TASK FORCE REPORT
PROJECT 7185
#2 OPEN HEARTH
FUME ABATEMENT
MIDDLETOWN WORKS
May 15, 1968

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SECTION I

INTRODUCTION

The Task Force herein submits its report, summarizing its recommendations for gas cleaning facilities for the three natural draft furnaces at the Middletown Works No. 2 Open Hearth Shop. A more complete description of the scope of the work and equipment details will be recorded with a complete cost estimate in the forthcoming Engineering Report.

These recommendations have been agreed upon by the Task Force members after review of visits to all types of treatment facilities, test data and a previous Kaiser Engineers study, consultation with appropriate Armco personnel and discussions with equipment suppliers. The criteria have been established with considerations for compliance with state and local air pollution control requirements, economy of treatment, and compatibility with furnace operation.

The basis for the design of a gas cleaning system was established in 1965 through an extensive testing program by Armco and Kaiser Engineers personnel. Measurements were made of dust concentrations, temperatures, volumes, and composition of gases. The investigations were published in Report No. 65-21-RE titled "Study of Proposed Gas Cleaning Systems No. 2 Open Hearth Shop" dated June 1965.

The objective of this Task Force was to examine all possibilities in order to develop a gas cleaning scheme that would meet cleaning requirements at the lowest possible investment without adversely affecting the open hearth operations. Of the many possible gas cleaning schemes, investigated, the following three were selected for detailed study:

1. Individual high energy scrubber systems.

2. Centralized precipitator system preceeded by a centralized air-to-air heat exchanger system.

3. Centralized precipitator system preceeded by individual air-to-air heat exchangers at each furnace.

After reviewing all available information, the Task Force recommends the individual high energy scrubber systems because they require the lowest capital expenditure and offer the greatest reliability. A comparison of the approximate capital cost for the three alternate schemes is summarized in Section VII. The target date for completion of this project is late 1969 or early 1970.

To meet our commitments to the citizens of Middletown will require early approval of this report and the subsequent program and appropriation request.

SECTION II

GENERAL DESCRIPTION

The gas cleaning system for each furnace consists of a high energy wet scrubber, mist eliminator, slurry system, fan, cold stack, connecting duct work, instrumentation and services. The object of the gas cleaning system is to provide the proper draft at the base of the hot stack and discharge clean gas to the atmosphere without decreasing the production of the furnace.

The system is tapped into the existing natural draft stacks at a point approximately 75 feet above grade. Two water cooled butterfly dampers will be provided to by-pass the dirty gas to the atmosphere in case of equipment failure. The hot ductwork connecting the natural draft stack and the Venturi scrubber will be designed so that expansion forces will not be transmitted to the stack.

The dirty gas flows from the hot ductwork down through the vertical scrubber. A high energy wet scrubber operates on the principle of impaction, the collision of small dirt and water particles at high velocities causes an agglomeration of particles which can be removed from the gas stream in a separator. The efficiency of the gas cleaning system is primarily a function of the pressure drop across the scrubber.

The vertical separator section, downstream of the scrubber, removes the agglomerated dirt and water particles from the gas stream. The clean gas is exhausted from the top of the separator and the slurry is drained from the bottom.

The induced draft fan, which maintains a maximum pressure differential across the system of 56" W.G., exhausts the clean gas through the 150 foot cold stack. The fan noise level will be dampened by enclosing the fans and equipping the system with sound attenuators. The fan and motor, if practical, will be designed so that it may be used in the B.O.F. gas cleaning system in an emergency.

A graphic control panel, located in the central control room, will be provided for constant monitoring and complete control of all the gas cleaning equipment. The control system maintains a preset draft at the base of the stack automatically. The system will be protected by a series of interlocks which will reverse the dampers and by-pass the dirty gas out the existing stack in the case of major equipment failures. Minor equipment failures will be annunciated on the main control panel. Instrumentation will be transmitted and controlled electronically wherever practical.

The slurry will flow by gravity from the separator to a classifier to remove large particles. From the classifier, an 1800 gpm pump will recirculate 600 gpm to wet the scrubber approach and pump the remaining 1200 gpm into a gravity header to the water treatment plant (Project 7183). The supply and return headers will be sized to accommodate three future scrubbers. The large particles will be discharged into dumpster boxes and trucked to the dump.

