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R & D REPORT NO. 53

Interim Report No. 9

# DEVELOPMENT OF A PROCESS FOR PRODUCING AN ASHLESS, LOW-SULFUR FUEL FROM COAL

## Volume III - Pilot Plant Development Work
## Part 2 - Construction of Pilot Plant

Period Covered: June 1972-June 1974

Contract E(49-18)-496

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Contract E(49-18)-496

Prepared by:

The Pittsburgh & Midway Coal Mining Company
Fort Lewis, Washington

for

Energy Research and Development Administration
Washington, D.C. 20545

This report provides a summary of the construction of a 50 ton per day pilot plant on a site located at Fort Lewis, Washington. The plant was designed to study the production of a low sulfur, ashless fuel by solvent refining coal. The as-built configuration of the pilot plant is emphasized, and a complete process description is included. Process and design modifications which were made since the original design report was issued are discussed in detail. The report also includes an equipment list, equipment and piping specifications, as-built drawings, and photographs of the plant-site at various stages of construction.

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## I. INTRODUCTION

The Pittsburg and Midway Coal Mining Company, a subsidiary of Gulf Oil Corporation, signed a contract with the Office of Coal Research, U.S. Department of the Interior, in October, 1966 to design, construct, and operate a pilot plant for removal of ash and sulfur from coal. Although removal of both ash and sulfur are significant features, the process has often been referred to as a coal de-ashing process. In an effort to apply a more descriptive name, the process will be designated as the Solvent Refined Coal Process. The ashless, low sulfur coal product will be called Solvent Refined Coal. The process originated as a result of research work carried out under an Office of Coal Research contract by Spencer Chemical Company, now a part of Gulf Oil Corporation.

The objectives of the current project are (1) to further study and develop the Solvent Refined Coal Process; (2) to provide additional process and cost data for evaluation of the commercial possibilities of the process and for the design of future commercial plants; and (3) to provide large quantities of ashless, low sulfur coal for end-use evaluation, testing, and market development.

On July 10, 1967, the Pittsburg and Midway Coal Mining Company contracted with Stearns-Roger Corporation of Denver, Colorado, to design a pilot plant to carry out this work. The design was completed in 1968 and was reported in detail in Office of Coal Research R&D Report No. 53.[(1)]

By 1972, funds became available for construction of the pilot plant, however, the lowest cost proposal for construction (by The Rust Engineering Company) was higher than the funds available. For this reason the design of the pilot plant was reviewed, and a number of items were eliminated or modified to decrease costs. In February 1972, a purchase order was issued to The Rust Engineering Company to enable them to proceed with engineering work required to obtain a fixed price for the revised plant design. This engineering work resulted in revised specifications and drawings for the pilot plant and a lower fixed price for the detail engineering and construction of the plant. A construction contract with Rust Engineering, based on the revised project scope, was signed on June 4, 1972. Field work at the plant site started on June 26, 1972.

Construction of several utility sections of the plant was completed in February, 1974, and these sections were accepted by P&M at that time for commissioning. Most of the work outlined in the original construction con-

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(1) "Development of a Process for Producing an Ashless, Low Sulfur Fuel from Coal", R&D Report No. 53, Interim Report No. 2, Volume III - Pilot Plant Development Work, Part 1 - Design of Pilot Plant, Prepared for the Office of Coal Research, Department of the Interior, Washington, D.C., under Contract No. 14-01-001-496.

tract was completed by Rust Engineering in July, 1974.

Since the completion of the original design of the SRC Pilot Plant in 1968, developments on several fronts have provided incentives for deletion, addition, or modification of many items of equipment in the plant. Among these developments are included the passage of the Occupational Safety and Health Act and more stringent emission control laws. Changes were also brought about by the need to resolve interferences in the initial design or the need to improve operability. Several changes resulted from analysis of the results of the continuing bench scale research that is being conducted by P&M on the SRC Process. And finally, some modification of the scope of the plant was required because of limited funding.

Areas of the plant which were significantly modified include the coal slurry preheating and dissolving area which was reduced to one preheater and two dissolvers; the mineral residue separation area in which the solvent recovery from the mineral residue was modified and the centrifuges were eliminated; the solvent recovery area in which one of the two vacuum flash drums and the heavy ends tower were eliminated; the desulfurization system which was redesigned; the hydrogen generation unit which was modified to produce synthesis gas or hydrogen; the waste treatment facilities; and the cement plant and coker areas which were deleted. This report includes an up-to-date description of the process and discussion of the design modifications which have been made since the original design report was issued. Areas of the plant design which were not modified are also discussed in complete detail with emphasis on the as-built configuration.

In addition, this report provides a summary of the construction work, as-built drawings, a complete equipment list and specification, and photographs of the plant-site at various stages of the construction.

## II. DISCUSSION OF ENGINEERING AND CONSTRUCTION WORK

### A. Design Basis

The original design basis for the SRC Pilot Plant was taken largely from the results of early development work by the Spencer Chemical Division of the Gulf Oil Corporation.[2] Product yields and operating condition data from Run No. 50 of that work were emphasized, and the plant was sized to process a nominal coal feed rate of two tons per hour with dissolving of coal in the presence of hydrogen. Subsequent laboratory work indicated that coal may also be dissolved effectively in the presence of synthesis gas, and design modifications have been made to provide this capability in the Pilot Plant.

Since one of the major objectives of the Pilot Plant is the collection of data and information, considerable emphasis has been placed on designing instrumentation and sampling capabilities. Provisions have been made to measure material balances around the entire plant and around each major section of the plant as well as to measure the performance of individual items of equipment. Major equipment has been designed to handle a wide range of operating conditions so that a correspondingly wide range of process information might be developed.

The general ranges of operating conditions which are expected to be used in the Pilot Plant are as follows:

1. Coal Feed Rate - 0.5 to 2.5 tons per hour.
2. Dissolver Pressure - 500 to 2200 PSIG.
3. Dissolver Temperature - 700 to 925$^{o}$F.
4. Solvent/Coal Ratio - 1.5 to 4 lbs/lb.
5. Liquid Residence Time - 0.2 to 1.8 hrs.
6. Hydrogen Rate - 800,000 SCFD or Synthesis Gas Rate - 600,000 SCFD.

### B. Plot Plan

The Solvent Refined Coal Plant, which has a nominal design capacity of 50 tons per day of coal, is located on a site of approx-

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(2) Kloepper, D.L.; Rogers, T.F.; Wright, C.H.; and Bull, W.C., "Solvent Processing of Coal to Produce a De-ashed Product", Prepared for Office of Coal Research, Department of Interior, Washington, D.C. under Contract No. 14-01-0001-275, August 27, 1962 to February 1965.

imately 20 acres in North Fort Lewis, Washington. This plant has been divided into a number of separate processing areas, each designated by a number. The general plot plan for the entire plant showing the overall arrangement is given in Appendix A. The plant layout was designed to provide some extra space between areas for safety reasons and to permit future expansion or modification. A listing of the processing areas included is as follows:

| | |
|---|---|
| Area 01 | Coal Preparation Area |
| Area 02 | Preheater and Dissolver Area |
| Area 03 | Mineral Separation Area |
| Area 04 | Solvent Recovery Area |
| Area 05 | Gas Recovery and Recompression Area |
| Area 06 | Future Cement Plant |
| Area 07 | Future Coking Unit |
| Area 08 | Product Solidification and Storage Area |
| Area 09 | Utilities Area |
| Area 09.1 | Process Waste Water Disposal System |
| Area 09.2 | Tank Farm |
| Area 09.3 | Cooling Water |
| Area 09.4 | Boilers |
| Area 09.5 | Hydrogen/Synthesis Gas and Inert Gas Generation and Desulfurization Units |
| Area 09.6 | Control Building |
| Area 09.7 | Shop and Warehouse Building |
| Area 09.8 | Dowtherm System |
| Area 09.9 | Dry Chemical Storage Building |

## C. Process Description

### 1. General Process Description

A description of the Pittsburg and Midway Solvent Refined Coal Process as it is to be studied in the plant is given in the following paragraphs. Figure 1 shows a general block flow diagram of the process. Specific details of the design of all areas of the plant are discussed in depth following this general description.

Raw coal is received in Area 01 by rail or truck, unloaded, crushed, and stored in two 350 ton storage bins. The sized coal (3/4" x 0) is then pulverized and mixed with a hydrocarbon solvent with a boiling range of 550° to 800°F. Initially, a blend of petroleum derived carbon black feedstock FS-120, and a coal tar distillate will be used as a start-up solvent. Ultimately, coal derived liquids will replace the start-up blend as process solvent. Design feed rates to the process are 4000 lbs/hr of coal and 12,000 lbs/hr of solvent for a total of 16,000 lbs/hr of slurry. Solvent-to-coal ratios will be varied from as low as 2/1 to ratios as high as 4/1.

The resulting coal solvent slurry is pumped with reciprocating pumps from Area 01 to the preheater in Area 02. Hydrogen or synthesis gas (hydrogen and carbon monoxide mixtures) and water, is added to the slurry as it enters the preheater. The slurry and hydrogen pass, under pressure, through a natural gas fired preheater to a reactor or "dissolver". In the preheater and dissolver the coal is depolymerized; dissolution of the coal is accomplished by reaction with hydrogen. The remaining undissolved material consists primarily of inorganic mineral matter in the coal and some undissolved carbonaceous material. Operating conditions in the preheater and dissolver range from 775° to 925° at pressures from 500 to 2000 psig.

Following the dissolver step, the excess hydrogen and gases produced in the reaction (hydrogen sulfide, carbon monoxide, carbon dioxide, methane and light hydrocarbon gases) are separated from the slurry of undissolved solids and coal solution. The excess hydrogen and other gases pass to Area 05 and Area 09.5 where the hydrogen sulfide and carbon dioxide are removed in a diethanolamine (DEA) absorption system. The acid gases (hydrogen sulfide and carbon dioxide) released from the regenerated DEA are then processed in a Stretford sulfur recovery unit for conversation of the $H_2S$ to molten elemental sulfur, which is a product of the process. A portion of the clean hydrogen-hydrocarbon gas stream from the DEA absorber is vented to flare, and the remainder is recycled to the process. Fresh hydrogen from the hydrogen generator in Area 09.5 is compressed and is added to the recycle stream to maintain hydrogen purity in the circulating gas.

The slurry from the gas-liquid separator in Area 02 goes to mineral separation, Area 03, where the solids are separated from the coal solution using either or both of two rotary pressure precoat filters. One filter has a filtering area of 80 square feet, and the other has an area of 40 square feet. These filters consist essentially of a rotating drum inside a pressure vessel. Diatomaceous earth is deposited on a screen stretched around the periphery of the drum using process solvent as the precoat slurry medium. Coal solution is then charged to the filters for the filtration cycle. Hot inert gas is circulated through the filters and filtrate receivers to maintain filtration pressure at approximately 150 psig. Filtration temperature will range from approximately 350° to 650°F.

As the solids are deposited over the precoat on the rotating drum they are sprayed with wash solvent to remove imbibed coal solution. The solids and a small layer of precoat are shaved from the drum during each revolution with a doctor blade. The filter cake, consisting of the undissolved solids and diatomaceous earth, is then taken to an indirect, natural gas fired, rotary kiln for drying and removal of the wash solvent. The wash solvent vapors are condensed, and are pumped to Area 04 for fractionation. The dry mineral residue is cooled with water in an indirect rotary cooler and is stored in a silo.

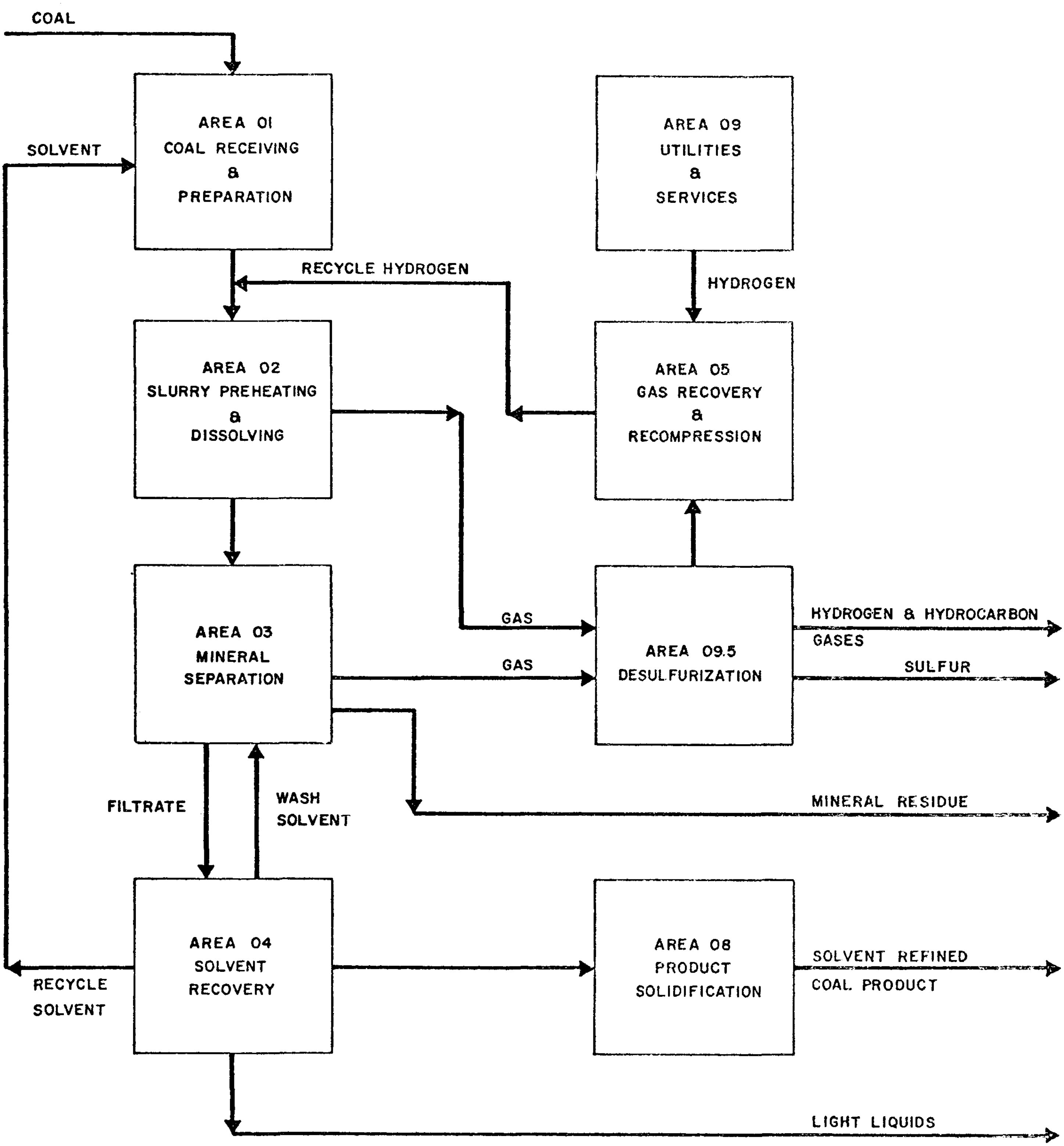
The solids-free coal solution from the filter goes to solvent recovery, Area 04, where the solvent is removed by vacuum distillation. The heat requirement for the vacuum flash is supplied by a gas fired preheater. The vacuum flash overhead is condensed and is sent to two fractionation columns for separation into a light oil fraction, a wash solvent fraction, and the process solvent for recycle to Area 01, slurry blending.

The vacuum bottoms stream (Solvent Refined Coal) is the principal product of the process. SRC from the vacuum tower may be solidified on a water cooled, stainless steel cooling belt or may be formed into prills in a prilling tower. The solidified product is then sent via conveyors and elevators to product storage in Area 08.

Operation of all important areas of the Pilot Plant is monitored by a computer data acquisition system. The computer is connected directly to process sensors such as thermocouples, flow meters, pressure transmitters, and chromatographs which measure process conditions. Values of all of these parameters will be constantly recorded, averaged, and used as the basis for engineering calculations of process performance. Input and output devices of the computer are located in the plant control room to provide for rapid access of current information by plant personnel. Permanent records of plant performance are also produced to aid long-range process development.

FIGURE I

# Pilot Plant Block Flow Diagram



## 2. AREA 01 - COAL RECEIVING AND SLURRY BLENDING

The Coal Receiving and Slurry Blending Area consists of conveyor belts, bucket elevators, a coal crusher, storage bins, a dry pulverizer, a dehumidification system, and facilities for blending pulverized coal with process solvent. The area has been designed to receive the coal that will be charged to the remainder of the plant and prepare it for processing.

Coal can be received by rail or truck. It is dumped into a receiving hopper under the railroad siding. The maximum size of the coal is limited by the 3" x 6" openings in the grating covering of the receiving hopper. Ordinarily, the coal will be received in open top hopper cars of 70 to 100 tons capacity. Since the receiving hopper is a single hopper construction, it will be necessary to unload a single compartment at a time. A car puller is provided to position the cars as necessary.

At the base of the receiving hopper is an oscillating track hopper feeder which delivers the coal to a belt conveyor at a 35 TPH rate. As the belt passes under a metal detector, tramp metal is removed. The belt discharges directly into a primary crusher which reduces the coal to 3/4" size for storage. The crushed coal discharges into a bucket elevator which carries it to a shuttle conveyor. The shuttle conveyor can discharge the coal into either of two storage bins. The storage bins will each hold 350 tons or the equivalent of about one week's supply each at the maximum feed rate of two tons per hour.

The coal can be transferred either automatically or manually to the surge bin which supplies coal to the pulverizer system. The nominal rate for transfer of coal to the surge bin is 9 TPH. Separate feeders and duct work are provided for each storage bin. The feeders are variable speed driven belts which discharge the coal into diverter chutes, directing the coal to either the reclaim conveyor or to the crushed coal surge bin. The coal going to the surge bin is raised by a bucket elevator for gravity drop into the surge bin. High and low level switches are installed in the bin for automatic operation. When automatic mode is selected the feeder, elevator, etc. will automatically start and stop to maintain the proper coal feed level.

Proper setting of the chute diverter will transfer the coal to the reclaim conveyor belt. The belt delivers the coal to a bucket elevator which raises the coal for gravity flow to either a railcar or a truck for removal from the plant.

A dust collection system collects dust-laden air from various points in the unloading and storage system up to and including the crushed coal surge bin. The dust-laden air is filtered in a baghouse and is released to the atmosphere. The fines are returned to the surge bin bucket elevator.

Coal from the surge bin is weighed and is fed into the dry pulverizer by a variable speed gravimetric feeder which automatically controls the desired feed rate of 4800 lbs./hr. or less. The weighed coal drops into the pulverizer through a rotary valve which restricts the inert gas loss from the grinding system.

The dry pulverizer is a ball and race type mill which simultaneously grinds the coal to the desired size and dries the coal to a 1-3% moisture level. As the coal is ground in the mill, a hot recirculating inert gas stream dries, classifies, and then conveys the coal from the mill. The inert gas entrained coal is separated in a baghouse dust collector. A reverse gas jet device releases the coal from the bags. The pulverized and dried coal then drops through a rotary valve into a dust scrubber and venturi where it is slurried with solvent. The volume of solvent used is automatically controlled to maintain a desired ratio with the weight of coal fed into the pulverizer.

The dust-free gas leaving the baghouse is contacted with a recirculating cool water stream in the dehumidifier. Water removed from the coal is condensed and separated here. The dehumidified inert gas is recompressed, reheated, and returned to the pulverizer. The recycled inert gas rate is controlled to produce the desired particle size and mill loading. The oxygen content of the recycle stream is continuously monitored, and make-up inert gas input is controlled to maintain a low oxygen concentration. Heat is added by an indirect fired heater to maintain a fixed pulverizer outlet temperature.

The slurried coal from the venturi is accumulated in a slurry blend tank. The slurry is maintained in suspension by both continuous recirculation and mechanical mixing. High pressure reciprocating feed pumps with variable speed motors are fed from the recirculation line. These pump the slurry into the preheater and dissolver system. A flow controller varies the pumping rate as necessary to maintain a constant flow. The slurry level in the blend tank overides the flow controller if necessary to maintain a minimum level in the blend tank.

The reciprocating pumps are equipped with variable speed drives which can be automatically or manually controlled. Normally both pumps operate in parallel, although each pump has sufficient capacity to handle the entire input to the plant if necessary. Generally, the speed of one of the pumps is set manually from the control panel, while the speed of the other is controlled by the flow rate of slurry to the preheater. Either pump can be controlled by either of these methods. This arrangement has been provided so that either pump can be speeded up to compensate for failure or partial failure of the other pump. In order to further alleviate possible plugging problems in the feed pumps, an emergency solvent system has been provided to allow the operator to inject solvent into the suction side of either pump at any time by operating a pushbutton.

## 3. AREA 02 - COAL SLURRY PREHEATING, DISSOLVING, AND FLASHING

The preheater and dissolver area includes the slurry preheater, two dissolvers, and auxiliary equipment such as the high pressure and intermediate pressure vessels for separation of liquid and vapor products. The entire dissolver area has been designed to carry out the hydrogenation-solution process at pressures as high as 2000 psig and at temperatures as high as 925$^{o}$F. The coal slurry enters Area 02 via the high pressure slurry pump discharge in Area 01.

Hydrogen is added to the coal-solvent slurry immediately before the inlet to the preheater. The hydrogen stream normally consists of recycle plus fresh hydrogen. In such cases, the hydrogen stream fed to the preheaters contains methane and other light hydrocarbons in addition to the hydrogen. The purity (hydrogen content) of the total hydrogen input stream will generally be in the range 70 - 85%, although this will be studied as a variable in the process. The hydrogen rate is regulated by a flow control loop to give a constant rate of hydrogen input to the process.

All of the heat input to the solution process, including that required for the endothermic heat of reaction, takes place in the preheater. There is no significant heat input to the dissolvers, although they are insulated and provided with electrical heat tracing to avoid excessive heat losses and to assist in startup.

Previous work had indicated that the slurry would go through a gel stage during the early phases of the solution step, probably while it is passing through the preheater. To allow for this effect, the slurry pumps and furnace were specified to be able to handle unusually high pressure drops. In addition, provisions have been made to measure the temperature and pressure at a number of points in the heater, so that significant information can be obtained on heat transfer, pressure drop, and viscosity changes throughout the preheater during Pilot Plant operation.

It is anticipated that coking in the furnace tubes may be a problem, particularly at some low solvent-to-coal ratios, at high temperatures, and during stoppage of liquid flows. To minimize the possibility of coking in the tubes, the specifications for the preheater limit the heat flux to a maximum of 10,000 BTU per hour per square foot of inside tube area. Equipment has been provided in the design for removal of any coke deposits by combustion with steam and air. It is expected that coking will be detected by pressure drop changes early enough to permit the use of this technique.

A high pressure solvent line has been provided at the outlet of the slurry feed pumps to permit washing the coal slurry out of the preheater and the adjoining feed lines in case of failure of the slurry feed pumps. The high pressure solvent can be introduced to the feed line by operating a pushbutton located in the control room. This opens a solenoid valve and allows instrument air to open a control valve in the solvent line. The solvent is supplied at a pressure of 2800 psig from the process solvent accumulator by a high pressure reciprocating pump. This pump is started by the same pushbutton used to open the solenoid valve. No provision has been made to heat this high pressure solvent as it will be used on an emergency basis only, and the cold solvent will, in this case, help to cool the preheater.

The slurry preheater has been designed with certain combustion safeguards and emergency shutdown systems. These are as follows:

A. In the event of a high stack temperature (most often caused by uncontrolled combustion or a ruptured furnace tube) a Type I shutdown would take place. A Type I shutdown automatically initiates the following actions:

   1. An alarm sounds in the main control panel, with the source of the trouble indicated on an annunciator panel.

   2. The slurry feed pumps are shut off.

   3. Solenoid valves are actuated to cut off the flow in the fuel gas line, the hydrogen supply line, and the transfer line from the preheater outlet to the dissolvers. The latter valve insures that large quantity of hydrogen and slurry in the dissolvers does not rush back into the preheater in the event of a severe loss in pressure from a ruptured tube.

B. If the slurry outlet temperature reaches a specified upper limit, a Type II shutdown occurs. This type of shutdown automatically shuts off the main fuel gas supply to the heater. In addition, an alarm sounds in the main control room, while the source of the trouble is indicated on the annunciator panel.

C. Each pilot burner is equipped with an ultra-violet flame detector. In the event the pilot flame goes out, the safety shut-off valve for that particular pilot and main burner automatically closes.

D. A steam line has been provided to supply 200 psig snuffing steam to the firebox. The snuffing steam is activated by either one of two pushbuttons located at the main and the local control panels. These pushbuttons open a solenoid valve in the air supply line to a control valve, which in turn opens to let steam into the firebox. The steam purge remains activated until manually shut off.

E. A high inlet temperature switch actuates a system which closes a block valve downstream of the HP slurry pump and closes a block valve in the water injection system. A high inlet temperature indicates a pump discharge valve failure or other malfunctions in the preheater feed system allowing a backflow through the preheaters.

As the hydrogen-slurry mixture passes through the preheater, some solution of coal takes place, but the dissolvers are necessary to allow time for complete solution of the coal. The dissolver configuration selected for the pilot plant consists of two vertical tubes in series. Each of the two dissolvers has an inside diameter of 24 inches and is 30 feet high. The dissolvers are clad vessels, with a shell of 2-1/4% chromium - 1% molybdenum steel and a 3/16" lining of stainless steel which was applied by a weld overlay technique. The overlay consists of a 3/32 inch layer of 309L covered by a 3/32 inch layer of Type 347 stainless steel. The normal outlet for each dissolver is at the top (inlet at bottom), but the first dissolver has an additional outlet in the center (must be separately piped) to provide for operation at very low residence times. The second dissolver (Dissolver "B") can be bypassed, allowing a four fold variation in reactor volume. Since the pumping rate can be varied from about one-third to full capacity, a twelve-fold variation in residence time is possible in this system. The total dissolver volume has been specified to allow a liquid residence time of about 0.6 hours at the nominal charge rate of two tons of coal per hour with a 3 to 1 solvent to coal ratio. This is in addition to the estimated volume occupied by the gas as it passes through the reactor.

Additional equipment has been provided through the plant to provide synthesis gas instead of hydrogen for additional experimental work. A high pressure water injection system has been provided for use with the synthesis gas experiments. Normally hydrogen will be used without using water injection.

The dissolvers are each provided with a safety relief valve of the type which automatically resets when the excess pressure is relieved. In addition, the first dissolver is provided with a pressure control valve which will open to relieve the pressure with much less of an upset than would occur with a relief valve. The control valve is actuated by a pressure switch which opens a solenoid valve in the air line operating the control valve. Normally the control valve operates to relieve excess pressure, but in case of a severely excessive pressure, the relief valve can also operate. The excess pressure control valve and all relief valves discharge fluids to the flare system.

The effluent from the dissolvers is partially cooled by an air-cooled heat exchanger, and then it goes to a gas-liquid separator (high pressure flash drum) which is maintained at 550$^{\circ}$F. The primary reason for holding the high pressure separator at this temperature is to keep the slurry of coal solution and undissolved solids hot enough to allow it to flow freely. Furthermore, there are some indications from earlier work that cooling the slurry and then reheating it prior to filtration can result in some repolymerization of the coal product.

The vapor from the high pressure separator is cooled to 250°F temperature by an air-cooled heat exchanger, is further cooled to 100°F by a water-cooled condenser, and then goes to the recycle condensate separator. The vapor from this separator consists of unreacted hydrogen and light hydrocarbons, mostly methane. The pressure of the entire preheater-dissolver system is controlled by a pressure control valve in the vapor line from the recycle condensate separator. After passing through the control valve, the gas goes to the hydrogen recompression and recovery area.

The liquid from the recycle condensate separator consists of essentially all of the water produced in the reaction, some light hydrocarbon liquids, and a small part of the process solvent. There is some possibility of an emulsion being formed here, but even if there is a distinct phase separation, the density of the liquid may vary from slightly higher than to slightly lower than that of water. For these reasons no attempt has been made to separate the water at this point. This entire stream goes to the flash condensate separation system in Area 03.

The hot slurry in the high pressure flash drum goes through a liquid level control valve to an intermediate pressure flash drum which is maintained at 550°F. The vapor from this drum, consisting largely of light hydrocarbons and hydrogen, goes through a pressure control valve to the flash condensate separator in the mineral separation area. The slurry in the intermediate pressure flash drum goes through a liquid level control valve to the filter feed tank in the mineral separation area. This slurry consists of most of the original solvent, the dissolved coal, and the undissolved coal solids. The intermediate pressure flash drum serves two general purposes: (1) it divides the liquid pressure reduction step into two stages thereby reducing valve wear; and (2) it provides a means of obtaining additional equilibrium data.

## 4. AREA 03 - MINERAL SEPARATION

The purpose of the Mineral Separation Area is to separate all undissolved solids from the coal solution slurry received from the Dissolver Area. The clarified solids-free coal solution is sent to the Solvent Recovery Area where the solvent used and made in the process is separated from the coal product. The solids removed from the coal solution are further processed in a mineral residue dryer to recover any included solvent and produce a dry solids material for disposal.

In the following discussion, Area 03 has been divided into two sections; the Filter Section and Mineral Residue Drying Section. This division was made to segregate the two operations which are widely different in type of procedures.

### a. Filter Section

The slurry feed to the mineral separation system consists of the dissolved coal solution, the undissolved solids, and some light hydrocarbons produced by the hydrogenation reactions in the dissolver. Most of the light hydrocarbons produced in the dissolver, as well as the excess hydrogen and a small part of the process solvent, are separated in the dissolver area and do not reach the mineral separation area. The slurry may also contain some dissolved $H_2S$, although most of the $H_2S$ is separated in the dissolver area.

The properties of the slurry make the removal of undissolved solids a very difficult separation step. First, the solids are very fine, ranging from about one micron to about 20 microns in size, with probably most of the solids closer to the one micron size. Separation of such fine particles requires the use of a filter aid such as diatomaceous earth. In addition, the filtering surface must be continuously renewed as the filter aid becomes blinded by the fine solids. This means that a rotary precoat filter is the only type of filter which can be considered for this separation.

Another factor which makes the separation a difficult one is the very high viscosity of the coal-solvent solution at ambient temperatures. From previous work, it appears that a temperature in the range of 350°F to 650°F is required to decrease the viscosity sufficiently to attain any reasonable separation rate. In order to minimize vaporization of the solvent at such high temperatures, it is necessary to operate at a pressure of about 100 psig to 200 psig.

Filtration experience at the pressures and temperatures needed is very limited. Therefore, the pilot plant must be considered as a development unit. The plant design and operating procedures will require revision as experience is developed. For ease of description, this section on filters is divided as follows:

1. Feed System
2. Condensate System
3. Filter System
4. Precoat System
5. Filter Cake Removal

Feed System

The slurry consisting of coal solutions and undissolved mineral residue flows from the Slurry Preheating and Dissolving Area into a filter feed flash vessel. The vessel is equipped with a mixer to keep the solids in suspension. In addition, the slurry is continuously recirculated by a pump through a Dowtherm exchanger. The exchanger provides the heat to maintain the slurry in the feed vessel and the filters at the desired temperature level, which is usually between 500 and 700°F)

Although the coal solution has been previously flashed, some additional flashing of light ends will take place in the filter feed flash vessel. The vapor released is let down through a control valve to the condensate system. The pressure of the feed flash is maintained at approximately the same pressure as the filtrate receivers. This minimizes flashing in the filter system. The pressure control system is a split range controller, and if the volume of vapors released is insufficient to maintain pressure, inert gas will be let in to hold the control pressure.

The volume of slurry which will pass through the filters will vary continuously depending on many variables. To provide a workable system, the feed flash vessel is large (about 2000 gallons) and will provide about one hour's surge volume. In addition, a filter feed surge vessel (about 12,000 gallons) will hold approximately seven hour's surge at maximum rates.

The filter feed flash vessel is generally operated about one-half full. When production of dissolved coal slurry exceeds filtration capacity, a slip stream is taken from the discharge of the filter feed flash recirculation pump and is sent to the surge vessel to hold the level on the feed flash vessel on level control.

The surge vessel is normally operated at 20 psi lower pressure than the flash vessel. This differential is necessary in some instances to provide a driving force to return solution from the filters during startup or sluicing. The pressure is maintained by a split range pressure controller which will add or release inert gas as needed. The surge vessel is equipped with a mixer to maintain the solids in suspension, and, if needed, the discharge pump can also be used to recycle the solution. The surge vessel is heated electrically to overcome heat losses while holding a 500°F to 700°F temperature level.

Feed to each filter is supplied by individual filter feed flash discharge pumps. However, these services can be altered if desired. The volume of feed to each filter is flow controlled. The rate is normally more than the filter can handle and the excess is returned on level control. The excess rate not only provides a positive level control (filter submergence), but also provides a means of keeping the filter hot. The excess returns to the filter feed flash system where it is reheated by the Dowtherm exchanger.

Several alternatives provide operating flexibility:

a. The surge vessel discharge pump can feed to the filters directly if this should be necessary due to pump breakdown.

b. The surge vessel discharge pump and the feed flash discharge pumps can feed directly to the vacuum flash.

c. The vacuum flash feed accumulator contents can be returned to the surge vessel. This is particularly useful if some dirty material should get through the filters.

d. The surge vessel can generally accumulate any flushing material until it can be reprocessed.

e. Wash solvent can be added to the filter feed on flow control should it be desirable to investigate the effect on filtration rate of dilution with a light solvent.

Condensate System

The vapors released from the filter feed flash combine with the liquid separated in the intermediate pressure flash of the dissolver areas and pass through a water cooled exchanger into the Flash Condensate Separator #1. The combined stream contains hydrocarbon liquids and water. The gravity of the hydrocarbon liquids can be such that in some instances it may be heavier than water, yet at other times it may be lighter than water. In Separator #1, the heavier than water hydrocarbons are separated from water and lighter hydrocarbons. The heavy hydrocarbons are then sent to the light ends column feed tank in the solvent recovery area. The bottom drawoff is automatically controlled by a level control device which is calibrated to sense the difference in gravity.

The water and lighter hydrocarbons flow over a weir in the separator and flow by gravity to the Flash Condensate Separator #2.

In Separator #2, water is separated from the lighter hydrocarbons. The water drawoff from the bottom of the separator is automatically controlled, and the water is sent to the recycle process water tank. A level control device senses the gravity of the liquid and allows only water to pass out the bottom. The light hydrocarbons are withdrawn automatically on level control and flow to the light ends column feed tank along with the heavy hydrocarbons from Separator #1.

The vapors separated in both separators are released under pressure control and can be further treated in the Desulfurization Unit or sent directly to the flare.

The water accumulated in the recycle process water tank is recycled by means of the water booster pump back to the coal slurry feed if desired. Provisions are made for using treated water or raw water if needed to reduce salt concentration. The booster pump is equipped with a control to regulate the volume recycled. Any process water not used is pumped by the recycle water pump through a level control valve to the waste incinerator. Pressure is maintained on the water tank by means of a split range pressure controller using inert gas and venting to the flare.

Filter System

Two rotary pressure precoat filters have been provided to handle filtration of the slurry of coal solutions and undissolved solids. One filter has a total filtering area of 80 square feet while the other has an area of 40 square feet. The two different filter sizes are necessary to provide the flexibility required to explore the effects of conditions on rates and yet maintain a capacity suitable for obtaining useful data. The actual filtration rates obtainable are dependent not only upon the conditions of filtration, but also on the conditions maintained in the dissolvers. It is expected that at some experimental conditions the filter rates may be less than 50 pounds per hour per square foot of area, while at other conditions the rates will be greater than 200 pounds per hour per square foot of area.

The filters have been specially designed for this process by Goslin-Birmingham Corporation of Birmingham, Alabama, in cooperation with P&M engineers. Both filters are of the same design and have the same drum diameter (6 feet). The only difference between the two filters is drum width. One filter has a drum 4 feet wide while the other filter drum is 2 feet wide.

The filters consist essentially of a rotating drum inside a pressure vessel. Filter cloth is stretched around the periphery of the drum and is normally precoated with a three to six inch layer of diatomaceous earth. A sharp blade is provided to shave off a thin layer of the precoat, together with the solids collected, as the drum revolves. The knife is adjustable to give a cutting rate of 1 to 12 thousandths of an inch (mils) per revolution. An indicator dial is provided to give an indication of the distance of the knife blade from the drum. A switch is provided to automatically stop the knife advance at a minimum distance from the drum. Although the knife advance rate is adjustable, a manual calibration will be necessary.

The filter has been designed to operate at any drum submergence level between 0 and 50%, although a 50% submergence level is considered normal. Two separate methods of level control are provided. The first method will use a bubbler type level control and a level control valve. The second method uses overflow pipes located at 30%, 40%, and 50% submergence. The first method is the normal method of level control to be used in the pilot plant. It has the advantage that the feed system pressure control is not dependent on the filter pressure. In addition, the flow rate of liquid returned to the feed system can be measured. The second method, if used, depends upon gravity flow only and therefore limits the filter vat pressure to the pressure of the feed system.

At a submergence level of 50%, about half of the bearing area supporting the drum is covered with liquid. To keep small solid particles of the slurry out of the bearings, a seal is provided at each edge of the bearing system. In addition, a pressure lubricating system provides a positive pressure and a small flow of lubricant through the seal to help keep the process fluid away from the bearing.

The speed of drum rotation can be manually changed from the highest speed of one <u>minute</u> per <u>revolution</u> to the slowest speed of 12 <u>minutes</u> per <u>revolution</u>. The fastest speed is normally used during precoating. The optimum speed for normal operation is one of the factors to be determined by plant operation studies.

The filters are designed for a maximum operating pressure of 200 PSIG at an operating temperature of 700°F. However, for practical purposes, the maximum operating pressure should not exceed 190 PSIG since the system relief valves are set at 200 PSIG.

Each filter is provided with three spray headers equipped with nozzles for washing the filter cake with hot wash solvent as it emerges from the liquid. The spray headers are spaced around the top of the filter so as to cover all of the drum above the level of the filter except that portion adjacent to the scraper knife. The three spray headers are fed by independent pipes so the effectiveness of each header location can be evaluated by using only one header at a time. The wash solvent should displace coal solution from the layer of mineral residue and precoat. It is expected that excess wash solvent will be drained off before the solids reach the scraper knife. Two other spray nozzles, also fed by independent pipes, are located above the scraper knife. These will not normally be used, (to avoid excessive wetting of the dry solids) but are available if intermittent washing of accumulated solids from the knife is necessary. The wash solvent in the latter lines is supplied at room temperature.

The wash solvent for the filters is a light liquid fraction derived from the process, (initially a light fraction from the start-up solvent). The wash solvent for the filters must have a boiling range high enough so that most of it remains in the liquid phase at the maximum temperature of the filter (about 700°F). On the other hand, the wash solvent must be light enough to be readily removed from the mineral residue during the drying step. While the optimum boiling range for the wash solvent is not yet known, it is expected to be about 450 to 550°F.

Wash solvent is pumped to the filters from the wash solvent accumulator which is located in the solvent recovery section. It is normally heated in a Dowtherm exchanger to the temperature of the filter, with temperature control provided by a control loop on the Dowtherm circulation. The flow rate of hot wash solvent to the filter is controlled at a fixed rate for each filter.

To permit removal of the precoat "heel" (the thin layer of precoat remaining after the precoat has been cut to a minimum thickness) a sluicing nozzle has been provided in the filter. Process solvent from the solvent flush system flows through a connecting line to this nozzle to wash off any precoat remaining on the filter screen. This connection can also be used for removal of precoat and flushing of the system during an emergency or an unplanned shutdown.

Several other devices are provided in the filter:

a. An internal agitator is provided to stir the vat beneath the filter drum. It is a rocker type agitator with an adjustable speed from zero to 26 revolutions per minute. The agitator must be removed if a precoat cake of more than 3 inch thickness is used.

b. A screw feeder is provided to convey the cake cut by the knife to a central outlet. The screw turns at a constant rate of 60 RPM.

c. Observation ports are provided to admit light and observe the condition of the filter cake and knife. The ports are equipped with wash nozzles which can inject short spurts of solvent to clean the inside of the ports. An inert gas pressure is maintained between the two panes in each sight port to reduce the pressure drop across each pane.

Heat is supplied to the filters by recycling feed back to the filter feed flash vessel where it is reheated by the Dowtherm heater. Additional heat is provided by the hot wash solvent and the hot filter gas recycle. The filter vats are also electrically traced and insulated.

A hood is provided over each filter to collect any escaping gas. Some filter gas will continually escape through the various drive packings. An exhaust fan is provided for the hoods.

The filter feed enters the filter vat, where a selected level is maintained. The liquid is forced through the filter aid by the difference in pressure between the outside and inside of the drum. This pressure difference is maintained by the gas recycle system. Gas also passes through the filter aid through the surface above the liquid level. The solids collect on the surface of the precoat. As the solids cake passes through the vapor space, a wash solvent is sprayed on it to wash the coal solution from the cake. The filter gas passing through the cake forces the majority of the liquid out of the cake and into the drum.

The mixture of liquid and gas goes to the appropriate filtrate receiver (one for each of the two filters). The filtrate receivers are cone-bottom vessels which minimize the retention of solids. The filtrate receiver does not normally contain solids, but some solids could be present at times from filter aid passing through the screen at the beginning of precoating operations, or possibly from slurry breaking through the filter screen. If solids are retained in the filtrate receiver they could later cause contamination of normally clean product.

Liquid product is pumped from the two filtrate receivers by three centrifugal pumps. The three pumps are connected so that any pump can be used with either of the two receivers. The liquid is normally pumped to the vacuum flash section of the solvent recovery area. Alternately the liquid can be pumped back to the precoat slurry tank (during precoating), to a filter, to the filter feed tank, or to the filter feed surge tank. In all cases the rate of flow from the filtrate receivers is controlled by a level control loop.

Pressure control in the filtration system is maintained by circulating a stream of inert gas through the filters. Two separate inert gas systems are provided, one for each filter. The two systems are essentially identical except for a size variation corresponding to the difference in size of the filters. Inert gas is used to minimize explosive hazards. Make-up inert gas is added to the system through instrument purges and through a purge in the filter cake outlet standpipe.

The gas circulating in each system always goes through the same filter whether the filter is being precoated or whether it is in normal operation. Consequently, the pressure drop through the filter will not be disturbed or upset when the filter is switched from precoating to normal operation and back again. This should minimize the chance of filter cake damage due to pressure fluctuations. In addition, the separate gas circulation systems will make it easier to obtain good material balances when the filter in operation is switched in the middle of a run. The filter gas always contains the quantity of hydrocarbon vapor which corresponds to equilibrium conditions in the filter.

The filter gas leaves the filter along with the filtrate through the screen and the main filtrate outlet. The gas and liquid are separated in a filtrate receiver which is maintained at about the same temperature as the filter. The filter gas is then cooled by a series of heat exchangers, the last one water-cooled, to condense normally liquid hydrocarbons.

The cooled gas mixture goes to a gas compressor scrubber. The pressure on this vessel (essentially the downstream pressure for the filtration step as well as the compressor suction pressure) is maintained by bleeding a small side stream of the gas to the flare system. The hydrocarbons condensed prior to entering the compressor are returned to the filter gas after the gas has been recompressed. The gas is reheated in a series of heat exchangers, the last one Dowtherm heated, to the filter temperature before it is returned to the filters. The initial heating takes place by exchange with the hot gas from the filtrate receiver. The liquid hydrocarbons are revaporized in these heat exchangers so that the stream again contains an equilibrium quantity of hydrocarbon vapors.

After re-saturation, the filter gas goes to a vapor surge drum before entering the filter. This surge drum provides additional capacity in the system to help minimize pressure surges and upsets that could break up the filter cake. The pressure at this point is regulated by a pressure control valve on a bypass line to the suction side of the compressor. Enough filter gas is bypassed through this valve to control the upstream pressure on the filter at the desired level.

Precoat System

Because of the extremely fine solid particles to be filtered, it is necessary to use a filter aid such as diatomaceous earth on the filter screen. The filter aid rapidly becomes blinded with the fine particles, however, and the solids plus a thin layer of precoat must be continually removed to maintain a reasonable rate of filtration. The precoat is initially deposited by mixing a commercial diatomaceous earth filter aid with the process solvent and filtering the resulting slurry. The precoat system consists of a precoat receiving tank, a pump to transfer the precoat-solvent mixture to a precoat slurry pressure vessel, a pump to circulate the precoat slurry from the pressure vessel through a Dowtherm heat exchanger and back to the vessel, and a pump to transfer the precoat slurry to the filters. Both slurry mixing vessels are equipped with mixers. The pumps are all rotary gear pumps which were selected in preference to centrifugal pumps to minimize fracturing of the precoat by the highly turbulent action of a centrifugal pump.

A slipstream from the circulating pump is cooled in an aerial cooler followed by a water cooled exchanger and flows continuously (while mixing precoat) to the precoat mixing tank. Dry precoat is added manually to a bucket elevator, which dumps the precoat into the top of the precoat mixing tank. Here the precoat is mixed with the cold process solvent to a high concentration. It is anticipated that the highest concentration which can readily be pumped will be used for this tank. This mixture is then pumped to a precoat slurry pressure vessel. The major purpose of this vessel is to prepare a slurry for precoating and to allow for heating it to the filtration temperature. It is necessary to precoat the filters at about the same temperature and pressure as used in the actual filtration step to avoid breaking up the precoat layer by expansion or contraction due to temperature or pressure changes. The process solvent in this tank is maintained at the desired temperature (500 to 700°F) by circulating the solvent (or precoat slurry) through a Dowtherm heat exchanger and back to the precoat slurry pressure vessel. The temperature is controlled by a temperature control valve in the Dowtherm line. The rapid circulation through the heat exchanger also helps to keep the precoat thoroughly mixed with solvent.

The concentration of the precoat slurry in the precoat slurry pressure vessel is expected to be about 2% initially. This is the concentration generally recommended by filter and filter aid manufacturers for precoating. During precoating this slurry is pumped to the main inlet line of the appropriate filter. The rate of gas circulation required through the filter to provide sufficient pressure drop for initial deposition of precoat is higher than the normal gas circulation rate. Initially all of the compressor discharge may be required to provide the pressure drop.

The process solvent is separated from the circulating gas in the appropriate filtrate receiver and is returned to the precoat slurry pressure vessel. The return flow is regulated by a level control loop on the liquid level in the filtrate receiver.

A base coat of asbestos fiber is deposited on the drum before precoating to prevent the fine particles of precoat from wedging in the filter screen. This asbestos fiber base coat can be added in the same way as the precoat, and an attempt will be made to do this. The major problem with this approach is that the long asbestos fibers may become a contaminant for the main precoat layer. In this case they would interfere with uniform cutting of the precoat. To avoid such contamination, an alternate method for addition of the fibers has been provided. This consists of a small feed tank attached to each of the main filter outlet lines. This feed tank is equipped with connections for venting and for pressurizing a concentrated slurry directly into the filter system. Although this slurry would be fed cold, the quantity is so small (about 5 gallons total) that its effect on the filter system temperature would be negligible. At the time of addition of the fiber, hot process solvent would be circulating between the filtrate receiver and the filter.

The precoat cake can be deposited to a thickness of as much as 6". However, the agitator must be removed from the filter vat for cake thicknesses greater than 3". Whenever the knife advances to within 1/4" of the drum, the advance will automatically stop. The remaining heel can either be removed by sluicing or left on the filter where a new thickness of precoat can be deposited over it.

Filter Cake Removal

One of the major problems in designing continuous solid separation equipment for operation under pressure involves continuous dischange of the solids to atmospheric pressure. It is necessary to have equipment which will allow solids to flow out of the system continuously or semi-continuously, without significant leakage to the surroundings. The problem is especially critical with filters, where pressure upsets can destroy the uniform layer of precoat on the filter screen.

The cake removed by the filter knife is dropped into separate 8" diameter standpipes for each filter by an internal screw conveyor. The standpipes are electrically traced to prevent solvent vapor condensation and to keep the cake hot. A Sier-Bath screw pump at the base of each standpipe is used to let the pressure down from about 150 psig to essentially atmospheric pressure. In this case the pump decreases the pressure rather than performing its usual function of increasing pressure. The screws of the pump, together with the solids in the standpipe and in the line to the mineral residue dryer are intended to act as a seal to maintain the pressure differential between the filter and the dryer. It is essential that this pressure differential be maintained effectively, so that there are no pressure fluctuations or upsets in the filter to dislodge the precoat from the drum and disturb its filtering effectiveness. Nuclear type level detectors in the standpipes are used to set the variable speed drives of the screw pumps.

A plug-type shut-off valve is located directly below the Sier-Bath screw pump to isolate the system if necessary. In addition, a sample connection has been provided in the line. When necessary, a sample of the solids will be withdrawn through a plug valve into a special sample bomb.

This system of solids letdown is a new and untried system. In order for it to work the cake must have a semi-plastic consistency. If it is too dry the solids may not flow into the pump without the addition of solvent. If too much solvent is added the cake may leak through the pump. Provisions have been made to add solvent at a measured rate if necessary.

Mineral Residue Drying

The Mineral Residue Drying Section of the Mineral Separation Area consists essentially of filter cake drying in a rotary calciner followed by recovery of the vaporized solvent. The dried mineral residue is transferred to a bin for storage and shipment to potential users of the material.

The solids from each of the two filters after passing through the appropriate Sier-Bath pumps (maximum capacity 3 GPM) are discharged into the rotary dryer at 5 psig and 550°F - 700°F. The rotary dryer is designed to receive wet ash containing as much as 70% solvent with a boiling range of 450°F - 700°F. The particle size of the solids ranges from 1 to 50 microns. The wet solid will normally be much dryer than the above figure of 70%. Excessive amounts of solvent may enter the rotary dryer at times, however, due to condensation of liquids from the saturated gas in the filters.

The wet solids are heated to 700°F in the rotary dryer by indirect heating with fuel gas and combustion air. The dryer is essentially a rotating cylinder slightly inclined from the horizontal and housed in a refractory lined furnance. The mineral residue is quickly moved into the active section of the dryer by sprial flights. The active section is equipped with several staggered rows of combined agitating and lifting flights. The mineral residue is discharged from the dryer into a standpipe. The dried solids are removed from the standpipe through a rotary valve. The solvent vapors from the dryer, along with dust particles, are routed into a dust collector, where the dust particles are removed.

Solids from the rotary valve and from the dust collector are led to a mineral residue cooler through a duct where the solids are cooled from between 700 and 750°F to 100°F by an indirect water spray.

The cooled and dried mineral residue leaves the hoppered portion of the mineral residue cooler through a rotary valve and falls onto a gravimetric feeder for weighing and transfer to a bucket elevator, a chute, and into a mineral residue bin. The bin is equipped with a top dust collector and exhaust blower. It is also provided with a solenoid operated pneumatic sliding valve for control of mineral residue removal. The design flow rate for the mineral residue to the bin is 520 lb./hr.

