gasifier Grate Castings:

10.1 Duty: To remove ash from the gasifier, and to distribute air/steam blast thru the gasification zone.

10.2 Operating & Design Conditions:

	Operating	Design
Temperature ^{o}F	300	650
Pressure p.s.i.g.	2.16	4.32

Grate is to rotate at a maximum speed of one revolution every 2 hours. For details of grate drive unit and hydraulic cylinders, see Spec. W201.

11. Gasifier Refractory:

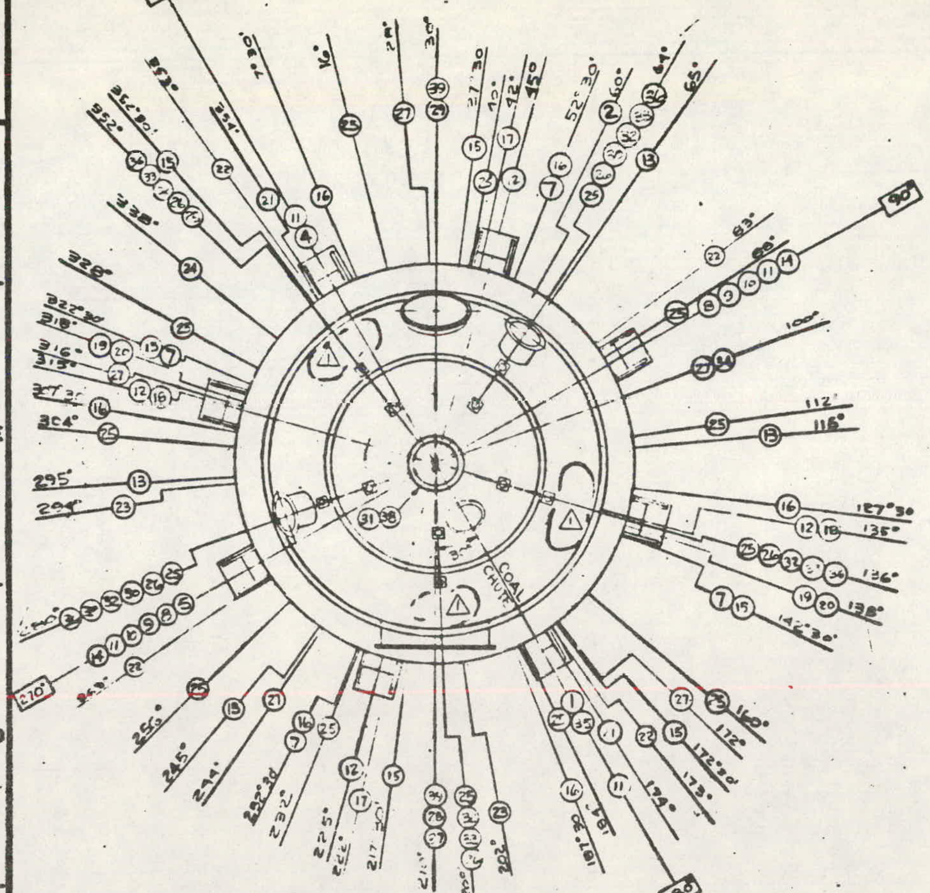
11.1 Unstirred Gasifiers

Refractory material Spec.	SP-R201/SR3
Refractory installation Spec.	SP-R201/SR2

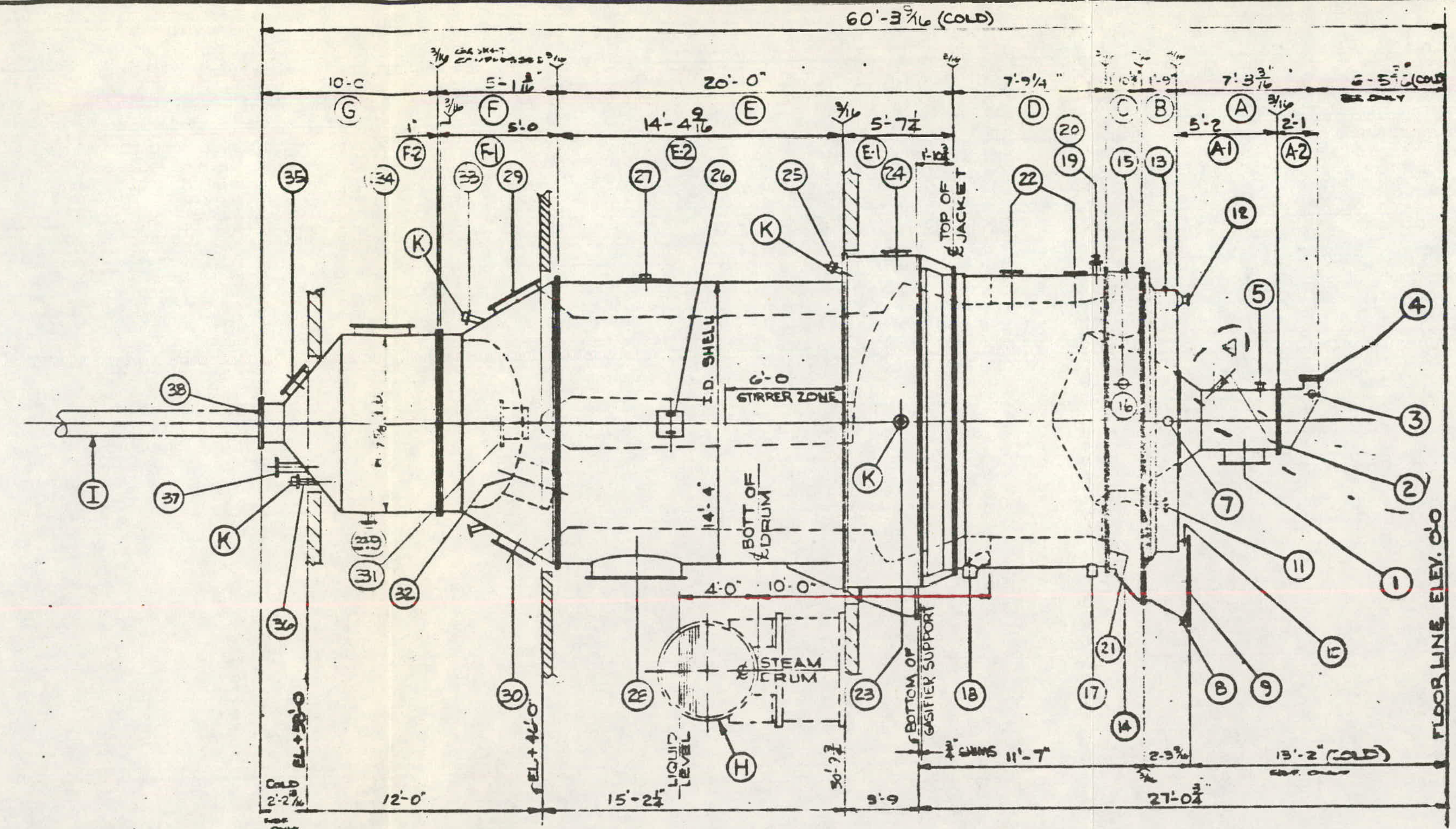
11. Gasifier Refractory (Continued):

11.2 Stirred Gasifiers

Refractory material Spec.	SP-R201/SR5
Refractory installation Spec.	SP-R201/SR4



ORIENTATION PLAN



NOZZLE SCHEDULE

REF.	SIZE	QTY.	SERVICE	FLANGES
(A)	BLAST INLET		ASSEMBLY DWG. M-307	
1	[illegible]	1	BLAST INLET	[illegible] SQ.
2	2" [illegible]	1	THERMOCOUPLE	150# R.F. [illegible]
3	2 ø SCH 40	1	DRAIN	2 FS SCREWED CAP
4	8" x 1'-0"	1	ASH CLEAN OUT	1'-[illegible] x 1'-5½
5	3" ø SCH 40	1	SPARE	150# RF SQ.
(B)	GRATE SUPPORT [illegible]		DWGS. M-312 & M-313	
7	[illegible]	4	INSPECTION PORT	
8	¾" SCH 40	2	WATER INJECTION CONNECTION	¾"-150#
9	3'-9⅛ x 4'-11"	2	ASH DISCHARGE	
10	¾ ø SCH. 40	2	WATER INJECTION CONNECTION	¾"-150#
11	4" ø	4	DRAIN-ASH	4"-125#
12	4" ø	4	DRAIN-ASH	4"-125#
13	½" ø	4	PLUG	
(C)	GRATE SUPPORT CASING		DWG. M-317	
14	1'-1¾ x 1'-9½"	2	ACCESS PORT	
15	½" ø	6	PLUG	
16	6" ø	6	ACCESS PORT	
(D)	WATER JACKET		DWG. M-309	
17	6" ø SCH 40	2	FEED WATER INLET	
18	8" Ø XXS 90° ELL	2	HOT WATER OUTLET	
19	4" ø SCH. 40	2	STOOL FOR 20	150# R.F. SQ.

REF.	SIZE	QTY.	SERVICE	FLANGES
20	1½ ø SCH 40	2	BLOW DOWN	150# [illegible]
21	2 ø	2	DRAIN	2" SCH. [illegible]
22	10" R.F. FLANGE	[illegible]	INSPECTION PORTS	
(E)	GASIFIER SHELL ASSEMBLY		DWG. M-304	
23	3" ø SCH 40	2	PYROMETER PORT	0'-6½" SQ.
24	1'-2 x 1'-10	1	ACCESS PORT	1'-6¾ x 2'-2½
25	3" ø SCH 40	15	RODDING PORT	0'-6⅛ SQ.
26	1'-0 SQ.	4	ACCESS PORT	1'-4 SQ.
27	1'-0 x 2'-6	5	ACCESS PORT	1'-4 x 2'-10
28	4'-6 ø	1	CLEAR GAS	5'-0 O.D.
(F)	GASIFIER LOWER CONE AND DISTRIBUTOR		DWG. M-305	
29	30" ø STD.	1	MAN HOLE	3'-0 O.D.
30	18" ø STD	2	TOP GAS	125# R.F. S.O.
31	24 ø X.S.	1	STIRRER PORT	2'-4 O.D.
32	24 ø	5	COAL DISTRIBUTION	
33	3" ø SCH 40	5	RODDING PORT	0'-6⅛ SQ.
(G)	GASIFIER UPPER CONE		DWG. M-306	
34	30" STD.	1	MAN HOLE	3'-0 O.D.
35	10 SCH. 40	1	COAL INLET	150# R.F. S.O.
36	3" ø SCH. 40	5	RODDING PORT	0'-6⅛ SQ.
37	6" ø SCH. 40	1	COAL LEVEL ALARM	150# R.F. S.O.
38	24 ø X.S.	1	STIRRER SHAFT PORT	2'-4 O.D.

REF.	SIZE	QTY.	SERVICE	FLANGES
39	3" Ø SCH. 40	2	LEVEL SENSOR	150# R.F. SQ.
(H)	GASIFIER STEAM DRUM		DWG M-310	
(I)	GASIFIER STIRRER		DWG. M-315	
(K)	GASIFIER RODDING PORT COVER		DWG. M-336	

UNSTIRRED GASIFIER MAXIMUM OPERATING WT. = 264 TONS
STIRRED GASIFIER MAXIMUM OPERATING WT. = 252 TONS (1)

FOR GASIFIER GENERAL ARRANGEMENT SEE DRAWINGS:
M-302 UNSTIRRED
M-303 STIRRED

BABCOCK CONTRACTORS INC.
A subsidiary of Babcock [illegible]
3001 M300 0
FINAL REVIEW

DATE	BY	CHK	DESCRIPTION	APP.
9-22-78		L.S.	FOR BIDDING	J.C.M.
		L.S.	FINAL REVIEW	
11-[illegible]-78			RELEASED FOR CONSTRUCTION	D.[illegible]

U. S. DEPARTMENT OF ENERGY
FUEL GAS DEMONSTRATION PLANT PROGRAM
SMALL SCALE INDUSTRIAL PROJECT—CONTRACT NO. ET-78-C-01-2578
PREPARED BY McKee ENGINEERS AND CONSTRUCTORS
CLEVELAND — OHIO
4814-D 02-01-2

FOR ERIE MINING COMPANY
PICKANDS MATHER AND CO. MANAGING AGENT
HOYT LAKES — MINNESOTA

COAL GASIFICATION
GASIFIER - COMMON
EXTERIOR VIEW

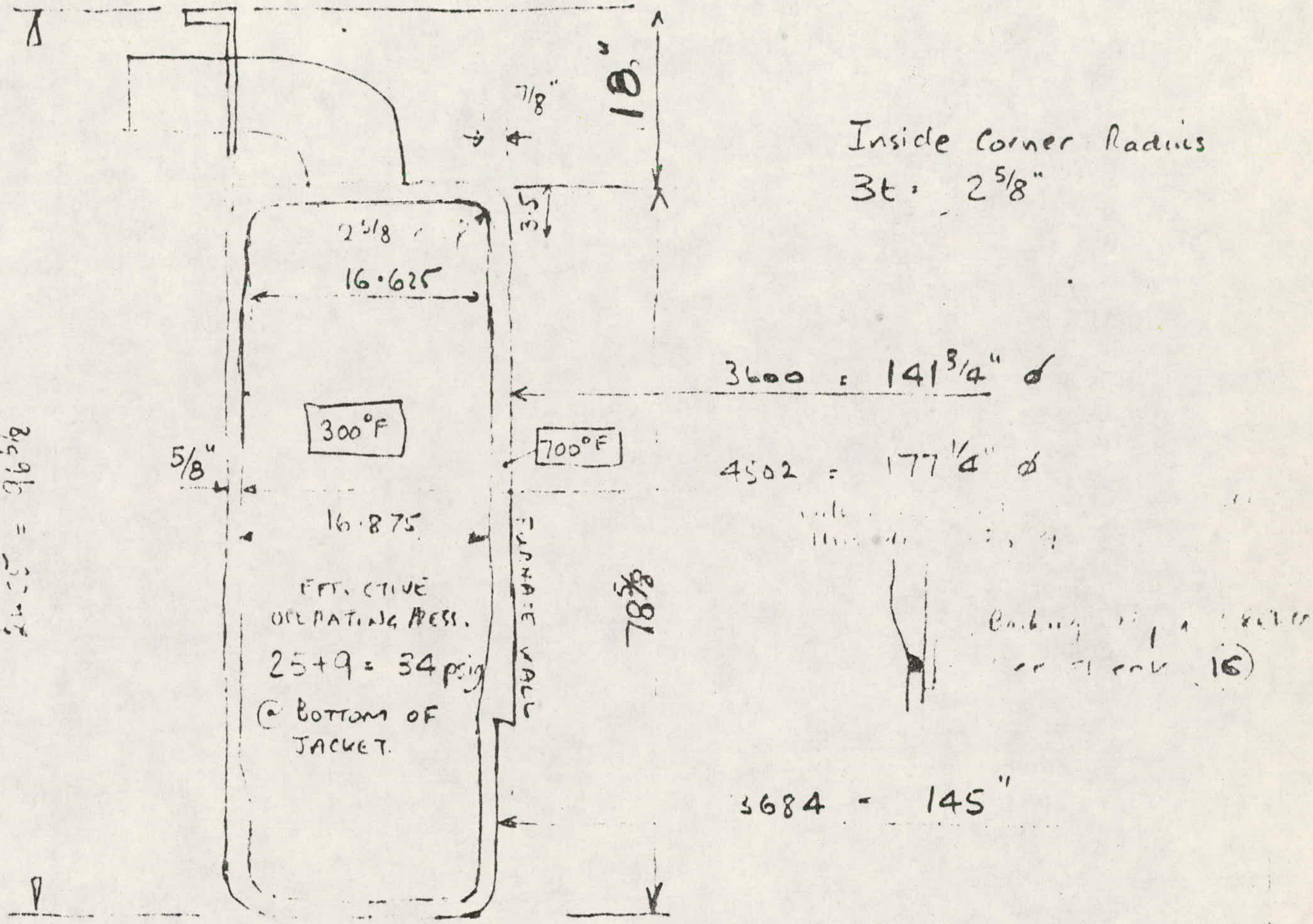
SCALE ¼" = 1'-0
REVISION 1
9

PART 2

BABCOCK CONTRACTORS, INC. SUBJECT CALCULATIONS FOR COOLING WATER JACKET ON GASIFIER

HOLLEY, KENNEY, SCHOTT

SHEET No. 1. OF 21
PROJECT SJ 3001
BY W. [illegible] DATE 6/30/78
CH. .... DATE ....



Shell Length = 79 1/4"

Internal operating pressure = 25 psig @ STEAM DRUM.

Head of liquid from liquid level in steam drum to bottom of gasifier jacket = 20 FT.

∴ External pressure head = $20 \times \frac{62.4}{144}$ = 8.7 psi Say 9 psi.

Material of construction ASTM A 285 Gr. C.

Operating Temp. 300°F

Metal Temperature of Furnace Wall = 700°F

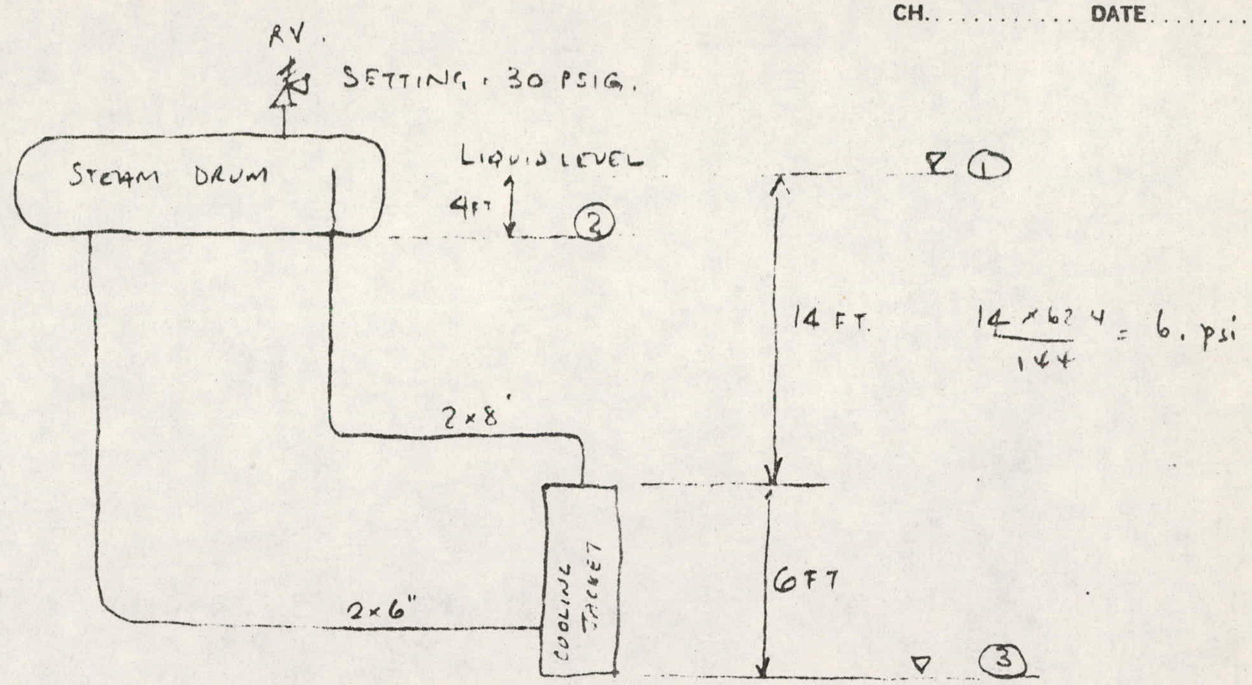
Corrosion allowance. on furnace wall 1/8" outside + 1/16" inside

all other walls 1/16"

BABCOCK CONTRACTORS, INC. SUBJECT ....

HOLLEY, KENNEY, SCHOTT

SHEET No. 2 OF 21
PROJECT SJ 3001
BY [illegible] DATE 6/30/78
CH. .... DATE ....



(1) OPERATING PRESSURE = 25 PSIG. MAWP = 30 PSIG. (RV. setting)

(2) MAWP + LIQUID HEAD = $30 + \frac{4 \times 62.4}{144} = 1.733 = 32$ PSIG.

(3) MAWP + LIQUID HEAD = $30 + \frac{20 \times 62.4}{144} = 38.66 = 40$ PSIG.

USE (2) FOR DESIGN OF STEAM DRUM.
(3) FOR DESIGN OF COOLING JACKET.

1) CALCULATION FOR FURNACE WALL SUBJECT TO EXTERNAL PRESSURE IN ACCORDANCE WITH ASME SECTION I Clause PFT. 16.4

$$p = \frac{57.6}{D}(300t - 1.03L)$$

Where p = Max allowable working pressure psig (MAWP)
t = Corroded thickness ins = 7/8 − 1/8 on fire side − 1/16 on water side
= 11/16 = 0.6875"
L = Length of Furnace Section = 79.25 (Changed to 78.625")
D = Outside Dia of furnace (lower section) = 146.75"

$$\therefore p = \frac{57.6}{146.75}(300 \times 0.6875 - 1.03 \times 79.25) = 48.9 \text{ psi.}$$

The longitudinal and circumferential joints may be fusion welded of the double-welded butt type. Welds are to be post weld heat treated and a bend test of sample welding is required
No radiography is required
Where full radiography has been done then bend test may be eliminated.

Margin between M.A.W.P and operating pressure

= 48.9 − 34 = 14.9 psi

$$\% = \frac{14.9}{34} \times 100 = 43.8\%.$$

The corner stress factor of 1.1 shown on page 5 does not need to be applied here because the above formula is based on elastic stability and not on the yield strength of the material.

(2) CALCULATION FOR JACKET OUTER CYLINDER SUBJECT TO INTERNAL PRESSURE

ASME SECTION I Clause PG 27.2.2.

$$P = \frac{2SE(t-c)}{D-2y(t-c)}$$

where

P = MAWP. psig.

S = M.A. stress at operating temperature of the metal. = 13800 psi (Take water temperature + 15% = 300 + 50 = 350 °F.)

E = Efficiency Take 0.9

t = 5/8" − 1/16" c.a = 0.5625"

D = Outside dia of cylinder = 177 1/4 + 1 1/4 = 178.5"

y = Temperature Coefficient = 0.4.

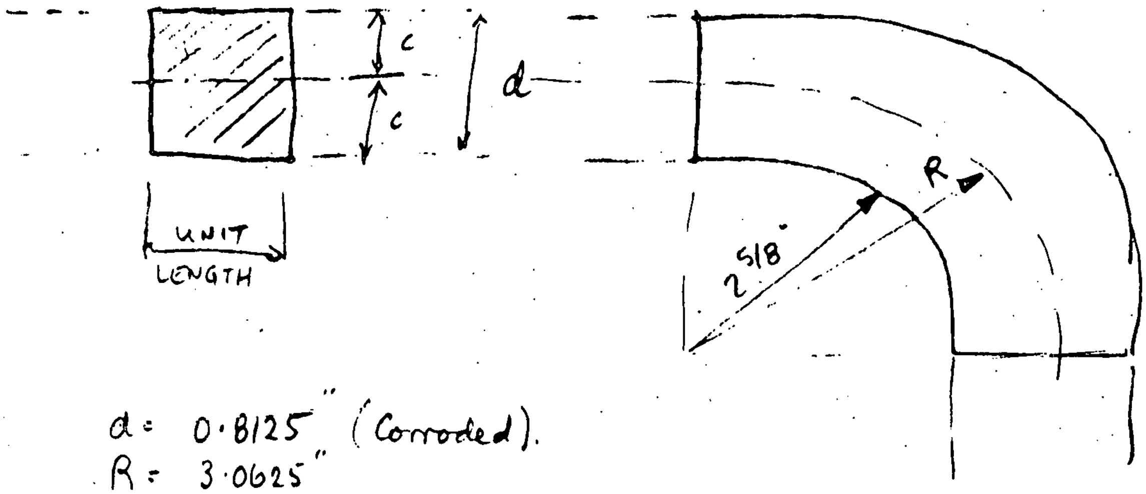
$$\therefore P = \frac{2 \times 13800 \times 0.5625}{178.5 - 2 \times 0.4 \times 0.5625} = \frac{15525}{178.05} = 87.19 \text{ psig.}$$

This will allow material for nozzle reinforcement See sheet No.

The corner stress factor of 1.1 shown on Sheet (5) does not apply here because the corner section is already thicker than the above outer cylinder by a factor of $\frac{0.875}{0.625} = 1.4$

(3) CALCULATION FOR RELATIVE STRESSES IN RADIUSED CORNERS AND STRAIGHT SIDES ON COOLING JACKET.

ADAPTATION OF ROARK "FORMULAS FOR STRESS & STRAIN" TABLE VII Case 1.



$d = 0.8125''$ (Corroded).
$R = 3.0625''$
$c = 0.40625$

$\frac{R}{c} = \frac{3.0625}{0.40625} = 7.54$

$k_i = 1.1$ (Inside)
$k_o = 0.915$ (outside)

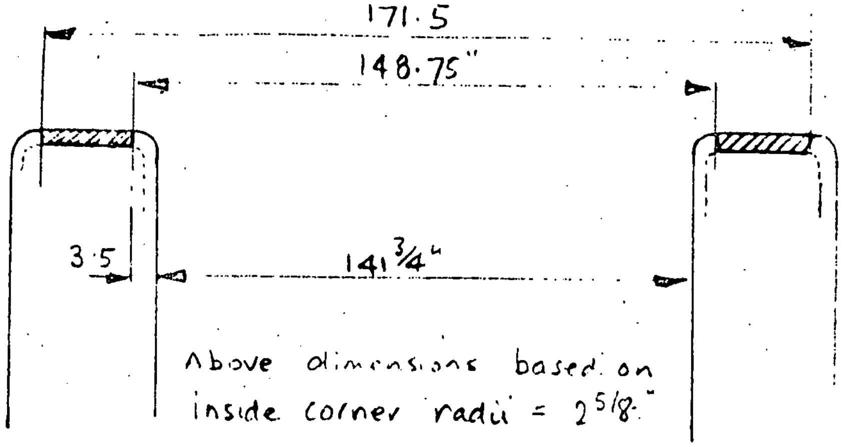
∴ Stress on inside (concave edge) of the corner shall be 1.1 × calculated stress in the straight side of the jacket.

(4) CALCULATION FOR TOP & BOTTOM PLATES OF COOLING JACKET.

FORMULA FROM ROARK "FORMULAS FOR STRESS & STRAIN"
TABLE X. Cases 76 and 77

The edge conditions are taken as being halfway between fixed and simply supported and the correction factor of 1.1 on sheet 5 is to be considered. This is actually conservative as the edge conditions have not been taken as being totally fixed.

Take Top Plate as this is the widest.



$a = \frac{171.5}{2} = 85.75$ $\qquad \frac{a}{b} = \frac{85.75}{74.375} = 1.153$ take as 1.25.

$b = \frac{148.75}{2} = 74.375$.

For Case 76 $\beta = 0.03$; $k_{inner} = 0.1071$; $\qquad$ Case 77 $\beta_{inner} = 0.0205$, $k_{inner} = 0.1051$, $\qquad$ Mean 0.02525, 0.1061

$\text{Stress} = \frac{\beta\, w\, a^2}{t^2}$ $\qquad$ (w = pressure psi. = MAWP)

$t = 0.875 - 0.0625 = 0.8125$.

$\therefore \text{MAWP} = \frac{S \times t^2}{\beta \times a^2}$ $\qquad$ S. allowable stress $= \frac{13800}{1.1} = 12545$ lb/sq.

$\text{MAWP} = \frac{12545 \times 0.8125^2}{0.02525 \times 85.75^2} = 44.60$ psig.

BABCOCK CONTRACTORS, INC. SUBJECT

HOLLEY, KENNEY, SCHOTT

SHEET No. 7. OF 21
PROJECT SJ3001
BY Whubb DATE 6/30/78
CH. DATE

(4) CONTINUED.

Edge Shear/linear inch. = kwa. = 0.1061 x 40 x 8575
= 364 lb/sqin.

See also calculation on sheet No. 9.

(5) CALCULATION FOR NOZZLE REINFORCEMENT.
ASME SECTION I Clause PG-36.
NOZZLES IN COOLING JACKET OUTER SHELL.

2 × 4" NB Stools for blowdown nozzle
2 × 6" NB water inlets

Nominal shell thickness = 5/8" - 1/16" corrosion allowance = 0.5625"

(i) 6" N/B CONNECTION

Area of reinforcement reqd = A = d × tr × F

d: dia of hole in shell (ignore reinforcement provided by Nozzle wall)

d = 6.625"

tr = required thickness of seamless shell. (see also sheet 4)

$$t_r = \frac{PD}{2SE + 2yP}$$ where P = 40 psig.
D = 178.5
S = 13800
E = 1.0
y = 0.4.

$$t_r = \frac{40 \times 178.5}{2 \times 13800 + 2 \times 0.4 \times 40} = 0.258''$$

F = 1

A = 6.625 × 0.258 × 1 = 1.71 sq ins.

Area available for reinforcement.
The larger of

$$A_1 = (E_1 t - F t_r) d \qquad (E_1 = 1, \; F = 1)$$

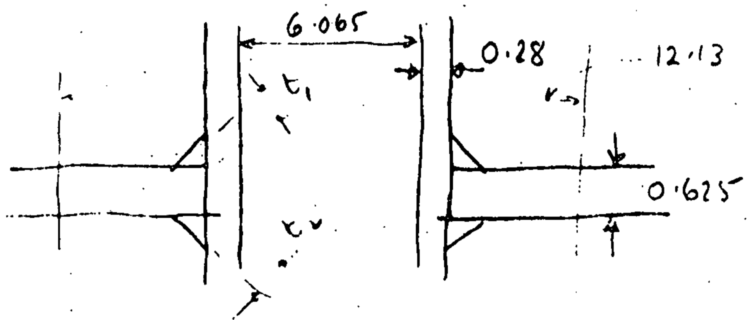
$$A_1 = (0.5625 - 0.258) \times 6.625 = 2.017$$

$$A_1 > A.$$

No additional reinforcement is required.

The same conclusion also applies to the 4" NB connection.

Weld Strength calculation



PW-16.1 $\quad t_{min} = 0.28$

$t_1 + t_2 = 1\tfrac{1}{4} t_{min} \qquad 1\tfrac{1}{4} t_{min} = 0.35$

t_1 or t_2 not less than $\tfrac{1}{4}$" or $0.7 t_{min}$

$\therefore t_1 = 0.25$, $t_2 = 0.25$ } 0.5

Fillet size $= 0.25 \times \sqrt{2} = 0.353$"

Example see A68.

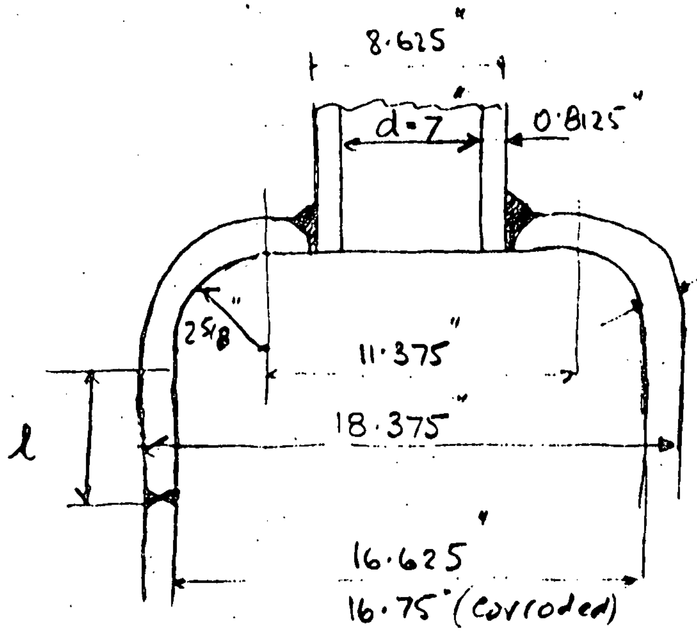
Load to be carried by weld =

$$W = [(6.625 \times 0.258) - (12.13 - 6.625)(0.625 - 0.258)]\, 13800$$

$$[1.70925 - (5.505)(0.367)]\, 13800$$

Because the shell is more than 2x required thickness the above answer is negative indicating no need for checking any further

(6) CALCULATION FOR NOZZLE REINFORCEMENT IN TOP PLATE



8" NB × sch XXS Long R. Elbow.
0.875 wall thickness (0.8125 corroded)
See below

$t = 0.875 - 0.0625 = 0.8125$

From clause PG. 31.3.3.

$$t_r = d\sqrt{\frac{ZCP}{S}}$$

$$= 16.75\sqrt{\frac{2.5 \times 0.25 \times 40}{13800}} = 0.7129''$$

From PG 35.2.
Area required to be compensated

$$A = 0.5d \times t_r = 0.5 \times 7 \times 0.7129 = 2.495 \text{ sq in}$$

The two 8" Nozzles will feed into 1-10" line.