A continuous 100 gpm supply of cooling water will be pumped from the return header of the existing cooling water circuit to the water cooled dampers and fan bearings and returned to the same return header.

The source of the electric power will be from the existing Substation No. 17. The distribution voltage from this substation will be 13,200 volts.

This substation consists of two 20,000 KVA transformer banks, No. 7 and No. 8, with a primary voltage of 132,000 volts and the secondary voltage is 13,200 volts. One bank of transformers, No. 7, (3 single phase transformer in a closed delta) is now feeding an existing load. The second bank, No. 8 is energized but has no appreciable load connected. No. 8 bank of transformers will require a zigzag transformer on the secondary to match the existing No. 7 bank.

This project will add one cubicle complete with all relaying and metering to this existing 15 KV switchgear. These two transformer banks may now be paralleled through an existing 15 KV walk-in type switchgear.

A wood pole line with three wires will feed 13,200 volts to a new substation, No. 605, at the northeast corner of the No. 2 Open Hearth shop. The wood pole transmission line will follow Lefferson Road, north to the McGraw Construction Co. field office area, from whence the line will follow the newly paved patrol road and then south to the new Substation No. 605.

The purpose of this station is to receive and distribute the 13,200 volts to transformers to obtain 2400 volts for the three 2000 HP motors and 460 volts for the auxiliary equipment required.

The station will consist of a steelox building 40' x 60' and will house all indoor type equipment instead of using outdoor weather proof type equipment. The transformers used indoors will contain a non-flammable type coolant.

The 2400 volt leads to the three 2000 HP motors and the 460 volt feeders to the three motor control centers will be installed (in galvanized steel conduits) on steel supports on the roof of the No. 2 Open Hearth lean-to.

Galvanized steel conduit runs will be made from the lean-to roof to the individual 2000 HP motors and to the individual motor control centers.

Galvanized steel conduits will leave from the motor control centers to each individual auxiliary motor and for motor controls.

Galvanized steel conduits will be used for all control and instrumentation runs from the respective equipment to the control and instrumentation room.

The equipment steel platforms will be used as much as possible to support these many runs of steel conduits.

Since it is anticipated that No. 2 Open Hearth furnaces No. 9-10-11 will be equipped for fume abatement in the future, the following provisions will be built-in at this time:

a. The incoming 13 KV power feeder is designed to carry the fume abatement capacity of all six furnaces operating at the same time.

b. The conduit roof bracket supports on the roof of the lean-to are designed to carry the future two 13 KV feeders for fume abatement of furnaces No. 9-10-11.

SECTION III

MAJOR EQUIPMENT LIST

Three (3) High energy wet scrubber systems of suitable corrosion and errosion resistant materials.

Three (3) Water cooled (butterfly valve type) motor operated dampers for the existing 7'-6" I.D. hot stack.

Three (3) Water cooled (butterfly valve type) motor operated dampers for the new hot duct to the scrubber.

Three (3) Hot duct sections from the existing hot stacks to the new scrubber. The ducts, which include expansion joints and/or a water seal, will be constructed of mild carbon steel lined with a suitable refractory.

Three (3) Cold duct sections from the separator to the induced draft fan. The ducts will be constructed of mild carbon steel with a suitable corrosive and abrasive resistant lining.

Six (6) Vibration isolators at the inlet and outlet of each fan.

Three (3) Induced draft fans designed for approximately 150,000 ACFM saturated of clean gas at a temperature of 165° F. and a pressure differential of 56" W.G. The fan will be constructed of suitable corrosive and abrasive resistant material. The fan will be equipped with water sprays to keep the fan wheel clean.

Three (3)	Fan drivers will be approximately 2000 HP, 2400 volts, 1200 rpm, NEMA class B design, 1.15 service factor, with Class B insulation, NEMA type II outdoor enclosures and same rotation as B.O.F. fan motors. Split sleeve oil ring bearings, corrosion resistant finish and hardware. Motors will be equipped with 460 volt space heaters, winding temperature detectors, bearing resistance thermometers, oversized terminal boxes, and lightning and surge arrestors mounted in boxes.
Three (3)	Cold stacks, complete with ladder cage and platforms approximately 150' high, constructed of mild carbon steel with a suitable liner.
Three (3)	Classifiers to be installed directly below the separators. The classifier tank will be constructed of carbon steel with a suitable lining and the mechanism will be of either 316 stainless steel or carbon steel with an abrasion and corrosion resistant coating.
Six (6)	Sludge pumps rated at 1800 gpm and constructed of an abrasive and corrosive resistant alloy.
One (1)	Graphic control panel to be located in the central control room.
Two (2)	Cooling water supply pumps and pump tank rated @ 300 gpm.
One (1)	2400 volt unit substation - 5000/6250 KVA.
One (1)	460 volt unit substation - 1000/FUT 1250 KVA.
One (1)	13.8 KV switchgear.

