Crandon Project pyrite processing study, phase II : economics, capital costs, operating costs, revenues. 2489/02 June 1981

Davy McKee Engineers and Constructors
[s.l.]: Davy McKee Engineers and Constructors, June 1981

https://digital.library.wisc.edu/1711.dl/VOX2JWI6UDPMZ8W

Attachment 5

EXXON MINERALS COMPANY, U.S.A.

HOUSTON, TEXAS

CRANDON PROJECT

PYRITE PROCESSING STUDY

PHASE II - ECONOMICS

CAPITAL COSTS

OPERATING COSTS

REVENUES

JUNE 1981

2489/02

Davy McKee
ENGINEERS AND CONSTRUCTORS

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A
PYRITE PROCESSING STUDY

PHASE II

TABLE OF CONTENTS

SECTION

2489/2
June 1981

EXXON MINERAL COMPANYS, U.S.A.
PYRITE PROCESSING STUDY

PHASE II

CAPITAL COSTS, OPERATING COSTS, REVENUES

1. INTRODUCTION

Phase II of the Pyrite Processing Study is based on the conclusions of Phase I which indicated that:

- Markets were available for the anticipated products.
- Transportation modes of adequate capacity could be made available.
- Commercially proven process routes can be followed to produce the selected products.

The selected products that we will further investigate for capital costs, operating costs and revenues are as follows:

Sulfuric Acid
Iron Pellets
Diammonium Phosphate
Nonferrous and Precious Metals

A description of the process facilities, flowsheets, equipment lists and plot plan follows, which provides the information for the capital cost estimates and eventual operating cost estimates.

The operating costs, along with revenues received from the products produced determine the viability of each process route.

Further, we have provided an Alternate Case A that utilizes all the proposed Crandon pyrite concentrate (1,094,800 MTPY) without separation into -20, +20 micron fractions, and estimated the capital costs, operating cost, and revenues for the same selected products. The capital and operating costs for the alternate case have been factored utilizing in-house background data.

During the later phases of the study, Exxon requested additional alternates to the study. Alternate B and B-1 are identical to the Base Case and Alternate Case A, except that the sulfuric acid from the zinc refinery will not be available. Only the phosphoric acid and DAP plants will be affected by reduced output. The capital costs, operating costs and revenues will be factored as in Alternate A. These new alternates will be identified as B and B-1.

1.1 PROCESS FACILITIES DESCRIPTION

The descriptions of the process facilities are based on process flow diagram 2489-01 through 07 which are in Section 7 of this document. The annual pyrite feed to the complex will be 315,000 metric tons at 15% moisture, equivalent to 267,400 dry metric tons.

The analysis of the Crandon pyrite concentrate is as follows:

Element	Assay, % Slime (-20 micron)
Fe	43.60
Cu	0.12
Ni	0.0035
Pb	0.123
Zn	0.66
Bi	0.010
Cd	0.0022
Cr	0.0034
Co	0.017
Mn	0.019
Hg	0.0004
Mo	0.0004
Ti	0.038
Sn	0.001
Te	0.0048
S	49.12
SiO_2	2.20
Al_2O_3	0.52
CaO	0.073
MgO	0.56

The complex is intended to process the Crandon pyrite concentrates into clean iron pellets and sulfuric acid. The 400,000 MTPY of sulfuric acid along with the 320,000 MTPY of sulfuric acid from the produced zinc refinery, will be further processed through the intermediate phosphoric acid step into Diammonium Phosphate Fertilizer (DAP).

Phosphate rock and ammonia must be purchased to achieve the latter step.

From the diammonium process step, we can eliminate process steps back to the basic sulfuric acid process to attain the most economical project.

The cinder produced in the roasting step will be processed further to remove the nonferrous impurities to make a pellet usable in the steel industry. The nonferrous metals and precious metals removed from the cinder are recovered in a further process step.

1.1 PROCESS AREA 01 (Reference Drawing 2489-01)

Pyrite Unloading, Storage & Handling

The pyrite would be loaded on railroad cars at Crandon and received at either of the process centers - Green Bay, Wisconsin or Evansville, Indiana; two trains per week, 48-car trains, hauling approximately 7200 MT (75 MT per car) which will cover the normal operating requirements. The trains are unloaded by a rotary car dumper with a capacity to dump one of the unit trains in eight hours. A surge hopper below the dumper insures a steady feed to a 900mm (36") apron feeder which transfers the pyrite to an inclined 60mm (24") stockpiling conveyor. The stockpiling conveyor distributes the pyrite into a covered storage building, 90m (295') by 30m (98') with a storage capacity of 30,000 MT (one month).

A rail mounted electric-powered reclaimer collects and discharges the material onto the 600mm (24") reclaimer belt conveyor. A low speed desintegrator will reduce any oversize agglomerated pyrite before transferring to the conveyor that feeds two surge bins in the roasting area.

1.1.2 PROCESS AREA 02 (Reference Drawing 2489-02)

Pyrite Roasting Plant

The pyrite roasting plant is designed to treat 267,400 dry metric tons per year of fine (minus 20 micron) Crandon pyrite concentrate. Based on a 320 day operating year, the average daily tonnage treated is 840 MT (dry). The operation is performed in two parallel roasting trains with an average capacity of 420 MT/day each or 17.5 MT per hour.

Each train receives the pyrite in a 50 m^3 surge bin, with an 8 hour retention capacity. A weigh belt feeder delivers a constant feed to the roaster by the way of a specially designed rotary valve.

Air at 1.34 atm (5 psi) and a rate of 40,000 Nm^3 per hour (23,540 scfm) is blown into the hearth of each roaster. The air is regulated to maintain a high level of magnetite in the cinder. The temperature of the exit gases at 950°C (1742°F) is controlled automatically by water injection, utilizing the bleed effluent from the sulfuric acid plant.

The roaster gas containing 15.5 to 16.0% SO_2 on a dry basis, with a volume of 37,600 Nm^3/hr (22,150 scfm), carries over about 90% of the fine cinder into the dust collecting trains. The waste heat boiler collects about 70% of this carry-over dust load and reduces the gas temperature to 343°C (650°F). At the same time it generates 12.5 MT per hour of saturated steam at 42 atm (650 psi).

The gas is further cleaned by 8 cyclones arranged in two series sets with two parallel lines. The dust content is reduced from 120 grams/Nm^3 (18.4 grains/acf) to 48 grams/Nm^3 (7.3 grains/acf).

An electrostatic precipitator cleans the still hot gases to 1.3 grams/Nm^3 (0.2 grains/acf) before delivery to the sulfuric acid plant.

The collected fine cinder from the waste heat boiler, cyclones, precipitator and roaster overflow is handled in a resonance conveyor system which deliver it to the rotary cooler. Solid spillage from other areas and the iron residue from the metals recovery area (07) are introduced at this point.

The rotary cooler consists of a steel rotating cylinder, 1.8m diameter (6'0") by 9.1m (30'0") in length with a brick and castable lining. Calcium chloride solution from Area 07 is sprayed onto the cinder mass, providing simultaneous cooling, moistening and calcium chloride addition.

The cooled cinder from both roasting-cooling lines is collected by a 600mm (24") inclined conveyor that elevates the material to the blending bins of the iron pelletizing and cleaning plant, Area 06.

1.1.3 PROCESS AREA 03 (Reference Drawing 2489-03)

Sulfuric Acid Plant

The sulfuric acid plant will produce 1250 MTPD of 100% acid with an acid strength of 93%.

The gas flow from the two roaster lines is 75,200 Nm^3/h (126,000 acfm) at 343°C (650°F) and is quenched in a venturi type scrubber to 60°C (140°F) by water and a recirculating stream of weak acid (1 to 5% H_2SO_4). Most of the residual dust and SO_3 in the gas is removed by the weak acid.

The SO_2 gas is then cooled to 44°C (110°F) to reduce the moisture content. The acid mist and the last traces of dust are removed from the gas stream in two mist precipitators in series. The run-off from the precipitators and the condensate from the cooler is returned to the scrubber pump tank. The scrubber solution is purged continuously to control the acid concentration. After air stripping of the SO_2 content, the effluent is sent to Area 02 for use in the roaster feed.