The vaporized solvent, along with light hydrocarbon vapors, is purged from the dryer with inert gas and is passed through a cyclone dust collector to a condensate scrubber. Here the solvent vapors are scrubbed and condensed by scrubbing with liquid solvent. Condensate is accumulated in a drum, which operates at slight positive pressure. The solvent for scrubbing is circulated by a pump which is rated for a design flow rate of 500 GPM at 245 feet of total differential head. It is cooled by a water cooler and is returned to the scrubber and condensate drum. The solvent temperature at the outlet of the cooler is controlled by regulation of the flow of cooling water through the cooler.

The recovered solvent is filtered and is sent to the light ends removal column. Design flow rate for the solvent recovered is 346 lb./hr.

Uncondensed hydrocarbon vapors from the dryer condensate drum are removed from the system to the Stretford Desulfurizer with a blower. The suction pressure of the blower is maintained near atmospheric pressure. During startup or upon abnormal conditions the blower gases may be vented to the flare system.

A sample connection is provided in the discharge line of the dryer exhaust blower for analysis of the gases by a chromatograph.

5. Area 04 - Solvent Recovery

The solvent recovery area consists of two major distillation sections. The first is a vacuum flash section for separating solvent from the solvent refined coal product. The second section consists of two distillation columns for separating the light ends, wash solvent, and process solvent from a mixture of the vacuum flash overhead and the miscellaneous light streams from other sections of the plant.

The purpose of the vacuum flash section is to separate distillate material, including the process solvent and all lighter products, from the solvent refined coal. After filtration, the clarified liquid is pumped through a gas fired preheater to a vacuum flash drum. A vacuum flash accumulator has been provided to act as a surge tank so that the feed to the vacuum flash tower can be kept relatively constant even if the filtration rate fluctuates greatly. This may readily occur during periods when operating difficulties are being experienced with the filter.

The filtrate or clarified liquid is heated to a temperature of about 800 to 875°F in the vacuum flash preheater.

The vacuum flash preheater is a Foster-Wheeler Corporation vertical, direct fired, natural draft process heater. The normal duty of this heater is 4.4 MM BTU/Hr which is supplied to process liquid containing up to 20% dissolved solids by a combination of one pilot burner and one main gas burner.

The heater tubes are of helical coil construction, and the material is 7Cr-1/2 Mo. The outside diameter of the tube is 3.5" with a tube thickness of 0.41".

The pressure in the preheater coil is maintained at about 100 PSIG by a pressure control valve at the outlet of the heater. This keeps the feed stream in liquid state during preheating. As the liquid flows through the pressure control valve, all of the process solvent and lighter liquids are vaporized and are taken overhead from the vacuum flash drum.

The conditions in the vacuum flash drum determine the quantity of hydrocarbon oil removed from the solvent refined coal product, and hence influence its melting point. If a high melting point is desired for the solvent refined coal product, the temperature and vacuum will be high, and conversely, if a low melting point product is desired, the temperature and/or vacuum will be decreased.

Even when the dissolver product is not filtered, it will be necessary to recover process solvent. This may occur when the filtration rate is not high enough to filter all of the dissolver product, or when the filters are temporarily shut down because of operating difficulties. There will also be times when only part of the solids will be removed. Such situations may arise frequently during operation of the pilot plant, especially in the early stages of operation. At these times it will be necessary to recover solvent from the unfiltered or partly filtered product, and segregate the off specification product in "slop product" storage until sufficient filtered material has been processed to flush the "slop product" from the system. The "slop product" will have the general appearance and characteristics of the solvent refined coal product except that it will contain an appreciable quantity of solids. The "slop product" is not to be confused with waste product normally going to the waste disposal system.

The overhead product from the vacuum flash goes through an aerial cooler and a water cooled condenser to the vacuum flash condensate drum. The condensed liquid goes directly to the light ends column in the solvent fractionation section.

The vacuum flash system is designed to operate at an absolute pressure as low as 2 psig. The vacuum is attained by a two-stage steam jet system connected to the vacuum flash condensate drum. The absolute pressure in the system is controlled by a pressure control valve in a by-pass line between the first and second stage steam jets. The pressure can then be increased or decreased by adjusting the rate of bleed-back flow from the second stage to the first stage steam jet.

The solvent fractionation section is designed to separate the various liquid products made in the process from the process solvent. The major component of the feed to this section is the overhead from the vacuum flash section. In addition to this stream, however, a number of other light hydrocarbon streams from other parts of the plant are fed into the fractionation section at this point. These other streams are liquids from the flash condensate separator in the solids separation area, from the solids dryer condensate drum in the mineral recovery section, from the condensate separator in the dissolver section, from the filter gas scrubbers, from the filter gas surge tank, and vapor from the vacuum flash accumulator. A light ends column feed tank has been provided to act as a surge tank so that the feed to the light ends column can be kept relatively constant even though the supply streams vary widely.

The combined stream cited above is preheated by a heat exchanger using Dowtherm. The preheated liquid then enters the light ends removal column. The purpose of this column is to separate as an overhead product all hydrocarbons lighter than the wash solvent used in the filtration step. This fraction also includes any water left in the streams from other steps. The light ends removal column is a packed column with the rectification section significantly smaller in diameter than the stripping section (16" and 22", respectively). The column operates at atmospheric pressure, with provision for refluxing part of the overhead product. The quantity of reflux is regulated by a flow control valve.

The light hydrocarbon products and water (if any) are drained through a level control valve from the reflux drum to an oil-water separator. The oil-water separator has been designed so that the water and light hydrocarbons can be drained off separately. Water is periodically drained manually while the light oil is drained automatically through a level control valve. The light hydrocarbon stream is essentially a stablized naphtha, consisting of hydrocarbons ranging from $C_5$ to as high as 350 - 450°F in boiling point. The water phase contains some phenols and other oxygenated compounds, and will be sampled periodically to permit evaluation of the possibility of by-products recovery . Most of this water, however, will be drained to the chemical waste system and treated in the waste disposal area.

The bottoms stream from the light ends removal column is pumped to the wash solvent column. This is a plate column designed to separate wash solvent as an overhead product. The wash solvent is then recycled for use in the filters. The wash solvent column operates at atmospheric pressure, with product reflux through a flow control valve. The temperature at the top of the column can be varied to produce wash solvent of varying boiling range. The most effective boiling range for the wash solvent will be determined during actual operation of the pilot plant, but for design purposes, the boiling range of the wash solvent was considered to be 450-550°F. The wash solvent product is removed from the reflux drum through a liquid level control valve. It is cooled by a water-cooled heat exchanger and is sent to a wash solvent accumulator. In normal operation, some liquid in the wash solvent boiling range will be produced by the hydrogenation reactions in the dissolver. The appropriate quantity of wash solvent is recycled to the filters, while the excess wash solvent is a net product of the process.

For design work, the boiling range of the process solvent was considered to be 550 to 800°F. The bottoms from the wash solvent column will be used directly as process solvent. The bottoms product from the wash solvent column is pumped out of the reboiler through a control valve that is regulated by the reboiler liquid level. It then goes through an air-cooled heat exchanger to the process solvent accumulator. The process solvent accumulator is designed to hold solvent as hot as 650°F, but it is normally expected to hold solvent at about 100 to 150°F.

### 6. Area 05 - Hydrogen Recovery and Recompression

The Gas Recovery and Recompression Area provides auxiliary services for the Dissolver Area. It has three purposes: (1) It provides a recycle hydrogen stream of a controlled hydrogen concentration and free of $H_2S$; (2) It removes the sulfur compounds from the vent gas before disposal; and (3) It boosts the pressure of the fresh hydrogen for makeup into the high pressure dissolver system.

The operation of Gas Recovery and Recompression Area is integral to the operation of the dissolvers and therefore its operation must be closely coordinated with that of the dissolver system.

The gas separated from the dissolver liquids in the high pressure condensate separator of the Dissolver Area is treated and recompressed for recycle to the preheater and dissolvers. A portion of the gas is vented and fresh hydrogen is added to maintain a fixed concentration of hydrogen in the recycle. The fresh hydrogen comes from the hydrogen plant at a pressure of 75 psig. It is compressed to raise the pressure so that it can be fed into the recycle stream.

The high pressure gases from the dissolver area contain $H_2S$ and other sulfur compounds which must be removed. The removal is affected by contacting the gas with Diethanolamine (DEA) at high pressure. The sour gas from the regeneration of the sour amine solution is further processed in a Stretford Unit to recover elemental sulfur.

The $H_2S$ free gas from the DEA unit goes to the recycle hydrogen compressor suction scrubber. Liquid removed in the scrubber is automatically withdrawn through a trap to the flare knockout drum. The scrubber is equipped with two separate liquid level switches at different levels. The switch at the lower level alarms the main panel upon accumulation of liquid due to trap failure. The upper switch stops the recycle compressor before possible carryover of liquid into the compressor suction.

A portion of the $H_2S$ free gas is analyzed, measured and vented as necessary to maintain a constant suction pressure for the recycle compressor. The volume of recycle gas is measured before recompression. A low suction pressure alarm is provided to warn the operator of this abnormal condition.

The recycle gas is recompressed in a single stage reciprocating compressor. The compressor is equipped with a two compartment distance piece. One compartment is purged with inert gas and is vented to the atmosphere. The discharge pressure is controlled by bypassing part or all of the compressed gas through a pressure control valve and a water cooled exchanger back to the suction scrubber. This arrangement allows the recycle compressor to operate continuously even though the hydrogen rate to the dissolvers may drop to zero. A manual bypass is provided for starting the compressor under no-load conditions.

The discharge of the recycle compressor passes through a water cooled exchanger into the recycle scrubber. Any liquids condensed are separated in the scrubber. The condensate free gas then supplies the hydrogen for the process. The liquid which is separated in the scrubber is automatically withdrawn through an on and off level control valve actuated by a level switch in the scrubber. The liquid flows to the flare knockout drum.

The compression system for making up fresh hydrogen to the process is similar to the recycle hydrogen compression system. Fresh hydrogen from the hydrogen plant is measured and flows to the fresh hydrogen first stage scrubber. The excess fresh hydrogen supply is returned to the hydrogen plant on pressure control. A low suction pressure alarm warns the operator of an abnormal condition. Liquid which separates in the scrubber is automatically drained by a trap and is sent to the flare knockout drum. The scrubber is equipped with two level switches at different levels. The switch at the lower level alarms the main panel of an accumulation of liquid due to trap failure. The upper switch stops the compressor before liquid is carried over into the compressor suction.

The fresh hydrogen compressor is a three stage compressor with interstage cooling. The compressor is provided with two compartment distance pieces. One compartment of each piece is purged with inert gas and is vented to the outside. The third stage discharge pressure is controlled by bypassing part or all of the flow back to the first stage suction scrubber by means of a pressure control valve through a recycle water cooled exchanger. The system provides flexibility in the volume of gas added to the process while allowing the compressor to run continuously. A manual bypass valve is provided for starting the compressor in a no-load condition.

The fresh hydrogen make up to the process is controlled by an analyzer which maintains a set hydrogen concentration in the recycle hydrogen stream. The analyzer adjusts a flow control valve which injects the fresh hydrogen into the recycle hydrogen compressor bypass stream ahead of the water cooler.

Fresh hydrogen storage bottles are provided to supply hydrogen for a period of one hour during upsets in the hydrogen generation plant. These bottles will be charged with fresh hydrogen during plant startup using both the fresh hydrogen and recycle hydrogen compressors. During upsets the hydrogen is fed into the first stage suction scrubber of the fresh hydrogen compressor on pressure control. This reserve supply of hydrogen will also provide make up hydrogen for pressure maintenance during an emergency shutdown.

7. Area 08 - Product Solidification and Storage

This area contains equipment for the solidification, storage, and shipment of the solvent refined coal product (SRC). Molten SRC flows to this area from the vacuum flash drum in Area 04. The coal product is solidified and is stored in 150 ton bins for shipment. Product shipments can be made by truck or rail in bulk or bagged form.

Two methods of product solidification are available: (1) A prilling tower, and (2) a Sandvik cooling belt. Both methods can solidify the SRC by cooling it from about 600°F to about 150°F. However, a system for heating or cooling the molten SRC charge to the prilling tower is provided so that the effects of temperature and viscosity on the prilling operation can be studied. This temperature control system involves heat exchange between molten SRC and a Dowtherm stream which has either been heated in a Cromolox heater or cooled in an air fin cooler. Temperatures as high as 730°F and as low as 500°F can be achieved at the prilling nozzles. The prilling tower uses direct contact with ambient air for cooling and solidification of the product. The molten product is sprayed downward from the top of the tower, and it contacts the rising air stream countercurrently. The air is exhausted from the tower through cyclones to prevent entrainment of solids.

The Sandvik cooling belt uses a system of water sprays to cool the underside of a stainless steel cooling belt on which the molten SRC is traveling.

Normally the prilling tower will be used to solidify the SRC. The cooling belt is provided for start-up and as a back-up for the prilling tower. After solidification, the SRC is moved to storage bins by a series of conveyors and bucket elevators. Solidified product is weighed just prior to entering the storage bins. Four product storage bins are provided; one for offgrade product, and three for on-grade product. Each bin will hold about 150 tons, or about four days run at full rate. From the bins, the SRC can be (1) directed to the product bagger, or (2) conveyed in bulk for truck or rail shipment. Bulk shipments are weighed just before the product enters the bulk carrier.

All controls for Area 08 equipment are mounted on the equipment or on one of the two local control panels. The main control room can not control <u>any</u> Area 08 operations.

8. <u>Data Acquisition System</u>

The plant computer data acquisition system consists of a computer, various input and output devices, a process interface, and a mass data storage facility. It has been specified to automatically carry out many of the process monitoring and data recording tasks which are necessary in a pilot plant.

All analog input signals enter the computer through Foxboro Spec 200 transducers as 0 to 10 volt signals. These signals are digitized in the Interspec Module (process interface) and are read into the Foxboro Fox 2/30 computer with a resolution of one part in 4000. All of the 228 analog input points are scanned at least twice every minute.

Digital input capability is also provided to enable communication of chromatograph status to the computer. The three process chromatographs in the plant each signal "in-service", start of analysis, stream identification, calibration run, and "come read" status by means of contact closures. The computer responds to changing chromatograph status by executing various programs which read and store chromatograph data.

All of the process information measured by the computer is averaged for one hour periods. The averages are typed out on a logging typer and are retained in the 980K drum memory for a period of three days. During the three day period for which process information is retained, plant personnel will evaluate the data and will also add data from other sources, such as the plant laboratory or operation records, to more fully define plant operation. Extensive engineering calculations will be performed by the computer using selected portions of the data to document plant operation over the desired period. Permanent records will be retained both as typed copy and as punched paper tape for ease of further processing.

9. Utilities

a. Electrical Power

Electrical power is supplied to the SRC plant by Tacoma City Light at 13.8 KV. The SRC plant underground system feeds 13.8 KV power to nine separate transformers. These transformers reduce the voltage from 13,800 volts (13.8 KV) to 480 volts and feed the load centers. The load centers contain circuit breakers plus other protective devices that accept and pass on the 480 volt electricity from the transformers. Power is fed directly from the load centers to some large motors but most motors and other electrical devices receive power from motor control centers which are fed from the load centers.

A 1500 KW emergency power system is being installed which will provide electrical power in the event of failure of the primary power supply system. The emergency system includes three diesel motor-generator sets, which feed the plant load centers directly, and switchgear which automatically disconnects the primary power supply and connects the emergency system when a power failure occurs. A battery pack power supply for electronic instruments is also provided so that control of the plant will be maintained even during the time required for switching. The seriousness of very short power outages is minimized by the presence of time delay relays on critical motors throughout the plant. These relays allow motors to ride out brief outages thus eliminating the requirement for manually restarting motors which are in critical service.

b. Process and Cooling Water System

Water for the SRC plant is supplied from the Fort Lewis water system. The plant water system provides domestic water, raw water, cooling water and fire water for all parts of the plant. Fire protection water and domestic water supply lines are protected from possible process backflow with a back flow preventer. Raw water is used in the waste disposal system, the slurry preheater and vacuum flash preheater decoking scrubbers, as feed for the boilers and cooling tower, and as service utility water at utility stations located throughout the Pilot Plant.

Cooling water is used for numerous heat exchangers, compressors, mixers, and pumps throughout the plant. The cooling water system consists primarily of the cooling tower, three centrifugal circulating pumps for cooling water, and connecting lines to and from the various heat exchangers and equipment requiring cooling. The design rate of water circulation is 5000 GPM. Chemical feed sets, including pumps and mixing tanks, have been provided to add chemicals as necessary for cooling water treatment.

c. Plant Air and Instrument Air

Compressed air for instruments and general plant service is provided by two reciprocating air compressors, each capable of supplying 150 SCFM of air at a pressure of 100 psig. The compressors are each equipped with an intake air filter and an after-cooler. The compressed air goes to an air receiver, then through a prefilter to one of two air dryers. The dryers are the desiccant type, with one dryer being used while the other is regenerated. The dryers are switched between drying and regeneration by automatic timing controls. An afterfilter is provided to remove any particulate matter that may remain in the air leaving the dryer.

d. Fire Prevention

The Fire protection system for the pilot plant consists of:

1. Fire hydrants with fire hose cabinets for hose storage.
2. Wall-hung fire hose racks.
3. Hand held dry chemical extinguishers.
4. Fire hose cabinets.
5. Level operated deck pipes.
6. Automatic sprinklers.

Nine fire hydrants with cabinets for hose storage have been provided in the pilot plant area, and two fire hydrants with hose cabinets have been provided at the Administration Building. Water for the hydrants, hoses, and deck pipes is taken from the main water lines of the plant. Water for the plant is available through two different supply mains to help insure that a supply of water is always available for fire protection. A fire water booster pump will be added to insure that adequate pressure is maintained.

Wall-hung fire hose racks are provided on each floor of the coal preparation building. In addition, weather-tight fire hose cabinets are provided at strategic locations in the two buildings housing the product solidification equipment and the product storage equipment and bins. In the utilities area, two wall-hung fire hose racks are provided in the shop and warehouse building and one in the control building.

The lever operated deck pipes are provided in the dissolver area to cover any fires in and around the dissolvers. The pipes are designed to spray water on any part of the dissolvers. The location of the lever operating the water is sufficiently remote from the dissolvers to allow access in the event of a fire in or around the dissolvers.

An automatic sprinkler system is provided for all three floors of the mineral separation area, for all six levels of the solvent recovery area and at the upper level of the prilling tower. The sprinkler heads are of the type which produce a fog or mist or water. The sprinklers are activated by heat detecting devices located throughout the above areas. A visual and audible alarm is also activated in the control room when any of the sprinklers is set off.

The hand operated dry chemical fire extinguishers are placed at strategic locations throughout the plant. One hundred 5-pound extinguishers and five 10-pound extinguishers have been provided in the design.

e. Fuel Gas

All fuel for the Pilot Plant will be natural gas. Natural gas will be supplied at 50 psig by Washington Natural Gas Company. The units of the Pilot Plant using natural gas are the hydrogen unit, the dry pulverizer preheater, the slurry preheater, the vacuum flash preheater, the Dowtherm preheater, the mineral residue dryer, the boilers, the inert gas generator, the flare system, and the thermal oxidizer in the waste treatment area.

f. Plant Steam System

Steam is used in the Pilot Plant for the vacuum jet system, for emergency snuffing steam at the fired preheaters, for decoking of the preheater coils, for DEA regeneration, for the hydrogen generation unit, for heating tanks in the tank farm, for the waste treatment plant burner atomizer, for some of the space heaters, and for general service steam throughout the plant.

The steam is supplied at a pressure of 200 psig (corresponding to a temperature of 387°F) by two steam generating boilers. Each of the boilers is capable of generating 35,000 lb. per hour of steam as long as sufficient boiler feed water is available. The boilers are a conventional type fired by gas, complete with all required controls and local instrument panel. Water used as feed for the boilers is demineralized in a cation-anion exchange unit which produces up to 75 GPM of boiler feed water. The deionized water then goes to a deaerating heater before being sent to the steam boiler. The water is treated as necessary with chemicals to control corrosion and scale formation.

g. Process Waste Disposal System

The process waste disposal system handles all of the waste water from the plant except that going to the sanitary sewer system or removed through the storm sewers.

This consists of water from two sources: (1) that actually produced from the coal during the process; and (2) water collected by the process waste drains located in the various operating areas of the plant.

The water actually produced by the process is accumulated primarily in the light oil-water separator or the recycle water tank in the mineral separation area. This water, rich in phenols, goes directly to the process waste incinerator. The incinerator vaporizes the process waste water and burns all of the phenols and other organic compounds in the water, as well as all of the sludge from the main waste treatment system. The vaporized water is recondensed and is circulated to the main waste water treating system.

The waste water from the process chemical drains flows to a surge reservoir, 60 feet in diameter and 10 feet deep, located in the waste disposal area. Any solids in the water settle to the bottom of the reservoir and are removed through a screw-type sludge pump. The clarified water is removed from the reservoir by a centrifugal pump connected to a floating intake on the surface of the reservoir. This waste water goes to a waste disposal treater where acid, alum, and polyelectrolyte are added.

Water from the waste disposal treater flows to another oil-water separator where additional alum and electrolyte are added. Any oil separated in this step is also sent to the waste incinerator. Overflow from this separator flows to a biological treatment unit where water soluble organic compounds are removed in an activated sludge unit with extended aeration.

The treated water is pumped out of the bio-unit through a sand filter to remove turbidity and through an activated carbon filter to remove any traces of phenolic compounds. Two sand filters and two activated carbon filters are provided so that one can be used while the other is regenerated by backwashing. The treated water is then diluted with raw water in a dilution tank. The diluted water then flows to a catch basin and then to the swamp southwest of the plant site.

h. Flare & Blow-down System

All of the gases purged from the Pilot Plant go into the flare piping system to be carried to the flare stack. All safety relief valves are also connected to the flare system. The entire flare and blow-down system is continuously purged with inert gas to prevent fires or explosions in the lines. The gases are burned in the flare stack, supplemented with natural gas if necessary to maintain combustion. A flame front generator is provided in the flare stack for ignition of the gases.

i. Inert Gas & Hydrogen Generators

The inert gas generator and hydrogen generator are combined in a specially designed gas generating system to concurrently produce hydrogen or a mixture of hydrogen and carbon monoxide, plus inert gas. The hydrogen generator consists of a reformer, shift converter, monoethanolamine absorber, and a natural gas fired MEA regenerator. This unit will supply 800,000 SCF per day of hydrogen at 75 psig. Natural gas is used both as a feedstock and as fuel for the hydrogen unit which supplies all of the hydrogen for the process.

Flue gas from the inert gas generator passes through a deoxo purifier, a MEA absorber for removal of $CO_2$, compressors, a dryer, and a storage tank. The inert gas unit is capable of supplying 30,000 SCFH of nitrogen at a pressure of 250 psig. These units are designed such that the inert gas unit or the hydrogen generator may be operated independently if required.

In cases where hydrogen and carbon monoxide mixtures are to be produced in the hydrogen generator, carbon dioxide from the regenerated amine is compressed and charged to the reformer. In this case, both the inert gas and the hydrogen generator must be operated simultaneously.

j. <u>Desulfurization Unit</u>

The gas desulfurization unit removes hydrogen sulfide and carbon dioxide from the gases produced in the preheater and dissolver in Area 02. This system consists essentially of two units, a diethanolamine (DEA) absorber for removal of $H_2S$ and $CO_2$ and a Stretford Unit. The DEA is regenerated with steam, and the acid gases ($H_2S$ and $CO_2$) liberated during regeneration pass to the Stretford sulfur recovery system. Clean gas containing hydrogen and hydrocarbon gases from the DEA unit is sent to the flare or recycled to the process.

In the Stretford unit, hydrogen sulfide is absorbed from the gas steam by countercurrent contacting with the Stretford solution. After reaction, the Stretford solution, containing the $H_2S$, passes to an oxidizer vessel where air is sparged upward through the solution. Elemental sulfur forms as a froth at the top of the oxidizer. This sulfur slurry is fed to a sulfur melter where the water is vaporized. The molten sulfur is then sent to a storage tank.

k. <u>Tank Farm</u>

Liquid products from the Pilot Plant, as well as raw and used process solvent, are stored in the tank farm. The tank farm includes three 20,000 gallon cone-roof tanks for process solvent, one 20,000 gallon cone-roof tank for wash solvent, and one 20,000 gallon dished-head tank for process naptha. Two centrifugal pumps are arranged so that process solvent can be pumped from any of the three tanks to any other tank, to the process solvent accumulator, to the solvent recovery system for fractionation, or to the tank farm loading pump for shipment out of the plant. A centrifugal wash solvent transfer pump is also provided in the tank farm to pump wash solvent to the wash solvent accumulator and to the process. The process naptha can be drained using the tank farm loading pump.

l. Seal Flush System

All of the centrifugal pumps in the Pilot Plant operating on hot or solids-containing material require a seal oil to flush and lubricate the mechanical seals. This seal flush oil is provided by a central seal flush system, using process solvent as the seal oil. The seal flush system consists of a seal flush accumulator, two centrifugal circulating pumps, a seal flush filter, connecting lines to and from all pumps using the seal oil, and a water cooled heat exchanger to cool the hot oil returning to the seal flush accumulator. The seal oil is supplied to the pumps and mixers at 150°F and 240 psig.

m. Dowtherm System

In many areas of the plant, Dowtherm heat exchangers are used to supply process heat. The use of Dowtherm exchangers eliminates the need for numerous fired heaters throughout the plant. The Dowtherm system consists primarily of a surge tank, two centrifugal circulating pumps, a gas-fired heater for the Dowtherm, and connecting lines to and from the numerous heat exchangers throughout the Pilot Plant. In addition, the system is provided with a Dowtherm reclaimer, a reclaimer surge tank, and a reciprocating pump to return reclaimed Dowtherm to the system. In general the Dowtherm is reclaimed by distilling it so that any polymerized material is left behind in the reclaimer. The overhead reclaimed Dowtherm is condensed and enters the surge tank prior to being returned to the main Dowtherm system. Any make-up Dowtherm required can be added at this point. The Dowtherm is supplied to the various heat exchangers and tracing lines at 770°F and 250 psig. The temperature to which the process fluid is heated is normally controlled by a temperature element placed in the process fluid.

n. Solvent Flush System

A solvent flush system is provided in the plant to enable removal of heavy viscous coal products and/or solids particles from all vessels and lines. The highly viscous nature of the materials handled in the Pilot Plant makes such a system necessary for proper operation and for collection of reliable data. The flush solvent system consists of a flush solvent storage tank (accumulator) a flush solvent circulating pump (centrifugal) a Dowtherm exchanger for heating the flush solvent to about 400-600°F, and connecting lines to all parts of the plant requiring flush solvent. Two electrical heaters are provided in a special line to further heat the flush solvent to about the temperature of the dissolvers (700°F to 900°F). This line goes to the dissolver area only.

Flush solvent at 400-600°F is provided in separate lines to the filters for both flushing and sluicing of precoat heel, to the filtrate pumps, to the filter feed tank and to the bottoms lines from the vacuum flash drum. In addition to its function of cleaning out lines and equipment, the solvent flush system can also be used for circulating hot solvent during testing and/or during start-up. In such cases, the solvent would be relatively clean and would be returned to the solvent flush system. Return lines have been provided from the dissolver area and from the vacuum flash drum section. An air-cooled heat exchanger has been provided in the return line to cool the solvent coming back to the accumulators. Flush solvent contaminated with coal slurry will be sent to the Filter Feed Surge Vessel for storage until it can be fractionated without interfering with data collection.

D. As Built Drawings

1. General

The as built drawings of the SRC Pilot Plant, which are included in this report, describe details of architecture, piping, mechanical equipment, materials of construction, instrumentation, process flow, and general arrangement of the plant. Material balances for coal processing in the presence of hydrogen and also for processing in the presence of synthesis gas are included with the piping and instrumentation drawings. A drawing index, drawings, material balances and other information useful in interpreting the drawings are all presented in Appendix B.

2. Mechanical Equipment

Mechanical equipment, such as pumps, compressors, tanks, vessels, heat exchangers, conveyors, elevators, filters, pulverizers, etc., are indicated on the flow sheets by symbols. In addition, each piece of equipment has an equipment number in or near the equipment symbol on the flow sheets. A short description or the name of that particular piece of equipment is also given under the equipment number in the margins of the piping and instrument diagrams.

The equipment numbering system is outlined below. Equipment number 01D56003 is a typical number for a centrifugal pump located in Area 01. The numbers are subdivided as follows:

01 D 56003

The first two digits designate the Area location (Area 01, 02, 03, etc.) — 01

The alphabetical character separates the area designation from the equipment number. — D

The remaining five digits serve as the equipment number. — 56003

3. Pipe Line Number System

The process piping, which conveys fluids from one piece of equipment to another and also between the various areas, is described by line numbers. Each line number indicates the size of pipe, the service, the type of material flowing in the pipe, the specific line number, and a material of construction specification. A typical line number is described below.

SIZE

4" CS - 5 - E1 — Material Specification

5 — Line Number

CS — Service in the Pipe

Service abbreviations of the materials handled in the SRC plant are given in Appendix B.

4. Piping System Specifications

Materials of construction for the process piping are designated by a piping material specification number on the flow sheets. This specification number also is used to indicate the pressure class of the piping (300# flanged, etc.), the types of valves, and flanged or welded construction. Process valves are tagged with a number (a typical valve tag number would be V1080) and only specific valves may be used with specific piping material specifications. A summary of piping material specification numbers is given in Appendix B to indicate types of material, pressure classification, and type of construction used in the process piping for the SRC Pilot Plant.

5. Line and Instrument Symbols

Flow of gases, liquids, slurry and material from one piece of equipment to another is indicated by the following symbols on the P&I Diagrams:

| | LINE SYMBOLS |
|---|---|
| ——————— | Process Piping |
| —//———//— | Instrument Pneumatic Signal Lines |
| ------------ | Instrument Electrical Signal Lines |
| -x-x-x-x-x-x- | Capillary Tubing |
| x x x x x x | Flexible Hose |

A table of instrumentation nomenclature is included in Appendix B.

E. Major Equipment

A list of all major equipment installed in the Pilot Plant is given in Appendix C. The list includes for each item the item number, a brief description of the item, and the supplier of the item.

F. Construction Summary

The contract for construction of the pilot plant was signed with Rust Engineering Company on June 14, 1972 and construction began with the initiation of site clearing on June 26, 1972. Construction of the plant proceeded for two years and was completed during June, 1974. A chronological record of various milestones of the construction of the plant is listed in Appendix D.

G. Photographs

Photographs of the plant at various stages of construction are included in Appendix E. Each photograph is identified by the subject and the date on which it was taken.

H. Pilot Plant Design Modifications

The original design of the SRC Pilot Plant was completed in 1968 by the Stearns-Roger Corporation. During the four years that passed before construction of the plant was started, many developments occured that provided incentives for modification of the original design.Many detail changes were required to bring the plant into compliance with the Occupational Safety and Health Act which was passed by Congress. More stringent air and water emission control regulations also provided the necessity for review and modification of several plant systems. The incentive for additional changes was provided by the results of bench scale research on the process which pointed the way to several significant improvements. Changes in the original design were also required to resolve interferences and improve operability. Finally, some modifications of the Pilot Plant design were required to lower its cost.

The following pages list and discuss some of the more significant modifications of the original Pilot Plant design.

Area 01 - Coal Receiving & Preparation Area

1. Additional pickup ports were added over elevator chutes and bins to minimize dust problems. Capacity of the dust collector was also increased to handle the additional load.

2. The ball mill and all associated equipment was deleted. The associated equipment includes a gravimetric feeder, a secondary coal crusher, and a liquid cyclone.

3. The slurry heating vessel, together with the slurry circulating heater and the slurry heating tank condenser and associated lines were deleted.

4. The Dracco Model #4 dust collector was changed to a Micro Pulsaire Model #130S-6-20.

5. The controls for circulating inert gas through the pulverizer and dust collector circuit were modified to provide better control over the flow and to provide gas to the seals of the pulverizer.

6. The flow circuit for the water circulating through the dehumidifier to cool and dry the inert gas was modified. The modification consisted primarily of separating this water from the cooling tower circuit by adding an indirect heat exchanger between these two streams. This change was made primarily to prevent coal particles from contaminating the cooling water. The water used for direct cooling of inert gas is thus maintained in a closed loop with excess water being diverted to the waste treatment system. A continuous purge to the drain system is necessary to remove the water resulting from drying of the coal.

7. Additional high pressure pumps were provided for pumping seal oil to the seals of the high pressure reciprocating slurry charge pumps.

8. The safety relief valves at the outlets of the high pressure slurry pumps were re-piped so as to discharge slurry back to the slurry feed tank and the slurry feed tank was vented to the atmosphere outside the building.

Area 02 - Slurry Preheating and Dissolving Area

1. One of the two slurry preheaters was deleted.

2. Two of the four dissolvers were deleted.

3. The length of the remaining two dissolvers was decreased from 40 feet to 30 feet.

4. A control valve was added in the slurry feed line to the preheater. It is actuated by a high temperature in the feed inlet line. The purpose of the control valve is to prevent backflow of hot slurry in the event that the safety valve on the slurry discharge pump sticks open.

5. A ceramic type filter element was added above the preheater decoking scrubber to prevent discharge of fine coke particles to the atmosphere during decoking operations.

6. The high pressure solvent pump was changed from a three stage centrifugal pump to a reciprocating pump.

7. The size of the slurry line from the preheater through the dissolvers to the high pressure flash drum was decreased from 6" to 4". The material in this lines was changed from 310 stainless steel to 347 stainless steel.

8. The slurry preheater was moved to a point closer to the dissolvers and the expansion loop in the pipe rack between the preheater and dissolvers was eliminated.

9. The 310 cladding in the dissolvers was changed to a two-pass overlay consisting of a 3/32 inch layer of 309L plus a 3/32 inch layer of 347 stainless steel.

10. The 15" Autoclave Engineers head on the dissolvers was changed to a 15" Grayloc head.

<u>Area 03 - Mineral Separation Area</u>

1. The reclaim vessel and associated equipment was deleted.

2. The centrifuge feed flash vessel and associated equipment was deleted.

3. The filter feed-Dowtherm heat exchanger was changed from vertical to horizontal configuration.

4. Two oil-water separators were added to replace the flash condensate separator. This change was made to provide for separation of water from the light liquid product streams prior to distillation. The large quantity of water present in the synthesis gas mode of operation makes it necessary to do this. Most of the water from the process effluent is separated at this point.

5. The two process fluid heat exchangers in the filtration gas

stream were changed from a side-by-side arrangement to a stacked arrangement to provide a better configuration for more efficient heat exchange.

6. The spare filter gas compressor and associated equipment was deleted.

7. The screw conveyor carrying mineral residue to the fluid bed dryer was deleted.

8. The mineral residue is now carried to the rotary drum dryer by a 2 1/2" line with long radius ells and no sharp bends. The mineral residue will be extruded through the 2 1/2" line by Sier-Bath screw pumps. The pressure drop from 150 psig to atmospheric pressure will be taken across the screw pump and the 2 1/2" line containing mineral residue.

9. The fluid bed dryer, including the associated dust collector and cooler, was replaced by a rotary drum dryer with an associated rotary cooler and cyclone dust collector.

10. The method of condensing solvent vapors also changed significantly. Instead of an air cooler and a water cooled exchanger in series, the system was designed to cool and condense the solvent vapor by quenching with recycle solvent through an eductor. The eductor was designed to minimize the possibility of building up a back pressure in the rotary drum dryer thereby helping to avoid over-pressuring the seals on the dryer. The dryer seals are guaranteed to hold a maximum of only 2" of water. A further advantage of this system is that any solids carried over from the cyclone will be carried effectively into the dryer condensate drum. If the air cooler and heat exchanger had been left in the system, there would have been a strong possibility that solids would plug the heat exchanger and over-pressure the dryer.

11. With the above change, it was necessary to add a water-cooled heat exchanger to cool the recycle solvent stream. This cooler removes the heat entering the system from the hot solvent vapors.

12. A side liquid take-off was added to the dryer condensate drum to prevent solids carryover to the light ends column.

13. To further prevent solids from this source from reaching the light ends column, two filters (to be used alternately) were added in the line from the dryer condensate drum to the light ends column.

14. A dryer exhaust blower was added to remove inert gas overhead from the dryer condensate drum and to provide a means for controlling the pressure in the drum at a low level.

15. To get a more accurate measurement of the weight of mineral

residue produced, the load cells were removed from the mineral residue bin and a weight belt/feeder was added at the outlet of the mineral residue cooler.

16. The pneumatic conveying system originally provided to carry cool mineral residue to the mineral residue bin, together with the associated dust collector, was deleted.

17. A bucket elevator was added to convey the mineral residue from the weigh belt feeder to the top of the mineral residue bin. A small dust collector was added at the top of the mineral residue bin to keep dust from being carried out with the inert gas stream used to purge the mineral residue bin.

18. All of the centrifuges and associated equipment were deleted.

<u>Area 04 - Solvent Recovery Area</u>

1. One of the vacuum flash preheaters and associated equipment was deleted.

2. One of the vacuum flash drums and associated equipment was deleted.

3. The heavy oil blend tank and associated equipment was deleted.

4. The flush solvent lines around the coal product piping from the bottom of the vacuum flash drum were modified to provide a more positive means of flushing the coal product from these lines when necessary. A Dowtherm jacketed valve was added at the bottom of the coal product line leading to the Sandvik belt to facilitate switch-over from the Sandvik belt to the prilling tower.

5. A light ends column feed tank together with a light ends column feed pump and associated equipment were added to provide a surge vessel for the light ends column.

6. The method of heating the feed to the light ends column was significantly revised. The heat exchanger originally provided to simultaneously cool the vacuum flash overhead and heat the light ends column feed was eliminated. The Dowtherm heat exchanger originally used for final heating of the light ends column feed was increased in size to handle the entire load on the vacuum flash overhead. These changes were made to provide better control of both the vacuum flash overhead cooling and light ends column heating.

7. The control method for withdrawal of water from the light oil-water separator was simplified. This was made possible by the addition of the oil-water separators in the 03 Area. This change greatly decreases the amount of water reaching the light oil-water separator and makes it possible to provide a

manual drain at this point.

8. The heavy ends column and associated equipment was deleted.

Area 05 - Gas Recovery and Recompression

The spare hydrogen recycle compressor was deleted.

Area 08 - Product Solidification and Storage

1. The original prilling tower specified by Stearns-Roger was based on general technical information supplied by Horton Process Division of Chicago Bridge and Iron, Incorporated, and was not specified in detail for solvent refined coal. In order to design the prilling tower specifically for handling solvent refined coal, it was necessary to make a number of changes from the original sketch and drawings shown in the Stearns-Roger specifications. The changes required became even more extensive as a result of the necessity for studying the prilling of solvent refined coal over a wide variety of conditions. Developing basic information on the prilling of solvent refined coal, which does not currently exist, requires a study of the key variables such as viscosity, temperature, and pressure over a considerable range of conditions.

   One of the objectives of the Pilot Plant work is to produce a high melting point solid prilled product for use as a power plant fuel. The solid product would be pulverized and fed to the power plant as a pulverized solid. For such uses it is desirable to have as high a melting point as possible to avoid melting or sticking in the pulverizer. The production of a high melting point solid in the prilling tower requires that the molten solvent refined coal be heated to a temperature as high as 730°F prior to being forced through the prilling nozzles.

   Since the solvent refined coal product from the bottom of the vacuum drum will not always be this hot, provisions had to be made for heating the molten solvent refined coal. A heater was added to raise the temperature of the solvent refined coal by about 130°F prior to entering the prilling tower.

   In addition to a requirement for heating, there is also a requirement for cooling the solvent refined coal at times to provide the desired temperature at the prilling nozzles. Thus provision was also made for cooling the molten solvent refined coal.

   Both heating and cooling were enabled by the addition of a double pipe heat exchanger in the coal product line to the prilling tower. The heating and cooling medium for the double pipe exchanger is Dowtherm. The Dowtherm circulates in a closed loop through either a heating or cooling cycle for proper control of the temperature.

Heating of the Dowtherm is provided by a Chromalox electric heater, and cooling is provided by an air fin cooler. When the cooling cycle is used the Dowtherm flows through the heater, but the electric heaters are turned off. When the heating cycle is used, the cooler is bypassed.

2. One of the two Sandvik cooling belts was deleted.

3. The waste product conveying system with its associated equipment was deleted.

Area 09.5 - Desulfurization Unit, Hydrogen/Syn Gas-Inert Gas Unit

1. The caustic scrubbing system for treating high pressure recycle gas was deleted and a high pressure diethanolamine (DEA) unit was provided for this service. DEA absorption is a more efficient means of removing the greater amounts of carbon dioxide that are produced during operation in the synthesis gas mode. The hydrogen sulfide and carbon dioxide released by regeneration of the DEA is sent to the Stretford unit together with other low pressure streams containing acid gases.

2. The caustic scrubbing system for treating low pressure off gas was deleted and a Stretford unit was added for this service.

3. The hydrogen generation unit and the inert gas generation unit were combined into a single package unit designed to produce either pure hydrogen or a synthesis gas containing up to 50% carbon monoxide. The unit can also produce an inert gas containing $CO_2$ or a pure nitrogen stream.

Area 09 - Utilities

1. Since the Pilot Plant was originally designed in 1968, passage of the OSHA regulations required that potable water systems be completely separate from process water systems. Regulations required that a backflow preventer be provided at the plant where the process water system joins the main clean water supply. In the original design, the potable water (drinking fountains, eye wash fountains, plumbing fixtures, etc.) was taken from the process water lines in each area.

   This necessitated providing a new and separate potable water system. It was also necessary to heat trace the potable water system for freeze protection.

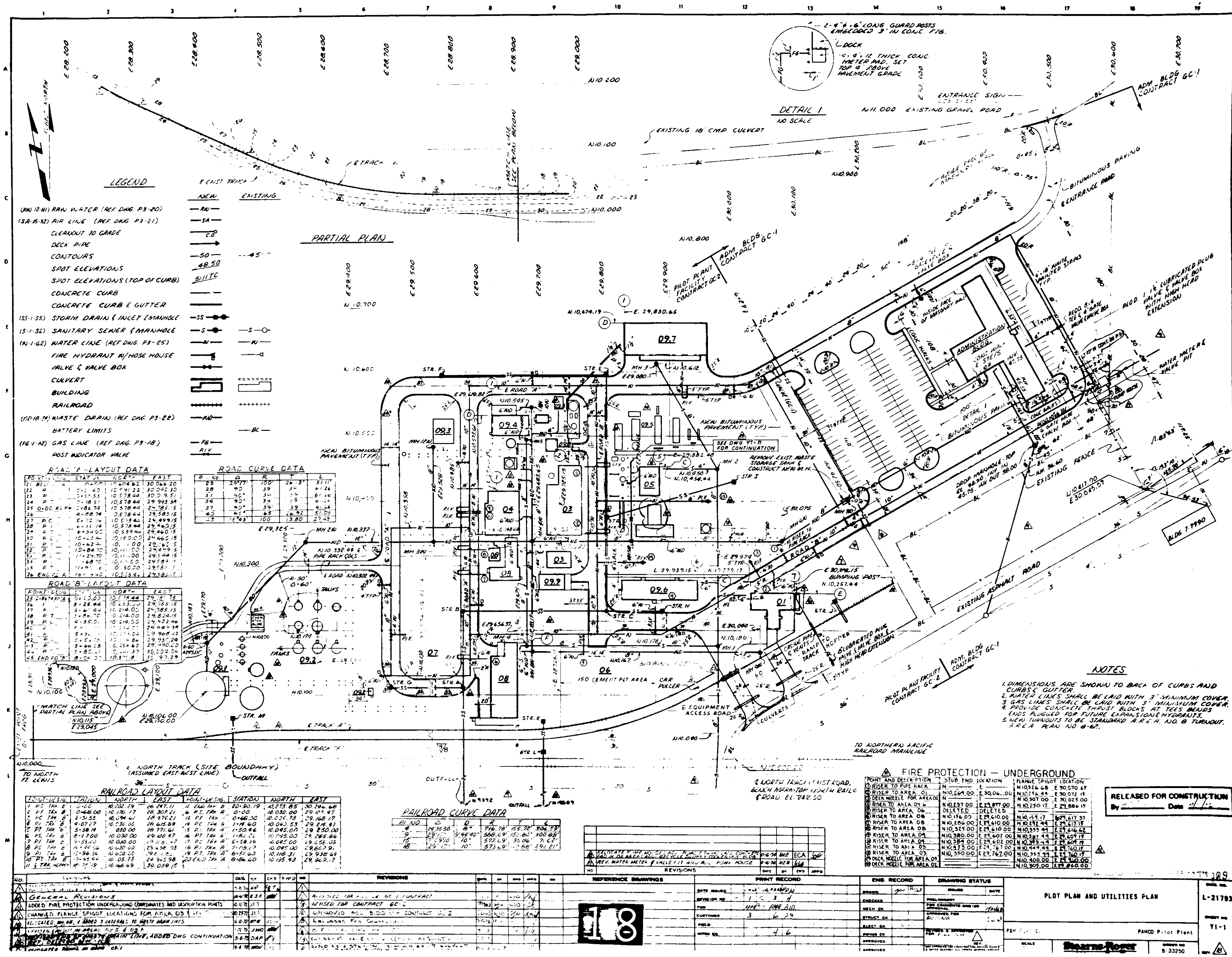
2. The steam condensate return system which was included in the Stearns-Roger design was eliminated, and provision was made

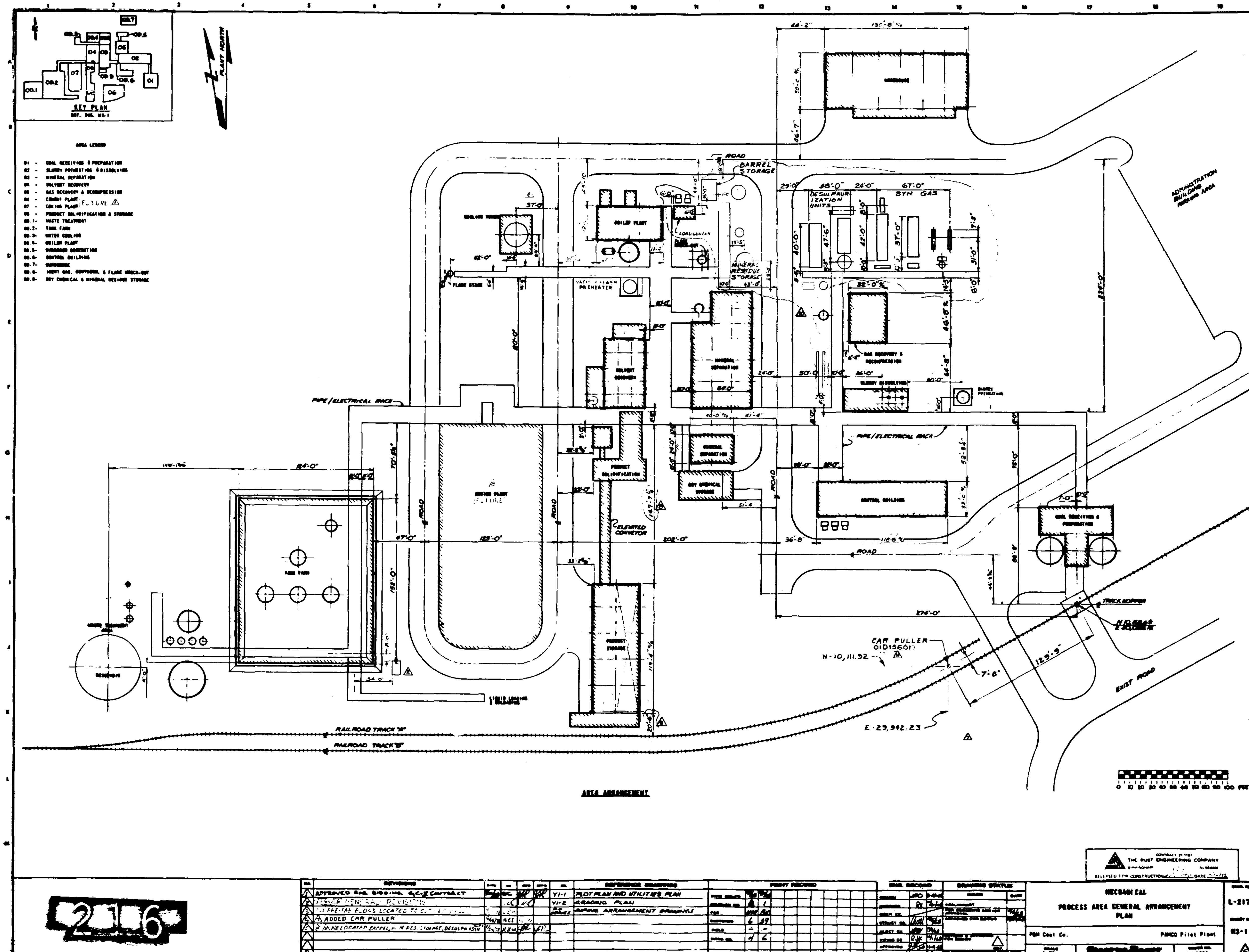
for return of condensate from the desulfurization unit only.

3. The fuel gas compressors were deleted since they became unnecessary when it was determined that fuel gas could be made available at 50 PSIG.