One (1) 125 volt D.C. battery and battery charger.

Three (3) Motor control centers - 600 volt, 600 amps.

Additions to Substation No. 17.

a. 3 - 167 KVA transformers

b. 1 - 15 KV walk-in type cubicle, with breaker, relaying, and metering.

SECTION IV

SPECIFICATION AND CAPACITIES

1. Waste Gas

The gas cleaning system design is based on the furnace using a maximum oxygen lancing rate of 100,000 CFH, or a maximum firing rate of 135 million BTU/Hr with combustion air plus 35 million BTU/Hr with oxygen.

The following characteristics of the waste gas at the base of the existing stack are considered normal expected maximums:

Gas Volume	- 62,000 standard cubic feet per minute wet (14% moisture)
Gas Temperature	- 1350° F. (Average) 1900° F. (three minute peak)
Static Pressure	- (-) 3.0" W.G. (Constant)
Dust Concentration	- 6 grains per standard cubic foot dry (during oxygen lancing)

2. Clean Gas

In order to achieve the required cleaning efficiency at the normal maximum waste gas discharge conditions outlined below, a total pressure differential of 56" W.G. across the system will be provided.

Gas Volume	- 94,000 standard cubic feet per minute saturated
Gas Temperature	- 180° F.
Static Pressure	- (+) 2.0" W.G.

Dust Concentration - .05 grains per standard cubic foot dry (instantaneous loading)

- .03 grains per standard cubic foot dry (average over oxygen lancing period)

3. Services

The various services required to operate the gas cleaning facilities are as follows:

Damper Cooling Water - A continuous 300 gpm supply of cooling water from the return header in the open hearth cooling tower circuit.

Scrubber Water - A continuous 3600 gpm supply of clarified water with a maximum of 1000 ppm suspended solids (to be provided under Project 7183).

Air - Less than 50 cfm dry where pneumatic controls are required.

Electrical - Power requirements include the following:

A new 13,200 volt electric power feeder will originate from the existing No. 17 Substation. This project will provide transformer bank No. 8 with a new zigzag transformer to match the existing No. 7 transformer bank. This project will also provide a new 15 KV cubicle and breaker to add to the existing outdoor switchgear.

A new 13,200 volt wood pole line will furnish power to the new No. 605 Substation at the northeast corner of No. 2 Open Hearth shop.

Substation No. 605 will feed 2400 volts to the three (3) 2000 HP motors and also feed three phase 460 volt, 60 cycle to the motor control centers for all auxiliary motors, for each of the three open hearth furnaces.

The total power requirements for each open hearth furnace is approximately 2000 KVA.

SECTION V

APPROXIMATE COSTS

The following budget estimates, based on available information, are as follows. A more complete cost estimate will be reported in the forthcoming Engineering Report. These costs do not include the water treatment which will be covered under Project 7183.

1. Capital Cost

   The following total includes all direct, indirect, ~~escalation~~, contingency and start up costs:

   Total Expenditure - $4,500,000

2. Operating Cost

   The following total includes yearly costs for labor, maintenance and power:

   Total Operating Cost - $380,000

SECTION VI

ALTERNATIVES INVESTIGATED

The following alternatives were investigated by the Task Force, but were not recommended for the #2 open hearth gas cleaning system.

Precipitators preceeded by waste heat boilers, which require the largest capital expenditure of any scheme investigated, cannot be economically justified by the value of the steam produced.

Precipitators preceeded by air-to-air heat exchangers, which have questionable reliability, require a larger capital expenditure than a scrubber system.

A scrubber system with gas cooling has several distinct advantages such as a smaller steam plume, lower power requirements and improved fan performance; but these advantages cannot justify the larger capital expenditure required.

Cap dampers should not be installed on the top of the 250 ft. high natural draft stacks because the caps are difficult to maintain and add additional stresses to the stack.