Bore of 10" sch 40 line = $10.75 - 2 \times 0.365 = 10.02''$ $\quad 10.02^2 = 100.4$

Bore of 8 sch XXS $= 8.625 - 2 \times 0.875 = 6.875$ $\quad 6.875^2 \times 2 = 95.5$

Flow areas more or less equal. So should be OK

Area available For Reinforcement.

$X = 2d = 2 \times 7 = \boxed{14''}$ ← This one.

or $d + 2(t + t_n) = 7 + 2(0.8125 + 0.8125)$
$= 10.25.$

$Y = 2\frac{1}{2} t$ or $2\frac{1}{2} t_n$ both are Same in this case

$= 2\frac{1}{2} \times 0.8125 = \boxed{2.03''}$

Since The allowable stress for A106A nozzles is less than for plate. the area to be compensated shall be increased as follows.

$$A = 2.495 + (0.7129 \times 2 \times 0.8125)\left(1 - \underbrace{\frac{12000}{13800}}_{0.1304}\right)$$

$$2.495 + 0.151 = \boxed{2.646 \text{ sq in}}$$

Area Provided.

(in Shell) $A_1 = (E_1 t - F t_r) d$

$= (1 \times 0.8125 - 1 \times 0.7129)\, 7 = \boxed{0.6972 \text{ sq in}}$

or $2(E_1 t - F t_r)(t + t_n) =$

$2(1 \times 0.8125 - 1 \times 0.7129)(2 \times 0.8125) = 0.3237 \text{ sq in}$

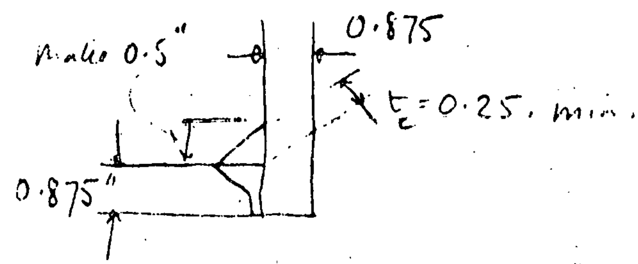
$$t_{rn} = \frac{PD}{2SE + 2yP} = \frac{40 \times 8.625}{2 \times 12000 \times 1 + 2 \times 0.4 \times 40} = 0.0143''$$

$A_2 = (t_n - t_{rn})\,5t = (0.8125 - 0.0143)\,5 \times 0.8125 = \boxed{3.242 \text{ sq in.}}$

$A_1 + A_2 = 0.6972 + 3.242 = \boxed{3.9392 \text{ sq in}}$

$3.9392 > 2.646$ so no further reinforcement is required.

<u>Weld size.</u> Fig PW.16.1



not less than smaller of 1/4" or 0.7 t_{min}

∴ use 0.25"

see Example A68

Load to be carried by weld.

$$W = \left[(8.625 \times 0.7129) - (14 - 8.625)(0.875 - 0.7129)\right] \times 13800$$

$$\left[6.149 - (5.375)(0.1621)\right] \times 13800$$

$$W = 5.277 \times 13800. = 72822 \text{ lb.}$$

Allowable unit stresses

Shear in fillet weld = $0.49 \times 12000 = 5880$ psi

Tension in groove weld = $0.74 \times 13800 = 10,212$.

Nozzle wall in Shear = $0.70 \times 12000 = 8400$.

Strength of Connection Elements:

(A) Fillet weld - shear.

$1.57 \times 8.625 \times 0.5 \times 5880 = 39811$ lb.

(B) Groove weld - tension on a 8.625 dia

$1.57 \times 8.625 \times 0.875 \times 10212 = 120{,}997$ lb.

(C) Groove weld - tension on $8.625 + 2 \times 0.5 = 9.625$ dia.

$1.57 \times 9.625 \times 0.875 \times 10212 = 135{,}026$ lb.

(D) Nozzle - shear.

$1.57 \times (8.625 + 7.125) \tfrac{1}{2} \times 0.875 \times 8400 = 90{,}873$ lb.

Possible path of failure

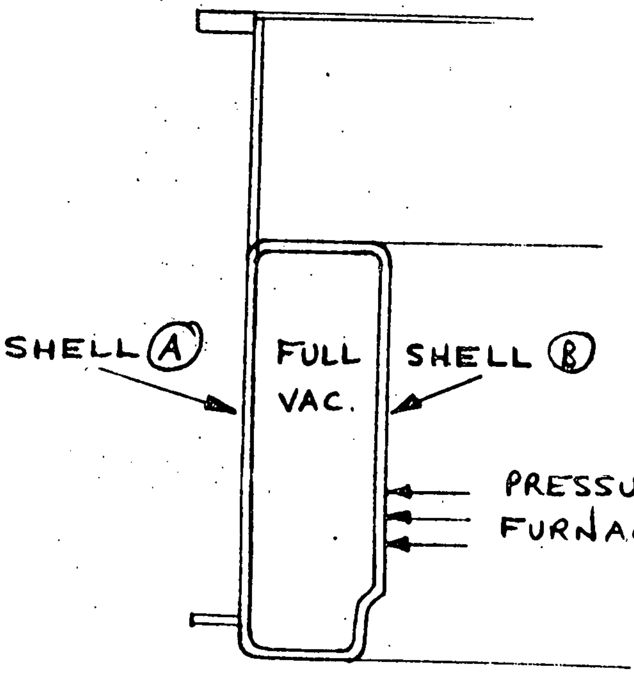
(1) Thro (A) & (B) total strength = $39811 + 120{,}997 = \underline{160808}$ lb

(2) Thro (C) strength $\underline{135{,}026}$ lb.

(3) Thro (A) & (D) total strength $39811 + 90873 = \underline{130684}$ lb

All paths are stronger than required strength of $\underline{72822}$ lb

Check on Cooling Water Jacket for full vacuum.



Outer Shell (A) subject to external pressure = 15 lb/□"

Inner Shell (B) subject to internal pressure = 19·3 lb/□"

Outer Shell (A) As stated for steam drum, there is no formula in ASME I for boilers under external pressure (the code only covers for furnace walls under external pressure)

Therefore it is proposed to use ASME VIII D.V. 1 Section UG 28.

∴ From Section UG 28

$t = \cdot 625'' - \cdot 0625''$ corrosion allowance $= \cdot 5625''$

$L = 6' 6\frac{5}{8}'' - 1\frac{3}{4}'' - 5\frac{1}{4}'' + (3\frac{1}{2} \times \frac{2}{3}) = 73 \cdot 96''$

$D_o = 14' 10'' = 178''$ $D_o/t = 316$ $L/D_o = \cdot 415$

From Fig UGO. 28.0, $A = \cdot 0006$

From Fig UCS. 28.2, $B = 8300$

(ASTM A285 Gr. C Yield = 30,000 lb/□")

Then $P_a = \dfrac{4B}{3(D_o/t)} = \dfrac{4 \times 8300}{3 \times 316} = \underline{\underline{35 \cdot 02 \text{ lb/□}''}}$

Since 35·02 lb/□" > 15 lb/□", Outer Shell (A) is adequate

Inner Shell (B)

From ASME I Section PG 27.2.2.

$P = \dfrac{2SE(t-c)}{D - 2y(t-c)}$

$= \dfrac{2 \times 13300 \times \cdot 9 \times \cdot 6875}{(143 \cdot 5) - 2 \times \cdot 4 \times \cdot 6875}$

$= \underline{\underline{115 \text{ lb/□}''}} > 19 \cdot 3 \text{ lb/□}''$

where P = MAWP.
S = allowable stress at 700°F = 13300 lb/□"
E = 0·9
y = 0·4
$(t - c) = \cdot 875'' - \cdot 1875''$ corrosion all
$= \cdot 6875''$
D = 141·75 + 1·75
= 143·5"

∴ Inner Shell is adequate

To Check reinforcement required on 6" N/Bore Feed Water Inlet Nozzle on Jacket Outer Wall for Extenal Pressure to ASME VIII Div.1

From Section UG 37,

Cross Sectional Area of compensation required

$= A = \frac{d \times t_r \times F}{2}$ where $d = 6{\cdot}625 - (2 \times {\cdot}2175)$ corroded

$= 6{\cdot}19''$

$F = 1$

t_r = thickness required for extenal pressure to Section UG28.

Actual thickness = ·5625" corroded.

$\therefore$ Let $t_r = 2/3 \times {\cdot}5625'' = {\cdot}375''$ as first try

$D_o = 14'\text{-}10'' = 178''$ $L = 73{\cdot}96''$ (See Sheet "R")

$D_o/t_r = 475$ $L/D_o = {\cdot}415$

From Fig UGO 28.0, $A = {\cdot}00032$

From Fig UCS 28.2, $B = 4400$

Then $Pa = \frac{4B}{3\,D_o/t_r} = \frac{4 \times 4400}{3 \times 475} = \underline{12{\cdot}35\ lb/\square''}$

TOO LOW

$\therefore$ Let $t_r = \underline{\cdot 405''}$ $\quad D_o/t_r = 439{\cdot}5 \quad L/D_o = 73{\cdot}96$

Then from Fig. UG0 28.0, $A = {\cdot}00037$

From Fig. UCS 28.2, $B = 5100$

$$P_a = \frac{4 \times 5100}{3 \times 439{\cdot}5} = \underline{\underline{15{\cdot}47 \text{ lb}/\square''}} \text{ JUST OK.}$$

Required thickness of nozzle wall $= t_{rn}$

$= \dfrac{PR}{S}$ (As Sheet E) where $P = 15 \text{ lb}/\square''$
$R = 3{\cdot}20375''$
$S = 12{,}000 \text{ lb}/\square''$

$$= \frac{15 \times 3{\cdot}20375}{12000} = \underline{{\cdot}004''}$$

Cross Sectional Area of Compensation required

$$= A = \frac{d \times t_r \times F}{2} = \frac{6{\cdot}19 \times {\cdot}405 \times 1}{2} = \underline{\underline{1{\cdot}253 \text{ sq. ins.}}}$$

Area available in shell for compensation $= A_1$

= greater of

1) $(E_1 t - F t_r) d$ where $E_1 = F = 1$

$$= ({\cdot}5625 - {\cdot}405)\,6{\cdot}19 = \underline{{\cdot}975 \text{ sq ins}}$$

or 2) $2(E_1 t - F t_r)(t + t_n)$ where $t_n = {\cdot}2175''$

$$= 2({\cdot}5625 - {\cdot}405)({\cdot}5625 + {\cdot}2175) = \underline{{\cdot}246 \text{ sq ins}}$$

$\therefore$ ·975 sq ins is available.

Area available in nozzle for compensation $= A_2$

= smaller of

1) $(t_n - t_m)\,5t$ where $t_m = \cdot 004''$

$= (\cdot 2175 - \cdot 004)(5 \times \cdot 5625)$

$= \cdot 600$ sq ins.

or 2) $(t_n - t_m)(5t_n + 2t_e)$ where $t_e = 0$ (assumed)

$= (\cdot 2175 - \cdot 004)(5 \times \cdot 2175)$

$= \cdot 232$ sq ins.

$\therefore$ ·232 sq ins is available.

Area available from nozzle inside jacket $= A_3$

$= (t_n - c)\,2h$ where $h =$ smaller of $2\cdot 5t$ or $2\cdot 5t_n$

$= (\cdot 2175 - \cdot 0625)(2 \times \cdot 544)$ $\quad = 2\cdot 5 \times \cdot 2175 = \cdot 544''$

$= \cdot 169$ sq ins $\quad$ (Actual max h available $= 14'' - 6'' - 5/8'' - 6\,5/8'' = \cdot 75''$)

Ignoring area available in welds,

Total area available $= A_1 + A_2 + A_3$

$= \cdot 975 + \cdot 232 + \cdot 169 = 1\cdot 376$ sq ins $> 1\cdot 253$ sq ins.

∴ No further compensation is required.

BABCOCK CONTRACTORS, INC. SUBJECT MAWP & RV Setting For Steam Drum and Cooling Jacket. SHEET No. 20 OF 21

PROJECT SJ 3001.

HOLLEY, KENNEY, SCHOTT BY WG/BBS DATE 7/27/78

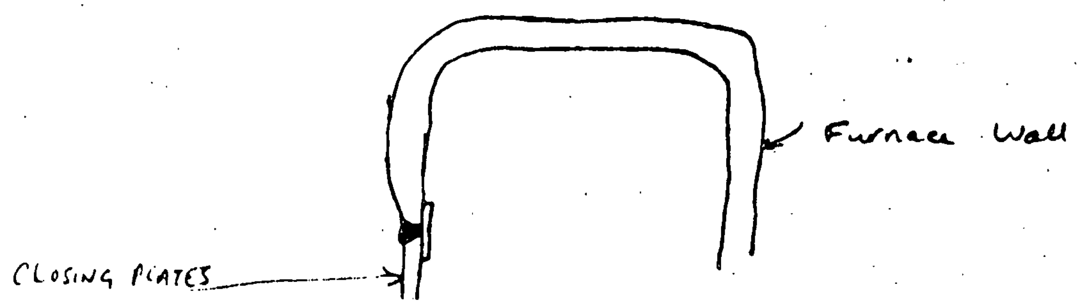
CH. DATE

Maximum allowable pressure shall be calculated for both Steam Drum and the Cooling Jacket. and the relief valve settings shall be set at the MAWP determined for each item or a figure below the MAWP providing there is sufficient margin between the operating pressure and the RV setting to prevent it opening during normal operation.

Conclusion the MAWP for system is 30 psig.

NOTE RE CONSTRUCTION OF CLOSING SEAM

For closing seams the construction is too large to ensure good root gap set up with TIG root run and therefore closing seams should be done using a backing strip as shown on GREFCO drawings.



6

DESIGN DATA

300'

1. CODE STAMP	ASME SECTION I CODE SYMBOL S
OTHER SPECS.	BCI SPECN NO R201/PV
DESIGN PRESS. @ TEMP.	40 (NOTE 1) PSIG @ SEE NOTE 2 °F
OPER. PRESS. @ TEMP.	25 PSIG @ SEE NOTE 3 °F
CODE NAME PLATE	YES
STRESS RELIEVING	YES
RADIOGRAPHING	100% ALL MAIN LONG'L & CIRC'L BUTT WELDS
JOINT EFFICIENCY	SHELL 90 % HEADS 90 %
NOM. CORR. ALLOWANCE	OUTER SHELL 1/16 INNER SHELL HEADS 3/16" NOZZLES 1/16"
MAX. ALLOW. PRESS. (New & Cold)	30 PSIG
(a) MAX. ALLOW. PRESS. LIMITED BY	NOZZLE REINFORCEMENT
HYDROS. TEST PRESS.	SHOP 51 PSIG FIELD 45 (SEE NOTE 4) PSIG

MATERIAL SPECIFICATIONS

(a) SHELL	ASTM A 285 GR. C
(b) HEADS	
(c) LINING	--
(d) SKIRT AND/OR SADDLES	SEE NOTE (5)
(e) BASE PLATE & CHAIRS	
(f) NOZZLE NECKS & PIPE	ASTM A106 GR A
(g) FLANGES	ASTM A105
(h) COUPLINGS (Screwed/Socket Weld)	
(j) GASKETS	1/16" C.A.F
(k) BOLTS (External)	ASTM A193. B7. (NUTS 2H)
(l) BOLTS (Internal)	—
(m) INTERNALS (Except as Noted)	—
~~(n) TRAYS~~	—
~~(p) CAPS~~	

M.H. & H.H. FURN. W/BLIND FLG. STUDS & GASKET YES

INSUL. OR FIREPROOFED SKIRTS TO HAVE SLEEVED OPNG.

FIREPROOFING (By Others)	INSIDE SKIRT	THK.	MATERIAL	SQ. FT.
	OUTSIDE SKIRT	THK.		

INSULATION (By Others) 4" THK. SQ. FT.

PAINT SHOP PRIMER

INSPECTED BY CUSTOMER ~~& LITWIN~~

WEIGHTS

~~(a) TRAYS~~	FURN. BY		
	INSTALLED BY —		LBS.
(b) CAPS	FURN. BY —		
	INSTALLED BY —		LBS.
~~(c) EST. VESSEL FABR. (Less Trays & Caps)~~			LBS.
(d) EST. VESSEL EMPTY (Less Oper. Liquid)			LBS.
(e) EST. VESSEL OPERATING			LBS.
(f) EST. VESSEL FULL OF WATER			LBS.

NOTES

(1) DESIGN PRESSURE INCLUDES LIQUID HEAD FROM ASSOCIATED STEAM DRUM. DESIGN ALSO FOR FULL VACUUM.

(2) INNER SHELL DESIGN TEMPERATURE 700°F, OTHER COMPONENTS OF JACKET DESIGN TEMPERATURE 350°F

(3) INNER SHELL OPERATING TEMPERATURE 600°F, OTHER COMPONENTS OF JACKET OPERATING TEMPERATURE = 267°F

(4) SHOP TEST PRESS MEASURED AT TOP OF JACKET. SITE TEST MEASURED AT TOP OF STEAM DRUM. HYDROSTATIC TESTS SHALL BE CARRIED OUT USING WATER AT 70°F MIN.

(5) BOLT HOLES IN FLANGES TO STRADDLE NATURAL C/L.

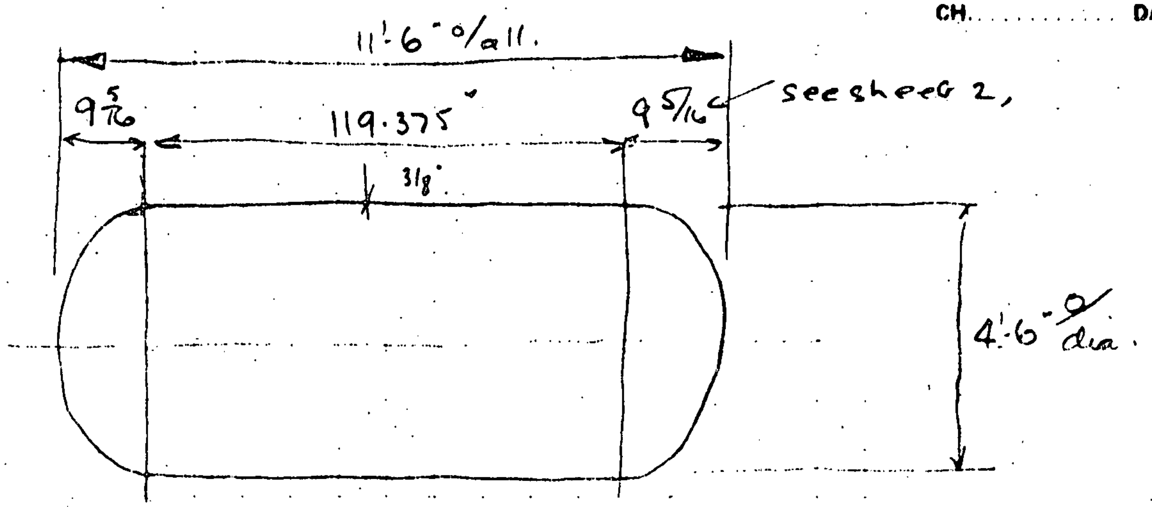
(6) DESIGN, FABRICATION & TESTING TO BE IN ACCORDANCE WITH ASME CODE SECTION I AND BCI SPEC R201/PV.

(7) WELDING SHALL BE IN ACCORDANCE WITH ASME IX. FABRICATOR TO PROVIDE WELDING PROCEDURES FOR BCI APPROVAL.

SH. 21 OF 21

6/30/

COOLING JACKET ON GASIFIER



Operating Pressure = 25 psig. and Full Vacuum,
Operating Temperature : 265°F.
Material ASTM. A 285 grade C. Allowable Stress @ 350°F = 13800.
Corrosion Allowance 1/16"
Design Temperature. 350°F
Design Code ASME Section I.
Min wall thickness (PG 16.3) = 1/4"
MAWP (governed by gasifier jacket) = 32 psig. at bottom of drum (30 psig at top of drum)

① CALCULATION FOR INTERNAL PRESSURE. (CYLINDRICAL SHELL). (Clause PG 27.2.2)

$$P = \frac{2SE(t-c)}{D-2y(t-c)}$$

p = MAWP. psig.
S = 13800 lb/sq in
E = 0.9
$t-c$ = 5/16" − 1/16" = 1/4"
D = 54"
y = 0.4.

$$\text{MAWP } P = \frac{2 \times 13800 \times 0.9 \times 0.25}{54 - 2 \times 0.4 \times 0.25} = 115.4 \text{ psig.}$$

As 115.4 is over three times the MAWP reqd. then no additional reinforcement will be required for nozzles.

(2) CALCULATION FOR DISHED ENDS. PG-29.

$$t = \frac{5PL}{4.8SE}$$

where P = 32 psig.
L = 54"
S = 13800
E = 0.9

$$t = \frac{5 \times 32 \times 54}{4.8 \times 13800 \times 0.9} = 0.145''$$

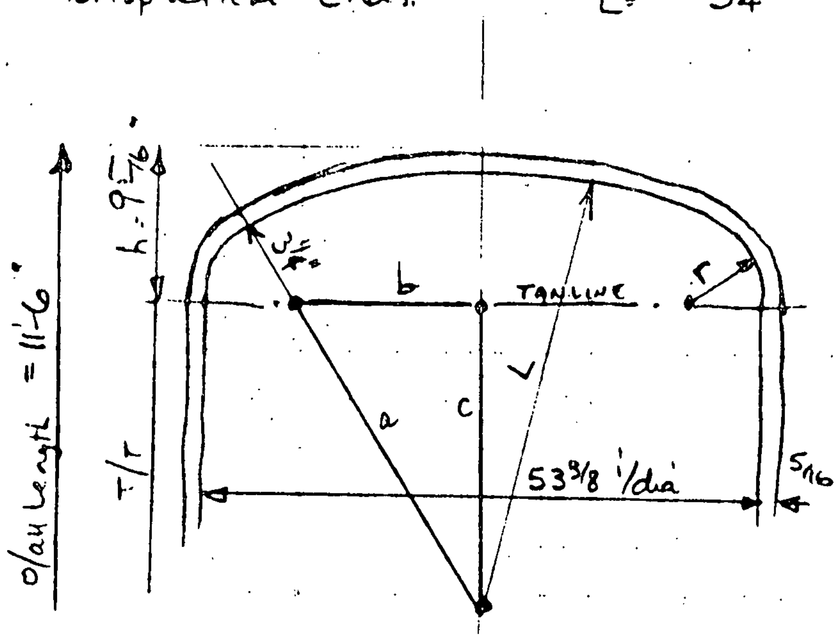
(Make t = same as for shell = 0.25" corroded.)

PG29.9.
With pressure on convex side side (full Vacuum)
Max allowable external pressure

$$MAWP_{(Ext)} = \frac{0.6 \times 0.25 \times 4.8 \times 13800 \times 0.9}{5 \times 54} = \underline{33.12}$$

OK

Torispherical Ends. L = 54" r = 6% × 54 = 3¼"
(minimum it may be greater)



$b = \frac{53^{3}/_{8}}{2} - 3^{1}/_{4} = 23.4375''$

$a = L - r = 54 - 3^{1}/_{4} = 50^{3}/_{4}''$

$c = \sqrt{a^2 - b^2}$
$= \sqrt{50.75^2 - 23.4375^2}$
$\sqrt{2575.563 - 549.32}$

$c = 45'$

$\therefore h = (L - c) + t$
$= 54 - 45 + 0.3125$
$= 9^{5}/_{16}''$

<u>Calculation for Steam Drum under Full Vacuum.</u>

There is no formula in ASME I for boilers under external pressure (The code only covers for Furnace Walls under external pressure)

It is proposed therefore to check this condition to ASME VIII Div. 1 1977, Section UG28 (Summer 1978 Addenda).

<u>From Section UG28,</u>

$t = \cdot 3125''$ corroded
$L = 126 \cdot 208''$ $(120'' + 2/3 \times 9\,5/16)$
$D_o = 54''$
$p = 15$ lb/□" $\quad D_o/t = 172 \cdot 8 \quad L/D_o = 2 \cdot 337$

Specified Minimum Yield for ASTM A285 Gr. C. = 30,000 lb/□"

From Fig. UGO. 28.0., $A = \cdot 00025$

From Fig. UCS 28.2, $B = 3500$ for Design Temp. $= 350°F$

Then $P_a = \dfrac{4B}{3\,D_o/t} = \dfrac{4 \times 3500}{3 \times 172 \cdot 8} = \underline{\underline{27 \text{ lb/□}''}}$

i.e. Barrel Thickness is adequate for full vacuum.

To Check reinforcement required on nozzles for external pressure of full vacuum.

A) HEAD MANWAY

From ASME VIII Div 1 UG 37,

Total Cross Sectional Area required $= A = \dfrac{d \times t_r \times F}{2}$

where $F = 1$ $d = 20'' - (2 \times 3/16'') = 19.375''$

t_r = wall thickness required for external pressure.

Since t_r is in spherical portion

From Section UG 33 c & Section UG 28 d

✱Assume $t_r = .125''$ Then $R_o/t_r = \dfrac{54.375}{.125} = 435$

$A = \dfrac{.125}{R_o/t_r} = \dfrac{.125}{435} = .00029$

From Fig UCS 28.2, $B = 4100$

Then $P_a = \dfrac{B}{R_o/t_r} = \dfrac{4100}{435} = \underline{\underline{9.42 \text{ lb}/\square''}}$

TOO LOW.

If $t_r = 2/3$ actual thickness of shell $= 2/3 \times 5/16$ (corroded) $= .208''$

$R_o/t_r = \dfrac{54.375}{.208} = 261.4$ & $A \ \dfrac{.125}{261.4} = .00048$

35

From Fig UCS 28.2, $B = 6750$

$$\therefore P_a = \frac{6750}{261 \cdot 4} = \underline{\underline{25 \cdot 8 \text{ lb}/\square''}}$$

i.e. Since 2/3 actual thickness is more than adequate for external pressure, remaining 1/3 thickness is more than adequate for compensation.

B) <u>SHELL NOZZLE "C"</u> (10" N/Bore)

Total Cross Sectional Area required $= A = \frac{d \times t_r \times F}{2}$

where $F = 1$ $d = 10 \cdot 75'' - (2 \times \cdot 3025) = 10 \cdot 145''$

t_r = wall thickness required for external pressure

From Section UG 28 c.

* Let $t_r = \cdot 125''$ corroded Then $D_o/t_r = \frac{54}{\cdot 125} = 432$

$$L/D_o = \frac{126 \cdot 208}{54} = 2 \cdot 337$$

Then from Fig UGO 28.0, $A = \cdot 000062$

From Fig UCS 28.2. A falls to left of curves.

$$\text{Then } P_a = \frac{2AE}{3(D_o/t_r)} = \frac{2 \times \cdot 000062 \times 28 \cdot 5 \times 10^6}{3 \times 432}$$

$$= 2 \cdot 73 \text{ lb}/\square'' \text{ TOO LOW}$$

$L/D_o = \frac{126.208}{54} = 2.337$

If $t_r = 2/3$ actual thickness $= .208"$

$D_o/t_r = \frac{54}{.208} = 259.6$ then $A = .00013$ from Fig UGO 28.0

From Fig UCS 28.2, A falls to left of curves.

Then $P_a = \frac{2AE}{3(D_o/t_r)} = \frac{2 \times .00013 \times 28.5 \times 10^6}{3 \times 259.6}$

$= \underline{\underline{9.51\ lb/\square"}}$

∴ Since t_r is more than $2/3 \times$ actual corroded thickness, there will not be adequate excess area in the shell for compensation.

Let $t_r = .250"$ $D_o/t_r = \frac{54}{.25} = 216$

From Fig UGO 28.0, $A = .000175$

From Fig UCS 28.2, A falls to left of curves.

Then $P_a = \frac{2AE}{3(D_o/t_r)} = \frac{2 \times .000175 \times 28.5 \times 10^6}{3 \times 216}$

$= 15.39\ lb/\square"$ JUST O.K.

∴ Area of compensation required $= \frac{d \times t_r \times F}{2}$

$= \frac{10.145 \times .250}{2} = \underline{\underline{1.268\ sq\ ins}}$

BABCOCK CONTRACTORS INC.

Calculation sheet E

Project/Contract No 3001 Subject Gas.fyer Steam Drum
Calculated by JR)den Approved by [illegible] date 19/2/79 Sheet 7 of 19

To determine t_m (required nozzle thickness)

At junction with vessel wall, nozzle will not collapse due to vacuum, since it is effectively restrained by vessel wall over that length which is considered to be available for reinforcement.

$\therefore$ Let t_m be thickness required for Circumferential Membrane Stress

Then from Roark – "Formulas for Stress and Strain" Table XIII Formula 1,

Circumferential Membrane Stress $= S_2 = \frac{pR}{t_m}$

$\therefore t_m = \frac{pR}{S}$ where $p = 15$ lb/□" $R = 5{\cdot}22375$" mean corroded

$S = 12{,}000$ lb/□" for A106 Grade A

$$= \frac{15 \times 5{\cdot}22375}{12000}$$

$$= \underline{\underline{{\cdot}00653"}} = t_m$$

Area available in shell = A_1 = greater of

1) $(E_1 t - F t_r) d$ where $E_1 = F = 1$ $t = \cdot 3125''$
$t_r = \cdot 250''$

$= (\cdot 3125 - \cdot 250)\ 10\cdot 145$

$= \underline{\underline{\cdot 634 \text{ sq ins}}}$

or 2) $2(E_1 t - F t_r)(t + t_n)$ where $t_n = \cdot 3025''$ corroded.

$= 2(\cdot 3125 - \cdot 250)(\cdot 3125 + \cdot 3025) = \underline{\underline{0\cdot 0770 \text{ sq ins}}}$

$\therefore$ $\underline{\cdot 634 \text{ sq ins is available}}$

Area available in nozzle = A_2 = smaller of

1) $(t_n - t_{rn})\, 5t$ where $t_{rn} = \cdot 00653''$ $t_n = \cdot 3025''$ corroded

$= (\cdot 3025 - \cdot 00653)\, 5 \times \cdot 3125$

$= \underline{\underline{\cdot 462 \text{ sq ins}}}$

or 2) $(t_n - t_{rn})(5t_n + 2t_e)$ where $t_e = 0$ (assumed).

$= (\cdot 3025 - \cdot 00653)\, 5 \times \cdot 3025$

$= \underline{\underline{\cdot 448 \text{ sq ins}}}$ $\therefore$ $\underline{\cdot 448 \text{ sq ins is available}}$.

Area available in nozzle inside vessel = A_3

$= (t_n - c)\, 2h$ where h = smaller of $2\cdot 5t$ & $2\cdot 5t_n$

$= 2\cdot 5 t_n = \cdot 756''$

$\therefore A_3 = (\cdot 3025 - \cdot 0625) \cdot 756 = \underline{\cdot 181 \text{ sq ins}}$

$\therefore$ Ignoring welds, Area available for compensation

$= A_1 + A_2 + A_3 = \cdot 634 + \cdot 448 + \cdot 181 = \underline{\underline{1 \cdot 263 \text{ sq ins}}}$

Since $1 \cdot 263 < 1 \cdot 268$ sq ins required,

add weld area $= A_4 = \dfrac{4 \times \cdot 3315^2}{2} = \underline{\cdot 2198 \text{ sq ins}}$.

$\therefore$ Total Area available $= 1 \cdot 263 + \cdot 2198 = \underline{\underline{1 \cdot 483 \text{ sq ins}}}$

$> 1 \cdot 248$ sq ins.