# APPENDIX A - PLOT PLAN

| Drawing No. | |
|---|---|
| Y1-1 | Plot Plan and Utilities Plan |
| M3-1 | Mechanical Process Area - General Arrangement Plan |


LEGEND
NEW
EXISTING
RAW WATER (REF. DWG. P3-20)
AIR LINE (REF. DWG. P3-21)
CLEANOUT TO GRADE
DECK PIPE
CONTOURS
SPOT ELEVATIONS
SPOT ELEVATIONS (TOP OF CURB)
CONCRETE CURB
CONCRETE CURB & GUTTER
STORM DRAIN & INLET & MANHOLE
SANITARY SEWER & MANHOLE
WATER LINE (REF. DWG. P3-25)
FIRE HYDRANT W/HOSE HOUSE
VALVE & VALVE BOX
CULVERT
BUILDING
RAILROAD
WASTE DRAIN (REF. DWG. P3-22)
BATTERY LIMITS
GAS LINE (REF. DWG. P3-18)
POST INDICATOR VALVE
PARTIAL PLAN
DETAIL 1
NO SCALE
ROAD "A" LAYOUT DATA
ROAD CURVE DATA
ROAD "B" LAYOUT DATA
RAILROAD LAYOUT DATA
RAILROAD CURVE DATA
ADMINISTRATION BLDG.
EXISTING ASPHALT ROAD
EXISTING FENCE
ENTRANCE ROAD
BITUMINOUS PAVING
ADM. BLDG CONTRACT GC-1
PILOT PLANT FACILITY CONTRACT GC-2
150 CEMENT PLT AREA
EQUIPMENT ACCESS ROAD
TO NORTHERN PACIFIC RAILROAD MAINLINE
NORTH TRACK (SITE BOUNDARY) (ASSUMED EAST-WEST LINE)
MATCH LINE SEE PARTIAL PLAN ABOVE
NOTES
1. DIMENSIONS ARE SHOWN TO BACK OF CURBS AND CURBS & GUTTER.
2. WATER LINES SHALL BE LAID WITH 3' MINIMUM COVER.
3. GAS LINES SHALL BE LAID WITH 3' MINIMUM COVER.
4. PROVIDE CONCRETE THRUST BLOCKS AT TEES BENDS ENDS PLUGGED FOR FUTURE EXPANSIONS HYDRANTS.
5. NEW TURNOUTS TO BE STANDARD A.R.E.A. NO. 8 TURNOUT, A.R.E.A. PLAN NO. 8-62.
FIRE PROTECTION — UNDERGROUND
RELEASED FOR CONSTRUCTION
PLOT PLAN AND UTILITIES PLAN
L-21793
Y1-1
PAMCO Pilot Plant
Stearns-Roger
B-33250
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
General Revisions
ADDED FIRE PROTECTION UNDERGROUND COORDINATES AND DESCRIPTION POINTS



KEY PLAN
PLANT NORTH
AREA LEGEND
ROAD
BARREL STORAGE
DESULPHURIZATION UNITS
SYN GAS
MINERAL RESIDUE STORAGE
VACUUM FLASH PREHEATER
PIPE/ELECTRICAL RACK
ELEVATED CONVEYOR
CAR PULLER
RAILROAD TRACK "A"
RAILROAD TRACK "B"
EXIST ROAD
ADMINISTRATION BUILDING PARKING AREA
AREA ARRANGEMENT
THE RUST ENGINEERING COMPANY
PROCESS AREA GENERAL ARRANGEMENT PLAN
PAMCO Pilot Plant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## APPENDIX B - PROCESS AND ENGINEERING FLOW DIAGRAMS

| | |
|---|---|
| M5-01-1 | Mechanical-Area 01 - Coal Receiving & Preparation General Arrangement Plan |
| M5-01-2 | Mechanical-Area 01 - Coal Receiving & Preparation General Arrangement Plan |

## SERVICE ABBREVIATIONS

| | |
|---|---|
| BD | Blowdown (Water) |
| CH | Chemical (Acid, Amine, Caustic, etc.) |
| CO | Condensate (Steam) |
| CP | Coal Product |
| CS | Coal Solution |
| CW | Cooling Water |
| DR | Drains |
| DT | Dowtherm |
| FG | Fuel Gas |
| FL | Flare & Vent |
| FP | Fire System Water |
| HL | Liquid Hydrocarbons |
| HY | Hydrogen/Synthesis Gas |
| IG | Inert Gas |
| MR | Mineral Residue (Ash) |
| NA | Instrument Air |
| RW | Raw Water |
| S | Sanitary Sewer |
| SA | Service Air |
| SL | Slurry |
| SS | Storm Sewer |
| ST | Steam |
| SCW | Service Cooling Water |
| TW | Treated Water |
| VA | Hydrocarbon Vapor |
| W | Potable Water |
| WP | Process Waste |

## PIPING MATERIAL SPECIFICATIONS

| PIPING CODE LETTERS | DESCRIPTION OF MATERIAL |
|---|---|
| A1 | 2500# Ring Joint Flanges, Carbon Steel, Welded Valves |
| A3 | 2500# Greyloc Flanges, 316 Stainless Steel, No Valves |
| A4 | 2500# Greyloc Flanges, 310 Stainless Steel, Welded Valves |
| A5 | 2500# All Welded, 304-L Stainless Steel, Welded Valves |
| A6 | 2500# Greyloc Flanges, 347 Stainless Steel, Welded Valves |
| B1 | 1500# Ring Joint Flanges, Carbon Steel, Welded Valves |
| B3 | 1500# Ring Joint Flanges, 304-L Stainless Steel, Welded Valves |
| B4 | 1500# Ring Joint Flanges, 316 Stainless Steel, Welded Valves |
| C1 | 900# Raised Face Flanges, Carbon Steel, Welded Valves |
| D1 | 600# Raised Face Flanges, Carbon Steel, Flanged Valves |
| D2 | 600# Raised Face Flanges, Carbon Steel, Welded Valves |
| D3 | 600# Raised Face Flanges, 304-L Stainless Steel, Flanged Valves |
| E1 | 300# Raised Face Flanges, Carbon Steel, Flanged Valves |
| E2 | 300# Raised Face Flanges, Chrome Moly Steel, Flanged Valves |
| E3 | 300# Raised Face Flanges, 304-L Stainless Steel, Flanged Valves |
| E4 | 300# Raised Face Flanges, Carbon Steel, Welded Valves |
| E5 | 300# Raised Face Flanges, Chrome Moly Steel, Welded Valves |
| E6 | 300# Raised Face Flanges, 304-L Stainless Steel, Welded Valves |
| E7 | 300# Ring Joint Flanges, Carbon Steel, Welded Valves |
| G1 | 150# Raised Face Flanges, Carbon Steel, Flanged Valves |
| G2 | 150# Cast Iron, Mechanical Joint |
| G3 | 150# Cast Iron, Bell & Spigot |
| G4 | 150# Raised Face Flanges, Carbon Steel, Welded Valves |
| H1 | 125# Cast Iron - Carbon Steel Pipe |
| H2 | 125# Copper Water Tube |
| S1 | Carbon Steel, Galvanized, Hub & Spigot |
| S2 | Vitrified Clay Piping, Hub & Spigot |
| S3 | Carbon Steel, Galvanized or Cast Iron, Mechanical Joint |
| S4 | Duriron, Bell & Spigot |
| S5 | Concrete Sewer Pipt |
| V1 | 150# Raised Face Flanges, Carbon Steel, Flanged Valves |
| X1 | 150# Raised Face Flanges, Carbon Steel, Flanged & Welded Valves |
| X2 | 150# Raised Face Flanges, Carbon Steel, Screwed & Flanged Valves |

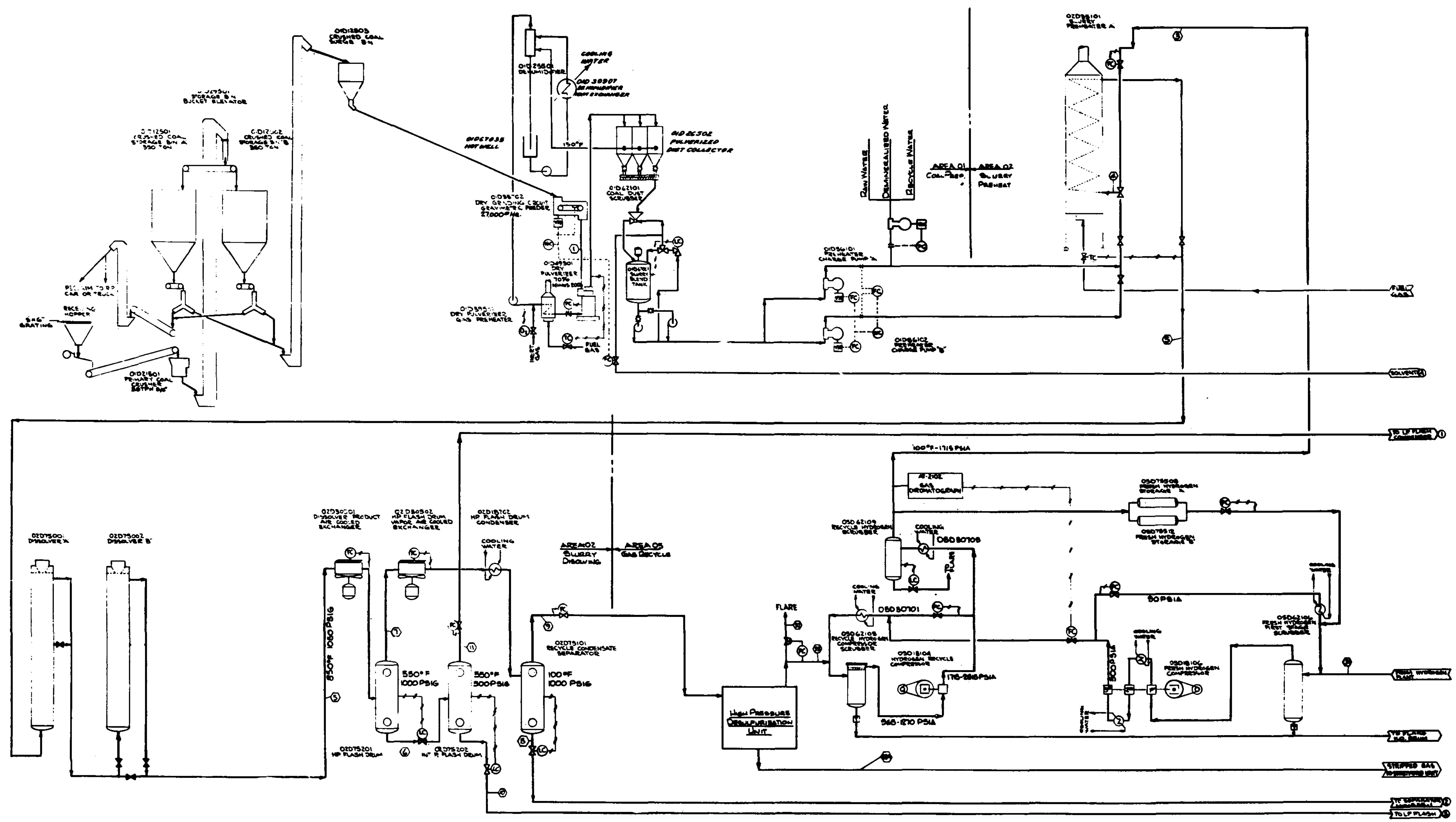
## INSTRUMENT PIPING SPECIFICATIONS

| | |
|---|---|
| N1 | 2500# 316 Stainless Steel Tubing, Swagelok Fittings |
| N2 | 2500# Chrome Moly Pipe, Screwed Valves |
| N3 | 2500# Carbon Steel, Screwed Valves |
| N4 | 1500# Carbon Steel Screwed & Socket Weld Valves |
| N5 | 300# & 600# Carbon Steel, Screwed Valves |
| N6 | Copper Tubing or Carbon Steel pipe, Screwed Valves |
| N7 | 125# Copper, Brass & Stainless Steel, Screwed Valves |

## INSTRUMENT NOMENCLATURE

| CODE LETTER | DESCRIPTION |
|---|---|
| A | Alarm Contact (Converts Elect. Signal) |
| AN | Annunciator Point |
| AR | Analyzer Recorder |
| AT | Analyzer Transmitter |
| CD | Computing Device or Signal Converter |
| CE | Conductivity Element |
| CI | Conductivity Indicator |
| CR | Conductivity Recorder |
| DC | Density Controller |
| DCV | Density Control Valve |
| DR | Density Recorder |
| DT | Density Transmitter |
| E/P | Electric to Pneumatic Converter |
| ER | Electric Relay |
| FC | Flow Controller |
| FCD | Flow Control Drive |
| FCV | Flow Control Valve |
| FE | Flow Element |
| FG | Flow Glass |
| FI | Flow Indicator or Purge Meter |
| FO | Flow Orifice (Restriction) |
| FQ | Integrator |
| FR | Flow Recorder |
| FRC | Flow Recorder Controller |
| FS | Flow Switch |
| FT | Flow Transmitter |
| HCV | Hand Control Valve |
| HIC | Hand Indicating Controller |
| H | High (Alarm Function) |
| IL | Indicating Light |
| IN | Indicator Multipoint |
| KD | Signal Converter |
| LC | Level Controller |
| LCV | Level Control Valve |
| LG | Level Glass |
| LI | Level Indicator |
| LMS | Limit Switch |
| LR | Level Recorder |
| LRC | Level Recorder Controller |
| LS | Level Switch |
| LT | Level Transmitter |
| L | Low (Alarm Function) |

| | |
|---|---|
| M | Motor |
| PB | Pushbutton |
| PC | Pressure Controller |
| PCV | Pressure Control Valve |
| P/E | Pneumatic to Electric Converter |
| pHC | pH Controller |
| pHE | pH Element |
| pHR | pH Recorder |
| pHT | pH Transmitter |
| PI | Pressure Indicator |
| PR | Pressure Recorder |
| PRC | Pressure Recorder Controller |
| PS | Pressure Switch |
| PSV | Pressure Safety Valve |
| PT | Pressure Transmitter |
| R | Recorder (Multipen) |
| SC | Sample Connection |
| ST | Speed Transmitter |
| SV | Solenoid Valve |
| SW | Switch (Electrical) |
| T | Trap |
| TB | Test Block |
| TC | Temperature Controller |
| TCV | Temperature Control Valve |
| TE | Temperature Element |
| TI | Temperature Indicator |
| TR | Temperature Recorder |
| TRC | Temperature Recording Controller |
| TS | Temperature Switch |
| TT | Temperature Transmitter |
| TW | Temperature Well |
| TX | Test Well |
| UVS | Flame Scanner |
| VR | Viscosity Recorder |
| VSD | Variable Speed Drive |
| VT | Viscosity Transmitter |
| WI | Weight Indicator |
| WT | Weight Transmitter |




MATERIAL BALANCE, ALL FLOW QUANTITIES IN POUNDS PER HOUR

| | (1) COAL FEED | (2) SOLVENT | (3) HYDROGEN TO FURNACE | (4) FURNACE INLET | (5) FURNACE OUTLET | (6) HP FLASH LIQUID | (7) HP FLASH VAPOR | (8) HP COND. SEPARATOR LIQUID | (9) HP COND. SEPARATOR VAPOR | (10) INT FLASH LIQUID | (11) INT FLASH VAPOR | (12) LP FLASH LIQUID (NET) | (13) LP FLASH VAPOR | (14) LP FLASH CONDENSER SEPARATOR LIQUID |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HYDROGEN | | | 183 | 183 | 151 | 8 | 143 | | 143 | 3 | 5 | 1 | 3 | |
| NITROGEN | | | | | | | | | | | | | | |
| CARBON DIOXIDE | | | | | 34 | 5 | 31 | 1 | 30 | 3 | 2 | 1 | 2 | |
| HYDROGEN SULFIDE | | | | | 72 | 16 | 56 | 3 | 53 | 13 | 3 | 6 | 7 | |
| $C_1 - C_4$ | | | 324 | 324 | 752 | 112 | 630 | 20 | 611 | 82 | 31 | 20 | 52 | 6 |
| $C_5$ - 200° | | | 11 | 11 | 90 | 30 | 52 | 32 | 30 | 35 | 3 | 26 | 9 | 9 |
| 200° - 550° | | | | | 201 | 132 | 60 | 60 | 1 | 128 | 4 | 100 | 20 | 25 |
| WASH SOLVENT | | | | | | | | | | | | | | |
| SOLVENT | | 12000 | | 12000 | 12000 | 11486 | 515 | 515 | | 11462 | 23 | 11317 | 143 | 166 |
| COAL | 4000 | | | 4000 | 2230 | 2230 | | | | 2230 | | 2230 | | |
| ASH | | | | | 530 | 530 | | | | 530 | | 530 | | |
| WATER | | | | | 440 | | 400 | 440 | | | | | | |
| HEAVY OIL | | | | | 26 | 26 | | | | 26 | | 26 | | |
| TOTAL | | | 518 | 16518 | 16518 | 14573 | 1045 | 1007 | 868 | 14502 | 71 | 14304 | 236 | 206 |
| TEMPERATURE °F | | | 100 | 300 | 850 | 500 | 550 | 100 | 100 | 500 | 550 | 600 | 600 | 100 |
| PRESSURE PSIG | | | 1700 | 1500 | 1050 | 1000 | 1000 | 1000 | 1000 | 500 | 500 | 115 | 115 | 75 |

| | (15) LP FLASH CONDENSER SEPARATOR VAPOR | INERT GAS TO FILTER | WASH TO FILTER | VENT GAS | FILTRATE | FILTER CAKE | VACUUM FLASH LIQUID | VACUUM FLASH VAPOR | VACUUM FLASH CONDENSATE | LIGHT ENDS COLUMN BOTTOMS | LIGHT ENDS COLUMN LIQUID PRODUCT | LIGHT ENDS COLUMN VAPOR PRODUCT | WASH SOLVENT COLUMN BOTTOMS | WASH SOLVENT COLUMN PRODUCT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HYDROGEN | 8 | | | | | | | | | | | | | |
| NITROGEN | | 78 | | 58 | 20 | | | 20 | 20 | | | 20 | | |
| CARBON DIOXIDE | 9 | 17 | | 12 | 6 | | | 6 | 6 | | | 7 | | |
| HYDROGEN SULFIDE | 10 | | | 3 | 3 | | | 3 | 3 | | | 6 | | |
| $C_1 - C_4$ | 77 | | | 21 | 9 | | | 9 | 9 | | | 43 | | |
| $C_5$ - 200° | 3 | | | 3 | 22 | | | 22 | 22 | | 63 | | | |
| 200° - 550° | | | | | 108 | | | 108 | 108 | | 200 | | | |
| WASH SOLVENT | | | 1048 | | 702 | 346 | | 702 | 702 | 1048 | | | | 1048 |
| SOLVENT | | | | | 11317 | | | 11317 | 11317 | 12000 | | | 12000 | |
| COAL | | | | | 2230 | | 2230 | | | | | | | |
| ASH | | | | | | 530 | | | | | | | | |
| WATER | | | | | | | | | | | 440 | | | |
| HEAVY OIL | | | | | 26 | | | 26 | 26 | 26 | | | 26 | |
| TOTAL | 102 | 95 | 1048 | 97 | 14456 | 866 | 2230 | 12216 | 12216 | 13074 | 703 | 50 | 12026 | 1048 |
| TEMPERATURE °F | 100 | 100 | 400 | 100 | 400 | 400 | 600 | 600 | 150 | 611 | 250 | 250 | 641 | 511 |
| PRESSURE PSIG | 5 | 300 | 300 | 130 | 130 | 150 | -11 | -11 | -13 | 22 | 10 | 10 | 22 | 10 |

| | HEAVY ENDS COLUMN BOTTOMS | HEAVY ENDS COLUMN PRODUCT | DRYER CONDENSATE | HYDROGEN VENT | RECYCLE HYDROGEN | FRESH HYDROGEN | INERT GAS TO DRYER | INERT GAS FROM DRYER | LT. OIL SEPARATOR OIL | TO FLARE (TOTAL ALL STREAMS) | LT. OIL SEPARATOR WATER | FILTER GAS COMP. DISCHARGE | FILTER GAS COMP. SCRUBBER LIQUID | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HYDROGEN | | | | 67 | 76 | 107 | | | | 75 | | 38 | | HYDROGEN |
| NITROGEN | | | | | | | 78 | 78 | | 156 | | 4200 | 10 | NITROGEN |
| CARBON DIOXIDE | | | | | | | 17 | 17 | | 40 | | 871 | 18 | CARBON DIOXIDE |
| HYDROGEN SULFIDE | | | | | | | | | | 19 | | 250 | 16 | HYDROGEN SULFIDE |
| $C_1 - C_4$ | | | | 287 | 324 | | | | | 428 | | 1421 | 100 | $C_1 - C_4$ |
| $C_5$ - 200° | | | | 9 | 11 | | | | 80 | | | 252 | 500 | $C_5$ - 200° |
| 200° - 550° | | | | 1 | | | | | 300 | | | | 1456 | 200° - 550° |
| WASH SOLVENT | | | 346 | | | | | | | | | | 3153 | WASH SOLVENT |
| SOLVENT | | 12000 | | | | | | | | | | | 6771 | SOLVENT |
| COAL | | | | | | | | | | | | | | COAL |
| ASH | | | | | | | | | | | | | | ASH |
| WATER | | | | | | | | | | | 440 | | | WATER |
| HEAVY OIL | 26 | | | | | | | | | | | | | HEAVY OIL |
| TOTAL | 26 | 12000 | 346 | 364 | 411 | 107 | 95 | 95 | 380 | 734 | 440 | 7110 | 12102 | TOTAL |
| TEMPERATURE °F | 600 | 400 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | TEMPERATURE °F |
| PRESSURE PSIG | -9 | -13 | 10 | 10 | 950 | 75 | 300 | 1 | 10 | 10 | 10 | 200 | 180 | PRESSURE PSIG |

CONTRACT 21-1161
THE RUST ENGINEERING COMPANY
RELEASED FOR CONSTRUCTION

REVISIONS
1 APPROVED FOR BIDDING GC-II CONTRACT

REFERENCE DRAWINGS | PRINT RECORD | ENG. RECORD | DRAWING STATUS

242

P&I DIAGRAM
COAL DE-ASHING PLANT
SHEET 1

L-21703
P3-1

P&M Coal Co. Pilot Plant

THE RUST ENGINEERING CO.

ALL QUANTITIES IN LB/HR.

| STREAM NUMBER | 1 | 2 | 2A | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14A | 14B | 14C | 14D | 14E | 15 | 16 | 17 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COAL FEED | SOLVENT FEED | WATER FEED | SYN GAS TO FURNACE | FURNACE INLET | DISSOLVER OUTLET | HP FLASH LIQUID | HP FLASH VAPOR | HP COND SEP LIQUID | HP COND SEP VAPOR | INT FLASH LIQUID | INT FLASH VAPOR | LP FLASH LIQUID NET | LP FLASH VAPOR | SEP NO-1 FEED | H.C. PHASE TO LT. ENDS C. | OIL & $H_2O$ TO SEP NO. 2 | LT. OIL TO LEC | $H_2O$ TO WASTE OR STORAGE | SEP NO. 1 + SEP NO. 2 VAPOR | INERT GAS TO FILTERS | WASH TO FILTERS | |
| HYDROGEN ($H_2$) | | | | 92 | 92 | 76 | 4 | 72 | 2 | 70 | 1 | 3 | | 1 | 6 | | | | | 6 | | | |
| CARBON MONOXIDE (CO) | | | | 1281 | 1281 | 951 | 50 | 901 | 25 | 876 | 17 | 33 | 5 | 12 | 70 | | | | | 70 | | | |
| NITROGEN ($N_2$) | | | | | | | | | | | | | | | | | | | | | 78 | | |
| CARBON DIOXIDE ($CO_2$) | | | | | | 720 | 100 | 620 | 27 | 593 | 60 | 40 | 20 | 40 | 107 | | | | | 107 | 17 | | |
| HYDROGEN SULFIDE ($H_2S$) | | | | | | 2 | 1 | 1 | | 1 | 1 | | | 1 | 1 | | | | | 1 | | | |
| $C_1-C_4$ | | | | 324 | 324 | 507 | 77 | 430 | 23 | 407 | 56 | 21 | 21 | 35 | 79 | | | | | 79 | | | |
| $C_5-200°F$ | | | | 11 | 11 | 14 | 5 | 9 | 6 | 3 | 4 | 1 | 3 | 1 | 8 | | 8 | 7 | 1 | | | | |
| 200°–450°F | | | | | | 16 | 11 | 5 | 5 | | 10 | 1 | 8 | 2 | 8 | 4 | 4 | 3 | 1 | | | | |
| WASH SOLVENT | | | | | | 217 | 185 | 32 | 32 | | 179 | 6 | 165 | 14 | 52 | 52 | | | | | | 1248 | |
| SOLVENT | | 8000 | | | 8000 | 8000 | 7657 | 343 | 343 | | 7642 | 15 | 7547 | 95 | 453 | 453 | | | | | | | |
| COAL | 2456 | | | | 2456 | 1514 | 1514 | | | | 1514 | | 1514 | | | | | | | | | | |
| MINERAL RESIDUE | 288 | | | | 288 | 624 | 624 | | | | 624 | | 624 | | | | | | | | | | |
| WATER | 1256 | | 0 | | 1256 | 1043 | | 1043 | 1043 | | | | | | 1043 | | 1043 | | 1043 | | | | |
| HEAVY OIL | | | | | | 24 | 24 | | | | 24 | | 24 | | | | | | | | | | |
| TOTAL | 4000 | 8000 | 0 | 1708 | 13708 | 13708 | 10252 | 3456 | 1506 | 1950 | 10132 | 120 | 9931 | 201 | 1827 | 509 | 1055 | 10 | 1045 | 263 | 95 | 1248 | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | |
| TEMPERATURE °F | 100 | 150 | | 100 | 100 | 797 | 600 | 600 | 100 | 100 | 600 | 600 | 600 | 600 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 600 | |
| PRESSURE PSIG | | | | 2250 | 2050 | 1500 | 1500 | 1500 | 1500 | 1500 | 750 | 750 | 115 | 115 | 50 | 50 | 50 | 50 | 50 | 50 | 200 | 200 | |

ALL QUANTITIES IN LB/HR

| STREAM NUMBER | 18 | 19 | 20 | 21 | 22 | 23 | | 24 | 25 | 26 | 27 | 28 | 31 | 32 | 32A | 33 | 34 | 35 | 36 | 38 | 42 | 43 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | VENT GAS | FILTRATE | FILTER CAKE | VACUUM FLASH LIQUID | VACUUM FLASH VAPOR | VACUUM FLASH COND. | LT. ENDS FEED | L.E.C. BOTTOMS | L.E.C. LIQUID PRODUCT | L.E.C. VAPOR PRODUCT | WASH SOL. COL. BOTTOMS | WASH SOL. COL. PRODUCT | DRYER COND. | SYN GAS VENT | ACID GAS FROM DEA UNIT | RECYCLE SYNGAS | FRESH SYNGAS | INERT GAS TO DRYER | INERT GAS FROM DRYER | TOTAL TO FLARE | FEED TO SULFUR REC. UNIT | SULFUR | |
| HYDROGEN ($H_2$) | | | | | | | | | | | | | | 13 | | 57 | 37 | | | 19 | 6 | | |
| CARBON MONOXIDE (CO) | 3 | 2 | | | 2 | 2 | 2 | | | 2 | | | | 157 | | 719 | 526 | | | 232 | 75 | | |
| NITROGEN ($N_2$) | 58 | 20 | | | 20 | 20 | 20 | | | 20 | | | | | | | | 78 | 78 | 78 | 70 | | |
| CARBON DIOXIDE ($CO_2$) | 25 | 12 | | | 12 | 12 | 12 | | | 12 | | | | | 593 | | | 17 | 17 | 737 | 737 | | |
| HYDROGEN SULFIDE ($H_2S$) | | | | | | | | | | | | | | | 1 | | | | | | 2 | 2 | |
| $C_1-C_4$ | 15 | 6 | | | 6 | 6 | 6 | | | 6 | | | | 72 | | 335 | | | | 172 | 100 | | |
| $C_5-200°F$ | 1 | 2 | | | 2 | 2 | 9 | | 9 | | | | | 1 | | 2 | | | | 2 | 1 | | |
| 200°–450°F | | 8 | | | 8 | 8 | 15 | | 15 | | | | | | | | | | | | | | |
| WASH SOLVENT | | 947 | 466 | | 947 | 947 | 1465 | 1465 | | | | 1465 | 466 | | | | | | | | | | |
| SOLVENT | | 7547 | | | 7547 | 7547 | 8000 | 8000 | | | 8000 | | | | | | | | | | | | |
| COAL | | 1514 | | 1514 | | | | | | | | | | | | | | | | | | | |
| MINERAL RESIDUE | | | 624 | | | | | | | | | | | | | | | | | | | | |
| WATER | | | | | | | | | | | | | | | | | | | | | | | |
| HEAVY OIL | | 24 | | | 24 | 24 | 24 | 24 | | | 24 | | | | | | | | | | | | |
| TOTAL | 102 | 10,082 | 1090 | 1514 | 8568 | 8568 | 9553 | 9489 | 24 | 40 | 8024 | 1465 | 466 | 243 | 594 | 1113 | 563 | 95 | 95 | 1240 | 999 | 2 | |
| | | | | | | | | | | | | | | | | | 342,000 | | | | | | |
| | | | | | | | | | | | | | | | | | SCFD | | | | | | |
| TEMPERATURE °F | 100 | 600 | 600 | 600 | 600 | 150 | | 611 | 250 | 250 | 641 | 511 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | | |
| PRESSURE PSIG | 130 | 130 | 150 | -11 | -11 | -13 | | 22 | 10 | 10 | 22 | 10 | 10 | 10 | 10 | 950 | 75 | 250 | 1 | ~5 | 10 | | |

| REVISIONS | ENGR. |
|---|---|
| | ORIGINATED BY G.P. |
| | DRAWN BY Ron H 6-27-74 |
| | CHECKED BY RS 6/27/74 |

SRC PILOT PLANT
MATERIAL BALANCE
SYNTHESIS GAS CASE –

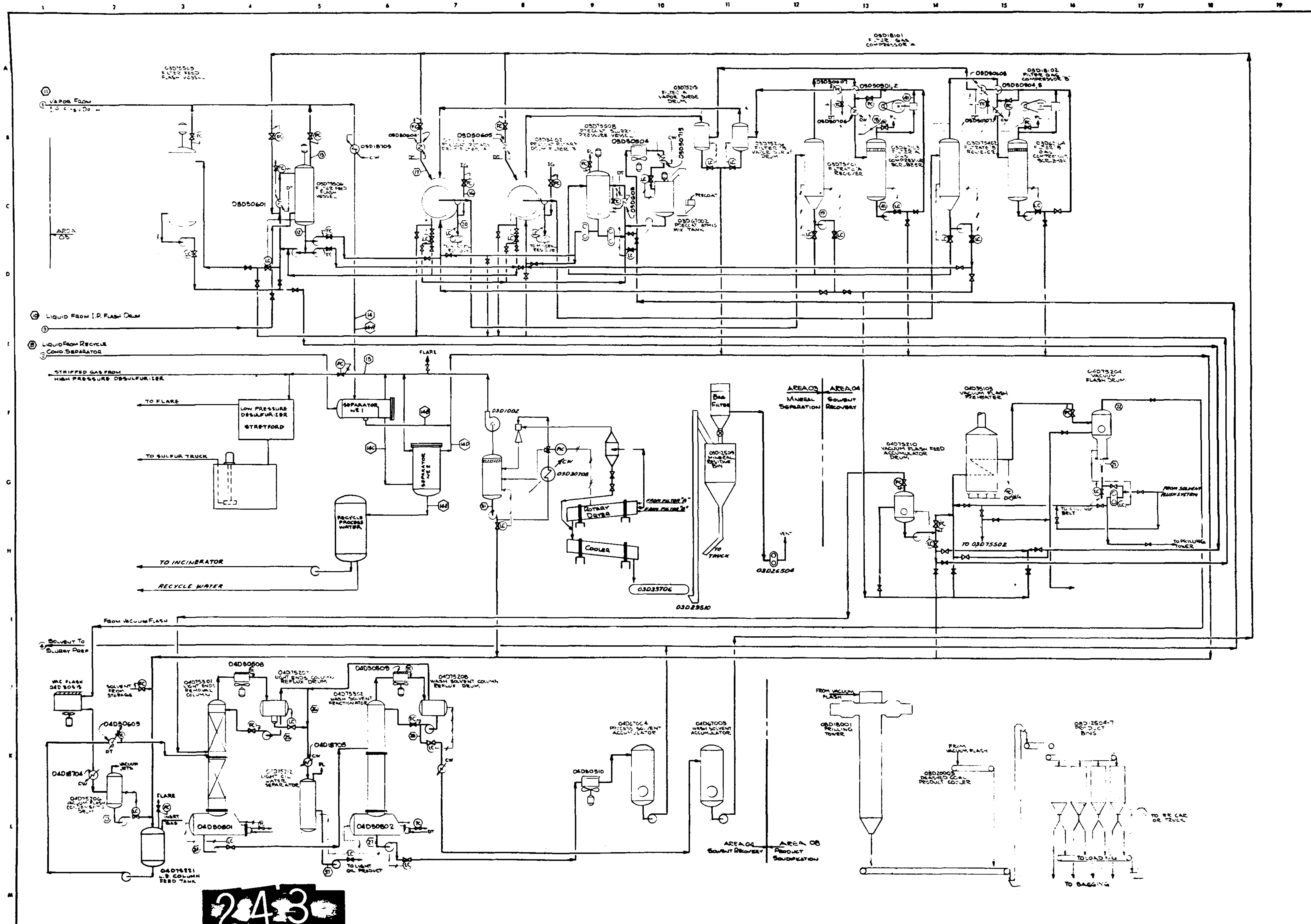
PITTSBURG & MIDWAY COAL MINING COMPANY SRC PILOT PLANT

SCALE – NONE

FORT LEWIS, WASHINGTON

L 21793

SHEET NO. P3-1-A (BY P&M)




243

| | |
|---|---|
| THE RUST ENGINEERING COMPANY | RELEASED FOR CONSTRUCTION — DATE 1-3-77 |

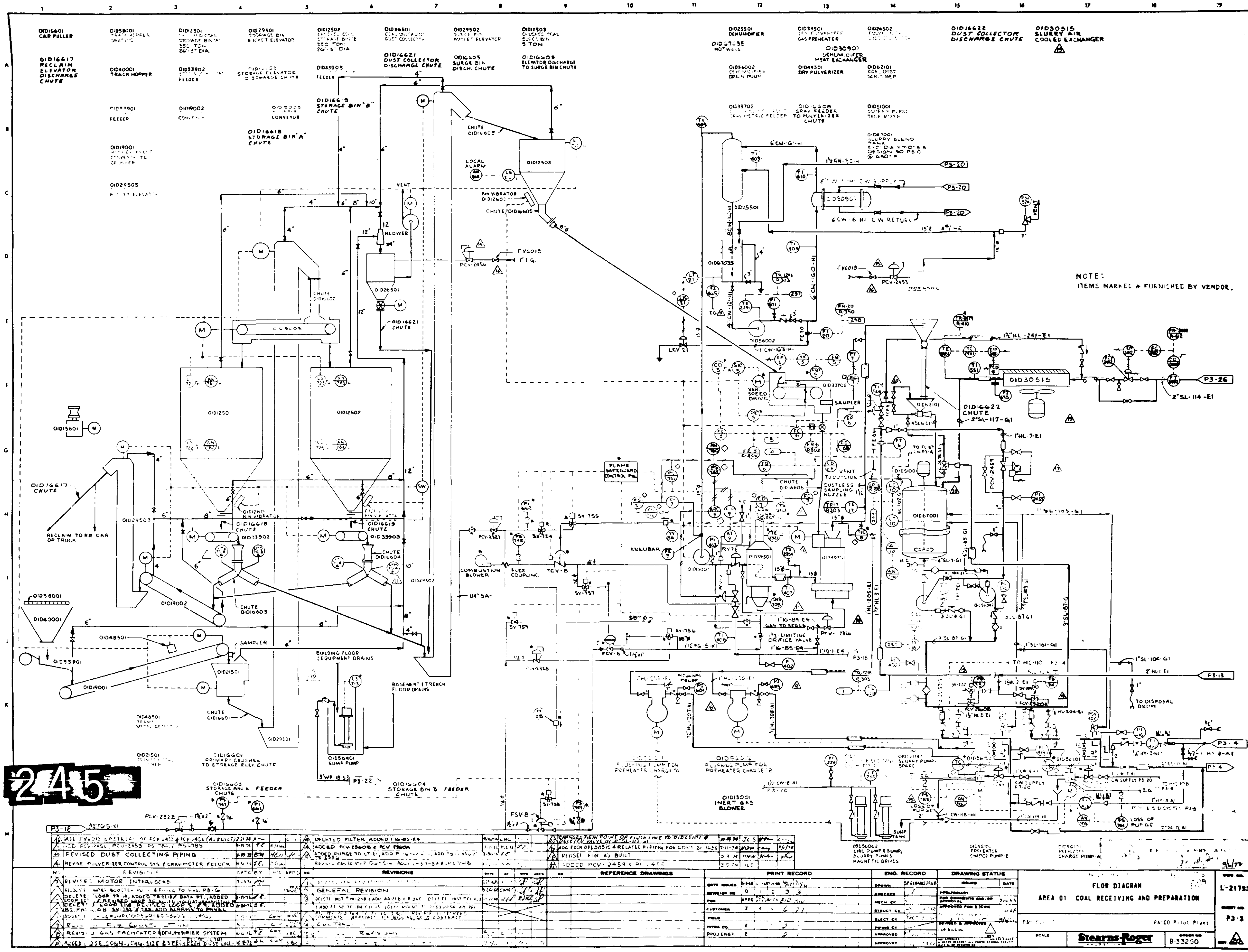
| NO | REVISIONS |
|---|---|
| 1 | APPROVED FOR BIDDING GC II CONTRACT |
| 2 | RELEASED FOR CONSTRUCTION |

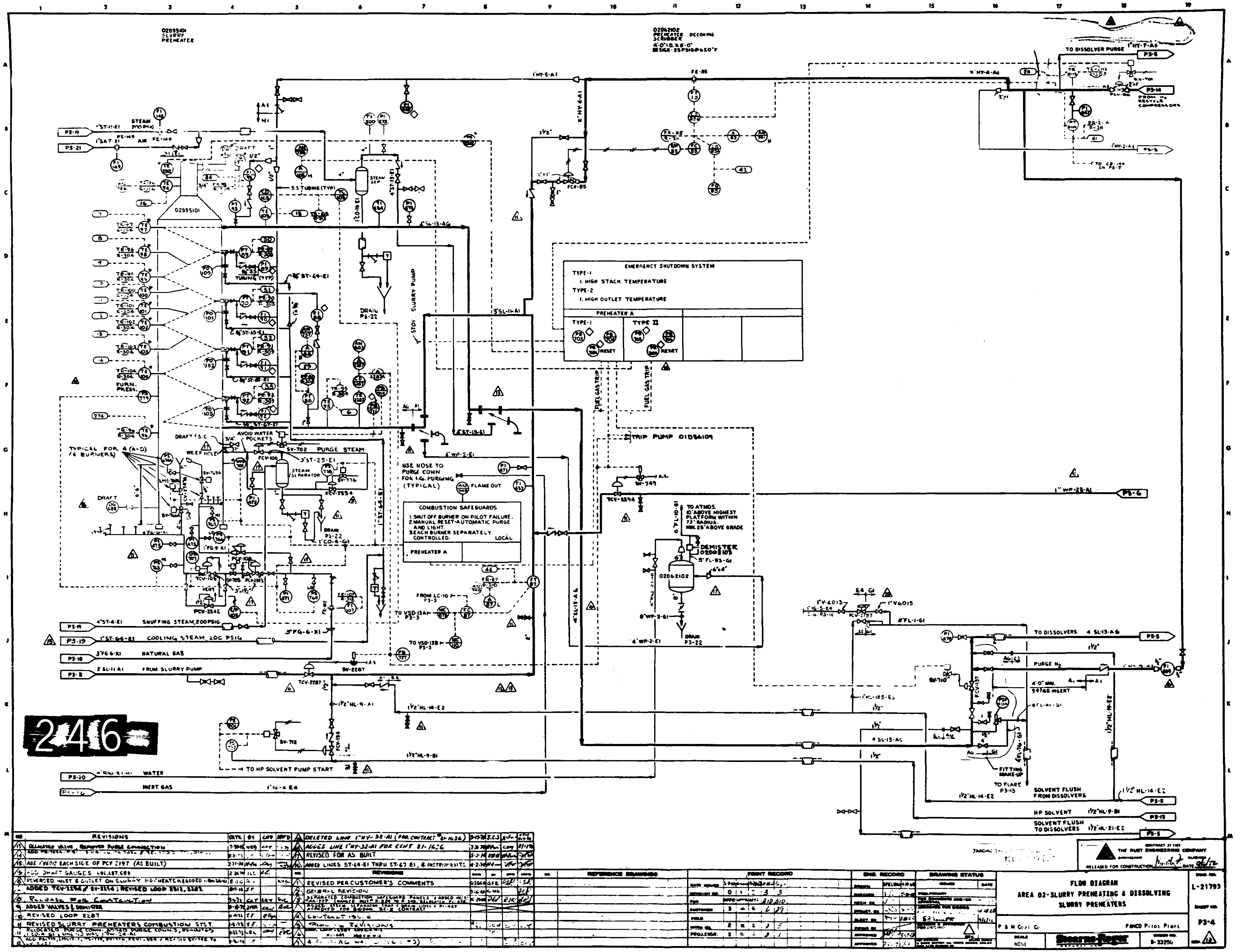
**P&I DIAGRAM**
**COAL DE-ASHING PLANT**
**SHEET 2**

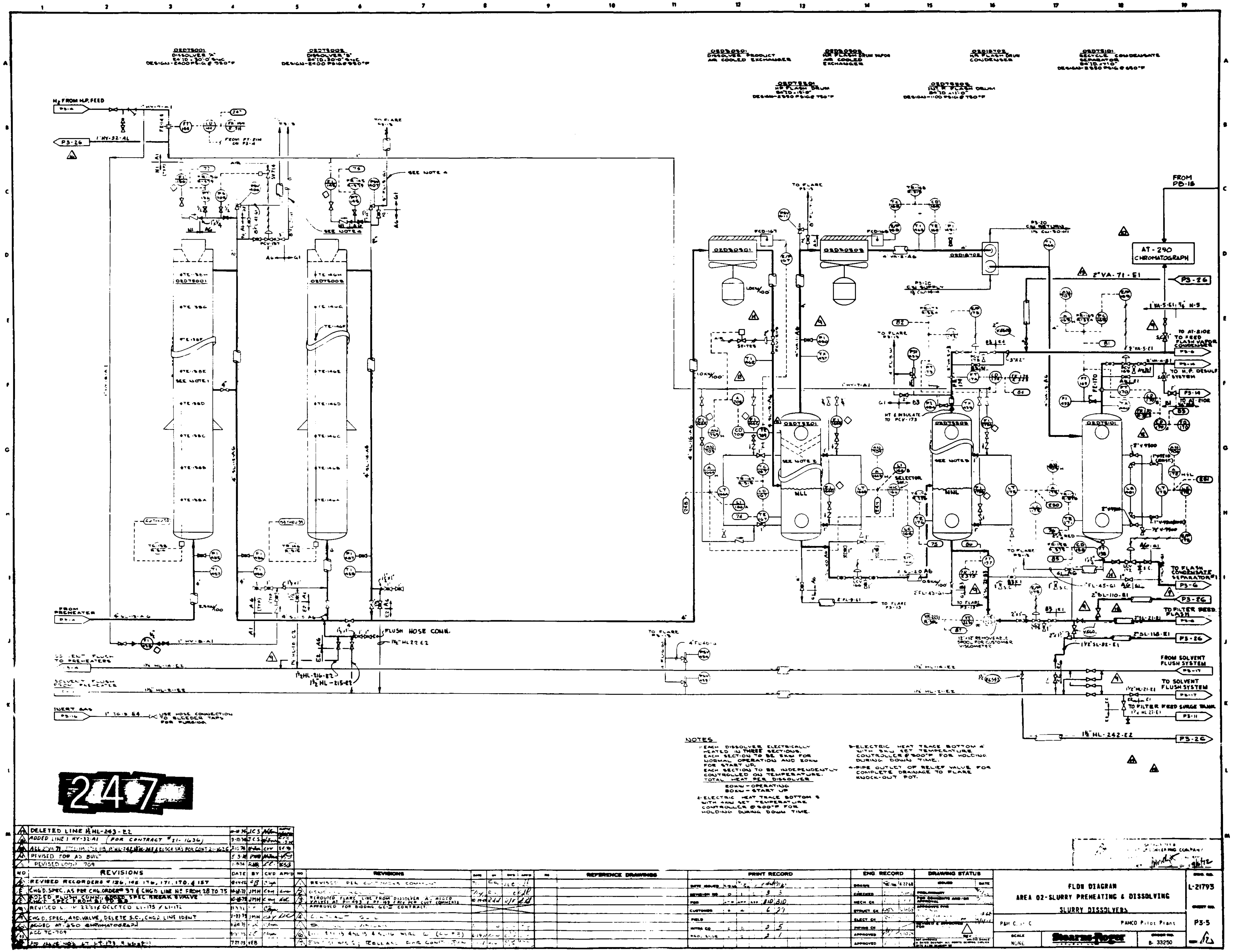
P&M Coal Co — Pilot Plant

THE RUST ENGINEERING CO — ORDER NO. 8-33250

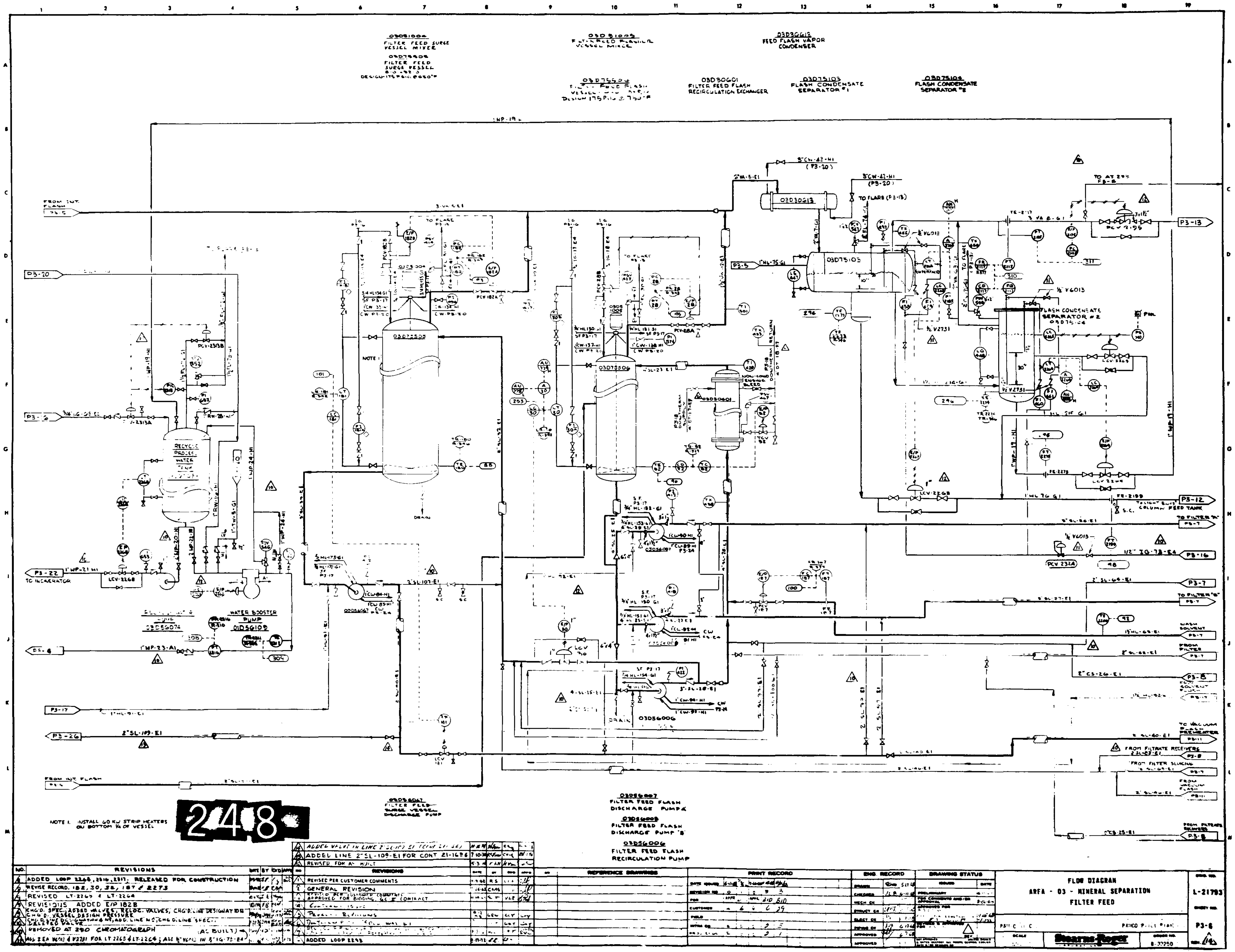
DWG. NO. L-21793 — SHEET NO. P3-2 — REV. 2


FLOW DIAGRAM
AREA 01 COAL RECEIVING AND PREPARATION
Stearns-Roger
L-21783
P3-3
B-33250
NOTE:
ITEMS MARKED * FURNISHED BY VENDOR.
01D15601 CAR PULLER
01D16617 RECLAIM ELEVATOR DISCHARGE CHUTE
01D40001 TRACK HOPPER
01D16622 DUST COLLECTOR DISCHARGE CHUTE
01D30515 SLURRY AIR COOLED EXCHANGER
01D12501
01D12502
01D12503
01D30515
01D67001
RECLAIM TO RR CAR OR TRUCK
COMBUSTION BLOWER
ANNUBAR
SAMPLER
BUILDING FLOOR EQUIPMENT DRAINS
BASEMENT TRENCH FLOOR DRAINS
01D56401 SUMP PUMP
01D13001 INERT GAS BLOWER
TO DISPOSAL DRUM
REVISED DUST COLLECTING PIPING
ADDED PCV-2459 & PI-2455
REVISED MOTOR INTERLOCKS
GENERAL REVISION
REVISED FOR AS BUILT
245


02035101 SLURRY PREHEATER
02062102 PREHEATER DECOKING SCRUBBER 4'-0" I.D. X 8'-0" DESIGN - 25 PSIG @ 650°F
TO DISSOLVER PURGE
FROM H2 RECYCLE COMPRESSORS
EMERGENCY SHUTDOWN SYSTEM
TYPE-1
1. HIGH STACK TEMPERATURE
TYPE-2
1. HIGH OUTLET TEMPERATURE
PREHEATER A
RESET
FUEL GAS TRIP
STRIP PUMP 01056109
TO ATMOS. 10' ABOVE HIGHEST PLATFORM WITHIN 75' RADIUS. MIN. 25' ABOVE GRADE
DEMISTER 02062103
02062102
DRAIN P3-22
SLURRY PUMP
STEAM SEPARATOR
PURGE STEAM
AVOID WATER POCKETS
TYPICAL FOR 4 (A-D) (4 BURNERS)
DRAFT
FURN. PRESS.
WEEP HOLE
USE HOSE TO PURGE CONN FOR I.G. PURGING (TYPICAL)
FLAME OUT
COMBUSTION SAFEGUARDS
1. SHUT OFF BURNER ON PILOT FAILURE.
2. MANUAL RESET - AUTOMATIC PURGE AND LIGHT.
3. EACH BURNER SEPARATELY CONTROLLED.
LOCAL
SNUFFING STEAM, 200 PSIG
COOLING STEAM, 20C PSIG
NATURAL GAS
FROM SLURRY PUMP
TO HP SOLVENT PUMP START
WATER
INERT GAS
TO DISSOLVERS
PURGE H2
FITTING MAKE-UP
TO FLARE P3-13
SOLVENT FLUSH FROM DISSOLVERS
HP SOLVENT
SOLVENT FLUSH TO DISSOLVERS
THE RUST ENGINEERING COMPANY
RELEASED FOR CONSTRUCTION
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
FLOW DIAGRAM
AREA 02-SLURRY PREHEATING & DISSOLVING
SLURRY PREHEATERS
P & M Coal Co
PAMCO Pilot Plant
SCALE NONE
8-33250
L-21793
P3-4
246