The dual radial concept for electrical power distribution cannot be justified for the gas cleaning system because emergency electrical repairs can be made without a shut down of the open hearth furnaces. Only the gas cleaning system will be shut down for emergency electrical repairs.

SECTION VII

COST COMPARISONS

The following costs represent the approximate capital expenditures required for the alternate schemes that were investigated. The Task Force feels that these estimates are sufficiently accurate for comparisons:

1. Individual high energy scrubber systems without gas cooling.

   Approximate Capital Expenditure - $4,500,000

2. Individual high energy scrubber systems with gas cooling.

   Approximate Capital Expenditure - $5,500,000

3. Precipitators preceeded by individual air-to-air heat exchangers.

   Approximate Capital Expenditure - $5,900,000

4. Precipitators preceeded by centralized air-to-air heat exchangers.

   Approximate Capital Expenditure - $7,000,000

In order to compare the various alternatives, it should be noted that the scrubber systems will require approximately a $1,200,000 expenditure for water treatment facilities. (Project 7183) The cost to expand the water treatment facilities for three future scrubbers would be approximately $350,000.

SECTION VIII

DRAWINGS

PR-3297-1987 - Proposed Gas Cleaning System - Plan

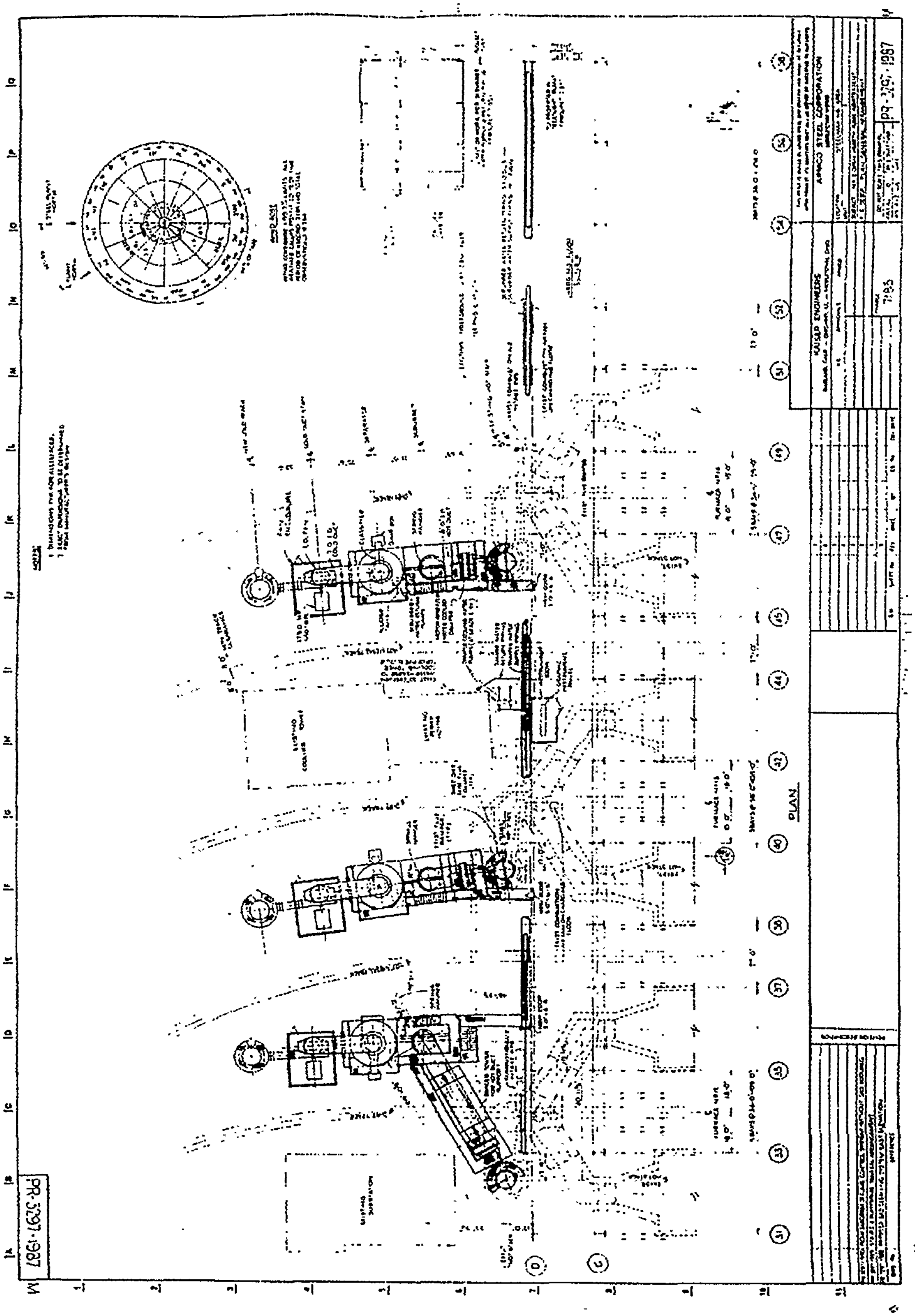
PR-3297-1988 - Proposed Gas Cleaning System - Section