The clean cooled gas from the precipitators plus the required amount of dilution air from the atmosphere is dried as it passes up through the drying tower packing by countercurrent contact with 93% circulating H_2SO_4. The acid is heated by condensation of moisture from the gas and dilution air, and the resulting dilution of the acid to 150°F. The acid flows by gravity to the drying tower pump tank where it is fortified by the addition of 98% H_2SO_4 from the intermediate and final absorption towers. Dilution water is also added to maintain the correct acid strength. The acid is recirculated to the drying tower by the drying tower pump. A portion of the hot 93% acid is transferred to the intermediate absorption tower for concentration control. Another portion is transferred to the 93% acid stripper where it is stripped of dissolved SO_2. The amount that is required for concentration control in the final absorber flows by gravity to the final absorption tower pump tank. The product acid cooler cools the acid to 43°C (110°F) and then is routed to storage. The remainder of the circulating acid is cooled to 43°C (110°F) in the shell and tube drying tower cooler and returns to the drying tower.

The dried gas passes through an entrainment separator in the top of the drying tower before flowing to the main gas blower. The main gas blower provides the necessary suction to draw the gas through the purification section and sufficient pressure to deliver the gas through the balance of the plant.

The majority of the cold SO_2 gas is heated in the shell side of No. 4 and No. 3 heat exchangers operating in parallel and is further heated to converter inlet temperature 438°C (820°F) in the shell side of the No. 1 heat exchanger. A portion of the cold SO_2 gas bypasses the heat exchanger system and first converter mass and can be used to automatically control the second bed inlet temperature.

The vanadium catalyst in the converter is arranged in four layers or "passes" with cooling between each layer in order to maintain optimum conversion of SO_2 to SO_3. The catalyst charge is distributed to obtain a total conversion of 93.7% through the fourth pass. The gas from the first pass is cooled in the tube side of the No. 1 heat exchanger by interchange with the converter inlet gas, and enters the second pass at 450°C (840°F). The hot gas from the second pass at 492°C (920°F) is cooled in the tube side of the No. 2 heat exchanger to 240°C (466°F) before entering the interstage absorption system. The SO_3 contained in the gas is absorbed and converted to sulfuric acid by a circulating stream of 98% sulfuric acid. The acid and gas flow co-currently through the venturi interstage absorber and leaves the tower at 140°C (285°F) permitting converter autothermal operation at SO_2 strengths below which cannot be achieved by conventional countercurrent towers. The gas leaves the interstage tower entrainment separator via a hot gas jacketed duct to prevent acid condensation on the duct walls and is reheated in the shell side of the No. 2 heat exchangers to 457°C (820°F). The gas from the interstage system can be mixed with a portion of the hot gas 492°C (920°F) from the second pass exit to control third pass inlet temperature of 437°C (820°F).

The gas exits the third pass at 437°C (820°F) and is cooled to fourth pass inlet temperature of 790°F in the tube side of the No. 3 heat exchanger. The gas leaving the fourth pass at 422°C (792°F) is cooled in the tube side of the No. 4 heat exchangers to 215°C (420°F) before entering the final absorption tower.

In the final absorption tower the remaining SO_3 is absorbed from the gas by a countercurrent circulating stream of 98% H_2SO_4. A mist eliminator installed in the tower removes acid mist to maintain a visibly clear stack. The gas leaves the tower mist eliminator essentially free of acid mist with an SO_2 content less than 600 ppm and is routed to the atmosphere via a stack.

In the interstage absorption tower the SO_3 is removed from the gas by absorption in a circulating stream of 98% sulfuric acid. The tower contains two venturi sections where the acid and gas are intimately contacted. Entrained acid is separated from the gas in the packed interstage entrainment separator. The acid, heated by absorption of SO_3 leaves the tower and flows by gravity to the interstage pump tank. The acid temperature in the pump tank is automatically maintained at 120°C (250°F) by recycle of cold acid from the interstage acid cooler. The 250°F acid is pumped through the shell and tube acid cooler where it is cooled to 77°C (170°F) before entering the venturi sprays. Acid concentration is controlled by cross transfer of 93% acid from the drying tower system. The acid produced in the interstage system is pumped to the drying system at 77°C (170°F) on level control.

In the final absorption tower, the remainder of the SO_3 is absorbed by countercurrent contact with a circulating stream of 98% sulfuric acid. The gas flows upward through the packing where it is intimately contacted with 98% acid which enters the tower at 77°C (170°F). The SO_3 is absorbed and the acid is heated to 100°C (210°F) by absorption of SO_3 and cooling the gas.

The acid flows by gravity to the final absorption tower pump tank where it is recirculated to the tower via the acid cooler. Acid concentration is controlled by cross transfer of 93% acid from the drying tower system and acid produced is pumped to the drying tower on level control.

An indirect fired start-up heater is provided to heat up the converter catalyst before the plant is started. This is accomplished by blowing dry air heated to 480°C (900°F) through the catalyst beds.

1.1.4 PROCESS AREA 04 (Reference Drawing 2489-04)

Phosphoric Acid Plant

The phosphoric acid plant is designed to consume 400,000 MTPY of sulfuric acid from the pyrite processing facility plus 320,000 MTPY sulfuric acid from the zinc metallurgical plant. This amount of acid requires 810,000 MTPY, 68 BPL (32% P_2O_5) phosphate rock and will produce 260,000 MTPY P_2O_5 in 28% and 54% P_2O_5 phosphoric acid.

Unground phosphate rock is received from battery limits at the rock storage silo.

A closed circuit ball mill grinding system handling 110 MTPH new feed produces a 68% solids slurry with less than 1.0% plus 28 mesh.

The phosphate slurry is digested with sulfuric acid in a six compartment tank. Specifically designed openings are made in the tank partitions so that the flow of slurry from one compartment to another is through the center of each compartment.

The phosphate rock slurry is fed to the No. 1 compartment and the sulfuric acid, at a rate of 85 MTPH, to No. 3 compartment. Slurry is drawn by vacuum from the No. 5 compartment to the flash cooler, where the heat of reaction is removed by vaporization of water. The temperature of the attack system is regulated by the vacuum in the flash cooler.

The cooled slurry returns to No. 6 compartment and part of it flows into the agitated two tank digestion system. The digestion tanks provide additional retention in a cooled slurry medium to insure that crystallization of the gypsum and fluosilicates is as complete as possible.

The filtration is performed by a vacuum tilting pan-type filter. The pans move on the rotating frame, passing successively beneath the slurry feeding trough and beneath three wash troughs, for strong acid wash, weak acid wash and water wash, respectively.

The slurry fed to the filter is allowed to settle briefly before vacuum is applied. This operation allows the larger particles to cover the cloth, thereby giving a precoating effect and a better clarified filtrate. The initial acid filtered, containing small amounts of gypsum, is returned to the No. 1 compartment in the attack system. Four filtrates are recovered from the filter: No. 1 filtrate (product acid), No. 2 filtrate (recycle acid), No. 3 filtrate (strong acid wash), and No. 4 filtrate (weak acid wash).

The gypsum filter cake is reslurried with pond water and pumped to the gypsum lagoon for disposal, at a rate of 820 metric tons per hour with an average of 20% solids.

The product acid, at an hourly rate of 107 MT and a 28% concentration of P_2O_5, is sent to storage. Half of that 28% acid is further concentrated by evaporation.

The 28% P_2O_5 acid is pumped at a rate of 15 MTPH P_2O_5 into No. 1 evaporator recycle line where it mixes with the circulating acid. Hot, concentrated acid flows from the bottom of the evaporator to the circulating pump which recycles the acid through the heat exchanger. Product acid from the evaporator is drawn from the overflow system and is pumped at 41% P_2O_5 concentration to a Lamella settler for clarification.

The Lamella settler receives nominal 41% P_2O_5 acid from the No. 1 evaporator transfer pump at 3-5% solids. The solids are agglomerated by addition of a flocculant to the acid in the Lamella feed tank. Solids are concentrated to 15 wt% in the Lamella underflow and clarified acid (1% solids) overflows to the 41% acid storage tanks. The 41% acid storage tanks provide a surge capacity of 800 MT P_2O_5. Clarified 41% acid is pumped to the No. 2 evaporator where concentration is completed. The Lamella underflow or sludge acid is pumped to a sludge acid tank where it is held for further clarification.

Vapors from each evaporator are drawn into a barometric condenser where the vapors are condensed by pond water. Air and noncondensables are exhausted from the condenser by steam ejectors. Each barometric condenser is sealed in a hotwell. Pond water from the hotwells is returned to the cooling pond.