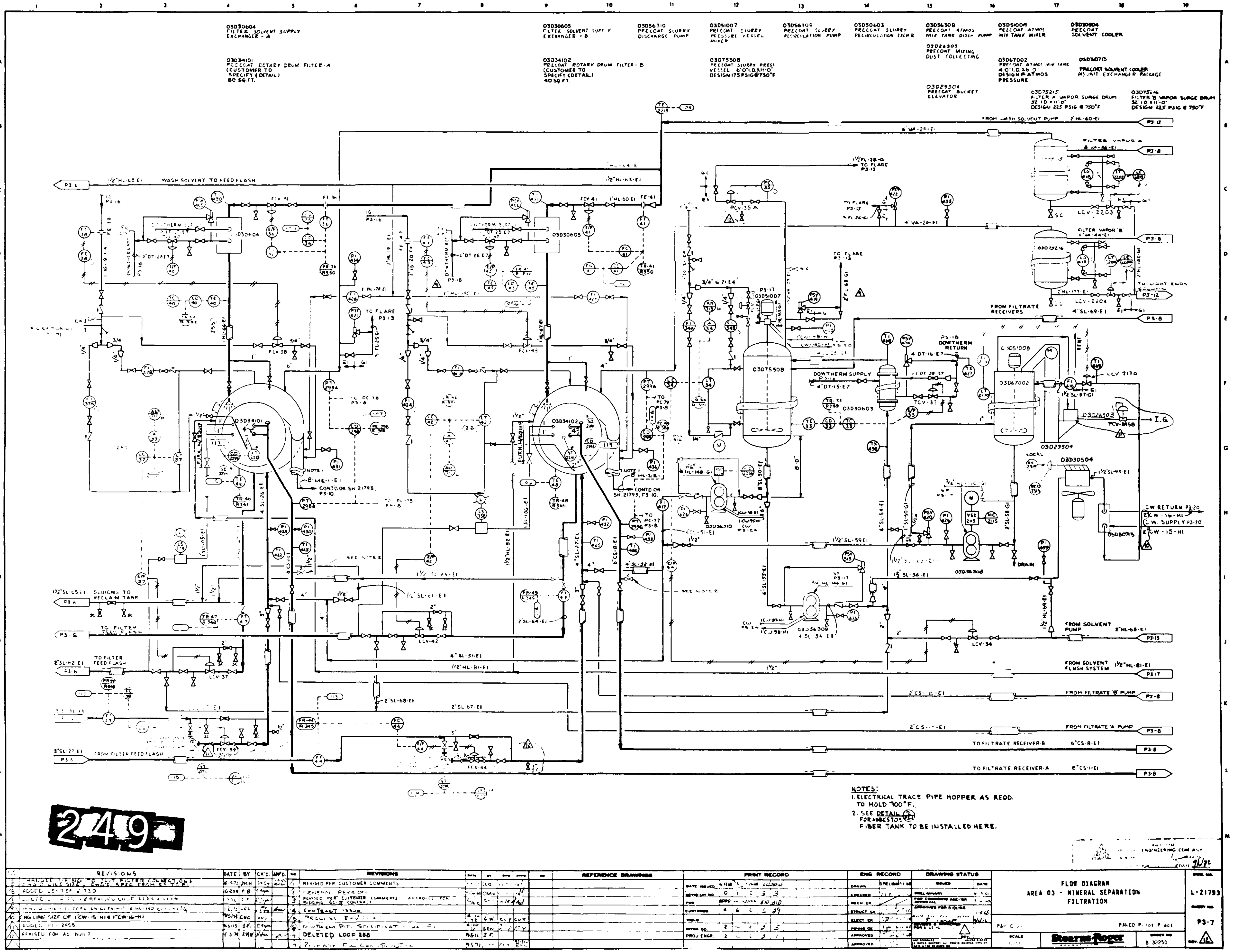


02D75001 DISSOLVER "A"
02D75002 DISSOLVER "B"
02D75301 HP FLASH DRUM
02D75302 INTER FLASH DRUM
02D75101
H2 FROM H.P. FEED
FROM PREHEATER
FLUSH HOSE CONN.
INERT GAS
USE HOSE CONNECTION TO BLEEDER TAPS FOR PURGING
AT-290 CHROMATOGRAPH
FROM P8-18
TO FLARE
SEE NOTE 4
SEE NOTE 2
SEE NOTE 3
SEE NOTE 1
SELECTOR
HT & INSULATE TO PCV-173
TO FLASH CONDENSATE SEPARATOR
TO FILTER FEED FLASH
FROM SOLVENT FLUSH SYSTEM
TO SOLVENT FLUSH SYSTEM
TO FILTER FEED SURGE TANK
TO H.P. DESULF SYSTEM
NOTES
1-EACH DISSOLVER ELECTRICALLY HEATED IN THREE SECTIONS. EACH SECTION TO BE 5KW FOR NORMAL OPERATION AND 20KW FOR START UP. EACH SECTION TO BE INDEPENDENTLY CONTROLLED ON TEMPERATURE. TOTAL HEAT PER DISSOLVER
20KW - OPERATING
60KW - START UP
2-ELECTRIC HEAT TRACE BOTTOM 5 WITH 4KW SET TEMPERATURE CONTROLLER @ 800°F FOR HOLDING DURING DOWN TIME.
3-ELECTRIC HEAT TRACE BOTTOM 4' WITH 3KW SET TEMPERATURE CONTROLLER @ 800°F FOR HOLDING DURING DOWN TIME.
4-PIPE OUTLET OF RELIEF VALVE FOR COMPLETE DRAINAGE TO FLARE KNOCK-OUT POT.
247
REVISIONS
FLOW DIAGRAM
AREA 02-SLURRY PREHEATING & DISSOLVING
SLURRY DISSOLVERS
PAMCO Pilot Plant
L-21793
P3-5
SCALE NONE
Stearns-Roger
B-33250

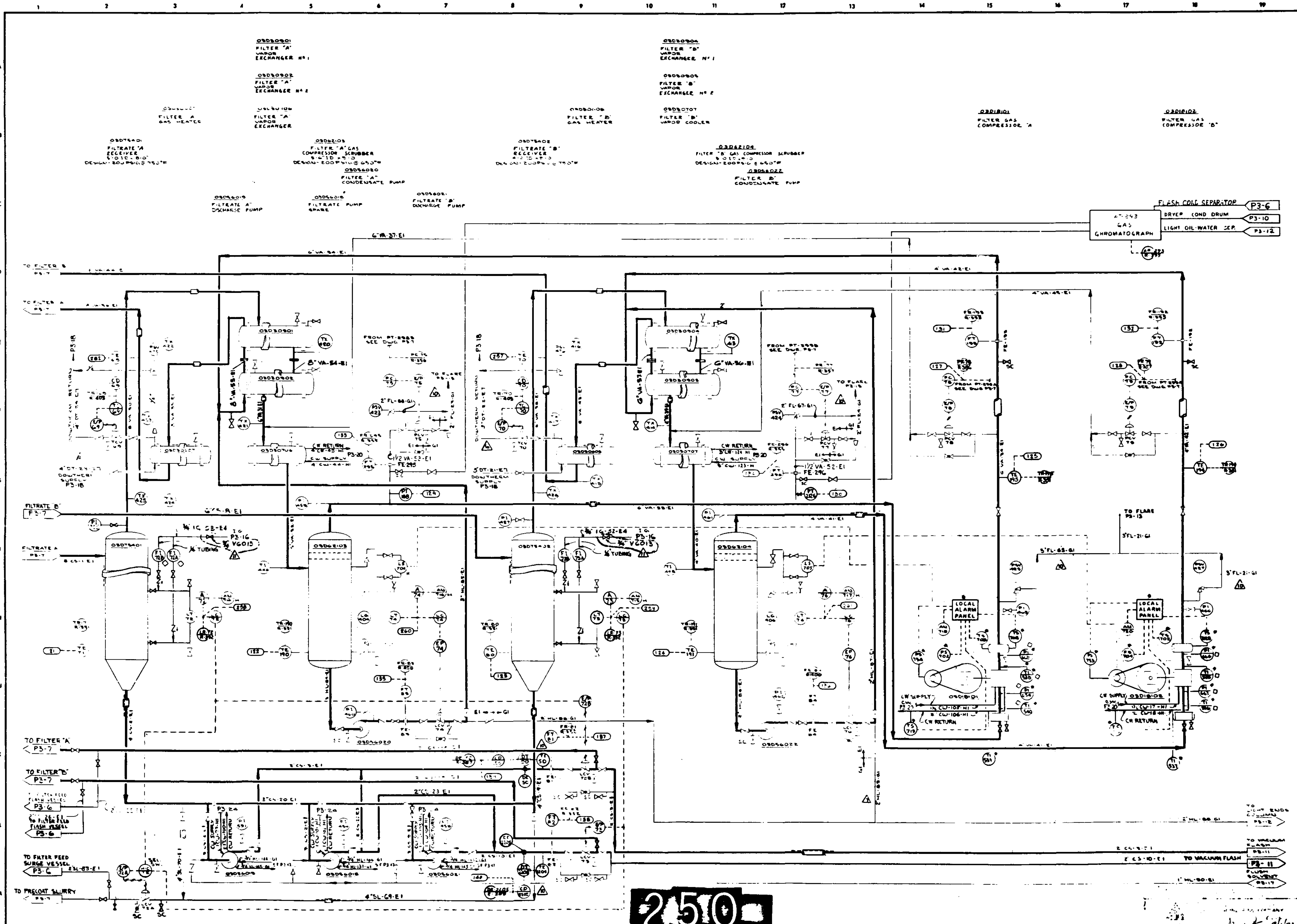


FLOW DIAGRAM
AREA - 03 - MINERAL SEPARATION
FILTER FEED
L-21793
P3-6
Stearns-Roger
8-32250
03D75103
FLASH CONDENSATE SEPARATOR #1
03D75104
FLASH CONDENSATE SEPARATOR #2
03D30613
FEED FLASH VAPOR CONDENSER
03D30601
FILTER FEED FLASH RECIRCULATION EXCHANGER
03D56007
FILTER FEED FLASH DISCHARGE PUMP "A"
03D56008
FILTER FEED FLASH DISCHARGE PUMP "B"
03D56006
FILTER FEED FLASH RECIRCULATION PUMP
WATER BOOSTER PUMP
01D56109
NOTE 1. INSTALL 60 KW STRIP HEATERS ON BOTTOM 1/4 OF VESSEL
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
248


B-12



03D30604 FILTER SOLVENT SUPPLY EXCHANGER - A
03D34101 PRECOAT ROTARY DRUM FILTER-A (CUSTOMER TO SPECIFY (DETAIL) 80 SQ FT.
03D30605 FILTER SOLVENT SUPPLY EXCHANGER - B
03D34102 PRECOAT ROTARY DRUM FILTER-B (CUSTOMER TO SPECIFY (DETAIL) 40 SQ FT.
03D56310 PRECOAT SLURRY DISCHARGE PUMP
03D51007 PRECOAT SLURRY PRESSURE VESSEL MIXER
03D75508 PRECOAT SLURRY PRESS VESSEL 6'-0" I.D. X 11'-0" DESIGN 175 PSIG @ 750°F
03D56309 PRECOAT SLURRY RECIRCULATION PUMP
03D30603 PRECOAT SLURRY RECIRCULATION COOLER
03D56308 PRECOAT ATMOS MIX TANK DISCH PUMP
03D26503 PRECOAT MIXING DUST COLLECTING
03D29504 PRECOAT BUCKET ELEVATOR
03D51008 PRECOAT ATMOS MIX TANK MIXER
03D67002 PRECOAT ATMOS MIX TANK 4'-0" I.D. X 6'-0" DESIGN @ ATMOS PRESSURE
03D75215 FILTER A VAPOR SURGE DRUM 3' I.D. X 11'-0" DESIGN 225 PSIG @ 750°F
03D30504 PRECOAT SOLVENT COOLER
03D30713 PRECOAT SOLVENT COOLER (4) UNIT EXCHANGER PACKAGE
03D75216 FILTER B VAPOR SURGE DRUM 3' I.D. X 11'-0" DESIGN 225 PSIG @ 750°F
WASH SOLVENT TO FEED FLASH
FROM WASH SOLVENT PUMP
FILTER VAPOR A
FILTER VAPOR B
TO FLARE
TO LIGHT ENDS
FROM FILTRATE RECEIVERS
DOWTHERM SUPPLY
DOWTHERM RETURN
SLUICING TO RECLAIM TANK
TO FILTER FEED FLASH
FROM FILTER FEED FLASH
SEE NOTE 2
DRAIN
FROM SOLVENT PUMP
FROM SOLVENT FLUSH SYSTEM
FROM FILTRATE 'B' PUMP
FROM FILTRATE 'A' PUMP
TO FILTRATE RECEIVER B
TO FILTRATE RECEIVER-A
CW RETURN
C.W. SUPPLY
NOTES:
1. ELECTRICAL TRACE PIPE HOPPER AS REQD. TO HOLD 700°F.
2. SEE DETAIL FOR ASBESTOS FIBER TANK TO BE INSTALLED HERE.
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
FLOW DIAGRAM
AREA 03 - MINERAL SEPARATION
FILTRATION
PAMCO Pilot Plant
Stearns-Roger
B 33250
L-21793
P3-7
249




| NO. | REVISIONS | DATE | BY | CHK | APP'D |
|---|---|---|---|---|---|
| 8 | RELEASE FOR CONSTRUCTION | 9-5-73 | CEY | | |
| 9 | REVISIONS 2205, 50, 83, 78, 84, 79, 69, /70 RECORDS | | | | |
| 9 | RELOCATED VALVES CHANGED EQUIPMENT REFERENCE. | | | | |
| 9 | REVISED COMPRESSORS 03D18101 / 03D18102 | | | | |
| 10 | REVISED LOOP 50 & 2205 | | | | |
| 10 | [illegible] | | | | |
| 11 | ADDED 3/4" VG013 IN LINES 3/4 1G-52-E4 & 3/4 1G-53-E4 (AS BUILT) | | | | |

| NO. | REVISIONS |
|---|---|
| 1 | REVISED PER CUSTOMER COMMENTS. |
| 2 | GENERAL REVISION |
| 3 | DELETED INST. SW 701, TS 701, 702, 703, AN 721, 722, 723, ADD INST. PS 702, 703, 704, TS 719, 720, 721, CF 74, 76, LR 74, 75, CP 74, 76, AR 253, AT 293. REV. PER CUSTOMER COMMENTS. APPROVED FOR BIDDING GC CONTRACT. |
| 4 | [illegible] |
| 5 | [illegible] |
| 6 | [illegible] |

FLOW DIAGRAM
AREA 03 MINERAL SEPARATION
FILTRATION AUXILIARIES

PAMCO Pilot Plant

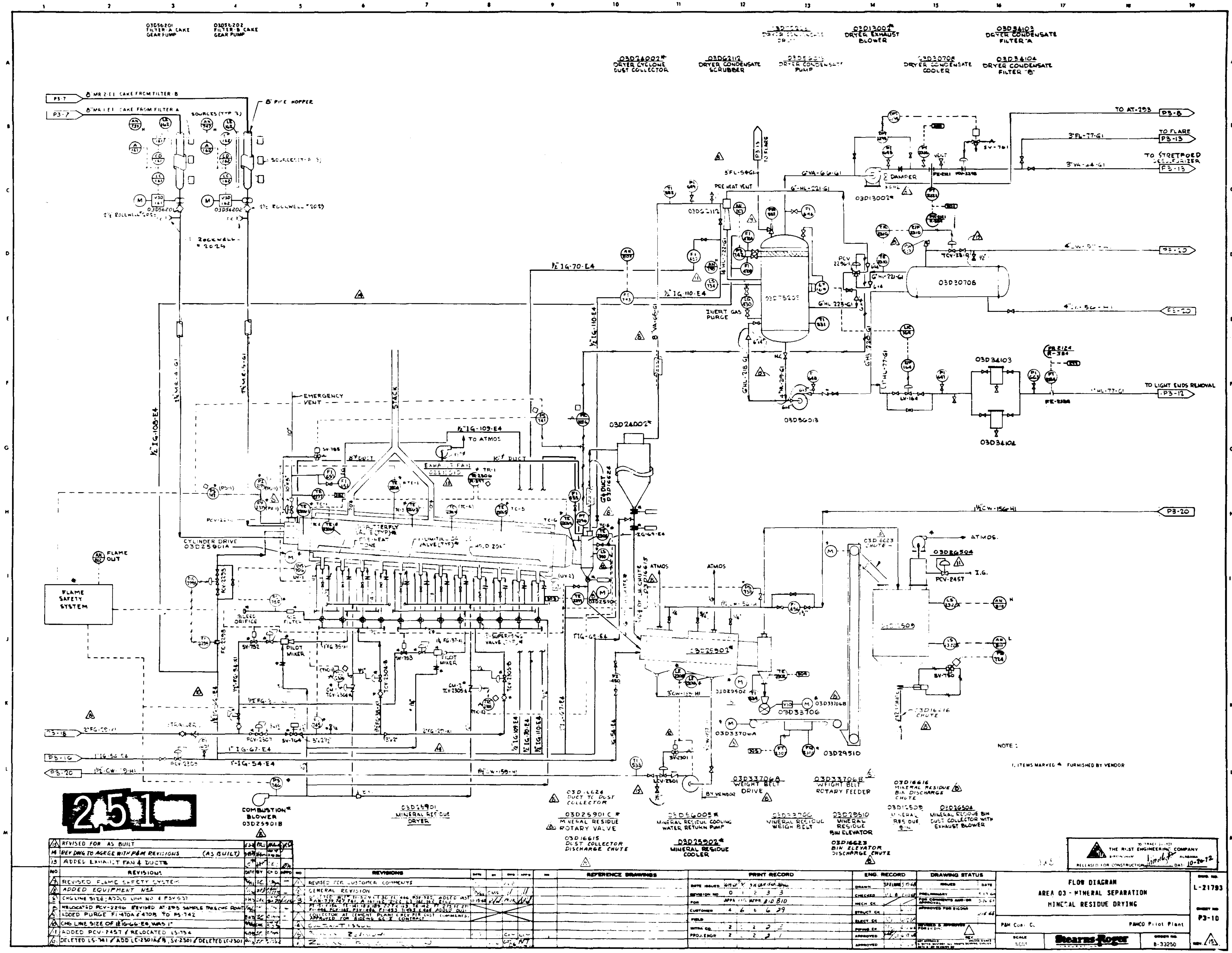
Stearns-Roger

ORDER NO. B 33250

DWG. NO. L-21793

P3-8

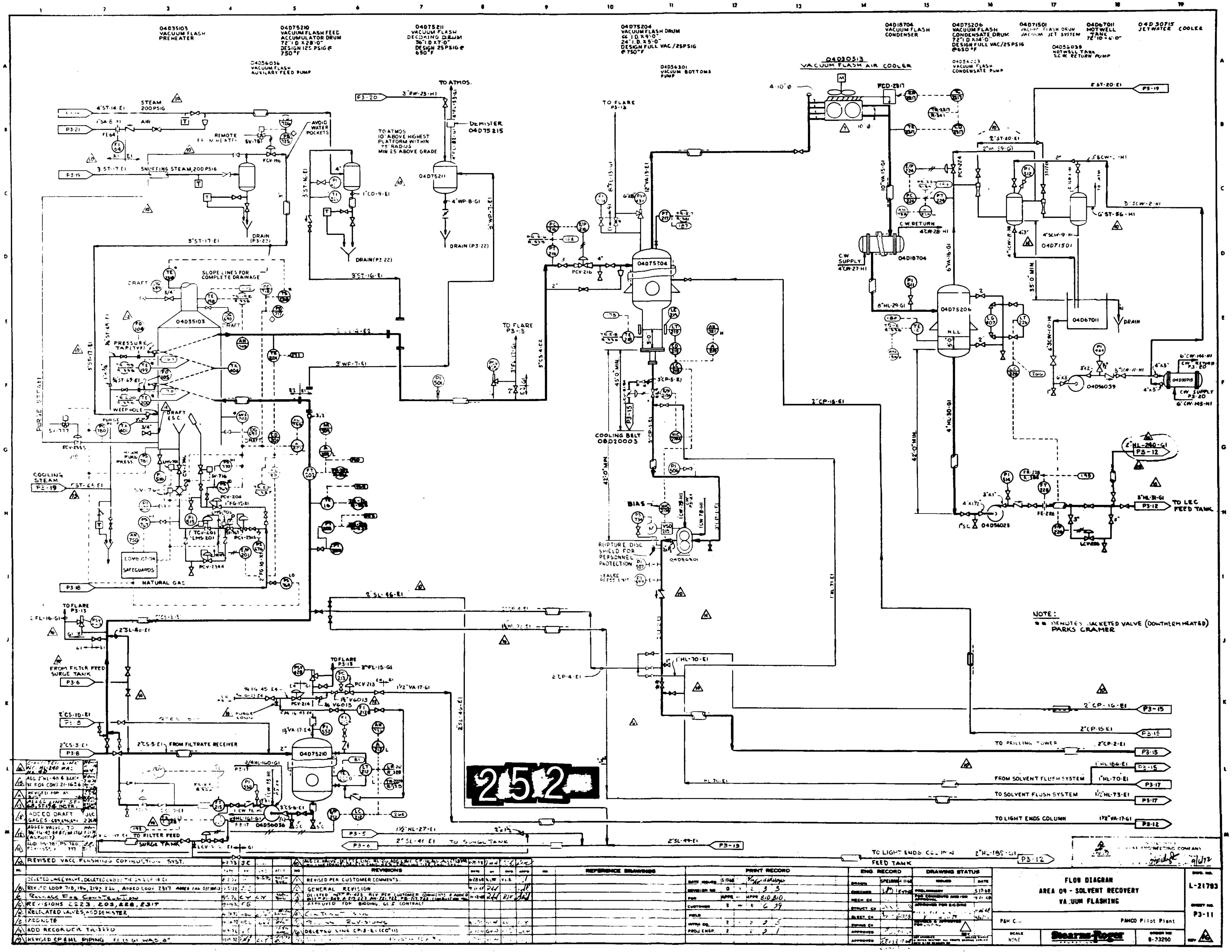
REV. 11

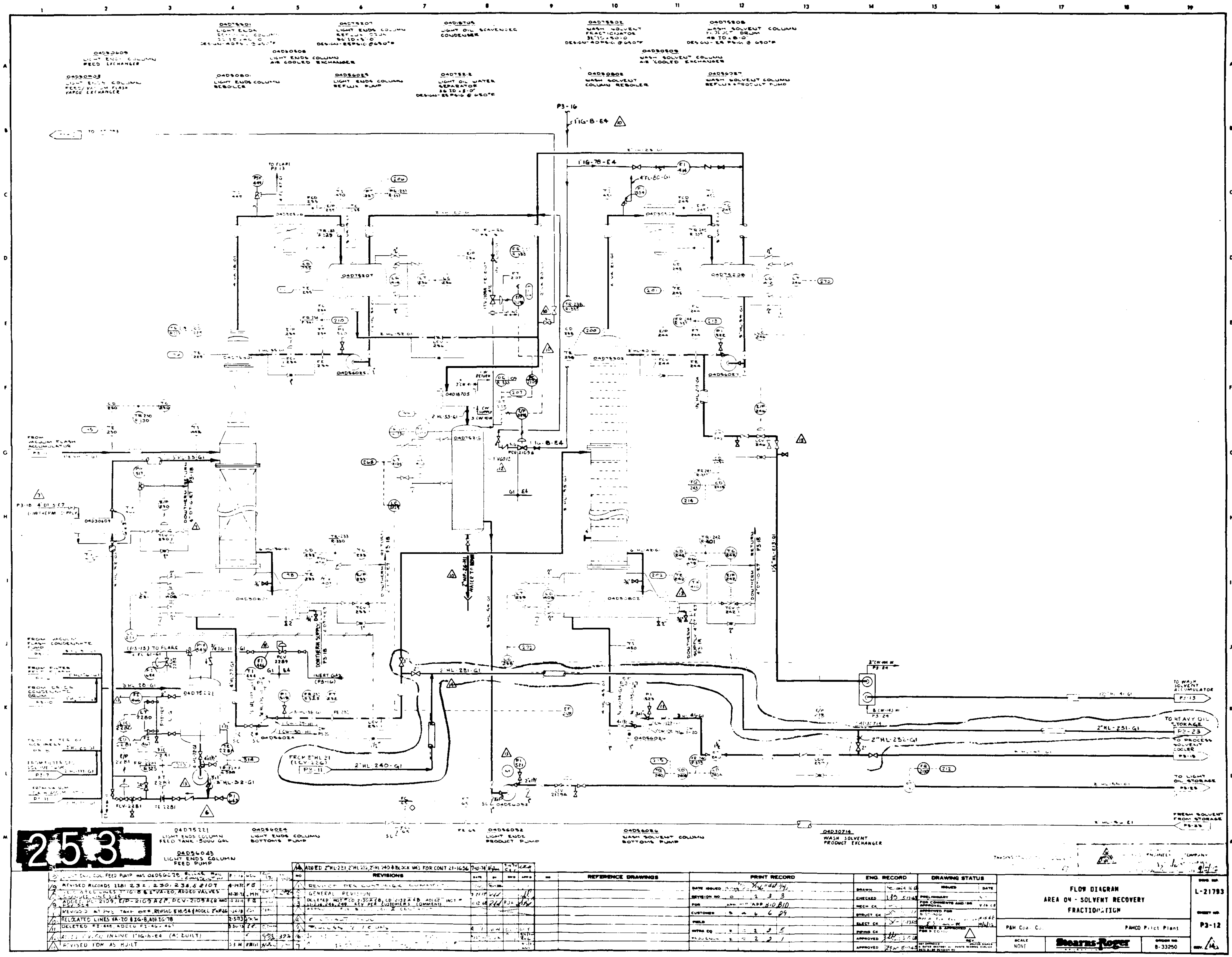


03D56201 FILTER A CAKE GEAR PUMP
03D56202 FILTER B CAKE GEAR PUMP
03D13002* DRYER EXHAUST BLOWER
03D34103 DRYER CONDENSATE FILTER "A"
03D24002* DRYER CYCLONE DUST COLLECTOR
03D62112 DRYER CONDENSATE SCRUBBER
03D30708 DRYER CONDENSATE COOLER
03D34104 DRYER CONDENSATE FILTER "B"
TO AT-293
TO FLARE
TO STRETFORD
TO LIGHT ENDS REMOVAL
EMERGENCY VENT
STACK
TO ATMOS
ATMOS
INERT GAS PURGE
FLAME SAFETY SYSTEM
FLAME OUT
CYLINDER DRIVE 03D25901A
COMBUSTION* BLOWER 03D25901B
03D25901 MINERAL RESIDUE DRYER
03D16624 DUCT TO DUST COLLECTOR
03D25901C* MINERAL RESIDUE ROTARY VALVE
03D16615 DUST COLLECTOR DISCHARGE CHUTE
03D25902* MINERAL RESIDUE COOLER
03D37706A WEIGHT BELT DRIVE
03D37706B WEIGHT BELT ROTARY FEEDER
03D37706 MINERAL RESIDUE WEIGH BELT
03D29510 MINERAL RESIDUE BIN ELEVATOR
03D16623 BIN ELEVATOR DISCHARGE CHUTE
03D16616 MINERAL RESIDUE BIN DISCHARGE CHUTE
03D26504 MINERAL RESIDUE BIN DUST COLLECTOR WITH EXHAUST BLOWER
NOTE:
1. ITEMS MARKED * FURNISHED BY VENDOR
251
REVISIONS
REVISED FOR AS BUILT
REV DWG TO AGREE WITH P&M REVISIONS (AS BUILT)
ADDED EXHAUST FAN & DUCTS
REVISED FLAME SAFETY SYSTEM
ADDED EQUIPMENT NO.
RELOCATED PCV-2296 REVISED AT-293 SAMPLE
ADDED PURGE
CHG LINE SIZE
ADDED PCV-2457 / RELOCATED LS-754
DELETED LS-741 / ADD LE-2301A&B, SV-2301 / DELETED LC-2301
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
THE RUST ENGINEERING COMPANY
BIRMINGHAM ALABAMA
RELEASED FOR CONSTRUCTION
DATE 10-20-72
FLOW DIAGRAM
AREA 03 - MINERAL SEPARATION
MINERAL RESIDUE DRYING
P&M Coal Co
PAMCO Pilot Plant
Stearns-Roger
DWG. NO. L-21793
SHEET NO. P3-10
ORDER NO. 8-33250
REV. 15

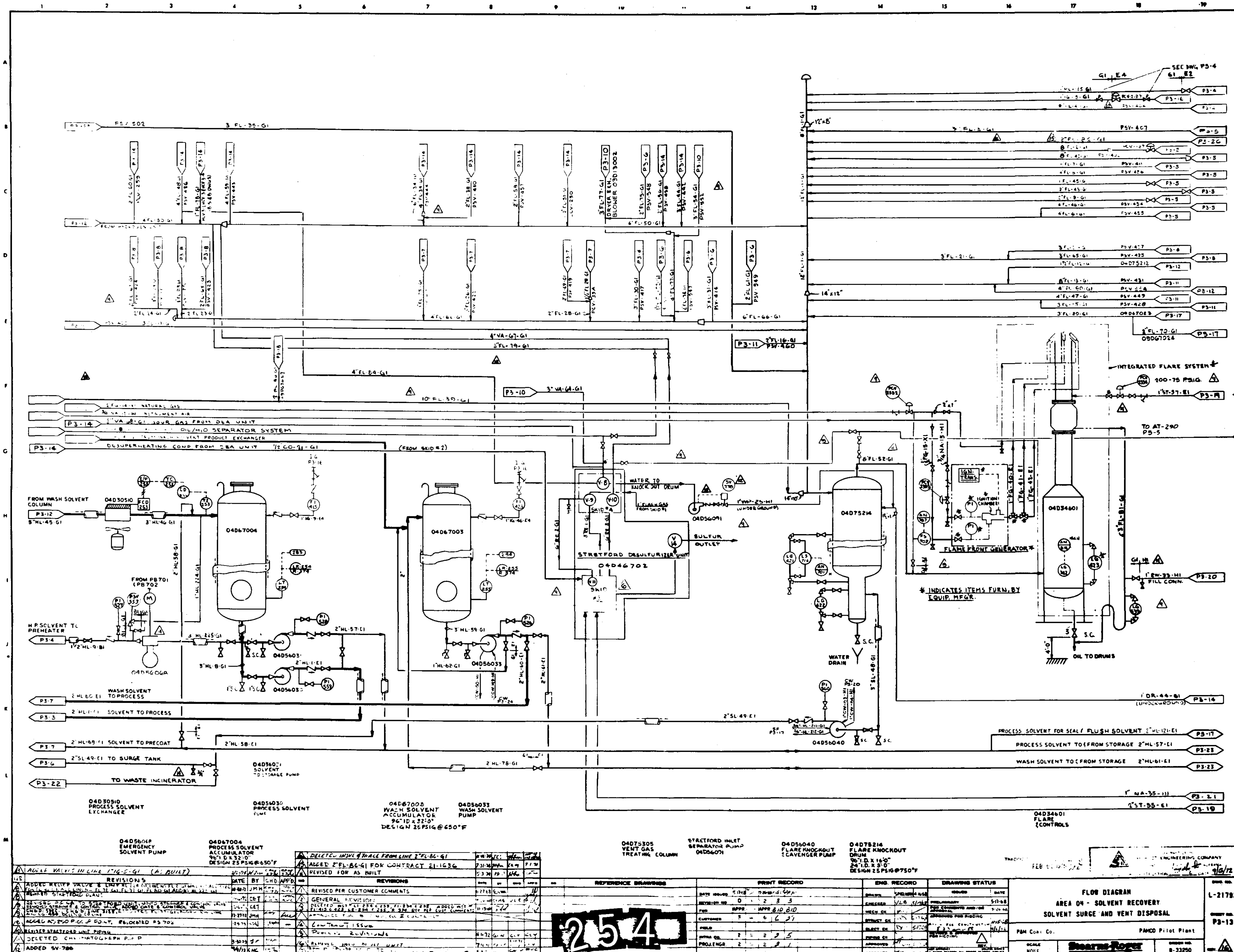



2

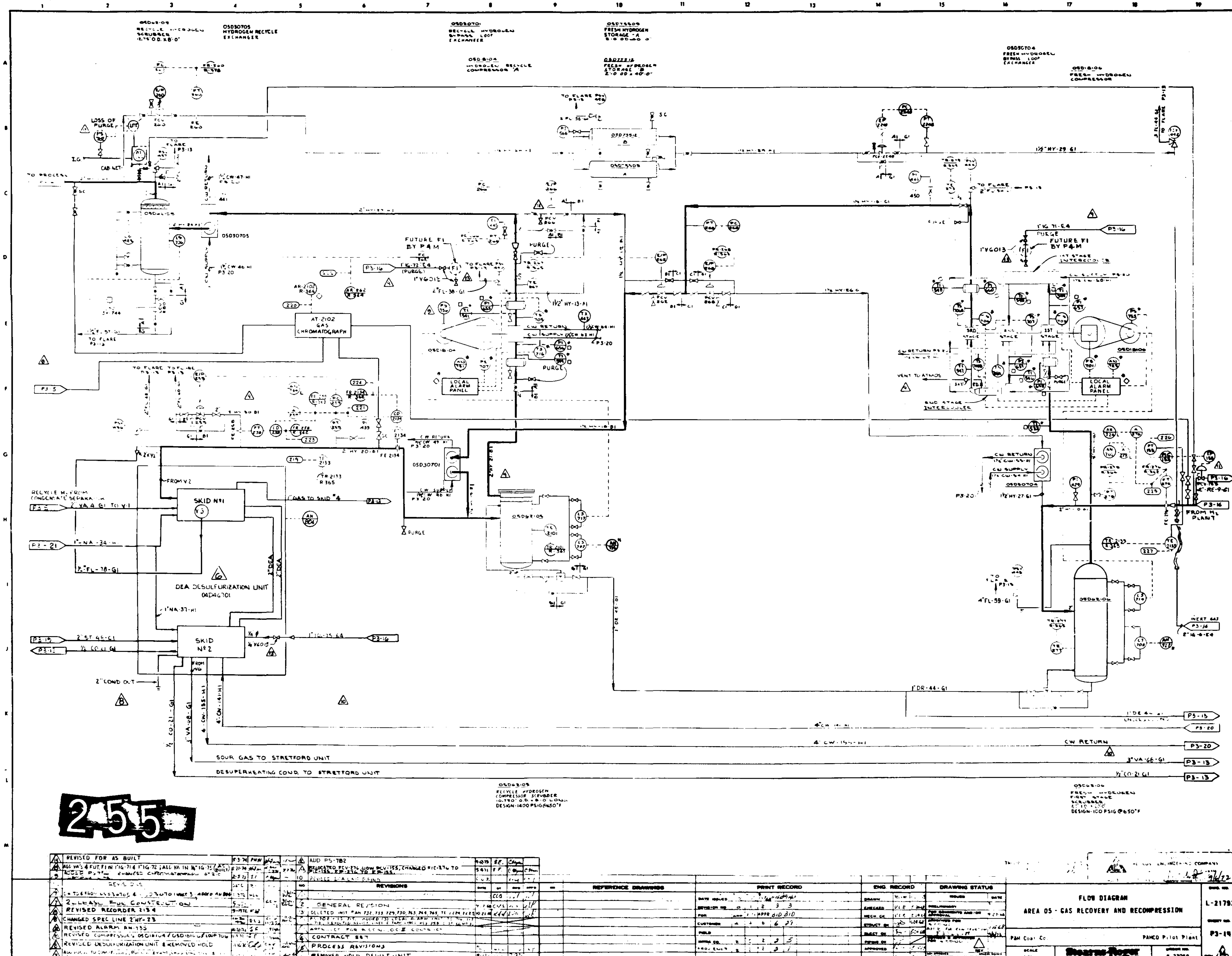

04D35103 VACUUM FLASH PREHEATER
04D75210 VACUUM FLASH FEED ACCUMULATOR DRUM
04D75211 VACUUM FLASH DECOKING DRUM
04D75204 VACUUM FLASH DRUM
04D18704 VACUUM FLASH CONDENSER
04D75206 VACUUM FLASH CONDENSATE DRUM
04D71501 VACUUM FLASH DRUM VACUUM JET SYSTEM
04D67011 HOTWELL TANK
04D30715 JETWATER COOLER
04D30513 VACUUM FLASH AIR COOLER
04D56036 VACUUM FLASH AUXILIARY FEED PUMP
04D56301 VACUUM BOTTOMS PUMP
04D56025 VACUUM FLASH CONDENSATE PUMP
04D56039 HOTWELL TANK S.C.W. RETURN PUMP
TO ATMOS.
DEMISTER 04D75215
TO FLARE
SNUFFING STEAM, 200 PSIG
DRAIN
SLOPE LINES FOR COMPLETE DRAINAGE
NATURAL GAS
COMBUSTION SAFEGUARDS
COOLING STEAM
PURGE STEAM
COOLING BELT 08D20003
BIAS
RUPTURE DISC SHIELD FOR PERSONNEL PROTECTION
C.W. SUPPLY
C.W. RETURN
TO LEC FEED TANK
FROM FILTER FEED SURGE TANK
FROM FILTRATE RECEIVER
TO FILTER FEED SURGE TANK
TO PRILLING TOWER
FROM SOLVENT FLUSH SYSTEM
TO SOLVENT FLUSH SYSTEM
TO LIGHT ENDS COLUMN
TO LIGHT ENDS COLUMN FEED TANK
NOTE:
DENOTES JACKETED VALVE (DOWTHERM HEATED) PARKS CRAMER
252
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
FLOW DIAGRAM
AREA 04 - SOLVENT RECOVERY
VACUUM FLASHING
PAMCO Pilot Plant
SCALE NONE
Stearns-Roger
ORDER NO. 8-33250
DWG. NO. L-21793
SHEET NO. P3-11

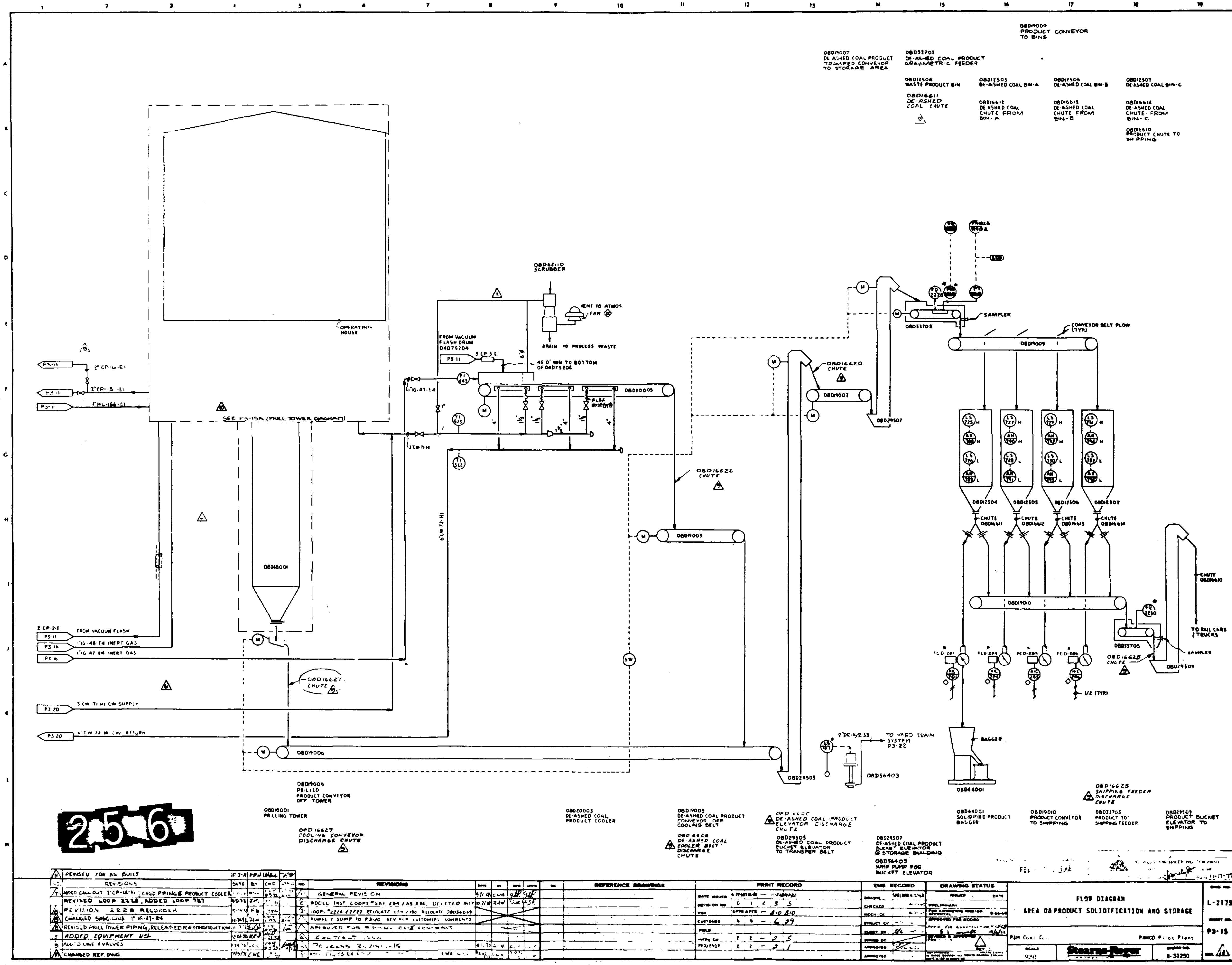


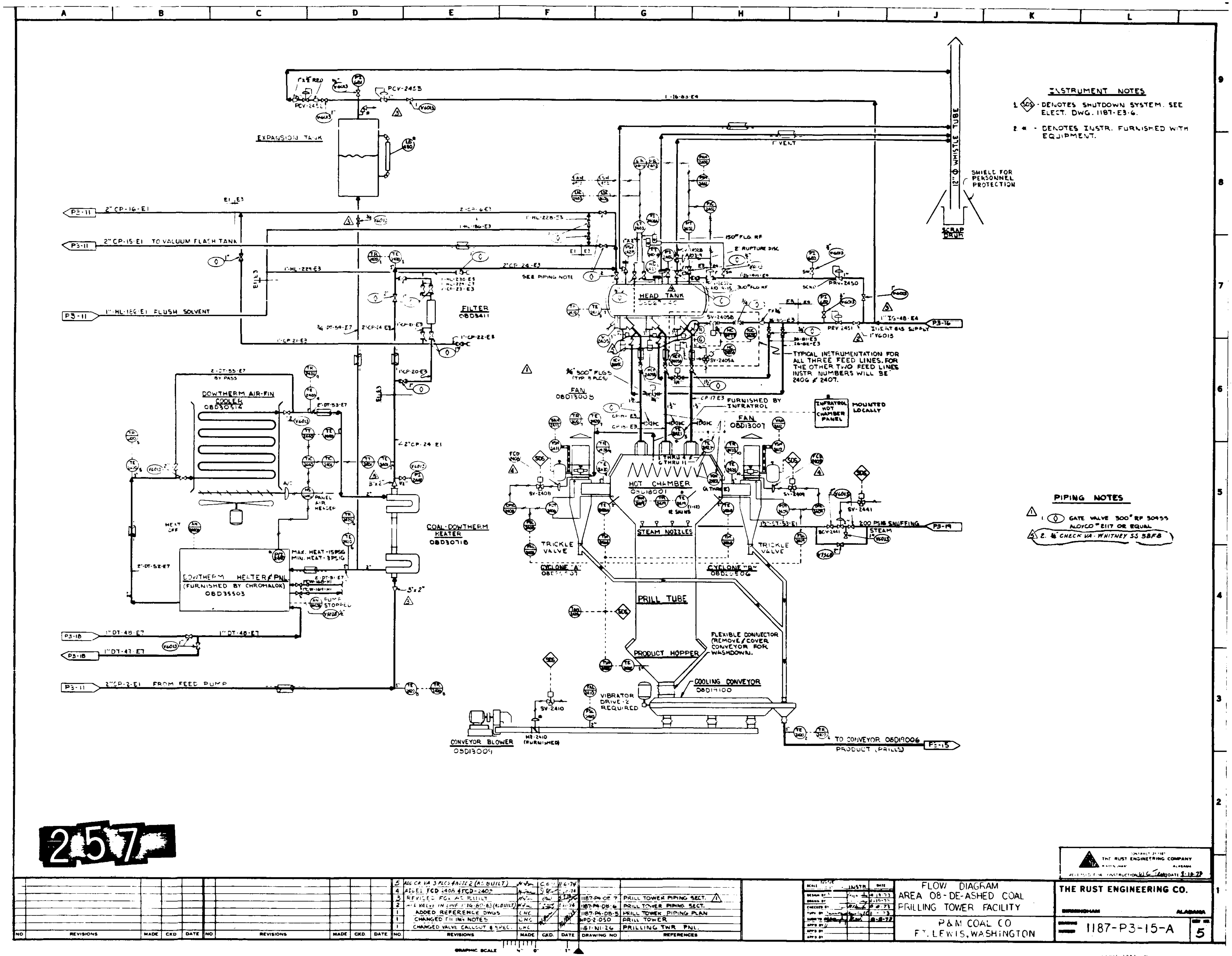
FLOW DIAGRAM
AREA 04 - SOLVENT RECOVERY
FRACTIONATION
P&M Coal Co.
PAMCO Pilot Plant
SCALE NONE
Stearns-Roger
ORDER NO. B-33250
L-21793
P3-12
253
TO WASH SOLVENT ACCUMULATOR P3-13
TO HEAVY OIL STORAGE P3-23
TO PROCESS SOLVENT COOLER P3-18
TO LIGHT OIL STORAGE P3-23
FRESH SOLVENT FROM STORAGE P3-23
FROM VACUUM FLASH ACCUMULATOR

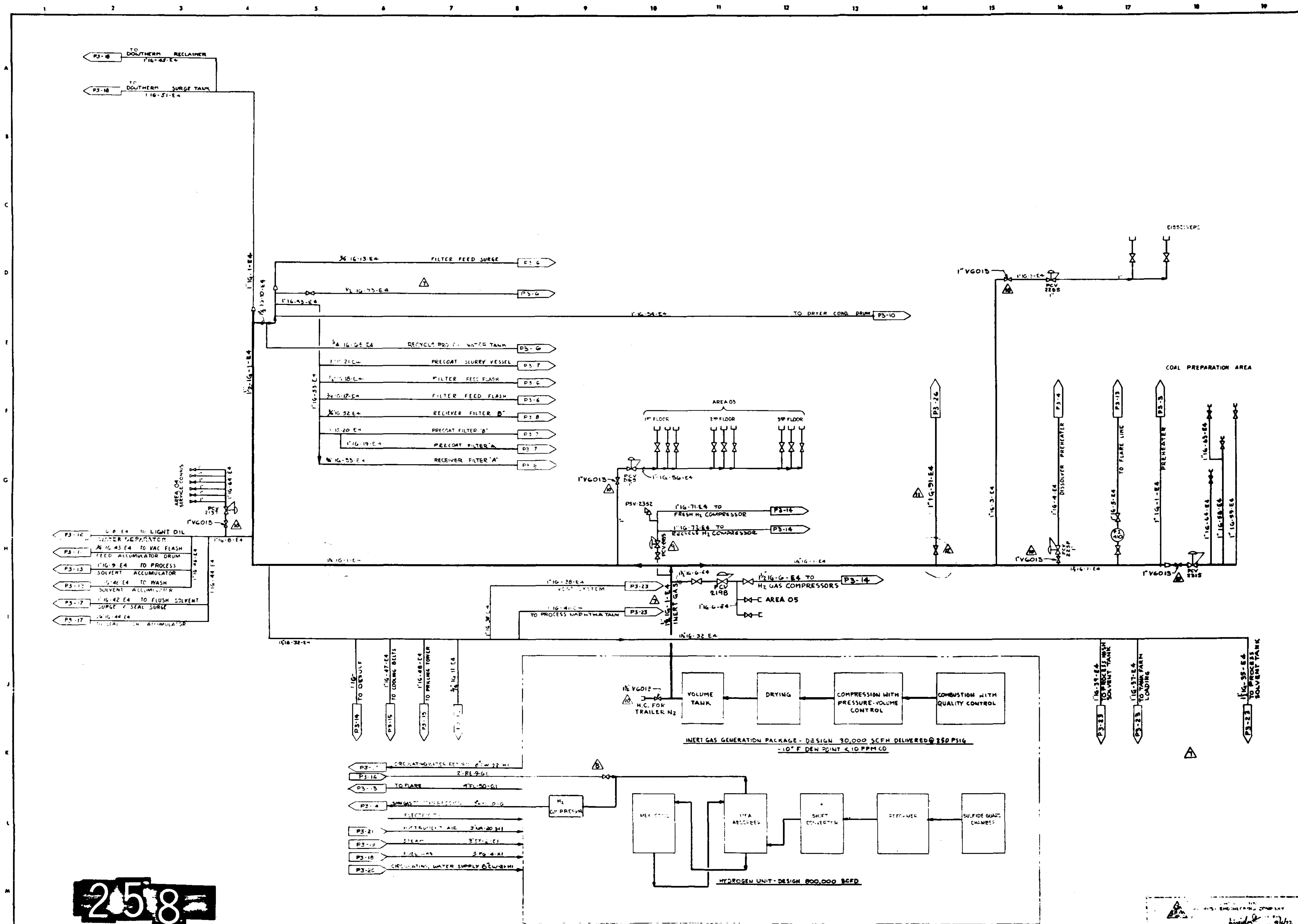


FLOW DIAGRAM
AREA 04 - SOLVENT RECOVERY
SOLVENT SURGE AND VENT DISPOSAL
P&M Coal Co.
PAMCO Pilot Plant
L-21793
P3-13
B-33250
Stearns-Roger
STRETFORD DESULFURIZER UNIT
04D46702
FLAME FRONT GENERATOR
INTEGRATED FLARE SYSTEM
* INDICATES ITEMS FURN. BY EQUIP. MFGR.
04D30510 PROCESS SOLVENT EXCHANGER
04D56030 PROCESS SOLVENT PUMP
04D67003 WASH SOLVENT ACCUMULATOR 96"I.D. X 22'0" DESIGN 25PSIG@650°F
04D56033 WASH SOLVENT PUMP
04D56068 EMERGENCY SOLVENT PUMP
04D67004 PROCESS SOLVENT ACCUMULATOR 96"I.D. X 32'0" DESIGN 25PSIG@650°F
04D75305 VENT GAS TREATING COLUMN
STRETFORD INLET SEPARATOR PUMP 04D56071
04D56040 FLARE KNOCKOUT SCAVENGER PUMP
04D75214 FLARE KNOCKOUT DRUM 96"I.D. X 16'0" 24"I.D. X 3'0" DESIGN 25PSIG@750°F
04D34601 FLARE & CONTROLS
FROM WASH SOLVENT COLUMN
H.P. SOLVENT TO PREHEATER
WASH SOLVENT TO PROCESS
SOLVENT TO PROCESS
SOLVENT TO PRECOAT
TO SURGE TANK
TO WASTE INCINERATOR
WATER TO KNOCK OUT DRUM
SULFUR OUTLET
WATER DRAIN
OIL TO DRUMS
PROCESS SOLVENT FOR SEAL / FLUSH SOLVENT
PROCESS SOLVENT TO / FROM STORAGE
WASH SOLVENT TO / FROM STORAGE
DESUPERHEATING COND FROM DEA UNIT
OIL/H2O SEPARATOR SYSTEM
TO AT-290
254