PR-3297-1990 - Flow Diagram of Fume Control System

PR-3297-1998 - 13.8 KV Switchgear & Electrical Control House - Layout

PR-3297-2000 - Power Line Location to Electric Control Room

A complete set of scoping drawings, including the alternates, is available upon request.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PLAN
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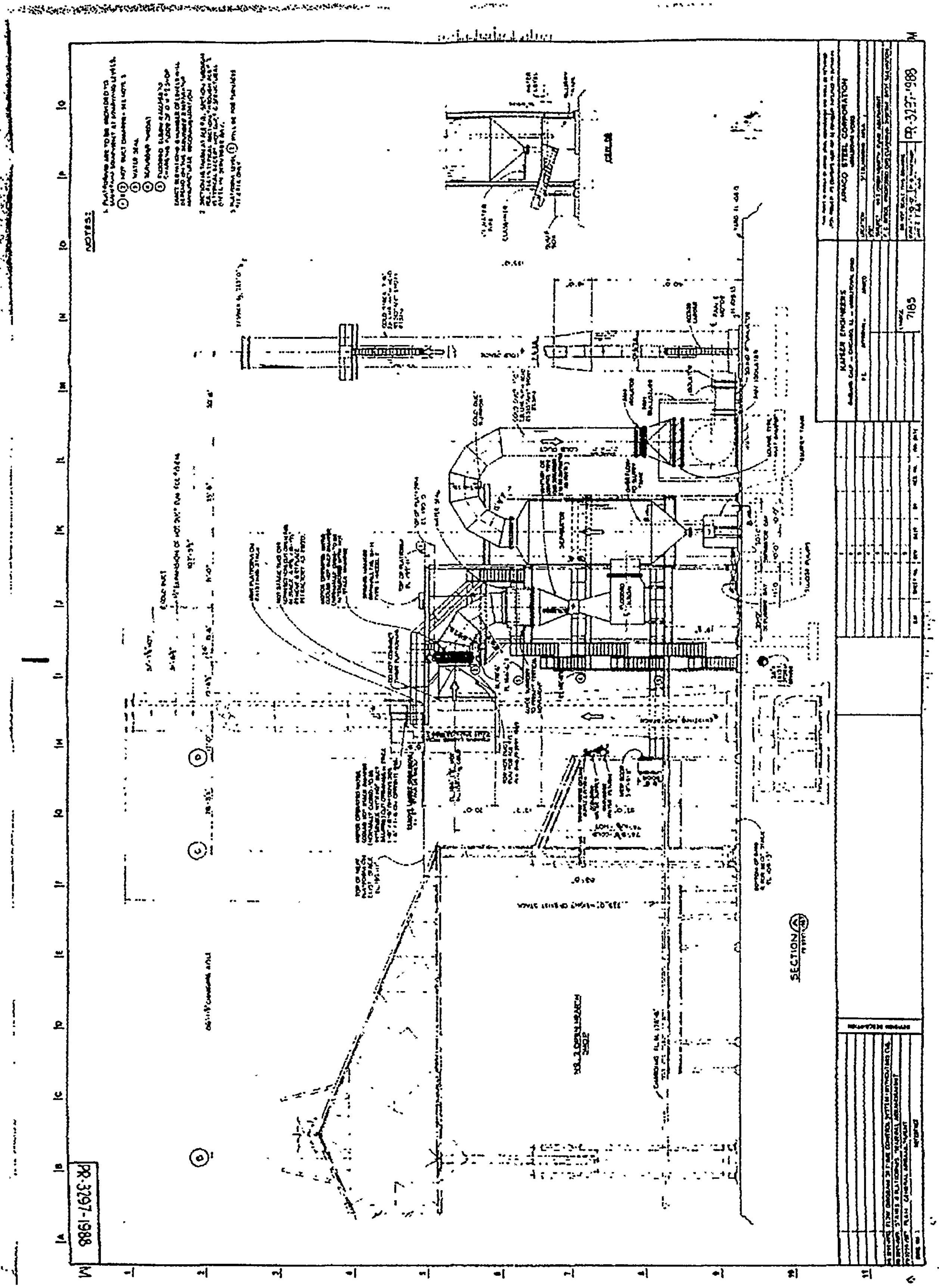
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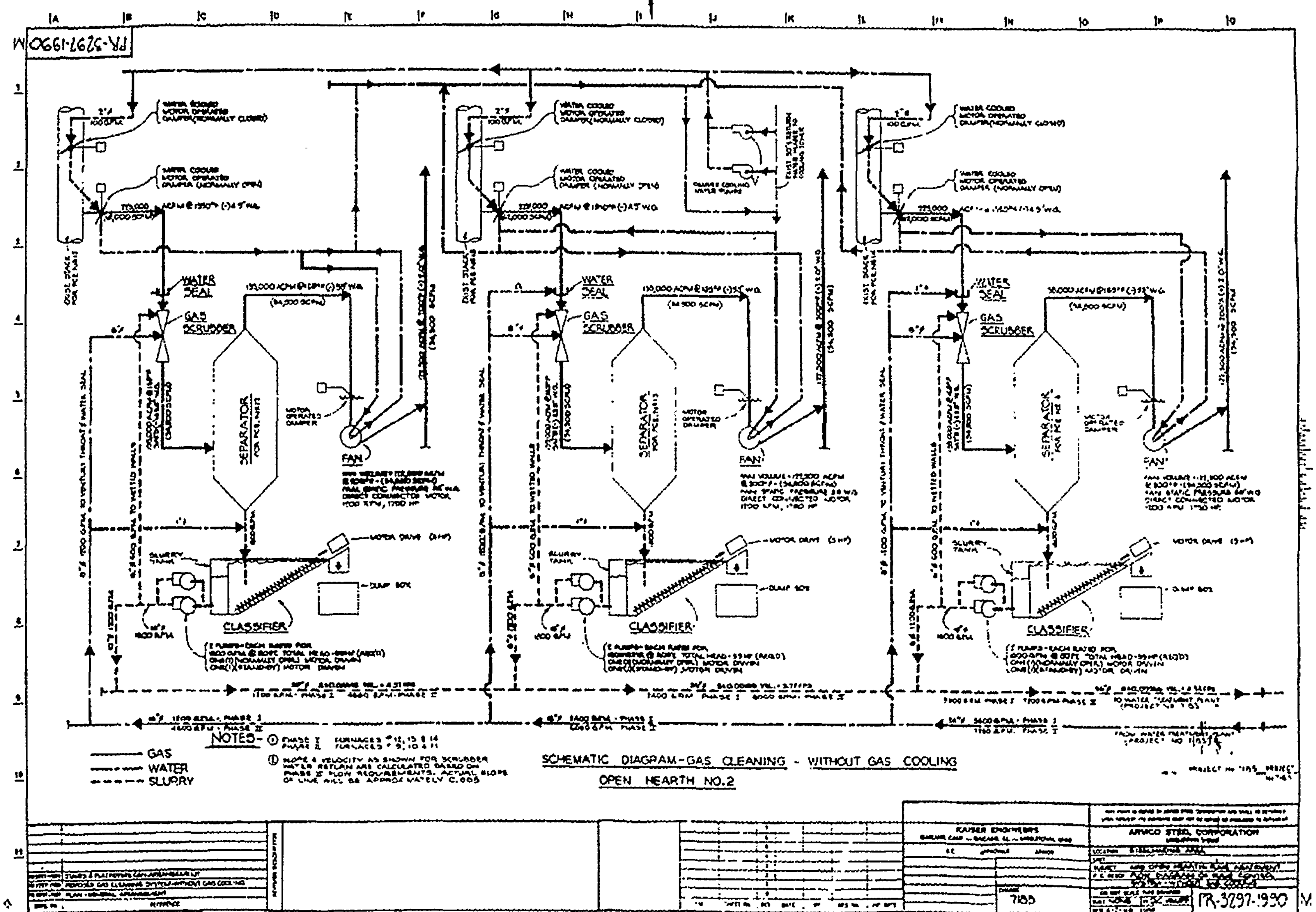
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WATER SEAL
GAS SCRUBBER