Vent air from the storage tanks and hotwells is scrubbed in a packed tower before being released to the atmosphere in order to meet U.S. standards.

The fluorine recovery system is a spray tower located between the phosphoric acid evaporator and the barometric condenser. The spray tower receives evaporator vapors consisting of fluorine (as HF and SiF_4), water vapor, and minor amounts of air and entrained P_2O_5 (as H_3PO_4). The vapors contain 2 to 6% fluorine by weight.

In the spray tower, a solution of ammonium bifluoride, in water, is sprayed to scrub the fluorine compounds from the evaporator vapors. The solution of ammonium fluosilicate and fluosilicic acid is recycled through the spray tower with a portion of the recycle taken as product by use of a specific gravity control system.

As phosphoric acid is concentrated in the first stage evaporator, solids consisting mainly of $CaSO_4$ precipitate out of solution. These solids contain very little or no P_2O_5 (inert solids). At higher P_2O_5 concentrations, precipitates of iron and aluminum phosphates occur.

Sludge acid from the 41% Lamella is fed to a continuous belt filter where the solids are separated and washed with two countercurrent washes. The No. 1 filtrate is pumped to the 41% acid storage tanks and the No. 2 filtrate is pumped to the No. 1 evaporator feed tank. The washed solids are slurried with pond water and pumped to the gypsum slurry tank in the filtration area for disposal.

1.1.5 PROCESS AREA 05 (Reference Drawing 2489-05)

DAP Granulation Plant

The manufacture of DAP starts in the tank reactor where acid is partially neutralized with liquid ammonia. 28% P_2O_5 acid is metered to the scrubber seal tank and circulated to the venturi scrubbers for removal of ammonia and dust from the effluent gas streams. A portion of this scrubber seal tank acid and 54% P_2O_5 phosphoric acid are metered into the tank reactor to maintain the proper acid strength for granulator feed. Vaporous or liquid ammonia is metered into the tank reactor below the liquid level and regulated to maintain the proper NH_3 to H_3PO_4 mole ratio required for the fertilizer grade being produced. A small flow of sulfuric acid to the tank reactor is also required to control the % P_2O_5 in the product.

The resulting slurry from the tank reactor is pumped continuously to the granulator. Here the slurry is distributed over a large cascading recycle stream of dry solids. The slurry wets the fine particles which are coated and rolled together to produce the larger fertilizer granules needed in the product. Ammonia is introduced continuously under the rolling bed in the granulator to complete ammoniation to the product mole ratio required.

The wet fertilizer granules overflow directly into a dryer. Here they are dried by direct contact with a co-current hot air stream. A lump breaker at the dryer outlet protects the following conveying equipment and screens.

The dry particles discharge directly into a bucket elevator and are elevated to the screens. Double-deck screens divert the oversize product to the chain mills for size reduction. The mills discharge to the recycle conveyor. Screen fines flow by gravity directly to the recycle conveyor. The product size material enters a product surge bin for product removal and the excess overflows to the recycle conveyor.

Product material is fed continuously from the product surge bin to a rotary cooler by a weigh belt feeder. Cooled product at 120°F is transported to shipping or storage.

To minimize losses through dust, the dryer and cooler exhaust gases, together with all the vent streams from the conveyors and elevators, are sent to cyclones where the dust is separated and returned to the recycle conveyor. The cyclone off gases pass through the reactor granulator cooler vent (RGCV) and dryer primary scrubbers to recover the gaseous chemicals and to minimize air pollution from these gases prior to venting to the atmosphere. The gases from the tank reactor, which contain a large amount of steam, are vented directly to the RGCV primary scrubber where the steam is removed through condensation. A phosphoric acid solution of approximately 30% P_2O_5 is circulated in the scrubbers to recover ammonia and dust in the gas streams. The excess from the scrubber seal tank is returned continuously to the reactor and the recovered chemicals, together with the phosphoric acid, are used for the production of more fertilizer. The primary venturi scrubbers exit gases pass through a tail gas scrubber for fluorine removal before being vented to the atmosphere.

1.1.6 PROCESS AREA 06 (Reference Drawing 2489-06)

Iron Pelletizing & Cleaning Plant

Cooled pyrite cinder (29 MTPH) at 60°C (140°F) containing 10% moisture and 3% calcium chloride is discharged into four steel, wood-lined blending bins with a capacity of 75 m^3 each (2120 cubic feet).

A blending conveyor recycles the cinder in the bins, at a recycle rate of 1:3. The retention time in the blending recycle system is about 8 hours, providing a homogeneous blend.

Two rubber lined ball mills reduce the cinder to a uniform size distribution by breaking up the sintering formed during roasting. The uniform size improves the formation of green pellets and increases their crushing strength. The ball mills are a continuation of the blending process, as a kneading action takes place in the mills. To avoid choking in the mills due to the high moisture content of the cinder, 100mm (4 inch) grinding balls are used.

Further mixing is carried out in the pug mills, where final moisture and $CaCl_2$ control to produce the pellets is performed. From the pug mills the blended cinder is fed to two parallel balling discs, 3.65m (12 feet) diameter where green pellets of about 15mm (5/8 inches) and with a crushing strength of about 4 kg/pellet are produced.

The green pellets from the balling discs fall into a swing conveyor which transports the green pellets to the dryer conveyor which is an updraft type dryer with hot air recirculation. The temperature is controlled to avoid hot spots above 250°C (480°F) which volatilize the chlorides. The dryer fuel consumption is 2.51×10^6 kilo joules (2.38×10^6 Btu)/MT.

The dried pellets are screened to remove broken balls and fines. The fines are returned to the blending bins. The screened pellets, still at about 200°C (390°F) are transported to a surge bin which feeds a rotary kiln. The kiln has a feed section of 3.0m ID by 20m and a discharge section 3.5m by 16m. Two burners, one main and one auxiliary, provide the temperature profile required: 1250°C in the flame impingement zone and 800°C in the kiln discharge gases. The heat requirements are 5.02×10^6 kJ (4.76×10^6 Btu) per metric ton of pellets. The pellets discharge directly from the kiln to a brick lined shaft cooler where cooling air at a rate of 1100 Nm^3/MT pellets (520 scfm) reduces the temperature to 100°C (210°F). Part of heat in the cooler air is recovered for use as combustion air.

The cooled pellets go to a transfer conveyor to the pellet storage area. A distribution conveyor feeds the pellets to the four pellet bins with a total volume of 600 m^3 capacity which are also used as shipping bins.

The gases from the kiln, containing small amounts of entrained dust, SO_2, SO_3 and all the chlorine, as chlorides of zinc, lead, copper, silver, gold and/or hydrogen, is ducted, without cooling, to a dust chamber where some of the particulate is removed. These solids are returned to the blending circuit by a dust conveyor designed to carry up to 250 kg/h.

The gas flow, 28,000 Nm^3/h is quenched in a cooling tower made up of two vertical cylindrical towers connected at the bottom. The gas enters the first tower at the top and leaves the second tower, also at the top. The gases are contacted by curtains of aqueous solution that not only reduce the temperature by evaporation but also dissolve the metal chlorides present in the gas. The liquor circulation is 56 m^3/h (250 gpm), and its temperature is 65°C (150°F). A continuous bleed of this solution is sent to the metals recovery area.

The gases, at 65°C (150°F) are washed by a recirculating weak chloride solution at 40°C (104°F) in a turbulent contact absorber (TCA) where the temperature is reduced to 42°C (108°F) and most of the residual chlorides have been removed from the gases.

The solution is cooled by aeration in two parallel turbulent contact towers. Cooling air is fed at a rate of 125,000 m^3/h (59,000 scfm) to the two towers, each containing a cooling and washing section. The cooled solution is collected in a settler, and the overflow is pumped to the wash tower.

The gases from the wash tower go through two plate-type mist cottrells in parallel. The residual metal chlorides, HCl and SO_3 are recovered and the gases are exhausted in the stack. These gases have the following remaining impurities:

Cl - 0.15 gr/Nm^3
Zn - 0.03 gr/Nm^3
Cu - 0.25 gr/Nm^3
Pb - 0.025 gr/Nm^3
SO_3 - 1.1 gr/Nm^3

The solutions collected in the mist precipitators go to the same settler at the wash tower. A continuous bleed stream goes back to the metals recovery area.