FLOW DIAGRAM
AREA 05 - GAS RECOVERY AND RECOMPRESSION
L-21793
P3-19
P&M Coal Co.
PAMCO Pilot Plant
B-33250
255
DEA DESULFURIZATION UNIT
04D46701
SKID Nº1
SKID Nº2
AT-2102 GAS CHROMATOGRAPH
LOCAL ALARM PANEL
SOUR GAS TO STRETFORD UNIT
DESUPERHEATING COND. TO STRETFORD UNIT
CW RETURN
FROM H2 PLANT
INERT GAS
RECYCLE H2 FROM CONDENSATE SEPARATOR
05D30705 HYDROGEN RECYCLE EXCHANGER
05D30704 FRESH HYDROGEN BYPASS LOOP EXCHANGER
05D18106 FRESH HYDROGEN COMPRESSOR
05D18104 HYDROGEN RECYCLE COMPRESSOR "A"
REVISED FOR AS BUILT
GENERAL REVISION
CONTRACT SET
PROCESS REVISIONS
REVISED RECORDER 2134
REVISED ALARM AH-135
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS


08D19009
PRODUCT CONVEYOR
TO BINS
08D19007
DE-ASHED COAL PRODUCT
TRANSFER CONVEYOR
TO STORAGE AREA
08D33703
DE-ASHED COAL PRODUCT
GRAVIMETRIC FEEDER
08D12504
WASTE PRODUCT BIN
08D12505
DE-ASHED COAL BIN-A
08D12506
DE-ASHED COAL BIN-B
08D12507
DE-ASHED COAL BIN-C
08D16611
DE-ASHED
COAL CHUTE
08D16612
DE-ASHED COAL
CHUTE FROM
BIN-A
08D16613
DE-ASHED COAL
CHUTE FROM
BIN-B
08D16614
DE-ASHED COAL
CHUTE FROM
BIN-C
08D16610
PRODUCT CHUTE TO
SHIPPING
08D62110
SCRUBBER
VENT TO ATMOS
FAN
DRAIN TO PROCESS WASTE
OPERATING
HOUSE
FROM VACUUM
FLASH DRUM
04D75204
45'-0" MIN TO BOTTOM
OF 04D75204
SEE P3-15A (PRILL TOWER DIAGRAM)
08D20003
SAMPLER
CONVEYOR BELT FLOW
(TYP)
08D33703
08D16620
CHUTE
08D19007
08D29507
08D16626
CHUTE
08D19005
08D18001
FROM VACUUM FLASH
1"IG-48-E4 INERT GAS
1"IG-47-E4 INERT GAS
3"CW-71-H1 CW SUPPLY
4"CW-72-H1 CW RETURN
08D16627
CHUTE
08D19006
08D29505
TO YARD DRAIN
SYSTEM
P3-22
08D56403
BAGGER
08D44001
08D19010
08D33705
SAMPLER
08D16625
CHUTE
08D29509
CHUTE
08D16610
TO RAIL CARS
/TRUCKS
08D19006
PRILLED
PRODUCT CONVEYOR
OFF TOWER
08D18001
PRILLING TOWER
08D16627
COOLING CONVEYOR
DISCHARGE CHUTE
08D20003
DE-ASHED COAL
PRODUCT COOLER
08D19005
DE-ASHED COAL PRODUCT
CONVEYOR OFF
COOLING BELT
08D16626
DE-ASHED COAL
COOLER BELT
DISCHARGE
CHUTE
08D16620
DE-ASHED COAL PRODUCT
ELEVATOR DISCHARGE
CHUTE
08D29505
DE-ASHED COAL PRODUCT
BUCKET ELEVATOR
TO TRANSFER BELT
08D29507
DE-ASHED COAL PRODUCT
BUCKET ELEVATOR
@ STORAGE BUILDING
08D56403
SUMP PUMP FOR
BUCKET ELEVATOR
08D44001
SOLIDIFIED PRODUCT
BAGGER
08D19010
PRODUCT CONVEYOR
TO SHIPPING
08D33705
PRODUCT TO
SHIPPING FEEDER
08D16625
SHIPPING FEEDER
DISCHARGE
CHUTE
08D29509
PRODUCT BUCKET
ELEVATOR TO
SHIPPING
256
REVISED FOR AS BUILT
REVISED LOOP 2228, ADDED LOOP 787
REVISION 2228 RECORDER
CHANGED SPEC. LINE 1" IG-47-E4
REVISED PRILL TOWER PIPING, RELEASED FOR CONSTRUCTION
ADDED EQUIPMENT
ADDED LINE & VALVES
CHANGED REF. DWG.
REVISIONS
GENERAL REVISION
APPROVED FOR BIDDING
REFERENCE DRAWINGS
PRINT RECORD
ENG RECORD
DRAWING STATUS
FLOW DIAGRAM
AREA 08 PRODUCT SOLIDIFICATION AND STORAGE
L-21793
P3-15
P&M Coal Co.
PAMCO Pilot Plant
Stearns-Roger
8-33250


INSTRUMENT NOTES
1. SDS - DENOTES SHUTDOWN SYSTEM. SEE ELECT. DWG. 1187-E3-6.
2. * - DENOTES INSTR. FURNISHED WITH EQUIPMENT.
PIPING NOTES
EXPANSION TANK
HEAD TANK
FILTER 08D3411
DOWTHERM AIR-FIN COOLER 08D30514
DOWTHERM HEATER & PNL (FURNISHED BY CHROMALOX) 08D35503
COAL-DOWTHERM HEATER 08D30716
HOT CHAMBER
STEAM NOZZLES
PRILL TUBE
PRODUCT HOPPER
COOLING CONVEYOR
CONVEYOR BLOWER
12" WHISTLE TUBE
SHIELD FOR PERSONNEL PROTECTION
SCRAP DRUM
TO CONVEYOR 08D19006 PRODUCT (PRILLS)
2"CP-2-E1 FROM FEED PUMP
1"HL-186-E1 FLUSH SOLVENT
2"CP-15-E1 TO VACUUM FLASH TANK
FLOW DIAGRAM
AREA 08 - DE-ASHED COAL
PRILLING TOWER FACILITY
P&M COAL CO
FT. LEWIS, WASHINGTON
THE RUST ENGINEERING CO.
1187-P3-15-A
5




258

| REV | REVISIONS |
|---|---|
| 1 | GENERAL REVISION |
| 2 | REVISED PER PHYSICAL PIPING DRAWINGS |
| 3 | CONTRACT ISSUE |
| 6 | RELOCATED INERT GAS GEN. PACKAGE, CHGD. LINE IDENT |
| 10 | ADDED VALVE IN LINE 1"IG-91-E4 |
| 11 | ADDED 1"IG-91-E4 FOR CONTRACT 21-1656 |
| 12 | ADD 1"VG013 IN 3 PLACES; ADD 1½"VG013 & H.C. FOR TRAILER (AS BUILT) |
| 13 | CHANGED PSV-2351 TO PSV-2455 |

FLOW DIAGRAM
AREA 09 - UTILITIES AND SERVICES
INERT GAS AND HYDROGEN

PAMCO Pilot Plant

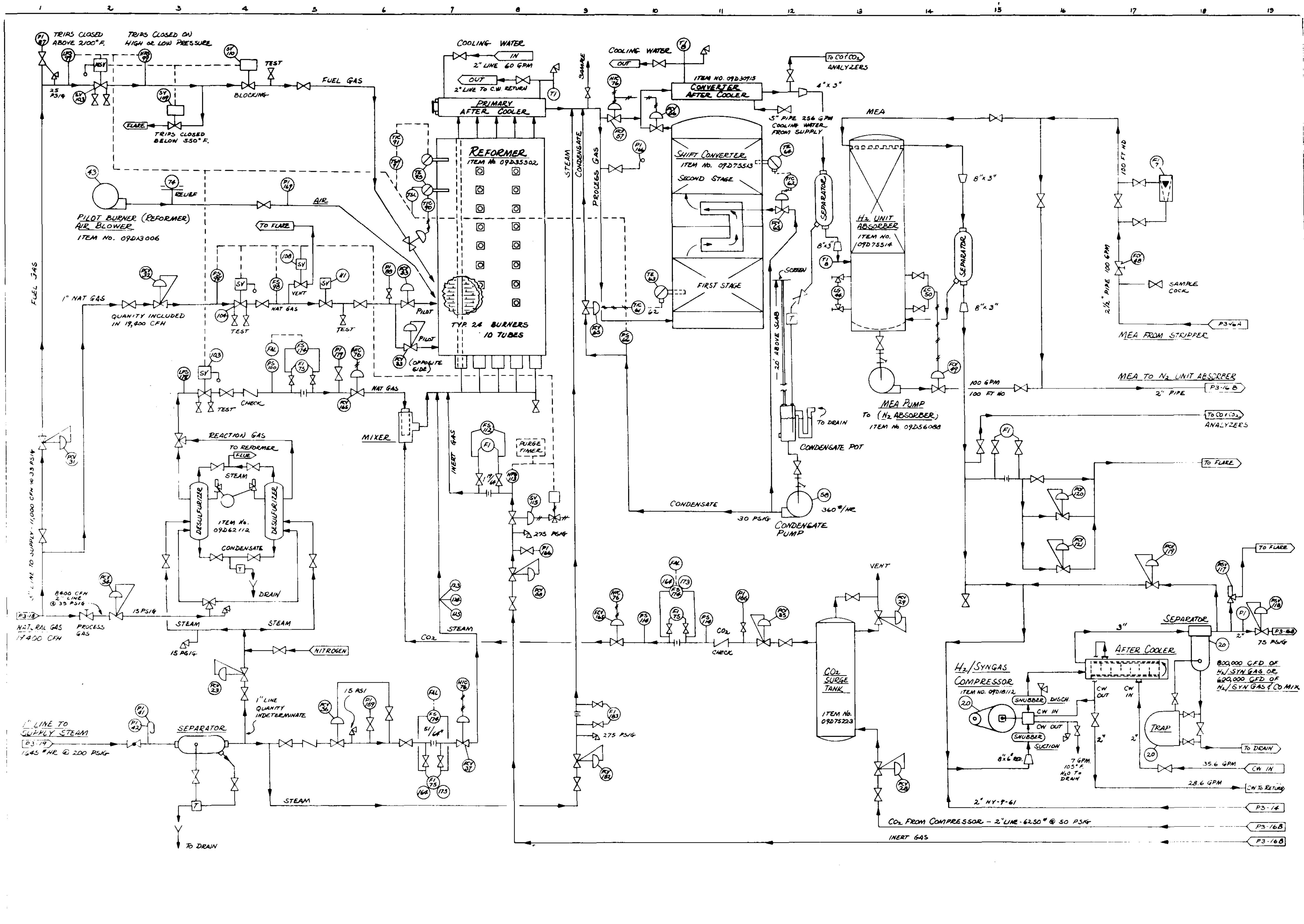
Stearns-Roger

SCALE: NONE

ORDER NO. 6-33250

DWG. NO. L-21793

SHEET NO. P3-16



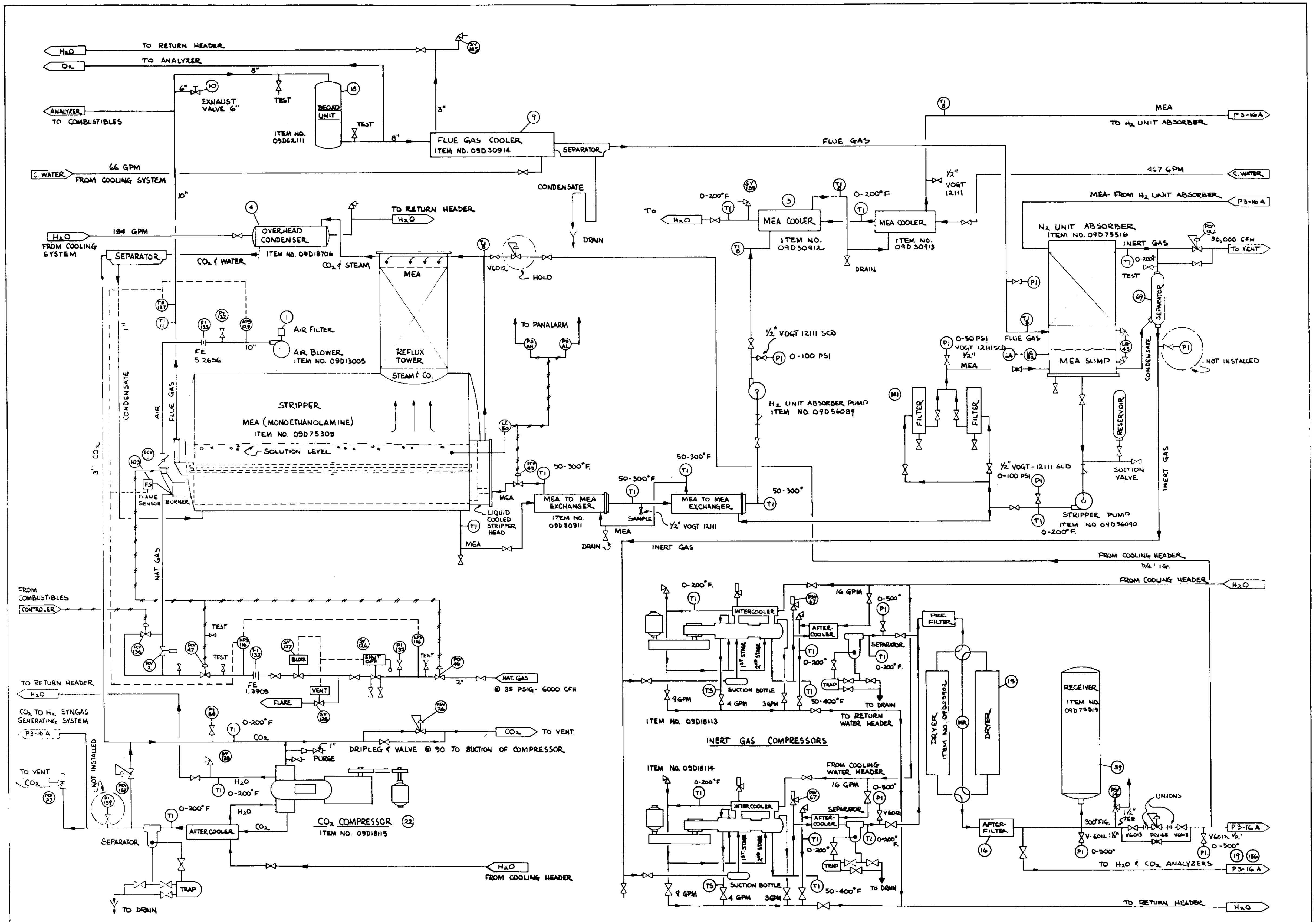

| No. | REVISIONS | DATE | BY | | No. | REFERENCE DRAWINGS | PRINT RECORD | ENG RECORD | | | DRAWING STATUS | DATE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1352363 | H2/SYN GAS PROCESS & INSTRUM. | DATE ISSUED | DRAWN | RJM | 11/21/78 | ISSUED | | |
| | | | | | | | CHECKED | CHECKED | | | PRELIMINARY | | |
| | | | | | | | REVISION No. | | | | | | |

SPECIAL PROCESS GAS GENERATING SYSTEM

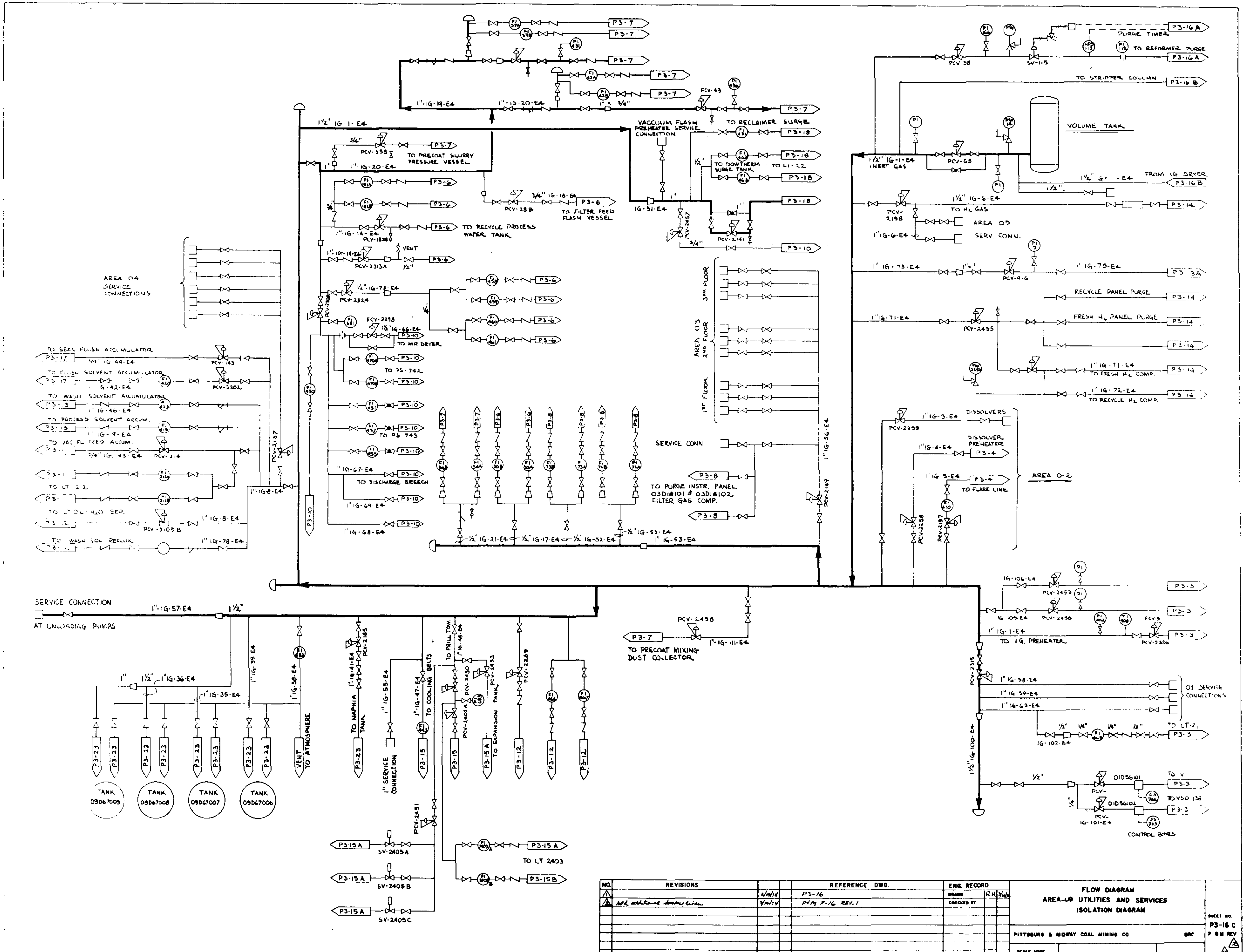
**$H_2$/ SYN GAS PROCESS & INSTRUM.**

P&M COAL CO. — SRC PILOT PLANT — P3-16-A

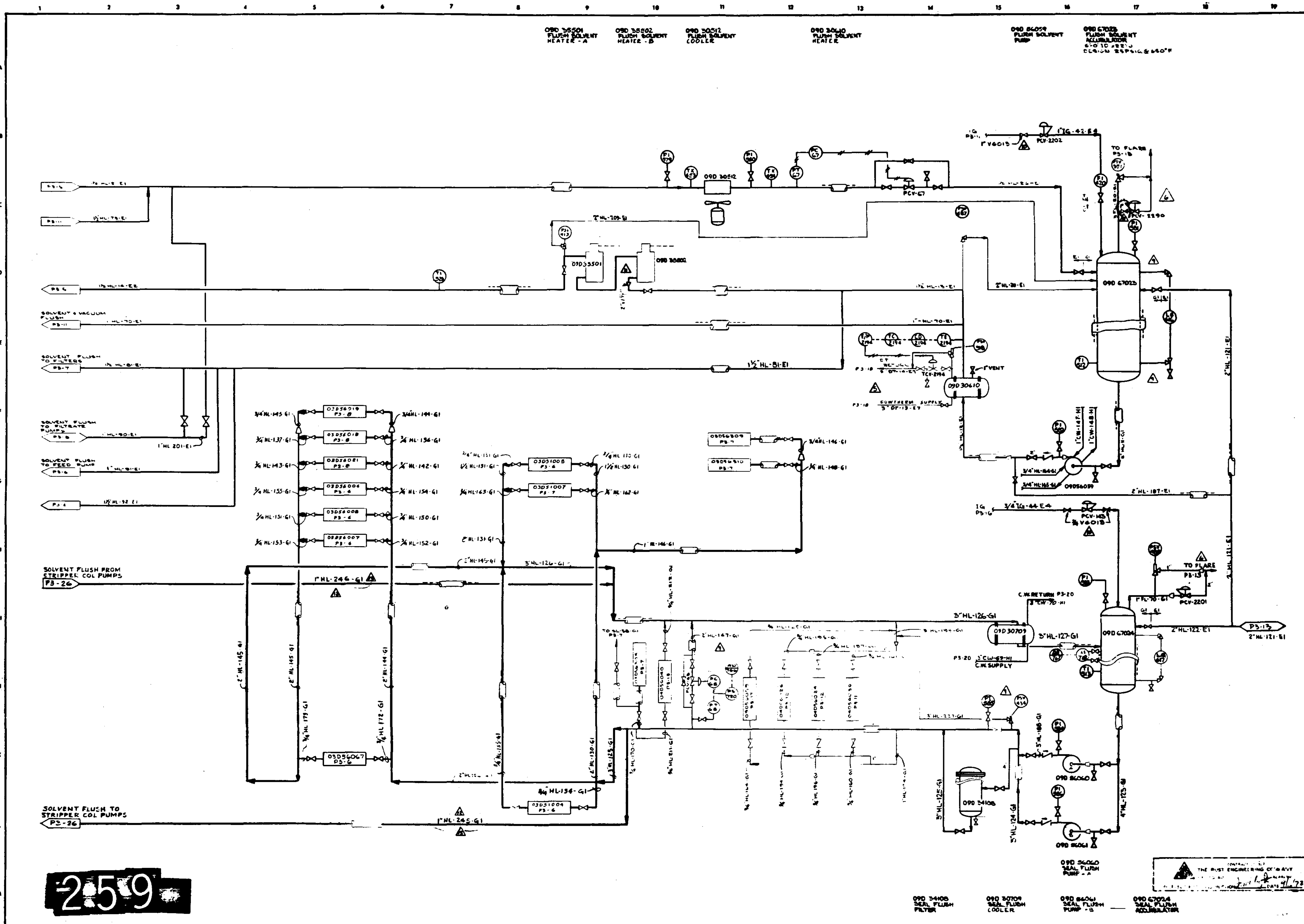
PITTSBURG AND MIDWAY COAL MINING CO
FT LEWIS, WASHINGTON




| REVISION | | REFERENCE | DWG. STATUS | | SPECIAL PROCESS GAS GENERATING SYSTEM | DWG NO. |
|---|---|---|---|---|---|---|
| △ | INERT GAS P&I DRAWING P3-16B | P3-16 | | | INERT GAS P&I DRAWING | SHEET NO. P3-16-B |
| | | | | | P&M COAL MINING CO. — SRC PILOT PLANT | P&M REV △ |
| | | | | | SCALE NONE — PITTSBURG AND MIDWAY COAL MINING CO. | |



FLOW DIAGRAM
AREA-U9 UTILITIES AND SERVICES
ISOLATION DIAGRAM
PITTSBURG & MIDWAY COAL MINING CO.
SRC
SHEET NO. P3-16 C
P & M REV 2
SCALE NONE
REVISIONS
REFERENCE DWG.
ENG. RECORD
DRAWN R.H.
CHECKED BY
1 2/18/74 P3-16
2 Add additional header lines 3/14/74 P&M P-16 REV. 1
VOLUME TANK
AREA 04 SERVICE CONNECTIONS
AREA 03
AREA 0-2
01 SERVICE CONNECTIONS
SERVICE CONNECTION AT UNLOADING PUMPS
TO PRECOAT MIXING DUST COLLECTOR
TO PURGE INSTR. PANEL 03D18101 & 03D18102 FILTER GAS COMP.
TO LT 2403
CONTROL BOXES




| NO. | REVISIONS | DATE | BY | CHD | APPD |
|---|---|---|---|---|---|
| 7 | RELOCATED DISCHARGE FROM RELIEF PSV-413 & PSV-467, ADDED 09D56067, | 9-5-75 | | | |
| 8 | HL-144 & 145 WERE ... CW-69 & 70 WERE ... | | | | |
| 9 | ADD VALVES | | JC | | |
| 10 | CHGD LINE NO. FROM HL-146-G1; DELETED VALVES; RELOCATED PSV-434 & ADD LINE NO | | | | |
| 11 | ADD VALVE EA SIDE OF PCV-143; ADD VA. IN LINE 1"IG-42-E4 (AS BUILT) | | | | |
| 11 | REVISED FOR AS BUILT | 5-7-76 | | | |
| 12 | ADDED LINES 1"HL-245 & 1"HL-246 (FOR CONTRACT 21-1636) | | JC | | |
| 13 | CORRECTED SPEC ON LINES 1"HL-245-G1 & 1"HL-246-G1 | | | | |

| NO. | REVISIONS |
|---|---|
| 1 | GENERAL REVISION |
| 2 | [illegible] |
| 3 | [illegible] |
| | APPROVED FOR BIDDING G.C. & CONTRACT |
| 3 | CONTRACT ISSUE |
| 4 | PROCESS REVISIONS |
| 5 | REVISED DOWTHERM SPEC. |
| 6 | ADDED PSV-991 & PCV-2290 (LINE TO FLARE ...) |

FLOW DIAGRAM
AREA 09 - UTILITIES AND SERVICES
SEAL FLUSH AND SOLVENT FLUSH SYSTEMS

P&M Coal Co. PAMCO Pilot Plant

SCALE: NONE

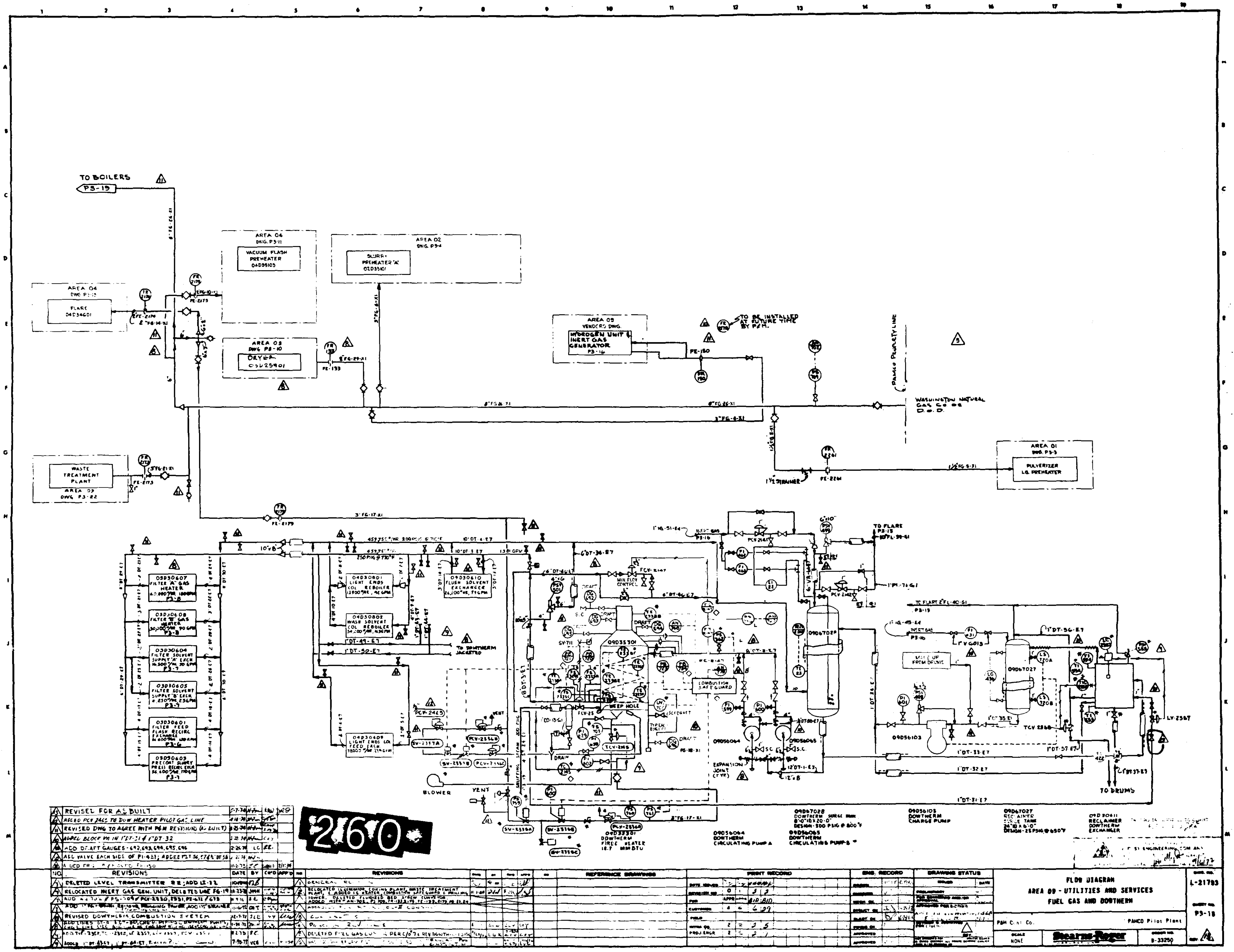
Stearns-Roger

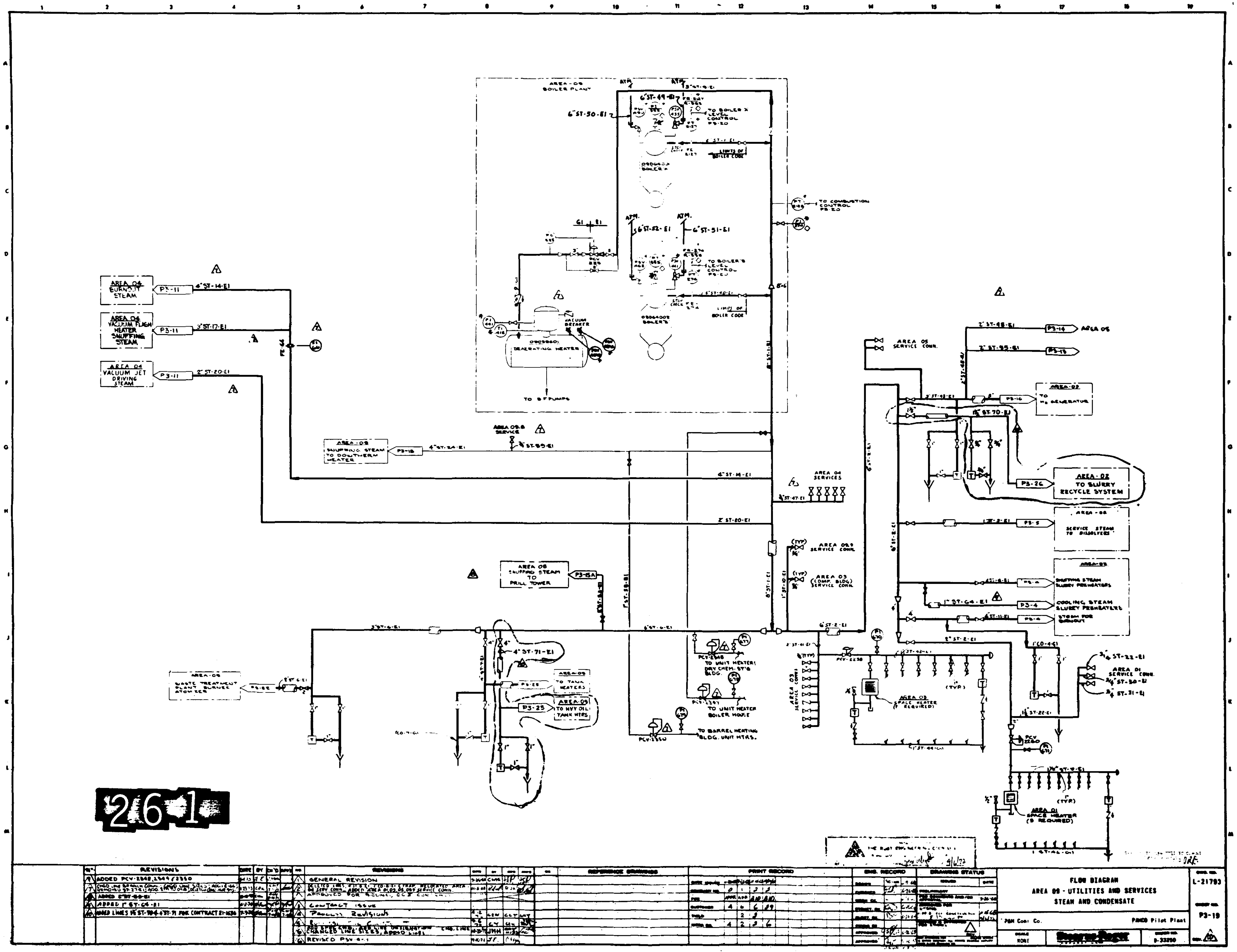
ORDER NO. B-33250

DWG. NO. L-21783

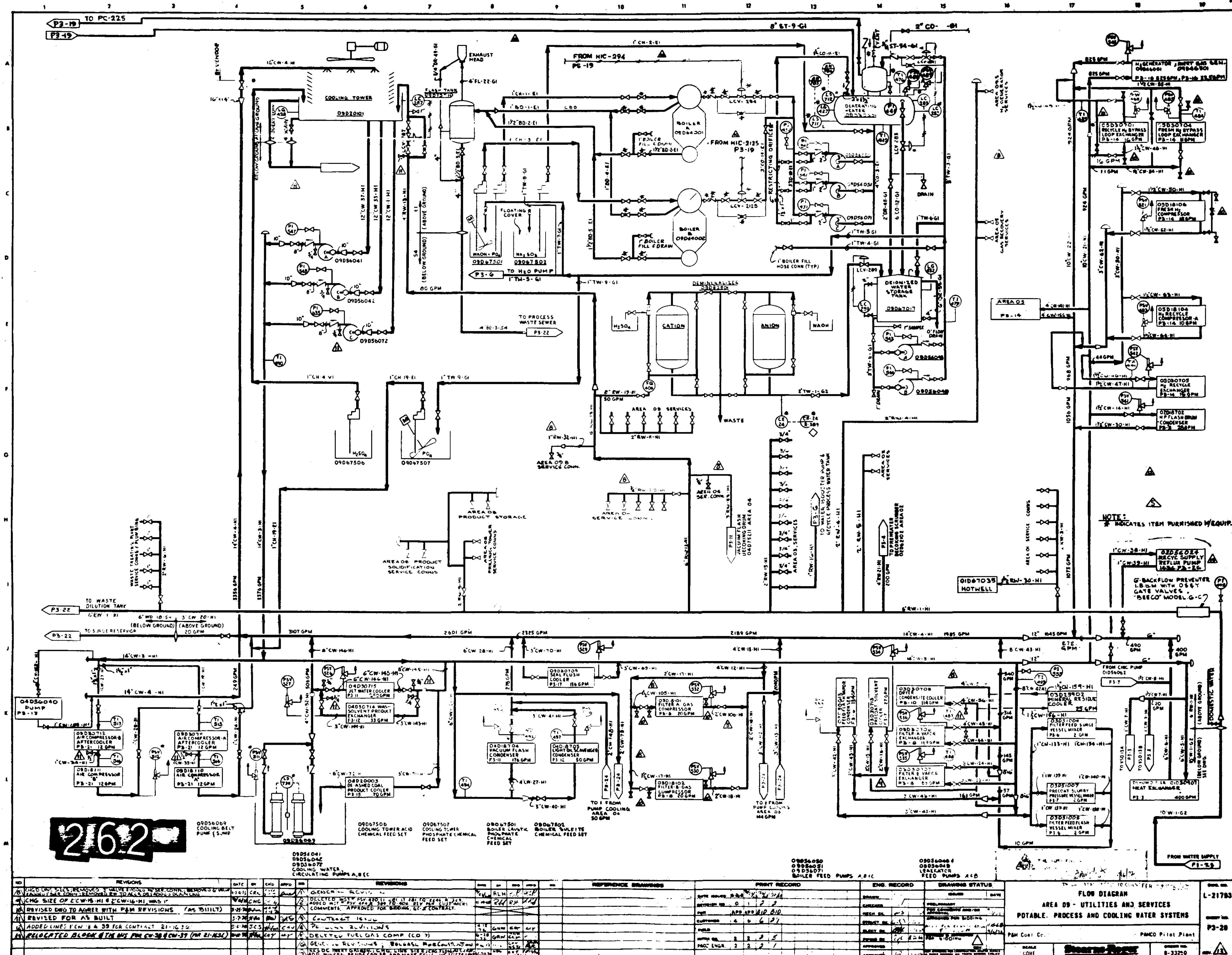
SHEET NO. P3-17

REV. 13

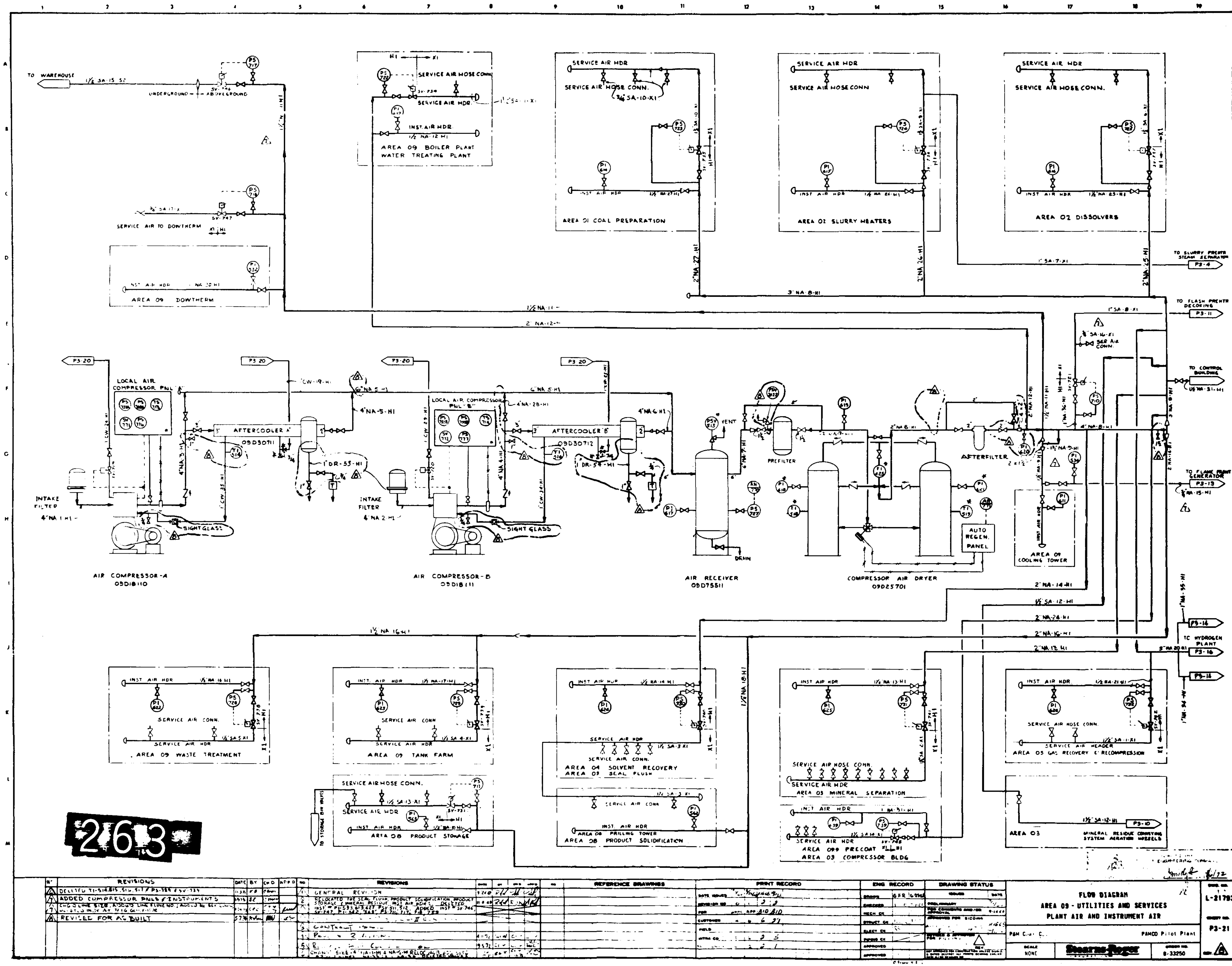

TO BOILERS
P3-19
AREA 04
FLARE
04D34601
AREA 04
VACUUM FLASH PREHEATER
AREA 02
SLURRY PREHEATER "A"
AREA 03
DRYER
AREA 09
VENDORS DWG.
HYDROGEN UNIT & INERT GAS GENERATOR
TO BE INSTALLED AT FUTURE TIME BY P&M.
WASHINGTON NATURAL GAS CO. OR D.O.D.
AREA 01
PULVERIZER LQ. PREHEATER
WASTE TREATMENT PLANT
AREA 07
TO FLARE
TO DOWTHERM JACKETED
COMBUSTION SAFEGUARD
WEEP HOLE
BLOWER
VENT
DRAIN
EXPANSION JOINT
TO DRUMS
09056064
DOWTHERM CIRCULATING PUMP A
09035301
DOWTHERM FIRED HEATER
09067028
DOWTHERM SURGE DRUM
09056065
DOWTHERM CIRCULATING PUMP B
09056103
DOWTHERM CHARGE PUMP
09067027
RECLAIMER SURGE TANK
DESIGN-25PSIG@650°F
09D30611
RECLAIMER DOWTHERM EXCHANGER
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
DRAWING STATUS
FLOW DIAGRAM
AREA 09 - UTILITIES AND SERVICES
FUEL GAS AND DOWTHERM
L-21783
P3-18
P&M Coal Co.
PAMCO Pilot Plant
NONE
Stearns-Roger
8-33250



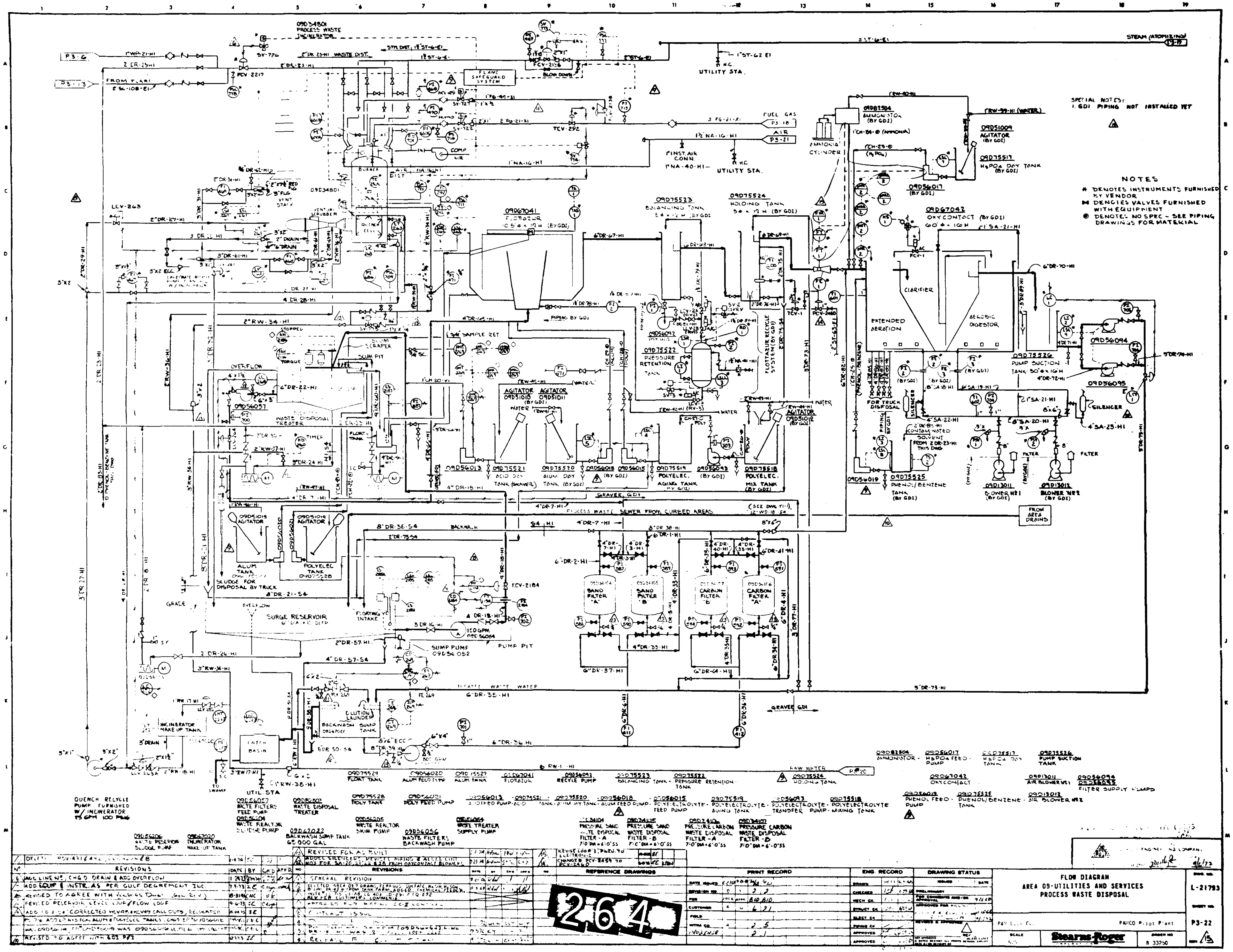
AREA 09 BOILER PLANT
6" ST-50-E1
6" ST-49-E1
TO BOILER X LEVEL CONTROL P3-20
TO COMBUSTION CONTROL P3-20
6" ST-52-E1
6" ST-51-E1
TO BOILER'S LEVEL CONTROL
DEAERATING HEATER
VACUUM BREAKER
TO B.F. PUMPS
AREA 04 BURNOUT STEAM
AREA 04 VACUUM FLASH HEATER SNUFFING STEAM
AREA 04 VACUUM JET DRIVING STEAM
P3-11
4" ST-14-E1
3" ST-17-E1
2" ST-20-E1
AREA 09 SNUFFING STEAM TO DOWTHERM HEATER
P3-18
4" ST-24-E1
4" ST-14-E1
2" ST-20-E1
AREA 04 SERVICES
AREA 05 SERVICE CONN.
2" ST-48-E1
2" ST-55-E1
P3-14
P3-15
AREA 05
AREA 02 TO H2 GENERATOR
P3-16
1 1/2" ST-70-E1
AREA 02 TO SLURRY RECYCLE SYSTEM
P3-26
AREA 08 SERVICE STEAM TO DISSOLVERS
P3-5
AREA 03
SNUFFING STEAM SLURRY PREHEATERS
1" ST-64-E1
COOLING STEAM SLURRY PREHEATERS
STEAM FOR BURNOUT
P3-4
AREA 09 SERVICE CONN.
AREA 03 (COMP. BLDG) SERVICE CONN.
AREA 06 SNUFFING STEAM TO PRILL TOWER
P3-15A
4" ST-71-E1
AREA 09 TO TANK HEATERS
P3-25
AREA 05 TO HVY OIL TANK HTRS.
AREA 09 WASTE TREATMENT PLANT BURNER ATOMIZER
PCV-2348
TO UNIT HEATERS DRY CHEM. ST'G BLDG.
PCV-2349
TO UNIT HEATER BOILER HOUSE
PCV-2350
TO BARREL HEATING BLDG. UNIT HTRS.
PCV-2230
AREA 03 SPACE HEATER REQUIRED
AREA 03 SERVICE CONN.
AREA 01 SERVICE CONN.
3/4" ST-22-E1
3/4" ST-30-E1
3/4" ST-31-E1
AREA 01 SPACE HEATER (9 REQUIRED)
(TYP)
REVISIONS
ADDED PCV-2348, 2349 / 2350
ADDED 1" ST-64-E1
ADDED LINES 1 1/2" ST-70-E1 & 4" ST-71
GENERAL REVISION
APPROVED FOR BIDDING
CONTRACT ISSUE
PROCESS REVISION
CHANGED LINE SIZES, ADDED LINES
REVISED PSV-4-1
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
FLOW DIAGRAM
AREA 09 - UTILITIES AND SERVICES
STEAM AND CONDENSATE
P&M Coal Co.
PAMCO Pilot Plant
SCALE NONE
L-21793
P3-19
261



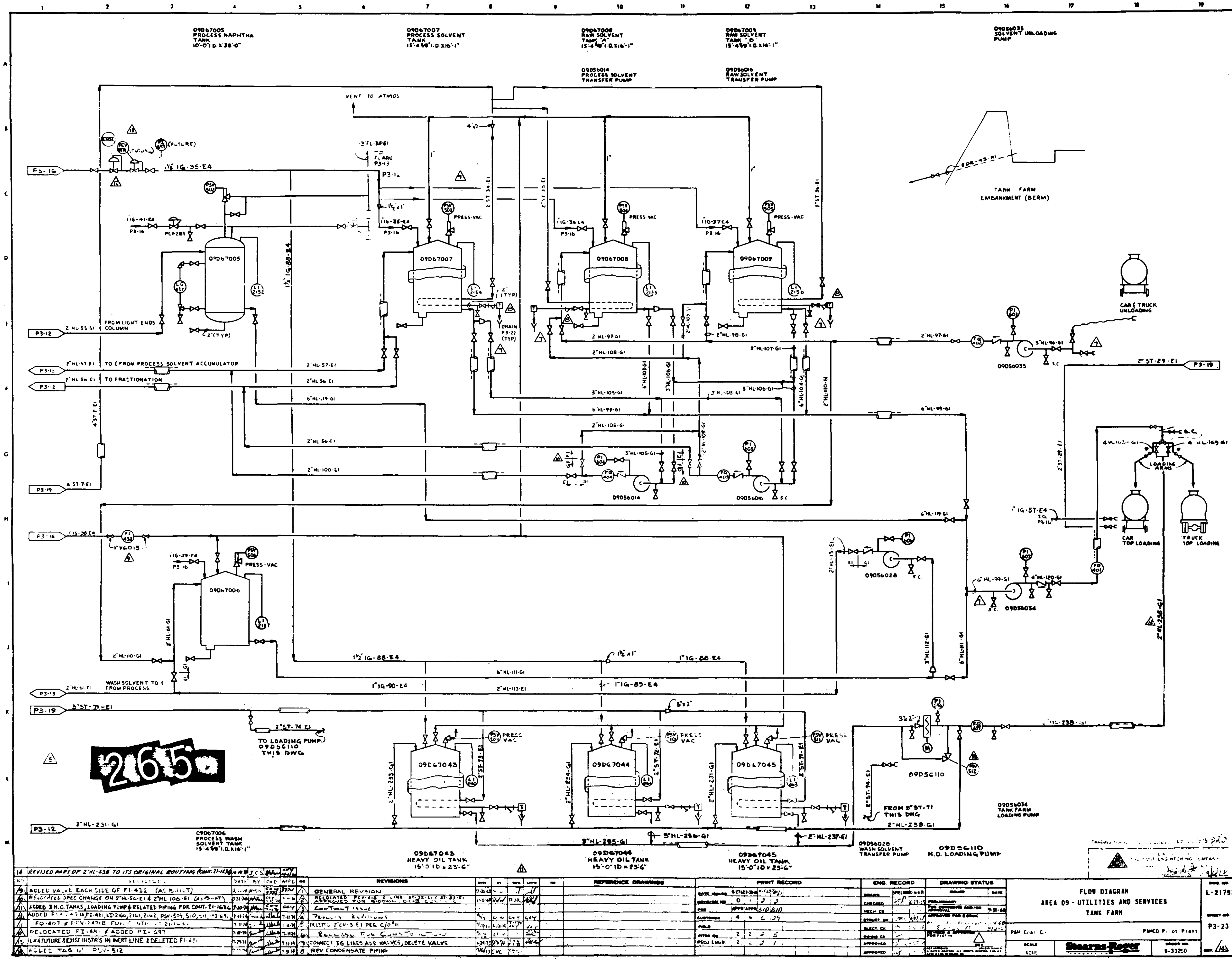
FLOW DIAGRAM
AREA 09 - UTILITIES AND SERVICES
POTABLE, PROCESS AND COOLING WATER SYSTEMS
P&M Coal Co.
PAMCO Pilot Plant
L-21793
P3-20
SCALE NONE
6-33250
262