SEPARATOR
FAN
MOTOR DRIVE
DUMP BOX
SLURRY TANK
CLASSIFIER
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GAS
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SCHEMATIC DIAGRAM-GAS CLEANING - WITHOUT GAS COOLING
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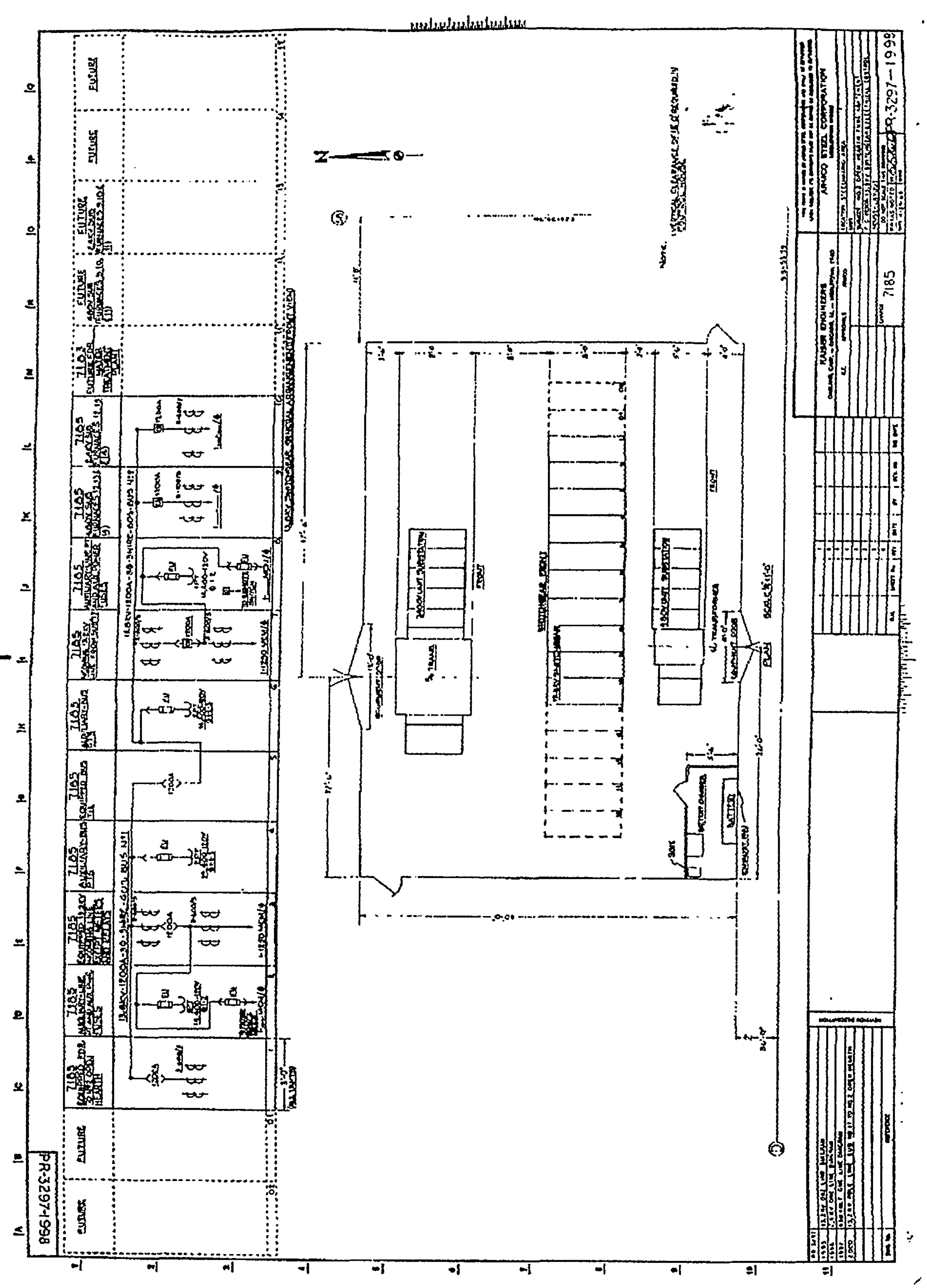