1.1.7 PROCESS AREA 07 (Reference Drawing 2489-07)

Nonferrous Metals Recovery & $CaCl_2$ Recycling

The bleed stream from the cooling, washing and cleaning gas system in the iron pellets plant has a rate of 6.75 m^3/h (30 gpm) and goes to the metals recovery plant for treatment.

The bleed has the following analysis:

Cu	6 gpl
Pb	6 gpl
Zn	30 gpl
HCl	60 gpl
H_2SO_4	25 gpl
Au	4 gm/m^3
Ag	85 gm/m^3

1.1.7.1 Clarification of the Metals Chloride Solution

The pregnant solution bled from the iron plant, at 65°C (150°F), flows to a 7.3 meter (24 feet) diameter thickener, where suspended solids including precipitated lead sulfate are settled out and removed by the underflow. The precipitate also contains most of the gold and part of the silver. The thickener is of rubber lined steel construction.

The thickener underflow is pumped to the lead recovery section. This underflow amounts to 16 m^3/day and contains 10% solids.

1.1.7.2 Sulfate Separation

The clarified solution is pumped from a 20 m^3 (706 ft^3) storage tank into 3 tanks of PVC lined steel construction. The first two tanks each have 7.5 m^3 capacity and the third tank has a capacity of 150 m^3 (5300 ft^3). The total retention time provided in the three tanks is about 20 hours. The three tanks are provided with rubber-lined agitators. Ground limestone (less than 1mm) is added to tanks 1 and 2, and the pH monitored at the entrance of tanks 2 and 3 controls the limestone additions.

The slurry after the growth of gypsum crystals in the large tank goes to a conical bottom settling tank 6m in diameter and 15m depth of rubber lined steel. The settled slurry at 30% solids is filtered and washed. The filtrate joins the settler overflow. Part of the gypsum from the settler underflow is recirculated at a rate of 3.4 m^3/h (15 gpm) to the first precipitation tank. The specific gravity of the slurry is about 1.6.

The daily gypsum output is between 8 to 10 MT.

1.1.7.3 Copper Recovery

The solution from the 20 m^3 (706 ft^3) surge tank, after the settler overflow, and gypsum filtrate, is pumped into a cementation tank of rubber-lined steel and heavy gauge stainless steel construction. About 1.1 Kg of light scrap iron is consumed per kilogram of copper. The cement copper output is 60 Kg per hour with 70% copper content. The cement copper slurry is pumped alternately to two filter presses covered with polypropylene cloth, 3.4 m^2 (36 sq ft) each, or 6.8 m^2 total. Each filter handles 140 kilograms of cement copper per cycle. The filtration is carried out at a pressure of 5 Kgm/cm^2 (70 psig). Two kilograms wash water per kilogram of cement copper are required.

1.1.7.4 Lead Recovery

Part of the lead which did not precipitate as a lead sulfate and was removed during clarification is still in solution (after cementation) and is recovered as lead sulfide by reaction with hydrogen sulfide.

About 150 kg per day of hydrogen sulfide are used and 300 kg per day of crude lead sulfide are precipitated out of the solution. The reaction is performed in a 4 m^3 rubber lined tank with agitation where about 30 minutes retention time are provided. The slurry is thickened in a 6 meter diameter by 1.5 meter side tank, and the thickened slurry (25% solids) is pumped to a press filter similar to the one used for the cement copper. The filter cake contains about 45% lead and also other sulfides of residual copper, iron, etc.

The overflow from the lead sulfide thickener, filtrate and wash water from the filter are sent to the iron removal section.

1.1.7.5 Iron Removal

The solution now contains the original iron, plus the amount introduced during copper cementation, and almost all the zinc and the chloride ions. The flow is 6.75 m^3/h (30 gpm) and contains:

Fe	-	10 g/l
Zn	-	30 g/l
Cl	-	60 g/l

The solution is received into 3 agitated tanks, in cascade, 8 m^3 (300 ft^3) each, where the temperature is raised by direct steam injection up to 80°C (175°F). At the same time sparger air is introduced below the agitator, and pulverized limestone (-200 mesh) is added to control the pH at 4.6.

The iron oxidized to the ferric state is precipitated and the resulting slurry overflows into a 6-meter diameter by 1.5-meter side conic bottom tank settler.

The settled slurry, containing between 15% to 20% solids (150 kg/h solids) is filtered by a filter press with the same characteristics of those used for cement copper and lead compounds. Settler overflow and filtrate are ready for zinc recovery. The iron cake is sent to the pelletization plant without washing.

1.1.7.6 Zinc Recovery

The clean solution, now about 75-80°C (165-175°F), is received into an agitated 8 m^3 (300 ft^3) tank where pH is adjusted to 8.6 by lime addition. The slurry overflows into a 7 meter (24') diameter thickener. The settled slurry at 15% solids (350 kg/h solids) is filtered by the way of a rotary drum vacuum filter and washed. The final solution with a concentration of about 10% calcium chloride is returned to the cinder cooling and pelletizing circuit.

2. ENVIRONMENTAL CONSIDERATIONS

2.1 PYRITE ROASTING IN TURBULENT BED REACTORS

Process Areas 01 & 02

The primary environmental consideration for pyrite roasting is fugitive dust escaping from the processing and handling equipment.

Because of the extremely fine character of the pyrite and calcine, the plant is designed to minimize the loss of fugitive dust to the atmosphere. Both Indiana and Wisconsin have regulations controlling such dust (Reference 1,2).

References

1. Indiana Air Pollution Control Regulations, Regulation APC 20, Fugitive Dust.

2. Wisconsin Air Pollution Control Rules, NR 154.11, Control of Particulate Emissions.

2.2 SULFURIC ACID MANUFACTURE

Process Area 03

Primary environmental considerations in sulfuric acid manufacture from roaster gas are an off gas containing small amounts of sulfur dioxide and acid mist and a weak acid purge stream containing mineral impurities from the roaster gas.

Neither the U.S. EPA, Indiana or Wisconsin have a regulation applying specifically to emissions from a sulfuric acid plant utilizing a feed gas from an iron pyrites roaster. The normal limit of 2 kg/metric ton of 100% sulfuric acid produced set for new sulfur burning plants appears to exclude facilities where conversion to sulfuric acid is utilized primarily as a means of preventing emissions to the atmosphere of sulfur dioxide. (Reference 1,2,3)

The U.S. EPA has established standards for new sources such as primary zinc, copper and lead smelters (Reference 4) which have some similarity to the roasting of iron pyrites and therefore could be considered when the appropriate agencies are reviewing the matter. The limit for the smelters is 650 ppmV, which can be achieved using a double absorption process.

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

The Federal Clean Air Act Amendments (CAAA) of 1977 impose additional limitations to sources of SO_2. Proposed amended regulations relating to the CAAA were published on September 5, 1979 (Reference 5) and probably will be promulgated in time to apply to this sulfuric acid plant. These regulations will subject the acid plant to a Prevention of Significant Deterioration (PSD) review provided the following conditions are present:

2.2.1 Plant is a listed source
2.2.2 Emission is a criteria pollutant
2.2.3 Emission is in excess of 100 short tons/year
2.2.4 Construction commenced after March 19, 1979

It is believed that all of these conditions are present with the sulfuric acid plant. A PSD review entails an analysis of ambient air quality in the area of the proposed new source over a period of time and a determination of whether the new source will cause an increase in sulfur dioxide beyond that allowed by the ambient air quality standards. It is not known whether this would occur without monitoring the air quality for the specific plant site or sites.

Acid mist content and the opacity of the off gas can be controlled at an environmentally acceptable level by using mist eliminators. The EPA (and Indiana) limit for acid mist is 0.075 kg per metric ton of sulfuric acid produced in a new sulfur burning acid production plant (Reference 1,6). Wisconsin does not have a regulation specifically for acid mist. The EPA and Indiana limit for opacity (another measure of acid mist) is 10% for sulfur burning acid plants. The EPA opacity limit for smelters is 20%.

The weak acid purge stream contains weak sulfuric acid, mineral impurities from the dust in the roaster gas and trace quantities of fluorides. It is utilized as part of the water feed to the roasting operations.

References

1. EPA Standards of Performance for New Stationary Sources, 40 CFR 60, Subpart H - Standards of Performance for Sulfuric Acid Plants.