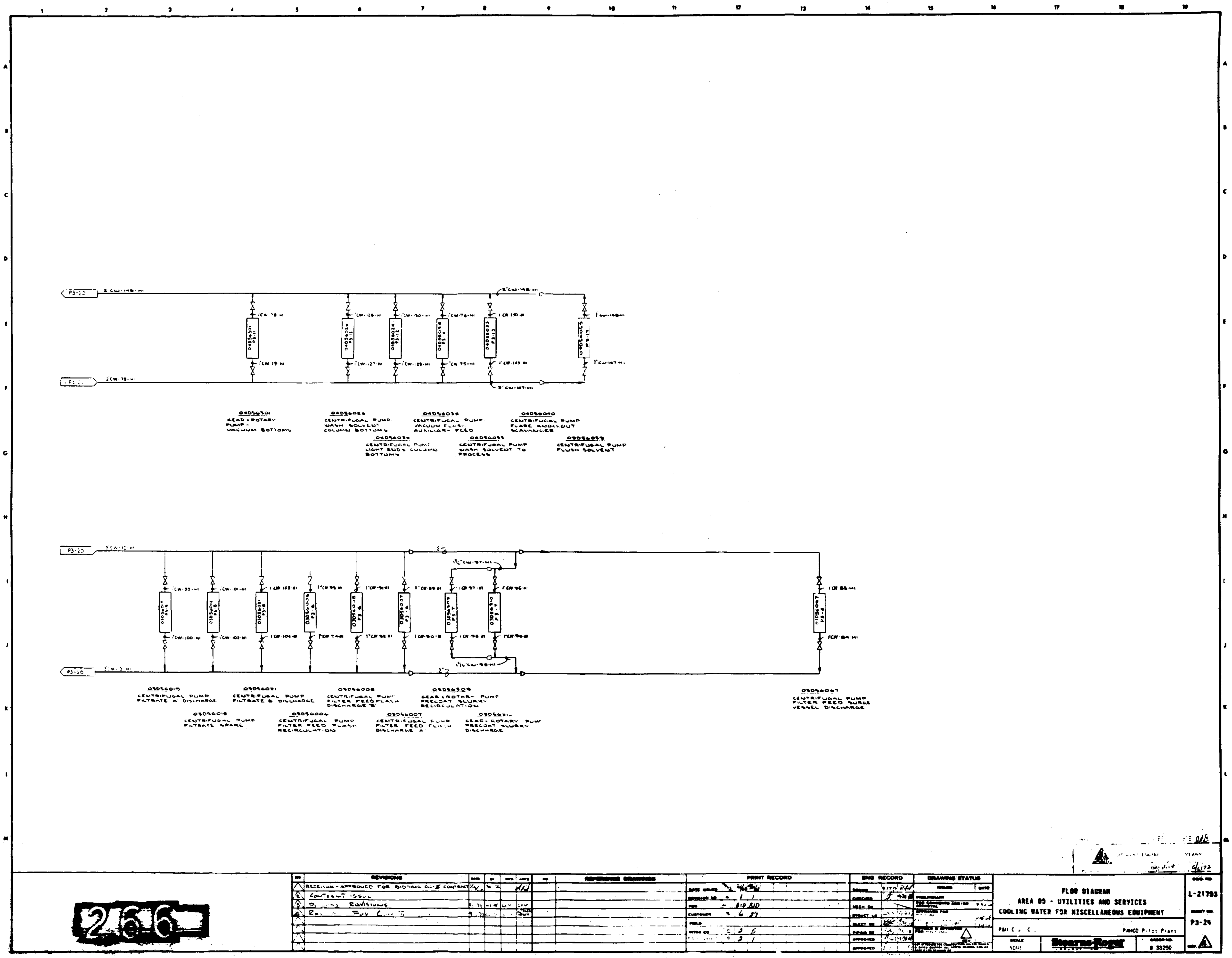


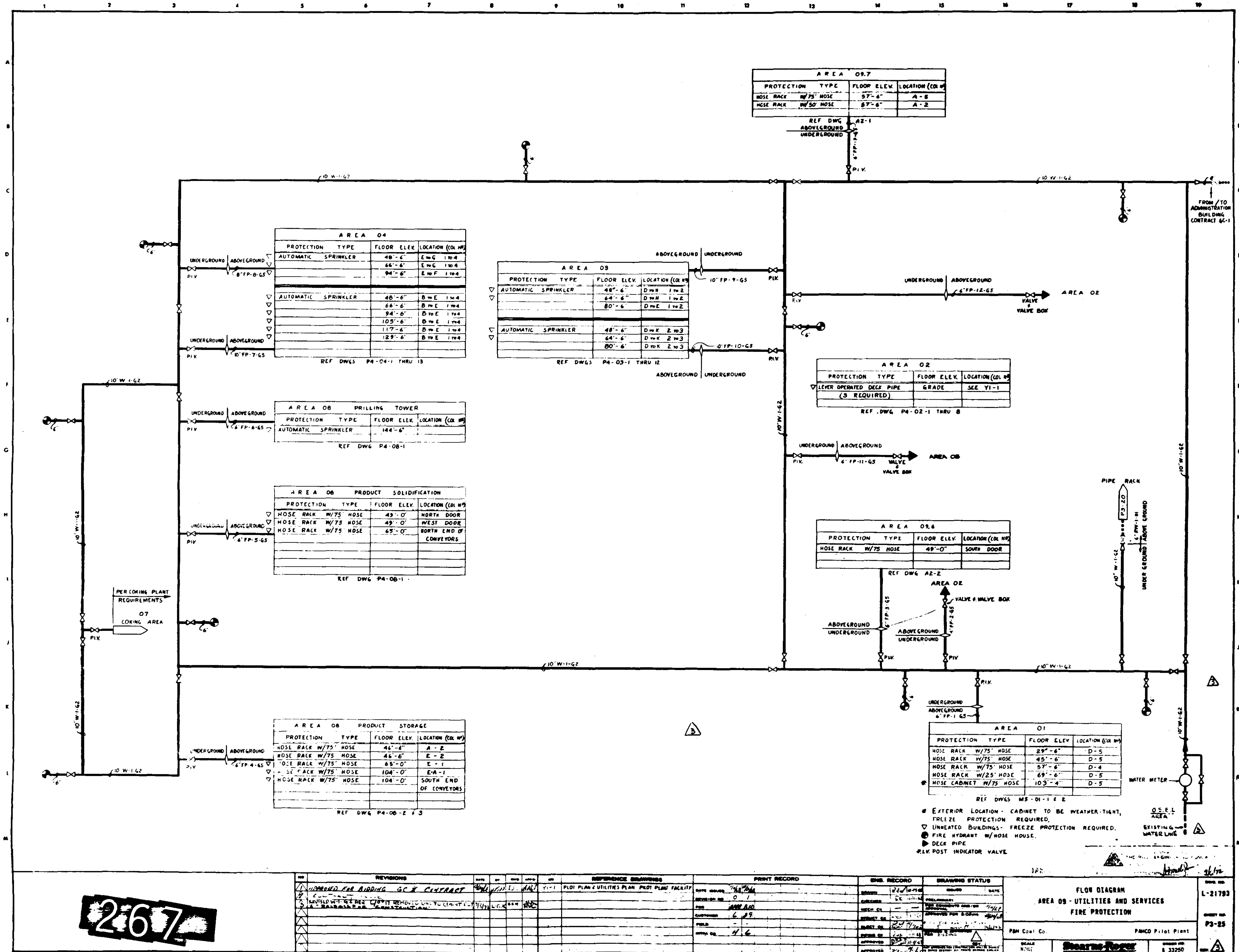
AIR COMPRESSOR-A 09D18110
AIR COMPRESSOR-B 09D18111
AIR RECEIVER 09D75511
COMPRESSOR AIR DRYER 09D25701
AFTERCOOLER "A"
AFTERCOOLER "B"
AFTERFILTER
PREFILTER
LOCAL AIR COMPRESSOR PNL
INTAKE FILTER
SIGHT GLASS
AUTO REGEN. PANEL
AREA 09 BOILER PLANT WATER TREATING PLANT
AREA 01 COAL PREPARATION
AREA 02 SLURRY HEATERS
AREA 02 DISSOLVERS
AREA 09 DOWTHERM
AREA 09 COOLING TOWER
AREA 09 WASTE TREATMENT
AREA 09 TANK FARM
AREA 04 SOLVENT RECOVERY
AREA 03 SEAL FLUSH
AREA 03 MINERAL SEPARATION
AREA 05 GAS RECOVERY & RECOMPRESSION
AREA 08 PRODUCT STORAGE
AREA 08 PRILLING TOWER
AREA 08 PRODUCT SOLIDIFICATION
AREA 09 PRECOAT
AREA 03 COMPRESSOR BLDG
AREA 03 MINERAL RESIDUE CONVEYING SYSTEM AERATION NOZZELS
TO WAREHOUSE
SERVICE AIR TO DOWTHERM
TO SLURRY PREHTR STEAM SEPARATOR
TO FLASH PREHTR DECOKING
TO CONTROL BUILDING
TO FLARE PILOT GENERATOR
TO HYDROGEN PLANT
FLOW DIAGRAM
AREA 09 - UTILITIES AND SERVICES
PLANT AIR AND INSTRUMENT AIR
P&M Coal Co.
PAMCO Pilot Plant
SCALE NONE
Stearns-Roger
B-33250
L-21793
P3-21

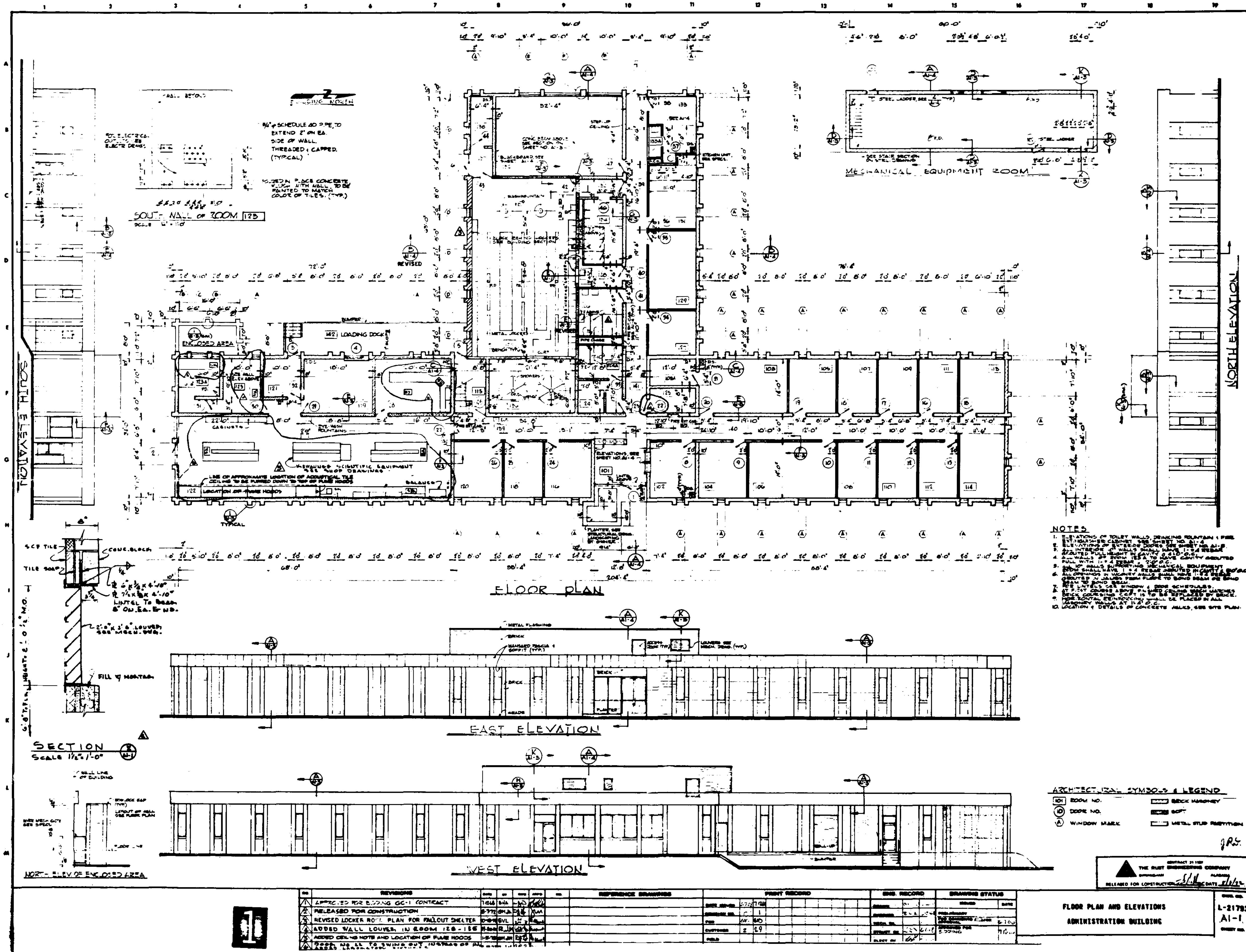


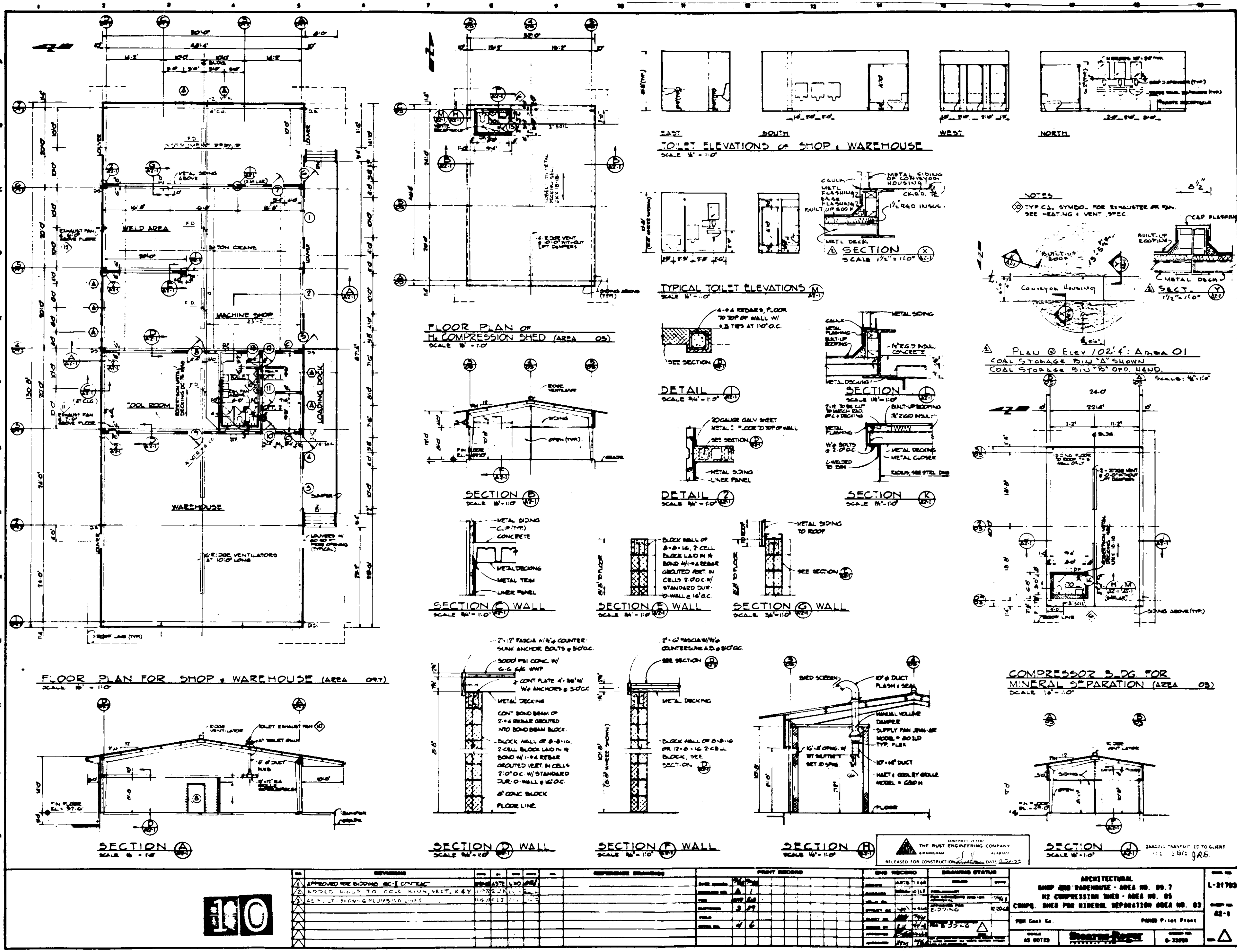
FLOW DIAGRAM
AREA 09-UTILITIES AND SERVICES
PROCESS WASTE DISPOSAL
L-21793
P3-22
Stearns-Roger
PAMCO Pilot Plant
NOTES
* DENOTES INSTRUMENTS FURNISHED BY VENDOR
DENOTES VALVES FURNISHED WITH EQUIPMENT
DENOTES NO SPEC - SEE PIPING DRAWINGS FOR MATERIAL
SPECIAL NOTES:
1. GDI PIPING NOT INSTALLED YET
09D34801 PROCESS WASTE INCINERATOR
FLOTAZUR
BALANCING TANK
HOLDING TANK
EXTENDED AERATION
CLARIFIER
AEROBIC DIGESTOR
SURGE RESERVOIR
SAND FILTER "A"
SAND FILTER "B"
CARBON FILTER "B"
CARBON FILTER "A"
ALUM TANK
POLYELEC. TANK
WASTE DISPOSAL TREATER
BACKWASH SUMP TANK
ELUTION LAUNDER
CATCH BASIN
INCINERATOR MAKE UP TANK
PUMP PIT
SUMP PUMP 09D54052
AMMONIA CYLINDER
STEAM (ATOMIZING)
FUEL GAS
AIR
UTILITY STA.
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
264


09D67005 PROCESS NAPHTHA TANK 10'-0" I.D. x 38'-0"
09D67007 PROCESS SOLVENT TANK
09D67008 RAW SOLVENT TANK "A"
09D67009 RAW SOLVENT TANK "B"
09D56035 SOLVENT UNLOADING PUMP
09D56014 PROCESS SOLVENT TRANSFER PUMP
09D56016 RAW SOLVENT TRANSFER PUMP
VENT TO ATMOS
TANK FARM EMBANKMENT (BERM)
CAR & TRUCK UNLOADING
FROM LIGHT ENDS COLUMN
TO & FROM PROCESS SOLVENT ACCUMULATOR
TO FRACTIONATION
LOADING ARMS
CAR TOP LOADING
TRUCK TOP LOADING
WASH SOLVENT TO & FROM PROCESS
TO LOADING PUMP 09D56110 THIS DWG
FROM 3" ST-71 THIS DWG
09D67006 PROCESS WASH SOLVENT TANK
09D67043 HEAVY OIL TANK 15'-0" I.D x 23'-6"
09D67044 HEAVY OIL TANK 15'-0" I.D x 23'-6"
09D67045 HEAVY OIL TANK 15'-0" I.D x 23'-6"
09D56028 WASH SOLVENT TRANSFER PUMP
09D56110 H.O. LOADING PUMP
09D56034 TANK FARM LOADING PUMP
265
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
FLOW DIAGRAM
AREA 09 - UTILITIES AND SERVICES
TANK FARM
P&M Coal Co.
PAMCO Pilot Plant
Stearns-Roger
L-21793
P3-23
B-33250

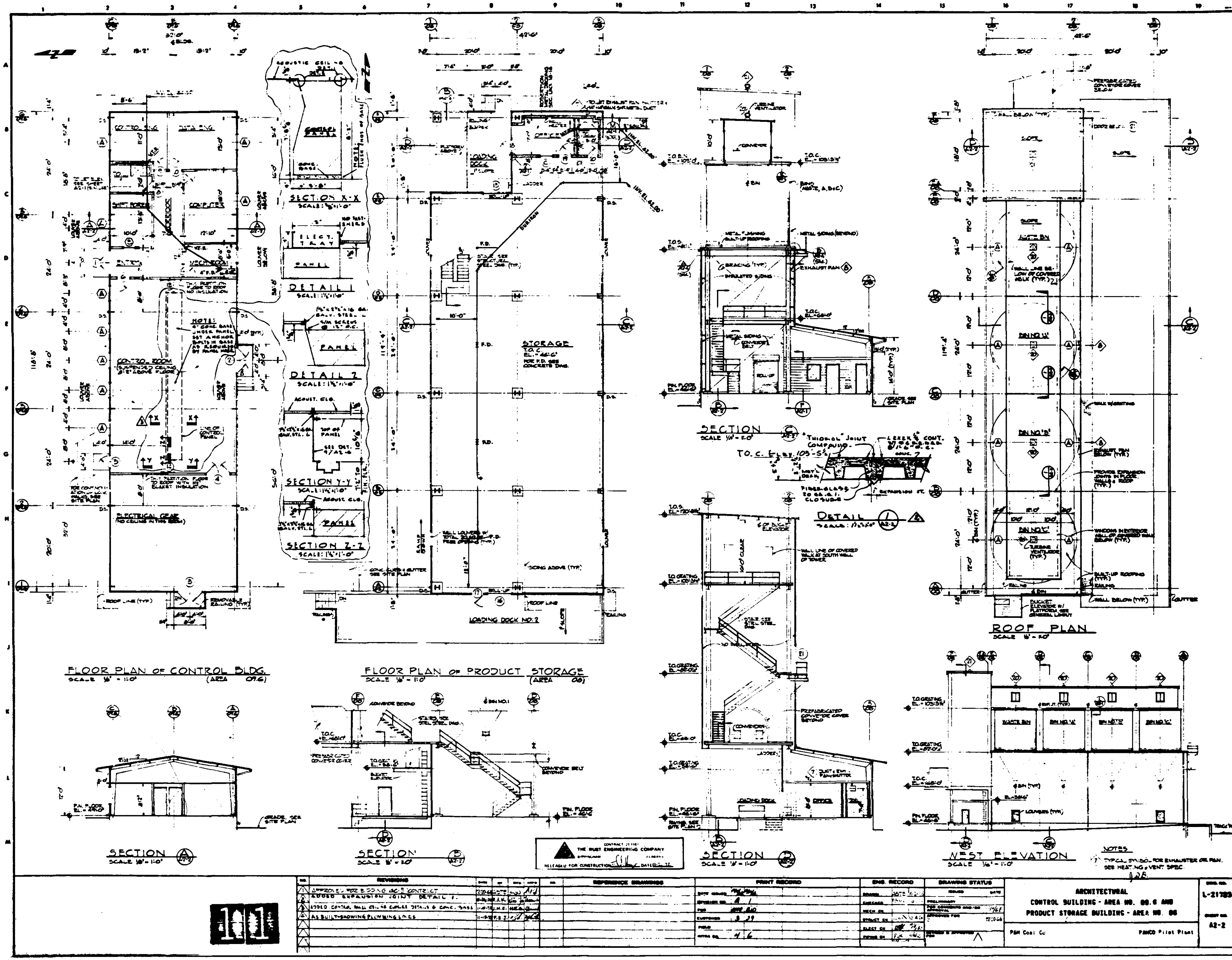

FLOW DIAGRAM
AREA 09 - UTILITIES AND SERVICES
COOLING WATER FOR MISCELLANEOUS EQUIPMENT
L-21793
P3-24
PAMCO Pilot Plant
NONE
Stearns-Roger
8 33250
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
266

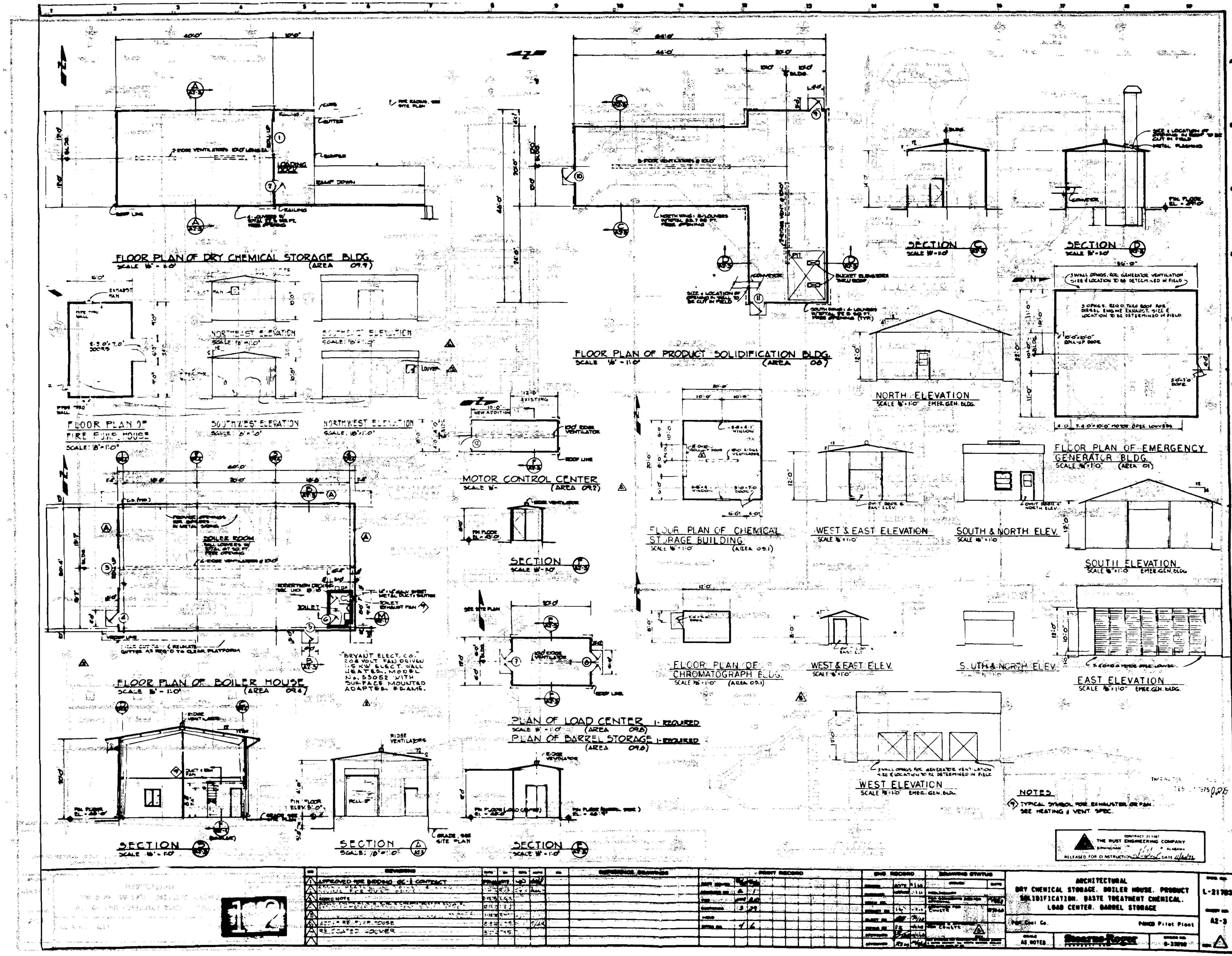

AREA 09.7
PROTECTION TYPE | FLOOR ELEV. | LOCATION (COL #)
HOSE RACK W/75' HOSE | 57'-6" | A-5
HOSE RACK W/50' HOSE | 67'-6" | A-2
REF DWG A2-1
ABOVEGROUND
UNDERGROUND
P.I.V.
10" W-1-G2
FROM/TO ADMINISTRATION BUILDING CONTRACT GC-1
AREA 04
PROTECTION TYPE | FLOOR ELEV. | LOCATION (COL #)
AUTOMATIC SPRINKLER | 48'-6" | E to G 1 to 4
66'-6" | E to G 1 to 4
94'-6" | E to F 1 to 4
AUTOMATIC SPRINKLER | 48'-6" | B to E 1 to 4
66'-6" | B to E 1 to 4
94'-6" | B to E 1 to 4
105'-6" | B to E 1 to 4
117'-6" | B to E 1 to 4
129'-6" | B to E 1 to 4
REF DWGS P4-04-1 THRU 13
8" FP-8-G5
10" FP-7-G5
AREA 03
PROTECTION TYPE | FLOOR ELEV. | LOCATION (COL #)
AUTOMATIC SPRINKLER | 48'-6" | D to H 1 to 2
64'-6" | D to H 1 to 2
80'-6" | D to E 1 to 2
AUTOMATIC SPRINKLER | 48'-6" | D to K 2 to 3
64'-6" | D to K 2 to 3
80'-6" | D to K 2 to 3
REF DWGS P4-03-1 THRU 12
10" FP-9-G5
10" FP-10-G5
UNDERGROUND ABOVEGROUND
6" FP-12-G5
VALVE & VALVE BOX
AREA 02
AREA 02
PROTECTION TYPE | FLOOR ELEV. | LOCATION (COL #)
LEVER OPERATED DECK PIPE (3 REQUIRED) | GRADE | SEE Y1-1
REF. DWG P4-02-1 THRU 8
AREA 08 PRILLING TOWER
PROTECTION TYPE | FLOOR ELEV. | LOCATION (COL #)
AUTOMATIC SPRINKLER | 144'-6"
REF DWG P4-08-1
6" FP-6-G5
6" FP-11-G5
AREA 08
AREA 08 PRODUCT SOLIDIFICATION
PROTECTION TYPE | FLOOR ELEV. | LOCATION (COL #)
HOSE RACK W/75' HOSE | 49'-0" | NORTH DOOR
HOSE RACK W/75' HOSE | 49'-0" | WEST DOOR
HOSE RACK W/75' HOSE | 65'-0" | NORTH END OF CONVEYORS
REF DWG P4-08-1
6" FP-5-G5
AREA 09.6
PROTECTION TYPE | FLOOR ELEV. | LOCATION (COL #)
HOSE RACK W/75' HOSE | 49'-0" | SOUTH DOOR
REF DWG A2-2
AREA 02
VALVE & VALVE BOX
6" FP-3-G5
6" FP-2-G5
PIPE RACK
P3-20
6" FW-1-H
UNDER GROUND ABOVE GROUND
PER COKING PLANT REQUIREMENTS
07 COKING AREA
10" W-1-G2
AREA 08 PRODUCT STORAGE
PROTECTION TYPE | FLOOR ELEV. | LOCATION (COL #)
HOSE RACK W/75' HOSE | 46'-6" | A-2
HOSE RACK W/75' HOSE | 46'-6" | E-2
HOSE RACK W/75' HOSE | 65'-0" | E-1
HOSE RACK W/75' HOSE | 104'-0" | E-A-1
HOSE RACK W/75' HOSE | 104'-0" | SOUTH END OF CONVEYORS
REF DWG P4-08-2 & 3
6" FP-4-G5
6" FP-1-G5
AREA 01
PROTECTION TYPE | FLOOR ELEV. | LOCATION (COL #)
HOSE RACK W/75' HOSE | 29'-6" | D-5
HOSE RACK W/75' HOSE | 45'-6" | D-5
HOSE RACK W/75' HOSE | 57'-6" | D-4
HOSE RACK W/25' HOSE | 69'-6" | D-5
# HOSE CABINET W/75' HOSE | 103'-4" | D-5
REF DWGS M5-01-1 & 2
WATER METER
O.S.B.L. AREA
EXISTING WATER LINE
# EXTERIOR LOCATION - CABINET TO BE WEATHER-TIGHT, FREEZE PROTECTION REQUIRED.
▽ UNHEATED BUILDINGS - FREEZE PROTECTION REQUIRED.
FIRE HYDRANT W/HOSE HOUSE.
DECK PIPE
P.I.V. POST INDICATOR VALVE
REVISIONS
1 APPROVED FOR BIDDING GC II CONTRACT
3 REVISED W-1-G2 REF. CONTRACT
REFERENCE DRAWINGS
Y1-1 PLOT PLAN & UTILITIES PLAN PILOT PLANT FACILITY
PRINT RECORD
ENG. RECORD
DRAWING STATUS
PRELIMINARY
FOR COMMENTS AND/OR APPROVAL
APPROVED FOR BIDDING
FLOW DIAGRAM
AREA 09 - UTILITIES AND SERVICES
FIRE PROTECTION
P&M Coal Co.
PAMCO Pilot Plant
SCALE NONE
Stearns-Roger
ORDER NO. 6 33250
DWG. NO. L-21793
SHEET NO. P3-25
REV. 3
267

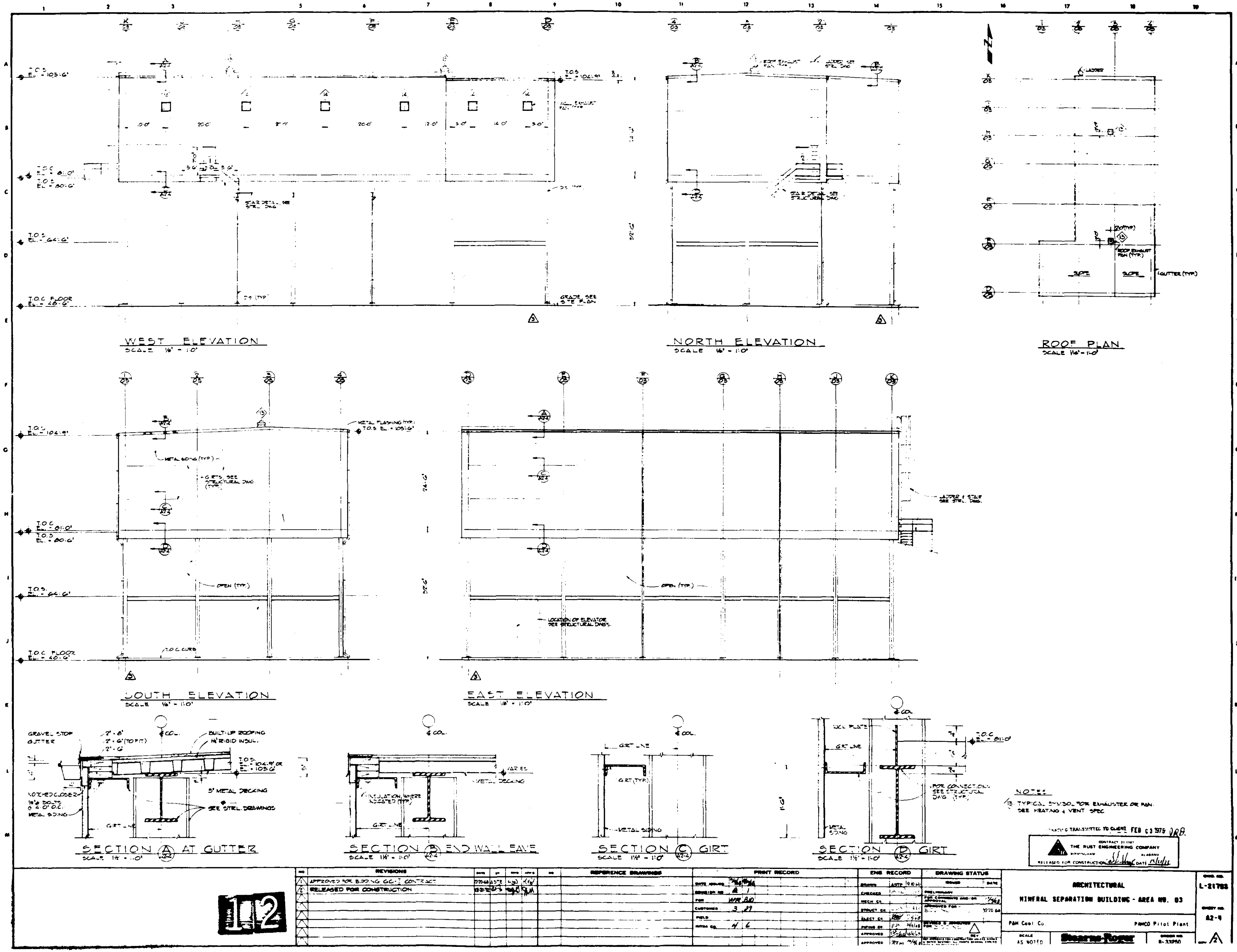

SOUTH WALL OF ROOM 123
MECHANICAL EQUIPMENT ROOM
SOUTH ELEVATION
NORTH ELEVATION
LOADING DOCK
ENCLOSED AREA
FLOOR PLAN
NOTES
SECTION
SCALE 1½"=1'-0"
EAST ELEVATION
WEST ELEVATION
NORTH ELEV OF ENCLOSED AREA
ARCHITECTURAL SYMBOLS & LEGEND
ROOM NO.
DOOR NO.
WINDOW MARK
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
DRAWING STATUS
APPROVED FOR BIDDING GC-1 CONTRACT
RELEASED FOR CONSTRUCTION
REVISED LOCKER ROOM PLAN FOR FALLOUT SHELTER
ADDED WALL LOUVER IN ROOM 128-136
ADDED CEILING NOTE AND LOCATION OF FUME HOODS
THE RUST ENGINEERING COMPANY
RELEASED FOR CONSTRUCTION
FLOOR PLAN AND ELEVATIONS
ADMINISTRATION BUILDING
L-21793
A1-1



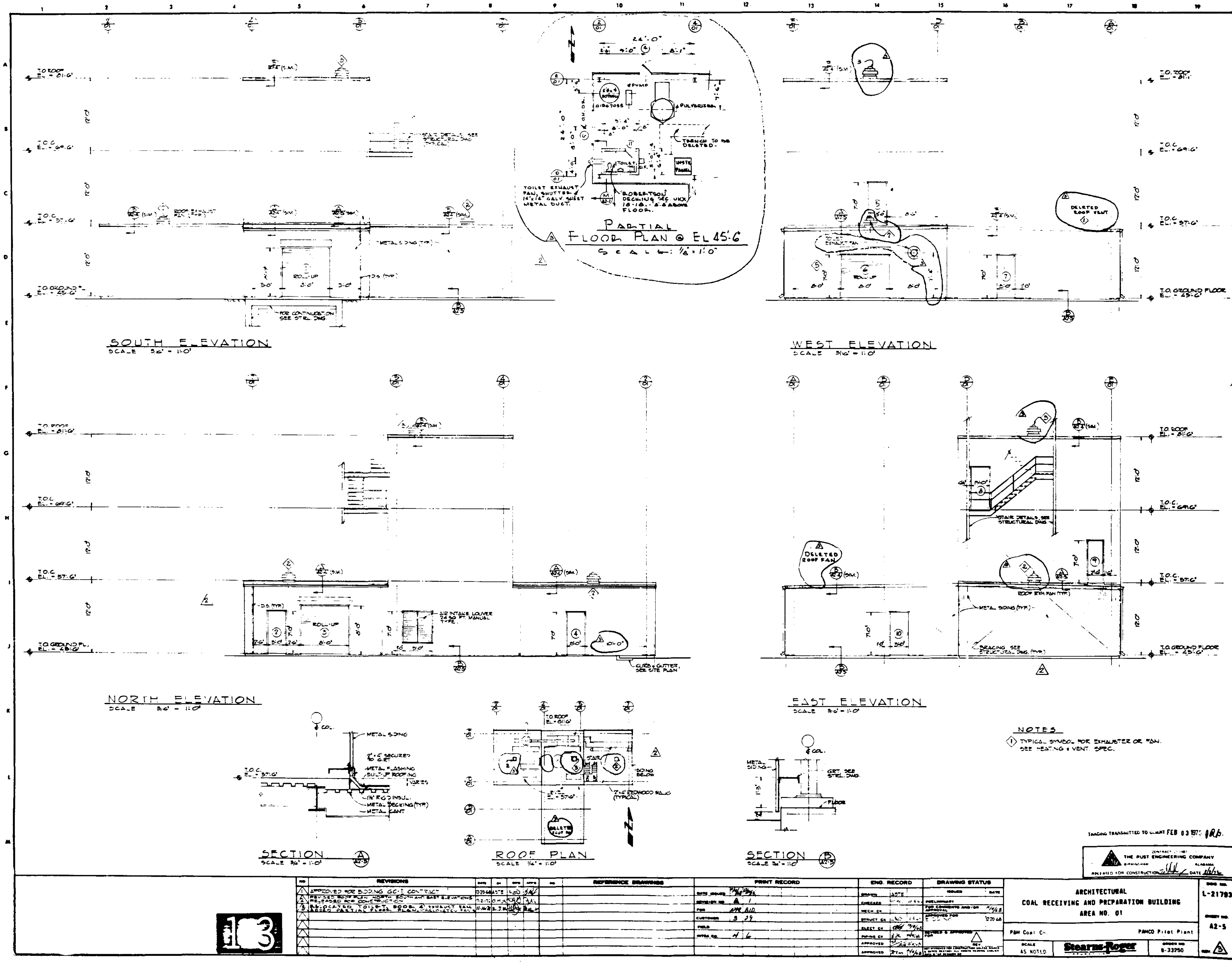
FLOOR PLAN FOR SHOP & WAREHOUSE (AREA 09.7)
SCALE 1/16" = 1'-0"
WELD AREA
MACHINE SHOP
TOOL ROOM
LOADING DOCK
WAREHOUSE
FLOOR PLAN OF H2 COMPRESSION SHED (AREA 05)
SCALE 1/8" = 1'-0"
TOILET ELEVATIONS OF SHOP & WAREHOUSE
EAST
SOUTH
WEST
NORTH
TYPICAL TOILET ELEVATIONS
NOTES
COMPRESSOR BLDG. FOR MINERAL SEPARATION (AREA 03)
SECTION A
SECTION B
SECTION C WALL
SECTION D WALL
SECTION E WALL
SECTION F WALL
SECTION G WALL
SECTION H
SECTION J
SECTION K
DETAIL 1
DETAIL 2
CONTRACT 21-1187
THE RUST ENGINEERING COMPANY
BIRMINGHAM ALABAMA
RELEASED FOR CONSTRUCTION
TRACING TRANSMITTED TO CLIENT
ARCHITECTURAL
SHOP AND WAREHOUSE - AREA NO. 09.7
H2 COMPRESSION SHED - AREA NO. 05
COMPR. SHED FOR MINERAL SEPARATION AREA NO. 03
Coal Co.
Pilot Plant
AS NOTED
L-21783
A2-1
APPROVED FOR BIDDING
AS BUILT - SHOWING PLUMBING LINES

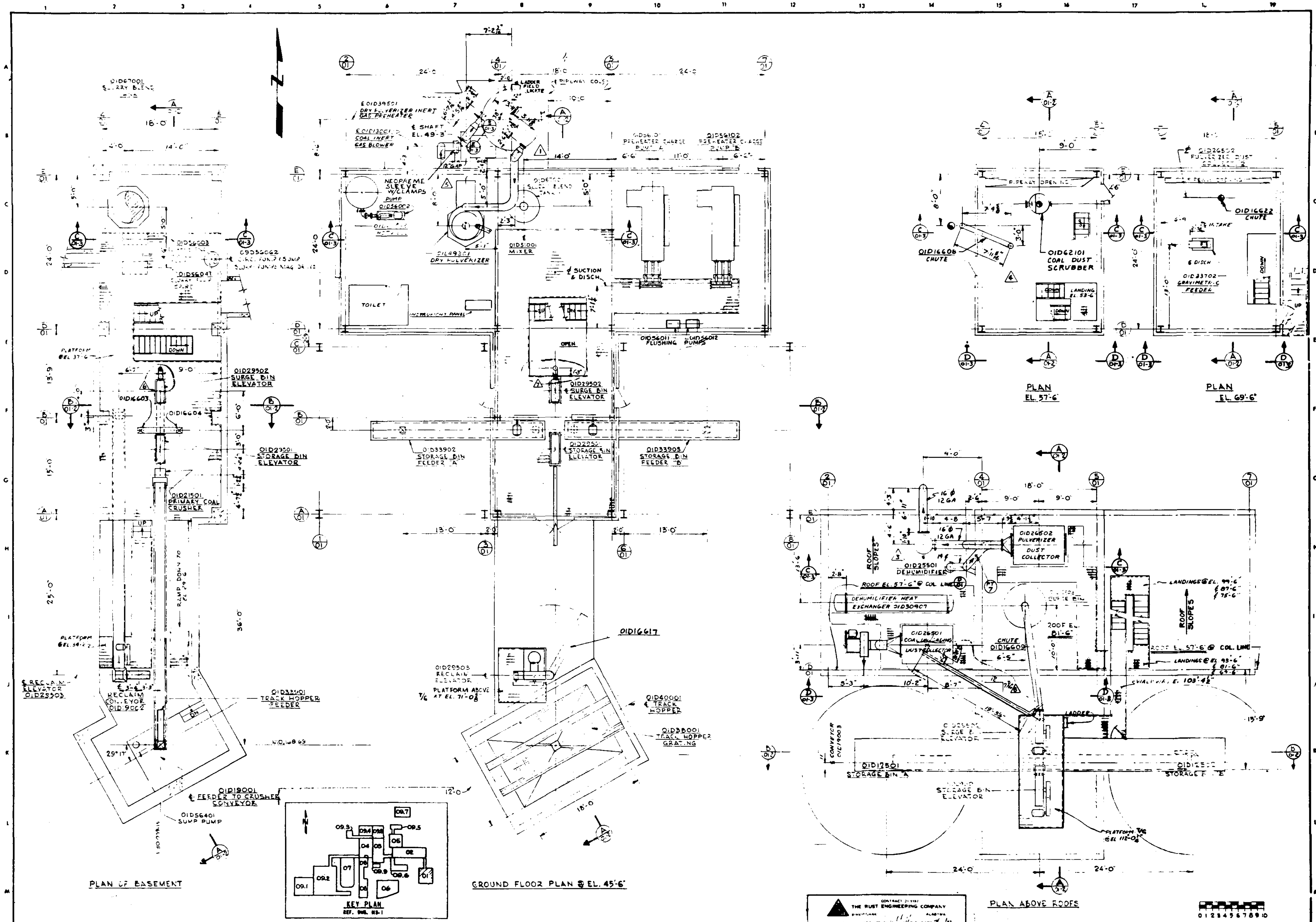

FLOOR PLAN OF CONTROL BLDG.
SCALE 1/8" = 1'-0" (AREA 09.6)
FLOOR PLAN OF PRODUCT STORAGE
SCALE 1/8" = 1'-0" (AREA 06)
STORAGE
CONTROL ROOM
COMPUTER
ELECTRICAL GEAR
LOADING DOCK NO. 2
SECTION X-X
DETAIL 1
DETAIL 2
SECTION Y-Y
SECTION Z-Z
SECTION A
SECTION B
SECTION C
SECTION D
ROOF PLAN
WASTE BIN
BIN NO. 'A'
BIN NO. 'B'
BIN NO. 'C'
WEST ELEVATION
SCALE 1/16" = 1'-0"
NOTES
TYPICAL SYMBOL FOR EXHAUSTER OR FAN. SEE HEATING & VENT. SPEC.
THE RUST ENGINEERING COMPANY
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
ARCHITECTURAL
CONTROL BUILDING - AREA NO. 09.6 AND
PRODUCT STORAGE BUILDING - AREA NO. 06
P&M Coal Co
PAMCO Pilot Plant
L-21783
A2-2


FLOOR PLAN OF DRY CHEMICAL STORAGE BLDG.
FLOOR PLAN OF PRODUCT SOLIDIFICATION BLDG.
SECTION
NORTHEAST ELEVATION
SOUTHEAST ELEVATION
SOUTHWEST ELEVATION
NORTHWEST ELEVATION
FLOOR PLAN OF FIRE PUMP HOUSE
NORTH ELEVATION
FLOOR PLAN OF EMERGENCY GENERATOR BLDG.
MOTOR CONTROL CENTER
FLOOR PLAN OF CHEMICAL STORAGE BUILDING
WEST & EAST ELEVATION
SOUTH & NORTH ELEV.
SOUTH ELEVATION
FLOOR PLAN OF BOILER HOUSE
FLOOR PLAN OF CHROMATOGRAPH BLDG.
WEST & EAST ELEV.
EAST ELEVATION
PLAN OF LOAD CENTER
PLAN OF BARREL STORAGE
WEST ELEVATION
NOTES
BRYANT ELECT. CO. 208 VOLT FAN DRIVEN 15 KW ELECT. WALL HEATER. MODEL No. 53062 WITH SURFACE MOUNTED ADAPTER FRAME.
THE RUST ENGINEERING COMPANY
ARCHITECTURAL
DRY CHEMICAL STORAGE, BOILER HOUSE, PRODUCT SOLIDIFICATION, WASTE TREATMENT CHEMICAL, LOAD CENTER, BARREL STORAGE
L-21703
A2-3



WEST ELEVATION
NORTH ELEVATION
ROOF PLAN
SOUTH ELEVATION
EAST ELEVATION
SECTION A AT GUTTER
SECTION B END WALL EAVE
SECTION C GIRT
SECTION D GIRT
GRAVEL STOP
GUTTER
BUILT-UP ROOFING
METAL DECKING
SEE STEEL DRAWINGS
METAL SIDING
OPEN (TYP)
NOTES:
TYPICAL SYMBOL FOR EXHAUSTER OR FAN. SEE HEATING & VENT SPEC
RELEASED FOR CONSTRUCTION
APPROVED FOR BIDDING GC-1 CONTRACT
REVISIONS
REFERENCE DRAWINGS
PRINT RECORD
ENG RECORD
DRAWING STATUS
TRACING TRANSMITTED TO CLIENT FEB 03 1975
CONTRACT 21 1187
THE RUST ENGINEERING COMPANY
BIRMINGHAM ALABAMA
ARCHITECTURAL
MINERAL SEPARATION BUILDING - AREA NO. 03
P&M Coal Co.
PAMCO Pilot Plant
AS NOTED
Stearns-Roger
L-21783
A2-4
112