$\therefore$ No further compensation is required.

c) <u>SHELL NOZZLE "B"</u> (8" N/Bore)

Total Cross Sectional Area required $= A = \dfrac{d \times t_r \times F}{2}$

where $t_r = \cdot 250''$, $F = 1$, $d = 8 \cdot 625 - (2 \times \cdot 2595)$ corroded

$= 8 \cdot 106''$

$\therefore A = \dfrac{8 \cdot 106 \times \cdot 250 \times 1}{2} = \underline{\underline{1 \cdot 013 \text{ sq ins}}}$

To determine required nozzle wall thickness t_m.

As for 10" N/Bore nozzle on Sheet "E", t_m can be determined

from $t_m = \frac{pR}{S}$ where $p = 15\ lb/\square''$ $R = 4{\cdot}18275''$ mean corroded

$S = 12000\ lb/\square''$ for A106 Gr. A.

$$t_m = \frac{15 \times 4{\cdot}18275}{12000} = \underline{\underline{{\cdot}00523''}} = t_m$$

Then area available in shell for compensation

$= (E_1 t - F t_r)\ d$ where $E_1 = F = 1$

$= ({\cdot}3125 - {\cdot}250)\ 8{\cdot}106 = \underline{{\cdot}507\ \text{sq ins.}}$

Area available in nozzle $= A_2 =$ smaller of

1) $(t_n - t_m)\ 5t$ where $t_n = {\cdot}2595''$ & $t_m = {\cdot}00523''$

$= ({\cdot}2595 - {\cdot}00523)\ 5 \times {\cdot}3125 = \underline{{\cdot}397\ \text{sq ins}}$

or 2) $(t_n - t_m)(5t_n + 2t_e)$ where $t_e = 0$ (assumed)

$= ({\cdot}2595 - {\cdot}00523)(5 \times {\cdot}2595) = \underline{{\cdot}330\ \text{sq ins}}$

$\therefore$ Area available $= \underline{{\cdot}330\ \text{sq ins}}$.

Area available inside vessel $= A_3 = 0$.

Area of Welds $\simeq \frac{.3125^2 \times 2}{2} = .0977$ sq ins $= A_4$

$\therefore$ Total Area available $= A_1 + A_2 + A_4$

$= .507 + .330 + .0977 = .9347$ sq ins. which is less than 1.013 sq ins.

• To avoid compensation plates, let nozzle wall = Schedule 80 = .500" = .4375" corroded.

Then Area A required $= \frac{7.75 \times .250 \times 1}{2}$

$(d = 8.625 - [2 \times .4375])$ $= .969$ sq ins

Area available in shell $= A_1 = (.3125 - .250)\,7.75$

$= .484$ sq ins

Area available in nozzle $= A_2 = (t_n - t_{rn})\,5 \times t$

$= (.4375 - .00512)(5 \times .3125) = .676$ sq ins

(revised $t_{rn} = \frac{15 \times 4.09375}{12000} = .00512$)

Area available in welds $= .0977$ sq ins. $= A_4$

$\therefore$ Total Area available $= A_1 + A_2 + A_4$

$= .484 + .676 + .0977 = 1.258$ sq ins.

$>$ 1.013 sq ins. i.e no further compensation required

D) SHELL NOZZLES "A" & "G" (6" N/Bore)

Total Cross Sectional Area required = A

$= \dfrac{d \times t_r \times F}{2}$ where $t_r = \cdot 250''$ (Sheet D) $F = 1$

$d = 6\cdot625 - (2 \times \cdot 2175'')$ corroded.

$= \dfrac{6\cdot19 \times \cdot 250 \times 1}{2}$ $= 6\cdot 19''$

$= \underline{\underline{\cdot 774 \text{ sq ins.}}}$

Area available for reinforcement in shell $= A_1$

= greater of 1) $(E_1 t - F t_r)\, d$. where $E_1 = F = 1$

$t = \cdot 3125''$ corroded

$t_r = \cdot 250''$

$d = 6\cdot 19''$

$= (\cdot 3125 - \cdot 250)\, 6\cdot 19$

$= \underline{\underline{\cdot 387 \text{ sq ins}}}$

or 2) $2(E_1 t - F t_r)(t + t_n)$ where $t_n = \cdot 2175''$

$= 2(\cdot 3125 - \cdot 250)(\cdot 3125 + \cdot 2175) = \underline{\underline{\cdot 066 \text{ sq ins}}}$

i.e. $\underline{\cdot 387 \text{ sq ins is available}}$

Area available for reinforcement in nozzle $= A_2$

= smaller of 1) $(t_n - t_m)\, 5t$ where $t_n = \cdot 2175''$

$t_m = \dfrac{PR}{S}$ (see Sheet "E")

$= \dfrac{15 \times 3\cdot 20375}{12000}$

$= \cdot 004''$

$\therefore$ A_2 is smaller of 1) $(t_n - t_m)\, 5t$

$$= (\cdot 2175 - \cdot 004)\, 5 \times \cdot 3125$$

$$= \underline{\underline{\cdot 3336 \text{ sq ins}}}$$

or 2) $(t_n - t_m)(5t_n + 2t_e)$ where $t_e = 0$ (assumed)

$$= (\cdot 2175 - \cdot 004)(5 \times \cdot 2175) = \underline{\underline{\cdot 232 \text{ sq ins}}}$$

i.e. <u>·232 sq ins is available</u>.

Area available inside vessel $= A_3 = 0$.

Area of welds available $= A_4 =$ <u>·0977 sq ins.</u>

(As Sheet J)

$\therefore$ Total Area Available for compensation

$$= A_1 + A_2 + A_4 = \cdot 387 + \cdot 232 + \cdot 0977$$

$$= \underline{\underline{\cdot 717 \text{ sq ins.}}} < \cdot 774 \text{ sq ins.}$$

• If nozzle wall is increased to Schedule 80,

$= \cdot 432'' = \cdot 3695''$ corroded,

Then Area A required $= \dfrac{5\cdot 886 \times \cdot 250}{2}$

$(d = 6\cdot 625 - [2 \times \cdot 3695])$ $= \underline{\underline{\cdot 736 \text{ sq ins.}}}$

$$t_m = \frac{pR}{S} = \frac{15 \times 3\cdot 12775}{12000} = \cdot 0039''$$

Then area available in shell $= A_1$

$= (\cdot 3125 - \cdot 250)\, 5\cdot 886 = \underline{\underline{\cdot 368 \text{ sq ins.}}}$

Area available in nozzle $= A_2$

$= (\cdot 3695 - \cdot 0039)(5 \times \cdot 3125) = \underline{\cdot 571 \text{ sq ins.}}$

or $(\cdot 3695 - \cdot 0039)(5 \times \cdot 3695) = \underline{\cdot 675 \text{ sq ins.}}$

i.e. $\underline{\underline{\cdot 571 \text{ sq ins}}}$ is available.

Area available in welds $= \underline{\underline{\cdot 0977 \text{ sq ins}}} = A_4$

$\therefore$ Total area available $= A_1 + A_2 + A_4$

$= \cdot 368 + \cdot 571 + \cdot 0977 = \underline{\underline{1\cdot 037 \text{ sq ins.}}}$

$>$ $\underline{\underline{\cdot 736 \text{ sq ins}}}$ i.e. no further compensation reqd.

E) SHELL NOZZLE "E" (4" N/Bore)

Total Cross Sectional Area required $= A$

$= \dfrac{d \times t_r \times F}{2}$ where $t_r = \cdot 250''$ (Sheet "D")

$F = 1$

$d = 4\cdot 5'' - (2 \times \cdot 1745''$ corroded$)$

$= \dfrac{4\cdot 151 \times \cdot 250 \times 1}{2}$ $= 4\cdot 151''$

$= \underline{\underline{\cdot 519 \text{ sq ins.}}}$

Area available in shell $= A_1 =$ greater of.

1) $(E_1 t - F t_r)\,d$ where $E_1 = F = 1$

$= (\cdot 3125 - \cdot 250)\,4 \cdot 151 = \underline{\underline{\cdot 259 \text{ sq ins.}}}$

or 2) $(E_1 t - F t_r)(t + t_n)$ where $t_n = \cdot 1745''$

$= (\cdot 3125 - \cdot 250)(\cdot 3125 + \cdot 1745) = \underline{\underline{\cdot 0304 \text{ sq ins.}}}$

i.e. $\underline{\cdot 259 \text{ sq ins is available.}}$

Area available in nozzle $= A_2 =$ smaller of

1) $(t_n - t_{rn})\,5t$ where $t_{rn} = \dfrac{pR}{S} = \dfrac{15 \times 2 \cdot 16275}{12000}$

$= (\cdot 1745 - \cdot 0027)(5 \times \cdot 3125)$ $\qquad = \cdot 0027''$

$= \underline{\underline{\cdot 268 \text{ sq ins}}}$

or 2) $(t_n - t_{rn})(5t_n + 2t_e)$ where $t_e = 0$ (assumed).

$= (\cdot 1745 - \cdot 0027)(5 \times \cdot 1745) = \underline{\underline{\cdot 150 \text{ sq ins}}}$

i.e. $\underline{\cdot 150 \text{ sq ins is available}}$

Area available inside vessel $= A_3 = 0$

Area available in welds $= A_4 = \underline{\cdot 0977 \text{ sq ins}}$

(as Sheet J)

$\therefore$ Total area available $= A_1 + A_2 + A_4$

$= \cdot 259 + \cdot 150 + \cdot 0977 = \underline{\underline{\cdot 5067 \text{ sq ins}}} < \underline{\underline{\cdot 519 \text{ sq ins.}}}$

• If nozzle wall is increased to Schedule 80,

$= \cdot 337'' = \cdot 2745''$ corroded.

Then $d = 4 \cdot 5 - (2 \times \cdot 2745) = 3 \cdot 951''$

& Cross Sectional Area required $= \dfrac{d \times t_r \times F}{2}$

$= \dfrac{3 \cdot 951 \times \cdot 250 \times 1}{2} = \cdot 494$ sq ins

$t_m = \dfrac{15 \times 2 \cdot 11275}{12000} = \cdot 0026$

Area available in shell $= A_1 = (\cdot 3125 - \cdot 250)\,3 \cdot 951$

$= \cdot 247$ sq ins.

Area available in nozzle $= A_2 =$ the smaller of

1) $(\cdot 2745 - \cdot 0026)(5 \times \cdot 3125) = \cdot 425$ sq ins.

or 2) $(\cdot 2745 - \cdot 0026)(5 \times \cdot 2745) = \cdot 373$ sq ins.

∴ $\cdot 373$ sq ins is available.

Area available in welds $= \cdot 0977$ sq ins.

Then total area available $= A_1 + A_2 + A_4$

$= \cdot 247 + \cdot 373 + \cdot 0977 = \cdot 718$ sq ins

$> \cdot 494$ sq ins

∴ No further compensation is required.

BABCOCK CONTRACTORS, INC. SUBJECT Steam Drum Design SHEET No. 17 OF 19

PROJECT 3001

HOLLEY, KENNEY, SCHOTT BY ..... DATE 7/5/78

CH. ..... DATE .....

Thickness For Wall of 20" Manhole.

$$t = \frac{PD}{2SE + 2yP} + C$$

Manhole neck to be rolled from A285C. plate.

$$t = \frac{32 \times 20}{2 \times 13800 \times 0.9 + 2 \times 0.4 \times 32} = 0.0257 + 0.0625 = 0.088$$

Make $t = \frac{1}{4}"$

c

DESIGN DATA

3001

CODE STAMP ASME SECTION I CODE SYMBOL S

OTHER SPECS. BCI SPEC NO R201/PV

DESIGN PRESS. @ TEMP. 32 (NOTE 1) PSIG @ 350 °F

OPER. PRESS. @ TEMP. 25 PSIG @ 267 °F

CODE NAME PLATE YES

STRESS RELIEVING YES

RADIOGRAPHING 100%

JOINT EFFICIENCY	SHELL 90 %	HEADS 90 %
NOM. CORR ALLOWANCE	SHELL 1/16"	HEADS 1/16"
	NOZZLES 1/16"	

MAX. ALLOW. PRESS. (New & Cold) 30 PSIG

(a) MAX. ALLOW. PRESS. LIMITED BY NOZZLE REINFORCEMENT

HYDROS. TEST PRESS. | SHOP 45 PSIG | FIELD 45 (NOTE 2) PSIG

MATERIAL SPECIFICATIONS

(a) SHELL ASTM A285 GR C

(b) HEADS ASTM A285 GR C

(c) ~~LINING~~ SADDLE WRAPPER PLATE ASTM A285GRC

(d) ~~SKIRT AND/OR~~ SADDLES ASTM A283 GR B

(e) NOZZLE NECK-ROLLED PLATE BASE PLATE & CHAIRS ASTM A285 GRC

(f) NOZZLE [redacted] PIPE ASTM A106. GR A

(g) FLANGES ASTM A105

(h) COUPLINGS (Screwed/Socket Weld) —

(j) GASKETS 1/16" C.A.F.

(k) BOLTS (External) ASTM A193 GR B7 (NUTS 2H)

(l) BOLTS (Internal)

(m) INTERNALS (Except as Noted)

~~(n) TRAYS~~

~~(p) CAPS~~

MH. [redacted] FURN. W/BLIND FLG. STUDS & GASKET AND DAVIT OR HINGE

INSUL. OR FIREPROOFED SKIRTS TO HAVE SLEEVED OPNG.

FIREPROOFING (By Others)	INSIDE SKIRT	THK.	MATERIAL	SQ. FT.
	OUTSIDE SKIRT	THK.		

INSULATION (By Others) 4" THK. SQ. FT.

PAINT SHOP PRIMER

INSPECTED BY CUSTOMER [redacted]

WEIGHTS

~~(a) TRAYS~~	~~FURN. BY~~	
	~~INSTALLED BY~~	LBS.
~~(b) CAPS~~	~~FURN. BY~~	
	~~INSTALLED BY~~	LBS.

~~(c) EST. VESSEL FABR. (Less Trays & Oper.)~~ LBS.

(d) EST. VESSEL EMPTY (Less Oper. Liquid) LBS.

(e) EST. VESSEL OPERATING LBS.

(f) EST. VESSEL FULL OF WATER LBS.

NOTES

(1) DESIGN PRESSURE INCLUDES LIQUID HEAD IN STEAM DRUM. DESIGN ALSO FOR FULL VACUUM.

(2) HYDROSTATIC TESTS SHALL BE CARRIED OUT WITH WATER AT 70°F MIN.

(3) BOLT HOLES IN FLANGES TO STRADDLE NATURAL ℄.

(4) FABRICATION & TESTING TO BE IN ACCORDANCE WITH ASME DESIGN, SECTION. I. AND BCI Spec R201/PV.

(5) WELDING SHALL BE IN ACCORDANCE WITH ASME IX. FABRICATOR TO PROVIDE WELD PROCEDURES FOR BCI APPROVAL

SH. 18 OF 19

7/5/78

STEAM DRUM

STEAM DRUM 3001

CONNECTION SCHEDULE

NOZZLE PROJECTIONS ARE FROM ℄ OF VESSEL TO EXTREME FACE OF FLANGE EXCEPT AS NOTED

2'-11" FOR ALL SIZES ~~& SMALLER~~

SH. 19 OF 19

FOR & LARGER

7/5/78

Nº Reqd	MK	RTG.	FCG	SIZE	h	φ	DESCRIPTION
							NAME PLATE
1	A	150	RF	6		0°	STEAM OUTLET
1	B	BUTTWELD		8"		180	CIRCULATION OUT
1	C	BUTTWELD		10"		180	CIRCULATION RETURN
1	D	150	RF	1"		0	BFW DIP PIPE
1	E	150	RF	4"		0	STOOL FOR D
1	F	150	RF	1"		180	BLOWDOWN DRAIN
1	G	150	RF	6"		0	RELIEF VALVE
1	H	150	RF	3/4"		0	PRESSURE VENT
1	J	150	RF	1½		0	PRESSURE INDICATOR
1	K	150	RF	1½"		0	SPARE (BLANKED)
2	L	150	RF	1½"		90°	LEVEL GAUGE
2	M	150	RF	1½		90°	LEVEL GAUGE
2	N	150	RF	1½"	*	—	LEVEL TRANSMITTER
1	P	150	RF	1½"		0	PRESSURE TRANSMITTER
1	R	150	RF	1½"		0	TEMP. INDICATOR
1	S	150	RF	20"	17"	—	MANHOLE WITH DAVIT OR HINGED COVER

* See elevation view

h - DIMENSIONS FROM REF. TANGENT φ LOOKING EAST

NOTES

(1) ALL FLANGES TO BE SLIP-ON TYPE

(2) FLANGES UP TO AND INCLUDING 4" SIZE MAY BE DOUBLE FILLET WELDED SEE ASME I PARA PG 42.9.1
FLANGES OVER 4" SIZE (EG MANHOLE) SHALL BE GROOVE WELDED. SEE PARA PG 42.9.2

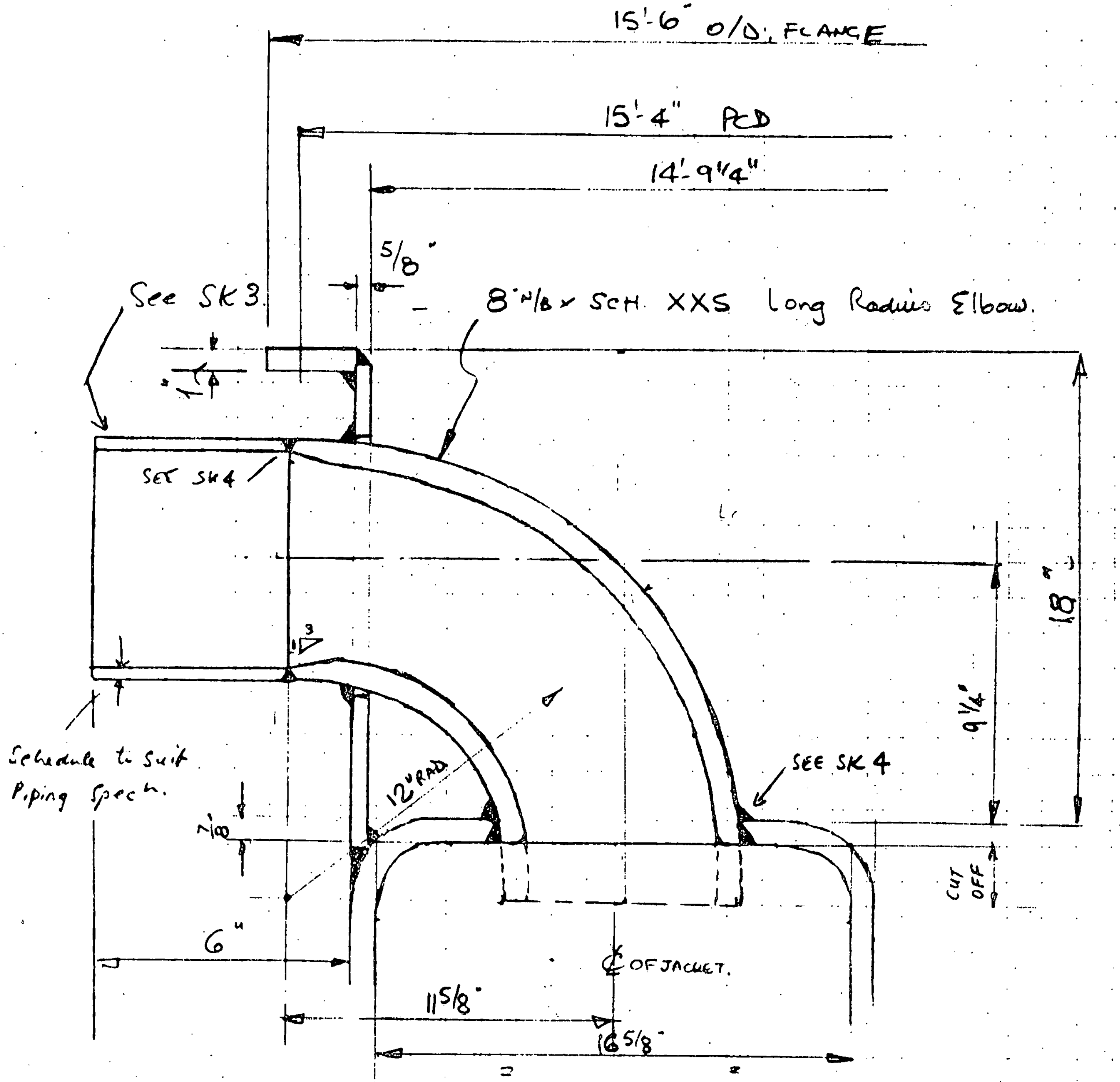
(3) NOZZLES SMALLER THAN 2" SIZE TO BE PROVIDED WITH 2 SUPPORT RIBS @ 90°.

T. STEAM DRUM

BABCOCK CONTRACTORS, INC. SUBJECT SET OUT FOR WATER JACKET OUTLET CONN^{N}

HOLLEY, KENNEY, SCHOTT

SHEET No. 1 OF 10
PROJECT BJ3051
BY W.Lud DATE 7/3/78
CH. DATE



SK 1A

HOLLEY, KENNEY, SCHOTT, INC. SUBJECT SHELL RING @ TOP OF WATER JACKET

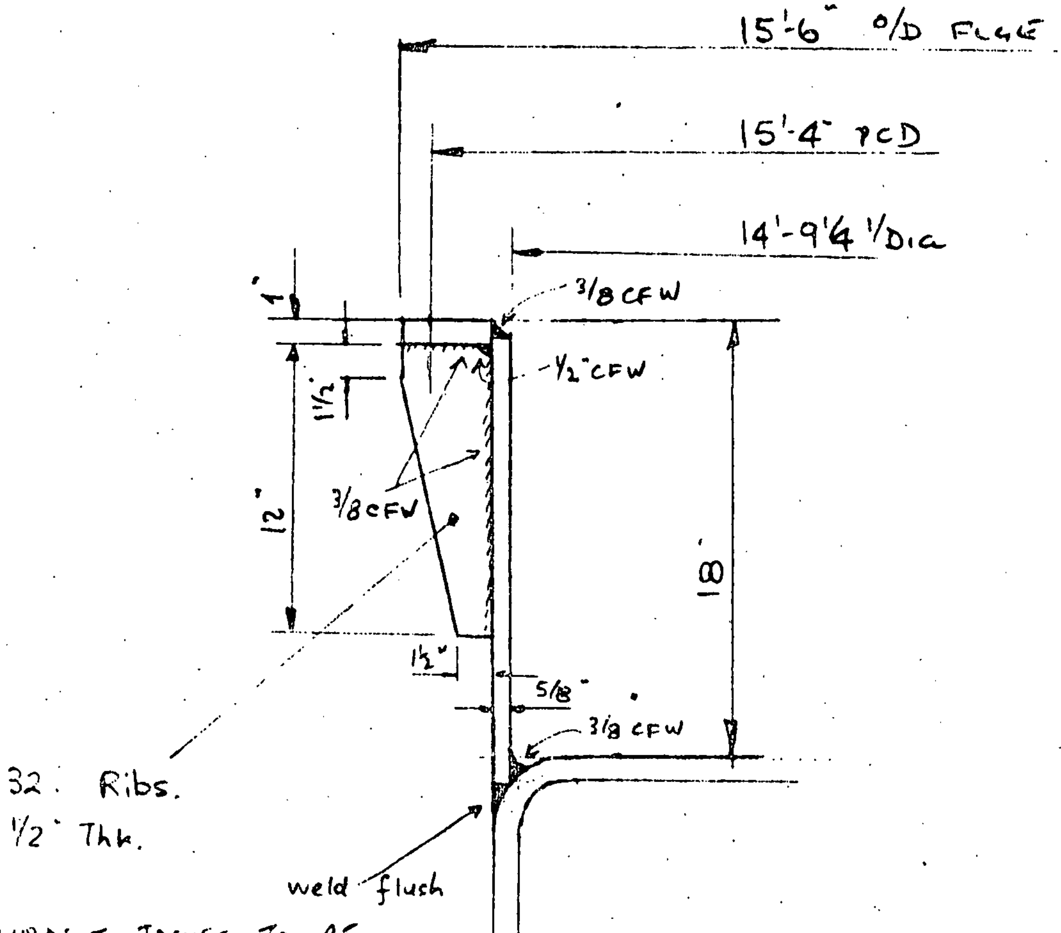
PITTSBURGH, PA. BECKLEY, W. VA.

SHEET No. 2 OF 10

JOB No. 3001

BY LWG DATE 7/3/79

CHKD. DATE



ALL WELDS TO JACKET TO BE COMPLETED BEFORE STRESS RELIEVING

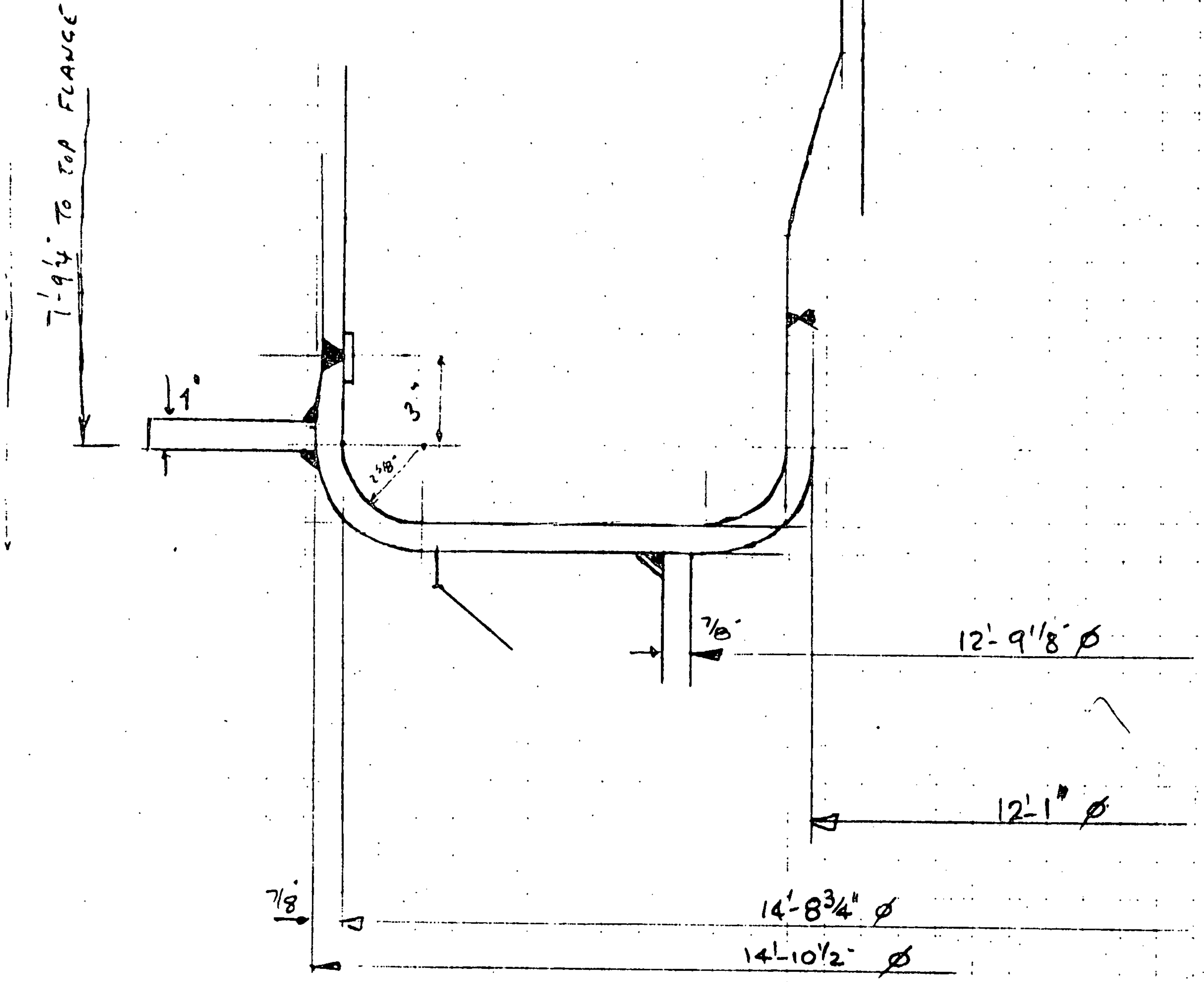
SK 1 B

13

BABCOCK CONTRACTORS, INC. SUBJECT LAYOUT OF GRATE RING SUPPORTS RELATIVE TO JACKET CORNERS

HOLLEY, KENNEY, SCHOTT

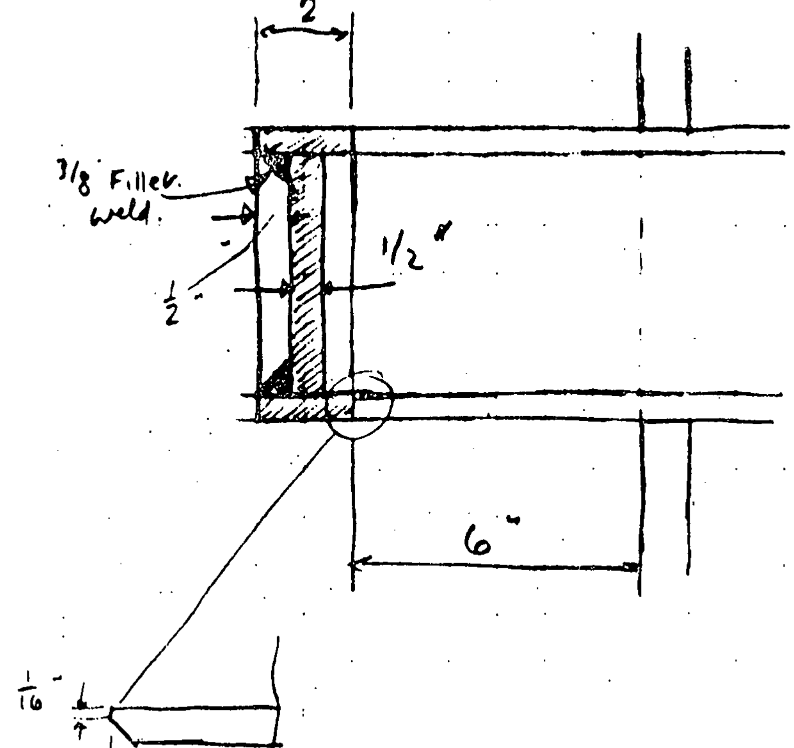
SHEET No. 3 OF 10
PROJECT 3001
BY W.Gibb DATE 7/3/78
CH. DATE



SK. 2

BABCOCK CONTRACTORS, INC. SUBJECT TESTING BLANKS ON JACKET NOZZLES AND STEAM DRUM NOZZLES — SHEET No. (4) OF 10

HOLLEY, KENNEY, SCHOTT — PROJECT 3001 — BY LH — DATE 7/6/78 — CH. .... DATE ....



NOTE MIN^M TEST TEMP 70°F

End Preparation (after completion of hydrostatic test. and site pressure test)

Thickness of Ends For Test.

Hydrostatic Test Pressure = 1.5 × MAWP.

MAWP For Jacket and Drum = 30 psig

∴ Test Pressure: 30 × 1.5 = 45 psig. For Steam Drum

45 + Liquid Head = 45 + 6 = 51 psig. Test Pressure for water Jackets

Connection's to be tested.

On Jacket 6" & 8" N/B.

on Steam Drum 10" & 8" N/B.

Thickness of Standard Wall Pipe.

6" = 0.28"

8 = 0.322"

10" = 0.365"

SK 3A

Bore of Nozzles.

6" = 6.625 − (2 × 0.28) = 6.055"

8" = 8.625 − (2 × 0.322) = 7.98"

10" = 10.75 − (2 × 0.365) = 10.02

$t = d\sqrt{\frac{CP}{SE}}$ Blank End Material 285C ∴ S = 13800

as we shall be using only a single fillet weld a joint efficiency of 0.6 will be used.

$t = d\sqrt{\frac{0.3 \times 45}{13800 \times 0.6}} = d \times 0.04.$

6" t = 0.04 × 6.055" = 0.242"

8" t = 0.04 × 7.98" = 0.319"

10" t = 0.04 × 10.02 = 0.400"

use 1/2" for all sizes. (will be adequate also for 5 psig test on water Jacket)

Allowable Shear Stress in weld = 0.49 × 12000 = 5880 psi.

Shear area = π × d × Fillet size thro. throat x.