2. Indiana Air Pollution Regulations, Regulation APC 13, Amended May 23, 1979.

3. Wisconsin Air Pollution Control Rules, NR 154.12, Control of Sulfur Emissions.

4. EPA Standards of Performance for New Stationary Sources 40 CFR 60, Subparts P, Q, R - Standards of Performance for Primary Copper, Zinc and Lead Smelters.

5. EPA Proposed Amendments to Prevention of Significant Deterioration Regulations, 44 FR 51924, September 5, 1979.

6. Indiana Air Pollution Regulations, Regulation APC 10, November 29, 1978.

2.3 PHOSPHORIC ACID MANUFACTURE

Process Area 04

Primary environmental considerations in phosphoric acid manufacture include particulate emissions from phosphate rock and handling, an off gas containing fluorides, an impure byproduct gypsum, and cooling pond water contaminated with fluorides and other impurities.

EPA has proposed performance standards for new phosphate rock plants (Reference 1). However, since wet grinding is used, there should be no problem with particulate emissions.

Fluoride gases in the form of silicon tetrafluoride and hydrogen fluoride are evolved in the reaction of sulfuric acid and phosphate rock and in subsequent filtration and evaporation sections of the plant. New source performance standards (NSPS) for wet process phsophoric acid plants have been established by the Federal EPA for fluoride emissions (Reference 2). This is 0.01 kg of fluoride per metric ton (0.02 lb per short ton) of equivalent P_2O_5 fed. Indiana and Wisconsin do not have standards established for phosphoric acid plants. The EPA limit is normally achieved by scrubbing the gases with pond water utilizing technology developed in existing phosphoric acid plants. The primary scrubbing device is a spray-cross flow packed bed scrubber.

The pond water is circulated so that the fluoride level builds up and is finally stabilized by precipitation and some evolution to atmosphere.

The pond water is also used as cooling water and is normally operated in a closed circuit. Sometimes it becomes necessary to discharge excess water from heavy rainfall and this is treated to remove the fluoride content. Such discharge would be covered by an NPDES permit issued by the EPA (Reference 3) and an equivalent State permit (Reference 4, 5). The accepted technology for treatment is two-stage neutralization (double liming).

The gypsum formed during the manufacture of the phosphoric acid is filtered and washed and sent to a gypsum pond as a slurry. The solid gypsum separates and the excess water overflows to the cooling pond.

The gypsum contains part of the fluoride originally present in the phosphate rock. This, however, is in a relatively insoluble form. The gypsum also contains radium 226 which was also originally in the phosphate rock. Because of the radioactivity, the U.S. EPA has proposed that byproduct gypsum from phosphoric acid manufacture be considered a special hazardous waste under the Resource Conservation and Recovery Act (Reference 6). If this is retained in the final regulation, special rules would be applied to the storage facility.

References

1. EPA Proposed Performance Standards for New Phosphate Rock Plants, 44 FR 54970, September 21, 1979.

2. EPA Standards of Performance for New Stationary Sources, 40 CFR 60, Subpart T, for Phosphate Fertilizer Industry: Wet Process Phosphoric Acid Plants.

3. EPA Regulations on the National Pollutant Discharge Elimination System, 40 CFR 122.

4. Indiana Stream Pollution Control Board Regulations, SPC-15, November 29, 1973.

5. Wisconsin Discharge Permits Regulations, Chapters NR200, 201, 220.

6. EPA Proposed Hazardous Waste Guidelines and Regulations 43 FR 58946, December 18, 1978.

2.4 DIAMMONIUM PHOSPHATE (DAP) MANUFACTURE

Process Area 05

Primary environmental considerations for DAP manufacture are a tail gas containing ammonia, fluorides and particulates, a pond water containing fluorides, ammonia and phosphate and fugitive dust from product handling.

Part of the tail gas originates in the reactor, granulator and product cooler. This is scrubbed with phosphoric acid in a wet venturi scrubber where dust and ammonia are recovered. Tail gas also originates from the dryer which is passed through a cyclone before being scrubbed with phosphoric acid in another wet venturi scrubber to recover dust. Each of the tail gas streams is then scrubbed with pond water in vertical packed bed or spray cross flow packed bed scrubbers to remove fluorides.

The combined tail gas is then sent to atmosphere through a stack. With properly designed equipment it should be in compliance with the U.S. EPA New Source Performance Standard for DAP plants for fluorine emission which is 0.03 kg/metric ton (0.06 lb/short ton) (Reference 1). It would also be in compliance with Wisconsin and Indiana particulate emission regulations (Reference 2,3). There are no Federal, Indiana or Wisconsin regulations controlling ammonia emissions except perhaps from an odor or nuisance standpoint. An adequately designed stack disperses the gases to minimize the nuisance.

Pond water is used to cool and scrub the gases as described above. The water is normally circulated in a closed circuit and accumulates fluoride, ammonia and phosphate impurities. If it becomes necessary to discharge excess water to a public stream, it will be necessary under EPA and state rules (Reference 4,5,6) to treat it to remove impurities. An accepted method of removal of fluoride and phosphate is precipitation by using two stage neutralization of double liming. If removal of ammonia is mandated, this could be done by air stripping of the water at high pH.

Fugitive dust is generated in the storage and handling of the DAP product. Both Indiana and Wisconsin have regulations controlling such dust (Reference 2,3). This is controlled by proper equipment and building design and treatment of the product with a dedusting agent prior to shipments.

References

1. EPA Standards of Performance for New Stationary Sources, 40 CFR 60, Subpart V, for Phosphate Fertilizer Industry - Diammonium Phosphate Plants.

2. Indiana Air Pollution Control Regulations, Regulation APC-5, Process Operations and APC-20, Fugitive Dust.

3. Wisconsin Air Pollution Control Rules, NR154.11 Control of Particulate Emissions.

4. EPA Regulations on the National Pollutant Discharge Elimination System, 40 CFR 122.

5. Indiana Stream Pollution Control Regulations, SPC-15, November 29, 1973.

6. Wisconsin Discharge Permits Regulations, Chapters NR200, 201, 220.

2.5 IRON PELLETIZING & CLEANING

Process Area 06

Primary environmental considerations in iron pelletizing and cleaning are a dryer off gas containing small amounts of calcine dust and off gas from the chloridizing operation containing small amounts of metals.

After the calcium chloride solution is added to the calcine and the pellets are formed, these are dried in a conveyor dryer using a hot flue gas/air mixture. The off gas from the dryer contains small amounts of calcine dust. These are removed in a wet scrubber.

The gas from the chloridizing operation is discharged from a stack after a series of cleaning operations to remove particulate matter and fume. It contains small quantities of copper, lead, zinc and iron as well as chloride and SO_3, probably in combination with the metals. No EPA or state performance standards have been issued for this type operation, probably because these standards have been written only for processes which are major pollution sources at present.

In the absence of performance standards, it is probable that the EPA and state agencies would expect Best Available Control Technology (BACT) to be applied based on the requirements of the Clean Air Act Amendments of 1977. This would apply to the sulfur oxides content of the off gas. The exact configuration and efficiency of the equipment would have to be negotiated.

References

1. Indiana Air Pollution Control Regulations, Regulation APC-20, Fugitive Dust.

2. Wisconsin Air Pollution Control Rules, NR 154.11, Control of Particulate Emissions.

2.6 NONFERROUS METALS RECOVERY

Process Area 07

The primary environmental considerations in nonferrous metals recovery from pelletizing plant sludges are a byproduct gypsum and contaminated water from drips and spills.

The gypsum is washed to remove residual chlorides and sent to the gypsum pond.

The contaminated water from drips and spills is collected and recycled.

3. ESTIMATED PLANT COSTS

PYRITE PROCESSING COMPLEX

Indiana or Wisconsin

3.1 CAPITAL COSTS

The capital cost estimates for the selected processes have been prepared by utilizing both of the following:

3.1.1 In-house information for recently built similar process facilities, with the pertinent corrections for differences in scope definition, uncertainty factors and price variations due to escalation, and,

3.1.2 The developed flowsheet, with identification of major pieces of equipment in sufficient detail to obtain a reliable quotation, and all other services evaluated by factors applied to the estimate for equipment.

In all cases the cost estimate is broken down into individual plant areas.