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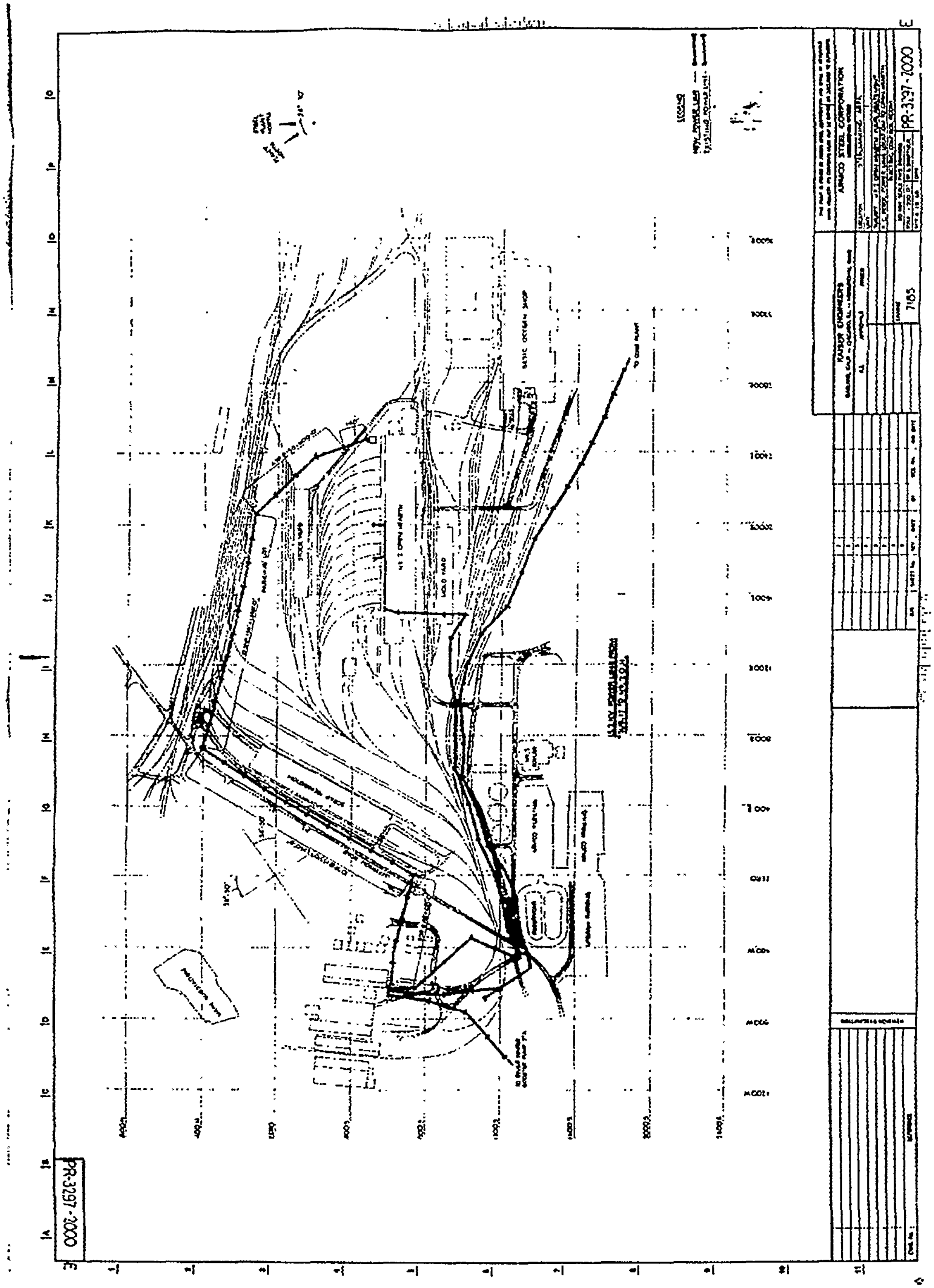
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ARMCO STEEL CORPORATION
KAISER ENGINEERS
BASIC OXYGEN SHOP
PR-3297-2000

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