Total load = π d × Pressure P

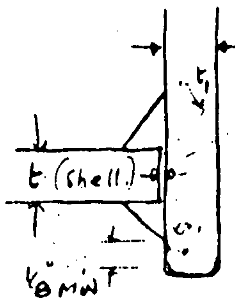
$Stress = \frac{\pi d \times P}{\pi d \times x} = \frac{P}{x} = \frac{45}{x}$

$x = \frac{45}{5880} = 0.0076"$

use 3/8" Fillet.

SK 3 B

(1)

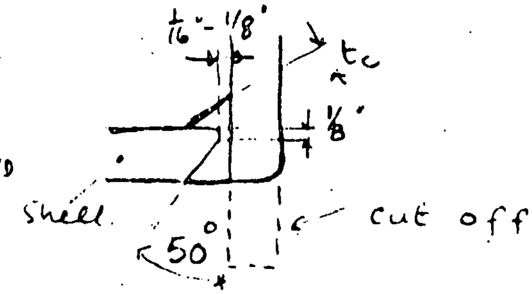


t_c - 1/8" $t_1 + t_2 = 1\frac{1}{4}\,t_{min}$
t_1 or t_2 not less than smaller of 1/4" or 0.7 t_{min}.

TYPICAL SET THRO NOZZLE WELD DETAIL FOR PRESSURE PARTS
SEE ASME 1 FIG PW-16.1.(d)

---

(2)



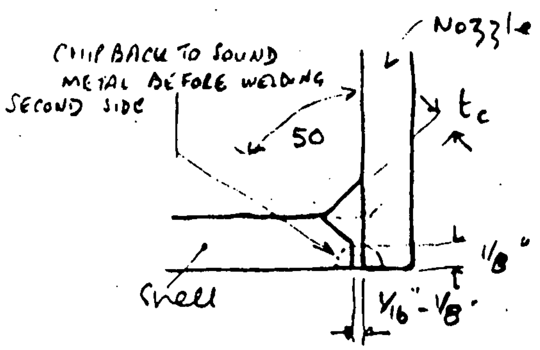
t_c Not less than smaller of 1/4" or 0.7 t_{min}

SEE ALSO SK.1.

WELD DETAIL FOR 8" OUTLET NOZZLE ON STEAM JACKET
SEE ASME 1. FIG PW-16.1.(g)

---

(3)



t_c Not less than smaller of 1/4" or 0.7 t_{min}.

WELD DETAIL FOR BLOWDOWN DRAIN (F) and PRESSURE VENT (H) ON STEAM DRUM.

SK 4A

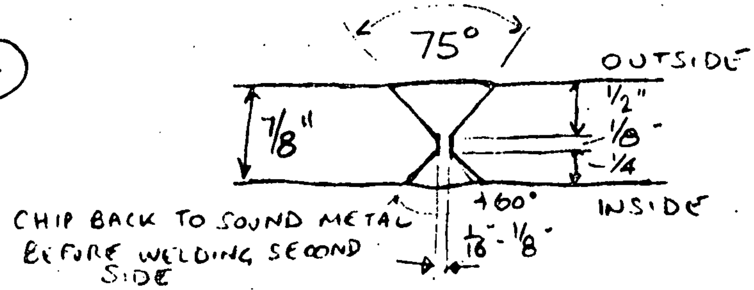
BABCOCK CONTRACTORS, INC.

HOLLEY, KENNEY, SCHOTT

SUBJECT WELD DETAILS
PRESSURE PARTS

SHEET No. 7 OF 10
PROJECT 3041
BY [signature] DATE 7/11/78
CH. DATE

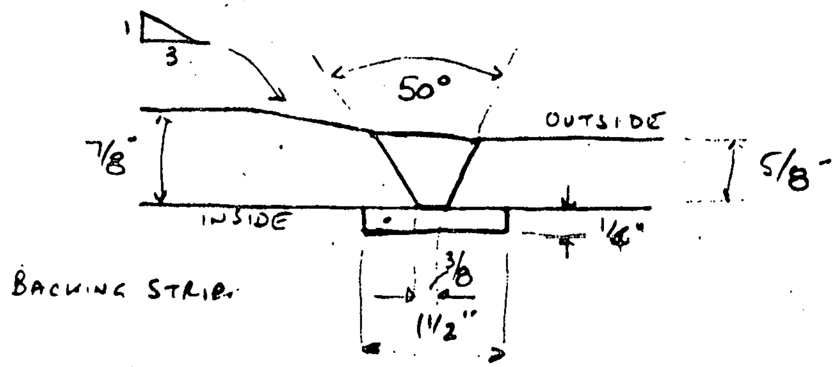
(4)



DOUBLE SIDED BUTTWELD FOR MAIN SEAMS ON JACKET.

---

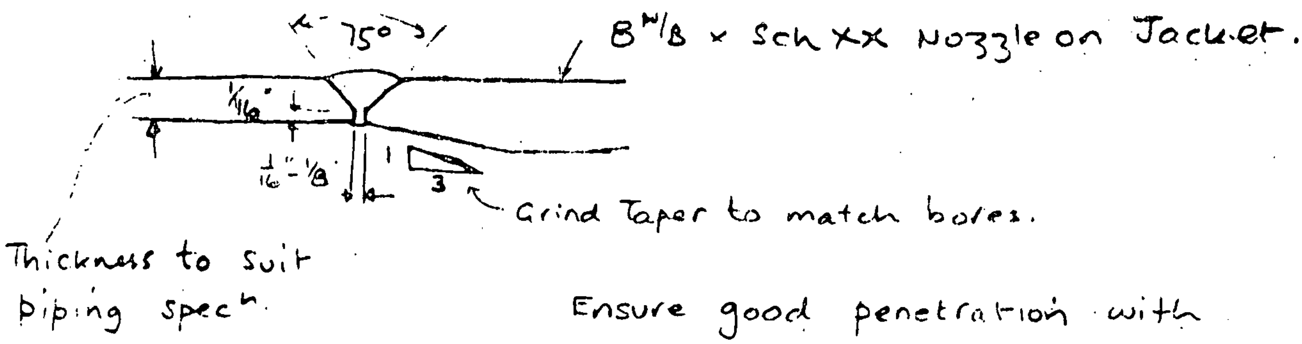
(5)



CLOSING SEAMS ON JACKET.

---

(6)

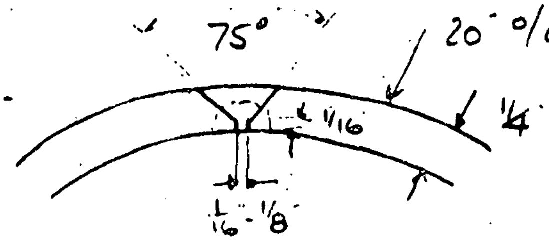


Ensure good penetration with root run.

BUTTWELD ON 8" OUTLET ON JACKET
SEE ALSO SK. 1

SK 4B

(7)

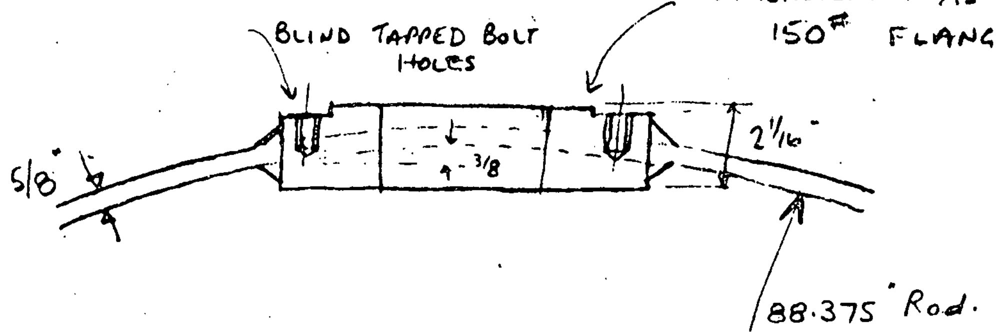


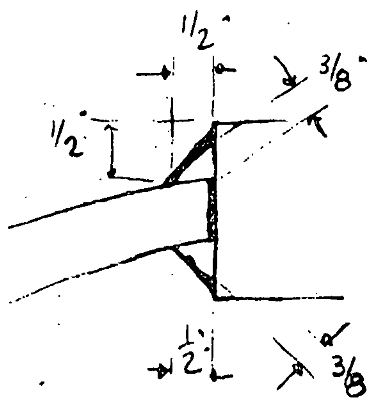
Chip back to sound metal before welding second side.

LONGITUDINAL SEAM IN NOZZLE WALL FOR 20" MANWAY ON STEAM DRUM.

---

(8)





PAD THICKNESS = 1/2" + 1/2" + 5/8 + 3/8
= 2" + 1/16" R.F.

DETAIL OF 10" N.B INSPECTION OPENINGS IN GASIFIER JACKET

---

(9) SLIP-ON FLANGE TO NOZZLE WELDS TO BE IN ACCORDANCE WITH ASME 1. PARA. PG 42.9.1 FOR FLANGES UP TO AND INCLUDING 4" N/B. AND PARAGRAPH PG 42.9.2 IF OVER 4" N/B (EG MANHOLE)

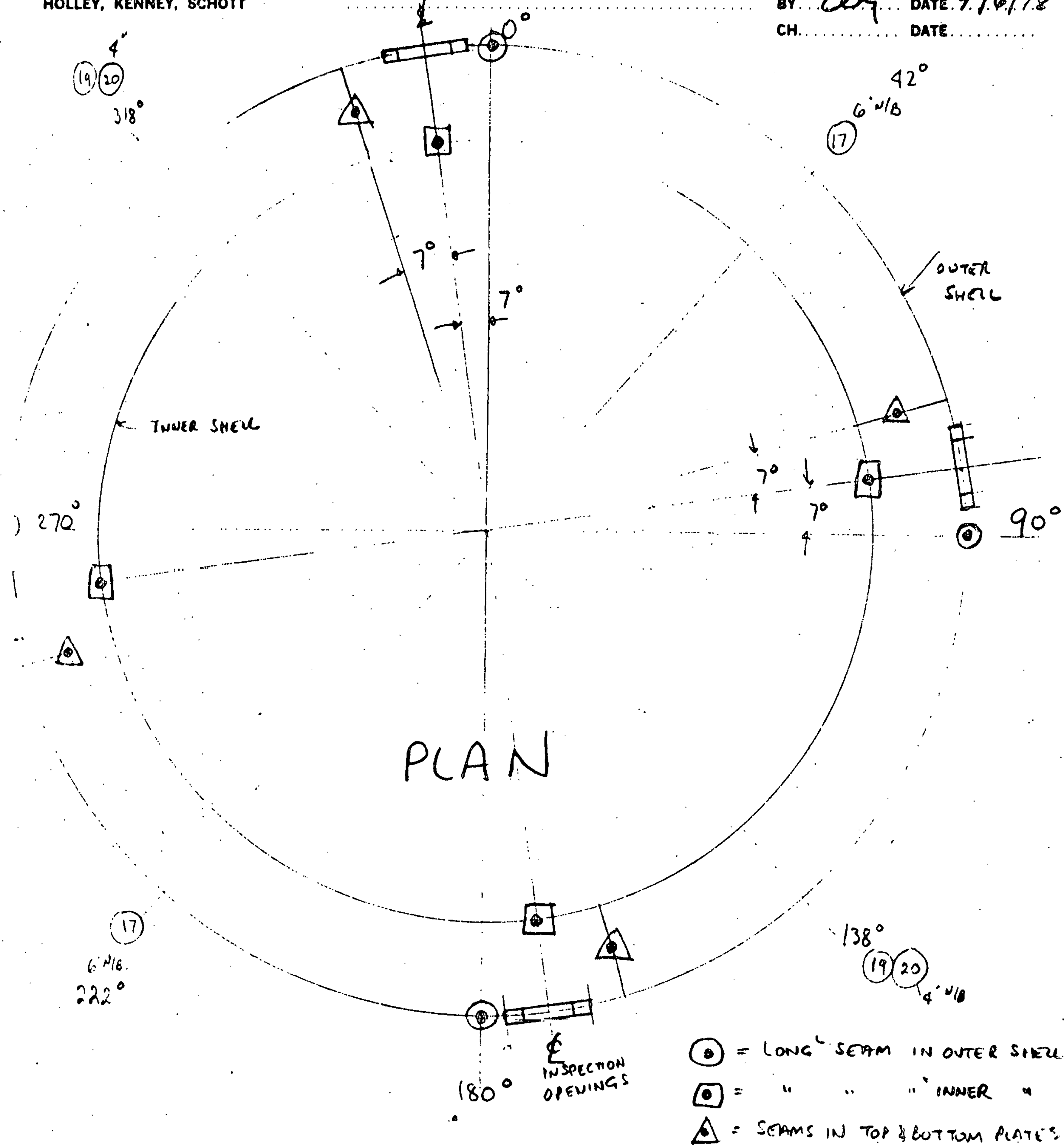
SK. 4C

BABCOCK CONTRACTORS, INC. SUBJECT LOCATION OF INSPECTION OPENINGS IN JACKET SHEET No. 1 OF 10

PROJECT 3001

HOLLEY, KENNEY, SCHOTT BY Ceg DATE 7/6/78

CH. DATE



10" N/B INSPECTION OPENINGS TO BE LOCATED AS SHOWN RELATIVE TO LONGITUDINAL SEAMS ON JACKET

THIS IS TO FACILITATE RADIOGRAPHY OF SEAMS

THE DIAGRAM IS BASED ON 4 LONG^L SEAMS IF POSSIBLE THIS SHOULD BE REDUCED TO 2 OR 3 - DEPENDING ON PLATE SIZE AVAILABLE

SK 5A

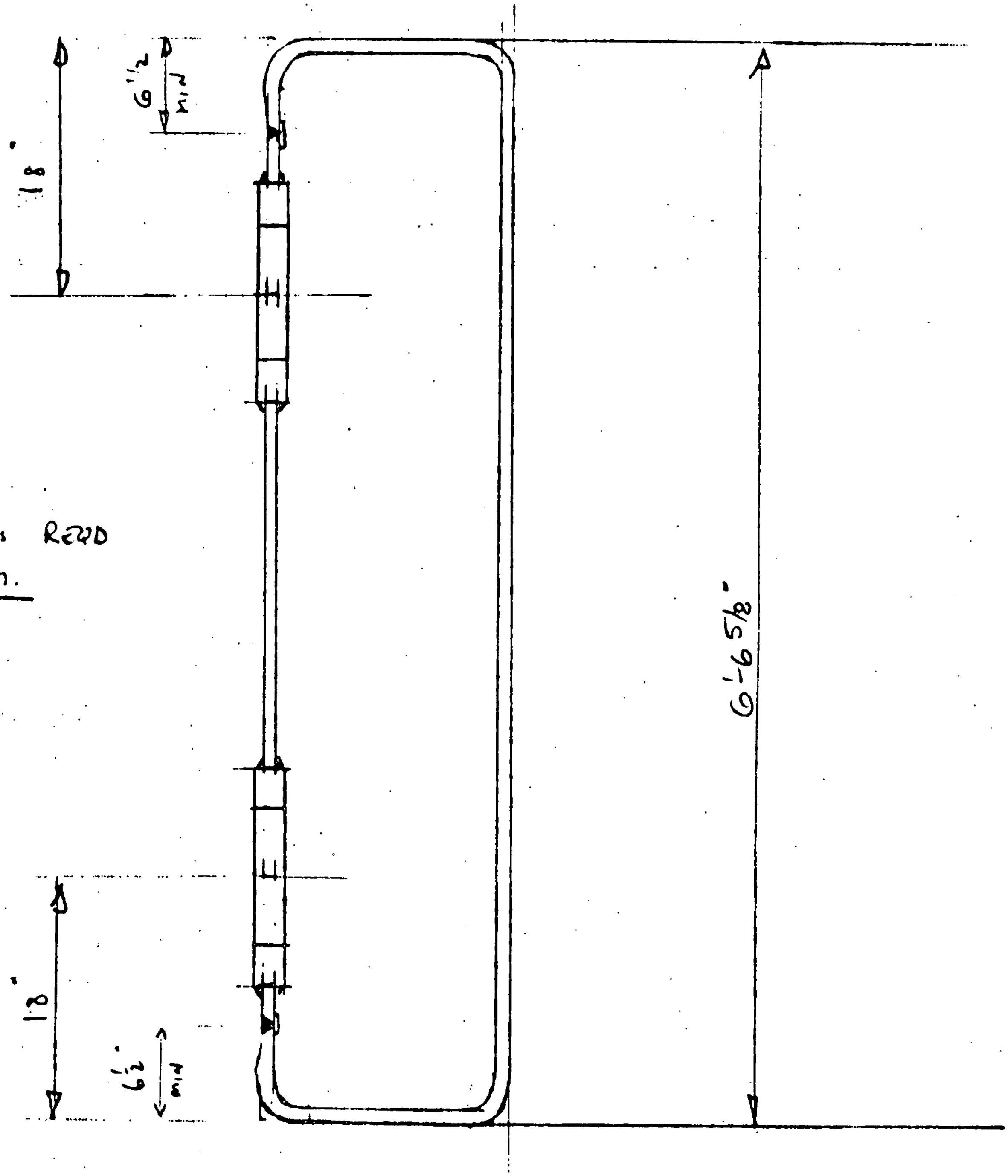
BABCOCK CONTRACTORS, INC. SUBJECT LOCATION OF INSP OPGS SHEET No. 10 OF 10

HOLLEY, KENNEY, SCHOTT PROJECT 3001

BY Ceg DATE 7/6/78

CH. .... DATE ....

2 OPENINGS REQD
PER SEAM.



ELEVATION

SK 5B

(Sk. 6 continues in non-code part)

PART 3

BABCOCK CONTRACTORS, INC.

HOLLEY, KENNEY, SCHOTT

SUBJECT LOADS DUE TO STIRRER

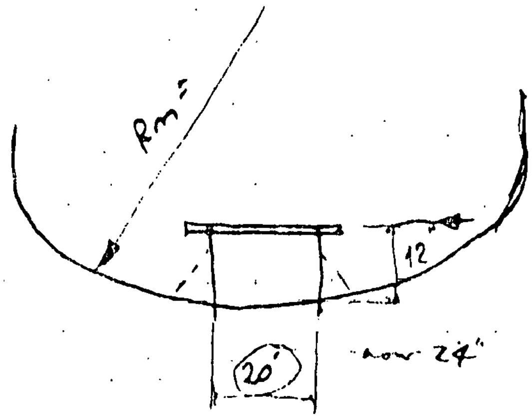
SHELL DESIGN

SHEET No. 1 OF 14

PROJECT 3001

BY Weill DATE 7/7/78

CH. DATE



DESIGN FOR HORIZONTAL FORCE ON SHAFT SUPPORT NOZZLE.
(PRELIMINARY ONLY, AS THE NOZZLE SIZE IS NOT YET CONFIRMED.)
DESIGN BASIS - WELDING RESEARCH COUNCIL BULLETIN 107,/AUG. 65
TABLE 3.

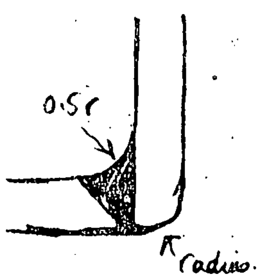
Moment due to horizontal Force = 10,000 × 12 = 120,000 lb ins.
Vessel Thickness = 0.5" less 1/8" c.a = 0.375"
Nozzle Thickness = 0.5" - 1/8 - = 0.375"

$$\Upsilon = \frac{r_m}{t} = \frac{9.8125}{0.375} = 26.2$$

$$\rho = \frac{T}{t} = \frac{0.375}{0.375} = 1.0$$

$$U = \frac{r_o}{\sqrt{R_m T}} = \frac{10}{\sqrt{108 \times 0.375}} = 0.25.$$

Stress Concentration Factors.



$$\frac{r_A}{T} = \frac{0.5}{0.5} = 1$$

$K_n = 1.6$

$K_b = 1.3$

$$K_n \times \frac{M_1}{T^2\sqrt{R_m T}} = \frac{1.6 \times 120{,}000}{0.375^2\sqrt{108 \times 0.375}} = 214{,}540$$

(6.364)

$$K_b \times \frac{6M_1}{T^2\sqrt{R_m T}} = \frac{1.3 \times 6 \times 120{,}000}{0.375^2\sqrt{108 \times 0.375}} = 1{,}045{,}883$$

(6.364)

From Fig SM6,1 $\gamma = 15$, $\rho = 2$

(N_x)	0.24
(M_x)	0.36
(N_y)	0.21
(M_y)	0.36

From Fig SM9, $\gamma = 50$ $\rho = 4$

0.145
0.17
0.28
0.54

From Fig SM2. $\gamma = 5$ $\rho = 1$

(N_x)	0.26
(M_x)	0.57
(N_y)	0.19
(M_y)	0.25

(By Inspection all Stresses Will be too high)

Increase Thickness of head and nozzle.

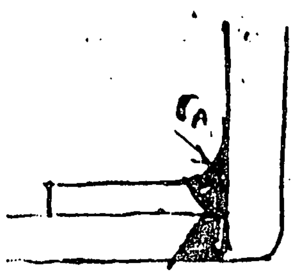
Vessel thickness = 0.5 less 0.125 ca = 0.375
Plus Reinforcing 0.5.

Total Effective thickness = 0.5 + 0.375 = 0.875"

Nozzle Wall thickness 0.625 less 0.125 ca = 0.5.

$$\gamma = \frac{r_m}{t} = \frac{9.75}{0.5} = 19.5.$$

$$\rho = \frac{T}{t} = \frac{0.875}{0.5} = 1.75.$$



Stress Concentration Factor

$$\frac{r_A}{T} = \frac{0.5}{0.875} = 0.571$$

$K_n = 1.75$

$K_b = 1.4$

$$K_n \times \frac{M_1}{T^2\sqrt{R_m T}} = \frac{1.75 \times 120{,}000}{0.875^2\sqrt{108 \times 0.875}} = 28{,}219$$
(9.72)

$$K_b \times \frac{6M_1}{T^2\sqrt{R_m T}} = \frac{1.4 \times 120{,}000 \times 6}{0.875^2\sqrt{108 \times 0.875}} = 135{,}450$$
(9.72)

$$U = \frac{r_o}{R_m T} = \frac{10}{108 \times 0.875} = 0.106$$

BABCOCK CONTRACTORS, INC. SUBJECT SHELL DESIGN SHEET No. 4 OF 14

HOLLEY, KENNEY, SCHOTT PROJECT 3001

BY DATE 7/1/78

CH. DATE

From Fig. SM6

(N_x) 0.62

(M_x) 1.1

(N_y) 0.225

(N_x) 1.1

Stresses still too high See Sheet 4A.

One way to reduce these stresses is to reduce the bending moment by shortening the nozzle standout.

allowable stress 90% yield = $0.9 \times 30{,}000 = 27{,}000$ psi

with a 12" standout we have a stress magnitude of $148995 + 17{,}495 = 166{,}490$

Nozzle S.O needs reducing to $12 \times \frac{27000}{166{,}490} = \underline{\underline{1.9"}}$

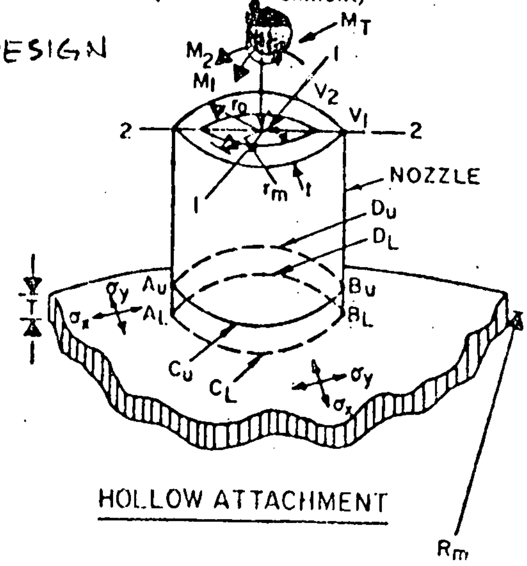
alternatively provide ribs on nozzle.

Table 3—Computation Sheet for Local Stresses in Spherical Shells (Hollow Attachment)

SHELL DESIGN

4 (A)

3c.01
7/7/78



HOLLOW ATTACHMENT

1. **Applied Loads***
   - Radial Load, P = 0
   - Shear Load, V_1 = 10000 lb.
   - Shear Load, V_2 = 0
   - Overturning Moment, M_1 = 120,000 lbin
   - Overturning Moment, M_2 = 0
   - Torsional Moment, M_T = 0
2. **Geometry**
   - Vessel Thickness, T = 0.875"
   - Vessel Mean Radius, R_m = 108
   - Nozzle Thickness, t = 0.5
   - Nozzle Mean Radius, r_m = 9.75
   - Nozzle Outside Radius, r_o = 10
3. **Geometric Parameters**
   - $\gamma = \frac{r_m}{t}$ = 19.5
   - $\rho = \frac{T}{t}$ = 1.75
   - $U = \frac{r_o}{\sqrt{R_m T}}$ = 0.106
4. **Stress Concentration Factors** due to:
   - membrane load, K_n = 1.75
   - bending load, K_b = 1.4

NOTE: Enter all force values in accordance with sign convention

From Fig.	Read curves for	Compute absolute values of stress and enter result	A_U	A_L	B_U	B_L	C_U	C_L	D_U	D_L
SP-1 to 10	$\frac{N_x T}{P}$ =	$K_n \left(\frac{N_x T}{P}\right) \cdot \frac{P}{T^2}$ =	−	−		−		−	−	−
	$\frac{M_x}{P}$ =	$K_b \left(\frac{M_x}{P}\right) \cdot \frac{6P}{T^2}$ =	−	+	+	+	−	+	−	
SM-1 to 10	$\frac{N_x T\sqrt{R_m T}}{M_1}$ =	$K_n \left(\frac{N_x T\sqrt{R_m T}}{M_1}\right) \cdot \frac{M_1}{T^2\sqrt{R_m T}}$ =					−17495	−	+	+
	$\frac{M_x\sqrt{R_m T}}{M_1}$ =	$K_b \left(\frac{M_x\sqrt{R_m T}}{M_1}\right) \cdot \frac{6M_1}{T^2\sqrt{R_m T}}$ =					−148,995	+	+	−
	$\frac{N_x T\sqrt{R_m T}}{M_2}$ =	$K_n \left(\frac{N_x T\sqrt{R_m T}}{M_2}\right) \cdot \frac{M_2}{T^2\sqrt{R_m T}}$ =	−		−					
	$\frac{M_x\sqrt{R_m T}}{M_2}$ =	$K_b \left(\frac{M_x\sqrt{R_m T}}{M_2}\right) \cdot \frac{6M_2}{T^2\sqrt{R_m T}}$ =	−		−					
Add algebraically for summation of σ_x =										
SP-1 to 10	$\frac{N_y T}{P}$ =	$K_n \left(\frac{N_y T}{P}\right) \cdot \frac{P}{T^2}$ =	−		−		−			
	$\frac{M_y}{P}$ =	$K_b \left(\frac{M_y}{P}\right) \cdot \frac{6P}{T^2}$ =	−			+	−	+		+
SM-1 to 10	$\frac{N_y T\sqrt{R_m T}}{M_1}$ =	$K_n \left(\frac{N_y T\sqrt{R_m T}}{M_1}\right) \cdot \frac{M_1}{T^2\sqrt{R_m T}}$ =					−6349	−	+	
	$\frac{M_y\sqrt{R_m T}}{M_1}$ =	$K_b \left(\frac{M_y\sqrt{R_m T}}{M_1}\right) \cdot \frac{6M_1}{T^2\sqrt{R_m T}}$ =					−148995	+	−	−
	$\frac{N_y T\sqrt{R_m T}}{M_2}$ =	$K_n \left(\frac{N_y T\sqrt{R_m T}}{M_2}\right) \cdot \frac{M_2}{T^2\sqrt{R_m T}}$ =	−		−					
	$\frac{M_y\sqrt{R_m T}}{M_2}$ =	$K_b \left(\frac{M_y\sqrt{R_m T}}{M_2}\right) \cdot \frac{6M_2}{T^2\sqrt{R_m T}}$ =	−		−					
Add algebraically for summation of σ_y =										
Shear stress due to load, V_1		$\tau_1 = \frac{V_1}{\pi r_o T}$ =					−	−	+	−
Shear stress due to load, V_2		$\tau_2 = \frac{V_2}{\pi r_o T}$ =	−							
Shear stress due to torsion, M_T		$\tau_3 = \tau_3 = \frac{M_T}{2\pi r_o^2 T}$ =	−	+				+		−
Add algebraically for summation of τ =										
COMBINED STRESS INTENSITY, S										
When σ_x & σ_y have like signs: $S = \frac{1}{2}\left[\sigma_x + \sigma_y + \sqrt{(\sigma_x - \sigma_y)^2 + 4\tau^2}\right]$										
When τ = 0, S = largest of σ_x, σ_y or $\lvert\sigma_x - \sigma_y\rvert$										
When σ_x & σ_y have unlike signs: $S = \sqrt{(\sigma_x - \sigma_y)^2 + 4\tau^2}$										

Check effect of reducing R_m which will be less than Head dia for a semi Ellipsoidal head.

8'6" dia head will have a $R_m = 72$" approx

Also increase Nozzle wall to $0.75 - 0.125 = 0.625$"

$$\gamma = \frac{r_m}{t} = \frac{9.6875}{0.625} = 15.5$$

Increase Head Thickness to $0.625 - 0.125 = 0.5$
plus pad $0.625 + 0.5 = 1.125$"

$$\rho = \frac{T}{t} = \frac{1.125}{0.625} = 1.8$$

Stress Concentration Factor

$$\frac{r_A}{T} = \frac{0.625}{1.125} = 0.555$$

$K_n = 1.75$

$K_b = 1.5$

$$U = \frac{r_o}{R_m T} = \frac{10}{72 \times 1.125} = 0.123$$

$$K_n \times \frac{M_1}{T^2 \sqrt{R_m T}} = \frac{1.75 \times 120{,}000}{1.125^2 \sqrt{72 \times 1.125}} = 18{,}436$$

(9)

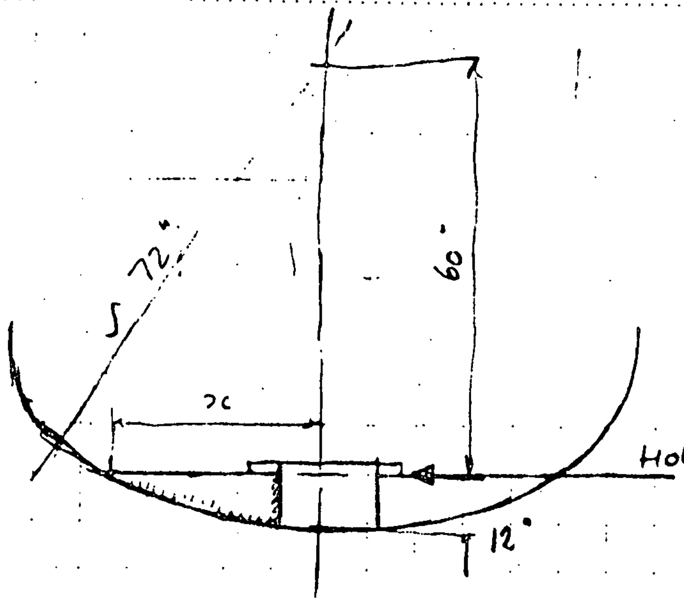
$$K_b \times \frac{6\,M_1}{T^2 \sqrt{R_m T}} = \frac{1.5 \times 6 \times 120{,}000}{1.125^2 \sqrt{72 \times 1.125}} = 94{,}815$$

(9)

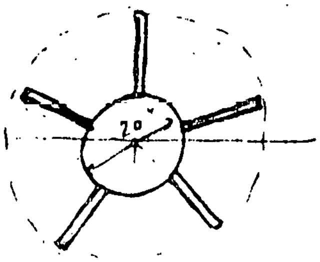
From Fig SM6.