SOUTH ELEVATION
SCALE 3/16" = 1'-0"
WEST ELEVATION
SCALE 3/16" = 1'-0"
NORTH ELEVATION
SCALE 3/16" = 1'-0"
EAST ELEVATION
SCALE 3/16" = 1'-0"
PARTIAL FLOOR PLAN @ EL 45'-6"
SCALE: 1/8" = 1'-0"
SECTION A A2-5
SCALE 3/4" = 1'-0"
ROOF PLAN
SCALE 1/16" = 1'-0"
SECTION B A2-5
SCALE 3/4" = 1'-0"
T.O. ROOF EL. = 81'-0"
T.O.C. EL. = 69'-0"
T.O.C. EL. = 57'-6"
T.O. GROUND FLOOR EL. = 45'-0"
ROLL-UP
METAL SIDING (TYP.)
AIR INTAKE LOUVER
DELETED ROOF VENT
DELETED ROOF FAN
STAIR DETAILS SEE STRUCTURAL DWG.
BRACING SEE STRUCTURAL DWG. (TYP.)
CURB & GUTTER, SEE SITE PLAN
TOILET EXHAUST FAN, SHUTTER & 14"x14" GALV. SHEET METAL DUCT.
ROBERTSON DECKING
TRENCH TO BE DELETED
PULVERIZER
TOILET
METAL SIDING
METAL FLASHING
BUILT-UP ROOFING
METAL DECKING (TYP.)
METAL CANT
FLOOR
NOTES
1. TYPICAL SYMBOL FOR EXHAUSTER OR FAN. SEE HEATING & VENT. SPEC.
TRACING TRANSMITTED TO CLIENT FEB 03 1971
THE RUST ENGINEERING COMPANY
BIRMINGHAM ALABAMA
RELEASED FOR CONSTRUCTION
REVISIONS
1 APPROVED FOR BIDDING GC-1 CONTRACT 12-20-68
2 REVISED ROOF PLAN, NORTH, SOUTH AND EAST ELEVATIONS RELEASED FOR CONSTRUCTION
3 RELOCATED TOILET, DOOR 4, EXHAUST FAN ADDED PARTIAL FLOOR PLAN
REFERENCE DRAWINGS
PRINT RECORD
ENG. RECORD
DRAWING STATUS
ARCHITECTURAL
COAL RECEIVING AND PREPARATION BUILDING
AREA NO. 01
P&M Coal Co.
PAMCO Pilot Plant
SCALE AS NOTED
Stearns-Roger
ORDER NO. 8-33250
DWG. NO. L-21793
SHEET NO. A2-5
REV. 3




| NO | REVISIONS | DATE | BY | APPD |
|---|---|---|---|---|
| 1 | APPROVED FOR BIDDING GC-II CONTRACT | | EK | |
| 2 | REQ'D. FOR COAL MATERIAL HANDLING | | | |
| 3 | GENERAL REVISION | 12/10/73 | T.S.W. | |
| 4 | ADDED CHUTES, CHUTE MK NO3 & CHG. CONV. 01D19002 | | HEJ | |
| 5 | ADDED DUCT DIM, SECT. E & REFERENCES | 11/3/75 | HEJ | |
| 6 | ADDED NEOPRENE SLEEVE | 6-20-77 | JWP | |
| 7 | REVISED SCREW CONVEYOR AND CHUTE | | BTJ | |

| NO | REFERENCE DRAWINGS |
|---|---|
| M5-01-2 | GEN ARRGT - SECTIONS |
| M5-01-3 | GEN ARRG'T - SECTIONS |
| M5-01- | SURGE BIN |
| M5-01-5 | DUST COLLECTING SYSTEM-PLAN |
| M5-01- | DUST COLLECTING - SECTIONS |

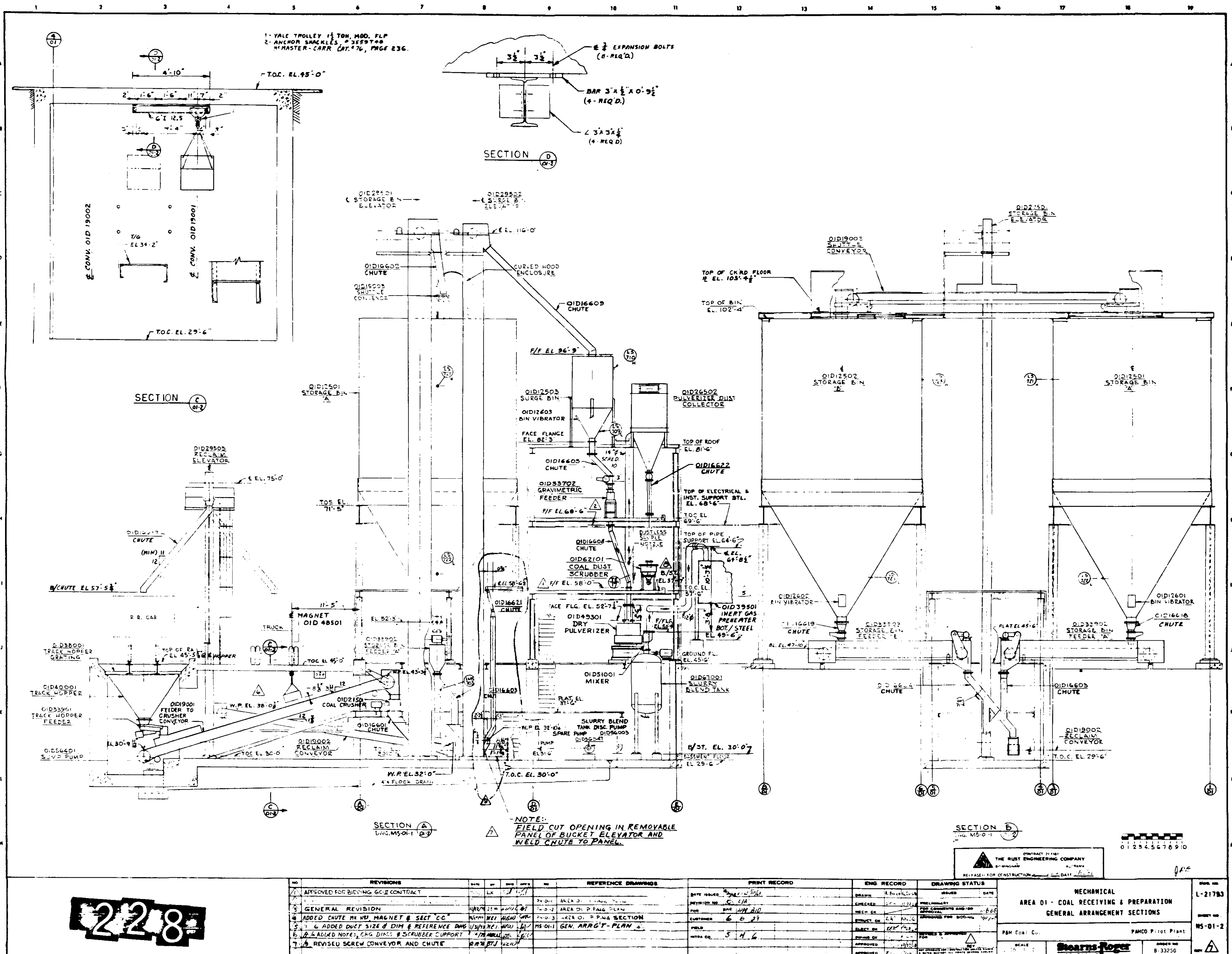
THE RUST ENGINEERING COMPANY
RELEASED FOR CONSTRUCTION

MECHANICAL
AREA 01 - COAL RECEIVING & PREPARATION
GENERAL ARRANGEMENT PLAN

PAMCO Pilot Plant

DWG. NO. L-21793
SHEET NO. M5-01-1
REV. 7

Stearns-Roger


SECTION C
SECTION D
SECTION A
SECTION B
1- YALE TROLLEY 1½ TON, MOD. FLP
2- ANCHOR SHACKLES #3559T48 McMASTER-CARR CAT. #76, PAGE 236.
T.O.C. EL. 45'-0"
T.O.C. EL. 29'-6"
¾ EXPANSION BOLTS (8-REQ'D)
BAR 3"x½"x0'-9½" (4-REQ'D.)
∠ 3"x3"x¼" (4-REQ'D)
01D12501 STORAGE BIN 'A'
01D12502 STORAGE BIN 'B'
01D12503 SURGE BIN
01D12603 BIN VIBRATOR
01D26502 PULVERIZER DUST COLLECTOR
01D53702 GRAVIMETRIC FEEDER
01D62101 COAL DUST SCRUBBER
01D49301 DRY PULVERIZER
01D51001 MIXER
01D67001 SLURRY BLEND TANK
01D39501 INERT GAS PREHEATER
01D48501 MAGNET
01D29502 RECLAIM ELEVATOR
01D40001 TRACK HOPPER
01D39501 TRACK HOPPER FEEDER
01D19001 FEEDER TO CRUSHER CONVEYOR
01D21501 COAL CRUSHER
01D19002 RECLAIM CONVEYOR
01D56601 SUMP PUMP
01D19003 SHUTTLE CONVEYOR
01D16609 CHUTE
CURVED HOOD ENCLOSURE
TOP OF CK'RD FLOOR EL. 103'-4½"
TOP OF BIN EL. 102'-4"
F/F EL. 96'-9"
F/F EL. 68'-6"
F/F EL. 58'-0"
GROUND FL. EL. 45'-0"
B/ST. EL. 30'-0"
BASEMENT FLOOR EL. 29'-6"
SLURRY BLEND TANK DISC. PUMP
NOTE: FIELD CUT OPENING IN REMOVABLE PANEL OF BUCKET ELEVATOR AND WELD CHUTE TO PANEL.
THE RUST ENGINEERING COMPANY
RELEASED FOR CONSTRUCTION
REVISIONS
1 APPROVED FOR BIDDING GC-II CONTRACT
3 GENERAL REVISION
4 ADDED CHUTE MK NO, MAGNET & SECT "C-C"
5 6 ADDED DUCT SIZE & DIM & REFERENCE DWG
6 ADDED NOTES, CHG. DIMS & SCRUBBER SUPPORT
7 REVISED SCREW CONVEYOR AND CHUTE
REFERENCE DRAWINGS
AREA 01 PIPING PLAN
AREA 01 PIPING SECTION
MS-01-1 GEN. ARR'G'T-PLAN
PRINT RECORD
ENG. RECORD
DRAWING STATUS
MECHANICAL
AREA 01 - COAL RECEIVING & PREPARATION
GENERAL ARRANGEMENT SECTIONS
P&M Coal Co.
PAMCO Pilot Plant
Stearns-Roger
B-33250
L-21793
MS-01-2
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# APPENDIX C - MAJOR EQUIPMENT LIST

EQUIPMENT LIST BY AREAS

Rev. 4 4/25/74

A. Coal Receiving and Preparation Area (01)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 01D12501 | BIN - Crushed Coal Storage "A" | UNION TANK - 350 Ton, 26' - 5" Ø |
| 01D12502 | BIN - Crushed Coal Storage "B" | UNION TANK - 350 Ton, 26' - 5" Ø |
| 01D12503 | BIN - Crushed Surge | UNION TANK - 6' - 9½" O.D. x 14' - 6" |
| 01D12601 | BIN VIBRATOR - Crushed Coal Storage "A" | SYNTRON - Mod. V-500 |
| 01D12602 | BIN VIBRATOR - Crushed Coal Storage "B" | SYNTRON - Mod. V-500 |
| 01D12603 | BIN VIBRATOR - Crushed Coal Surge | SYNTRON - Mod. V-50-B-1 |
| 01D13001 | BLOWER - Inert Gas | SPENCER TURBINE - Two Stage Centrifugal - 40 HP |
| 01D15601 | Car Puller | WEBSTER MFG. CO. - #5000; 5 HP |
| 01D15602 | Hayes Derailer | FEDERAL SIGN & SIGNAL CORP. - Hayes Model EB |
| 01D15603 | Hayes Derailer | FEDERAL SIGN & SIGNAL CORP. - Hayes Model EB |
| 01D16601 | Chute - Primary Crusher to Storage Elev. | WEBSTER MFG. CO. - 24" x 24" |
| 01D16602 | Chute - Storage Elevator Discharge | WEBSTER MFG. CO. - 14" x 18" |
| 01D16603 | Chute Storage Bin "A" | WEBSTER MFG. CO. - 14" x 14" Bifurcated |

A. Coal Receiving and Preparation Area (01)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 01D16605 | Chute Storage Bin "B" | WEBSTER MFG. CO. - 14" x 14" Befurcated |
| 01D16605 | Chute Surge Bin Discharge | WEBSTER MFG. CO. - 8" Ø |
| 01D16608 | Chute Gravimetric Feeder to Pulverizer | WEBSTER MFG. CO. - 6" Ø |
| 01D16609 | Chute Elevator Discharge to Surge Bin | WEBSTER MFG. CO. - 14" x 14" |
| 01D16617 | Chute Reclaim Elevator Discharge | WEBSTER MFG. CO. - 14" Ø |
| 01D16618 | Chute Storage Bin "A" | WEBSTER MFG. CO. - 19" Ø x 12" SQ |
| 01D16619 | Chute Storage Bin "B" | WEBSTER MFG. CO. - 19" Ø x 12" SQ |
| 01D16621 | Chute Dust Collector Discharge | WEBSTER MFG. CO. - 8" Ø |
| 01D16622 | Chute Dust Collector Discharge | WEBSTER MFG. CO. - 8" Ø |
| 01D19001 | Conveyor-Hopper Feeder to Crusher | WEBSTER MFG. CO. - 8" Ø |
| 01D19002 | Conveyor - Reclaim | WEBSTER MFG. CO. - 9TPH - 18" BW |
| 01D19003 | Conveyor Shuttle-Over 350 Tons Bins | WEBSTER MFG. CO. - 35TPH - 18" BW |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 4 4/25/74

A. Coal Receiving and Preparation Area (01)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 01D19011 | Screw Conveyor from Dust Collector | THOMAS CONVEYOR - 4" Dia. x 24' - 0" Long, Helicoid |
| 01D21501 | Crusher - Primary Coal Drive Motor | WEBSTER MFG. CO. - 35TPH, 15 HP, S/A 18" x 18" |
| 01D25501 | Dehumidifier | SCHUTTE-KOERTING - 36" Fig. 598 |
| 01D26501 | Dust Collector-Coal Unloading Including Air-Lock & Blower | BROWNLEE MORROW - Micro-Pul #130S-6-20; 700 cfm Airlock #6022 - 1/2 HP |
| 01D26502 | Dust Collector-Pulverizer Including Airlock & Blower | BROWNLEE MORROW - Micro-Pul #130S-8-20 Airlock #6022, 1/4 HP |
| 01D29501 | Bucket Elevator - Storage Bin | WEBSTER MFG. CO. - 35TPH - 48" x 18" |
| 01D29502 | Bucket Elevator - Surge Bin | WEBSTER MFG. CO. - 9TPH - 42" x 13" |
| 01D29503 | Bucket Elevator - Reclaim | WEBSTER MFG. CO. - 9TPH - 42" x 13" |
| 01D30907 | Dehumidifier Exchanger | SOUTHERN HEAT EXCHANGER #29 - 129 BEM |
| 01D33702 | Gravimetric Feeder - Dry Grinding Circuits | WALLACE & TIERNAN - 9" - 31130G09V.V |

A. Coal Receiving and Preparation Area (01)

| Item No. | Description | Manufacturer and Type |
| --- | --- | --- |
| 01D33901 | Feeder - Track Hopper | WEBSTER MFG. CO. ERIEZ #M653 - 24" x 30" |
| 01D33902 | Feeder - Storage Bin "A" | WEBSTER MFG. CO. 9TPH - 18" BW |
| 01D33903 | Feeder - Storage Bin "B" | WEBSTER MFG. CO. 9TPH - 18" BW |
| 01D33909 | Rotary Valve | WEBSTER MFG. CO. - Sprout-Waldron #14" x 10", 45 RPM |
| 01D38001 | Grating - Track Hopper | WEBSTER MFG. CO. - 12' - 0" Wide x 20' - 0" Long |
| 01D39501 | Inert Gas Preheater - Dry Pulverizer | BLACK, SIVALLS & BRYSON - 2 MMBTU/HR |
| 01D40001 | Track Hopper | WEBSTER MFG. - 12' - 0" x 18' - 0" x 7' - 9" Deep |
| 01D48501 | Metal Detector - Tramp Iron | WEBSTER MFG. CO. - Dings 24" x 30" x 13", 1570 W |
| 01D49301 | Dry Pulverizer | BABCOCK & WILCOX - #EL-29, 50 HP |
| 01D51001 | Mixer - Slurry Blend Tank | PRO-QUIP, INC. # 3ZC515, 3HP |

A. Coal Receiving and Preparation Area (01)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 01D56002 | Centrifugal Pump - Dehumidifier | GOULDS PUMPS - #3196, 3 x 4-13, MT, 400GPM @ 125 TDH |
| 01D56003 | Centrifugal Pump - Slurry Tank Discharge | MORRIS PUMPS - #1½ JC 14, 120 GPM @ 150 TDH |
| 01D56011 | Pump Flushing (Preheater Charge A) | J.M. FOSTER - Yarway Model C, 60 GPH |
| 01D56012 | Pump Flushing (Preheater Charge B) | J.M. FOSTER - Yarway Model C, 60 GPH |
| 01D56052 | Cent. Pump - Slurry Magnetic Drives Sump | |
| 01D56047 | Centrifugal Pump - Slurry Spare | MORRIS PUMPS - 1½ JC 14, 120 GPM @ 150 TDH |
| 01D56101 | Posit. Displ. Pumps Preheater Charge "A" | WILSON-SNYDER PUMPS - #63-10R, 2-1/8 x 6, 35 GPM @ 20 PSIG |
| 01D56102 | Posit. Displ. Pumps Preheater Charge "B" | WILSON-SNYDER PUMPS - #63-10R, 2-1/8 x 6, 35 GPM @ 20 PSIG |
| 01D56109 | Posit. Displ. Pumps Water Booster "V" Belt Drive w/ multi-pitch motor | UNION PUMP - #TD-30, 1 x 2-3/4, 1-4 GPM |
| 01D56401 | Vertical Centrifugal Pump-Sump | GOULDS PUMPS - #3171, 1½ x 3-6, ST, 50 GPM @ 20 TDH |

EQUIPMENT LIST BY AREAS

Rev. 4 4/25/74

B. Slurry Preheating and Dissolving (02)

| Item No. | Description | Manufacturer and Type |
| --- | --- | --- |
| 01D62101 | Scrubber - Coal Dust | SCHUTTE & KOERTING - Size SK, Fig. 254 |
| 01D67001 | Tank - Slurry Blend | UNION TANK - 60 Ø x 7' - 0" |
| 01D67035 | Dehumidifier Hotwell Tank | UNION TANK WORKS - 5'0" Ø x 9' - 0" |

B. Slurry Preheating and Dissolving (02)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 01D18702 | Condenser - High Pressure Flash Drum | SMITHCO ENGINEERING - #7325 - HGAJ |
| 02D30501 | Air Cooled Exchanger - Dissolver Product | HAPPY DIVISION OF ECO - Model 1F-0616-2048MD |
| 02D30502 | Air Cooled Exchanger - High Pressure Flash Drum Vapor | HAPPY DIVISION OF ECO - Model 1F-0616-2048MD |
| 01D35101 | Preheater - Slurry "A" | FOSTER WHEELER - 14.3 MM Btu |
| 02D62102 | Preheater - Decoking Scrubber | UNION TANK WORKS - 48 Dia. x 8' - 0" |
| 02D62013 | Purifier - Decoking Vent | ANDERSON IBEC - #HG4L, 25 psig @ 650$^{o}$F |
| 02D75001 | Dissolver "A" | WYATT DIVISION, U.S. INDUSTRIES - 24" I.D. x 30' - 0" |
| 02D75002 | Dissolver "B" | WYATT DIVISION, U.S. INDUSTRIES - 24" I.D. x 30' - 0" |
| 02D75101 | Separator - Recycle Condensate | WYATT DIVISION, U.S. INDUSTRIES - 24" I.D. x 7' - 0" |
| 02D75201 | Drum - High Pressure Flash | WYATT DIVISION, U.S. INDUSTRIES - 24" I.D. x 15' - 0" |
| 02D75202 | Drum - Intermediate Pressure Flash | WYATT DIVISION, U.S. INDUSTRIES - 24" I.D. x 11' - 0" |

EQUIPMENT LIST BY AREAS Rev. 4 4/25/74

C. Mineral Separation (03)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 03D12010 | Rotary Dryer Exhaust Fan | NEW YORK BLOWER - #192 LB, 2500 CFM @ 1" S.P. |
| 03D12509 | Bin - Mineral Residue | UNION TANK WORKS - 20' - 4" I.D. |
| 03D13002 | Blower - Exhaust | BARTLETT-SNOW - Lampson #D95, 15 HP |
| 03D16615 | Chute - Cooler Outlet | WEBSTER MFG. CO. - 3" Ø |
| 03D16616 | Chute - Mineral Residue Bin Outlet | WEBSTER MFG. CO. - 12" Ø |
| 03D16623 | Chute - Mineral Residue Bin Outlet | WEBSTER MFG. CO. - 12" Ø |
| 03D16624 | Chute - Duct to Dust Collector | WEBSTER MFG. CO. - 6" Ø |
| 03D18101 | Gas Compressor - Filter "A" | CHICAGO PNEUMATIC - Class 10-3/4 x 13 TB-125 HP |
| 03D18102 | Gas Compressor - Filter "B" | CHICAGO PNEUMATIC - Class 8 x 11 TB-75 HP |
| 03D25901 | Dryer - Mineral Residue | BARTLETT-SNOW - 48" OD x 32' - 9 Long, Style D |
| 03D25901 | Cylinder Drive | BARTLETT-SNOW - Falk #7527-NF-3-254U-7½HP |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 4 4/25/74

C. Mineral Separation (03)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 03D25901B | Combustion Blower | BARTLETT-SNOW - North American #2312035-1-7½ Turbo Blower |
| 03D25901C | Rotary Valve | BARTLETT-SNOW - Smoot #FT-12-1/3 HP |
| 03D25902 | Cooler - Mineral Residue | BARTLETT-SNOW - 36" O.D. x 15' - 0" Long |
| 03D26503 | Dust Collector, Precoat Mixing | WEBSTER MANUFACTURING - 13 Bag, 2 HP |
| 03D26504 | Dust Collector - Mineral Residue Bin | BROWNLEE MORROW - Micro-Pul #165-8-30 Cap 1200 cfm |
| 03D29504 | Bucket Elevator, Precoat | WEBSTER MFG. CO. - 30 CU. FT/HR - 11-3/4" x 36 |
| 03D29510 | Bucket Elevator - Mineral Residue Bin | WEBSTER MFG. CO. - 0.5TPH - 12" x 39" |
| 03D29801 | Passenger Elevator | EHRSAM No. 200S-1 |
| 03D30504 | Air Cooled Exchanger - Precoat Solvent Cooler | HAPPY DIV. OF ECO - #1F-0406-1036-MD |

C. Mineral Separation (03)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 03D30601 | Dowtherm Exchanger - Filter Feed Flash Recirculation | SOUTHERN HEAT EXCHANGER - #19-120 BEM |
| 03D30603 | Dowtherm Exchanger - Precoat Slurry Pres. Recirculation | SOUTHERN HEAT EXCHANGER - #19-120 BEM |
| 03D30604 | Dowtherm Exchanger - Filter Solvent Supply "A" | SMITHCO ENGINEERING - #6310-BCAAA |
| 03D30605 | Dowtherm Exchanger - Filter Solvent Supply "B" | SMITHCO ENGINEERING - #3310-BBBBA |
| 03D30607 | Dowtherm Exchanger - Filter "A" Gas Heater | SOUTHERN HEAT EXCHANGER - #23-192 BFM |
| 03D30608 | Dowtherm Exchanger - Filter "B" Gas Heater | SOUTHERN HEAT EXCHANGER - #17-192 BFM |
| 03D30613 | Heat Exchanger - Feed Flash Vapor | SOUTHERN HEAT EXCHANGER - S.H.E. #8-192 BEM |
| 03D30706 | Water Cooled Exchanger - Filter "A" Vapor | SOUTHERN HEAT EXCHANGER - #27-192 BEM |
| 03D30707 | Water Cooled Exchanger - Filter "B" Vapor | SOUTHERN HEAT EXCHANGER - #31-192 BFM |

C. Mineral Separation (03)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 03D30708 | Water Cooled Exchanger - Dryer Gas Condensate Cooler | SOUTHERN HEAT EXCHANGER - #21-192 BEM |
| 03D30713 | Water Cooled Exchanger - Precoat Solvent Cooler | SMITHCO ENGINEERING - #6210-HCAA |
| 03D30901 | Heat Exchanger - Filter "A" Vapor No. 1 | SOUTHERN HEAT EXCHANGER - #44-192-BFM |
| 03D30902 | Heat Exchanger - Filter "A" Vapor No. 2 | SOUTHERN HEAT EXCHANGER - #44-192-BFM |
| 03D30904 | Heat Exchanger - Filter "B" Vapor No. 1 | SOUTHERN HEAT EXCHANGER - #31-192 BFM |
| 03D30905 | Heat Exchanger - Filter "B" Vapor No. 2 | SOUTHERN HEAT EXCHANGER - #31-192 BFM |
| 03D33706 | Mineral Residue Weigh Belt | WALLACE TIERNAN - 9" - 31150GD-CS |
| 03D33706A | Weigh Belt Drive | WALLACE TIERNAN - Reeves Varispeed, 10:1 Range, ½ HP |
| 03D33706B | Weigh Belt Rotary Feeder | WALLACE TIERNAN - Sprout Waldron Type 2 |
| 03D34101 | Filter - Drum Filter "A" | GOSLIN-BIRMINGHAM, (80 Sq. Ft.) 6 Ø x 4' -3" Face - SHP |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 4 4/25/74

C. Mineral Separation (03)

| Item No. | Description | Manufacturer and Type |
| --- | --- | --- |
| 03D34102 | Filter - Precoated Rotary Drums "B" | GOSLIN-BIRMINGHAM - 6' Ø x 2' - 2 Face (40 Sq. Ft.) - 3 HP |
| 03D34103 | Filter - Cuno Microklean | GEORGE S. EDWARDS CO. - Cuno #6AX3 |
| 03D34104 | Filter - Cuno Microklean | GEORGE S. EDWARDS CO. - Cuno #6AX3 |
| 03D51004 | Filter Feed Surge Vessel Agitator | PRO-QUIP, INC. - #15 THW-30 15 HP |
| 03D51005 | Filter Feed Flash Vessel Agitator | PRO-QUIP, INC. - #3ZEW20 3 HP |
| 03D51007 | Precoat Slurry Pressure Vessel Agitator | PRO-QUIP, INC. - #ZEW30 3 HP |
| 03D56005 | Pump Centrifugal, Cooler Water Recirculation | BARTLETT-SNOW - Goulds - #3196, 1 x 1/2-6, ST, 25 GPM @ 100 TDH |
| 03D56006 | Filter Feed Flash Vessel Pump | GOULDS PUMPS - #3735, 3 x 4-11, M, 240 GPM @ 62 TDH |
| 03D56007 | Centrifugal Pump - Filter Feed Flash Discharge "A" | GOULDS PUMPS - #3735, 1 x 1½-8, M, 16/60 GPM @ 198 TDH |

EQUIPMENT LIST BY AREAS (cont'd)

Rev. 4 4/25/74

C. Mineral Separation Area (03)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 03D56008 | Centrifugal Pump - Filter Flash Discharge "B" | GOULDS PUMPS - #3735, 1 x 1½-8, M, 16/60 GPM @ 198 TDH |
| 03D56013 | Centrifugal Pump Dryer Condensate | GOULDS PUMPS - #3736, 3 x 4-11, H, 480/500 GPM @ 245 TDH |
| 03D56018 | Centrifugal Pump Filtrate Spare | GOULDS PUMPS - #735, 1 x 2011A, M, 2/35 GPM @ 309 TDH |
| 03D56019 | Centrifugal Pump Filtrate "A" Discharge | GOULDS PUMPS - #3735, 1 x 2-11A, M, 2/35 GPM @ 309 TDH |
| 03D56020 | Centrifugal Pump Filter "A" Condensate | GOULDS PUMPS - #3736, 1 x 1½ -8, M, 51 GPM @ 185 TDH |
| 03D56021 | Centrifugal Pump Filtrate "B" Discharge | GOULDS PUMPS - #3735, 1 x 2-11 A.M, 2/35 GPM @ 309 TDH |
| 03D56022 | Centrifugal Pump Filter "B" Condensate | GOULDS PUMPS - #3736, 1 x 1½ -8,M, 26 GPM @ 185 TDH |
| 03D56067 | Pump Filter Feed Surge Vessel | GOULDS PUMPS - #3735, 1 x 2-11A, M, 2/41/GPM @ 309 TDH |
| 03D56074 | Pump Recycle Water | GOULDS PUMPS - #3196, 1 x 2-10, MT, 20 GPM @ 306.5 TDH |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 4 4/25/74

C. Mineral Separation Area (03)

| Item No. | Description | Manufacturer and Type |
| --- | --- | --- |
| 03D56201 | Pump Filter "A" Cake Pump | SIER BATH PUMP DIV. - #ND, 3 GPM @ 195 PSI |
| 03D56202 | Pump Filter "B" Cake Pump | SIER BATH PUMP DIV. - #ND, 3 GPM @ 195 PSI |
| 03D56308 | Pump Precoat Solvent Atmos. Tank | SIER BATH PUMP DIV. - #SBD, 25 GPM @ 160 PSI |
| 03D56309 | Pump, Precoat Slurry | SIER BATH PUMP DIV. #SBF, 200 GPM @ 25 PSI |
| 03D56310 | Pump, Precoat Slurry | SIER BATH PUMP DIV. #SBF, 150 GPM @ 75 PSI |
| 03D62103 | Scrubber, Filter Gas Compressor "A" | UNION TANK - 42 Ø x 9'-0" |
| 03D62104 | Scrubber, Filter Gas Compressor "B" | UNION TANK - 36 Ø x 9'-0" |
| 03D62112 | Ejector Venturi Scrubber | KOERTROL - #7010, 14" - 4" Fig. 622K Nozzle |
| 03D67002 | Tank | UNION TANK - 48" Ø x 6'-0" |
| 03D67033 | Tank Recycle Water Storage | UNION TANK - 6 Ø x 13' High |
| 03D75103 | Separator Oil No. 1 | UNION TANK - 24" Ø x 5'-0" |
| 03D75104 | Separator Oil No. 2 | UNION TANK - 12-3/4 Ø x 5'-6" |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 4 4/25/74

C. Mineral Separation Area (03)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 03D75203 | Drum, Dryer Condensate | UNION TANK - 7'0" Ø x 10' - 0" |
| 03D75215 | Drum, Filter "A" Vapor Surge | UNION TANK - 52" Ø x 11' -0" |
| 03D75216 | Drum, Filter "B" Vapor Surge | UNION TANK - 52" Ø x 11' -0" |
| 03D75401 | Receiver, Filtrate "A" | UNION TANK - 60" Ø x 8'-0" |
| 03D75402 | Receiver, Filtrate "B" | UNION TANK - 48" Ø x 8'-0" |
| 03D75505 | Vessel, Filter Feed Surge | UNION TANK - 96" Ø x 32' - 0" |
| 03D75506 | Vessel, Filter Feed Flash | UNION TANK - 72" Ø x 9' -0" |
| 03D75508 | Vessel, Precoat Slurry Pressure | UNION TANK - 72" Ø x 11' -0" |

D. Solvent Recovery (04)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 04D13003 | Air Blower "A" | BLACK, SIVALLS & BRYSON - Roots, #74RA1, 30 HP |
| 04D13004 | Air Blower "B" | BLACK, SIVALLS & BRYSON - Roots, #74RA1, 30 HP |
| 04D18704 | Condenser - Vacuum Flash | SOUTHERN HEAT EXCHANGER - #31-192-AGT |
| 04D18705 | Cooler Light Oil Scavenger $H_X$ | SOUTHERN HEAT EXCHANGER - #10-192-BEM |
| 04D30508 | Light Ends Condenser (Air) Motor | HAPPY DIV. OF ECO - #1F-0608-1048-MD |
| 04D30509 | Condenser - Wash Solvent Column (Air) | HAPPY DIV. OF ECO - #1F-0608-1048-MD |
| 04D30510 | Process Solvent $H_X$ (Air) | HAPPY DIV. OF ECO - #1F-1014-1096-MVH |
| 04D30513 | Exchanger-Air Cooler Vacuum Flash | HAPPY DIV. OF ECO - #2F-1109-1084-MVH |
| 04D30609 | Heater Light Ends Column Feed $H_X$ | SOUTHERN HEAT EXCHANGER - #23-192 BEM |

D. Solvent Recovery (04)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 04D37014 | Cooler Wash Solvent Column Prod. $H_X$ | SMITHCO ENGINEERING - #7120-HBAA |
| 04D30715 | Cooler-Hotwell Jetwater $H_X$ | SOUTHERN HEAT EXCHANGER - #17-192 BEM |
| 04D30716 | DEA Cooler | BLACK, SIVALLS & BRYSON - BAS-TEX #04300 MTF |
| 04D30717 | Reflux Condenser | BLACK, SIVALLS & BRYSON - BAS-TEX #04300 MTB |
| 04D30801 | Reboiler Light Ends Column | SOUTHERN HEAT EXCHANGER - #17-102 A-U |
| 04D30802 | Reboiler Wash Solvent Column | SOUTHERN HEAT EXCHANGER - #29-102 A-U |
| 04D30804 | DEA Reboiler | BLACK, SIVALLS & BRYSON - Sheel & Tube #21-120 Type BU |
| 04D30908 | DEA Heat Exchanger | BLACK, SIVALLS & BRYSON - BAS-TEX #04300 MTF |
| 04D30909 | Stretford Solution Heater | BLACK, SIVALLS & BRYSON - Sheet & Tube #15-84 Type BEU |
| 04D30910 | Sulfur Meter | BLACK, SIVALLS & BRYSON - BAS-TEX #3 x 1½ x 300 Type 1 |

## D. Solvent Recovery (04)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 04D34109 | Full Flow Filter | BLACK, SIVALLS & BRYSON - PECO #55-23-336RG |
| 04D34110 | Charcoal Filter | BLACK, SIVALLS & BRYSON - 30" OD x 10' - 0" |
| 04D34601 | Flare | JOHN ZINK - #STF-C-8, 12' 3½ High |
| 04D35103 | Preheater Vacuum Flash | FOSTER-WHEELER - 4.4 MM Btu |
| 04D46701 | DEA Plant | BLACK, SIVALLS & BRYSON |
| 04D46702 | Stretford Plant | BLACK, SIVALLS & BRYSON |
| 04D56023 | Pump Vacuum Flash Cond. Motor | GOULDS PUMPS - #3736, 1 x 1½-8, m, 7/70 GPM @ 142 TDH |
| 04D56024 | Pump Light Ends Bottoms Motor | GOULDS PUMPS - #3735, 1 x 1½-8, m, 7/70 GPM @ 122 TDH |
| 04D56025 | Pump Light Ends Reflux Motor | GOULDS PUMPS - #3735, 1 x 1½-8, m, 1.25/4 TPM @ 142 TDH |
| 04D56026 | Pump Wash Solvent Column Bottoms Motor | GOULDS PUMPS - #3735 1 x 1½-8, m, 5/65 GPM @ 130 TDH |
| 04D56027 | Pump Wash Solvent Column Prod. and Reflux | GOULDS PUMPS - #3735, 1 x 1½-8, m, 10/35 GPM @ 110 TDH |

EQUIPMENT LIST BY AREAS (cont'd                                Rev. 5 4/25/74

D. Solvent Recovery (04)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 04D56030 | Pump Process Solvent Motor | GOULDS PUMPS - #3736, 1 x 2-11A, m, 5/35 GPM @ 525 TDH |
| 04D56031 | Pump Solvent to Storage Motor | GOULDS PUMPS - #3736, 1 x 2-11A, m, 5/35 GPM @ 525 TDH |
| 04D56032 | Pump Light Ends Product Motor | GOULDS PUMPS - #3736, 1 x 1½-8, m, 0.5/3 GPM @ 118 TDH |
| 04D56033 | Pump Wash Solvent Motor | GOULDS PUMPS - #3736, 1 x 2-13A, m, 1/15 GPM @ 555 TDH |
| 04D56036 | Pump Vacuum Flash Feed Accm. Drum Motor | GOULDS PUMPS - #3735, 1 x 2-11A, m, 5/50 GPM @ 420 TDH |
| 04D56039 | Pump Hotwell Motor | GOULDS PUMPS - #3735, 2 x 3-9, m, 112/175 GPM @ 162 TDH |
| 04D56040 | Pump Flare Knockout Scavenger Motor | GOULDS PUMPS - #3735, 1 x 2-11A, m, 50 GPM @ 346 TDH |
| 04D56043 | Centrifugal Pump Light Ends Column Feed | GOULDS PUMPS - #3736, 1 x 1½-8, m, 70 GPM @ 143 TDH |
| 04D56068 | Pump Emergency Solvent Motor | UNION PUMP COMPANY - #QD-100, 1-3/8 x 3, 31 GPM |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

D. Solvent Recovery (04)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 04D56075 | DEA Pump "A" | BLACK, SIVALLS & BRYSON - Union Pump #TD-60, 1-7/8 x 3, 33.8 GPM @ 4 PSI |
| 04D56076 | DEA Pump "B" | BLACK SIVALLS & BRYSON - Union Pump #TD-60, 1-7/8 x 3, 33.8 GPM @ 4 PSI |
| 04D56077 | DEA Booster Pump "A" | BLACK, SIVALLS & BRYSON - Union Pump #1½ x 2 x 7 VCM, 33.8 GPM @ 2.5 TDH |
| 04D56078 | DEA Booster Pump "B" | BLACK, SIVALLS & BRYSON - Union Pump #1½ x 2 x 7 VCM, 33.8 GPM @ 2.5 TDH |
| 04D56079 | Reflux Pump "A" | BLACK, SIVALLS & BRYSON - Crane Deming, AVS3062, 1½ x 1 x 6, 2 GPM @ 40 PSI |
| 04D56080 | Reflux Pump "B" | BLACK, SIVALLS & BRYSON - Crane Deming, AVS3062, 1½ x 1 x 6, 2 GPM @ 40 PSI |
| 04D56081 | Desuperheat Water Pump "A" | BLACK, SIVALLS & BRYSON - Worthinton #1TCO-E Turbine |
| 04D56082 | Desuperheat Water Pump "B" | BLACK, SIVALLS & BRYSON - Worthington #TCO - E, Turbine |
| 04D56083 | Stretford Solution Pump "A" | BLACK, SIVALLS & BRYSON - Union Pump #4 x 6 x 9 VCM, 640 GPM @ 14 TDH |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

D. Solvent Recovery (04)

| Item No. | Description | Manufacturer and Type |
| --- | --- | --- |
| 04D56084 | Stretford Solution Pump "B" | BLACK, SIVALLS & BRYSON - Union Pump #4 x 6 x 9 VCM, 640 GPM @ 14 TDH |
| 04D56085 | Stretford Slurry Pump "A" | BLACK, SIVALLS & BRYSON - Union Pump #1½ x 2 x 7 VCM, 20 GPM @ 2 TDH |
| 04D56086 | Stretford Slurry Pump "B" | BLACK, SIVALLS & BRYSON - Union Pump #1½ x 2 x 7 VCM, 20 GPM @ 2 TDH |
| 04D56087 | Stretford Transfer Pump Separator | BLACK, SIVALLS & BRYSON - Union Pump #2 x 3 x 7 VCM, 60 GPM @ 2 TDH |
| 04D56091 | Stretford Inlet Pump | GOULDS PUMPS - #3196, 1½ x 1-6, 5 GPM @ 70 TDH |
| 04D56301 | Pump Vacuum Flash Bottoms Motor | Sier Bath Pump Div. - #NA, 1-7 GPM @ 92 PSI |
| 04D56404 | Centrifugal Pump - Vertical | BLACK, SIVALLS & BRYSON - Lewis #MTS-0752½, 100 GPM @ 52 TDH |
| 04D67003 | Wash Solvent Accumulator Tank | UNION TANK WORKS, - 96" Ø x 32' - 0" |
| 04D67004 | Process Solvent Accumulator Tank | UNION TANK WORKS - 96" Ø x 32' - 0" |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

D. Solvent Recovery (04)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 04D67011 | Hotwell Tank | UNION TANK WORKS - 72" Ø x 6' -0" |
| 04D67034 | Stretford Oxidizer Tank | BLACK, SIVALLS & BRYSON - 144" OD x 25' - 0" |
| 04D67035 | Stretford Slurry Tank | BLACK, SIVALLS & BRYSON - 42" OD x 10' - 0" |
| 04D67036 | Sulfur Separator | BLACK, SIVALLS & BRYSON - 16" OD x 6' - 0" |
| 04D67037 | Sulfur Storage Tank | BLACK, SIVALLS & BRYSON - 84" OD x 15' - 0" |
| 04D67038 | Stretford Solution Mix Tank | BLACK, SIVALLS & BRYSON - 6' - 0" OD x 6' - 0" |
| 04D67039 | Stretford Surge Tank | BLACK, SIVALLS & BRYSON - 90" OD x 12' - 0" |
| 04D71501 | Vacuum Jet-Vacuum Flash Drum | SCHUTTE & KOERTING - 150 P.P.H. @ 25 mm Hg |
| 04D75106 | DEA Outlet Separator | BLACK, SIVALLS & BRYSON - 12' 3/4" OD x 5' - 0" |
| 04D75107 | DEA Flash Separator | BLACK, SIVALLS & BRYSON - 20" OD x 7' - 6" |
| 04D75108 | Stretford Inlet Separator | BLACK, SIVALLS & BRYSON - 12' 3/4" OD x 7' - 6" |
| 04D75109 | Stretford Outlet Separator | BLACK, SIVALLS & BRYSON - 12' 3/4" OD x 5' - 6' |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

D. Solvent Recovery (04)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 04D75204 | Drum-Vacuum Flash | UNION TANK WORKS - 86" Ø x 9' - 0" |
| 04D75206 | Drum-Vacuum Flash Condensate | UNION TANK WORKS - 72" Ø x 14' - 0" |
| 04D75207 | Drum Light Ends Reflux | UNION TANK WORKS - 36" Ø x 5' - 0" |
| 04D75208 | Drum Wash Solvent Column Prod. | UNION TANK WORKS - 48" Ø x 8' - 0" |
| 04D75210 | Drum Vacuum Flash Feed Accm. | UNION TANK WORKS - 72" Ø x 28' - 0" |
| 04D75211 | Drum Vacuum Flash Decoking | UNION TANK WORKS - 36" Ø x 7' - 0" |
| 04D75212 | Drum Light Oil Water Separator | UNION TANK WORKS - 36" Ø x 5' - 0" |
| 04D75214 | Drum Flare Knockout | UNION TANK WORKS - 96" Ø x 16' - 0" |
| 04D75215 | Purifier Decoking Vent | ANDERSON IBEC - #HG4L, 25 PSIG @ $650^{\circ}$F |
| 04D75221 | Tank - Light Ends Column Feed | UNION TANK WORKS - 84" Ø x 17' - 3" |
| 04D75222 | Steam Condensate Tank | BLACK, SIVALLS & BRYSON - 12' 3/4" OD x 6' - 0" |
| 04D75224 | DEA Surge Tank | BLACK, SIVALLS & BRYSON - 42" OD x 14' - 6" |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

D. Solvent Recovery (04)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 04D75301 | Light Ends Removal Column Vessel | HOFFMAN ENGR. CO. - (See Dwg.) 15" Ø and 22" Ø |
| 04D75302 | Wash Solvent Column | HOFFMAN ENGR. CO. - (See Dwg) |
| 04D75306 | DEA Absorber | BLACK, SIVALLS & BRYSON - 20" OD x 51'-0" |
| 04D75307 | DEA Still Column & Reflux Drum | BLACK, SIVALLS & BRYSON - 24" ID x 53' -0" |
| 04D75308 | Stretford Absorber | BLACK, SIVALLS & BRYSON - 24" ID x 62' -8" Top, 90" ID x 19' - 0" Bottom |

EQUIPMENT LIST BY AREAS

E. Gas Recovery and Compression (05) Rev. 5 4/25/74

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 05D18104 | Compressor "A" Hydrogen Recycle | CHICAGO PNEUMATIC - Class 3½ x 9 TB, 75 HP |
| 05D18106 | Compressor Fresh Hydrogen | CHICAGO PNEUMATIC - Class 6½-5½-3 3/4 x 13 TCB-3, 150 HP |
| 05D30701 | Recycle Hydrogen By-Pass Loop Exchanger | SMITHCO ENGR. - #7120 - HHAA |
| 05D20704 | Fresh Hydrogen ByPass Loop | SMITHCO ENGR. - #3220 - HBABA |
| 05D30705 | Fresh Hydrogen ByPass Loop | SMITHCO ENGR. - #7120 - HNBA |
| 05D62105 | Scrubber Hydrogen Recycle Compressor | UNION TANK WORKS - 10-3/4 Ø x 8' - 0" |
| 05D62106 | Scrubber Fresh Hydrogen First Stage | UNION TANK WORKS - 96 Ø x 20' - 0" |
| 05D62109 | Scrubber Recycle Hydrogen | UNION TANK WORKS - 12/3/4' x Ø 8' - 0" |
| 05D75509 | Vessel Fresh Hydrogen Storage "A" | UNION TANK WORKS - 24' Ø x 40' - 2" |
| 05D75512 | Vessel Fresh Hydrogen Storage "B" | UNION TANK WORKS - 24' Ø x 40' - 2" |

EQUIPMENT LIST BY AREAS

F. Product Solidification and Storage (08) Rev. 5 4/25/74

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 08D12504 | Bin Waste Product | UNION TANK WORKS - 20' - 0" centerline to centerline BMS x 35' - 0" |
| 08D12505 | Bin De-Ashed Coal Bin "A" | UNION TANK WORKS - 20' - 0" centerline to centerline BMS x 35' - 0" |
| 08D12506 | Bin De-Ashed Coal Bin "B" | UNION TANK WORKS - 20' - 0" centerline to centerline BMS x 35' - 0" |
| 08D12507 | Bin De-Ashed Coal Bin "C" | UNION TANK WORKS - 20' - 0" centerline to centerline BMS x 35' - 0" |
| 08D13007 | Centaxial Fan | Aerovent (McKim & Assoc.) #402 Type C, 32,000 CFM @ 8" S.P. |
| 08D13008 | Centaxial Fan | Aerovent (McKim & Assoc.) #402 Type C, 32,000 CFM @ 8" S.P. |
| 08D13009 | Conveyor Blower | NEW YORK BLOWER #229-QB, 6500 CFM @ 8" S.P. |
| 08D16610 | Chute Product to Rail Cars & Trucks | WEBSTER MFG. CO. 14" Ø |
| 08D16611 | Chute Waste Product Bin | WEBSTER MFG. CO. 14" x 14" Bifurcated |
| 08D16612 | Chute De-Ashed Coal Bin Outlet (Bin "A") | WEBSTER MFG. CO. 14" x 14" Bifurcated |

F. Product Solidification and Storage (08)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 08D16613 | Chute De-Ashed Coal Bin Outlet (Bin "B") | WEBSTER MFG. CO. 14" x 14" Bifurcated |
| 08D16614 | Chute De-Ashed Coal Bin Outlet "Bin "C") | WEBSTER MFG. CO. 14" x 14" Bifurcated |
| 08D16620 | Chute De-Ashed Coal Product Elev. Discharge | WEBSTER MFG. CO. 10" x 14" |
| 08D16625 | Chute Shipping Feeder Discharge | WEBSTER MFG. CO. Tapered |
| 08D16626 | Chute De-Ashed Coal Cooler Belt Discharge | WEBSTER MFG. CO. 3'-6" x 3' - 0" |
| 08D16627 | Chute Cooling Conveyor Discharge | WEBSTER MFG. CO. 10" Diameter |
| 08D18001 | Prilling Tower - Incl. Basic Equipment | HPD. INC. (Union Tank & Infratrol Oven (Hot Chamber) |
| 08D18002 | Elevator Personnel Prilling Tower | EHRSAM COMPANY Overhead Traction |
| 08D19005 | Conveyor, De-Ashed Coal Off (Cooling Belt) Drive Motor | WEBSTER MFG. CO. 3 TPH - 18" BW |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

F. Product Solidification and Storage (08)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 08D19006 | Conveyor Prilled Product Off Tower Cooling Belt Drive Motor | WEBSTER MFG. CO. 3 TPH - 18" BW |
| 08D19007 | Conveyor Transfer De-Ashed Coal to Storage Area Drive Motor | WEBSTER MFG. CO. 3 TPH - 18" BW |
| 08D19009 | Conveyor with Plow Product to Bins, Drive Motor | WEBSTER MFG. CO. 3 TPH - 18" BW |
| 08D19010 | Conveyor Product to Shipping Drive Motor | WEBSTER MFG. CO. 32 TPH - 18" BW |
| 08D19100 | Conveyor Cooler | REX CHAINBELT MODEL QAC-2460S, Cap. 3000#/hr |
| 08D20003 | Conveyor De-Ashed Product Cooler Drive Motor | SANDVIK CONVEYORS 300 #/hr, 32" Wide |
| 08D26506 | Cyclones Complete Trickle Valves | DUCON TYPE VM #2-455 Series 700/150 Type FA Valve |
| 08D26407 | Cyclones Complete Trickle Valves | DUCON TYPE VM #2-455 Series 700/150 Type FA Valve |
| 08D29050 | Bucket Elevator De-Ashed Coal to Transfer Belt Drive Motor | WEBSTER MFG. CO. 3 TPH - 14" x 36" |

F. Product Solidification and Storage (08)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 08D29507 | Bucket Elevator De-Ashed Coal to Storage Area | WEBSTER MFG. CO. 3 TPH - 12" x 36" |
| 08D29509 | Bucket Elevator to Shipping Drive Motor | WEBSTER MFG. CO. 32 TPH - 48" x 19" |
| 08D30514 | Dowtherm Air Fin Cooler | INFRATROL OLVEN CORP. 225,000 Bru/hr, 32 gpm |
| 08D30718 | Double Pipe Heat Exchanger | BAS-TEX CORP. Heating 150,000 But, Cooling 225,000 Btu, 454 Sq. ft. |
| 08D33703 | Gravimetric Feeder De-Ashed Coal Drive and Motor | WALLACE & TIERNAN 9" - 3115069C.S |
| 08D33705 | Feeder Product to Shipping Drive Motor | WALLACE & TIERNAN 18" - 31150G18C.S |
| 08D34111 | Filter Backwash | ENGINEERED PROCESS EQUIP. #SS-1524-STNG |
| 08D35503 | Heater Electric Dowtherm | CHROMALOX (Edwin Weigand Div.) RLDW-800-80-VW-SCR-XX |
| 08D42001 | Hydraulic Rail Ramp Dockboard & Motor | KELLY CO. c/o Hill' Engr. 20,000 #cap.; 1/3 hp Model 86056 |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