Qualifications to the capital cost estimates are:

- Probable accuracy of ±25%
- Engineer, Purchase, Construct in scope
- Present day, built in a day costs
- Wisconsin or Indiana, U.S. location
- Single contractor responsibility
- Permits by client
- 3000 psf soil bearing assumed
- Process fees included
- U.S. codes and standards
- Uninstalled spares by others

The offsite facilities were estimated as though the total complex were to be built through diammonium phosphate (DAP) (Figure 3).

As processes were eliminated, the items not necessary for that phase of the process were deleted and the magnitude of the facilities reduced.

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

Alternate Case A

The Base Case concept of the pyrite processing study was to utilize the minus 20 micron fraction, 764 MTPD, (840 STPD) of the pyrite concentrate for further processing, and utilizing the plus 20 fraction, 2364 MTPD (2600 STPD) of the pyrite, as mine fill.

The Alternate Case A is to utilize the total amount of the pyrite concentrate, 3128 MTPD (3440 STPD) to further process into marketable products as was done with the 764 MTPY of minus 20 micron material (slimes). The pyrite material would not be separated as previously which should enhance its ability to filter and drain and its handling qualities. The mixture is also somewhat different in the chemical analysis, but not enough to generate any significant difference in the product qualities.

The new product quantities that will be produced from the 3128 MTPD (3440 STPD) of Crandon pyrite utilizing the same process routes, Figures 1, 2 and 3, as indicated in the minus 20 micron fraction and is as follows:

CRANDON PYRITE PRODUCTS

(Alternate Case A)

Primary Products		
Pyrite concentrate	1,094,800 MTPY	(1,203,400 STPY)
Sulfuric acid - 100%	2,014,000 MTPY	(2,215,400 STPY)
Pyrite H_2SO_4	1,694,000 MTPY	(1,863,400 STPY)
Zinc plant H_2SO_4 (1)	320,000 MTPY	(352,000 STPY)
Iron pellets (65.1%)	718,000 MTPY	(859,100 STPY)
Secondary Products		
Phosphoric acid (100%)	727,300 MTPY	(800,030 STPY)
Diammonium phosphate	1,572,000 MTPY	(1,729,200 STPY)
Separating Supplies (Required)		
Phosphate rock (68-72 BPL)*	2,264,000 MTPY	(2,490,400 STPY)
Anhydrous ammonia*	346,000 MTPY	(380,600 STPY)

*The above major supplies are required to produce the secondary products.

(1) This sulfuric acid from the proposed zinc refinery will be utilized to produce P_2O_5 and DAP.

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

CRANDON PYRITE PRODUCTS

ALTERNATE CASES B & B-1

No Zinc Refinery Sulfuric Acid

ALTERNATE CASE B

Primary Products

Pyrites (slimes)	267,400 MTPY (294,500 STPY)
H_2SO_4 (100%) - pyrites	400,000 MTPY (440,000 STPY)
Iron pellets (65.2% Fe)	180,000 MTPY (198,000 STPY)

Secondary Products

Phosphoric acid (100% P_2O_5)	145,000 MTPY (159,000 STPY)
Diammonium phosphates (18-46-0)	313,000 MTPY (344,000 STPY)
Gypsum	1,100,000 MTPY (1,111,000 STPY)

Supporting Supplies

Phos rock (68-72 BPL)*	450,000 MTPY (495,000 STPY)
Ammonia (anhydrous)*	70,000 MTPY (76,400 STPY)

ALTERNATE CASE B-1

Primary Products

Pyrites (mixed)	1,094,000 MTPY (1,203,400 STPY)
H_2SO_4 (100%) - pyrites	1,694,000 MTPY (1,863,000 STPY)
Iron pellets (65.2% Fe)	718,000 MTPY (859,000 STPY)

Secondary Products

Phosphoric acid (100%)	611,740 MTPY (672,915 STPY)
Diammonium phosphates (18-46-0)	1,322,228 MTPY (1,454,450 STPY)
Gypsum	6,000,000 MTPY (6,600,000 STPY)

Supporting Supplies

Phos rock (68-72 BPL)	1,887,000 MTPY (2,075,300 STPY)
Ammonia (anhydrous)*	288,300 MTPY (317,130 STPY)

*The above major supplies are required to produce the secondary products - phosphoric acid, diammonium phosphate and byproduct gypsum.

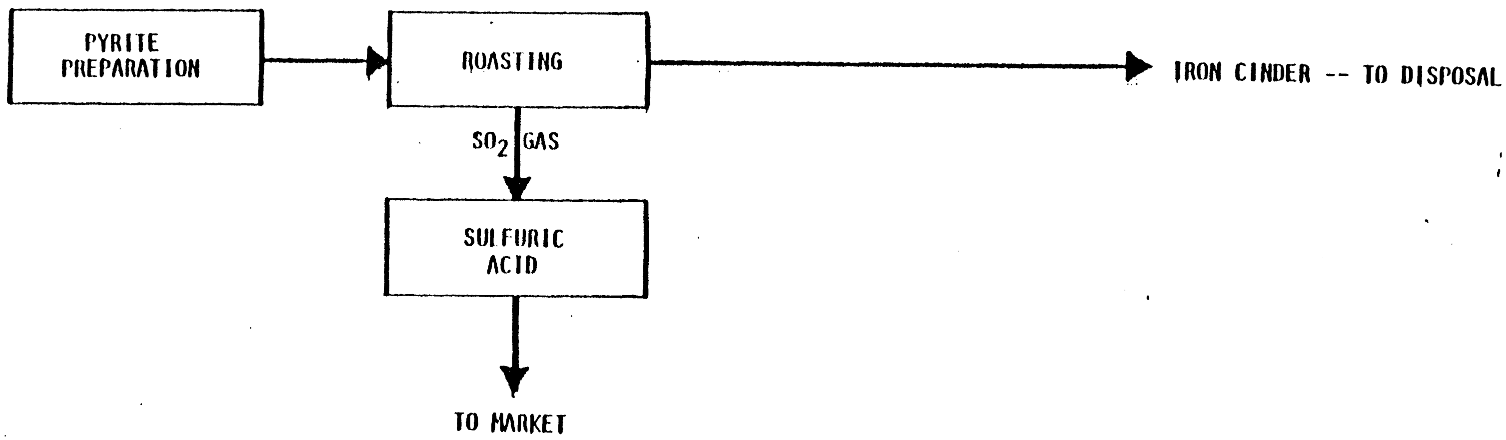
2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

OFFSITE FACILITIES

TOTAL COMPLEX THROUGH DIAMMONIUM PHOSPHATE

Administration Building w/Laboratory (equipped)
Parking Lot
Changehouse (equipped)
Fire House & First Aid Station (equipped)
Guard House
Truck Scale
Maintenance Shop/Warehouse (equipped)
Effluent Treatment Plant
Sewage Treatment Plant
Incoming Power Source (transformer by power company)
Plant Road System
Perimeter Fencing w/Gates
Railroad Spur & Sidings
Railroad Scale
Dock & Barge Unloading/Loadout Facilities - Phosphate Rock, Ammonia, DAP, Iron Pellets, Sulfuric Acid
Sulfuric Acid Storage & Handling
Diammonium Phosphate Storage Handling & Storage
Complex Fire Water System
Deep Well (process water)
Ammonia Unloading & Storage
Fuel Oil Storage & Distribution
Defoamer Storage & Distribution
Plant & instrument Air Compressors & Building
Phosphate Rock Storage - Stock & Reclaim System
Package Boiler, Water Treatment & Building
Site Preparation
Pipe Racks, Tie-ins & Distribution Systems
Neutralization plant
Gypsum pond
Water impoundment area
Complex substation (transformers by power company)