(N_x) 0.5 × 18436 = 9218
(M_x) 0.8 × 94815 = 75,852
} 85,070 lb/sq in (Steel too high

(N_y) 0.22 × 18436 =
(M_y) 0.8 × 94815 =
}



$x = \sqrt{72^2 - 60^2} = 39.8"$



5. Ribs. distributing load over head.

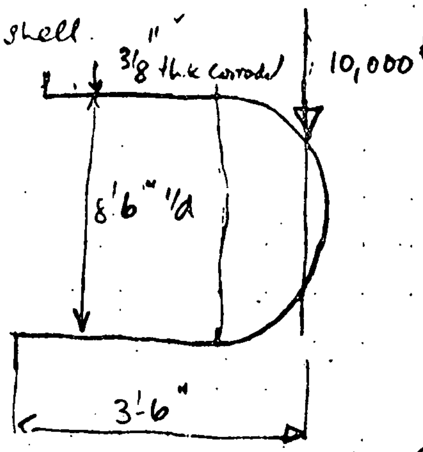
Removes the bending moment from nozzle, and head.

$\text{load / rib} = \frac{10,000}{5} = 2,000 \text{ lb.}$

$\text{Bearing Stress on vertical Edge of rib} = \frac{2000}{12 \times 0.25}$ (OK)

$\text{Shear stress in weld} = \frac{2000}{2 \times 39.8 \times 0.25} = 100 \text{ psi}$ (OK)

Stress in shell.

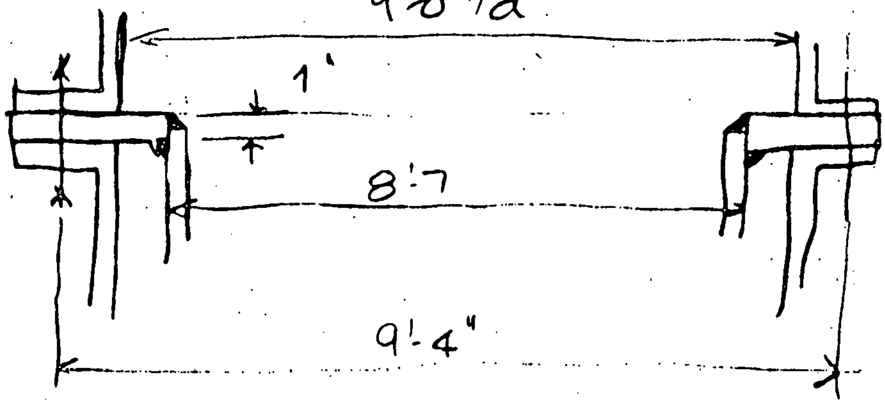


$B.M = 10,000 \times 42 = 420,000 \text{ lb-in.}$

$I = \frac{\pi}{64}(D^4 - d^4) = \frac{\pi}{64}(102.75^4 - 102^4) = 157903 \text{ in}^4$

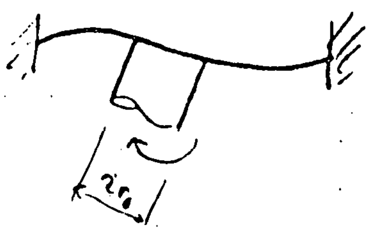
$\frac{M}{I} = \frac{f}{y} \quad S = \frac{420,000 \times 51}{157903} = 135.7 \text{ psi}$

$\delta = \frac{1}{3}\frac{Wl^3}{EI} = \frac{10,000 \times 42^3}{3 \times 30 \times 10^6 \times 157903} = 0.000052$



Twisting on Flange due to load from shaft support.

Roark Case 10. Table X.



$$a = \frac{108}{2} = 54''$$

$$r_0 = \frac{103}{2} = 51.5$$

$$\text{Max } S_r = \frac{3M}{4\pi t^2 r_0}\left[1 + \left(\frac{m+1}{m}\right)\log_e \frac{2(0.45a - r_0)}{0.45\,Ka}\right]$$

$$k = \frac{0.1a^2}{(r_0 + 0.28a)^2} = \frac{0.1 \times 54^2}{(51.5 + 0.28 \times 54)^2} = \frac{291.5998}{4438.2} = 0.066$$

$$\text{Max } S_r = \frac{3 \times 420{,}000}{4 \times \pi \times 1^2 \times 51.5}\left[1 + 1.333 \log_e \frac{2(\overbrace{0.45 \times 54 - 51.5}^{-27.2})}{0.45 \times 0.066 \times 54}\right]$$

Does not work because r_0 is too large relative to a.

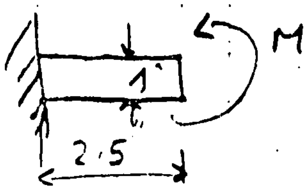
If we assume bracket $= [1 + 0] = 1$

$$\text{Max } S_r = \frac{3 \times 420{,}000}{4 \times \pi \times 1^2 \times 51.5} = 1947 \text{ lb/sq in.}$$

If we take unit moment $= \dfrac{420{,}000}{\pi D}$

$= \dfrac{420{,}000}{\pi \times 103} = 1298$ lb.

and assume bending moment applied to a unit length of the flange.

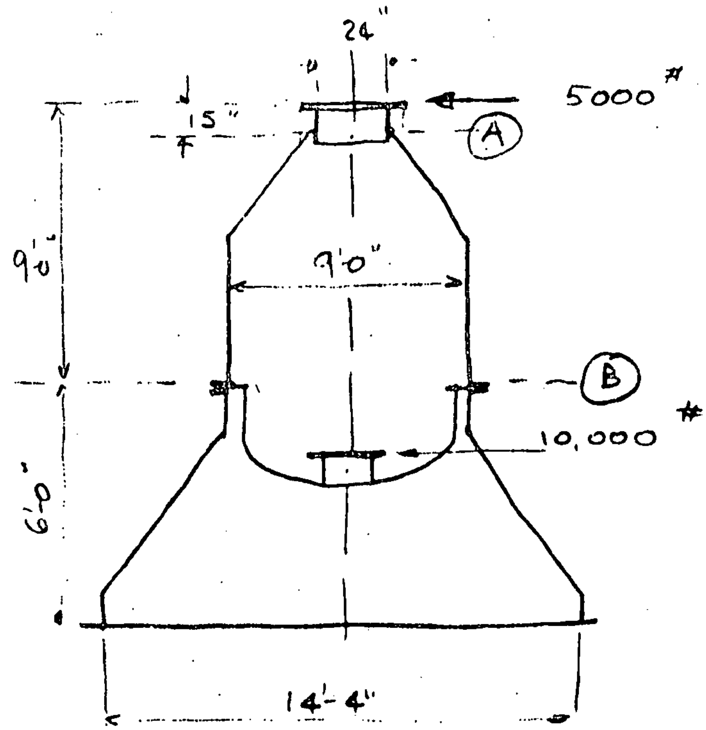


$I = \dfrac{bd^3}{12} = \dfrac{1 \times 1^3}{12} =$

Max Stress $= \dfrac{6 \times M}{t^2} = \dfrac{6 \times 1298}{0.1^2} = 7788$ lb/sq.

Max Deflection $= \dfrac{M l^2}{2EI} = \dfrac{1298 \times 2.5^2}{2 \times 30 \times 10^6 \times 0.083} = 0.00163$

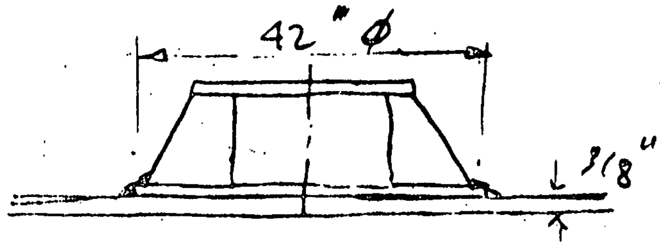
$=$



Bending moment @ Junction. (A) = 15 × 5000 = 75000 lb·in.

Thickness of cone = 3/8" + 3/8" pad = 3/4" less 1/8" c.a = 5/8"

If we take cone as a flat plate 9'6" dia with ribs to distribute load over reinforcing pad. say 42" φ



Roark Table X Case 10.

BABCOCK CONTRACTORS, INC. SUBJECT SHELL DESIGN SHEET No. 11 OF 14

HOLLEY, KENNEY, SCHOTT PROJECT 3001 BY DATE 7/7/78 CH. DATE

$$\text{Max } S_r = \frac{3M}{4\pi t^2 r_0}\left[1 + \left(\frac{m+1}{m}\right)\log_e \frac{2(0.45a - r_0)}{0.45ka}\right]$$

(at edge of pad)

$$0.45a = 0.45 \times \frac{108}{2} = 24.3$$

$$r_0 = 21$$

$$k = \frac{0.1a^2}{(r_0 + 0.28a)^2} = \frac{0.1 \times 54^2}{(21 + 0.28 \times 54)^2} = 0.223$$

$$m = 3 \quad \left(\frac{m+1}{m}\right) = 1.333$$

$$\text{Max } Sr = \frac{3 \times 75000}{4 \times \pi \times 0.25^2 \times 18}\left[1 + 1.333 \log_e \frac{2 \times (24.3 - 21)}{0.45 \times 0.223 \times 54}\right]$$

$$\left[1 + 1.333 \times \overset{0.197}{0.6675}\right]$$

$$1.2628$$

$\text{Max } S_r = 20{,}098$ lb/sq in OK design is conservative.

Bending Moment @ Junction (B) due to 5000# Load

$= 5000 \times 108 = 540{,}000$ lb ins.

Stress in shell

$$I = \frac{\pi}{64}\left(108.75^4 - 108.25^4\right) = 125{,}369$$

$$\frac{M}{I} = \frac{S}{y} \qquad S = \frac{540{,}000 \times 54}{125369} = 233. \text{ lb/sq in OK}$$

Stress in flange will be of similar order to Item on page (9)

Uplift on flanges @ 8

Assume 5000# Force and 10000# Force act in opposite directions so that total uplift is sum of both reactions.

Moment due to 5000# = 540,000 lb ins.

Reaction on bolts (uplift) = $\frac{540,000}{54}$ = 10,000 lb.

Moment due to 10,000# = 420,000# (See sheet 7)

Reaction on bolts (uplift) = $\frac{420,000}{54}$ = 7,778 lb.

Total uplift = 17,778 lb. (This will be counteracted by some small amount by deadweight)

Assume taken by half the bolts in the flange.

Size of bolt, say 5/8" root area 0.28 sq in.

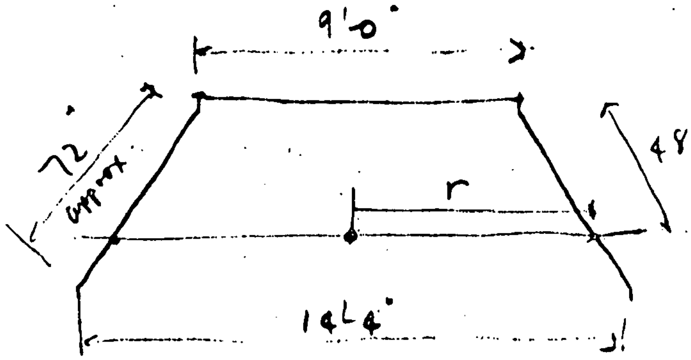
Allowable Stress (Tensile): 20,000 lb/sq in

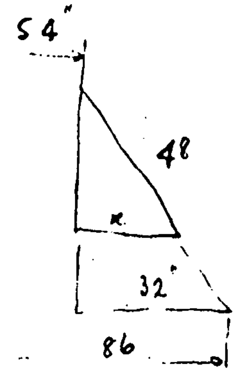
No of bolts = $\frac{17,778}{20,000 \times 0.28}$ = 3.17 bolts.

Actual No. (approx 4½" pitch)

= 70 approx.

Check for Elastic Stability of conical section.





$\frac{32}{72} = \frac{x}{48}$

$x = 21.3$

$r = 54 + 21 = 75$

Uplift = Downward reaction = 17778 lb (See Sheet (12))

this is distributed over half the diameter.

load per inch = $\frac{17778}{\pi \times 75}$ = 75.4 lb/inch.

Roark Case K Table XVI

Critical Compressive Stress = S'

$$S' = \frac{1}{6}\,\frac{E}{1-v^2}\left[\sqrt{12(1-v^2)\left(\frac{t}{r}\right)^2 + \left(\frac{\pi t}{b}\right)^4} + \left(\frac{\pi t}{b}\right)^2\right]$$

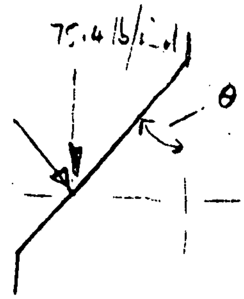
$b = \pi r = \pi \times 75 = 235.6.$ $V = 0.33$

$$= \frac{30\times10^6}{6 \times 0.89}\left[\sqrt{12 \times 0.89 \times \left(\frac{0.25}{75}\right)^2 + \left(\frac{\pi \times 0.25}{235.6}\right)^4} + \left(\frac{\pi \times 0.25}{235.6}\right)^2\right]$$

$$= 5617977.5\left[\sqrt{0.0001174 + \text{Negligible}} + 0.000011\right]$$

$= 60,933$ lb/sq in.

Compressive Stress = $\frac{75.4}{\text{Area}}$ Negligible



$\cos\theta = \frac{55\frac{1}{2}}{72} = 0.77$

(Actually, Radial Pressure = 75.4 × .77)

Radial pressure = $\frac{75.4}{0.77} = 97.9$ say 98 lb/in.

Roark Table XVI Case Q. (Cylinder)

$$p' = 0.807\frac{Et^2}{lr}\sqrt[4]{\left(\frac{1}{1-\nu^2}\right)^3\frac{t^2}{r^2}}$$

$$= \frac{0.807 \times 30\times10^6 \times 0.25^2}{72 \times 75}\sqrt[4]{\left(\frac{1}{0.89}\right)^3 \times \frac{0.25^2}{75^2}}$$

$$\sqrt[4]{1.418 \times 0.000011} = 0.0627$$

$= 17.58$ lb/sq.

Compressive Stress = $\frac{98}{\text{Area}} = \frac{98}{\pi \times r \times 0.25} = \frac{98}{\pi \times 75 \times 0.25}$

$= 1.66$ lb/sq.

Compressive Stresses are negligible.

BABCOCK CONTRACTORS, INC.

HOLLEY, KENNEY, SCHOTT

SUBJECT LOADS FROM REFRACTORY SHELL DESIGN

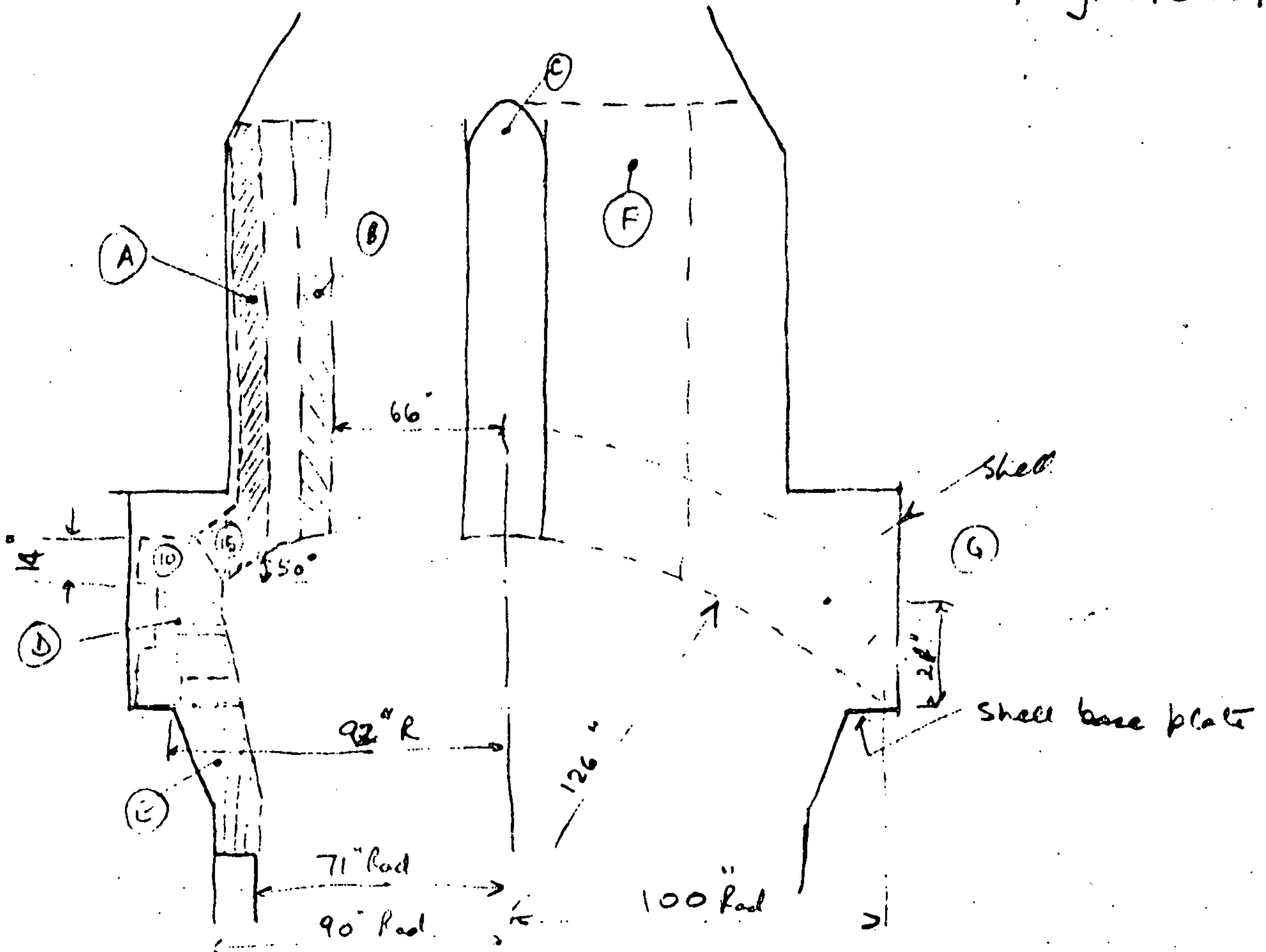
SHEET No. 1 OF 8

PROJECT 3001

BY [illegible] DATE 7/10/78

CH. DATE

Ref Dg. M5439.



(A) 58,000# Distributed via (15) & (10)

(B) 47,000# Transferred to shell via 5 arches.

(C) 5,100# " " " " " "

(D) 17,000# Vertical load on shell base plate.

(E) 14,580# Vertical load on cooling jacket.

(F) 33,000# Transferred to shell via 5 arches.

G 5,500# Self weight of 5 Arch. transferred into shell

BABCOCK CONTRACTORS, INC. SUBJECT .... SHEET No. (2) OF 8

PROJECT 3001

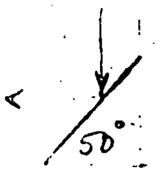
HOLLEY, KENNEY, SCHOTT ..... SHELL DESIGN ..... BY .... DATE 7/10/78

CH. .... DATE ....

Total Vertical & Horizontal reactions

(1) due to (A)

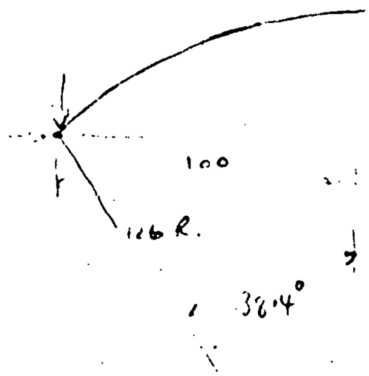
$$\text{Vertical} = \frac{38000^{\#}}{\pi(100^2-92^2)} = 8.0 \text{ lb/sq in.}$$



$$\text{Horizontal } \frac{38000 \times \tan 40^\circ}{2\pi \times 100 \times 14} = 3.62 \text{ lb/sq in} \checkmark$$

(2) Due to (B)

$$\text{Vertical} = \frac{47{,}000^{\#}}{5} = 9{,}400^{\#} \text{ per arch.} \checkmark$$



$$\text{Horizontal} : 9400 \times \tan 51.6 = 11{,}860^{\#} \text{ per arch.} \checkmark$$

(3) Due to (C)

$$\text{Vertical } \frac{5100^{\#}}{5} = 1020^{\#} \text{ per arch} \checkmark$$

$$\text{Horizontal } 1020 \times \tan 51.6 = 1290^{\#} \text{ per arch.} \checkmark$$

4) Due to (D)

$$\text{Vertical } \frac{17{,}000^{\#}}{\pi(100^2-92^2)} = 3.6 \text{ lb/sq in}$$

5) due to (E)

$$\text{Vertical} = \frac{14{,}500}{\pi(96^2-71^2)} = 1.5 \text{ lb/sq in} \checkmark$$

6) Cont

(6) Due to (F) Vertical $\frac{33000}{5} = 6{,}600^{\#}$ per arch.

Horizontal: $6600 \times \tan 51.6° = 8327^{\#}$ per arch

7) Due to (G) Vertical $\frac{5{,}500}{5} = 1{,}100^{\#}$ per arch

Horizontal $= 1{,}100 \times \tan 51.6 = 1388^{\#}$ per arch.

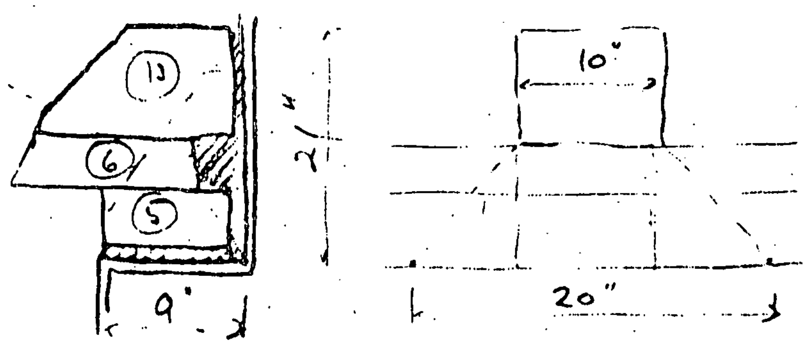
Total Vertical forces from each arch =

Vertical $= 9{,}400 + 1020 + 6600 + 1{,}100 = 18{,}120^{\#}$ per arch

Total horizontal forces from each arch –

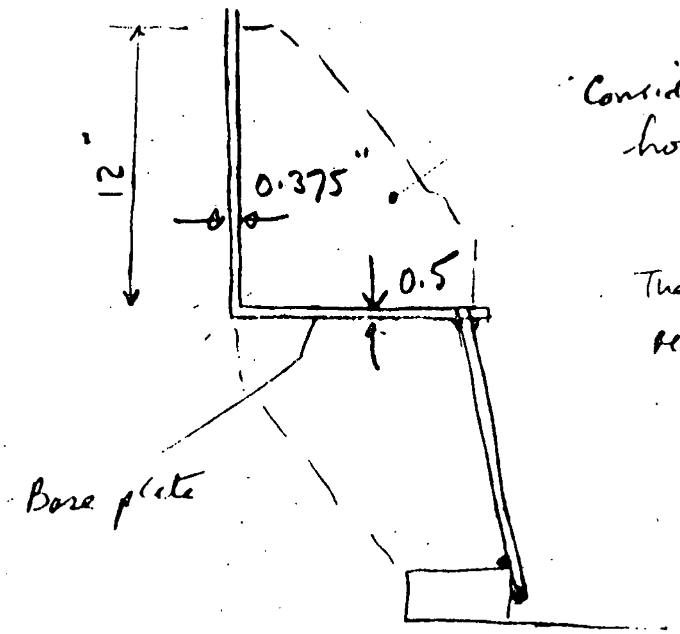
Horizontal $= 11{,}860 + 1290 + 8327 + 1388 = 22{,}865^{\#}$ per arch.

assume transferred via blocks (13), (6) (5a) (MW 5439)



Horizontal Force Distributed over Area = $10 \times 21 = 210$ sq in

Vertical Force Distributed over area = $9" \times 20" = 180$ sq in

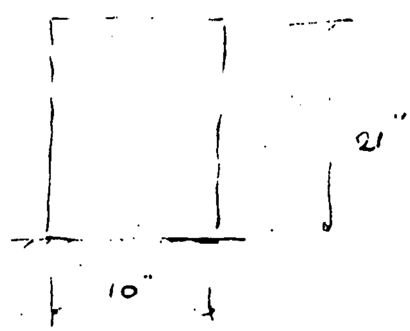


Consider this rib to accomodate horizontal + vertical reactions from arches.

These ribs to be located on ℄ of 5 refractory partitions.

Hoop stress in shell. due to horizontal force from arches.

Assume Flat plate



Assume edges simply supported.

Roark Table X case 36.

$$S = \beta \frac{wb^2}{t^2}$$

$\frac{a}{b} = \frac{21}{10} = 2.1 \quad \beta = 0.63 \qquad w = \frac{22865}{210} = 108.8$ lb/sq in

$$S = \frac{0.63 \times 108.8 \times 10^2}{0.3125^2} = 10{,}189 \text{ lb/sq in}$$ Too high

but ignores stiffness from bottom plate.

Check if all edges fixed

Roark Table X Case. 41

$\beta = 0.5$

& take $t = 0.5$,

$$S = \frac{0.5 \times 108.8 \times 10^2}{0.5^2} = 21{,}760 \text{ lb/sq in}$$

This is acceptable as the horizontal forces will be distributed over a larger area in practice. and the calculation ignores The stiffness given by rib.

e.g. if we take $b = 5''$ + plate Simply Supported.

$$\frac{a}{b} = \frac{21}{5} = 4.2. \quad \beta = 0.5.$$

$$S = \frac{0.5 \times 108.8 \times 5^2}{0.3125^2} = \underline{\underline{13{,}926 \text{ lb/sq in}}}$$

Hoop Stress in shell due to distributed load.

Total Pressure due to dist. load = $3.62 + \cancel{1.5} +$ gas pressure 4.3

$$= 9.42 \text{ psi}$$

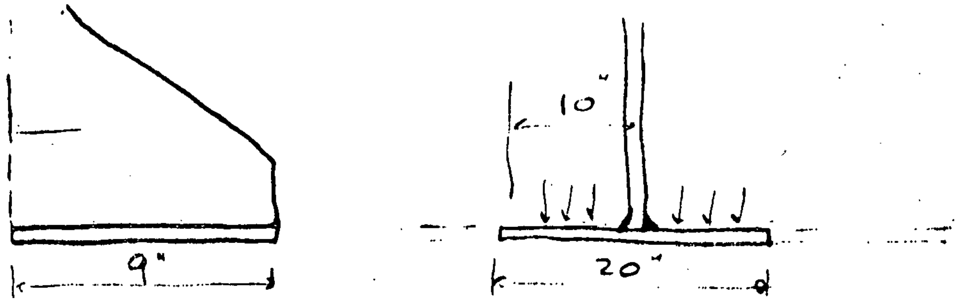
$$t = \frac{PR_o}{SE + 0.4P} = \frac{9.42 \times 100}{\underset{6900}{11{,}500 \times 0.6} + \underset{3.768}{0.4 \times 9.42}} = \underline{\underline{0.136''}}$$

Make shell 1/2" thick (but check for main supports)

BABCOCK CONTRACTORS, INC. SUBJECT .... SHEET No. ...... OF ......

HOLLEY, KENNEY, SCHOTT ..... SHELL DESIGN ..... PROJECT 3001 BY ...... DATE 7/10/78 CH ...... DATE ......

Stresses in base plate due to load from 5 arches.



$$w = \frac{\text{Total Vertical load}}{\text{area}} = \frac{18120}{9 \times 20} = 101 \text{ lb/sq in}$$

Take flat plate. 10" × 9" edges simply supported

$$\frac{a}{b} = \frac{10}{9} = 1.1 \qquad \beta = 0.29$$

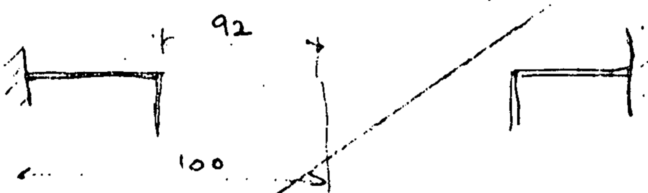
$$\text{Max } S = \beta \frac{wb^2}{t^2} = \frac{0.29 \times 101 \times 9^2}{0.5^2} = \underline{\underline{9163 \text{ lb/sq in}}}$$

~~Stress in base plate due to distributed vertical reactions~~

~~Total pressure = 8.0 + 3.6 + gas pressure 4.3~~

~~= 15.9 psi~~

VOID



~~$\frac{a}{b} = \frac{100}{92} = 1.08$~~

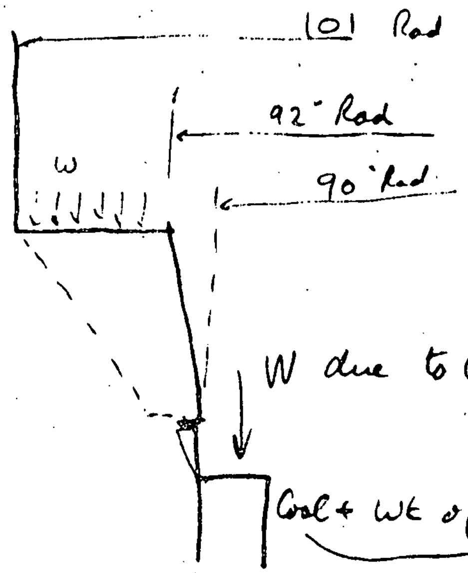
~~take 1.25, $\beta = 0.105$~~

~~Roark Table X Case 17~~ ~~$S = \beta \frac{wa^2}{t^2} = \frac{0.105 \times 15.9 \times 100^2}{0.5^2}$~~

~~$= \underline{66780} \text{ lb/sq in}$~~

~~This calculation should take into account the 32 gussets below the base plate. + load due to wt of cooling jacket~~

~~Pitch of gusset = $\frac{92" \times 2\pi}{32} = \underline{18"}$~~



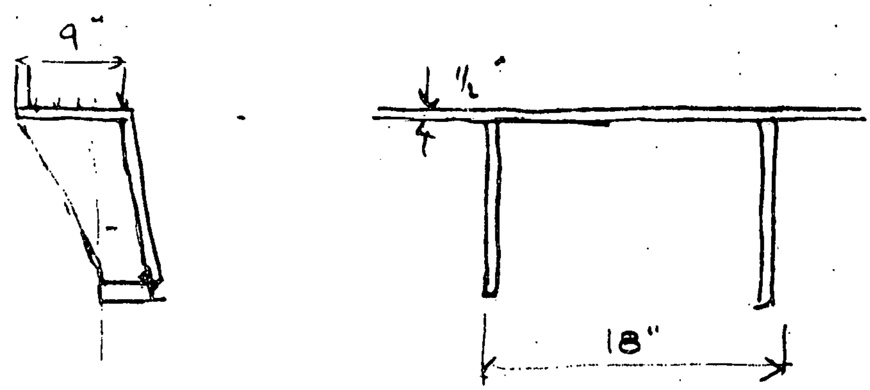
W due to E + wt of jacket + wt of grating + coal wt.

E

$\underbrace{\text{Coal + wt of jacket + wt}}$ of grating + wt of refractory

230,000 + 14500 = 244,500 lb

From Sheet 6 w = 15.9 psi

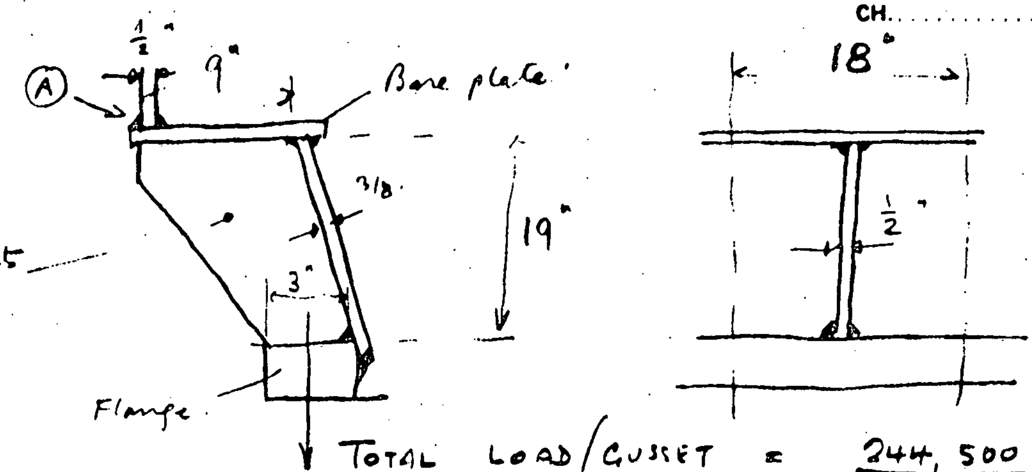


Flat plate with dist. load w. $\frac{a}{b} = \frac{18}{9} = 2$,

All edges fixed. Roark Table X Case. 41 $\beta = 0.5$

$S = \frac{\beta w b^2}{t^2} = \frac{0.5 \times 15.9 \times 9^2}{0.5^2} = 1238$ lb/sq.