F. Product Solidification and Storage (08)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 08D44001 | Bagger - Solidified Product Complete | ST. REGIS PAPER CO. 106-FGS, Screw Type Valve Bag Packer |
| 08D56402 | Sump Pump Manlift Pit & Motor | GOULDS PUMPS #3171, 1 x 1½-6, ST, 20 gpm @ 20 TDH |
| 08D56403 | Sump Pump for Elevator & Motor Pit | GOULDS PUMPS #3171, 1 x 1½-6, ST, 20 gpm @ 20 TDH |
| 08D62110 | Scrubber Off Cooling Conveyor 08D2003 | KOERTROL CORP. Size 6 #7014 |
| 08D67040 | Head Tank Prilling Tower | UNION TANK WORKS 3' - 0" Dia. x 5'-0" Long |

## G. Utilities (09)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D13005 | Stripper Blower | SURFACE COMBUSTION |
| 09D13006 | Reformer Blower | SURFACE COMBUSTION |
| 09D13001 | Air Blower #1 | GULF DEGREMONT - Roots Model RASJ, #812, 1600 cfm @ 10 psig |
| 09D13012 | Air Blower #2 | GULF DEGREMONT - Roots Model RASJ, #812, 1600 cfm @ 10 psig |
| 09D18110 | Air Compressor "A" | CHICAGO PNEUMATIC - Class 9 x 7 TUO, 40 hp |
| 09D18111 | Air Compressor "B" | CHICAGO PNEUMATIC - Class 9 x 7 TUO, 40 hp |
| 09D18112 | Compressor Hydrogen Syn/Gas | SURFACE COMBUSTION |
| 09D18113 | Compressor Inert Gas | SURFACE COMBUSTION |
| 09D18114 | Compressor Inert Gas | SURFACE COMBUSTION |
| 09D18115 | Compressor $CO_2$ | SURFACE COMBUSTION |
| 09D18706 | Stripper Condenser | SURFACE COMBUSTION |
| 09D20101 | Cooling Tower | MARLEY COMPANY - Class 500, Model 586-48-1 Cap. 5,000 gpm |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

G. Utilities (09)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D25701 | Air Dryer | C.M. KEMP CO. - Model 75-EA-1, Model PF-10 Prefilter |
| 09D25902 | Inert Gas Dryer | SURFACE COMBUSTION |
| 09D30512 | Cooler Flush Solvent | HAPPY DIV. OF ECO - #1F-1014-1096-MVH |
| 09D30610 | Heater Flush Solvent 25,000 #/hr 79 gpm | SOUTHERN HEAT EXCHANGER - #13-96-BFM |
| 09D30611 | Exchanger Dowtherm Reclaimer | CHARLES E. SECH ASSOC. INC. - Shell Press. 100 psig @ 750$^{o}$F |
| 09D30709 | Cooler Seal Flush | SOUTHERN HEAT EXCHANGER - #19-192-BFM |
| 09D30711 | Air Compressor "A" | CHICAGO PNEUMATIC 9 x 7 TUO, 40 HP |
| 09D30712 | Air Compressor "B" | CHICAGO PNEUMATIC 9 x 7 TUO, 40 HP |
| 09D30911 | Heat Exchanger MEA to MEA | SURFACE COMBUSTION |
| 09D30912 | MEA Cooler | SURFACE COMBUSTION |
| 09D30913 | MEA Cooler | SURFACE COMBUSTION |
| 09D30914 | Flue Cooler | SURFACE COMBUSTION |
| 09D30915 | Converter Cooler | SURFACE COMBUSTION |

G. Utilities (09)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D34104 | Filter A Pressure Sand Waste Disposal | GRAVER WATER CONDITIONING CO. - 7' Ø x 6" High |
| 09D34105 | Filter B Pressure Sand Waste Disposal | GRAVER WATER CONDITIONING CO. - 7' Ø x 6" High |
| 09D34106 | Filter A Pressure Carbon Waste Disposal | GRAVER WATER CONDITIONING CO. - 7' Ø x 6" High |
| 09D34107 | Filter B Pressure Carbon Waste Disposal | GRAVER WATER CONDITIONING CO. - 7' Ø x 6" High |
| 09D34108 | Filter Seal Flush | GEORGE S. EDWARDS CO. - Cuno amf #19563 |
| 09D34801 | Incinerator Process Waste Complete Unit (includes pump, stack, scrubber, blower & motor) | JOHN ZINK POLLUTION RESEARCH - 2200 #/hr |
| 09D35301 | Fired Heater-Dowtherm | FOSTER-WHEELER - 21 MM Btu |
| 09D35302 | Reformer | SURFACE COMBUSTION |
| 09D35501 | Heater Flush Solvent "A" | EDWIN L. WIEGAND DIV. EMERSON ELECT. CO. - Flow 2500 #/hr., Heat Transferred 260,000 Btu/hr., 300 psig |

## G. UTILITIES

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D51009 | Agitator - $H_3$ PO 4 Day Tank | GULF DEGREMONT - 1/4 hp |
| 09D51010 | Agitator Acid Day Tank | GRAVER WATER CONDITIONING CO. - 1/4 hp |
| 09D51011 | Agitator Alum Day Tank | GULF DEGREMONT - 1/4 hp |
| 09D51012 | Agitator Polyelectrolyte Mix Tank | GULF DEGREMONT - 1/2 hp |
| 09D51013 | Mixer - Alum Tank | GRAVER WATER CONDITIONING CO. - 1/4 hp |
| 09D51014 | Polyelectolyte Tank Mixer | GRAVER WATER CONDITIONING CO. - Neptune #A-1 |
| 09D56013 | Pump Acid Feed | GRAVER WATER CONDITIONING CO. - Neptune #525-S-PVC, 6.5 gph |
| 09D56014 | Pump Process Solvent Transfer | GOULDS PUMPS - #3736, 1 x 2-11A, m, 60 gpm @ 456 TDH |
| 09D56015 | Pump Polyelectrolyte Feed | GULF DEGREMONT - W&T Series A747, 2.08 gph w/Positioner |
| 09D56016 | Pump Raw Solvent Transfer & Motor | GOULDS PUMPS - #3736, 1 x 2-11A, m, 60 gpm @ 456 TDH |

D. Utilities (09)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D56017 | Pump $H_3\ PO_4$ Feed | GULF DEGREMONT - W&T Series 44, #44-211, 2.08 gph w/Positioner |
| 09D56018 | Alum Feed Metering Pump | GULF DEGREMONT - W&T Series A747, 20.8 gpm w/ Positioner |
| 09D56019 | Phenol/Benzine Pump | GULF DEGREMONT - W&T Series 44 - #44-215, 104 gph |
| 09D56020 | Pump Alum Feed | GRAVER WATER CONDITIONING CO. - Neptune #535-S-PCV, 18 gph |
| 09D56021 | Polyelectrolyte Feed | GRAVER WATER CONDITIONING CO. - Neptune #1505, 4.4 gph |
| 09D56028 | Pump Wash Solvent Transfer & Motor | GOULDS PUMPS - #3735, 1 x 1½-8, m, 60 gpm @ 161 TDH |
| 09D56034 | Pump Tank Farm Loading & Motor | GOULDS PUMPS - #3736, 1½ x 3-7, m, gpm @ 112 TDH |
| 09D56035 | Pump Solvent Unloading & Motor | GOULDS PUMPS - #3736, 1 x 1½-8, m, 60 gpm @ 101 TDH |
| 09D56041 | Pump Cooling Water Circ. A & Motor | GOULDS PUMPS - #3405, 8 x 10-14, L, 2500 gpm @ 138 TDH |

G. Utilities (09)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D56042 | Pump Cooling Water Circ. B & Motor | GOULDS PUMPS - #3405, 8 x 10-14, L 2500 gpm @ 138 TDH |
| 09D56048 | Pump Feed Deaerator A & Motor | GOULDS PUMPS - #3405, 2 x 3011, S, 50 gpm @ 100 TDH |
| 09D56049 | Pump Feed Deaerator B & Motor | GOULDS PUMPS - #3405, 2 x 3011, S, 50 gpm @ 728 TDh |
| 09D56050 | Pump Feed A & Motor | GOULDS PUMPS - #3316, 2 x 3-11, m, 84 gpm @ 728 TDH |
| 09D56051 | Pump Feed B & Motor | GOULDS PUMPS - #3316, 2 x 3-11, m, 84 gpm @ 728 TDH |
| 09D56054 | Pump Waste Treater Supply A | GOULDS PUMPS - #3196, 2 x 3-10, mt, 150 gpm @ 69 TDH |
| 09D56056 | Pump Waste Filter Backwash & | GOULDS PUMPS - #3195, 4 x 6-10, mt, 800 gpm @ 57 TDH |
| 09D56057 | Pump Waste Filter Feed & Motor | GOULDS PUMPS - #3196, 1½ x 3-6, st, 150 gpm @ 69 TDH |
| 09D56059 | Pump Flush Solvent & Motor | GOULDS PUMPS - #3735, 1 x 2-13A, m, 30 gpm @ 590 TDH |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

G. Utilities (09)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D56060 | Pump Seal Flush A & Motor | GOULDS PUMPS - #3736, 2 x 4-11, m, 100/150 gpm @ 82 TDH |
| 09D56061 | Pump Seal Flush B & Motor | GOULDS PUMPS - #3736, 2 x 4-11, m, 100/150 gpm @ 82 TDH |
| 09D56062 | Pump Circulating Slurry & Motor | E.D. GREEN CORP. - Pacific #1570.0, 22½ gpm @ 20 psig |
| 09D56064 | Pump Dowtherm Circulating A & Motor | GOULDS PUMPS - #3735, 4 x 6-13, L, 700/1550 gpm @ 320 TDH |
| 09D56069 | Pump Sump Cooling Belt Area 01 Motor | E.D. GREEN CORP. - Pacific #2095-D, 90 gpm @ 70 TDH |
| 09D56064 | Pump Dowtherm Circulating B & Motor | GOULDS PUMPS - #3735, 4 x 6-13, L, 700/1550 gpm @ 320 TDH |
| 09D56071 | Pump Feed C & Motor | GOULDS PUMPS - #3316, 2 x 3-11, m, 84 gpm @ 728 TDH |
| 09D56072 | Pump Cooling Water Circulating C & Motor | GOULDS PUMPS - #3405, 8 x 10-14, L, 2500 gpm @ 138 TDH |
| 09D56088 | $N_2$ Absorber Pump | SURFACE COMBUSTION |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

G. Utilities (09)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D56089 | $N_2$ Absorber Pump | SURFACE COMBUSTION |
| 09D56090 | Stripper Pump | SURFACE COMBUSTION |
| 09D56092 | Pump Flottazure Recycle | GULF DEGREMONT - Aurora Model L5 Turbine 42 gpm @ 116 FT |
| 09D56093 | Pump Polyelectrolyte Transfer | GULF DEGREMONT - 1/2 hp |
| 09D56094 | Filter Supply Pump No. 1 | GULF DEGREMONT - Goulds #3196, 1 x 1½-6, 75 gpm @ 116 FT |
| 09D56095 | Filter Supply Pump No. 2 | GULF DEGREMONT - Goulds #3196, 1 x 1½-6, 75 gpm @ 116 FT |
| 09D56103 | Pump Dowtherm Charge & Motor | FOSTER EQUIPMENT - Yarway #0731-34-3321 Type D, 227, 36 gph @ 290 psig |
| 09D56204 | Pump Waste Reaction Sludge & | MOYNO PUMPS, Frame 2L4, Type CDF, 3 gpm |
| 09D56205 | Pump Waste Reaction Skim & Motor | MOYNO PUMPS, Frame 2L4, Type CDF, 3 gpm |
| 09D56206 | Pump Waste Reservoir Sludge & Motor | MOYNO PUMPS, Frame 2L4, Type CDF, 3 gpm |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

G. UTILITIES

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D62111 | Deoxo Purifier | SURFACE COMBUSTION |
| 09D62112 | Desulfurizer | SURFACE COMBUSTION |
| 09D64001 | Boiler A | Babcock & Wilcox #FM10-52B, 250 psig 35000 #/hr |
| 09D64002 | Boiler B | Babcock & Wilcox #FM10-52B, 250 psig 35000 #/hr |
| 09D67005 | Tank Process Naptha | UNION TANK WORKS - 120" Ø x 38' - 0" |
| 09D67006 | Tank Process Wash Solvent | UNION TANK WORKS - 15' -4-5/8" Ø x 16' -1" |
| 09D67007 | Tank Process Wash Solvent | UNION TANK WORKS - 15' -4-5/8" Ø x 16' -1" |
| 09D67008 | Tank Raw Solvent A | UNION TANK WORKS - 15' -4-5/8" Ø x 16' -1" |
| 09D67009 | Tank Raw Solvent B | UNION TANK WORKS - 15' -4-5/8" Ø x 16' -1" |
| 09D67017 | Tank Storage Deoinized Water | UNION TANK WORKS - 18' - 0" Ø x 18' - 0" |
| 09D67020 | Tank Incinerator Makeup | UNION TANK WORKS - 72" Ø x 10' - 0" |
| 09D67022 | Tank Sump 65,000 Gal. | UNION TANK WORKS - 34' 0" Ø x 10' - 0" |

G. Utilities (09)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D67023 | Accumulator Flush Solvent Tank | UNION TANK WORKS - 72" Ø x 22' -0" |
| 09D67024 | Accumulator Seal Flush | UNION TANK WORKS - 60" Ø 12' - 0" |
| 09D67027 | Tank Surge Reclaimer | UNION TANK WORKS - 24" Ø x 6' - 0" |
| 09D67028 | Tank Surge Dowtherm | UNION TANK WORKS - 96" Ø x 20' -0" |
| 09D67041 | Flottazur | GULF DEGREMONT - 10' - 5" Ø x 12' - 2" w/ Skimmer |
| 09D67053 | Oxy Contact Tank | GULF DEGREMONT - 60" Ø x 18' High |
| 09D67501 | Chemical Feed Sets for Boiler NaOH & $PO_4$ | MILTON ROY CO. - 175 Gal Tank - #AR120A Pump - 1/4 hp |
| 09D67502 | Chemical Feeds Sets for Boiler Sulfite Na, $SO_3$ | MILTON ROY CO. - 55 Gal Tank - #AR120 Pump - 1/4 hp |
| 09D67506 | Chemical Feeds Sets-Cooling Tower $H_2 SO_4$ w/filter | MILTON ROY CO. - 55 Gal Tank - #AR123A Pump - 1/4 hp |
| 09D67507 | Chemical Feed Sets Phosphate Cooling Tower $PO_4$ | MILTON ROY CO. - 175 Gal Tank - #AR120 Pump - 1/4 hp |
| 09D75110 | Hydrogen Absorber Entrainment Separator | SURFACE COMBUSTION (Union Tank) |

## G. UTILITIES

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D75111 | Nitrogen Absorber Entrainment Separator | SURFACE COMBUSTION (Union Tank) |
| 09D75223 | $CO_2$ Surge Tank | SURFACE COMBUSTION |
| 09D75309 | Stripper | SURFACE COMBUSTION |
| 09D75510 | Boiler Blowdown Flash Vessel | UNION TANK WORKS - 36" Ø x 4' - 0" |
| 09D75511 | Vessel Air Receiver | UNION TANK WORKS - 48" Ø 12' - 0" |
| 09D75513 | Shifter Converter | SURFACE COMBUSTION |
| 09D75514 | Hydrogen Absorber | SURFACE COMBUSTION |
| 09D75515 | Inert Gas Receiver | SURFACE COMBUSTION |
| 09D75516 | Nitrogen Absorber | SURFACE COMBUSTION |
| 09D75517 | $H_3 PO_4$ Day Tank | GULF DEGREMONT - 50 Gal. |
| 09D75518 | Polyelectrolyte Mix Tank | GULF DEGREMONT - 275 Gal. |
| 09D75519 | Polyelectrolyte Aging Tank | GULF DEGREMONT - 275 Gal. 42" ID x 48" High |

EQUIPMENT LIST BY AREAS (cont'd) Rev. 5 4/25/74

G. UTILITIES (09)

| Item No. | Description | Manufacturer and Type |
|---|---|---|
| 09D75520 | Alum Day Tank | GULF DEGREMONT - 350 Gal 48" ID x 48" High |
| 09D75521 | Acid Day Tank | GRAVER WATER CONDITIONING CO. - 100 Gal. Cap |
| 09D75522 | Pressure Retention Tank | GULF DEGREMONT - 36" Dia. x 5' - 0" High, 100 psi |
| 09D75523 | Balancing Tank | GULF DEGREMONT - 3' - 0" Ø x 12' - 0" High |
| 09D75524 | Holding Tank | GULF DEGREMONT - 3' - 0" Ø x 12' - 0" High |
| 09D75525 | Penol-Benzine Tank | GULF DEGREMONT - 6' - 0" Ø x 16' - 0" High |
| 09D75526 | Pump Suction Tank | GULF DEGREMONT - 2' - 6" Ø x 16' - 0" High |
| 09D75527 | Alum Tank | GRAVER WATER CONDITIONING CO. - 260 Gal. 53" High - 38" Ø |
| 09D75528 | Polyelectrolyte Tank | GRAVER WATER CONDITIONING CO. - 100 Gal. |
| 09D75529 | Float Tank | UNION TANK - 36" Ø x 48" High |
| 09D75530 | Syn Gas Water Tank | SURFACE COMBUSTION - (Union Tank) 75 Gal |
| 09D82501 | Mineralizer-w/piping & Tank | CALIFORNIA FILTERS - 140,000 Gal Cap @ 50 gpm |

G. UTILITIES

| Item No. | Description | Manufacturer and Type |
| --- | --- | --- |
| 09D82503 | Disposal Waste Treater | GRAVER WATER CONDITIONING CO. - 20' - 0" Dia. x 20' High |
| 09D82504 | Ammoniator | GULF DEGREMONT - W&T V-800, 240 LB/Day |
| 09D82505 | Water Treating | GULF DEGREMONT |

# APPENDIX D - CONSTRUCTION MILESTONES

# CHRONOLOGY OF CONSTRUCTION OF PILOT PLANT

1972:

June 14: Contract signed with Rust Engineering Company for pilot plant construction.

June 26: Field work started with site clearing.

July:
- o Site clearing completed.
- o Site excavation and filling started.
- o Temporary field office erected on job-site.

August:
- o Rough grading of site completed.
- o Installation of underground utilities started.
- o Concrete placement for foundations started in Slurry Dissolving Area.
- o Installation of plant railroads started.

September: Construction of Administration Building started.

October: Ground Breaking Ceremony.

November:
- o Installation of underground utilities essentially completed.
- o Many foundations and floor slabs started.

December:
- o Road paving started.
- o Structural steel erection started.
- o Field fabrication of coal storage bins started.

1973:

January:
- o Structural steel erection in Coal Receiving and in Slurry Dissolving Areas completed.
- o Warehouse and Maintenance Shop prefab buildings erected, interior work started.

February:
- o Installation of prefab buildings continued, boiler house completed.
- o Most foundations and floor slabs completed.
- o Installation of processing equipment such as pumps, feeders, conveyors, and fans started.
- o Mineral Residue dryer installed.
- o Erection of product storage bins completed.
- o Warehouse and Maintenance Shop building interior work completed.
- o Installation of piping in pipe rack started.

March:
- o Road paving, curbs, gutters, and sidewalks completed.
- o Installation of vessels and heat exchangers in Mineral Separation and Solvent Recovery Areas started.
- o Packaged boilers received and installed.

| | |
|---|---|
| April: | o Dowtherm Heater erected.<br>o Vacuum Flash Preheater erected.<br>o All tanks in Tank Farm erected.<br>o Cooling Water Tower erection started.<br>o Control Room building completed, interior work continued.<br>o Erection of utility bridge structural steel completed. |
| May: | o Coal Slurry Pumps assembled and installed in Coal Receiving Area.<br>o Light ends and wash solvent columns assembled and installed in Solvent Recovery Area.<br>o SRC product solidification belt installation started.<br>o Control panels installed in Control Room. |
| June: | o Slurry preheater received and erected.<br>o Cooling water tower erection completed, installation of electrical, control, and piping systems continued.<br>o Inert gas, hydrogen, and carbon dioxide compressors installed. |
| July: | o Administration building completed and occupied by P&M personnel.<br>o Installation of minor equipment, electrical and piping continued.<br>o Painting of process equipment and piping continued. |
| August: | o Waste water discharge outfall completed.<br>o Finish grading and installation of gravel blanket completed.<br>o Rotary drum filters received and installed in Mineral Separation Area.<br>o Prilling Tower materials delivered. |
| September: | o Dust collection system in Coal Receiving Area completed.<br>o Filter gas compressors installed in Mineral Separation Area.<br>o Prilling tower structural steel erection started.<br>o Cooling water tower completed, installation of cooling water piping continued.<br>o DEA assembly #1 skid and vessels received and set.<br>o Hydrostatic testing of piping started on utility bridge.<br>o Final grading and seeding completed in Administration Building Area. |
| October: | o Electrical, heat tracing, and piping essentially completed in Coal Receiving Area.<br>o SRC product cooling belt installation completed.<br>o Erection of prilling tower structural members completed, piping started.<br>o Waste water incinerator installed in Waste Treatment Area.<br>o Power and lighting and piping in Boiler House completed.<br>o All major equipment for Desulfurization Unit received. |
| November: | o Dust cyclones installed on prilling tower.<br>o Foundations started for waste water clarifier and filters.<br>o Warehouse occupied by P&M personnel.<br>o All major equipment set for inert and syn gas generators and for the Desulfurization Unit. Piping, structural modifications and instrumentation started. |

December:
- o Erection of waste water clarifier started, filters set and piped in.
- o Hydrostatic testing of piping and X-ray of welds continued.
- o Piping and modifications on inert gas, hydrogen/syn gas, and desulfurization units continued.

1974:

January:
- o Chromatograph shed erected and chromatograph panels set.
- o Waste treatment and prilling tower work continued.
- o Piping and instrumentation testing continued.
- o Footings for rail and truck loading stations in Tank Farm completed.
- o Piping started on domestic water system.
- o Installation of plant laboratory furniture and equipment completed.

February:
- o Boilers and instrument air system taken over by P&M.
- o Fuel gas system taken over by P&M.
- o Raw water system taken over by P&M.
- o Warehouse taken over by P&M.
- o Portions of waste water treatment facilities completed and turned over to P&M.
- o Main steam headers taken over by P&M.
- o Piping and instrument checking continued.

March:
- o Inert gas generator taken over by P&M.
- o Dissolvers and flash drums received and set in Slurry Preheating and Dissolving Area. Piping and instrumentation installation continued.
- o Domestic water system completed.
- o Tank Farm completed and taken over by P&M.

April:
- o Dowtherm system taken over by P&M.
- o Inert gas headers taken over by P&M.
- o Seal flush system taken over by P&M.

May:
- o Coal Receiving and Preparation Area taken over by P&M.
- o Solvent Recovery Area taken over by P&M.
- o Slurry Preheater and Dissolving Area taken over by P&M.

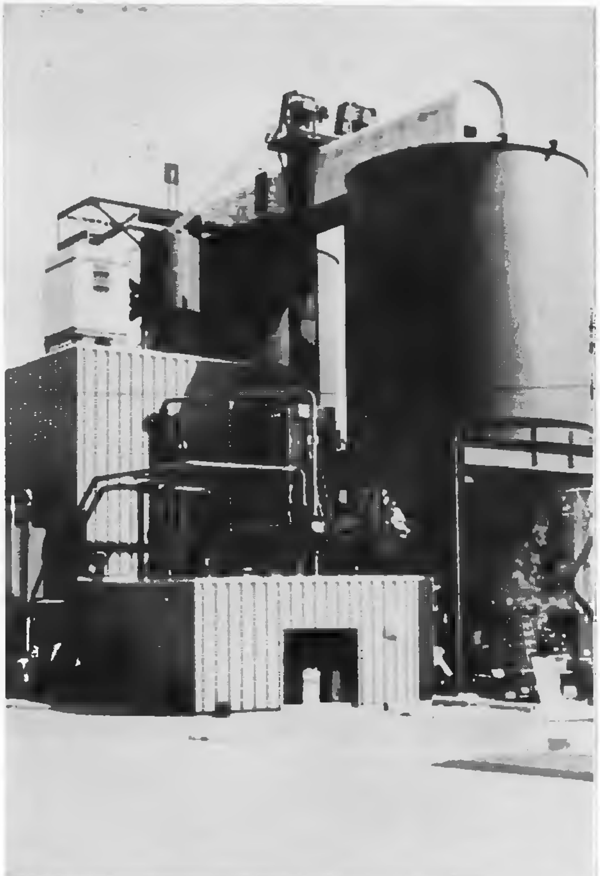
June:
- o Hydrogen gas generator taken over by P&M.
- o Flare system taken over by P&M.
- o Mineral Separation Area taken over by P&M.
- o Dry Chemical and Mineral Residue Storage Area taken over by P&M.
- o Control Room taken over by P&M.
- o Gas Recovery and Recompression Area taken over by P&M.
- o Desulfurization system taken over by P&M.

September:
- o Product Solidification and Storage Area taken over by P&M.

# APPENDIX E - PHOTOGRAPHS OF THE PILOT PLANT AT VARIOUS STAGES OF CONSTRUCTION

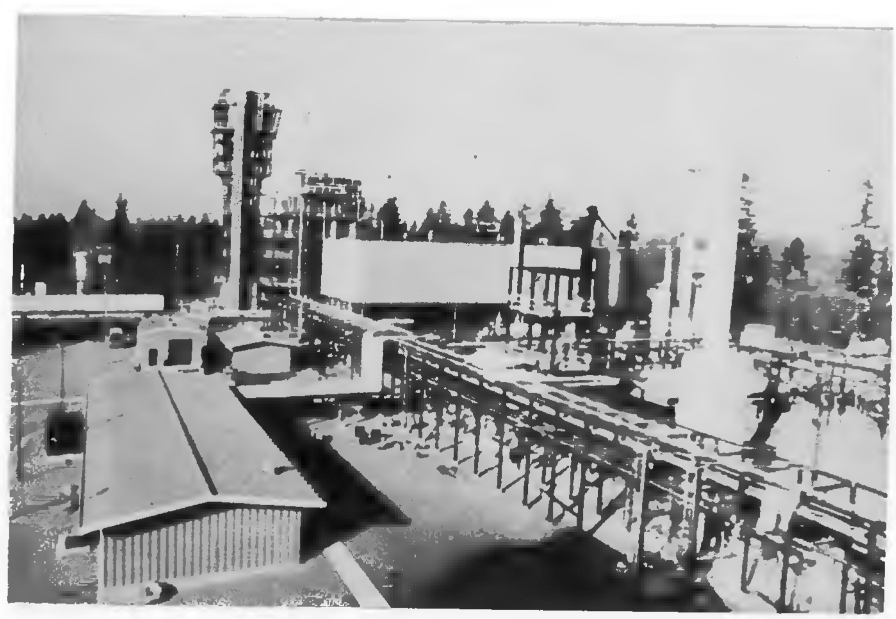
PRODUCT STORAGE BUILDING FOUNDATION
OCTOBER 26, 1972

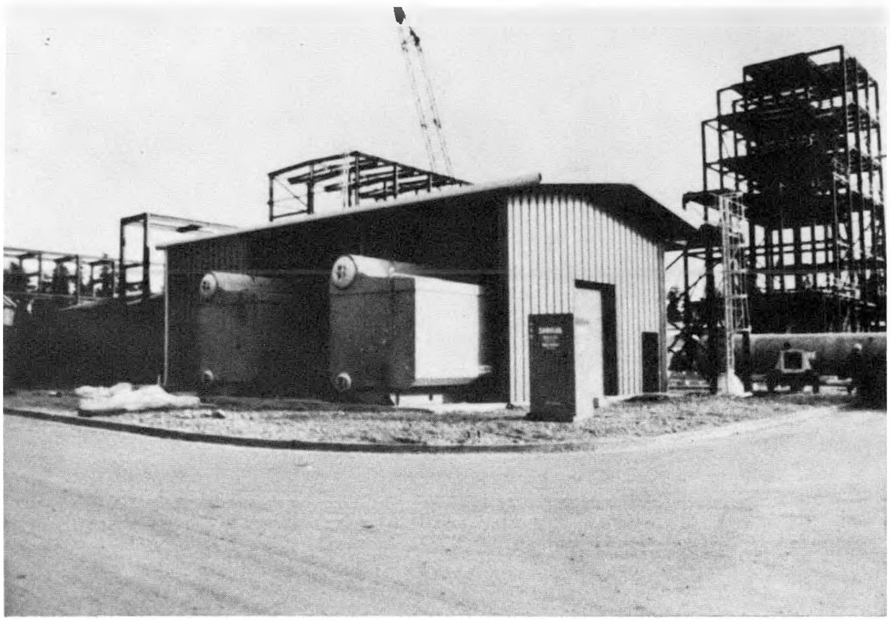
TANK FARM FOUNDATIONS
DECEMBER 21, 1972



COAL RECEIVING AND SLURRY BLENDING AREA
MARCH 18, 1974

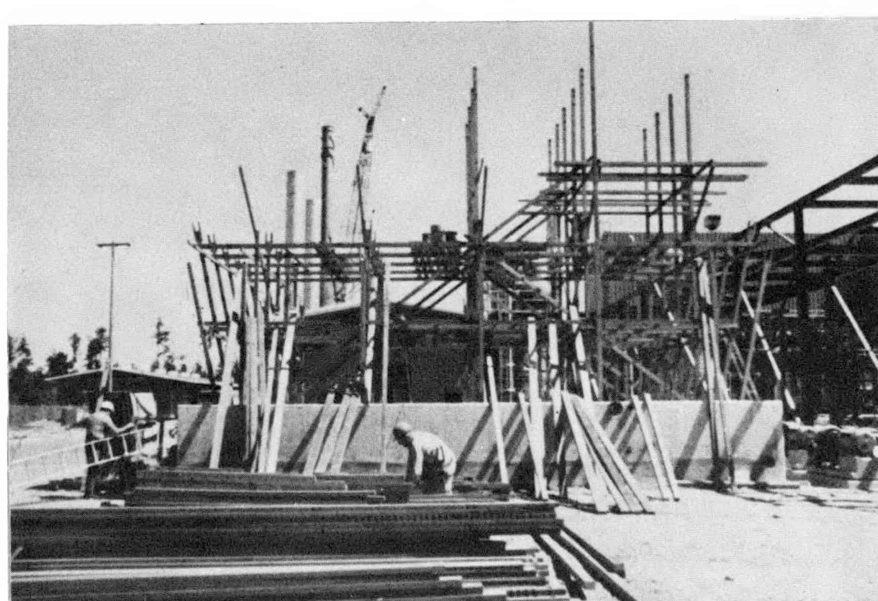
02, 03, 04 and 05 AREAS
VIEWED FROM COAL RECEIVING
MARCH 18, 1974

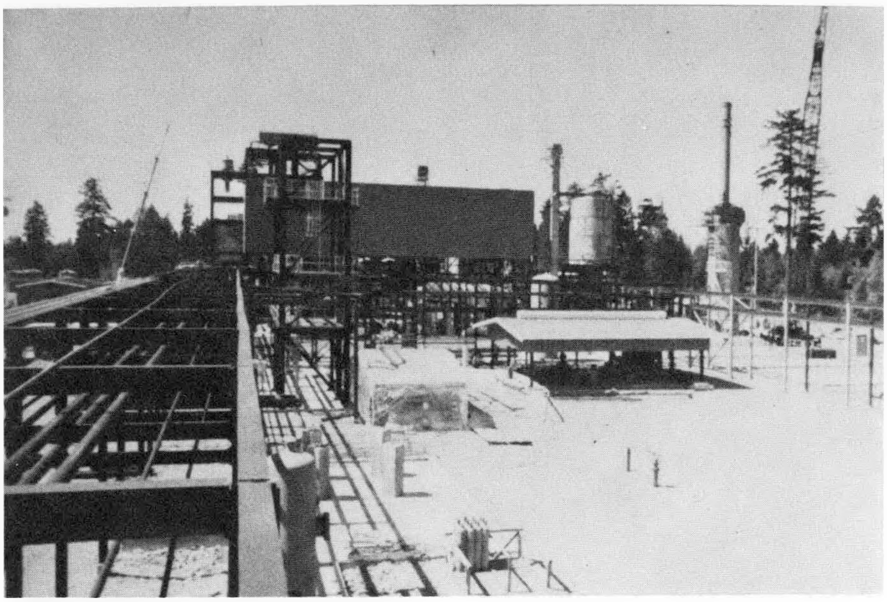




PACKAGE BOILERS
MARCH 16, 1973

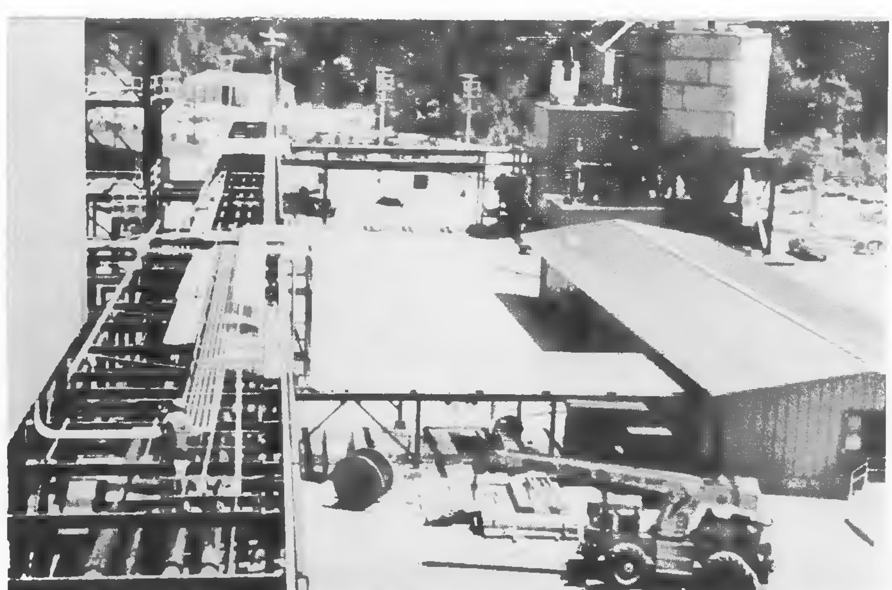
COOLING WATER TOWER
MAY 8, 1973

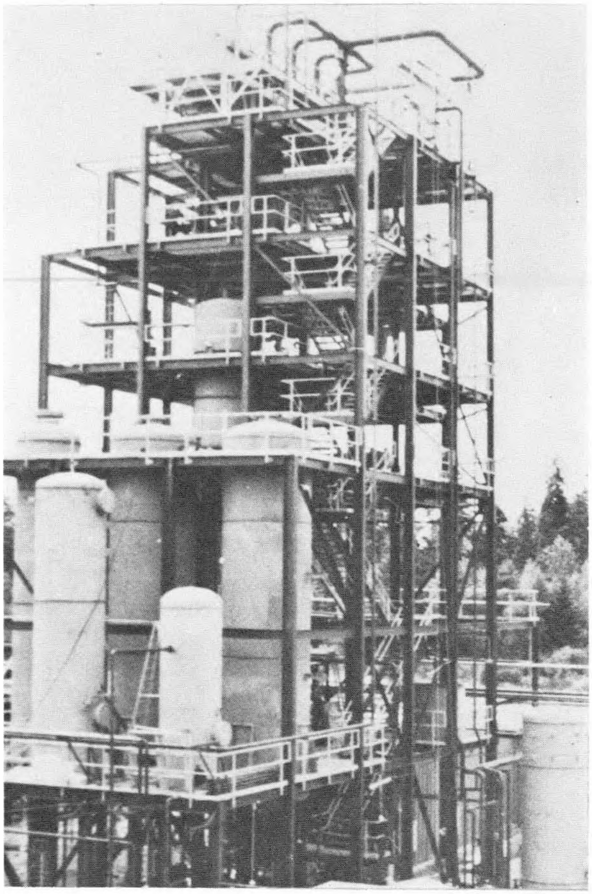




DISSOLVER, MINERAL SEPARATION AND GAS RECOVERY AREAS
MAY 8, 1973

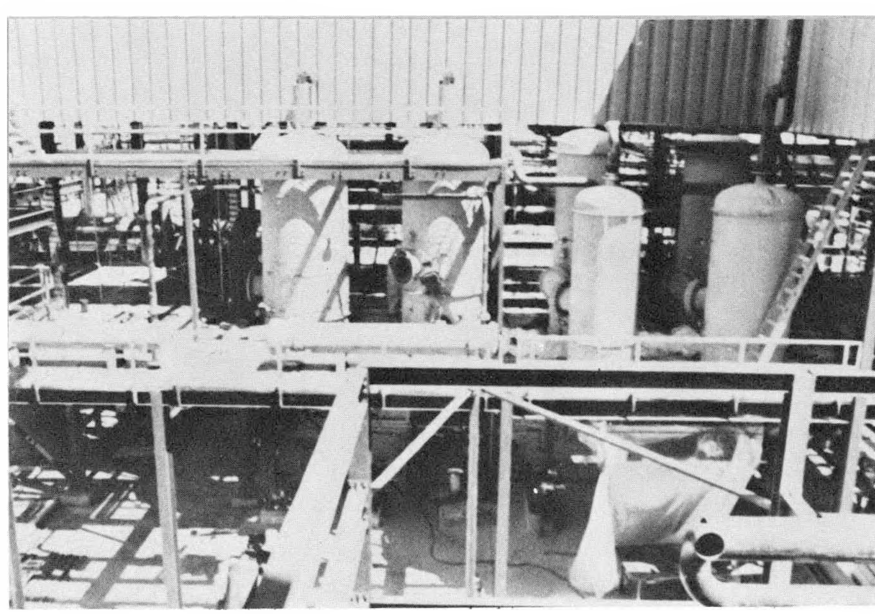
CONTROL ROOM AND COAL RECEIVING AREAS
JUNE 4, 1973

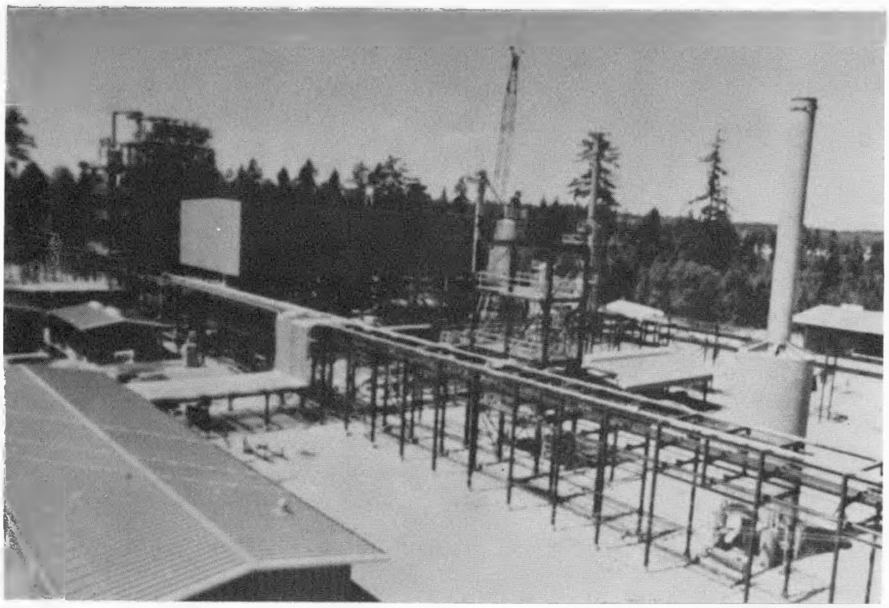




SOLVENT RECOVERY AREA
JUNE 13, 1973

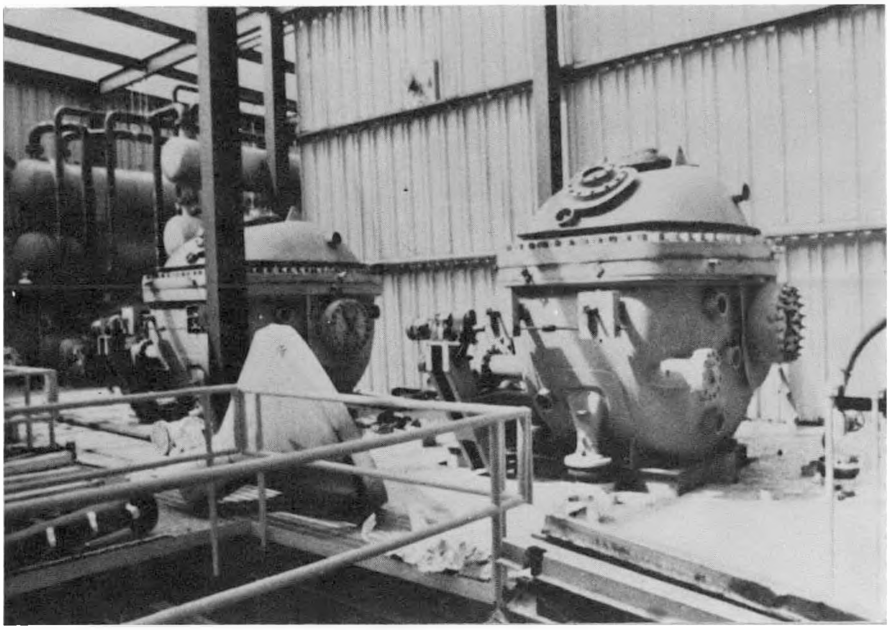
FILTRATION TANKAGE
JULY 9, 1974





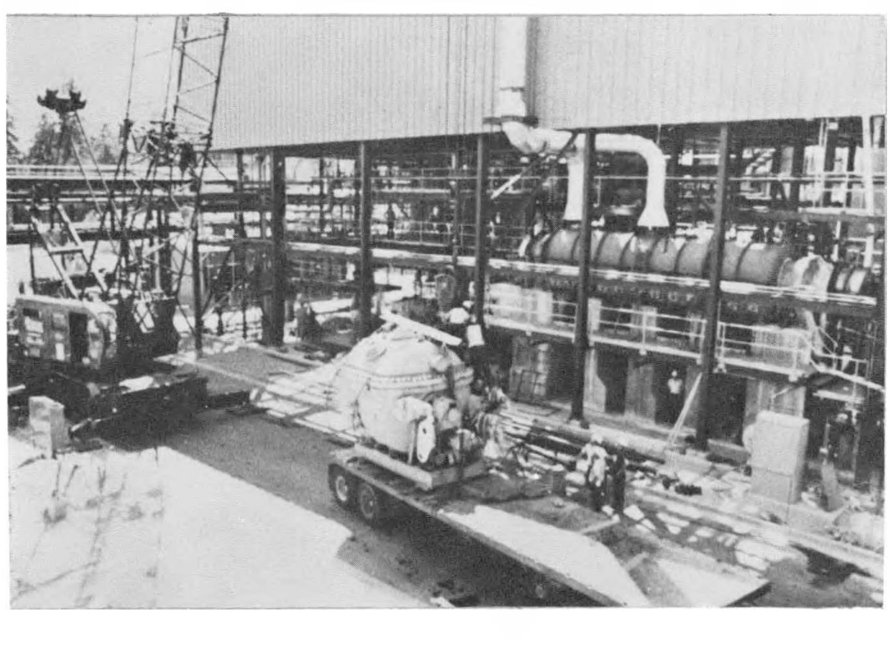
02, 03, 04, and 05 AREAS VIEWED FROM COAL RECEIVING
JULY 9, 1973

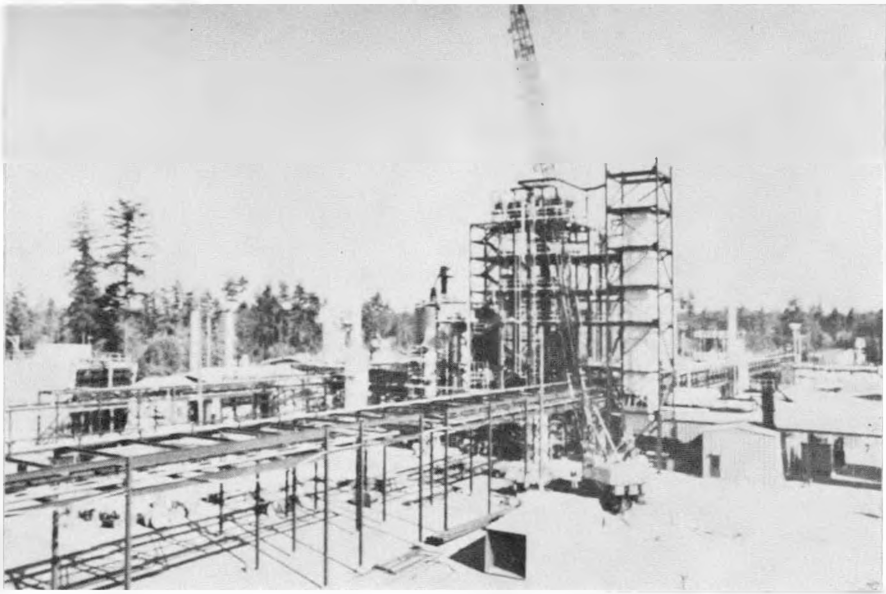
TANK FARM
JULY 9, 1973



ROTARY DRUM FILTERS
AUGUST 15, 1973

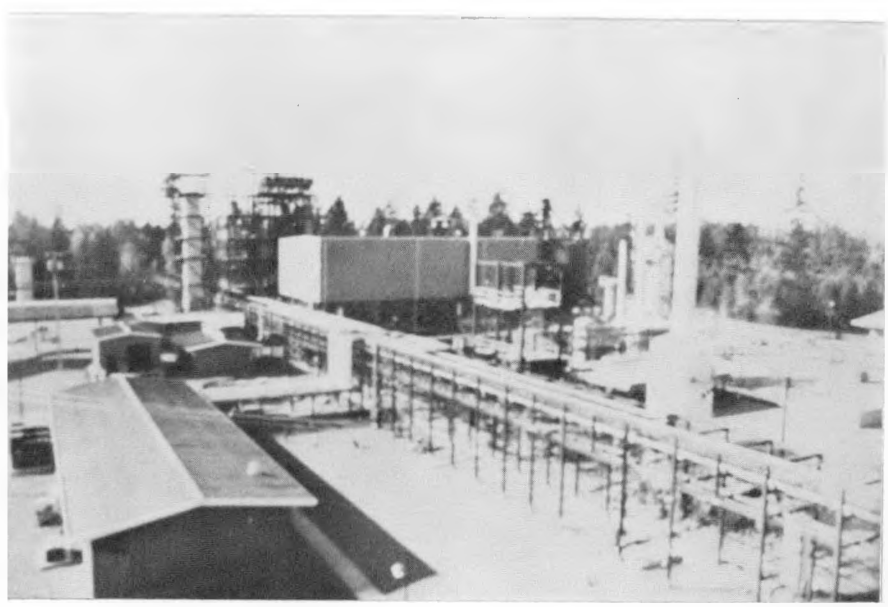
ROTARY DRUM FILTER AND MINERAL RESIDUE DRYER
AUGUST 15, 1973

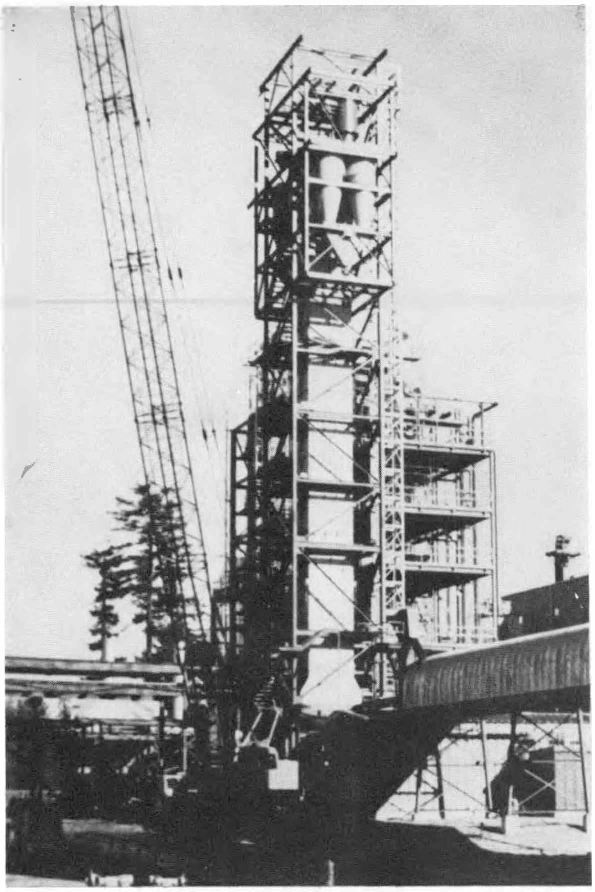




COOLING TOWER, BOILER HOUSE, DOWTHERM HEATER,
SOLVENT RECOVERY AND PRODUCT SOLIDIFICATION
OCTOBER 3, 1973

02, 03, 04 AND 05 AREAS VIEWED FROM COAL RECEIVING
OCTOBER 3, 1973



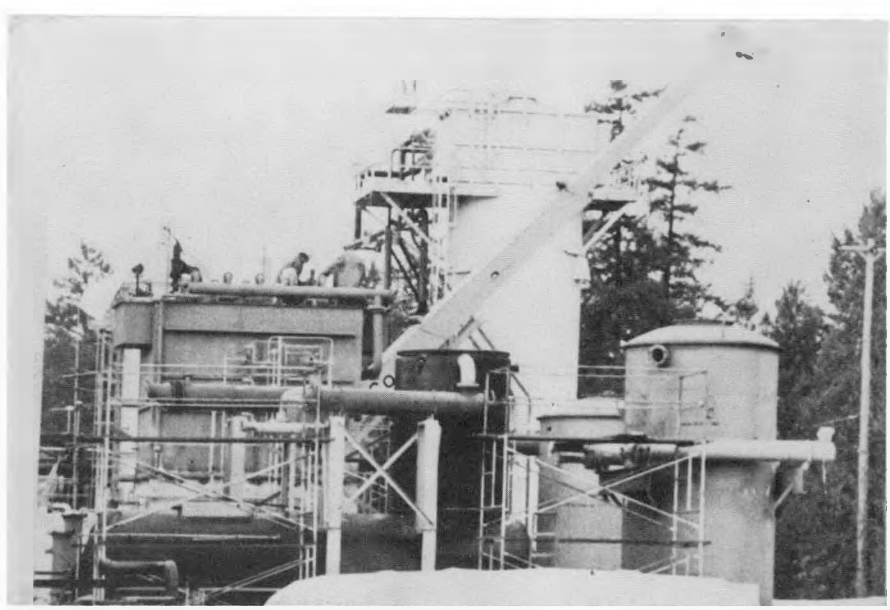


PRILLING TOWER
NOVEMBER 7, 1973

WASTE WATER TREATMENT AREA
FEBRUARY 20, 1974

SLURRY PREHEATER AND DISSOLVERS
MARCH 18, 1974

HYDROGEN AND INERT GAS UNIT
MARCH 18, 1974



AERIAL VIEW OF PLANT SITE
JULY 12, 1974