ALR 1/15/80

PROCESS BLOCK FLOW DIAGRAM

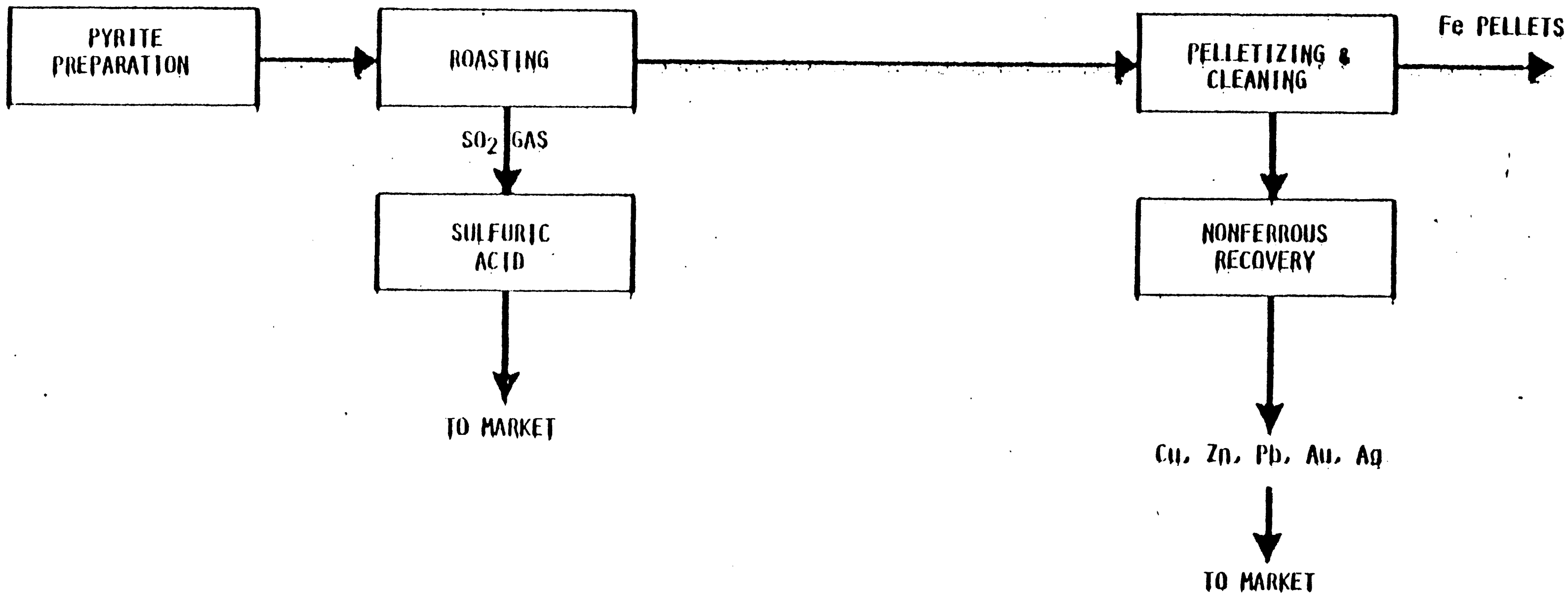
SULFURIC ACID ONLY. IRON CINDER TO DISPOSAL

FIGURE 1

Davy McKee

EXXON MINERALS COMPANY, U.S.A.

PYRITE PROCESSING STUDY



PROCESS BLOCK FLOW DIAGRAM

SULFURIC ACID, IRON PELLETS
AND NONFERROUS METAL RECOVERY

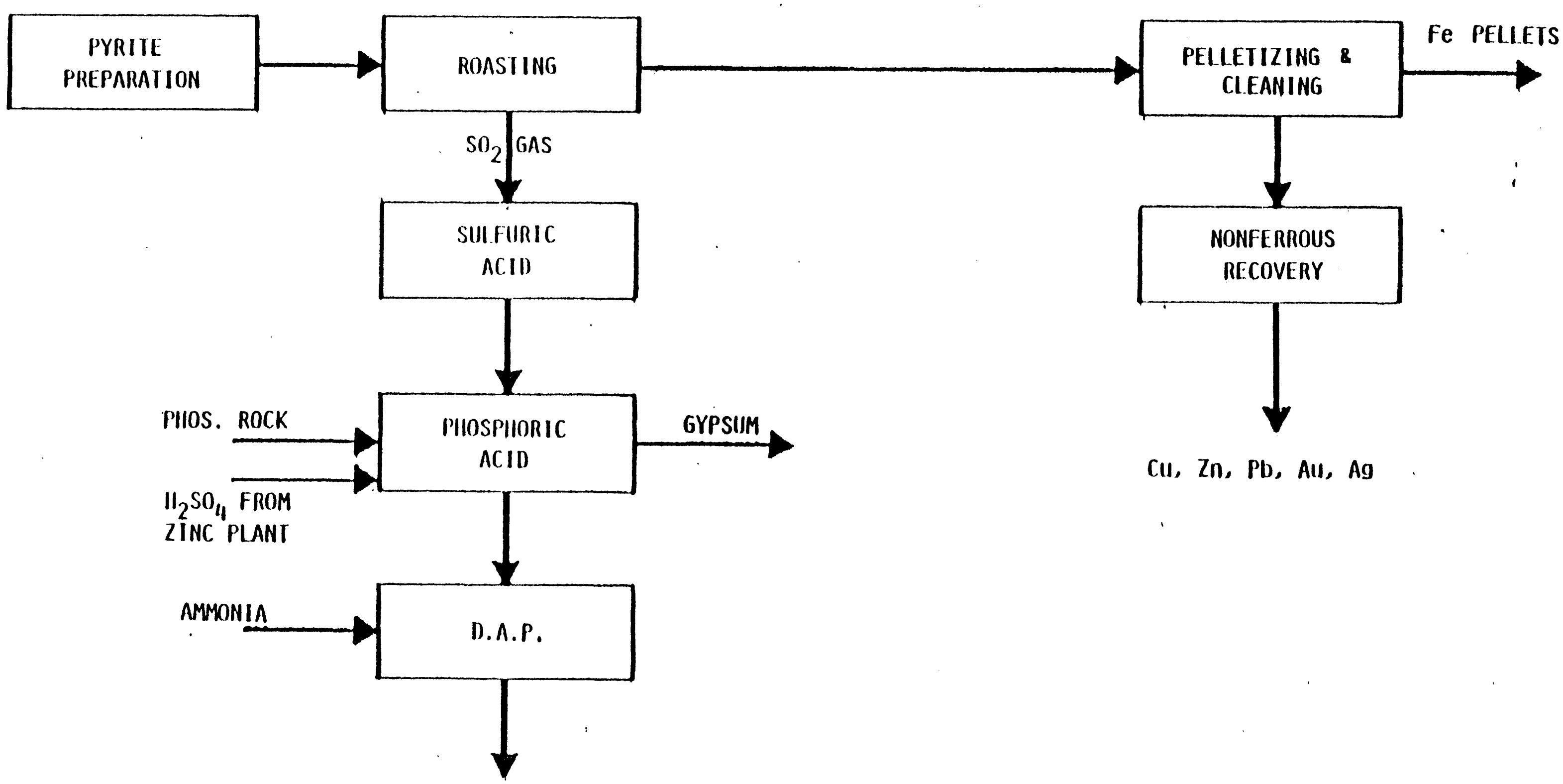
FIGURE 2

ALR 1/15/80

Davy McKee

EXXON MINERALS COMPANY, U.S.A.