No. of gusset = 32



TOTAL LOAD/GUSSET = $\frac{244,500}{32}$ = 7641 lb

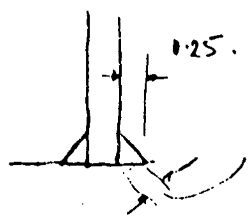
Gusset plates will take out bending from components due to the radial stiffener of the base plate + flange.
Check therefore tensile stress in shells and gussets and shear stress in weld.

Total shell area resisting load @ A = 18 × 0.5 = 9 sq ins

Stress = $\frac{7641}{9}$ = 849 lb/sq"

Plate area below base will be greater than at A.

Shear stress in weld at A



Throat = 0.7 × 0.25 = 0.176.

Weld area = 0.172 × 2 × 18 = 6.36 sq"

Stress = $\frac{7641}{6.36}$ = 1201 lb/sq"

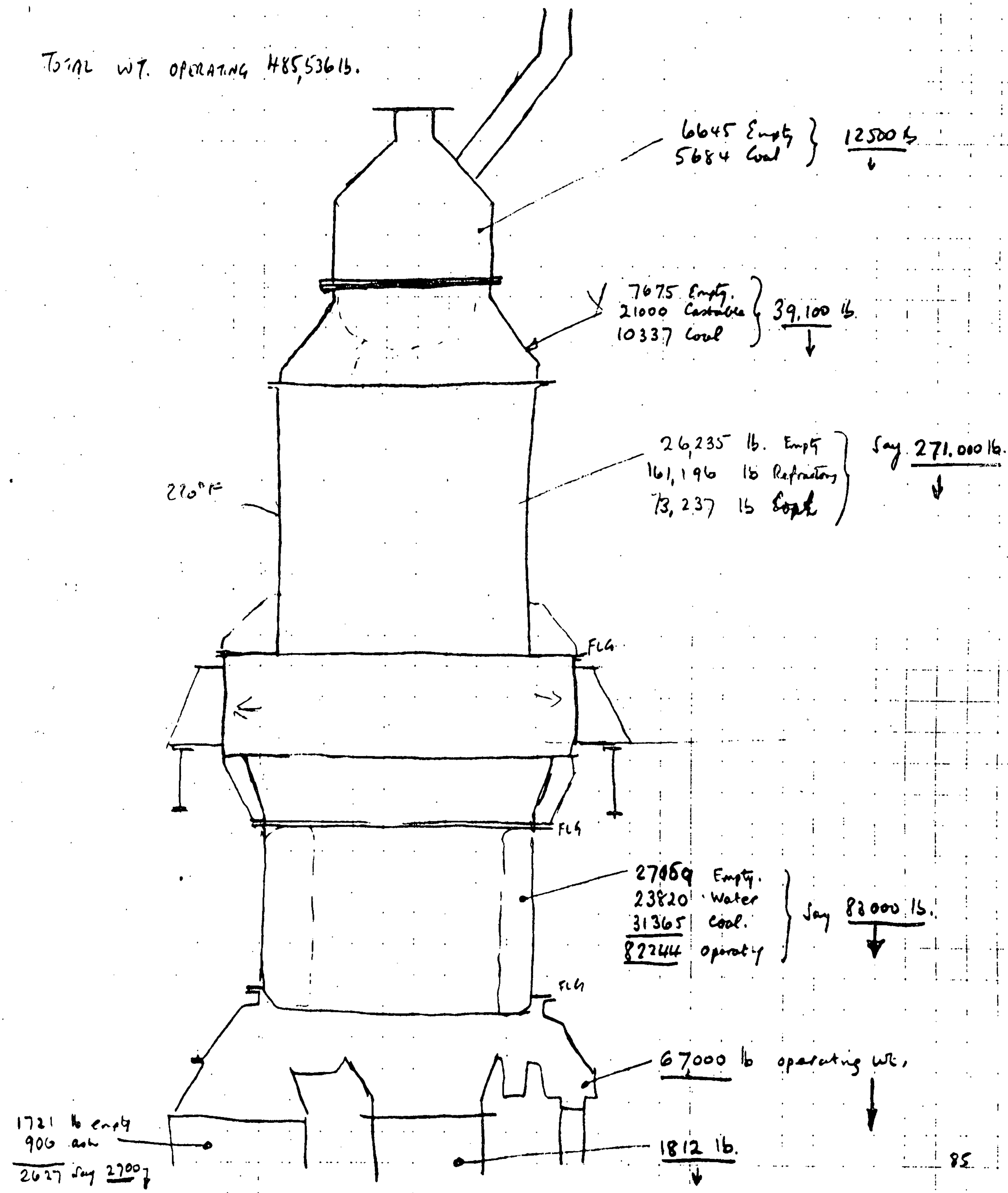
Weld area below base will be greater than at A

BABCOCK CONTRACTORS, INC. SUBJECT STRESSES IN FLANGED JOINTS DUE TO WEIGHT — SHELL DESIGN

SHEET No. 1 OF 6
PROJECT 3001
BY WGills DATE 7/7/78
CH. DATE

HOLLEY, KENNEY, SCHOTT

TOTAL WT. OPERATING 485,536 lb.



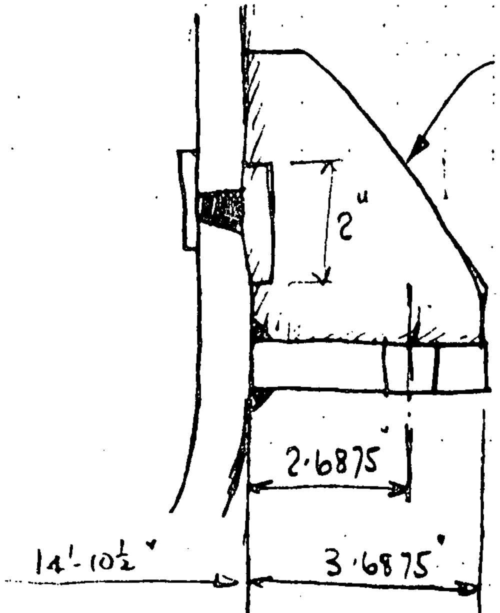
BABCOCK CONTRACTORS, INC. SUBJECT STRESSES DUE TO WEIGHT SHELL DESIGN

HOLLEY, KENNEY, SCHOTT

SHEET No. (9) OF 6
PROJECT 3001
BY .... DATE 7/7/78
CH. .... DATE ....

TOTAL LOAD OF GRATE ETC ON BOTTOM SUPPORT RING ON WATER JACKET

$$= 67{,}000 + 1812 + 2700 = 71512 + \text{wt of Coal above}$$
$$= 71512 + 31365 + 73237$$
$$= 176{,}114 \quad \text{Say } 177{,}000 \text{ lb.}$$

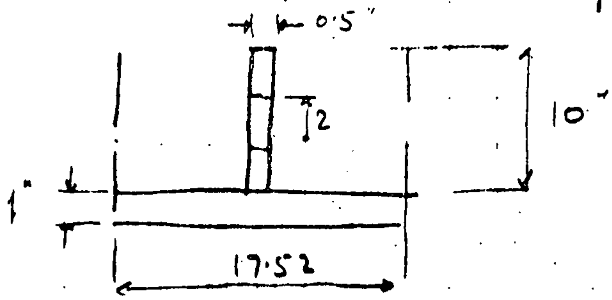


15-3 7/8
14'-10½
-5 3/8
2 11/16
2.6875
15'5

Load per gusset plate = $\frac{177000}{30}$ = 5900 lb

Allowable Shear stress = $0.26 \times 0.9 \times 13800 = 3230$ psi. (PG 55.3)

Length of Weld :



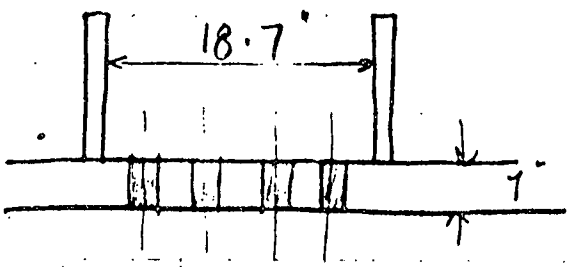
$$= (17.52 \times 2) + (10 \times 2) + 2" - 4" = 53$$

Stress Area = $x \times 53$ where x = Weld Size

$$\therefore 3230 = \frac{5900}{53 \times x} \quad \therefore x = \frac{5900}{53 \times 3230} = 0.035"$$

use ¼" Fillet welds (minimum)

Bending Stress in Support Ring.



4 bolts between each gusset plate. — assume load is evenly distributed.

Roark. Table X Case No. 45.

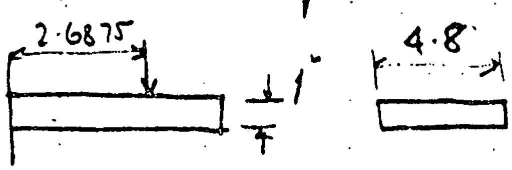
One long edge fixed, short edges supported, other edge free.

$\frac{a}{b} = \frac{18.7}{3.6875} = 5.07$ $\omega = \frac{5900}{18.7 \times 3.6875} = 85.56$ lb/sq in

$\beta = 3.$

$\text{Max } S = \beta \frac{\omega b^2}{t^2} = \frac{3 \times 85.56 \times 3.6875^2}{1^2} = \underline{3490}$ lb/sq in OK

alt. Take one bolt pitch as a cantilever beam.

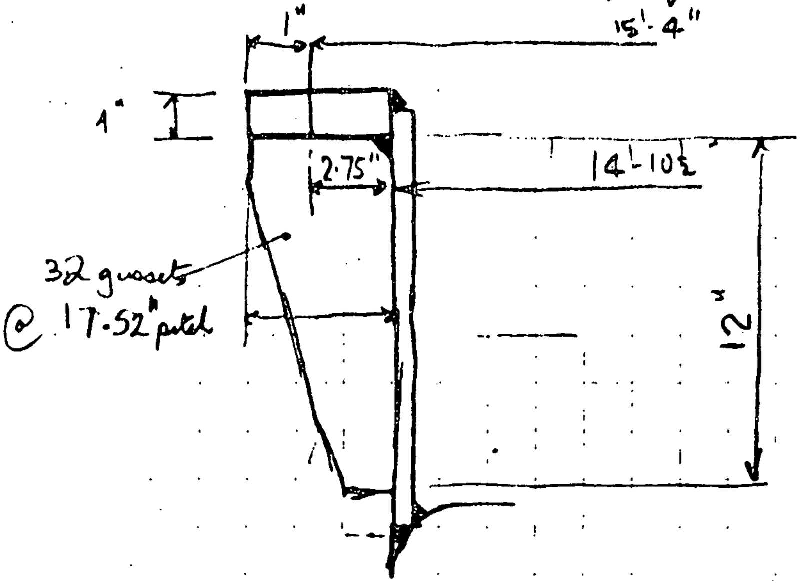


$M = Wl = 2.875 \times \frac{5900}{4} = 4240$ lb in.

$I = \frac{bd^3}{12} = \frac{4.8 \times 1^3}{12} = 0.4 \text{ in}^4$ $Z = 0.8 \text{ in}^3$

$S = \frac{M}{Z} = \frac{4240}{0.8} = \underline{5300 \text{ lb/sq in}}$ OK

Stress in connection at top of water Jacket



15-4
14-10½
-5½

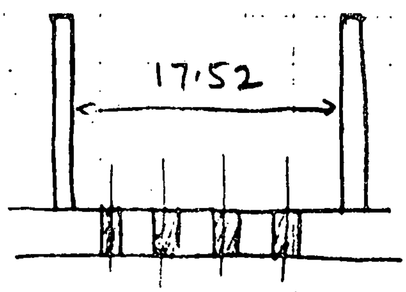
TOTAL WT = 73,000 + 83000 = 156,000 lb Plus wt of coal above
= 156,000 + 73237 = 229,237

load per gusset plate = $\frac{230,000}{32}$ = 7188 lb.

by inspection of previous calculation weld size = ¼" min.

Bending Stress in flange.

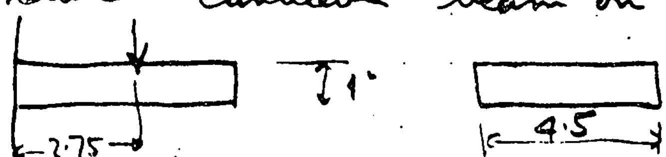
$\omega = \frac{7188}{17.52 \times 3.75}$, 109.4 lb/sq."



Roark Table X Case 45

$\frac{a}{b} = \frac{17.52}{3.75} = 4.675$ $\beta = 3$, Max S = $\frac{3 \times 109.4 \times 3.75^2}{1^2}$ = 4615 lb/sq
OK

Alternative - Cantilever beam on one bolt pitch.



$M = Wl = 2.75 \times \frac{7188}{4} = 4942$ lb in ; $I = \frac{4.5 \times 1^3}{12} = 0.375$

$S = \frac{M}{Z} = \frac{4942}{0.75} = 6589$ lb/sq. OK

Longitudinal Stress in shell attached to top of water jacket. (Tensile)

Total load = 229,237 lb.

Stress area = $\pi D \times t$

$= \pi \times 178 \times 0.625'' = 349$ sq in

Stress = $\frac{229,237}{349}$ = 657 lb/sq in. OK.

Stress in bolts at top of water jacket.

Total load = 229237.

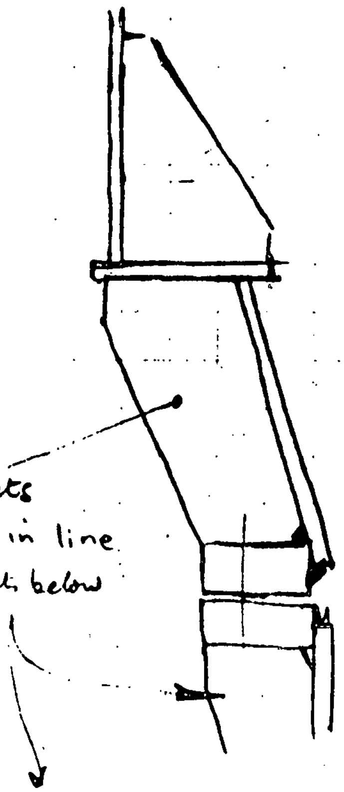
No of bolts = 128.

load per bolt = $\frac{229237}{128}$ = 1791 lb/bolt.

Stress = $\frac{1791}{\text{area}}$ - root area 7/8" bolt 0.55 sq in.

Stress = $\frac{1791}{0.55}$ = 3256. lb/sq in OK.

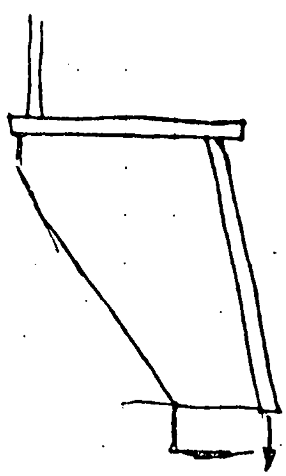
Conical Section at base of main shell.



32 - gussets orientation in line with gussets below

because gussets are in line flange calculation is same as sheet (4)

actually load should be slightly higher due to weight of refractory (14500 lb.) but stress levels are so low the conclusions will not be affected



W = 230,000 lb + wt of Refractory = 230,000 + 14,500
=

See Calculations For Loads From Refractory.

BABCOCK CONTRACTORS, INC.

HOLLEY, KENNEY, SCHOTT

SUBJECT CALCS FOR MAIN SUPPORT

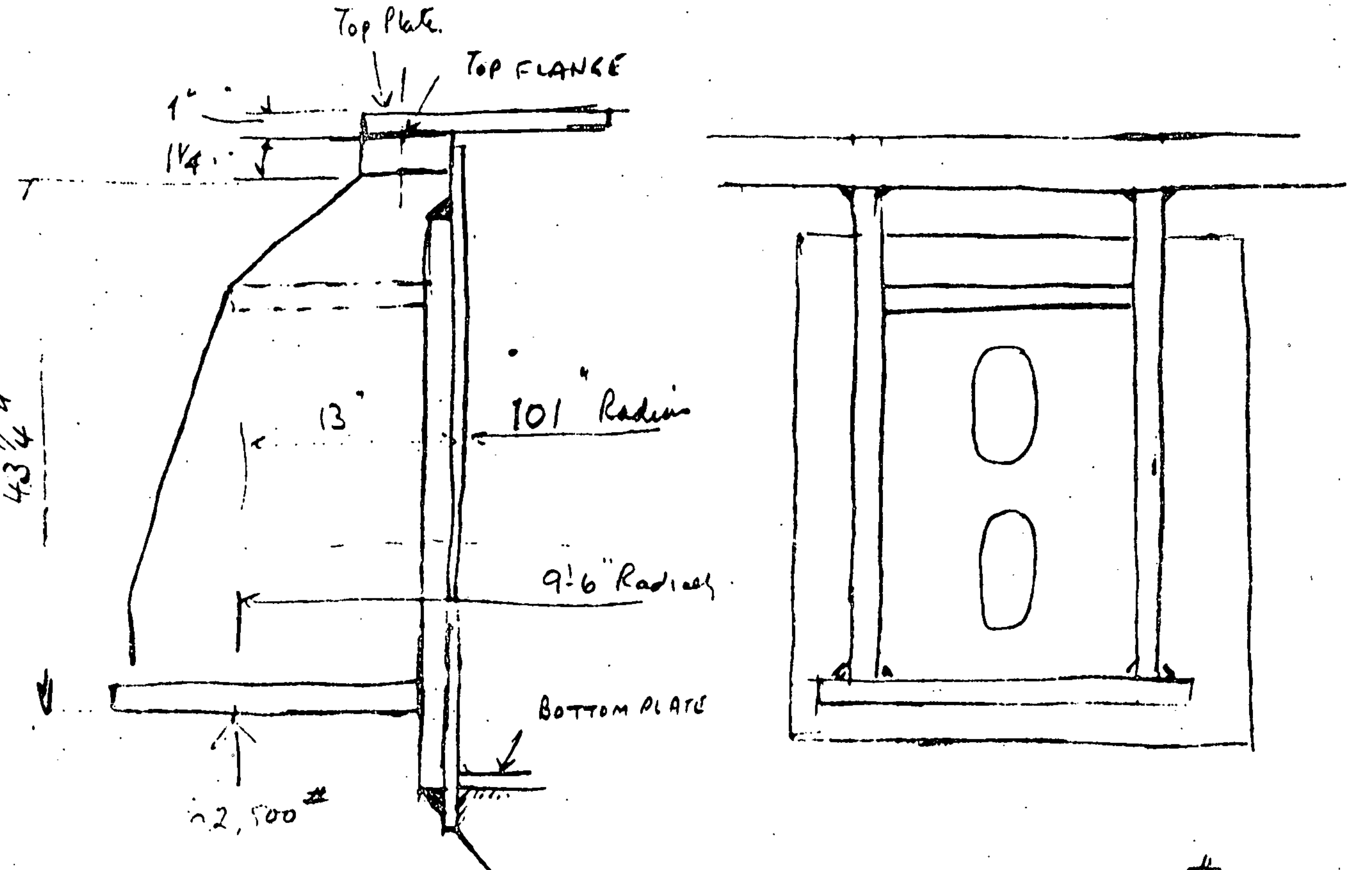
SHELL DESIGN

SHEET No. (1) OF 4

PROJECT 30001

BY CK DATE 7/8/78

CH. DATE



TOTAL WEIGHT OF GASIFIER OPERATING = 500,000#

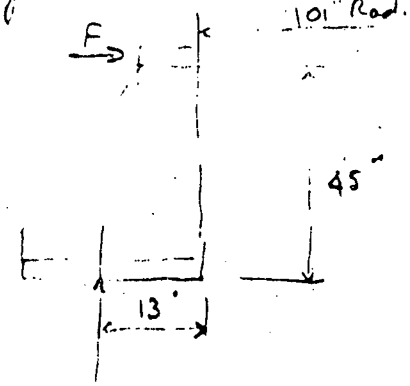
$$\text{LOAD / SUPPORT} = \frac{500,000}{8} = 62,500\#$$

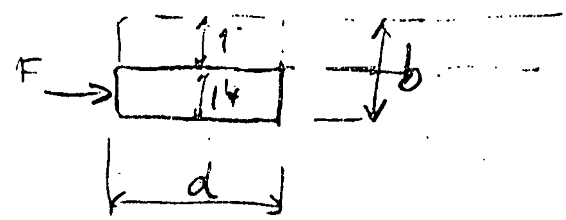
The top Flange, top plate with gussets back to upper shell. Contribute as a compression ring to resist the overturning moment on the bracket.

Take moment at 1/3 d above base.

Consider Top Flange as a compression ring.

radial compressive force will be distributed thro ring by bracket ribs, doubling plate + shell.





b =

500,000# Total Vertical Force.

$$F = 500{,}000 \times \frac{13}{45} = 144{,}444^{\#}$$

$$\text{load / inch of circ} = \frac{144{,}444}{2\pi \times 101} = 227 \text{ lb/inch.}$$

Critical load for buckling $p' = \dfrac{3EI}{r^3}$

$$p' = \frac{3 \times 30 \times 10^6 \times I}{101^3} = 87.35\, I.$$

If we take a safety factor of 4

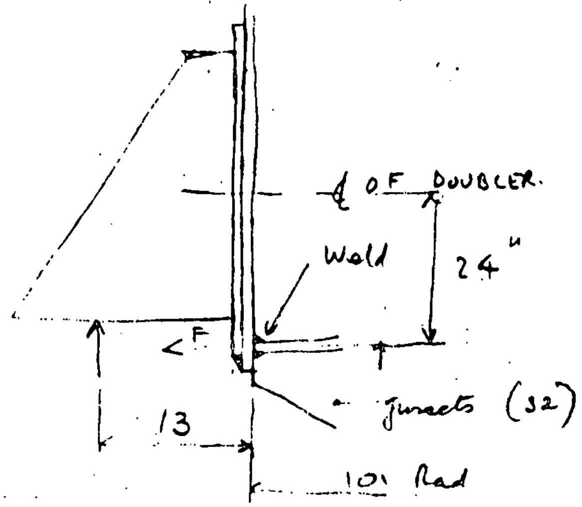
$$\text{Allowable } P = \frac{87.35\, I}{4} = 227$$

$$\therefore I = \frac{227 \times 4}{87.35} = 10.39 \text{ in}^4$$

$$I = \frac{bd^3}{12} = \frac{2.25 \times d^3}{12} = 10.39$$

$$d^3 = \frac{10.39 \times 12}{2.25} = 55.4$$

$d = 3.8"$ but Top plate has a width of $15 + 2.6 = 17.2$ and will contribute to compression ring .. So OK to leave flange width as it is @ 2 9/16". 92



Total Load on all gussets 500,000# distributed onto

Shell via doublers + 32 gussets

Radial Tension $F = 500{,}000 \times \frac{13}{24} = 270833^{\#}$

Tensile Load per inch of circ $= \frac{270833}{2\pi \times 101} = \underline{427 \text{ lb}}$ per inch.

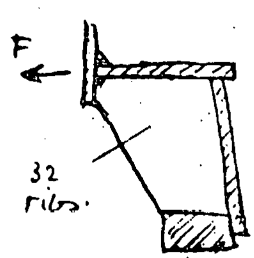
Tensile Load taken by bottom plate + 32 gussets & shell.

If we assume shell has no stiffener + no gussets.
Weld stress will be

$\frac{427}{\text{weld area}} = \frac{427}{1 \times 2 \times 0.7 \times 0.25} = 1220 \text{ lb/sq in}$

The strength of the section taking this horizontal component

is so strong no check necessary.



Stresses in weld.

Doubler to shell.

Tension area = 1/2 weld length × throat

$$= (41.75 + 22.875) \times (0.375 \times 0.7)$$ (Ignore weld – slot)

17 sq in.

Tensile Stress = $\frac{62500}{17} \times \left(\frac{13}{24}\right) =$ 1991 lb/sq in.

Shear area. = 22.875 × 2 × 0.375 × 0.7 Across Top/Bottom
plus 41.75 × 2 × 0.375 Sides.

= 12 + 31 = 43 sq in.

Shear Stress = $\frac{62500}{43}$ = 1453 lb/sq in

HOLLEY, KENNEY, SCHOTT, INC. SUBJECT GASKETS ON MAIN SHELL SHELL DESIGN SHEET No. 1 OF 2
PITTSBURGH, PA. BECKLEY, W. VA. JOB No. 3001
BY .... DATE 7/14/78
CHKD. .... DATE ....

Telephone Call to Garlock 7/14/78 Spoke to Mr. Evan Gauger.
Telephone No. (315) 597. 4811.

Re suitable gaskets for gasifier main flange joints.

He advised 3/16" thick Garlock Type 604.

This is a multi-ply. woven asbestos sheet impregnated with a rubber based cement.

Data given to Mr. Gauger

Duty - Product analysis.
Temp. 400°F
Pressure 4.32 psig.

Dimensions	Dia	14'-4 & 16'-10"
Width of gasket		2"
Dia of Bolt.		7/8"
Pitch of Bolts.		4.5" to 5"
Thickness of flange.		1"
Width of flange		2 3/4" approx.

Flanges not machined.

He advised a gasket seating pressure of 2200 lb/sq.in.

BOLT PITCH APPROX 5" avg.

BOLT SIZE 7/8" ∅

A307 Grade 36, allowable tension 22,000 lb/sq.

Tensile area, 0.4617 sq in.

Compressive Stress for 3/16" Garlock 604. = 2200 lb/sq.

Gasket width 2"

Gasket area = 2 × 5 = 10 sq in. less $\frac{\pi \times 1^2}{4}$

= 9.2 sq in

If we assume due to flange rotation the gasket area to be seated reduces to 66%

= 9.2 × 0.66 = 6.072 sq in

Bolt load available = 0.4617 × 22 000 = 10,157 lb

Bolt Load reqd = 6.072 × 2200 = 13358 lb

Try grade 50 Tensile Stress allowable = 30,000

Bolt load available = 0.4617 × 30,000 = 13851 lb/sq.

use grade 60 to give some margin of safety

'6

3001
A-3
Sh 2A
7/14/78

RIVETS AND THREADED FASTENERS
Tension
Allowable loads in kips

Unfinished Bolts and Threaded Parts
Tension on tensile stress area

ASTM Designation or Yield Stress		Allowable Tensile Stress F_t ksi	Nominal Diameter, in. ⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
			Tensile Stress Area, sq. in. 0.2260	0.3345	0.4617	0.6057	0.7633	0.9691	1.1549	1.4053
A307 Bolts		20.0	4.52	6.69	9.23	12.11	15.27	19.38	23.10	28.11
Threaded Parts F_y, ksi	36	22.0	4.97	7.36	10.16	13.33	16.79	21.32	25.41	30.92
	42	25.2	5.70	8.41	11.64	15.27	19.23	24.42	29.23	35.53
	45	27.0	6.10	9.03	12.47	16.35	20.61	26.17	31.18	37.94
	50	30.0	6.78	10.04	13.85	18.17	22.90	29.07	34.65	42.16
	55	33.0	7.46	11.04	15.24	19.99	25.19	31.98	38.11	46.37
	60	36.0	8.14	12.04	16.62	21.81	—	—	—	—

The definition of tensile stress area is given in the AISC Specification, Section 1.5.2.1. Values are based on UNC thread dimensions.
Nuts must meet specifications compatible with threaded parts.
For Upset Rods see AISC Specification, Section 1.5.2.1.

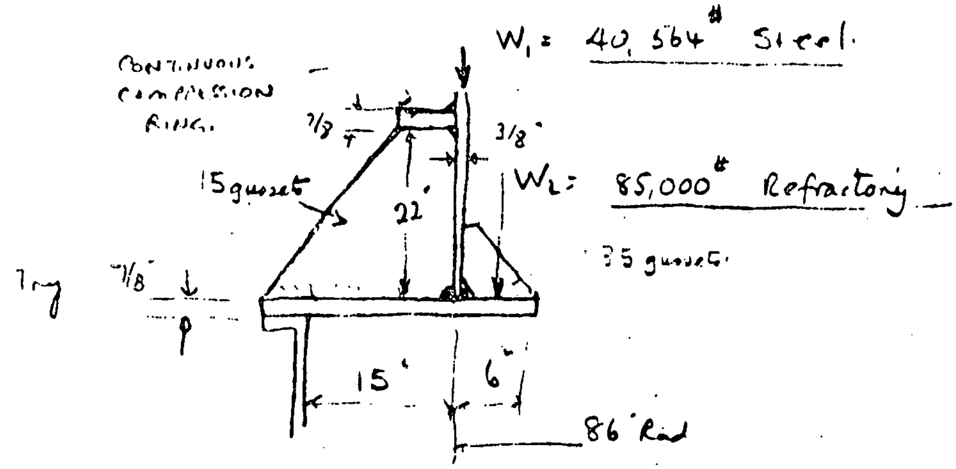
Rivets and High Strength Bolts
Tension on gross (nominal) area

ASTM Designation		Allowable Tensile Stress F_t ksi	Nominal Diameter, in. ⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
			Gross (Nominal) Area, sq. in. 0.3068	0.4418	0.6013	0.7854	0.9940	1.2272	1.4849	1.7671
Rivets	A502-1	20.0	6.14	8.84	12.03	15.71	19.88	24.54	29.70	35.34
	A502-2	27.0	8.28	11.93	16.24	21.21	26.84	33.13	40.09	47.71
Bolts	A325	40.0	12.27	17.67	24.05	31.42	39.76	49.09	59.40	70.68
	A490	54.0[a]	16.57[a]	23.86[a]	32.47[a]	42.41[a]	53.68[a]	66.27[a]	80.18[a]	95.42[a]

[a] For static loading only.

For allowable combined shear and tension loads, see AISC Specification, Section 1.6.3.

E.

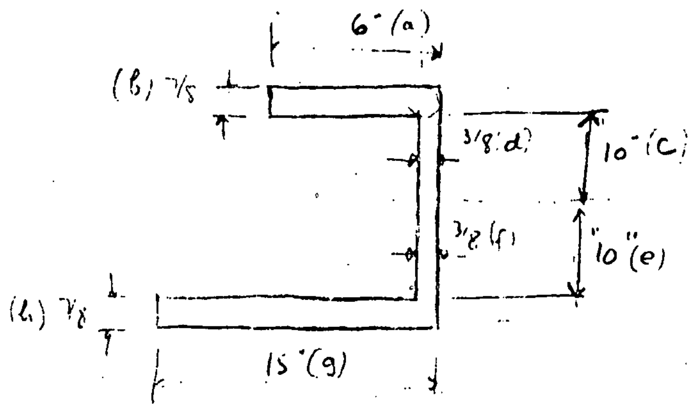


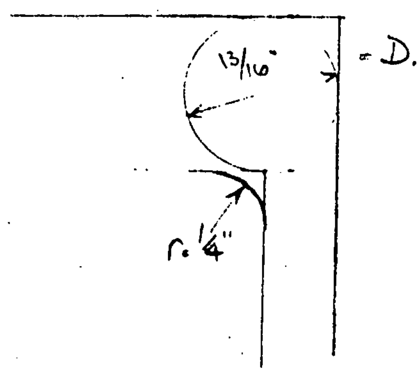
load per gusset = $\frac{40{,}564 + 85{,}000}{15}$ = 8371.#

Moment per gusset = 8371 × 15 = 125,565 lb in

Pitch of gusset = $\frac{2\pi\,86}{15}$ = 36."

Roark Table IX Case 20.





$$\theta = \frac{TL}{KG}$$

$$K = (K_1 + K_2 + \alpha_1 D^4) + (K_3 + K_4 + \alpha_2 D^4)$$

$$K_1 = ab^3\left[\frac{1}{3} - 0.21\,\frac{b}{a}\left(1 - \frac{b^4}{12a^4}\right)\right]$$

$$= 6 \times 0.875^3\left[0.33 - 0.21\,\frac{0.875}{6}\left(1 - \frac{0.875^4}{12 \times 6^4}\right)\right] = \underline{1.203.}$$

.58

0.999

0.2993

$$K_2 = c d^3 \left[0.33 - 0.105 \frac{d}{c}\left(1 - \frac{d^4}{192 c^4}\right)\right]$$

$$= 10 \times 0.375^3 \left[0.33 - 0.105 \times \frac{0.375}{10}\left(1 - \frac{0.375^4}{192 \times 10^4}\right)\right] = \underline{0.1735}$$

0.329

$$\alpha_1 = \frac{d}{b}\left(0.07 + 0.076 \frac{r}{b}\right)$$

$$= \frac{0.375}{0.875}\left(0.07 + 0.076 \times \frac{0.25}{0.875}\right) = \underline{0.0393}$$

α_2 is same. $= \underline{0.0393}$

$$\alpha_{1,2} D^4 = 0.0393 \times 0.8125^4 = 0.017$$

$$K_3 = 15 \times 0.875^3 \left[0.33 - 0.21 \frac{0.875}{15}\left(1 - \frac{0.875^4}{12 \times 10}\right)\right] = \underline{3.215}$$

0.32

$K_4 =$ Same as $K_2 = 0.1735.$

$$K = 1.203 + 0.1735 + 0.017 + 3.215 + 0.1735 + 0.017 = 4.71$$

$$\theta = \frac{TL}{KG} = \frac{125{,}565 \times 36}{4.71 \times 11.5 \times 10^6} = \underline{0.083 \text{ radians.}} \quad (4.78^\circ)$$

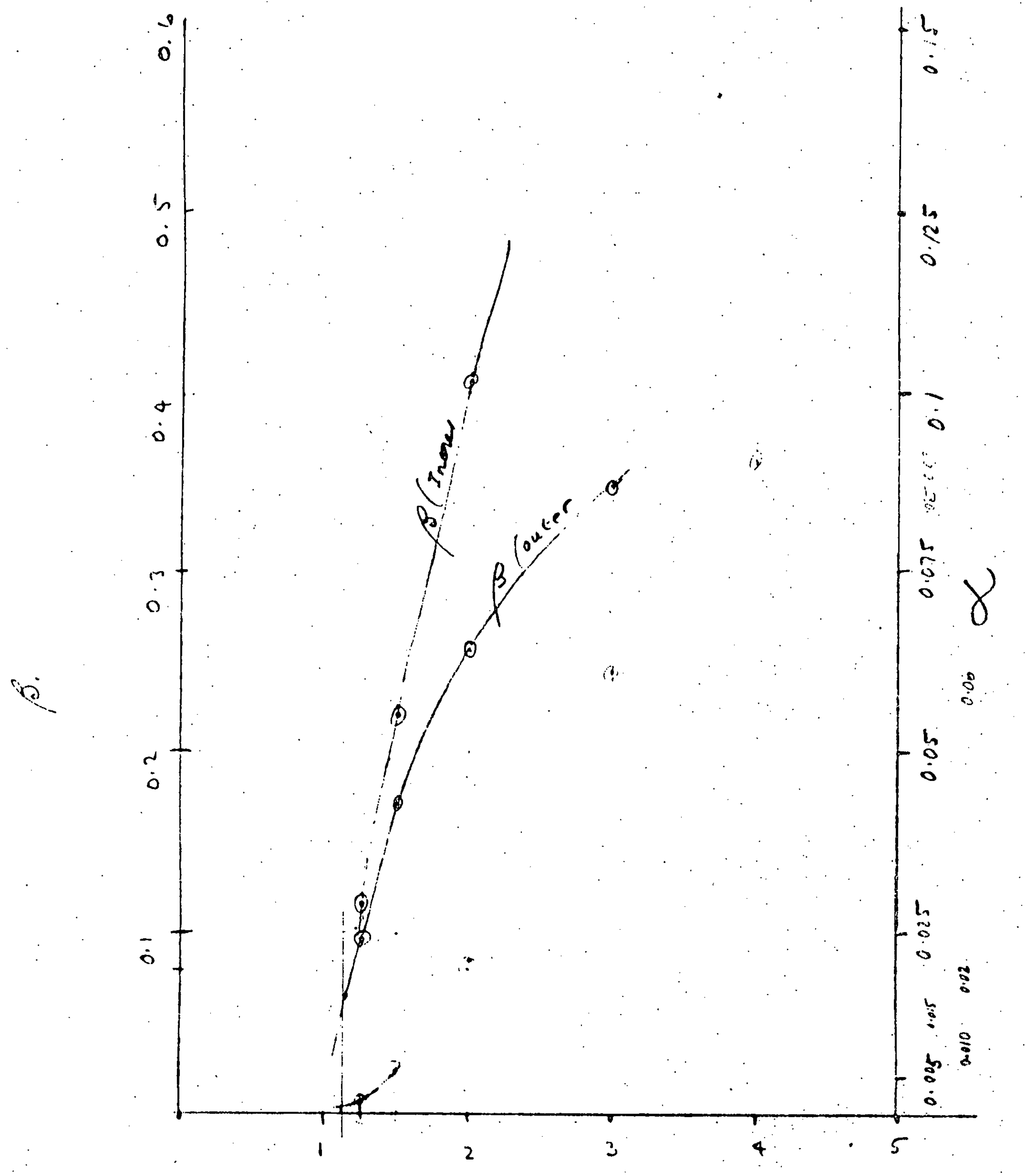
This is not a fair analysis because (1) does not consider effect of the lower plate bolted to the flange, & the shell continue above the top flange of the section. (2) The section is thro a ring not a straight beam

BABCOCK CONTRACTORS, INC. SUBJECT SHEET No. 4 OF 6

PROJECT 3001

HOLLEY, KENNEY, SCHOTT SHELL DESIGN BY DATE 7/12/78

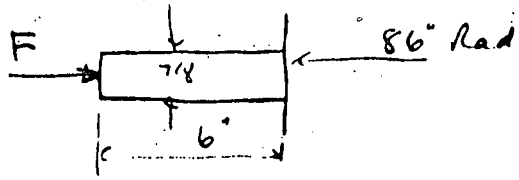
CH. DATE

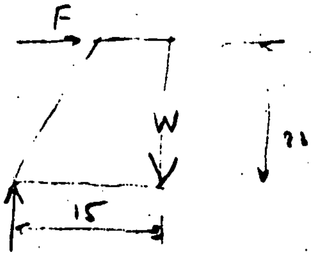


For a/b = 1.17 β inner & β outer = 0.063

lower α = 0.0013

If we take top compression ring.





$$\frac{W \times 15}{22} = F = (40{,}564 + 85000) \times \frac{15}{22} = 85612^{\#}$$

Ring will distribute load $= \dfrac{85612}{86 \times 2\pi} = 158$ lb/inch of circ.

Roark Table XV. Case 12. for Critical pressure p'

Ring with uniform radial load.

$$p' = \frac{3EI}{r^3}$$

$$I = \frac{0.875 \times 6^3}{12} = 15.75 \text{ in}^4$$

$$p' = \frac{3 \times 30 \times 10^6 \times 15.75}{86^3} = 2228^{\#}$$

Top Plate

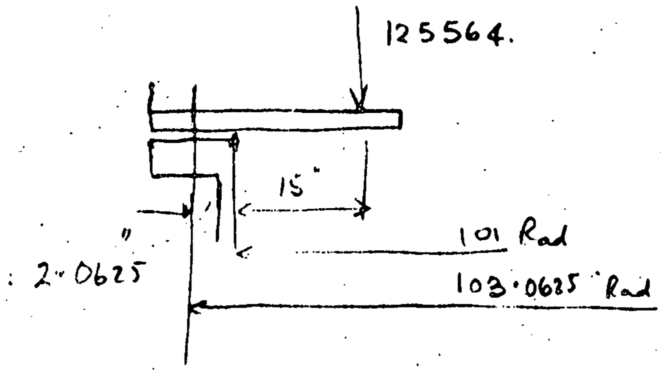
Roark Table X Case 20. $W = 125{,}564^{\#}$

$$\frac{a}{b} = \frac{101}{86} = 1.17 \qquad \beta = 0.063$$ (See sheet 4)

Max Stress $\dfrac{\beta W}{t^2} = \dfrac{0.063 \times 125564}{0.875^2} = \underline{10{,}332}$ lb/sq in

$$y = \frac{\alpha W a^2}{E t^3} = \frac{0.0013 \times 125564 \times 101^2}{30 \times 10^6 \times 0.875^3} = 0.082''$$ deflection.

Effect on flange below top plate



Tension load in bolts = $125564 \times \frac{15}{2.0625} = 913192$

No of bolts, 136

load per bolt: 6714 Stress: $\frac{6714}{0.4617} = 14543$ lb/sq in OK

Stress area: 0.4617"

load per inch of circ = $\frac{1205414}{2 \times \pi \times 103.06} = 1862$ lb.

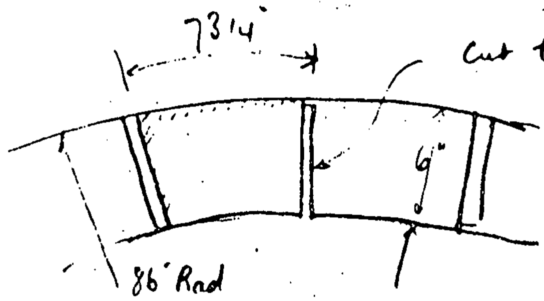
Bending Moment in flange = $1862 \times 2.0625 = 3840$ lb.in

For Unit Bending Stress $t = \sqrt[2]{\frac{6M}{S}}$

$$= \sqrt{\frac{6 \times 3840}{13{,}000}} = 1.33$$

make flange $1\frac{3}{8}$"

Support ledge for refractory:



Cut to allow for differential Expansion. Bricks will span the cut

TOTAL REFRACTORY WT = 85,000#

Area of support = $\pi(86^2 - 80^2) = 3129$ sq in.

Pressure = $\frac{85000}{3129} = 27$ lb/sq in.

Case 45 Table X
If we take plate $15\frac{1}{2} \times 6$" with long edge fixed short edges support. other edge free.

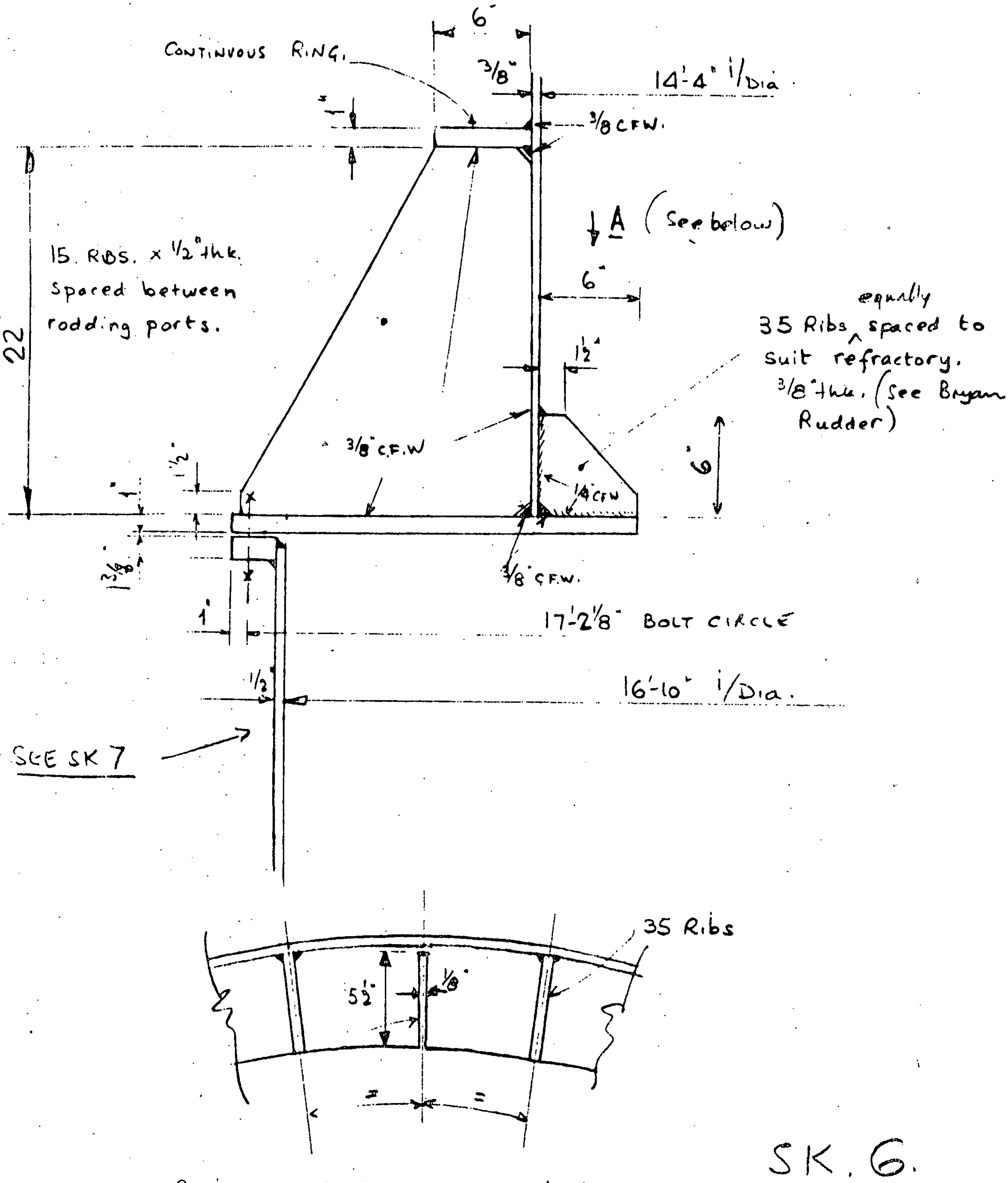
$\frac{a}{b} = \frac{15\frac{1}{2}}{6} = 2.58$

$\beta = 2.3$
$\alpha = 0.862$

$S_b = \beta \frac{wb^2}{t^2} = \frac{2.3 \times 27 \times 6^2}{1^2} = 2235$ lb/sq in OK.

$y = \alpha \frac{wb^4}{Et^3} = \frac{0.862 \times 27 \times 6^4}{30 \times 10^6 \times 1^3} = \underline{0.001"}$ ok

HOLLEY, KENNEY, SCHOTT, INC. SUBJECT SHELL DETAILS SHEET No. 1 OF 7
PITTSBURGH, PA. BECKLEY, W. VA. JOB No. 3001
BY Whittle DATE 7/12/78
CHKD. DATE



Radial slot between each rib to allow for differential expansion.

VIEW ON ARROW A

SK. 6.

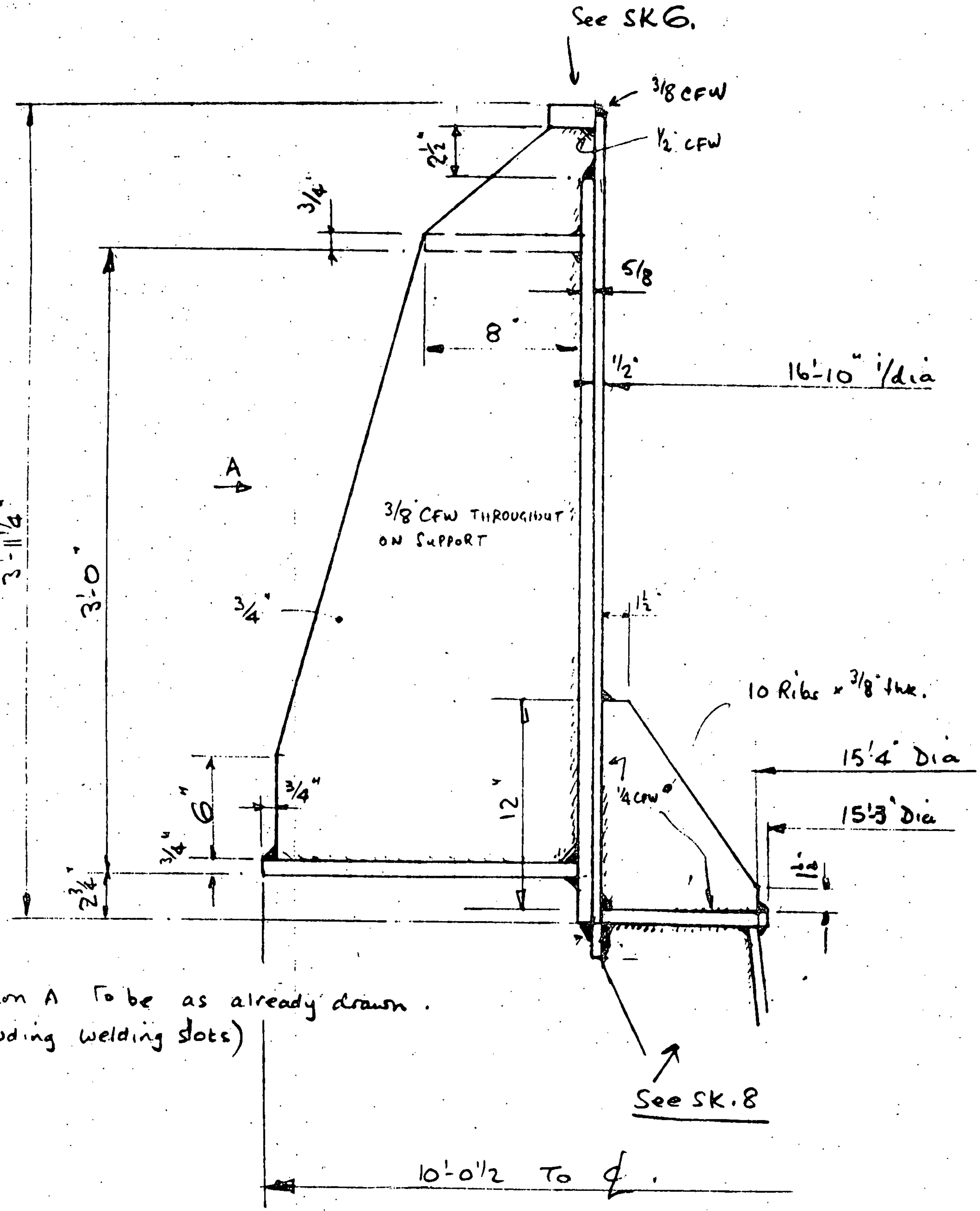
(SK1 - 5 are in code part)

HOLLEY, KENNEY, SCHOTT, INC. SUBJECT SHELL DETAILS SHEET No. 2 OF 7

PITTSBURGH, PA. BECKLEY, W. VA. JOB No. 3001

BY DATE 7/12/78

CHKD. DATE

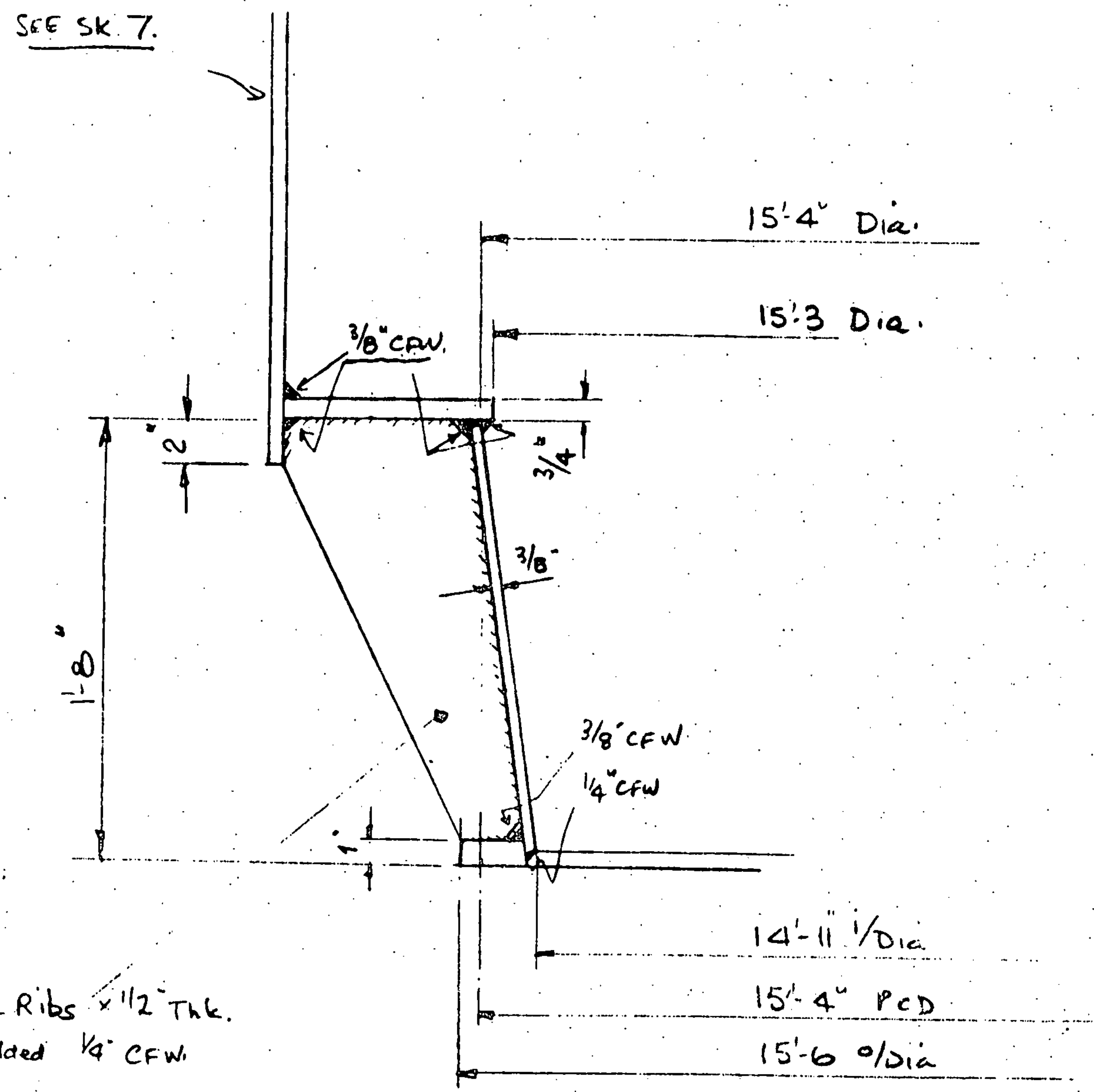


View on A To be as already drawn.
(including welding slots)

F HOLLEY, KENNEY, SCHOTT, INC. SUBJECT SHELL DETAILS

PITTSBURGH, PA. BECKLEY, W. VA.

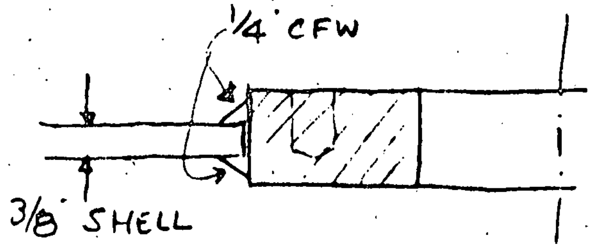
SHEET No. 3 OF 7
JOB No. 3001
BY DATE 7/12/78
CHKD. DATE

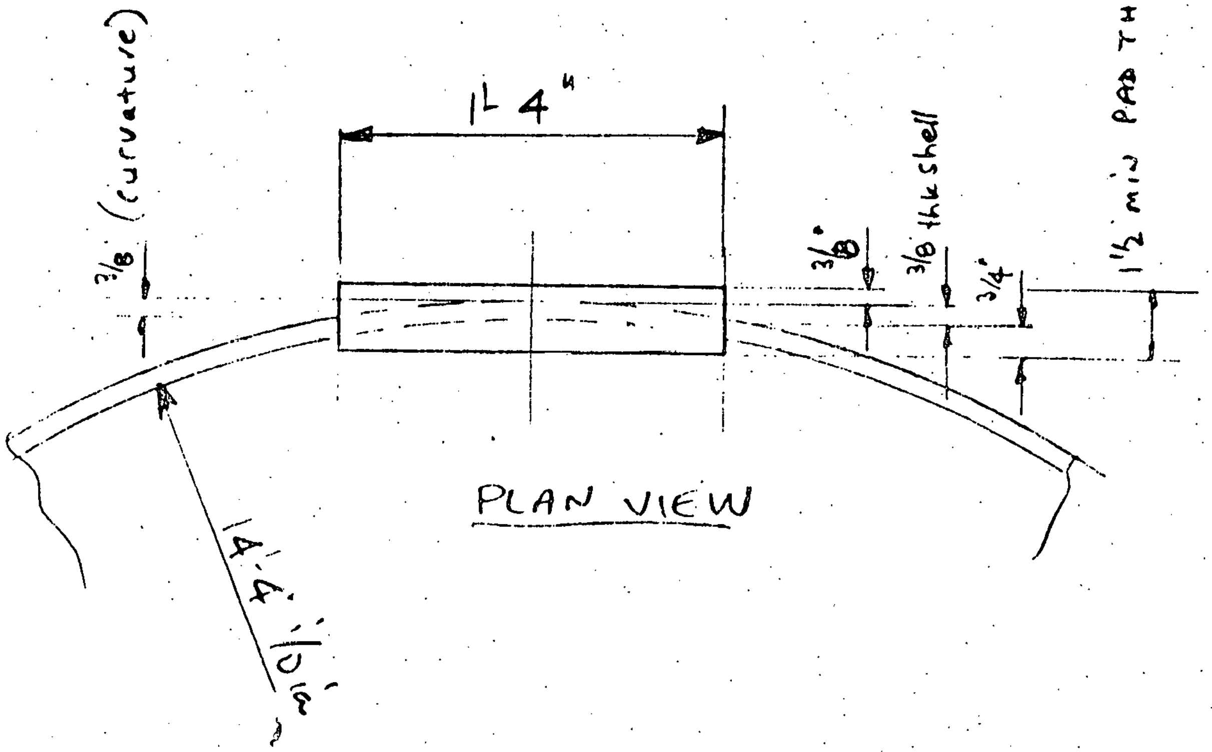


32 Ribs x 1/2" Thk.
Welded 1/4" CFW.

SK. 8.

4





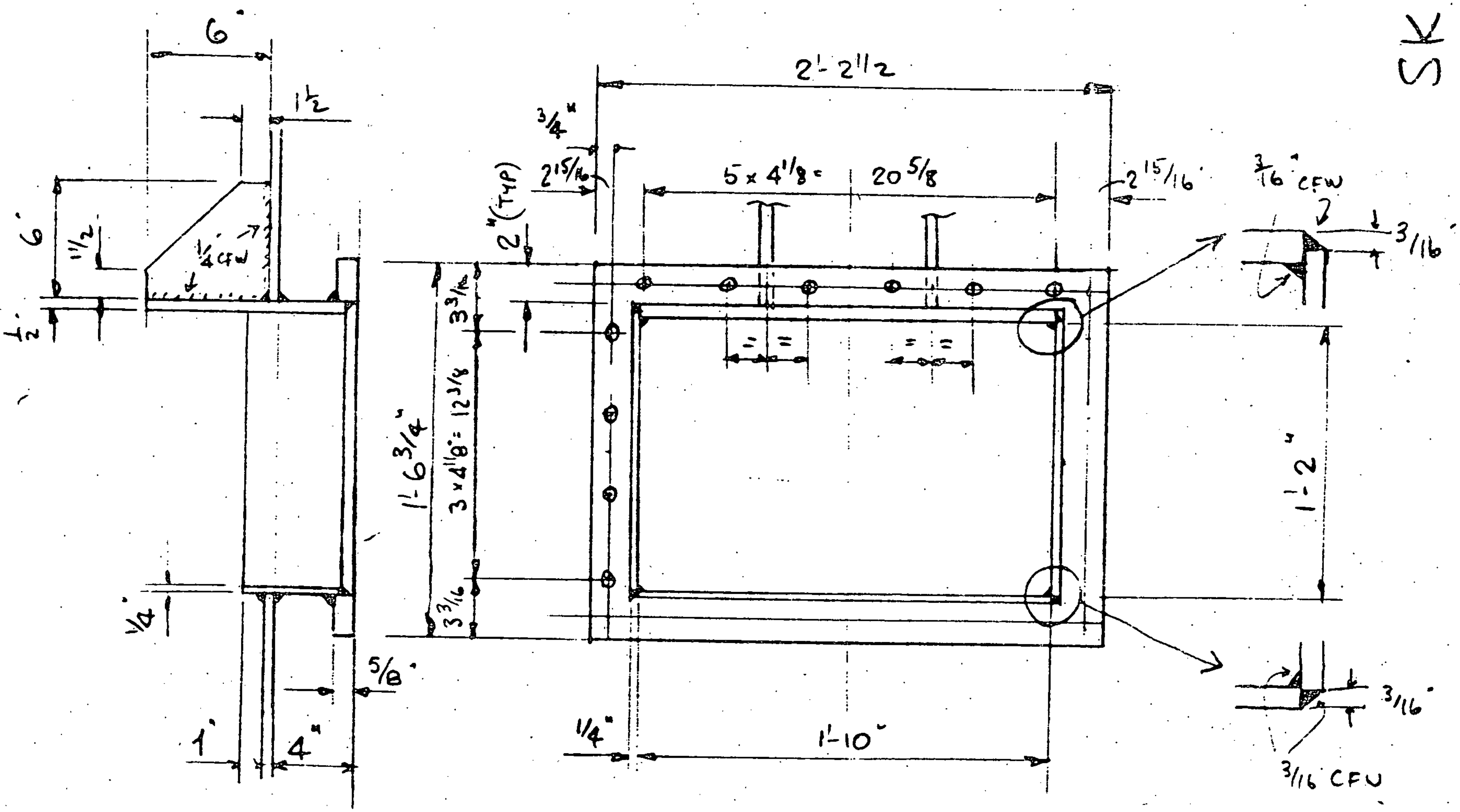
PLAN VIEW

DETAIL OF PAD TYPE ACCESS PORTS ON MAIN SHELL

SK 9

HULLET, KENNET, SCHUTT, INC. — SUBJECT SHELL DETAILS
SHEET No. ... OF 1
JOB No. 3001
BY ... DATE 7/12/78
CHKD. ... DATE ...
PITTSBURGH, PA. BECKLEY, W. VA.

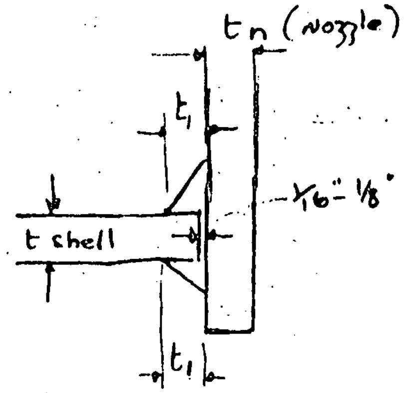
SK10



5/8" dia bolts. 11/16" dia holes.

SEE ALSO SK 11. FOR OTHER WELD DETAILS

(1)

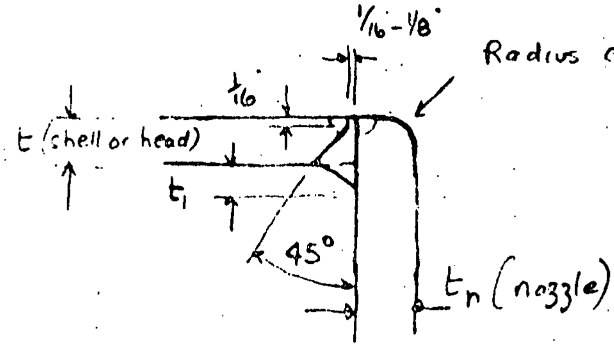


t_1 = Smaller of t or t_n but 1/4" minimum.

TYPICAL SET THRO NOZZLE

---

(2)

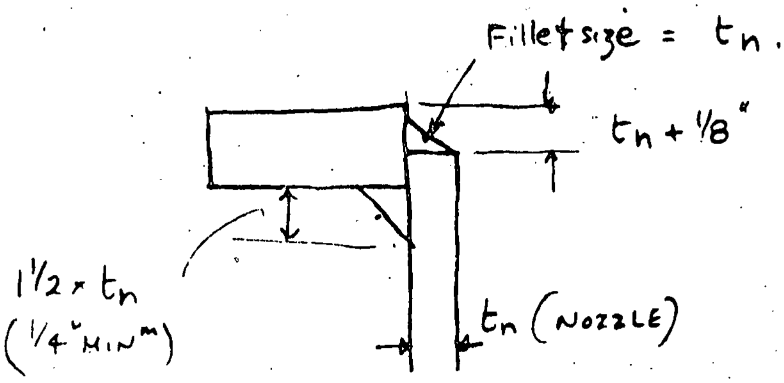


t_1 = thinner of t or t_n but 1/4" minimum.

TYPICAL FLUSH NOZZLE (EG. DOWNCOMERS ON COAL DISTRIBUTOR.)

---

(3)

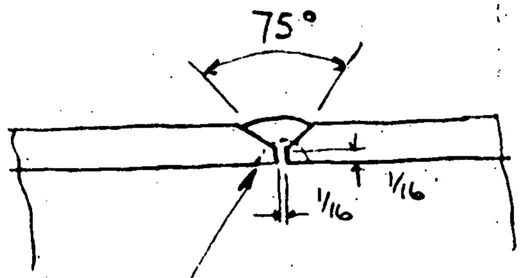


TYPICAL FLANGE TO NOZZLE WELD DETAIL

(FOR MAIN BODY FLANGE WELD DETAILS SEE OTHER SKETCHES)

SK 11 A

(f)



Chip back to sound metal before welding second side

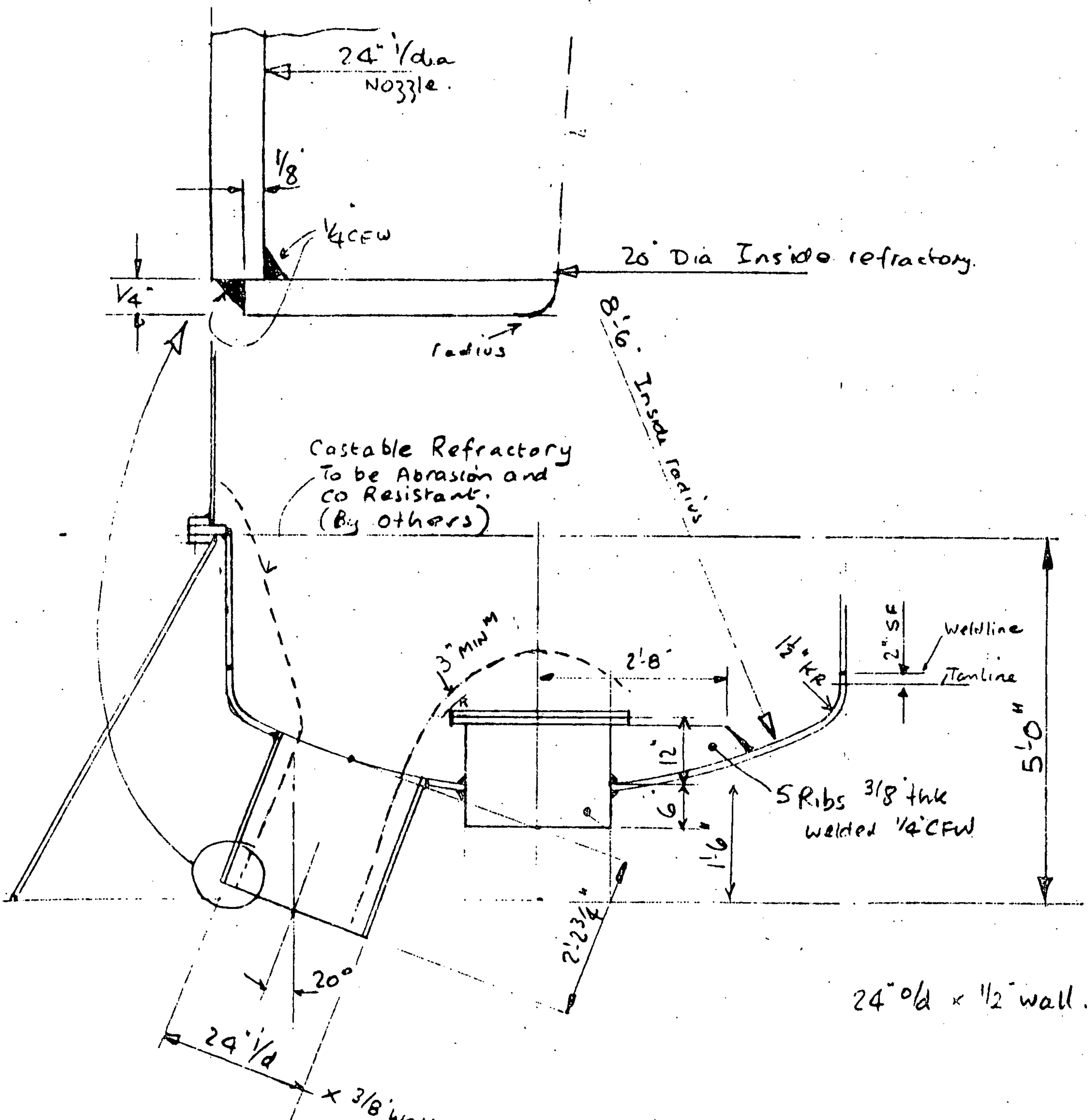
TYPICAL BUTTWELD IN SHELL LONGITUDINAL AND CIRCUMFERENTIAL SEAMS AND LONGITUDINAL SEAMS IN GAS OUTLET AND STIRRER SUPPORT NOZZLES.

SK 11 B 110

HOLLEY, KENNEY, SCHOTT, INC. SUBJECT Lower Cone & Distributor & Top Cone

PITTSBURGH, PA. BECKLEY, W. VA.

SHEET No. 1 OF 4
JOB No. 3001
BY Cer DATE 7/13/78
CHKD. DATE



Refractory in distribution nozzle to be 18" I/d at top and 20" I/d at bottom.

SK 12A

F HOLLEY, KENNEY, SCHOTT, INC. SUBJECT LOWER CONE & DISTRIB.

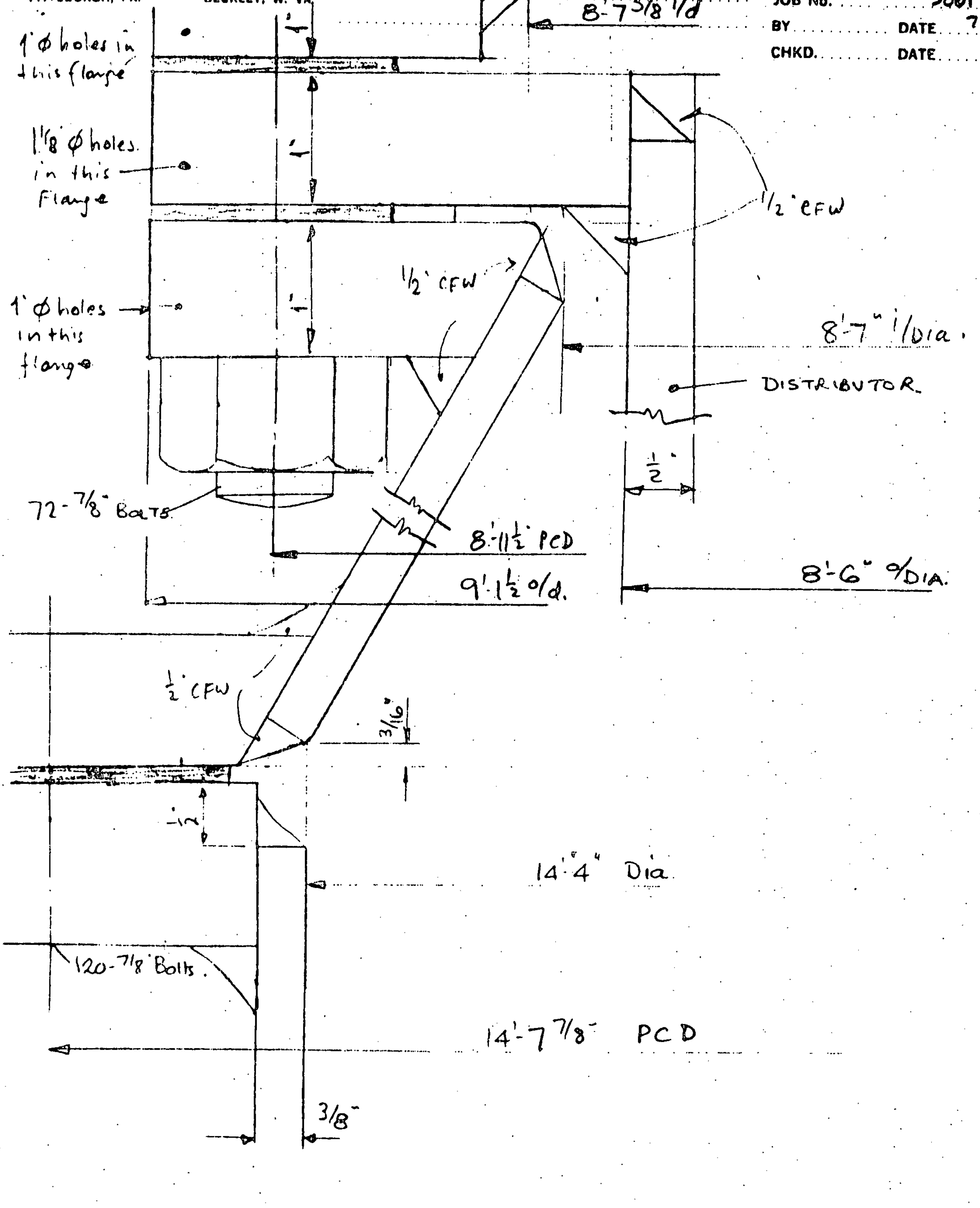
PITTSBURGH, PA. BECKLEY, W. VA.

SHEET No. 2 OF 4.

JOB No. 3001

BY DATE 7/13/78

CHKD. DATE

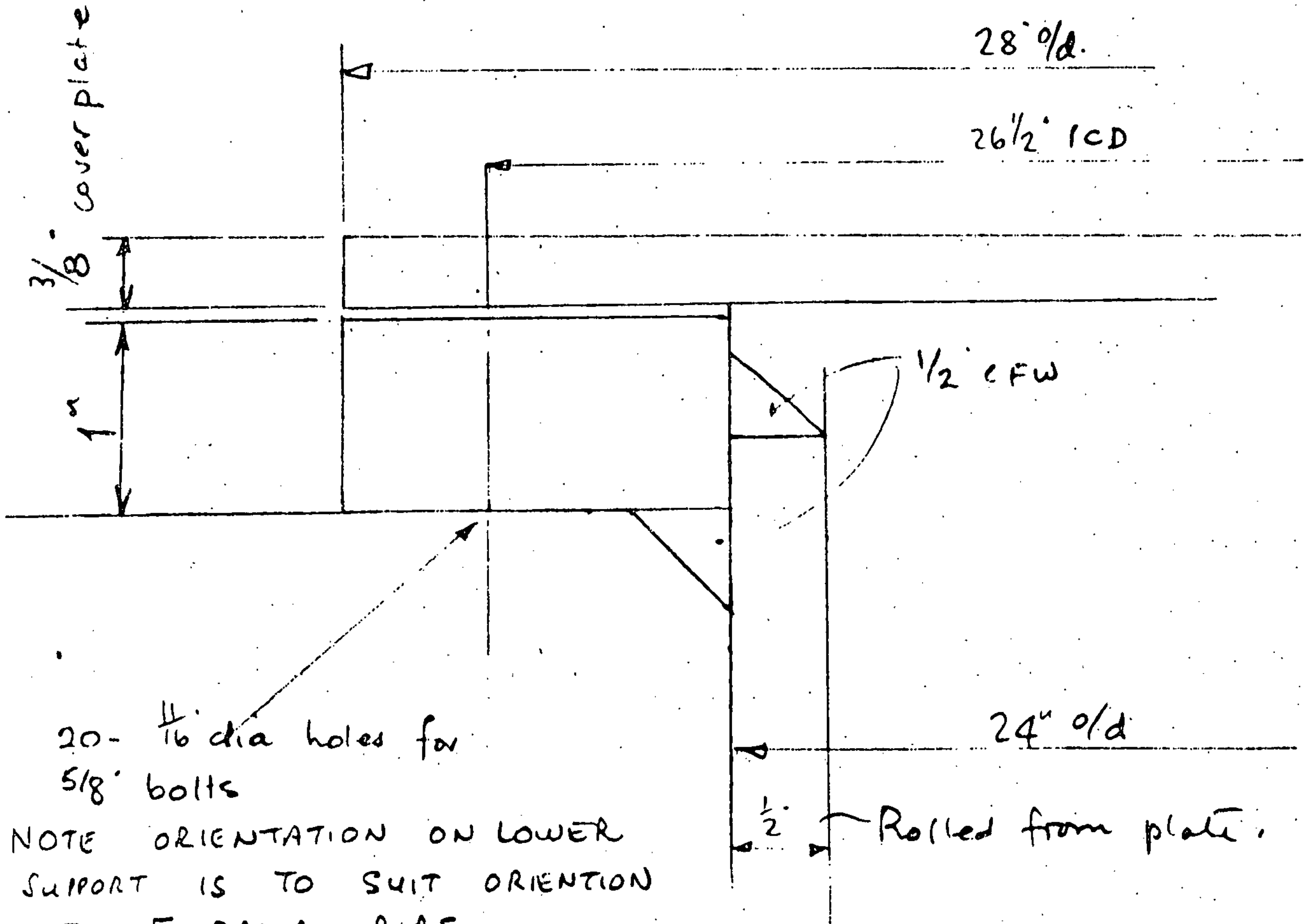


HOLLEY, KENNEY, SCHOTT, INC. SUBJECT Lower Cone & Distributor SHEET No. 3 OF 4

PITTSBURGH, PA. BECKLEY, W. VA. JOB No. 3001

BY DATE 7/13/78

CHKD. DATE



NOTE ORIENTATION ON LOWER SUPPORT IS TO SUIT ORIENTION OF 5 RADIAL RIBS

Detail of Nozzle Support for Stirrer.

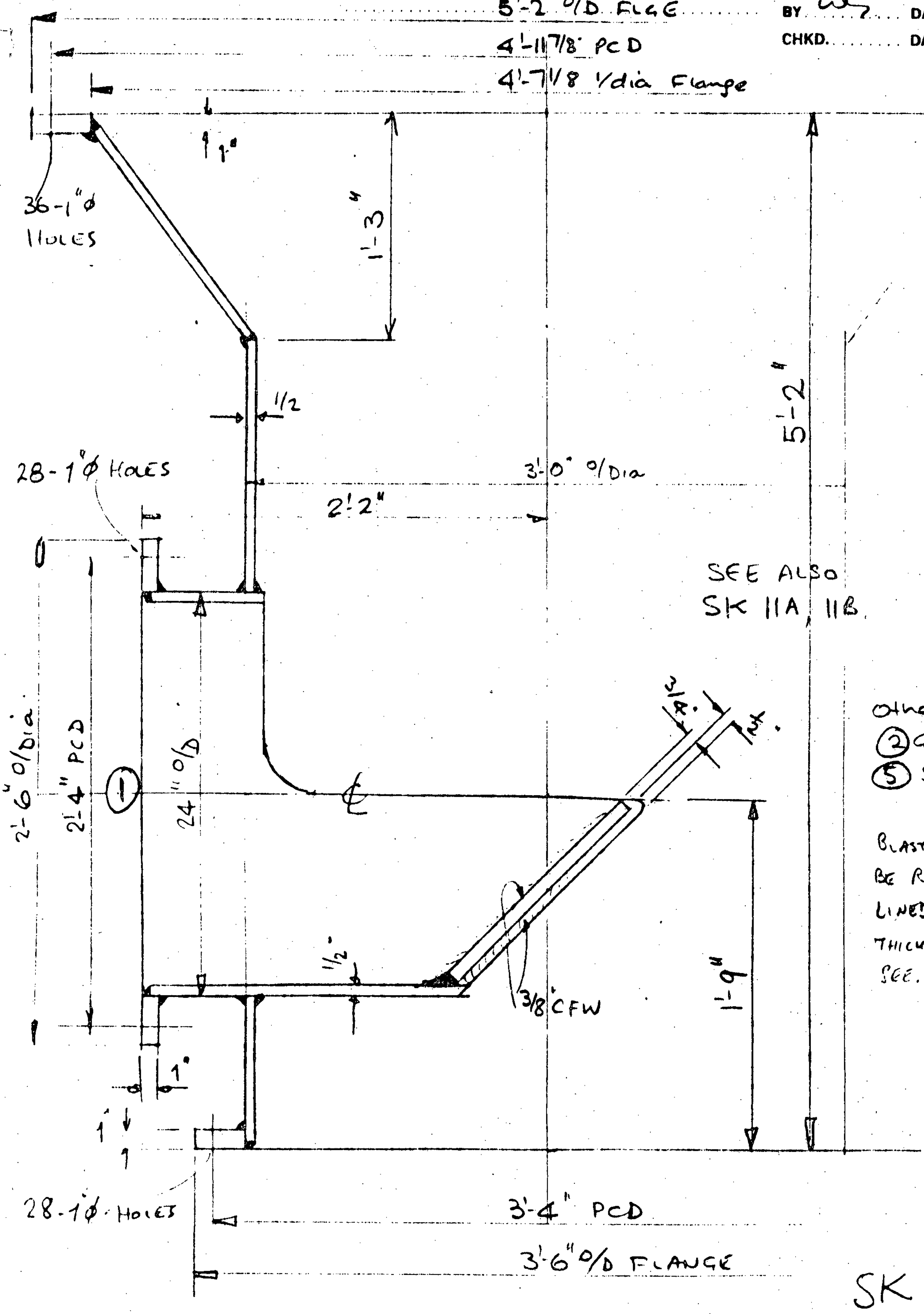
SK. 12.C 113

HOLLEY, KENNEY, SCHOTT, INC. SUBJECT BLAST INLET SHEET No. 1 OF 2

PITTSBURGH, PA. BECKLEY, W. VA. JOB No. J001

BY DATE 7/13/78

CHKD. DATE



Other Connection
(2) Grid Pyrometer
(5) Spare.

BLAST INLET TO BE REFRACTORY LINED. (BY OTHERS) THICKNESS (?) SEE. J. HEMINGWAY

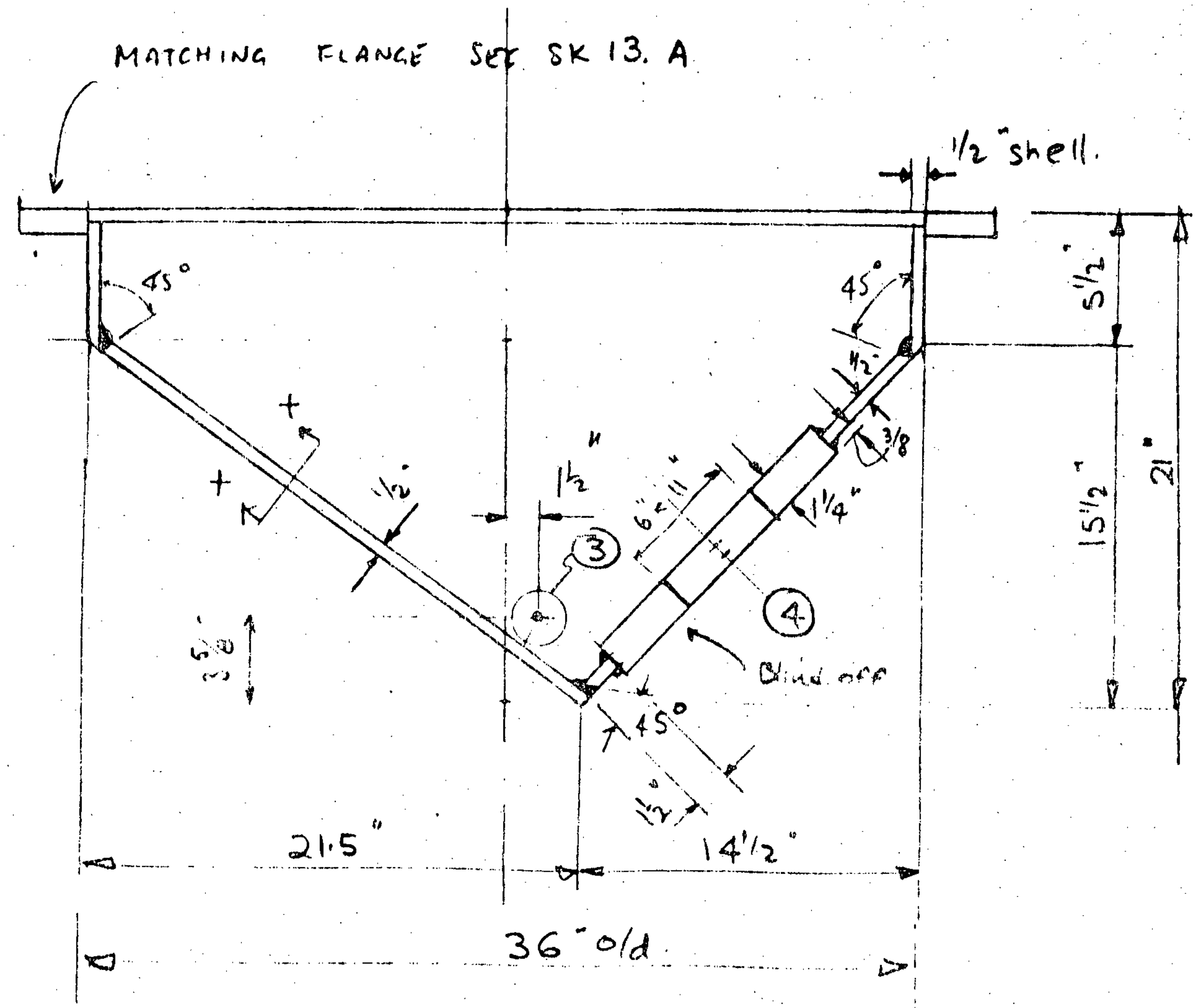
SK 13A

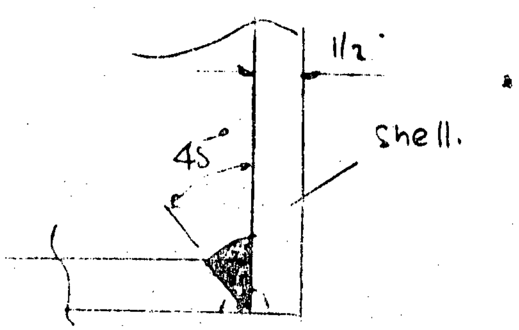
HOLLEY, KENNEY, SCHOTT, INC. SUBJECT BLAST INLET SHEET No. 2 OF 2

PITTSBURGH, PA. BECKLEY, W. VA. JOB No. 3001

BY DATE 7/13/78

CHKD. DATE





Section X–X

SK 13. B.

HOLLEY, KENNEY, SCHOTT, INC. SUBJECT BLAST INLET

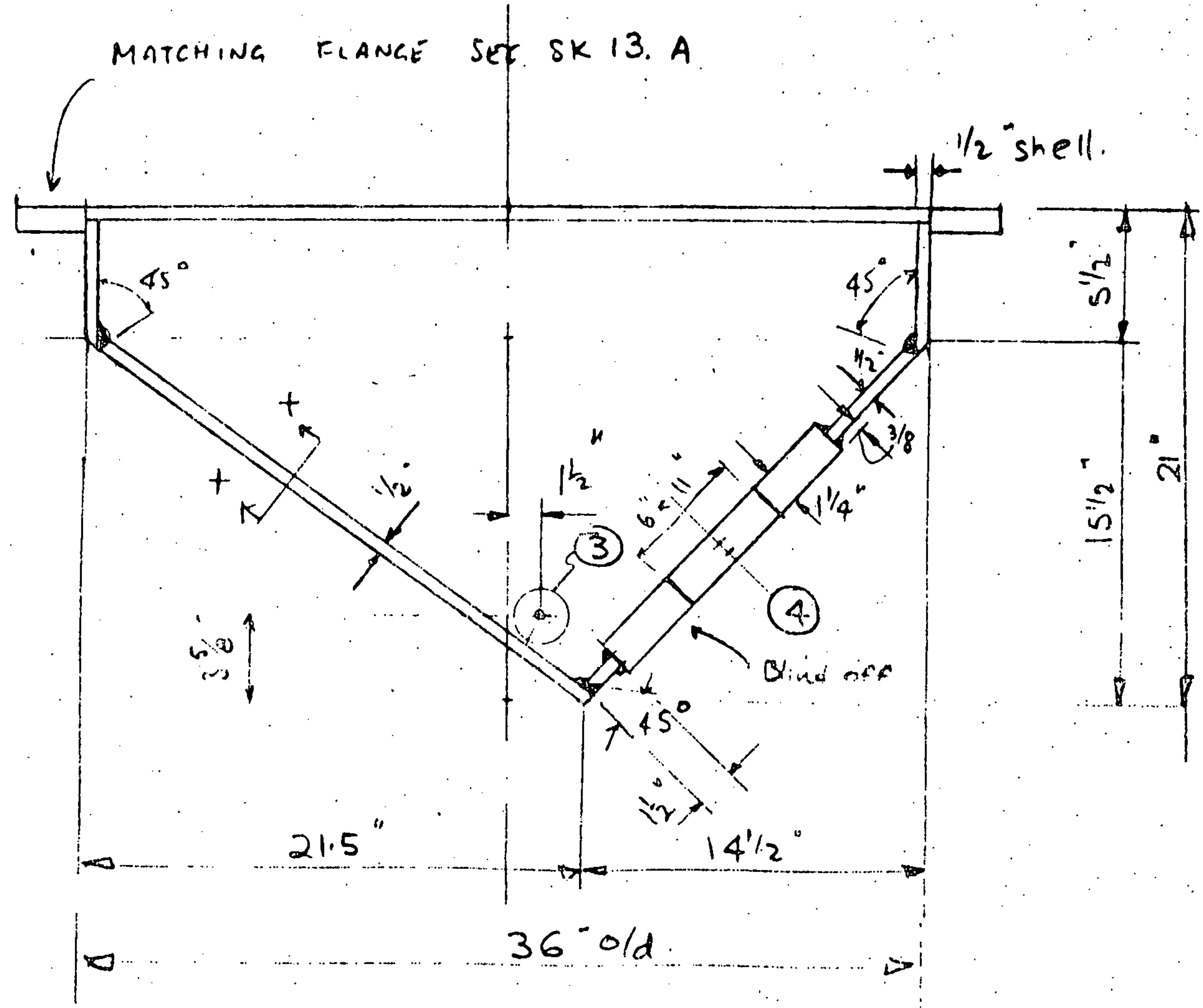
PITTSBURGH, PA. BECKLEY, W. VA.

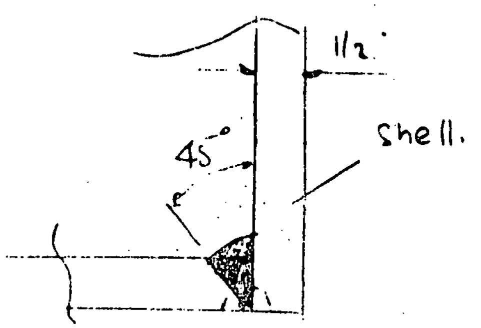
SHEET No.

JOB No. 300

BY DATE

CHKD. DATE

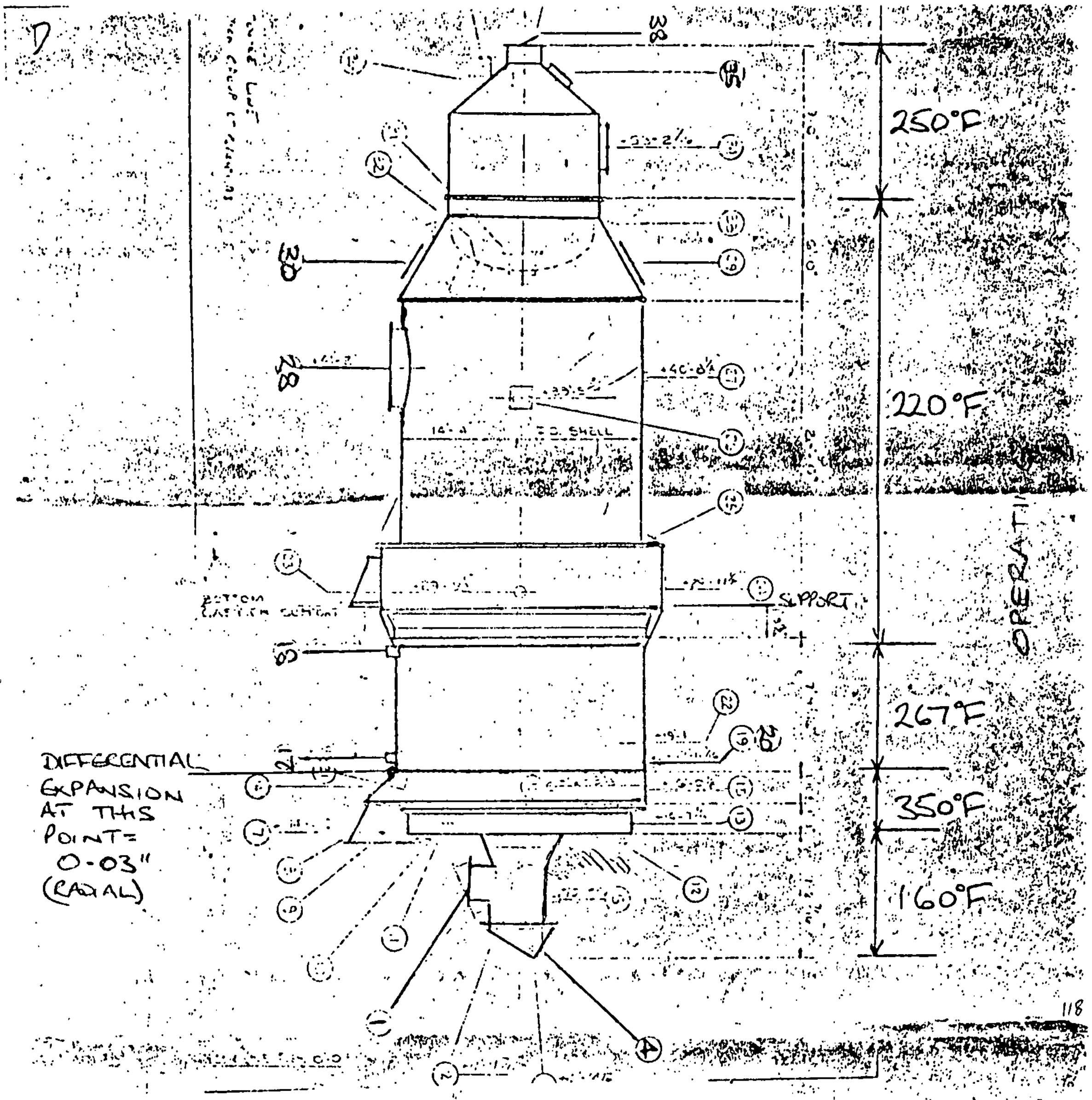




Section X–X

SK 13. B.

PART 4



GASIFIER – THERMAL MOVEMENTS

(AMBIENT TO OPERATING TEMPERATURES)

7/31/78

NOZZLE NUMBER	SECTION OF VESSEL	NOZZLE NAME	VERT. DISPL.	RADIAL DISPL.
38	COAL DISTRIB.	STIRRER SHAFT PORT	+0.46"	—
35	COAL DISTRIB	COAL INLET	+0.42"	0.05"
28	SHELL	CLEAR GAS	+0.18"	0.09"
30	SHELL	TOP GAS	+0.26'	0.10"
17	WATER JACKET	FEED WATER INLET	-0.15"	0.13"
18	WATER JACKET	HOT WATER OUTLET	-0.04"	0.13"
20	WATER JACKET	BLOWDOWN	-0.15"	0.13"
1	BLAST INLET	BLAST INLET	-0.27'	0.02'
4	BLAST INLET	ASH PORT	-0.29"	NEG

118