PYRITE PROCESSING STUDY



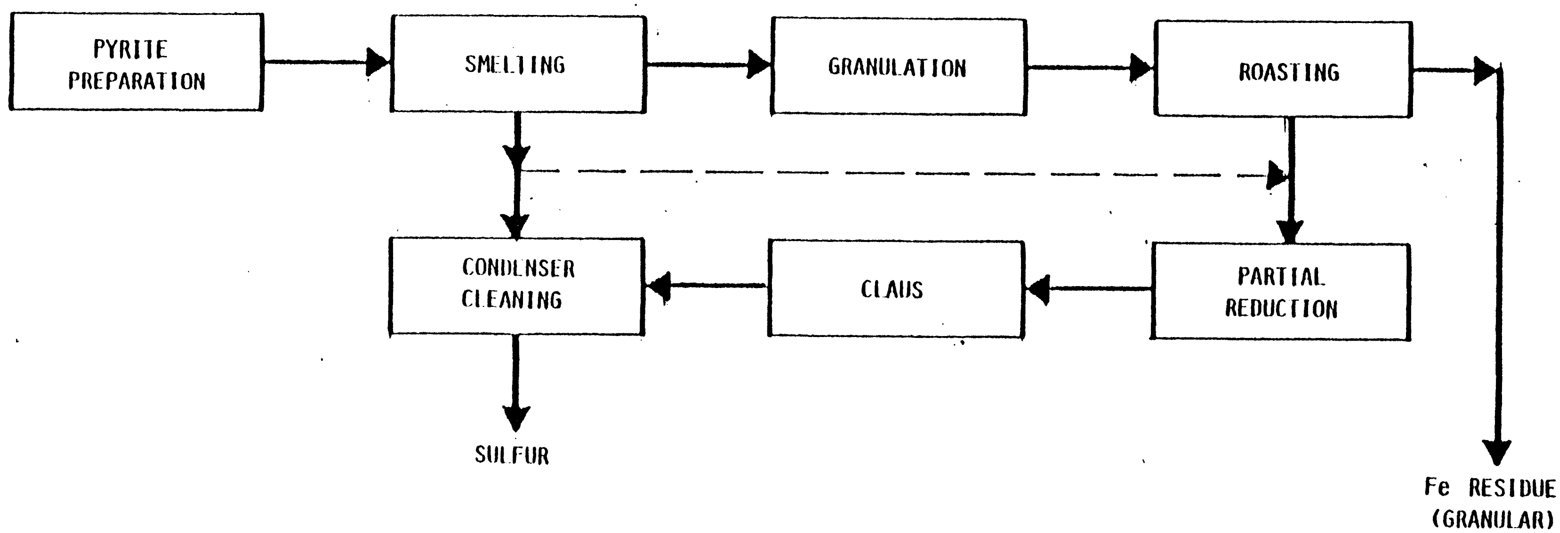
PROCESS BLOCK FLOW DIAGRAM
PELLET ROUTE
SULFURIC ACID, PHOSPHORIC ACID, D.A.P. AND IRON PELLETS
FIGURE # 3

ALR 1/15/80

Davy McKee

EXXON MINERALS COMPANY, U.S.A.

PYRITE PROCESSING STUDY



PROCESS BLOCK FLOW DIAGRAM
SULFUR RECOVERY & IRON RESIDUE

FIGURE # 4

ALR 1/15/80

Davy McKee

EXXON MINERALS COMPANY, U.S.A.

PYRITE PROCESSING STUDY

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

The capital costs for the process indicated (Base Case) are estimated as follows. The Alternate Cases A, B and B1 Capital Costs are also shown in this Section, Figures 4 through 11.

Sulfuric Acid Only - Pyrite Cinders to Waste (Figure 1)

	Capacity	$ Cost Millions
Pyrite Handling (01)	267,400 MTPY	4.0
Pyrite Roasting Plant (02)	267,400 MTPY	21.5
Sulfuric Acid Plant (03)	400,000 MTPY	18.0
Offsites		20.5
Total		64.0

Sulfuric Acid, Iron Pellets, Nonferrous Metals Reclamation (Figure 2)

	Capacity	$ Cost Millions
Pyrite Handling (01)	267,400 MTPY	4.0
Pyrite Roasting Plant (02)	267,400 MTPY	21.5
Sulfuric Acid Plant (03)	400,000 MTPY	18.0
Iron Pellet Plant (06)	180,000 MTPY	11.4
Nonferrous Reclamation (07)		1.6
Offsites		27.5
Total		84.0

Sulfuric Acid, Iron Pellets, DAP, Nonferrous Metals Reclamation (Figure 3)

	Capacity	$ Cost Millions
Pyrite Handling (01)	267,400 MTPY	4.0
Pyrite Roasting (02)	267,400 MTPY	21.5
Sulfuric Acid Plant (03)	400,000 MTPY	18.0
Phosphoric Acid - Diammonium Phosphate (04) and (05)	562,000 MTPY	45.5
Iron Pellet Plant (06)	180,000 MTPY	11.4
Nonferrous Metal Reclamation (07)		1.6
Offsites		43.0
Total		145.0

PYRITE PROCESSING STUDY

CAPITAL COST ESTIMATES

Sulfuric Acid Only - Pyrite Cinders to Waste (Figure 1)

	Base Case		Alternate Case A	
	267,400 MTPY Pyrite Feed ±25% Accuracy		1,094,000 MTPY Pyrite Feed, Order of Magnitude Accuracy	
	Capacity	$ Cost Millions	Capacity	$ Cost Millions
Pyrite Handling (01)	267,400 MTPY	4.0	1,094,000 MTPY	10.0
Pyrite Roasting Plant (02)	267,400 MTPY	21.5	1,094,000 MTPY	69.0
Sulfuric Acid Plant (03)	400,000 MTPY	18.0	1,694,000 MTPY	68.0
Offsites		20.5		63.0
TOTAL		64.0		210.0

Figure 4

Davy McKee

PYRITE PROCESSING STUDY

CAPITAL COST ESTIMATES

COST BREAKDOWN BY PLANT COMPONENTS

Sulfuric Acid Only - Pyrite Cinders to Waste (Figure 1)

	Base Case 267,400 MTPY Pyrite $ Cost Millions	Alternate Case A 2,094,000 MTPY Pyrite
Pyrite Handling		
Equipment	1.4	3.5
Bulk Materials	1.2	3.0
Construction	1.0	2.5
Home Office & Fees	0.4	1.0
Total	4.0	10.0
Roasting Plant		
Equipment	8.5	28.0
Bulks	5.4	17.0
Construction	5.5	17.0
Home Office & Fees	2.1	7.0
Total	21.5	69.0
Acid Plant		
Equipment	7.5	26.5
Bulks	5.0	19.0
Construction	4.0	15.5
Home Office & Fees	1.5	7.0
Total	18.0	68.0
Offsites		
Equipment & Services	8.2	25.0
Bulks	6.0	19.0
Construction	4.3	13.0
Home Office & Fees	2.0	6.0
Total	20.5	63.0
Plant Total	$64.0 Million	$210 Million

Figure 5

PYRITE PROCESSING STUDY

CAPITAL COST ESTIMATES

Sulfuric Acid, Iron Pellets, Nonferrous Metals Reclamation (Figure 2)

	Base Case 267,400 MTPY Pyrite Feed ±25% Accuracy		Alternate Case A 1,094,000 MTPY Pyrite Feed Order of Magnitude Accuracy	
	Capacity	$ Cost Millions	Capacity	$ Cost Millions
Pyrite Handling (01)	267,400 MTPY	4.0	1,094,000 MTPY	10.0
Pyrite Roasting Plant (02)	167,400 MTPY	21.5	1,094,000 MTPY	69.0
Sulfuric Acid Plant (03)	400,000 MTPY	18.0	1,694,000 MTPY	68.0
Iron Pellet Plant (06)	180,000 MTPY	11.4	718,000 MTPY	25.0
Nonferrous Reclamation (07)		1.6		4.0
Offsites		27.5		74.0
TOTAL		84.0		250.0

Figure 6

PYRITE PROCESSING STUDY
CAPITAL COST ESTIMATES
COST BREAKDOWN BY PLANT COMPONENTS

Sulfuric Acid, Iron Pellets, Nonferrous Metal Reclamation (Figure 2)

	Base Case 267,400 MTPY Pyrite $ Cost Millions	Alternate Case A 1,094,000 MTPY Pyrite $ Cost Millions
Pyrite Handling		
Equipment	1.4	3.5
Bulk Materials	1.2	3.0
Construction	1.0	2.5
Home Office & Fees	0.4	1.0
Total	4.0	10.0
Roasting Plant		
Equipment	8.5	28.0
Bulks	5.4	17.0
Construction	5.5	17.0
Home Office & Fees	2.1	7.0
Total	21.5	69.0
Acid Plant		
Equipment	7.5	26.5
Bulks	5.0	19.0
Construction	4.0	15.5
Home Office & Fees	1.5	7.0
Total	18.0	68.0
Iron Pellets		
Equipment	4.5	10.0
Bulks	2.8	7.0
Construction	2.6	6.0
Home Office & Fees	1.5	2.0
Total	11.4	25.0
Nonferrous Reclamation		
Equipment	.56	1.4
Bulks	.47	1.0
Construction	.47	1.1
Home Office & Fees	.16	.5
Total	1.6	4.0
Offsites		
Equipment & Services	8.3	23.0
Bulks	8.2	22.0
Construction	8.2	22.0
Home Office & Fees	2.8	7.0
Total	27.5	74.0
Plant Total	$84.0 Million	$250 Million

Figure 7

PYRITE PROCESSING STUDY

CAPITAL COST ESTIMATES

DAP, Sulfuric Acid, Iron Pellets, Nonferrous Metals Reclamation (Figure 3)

	Base Case		Alternate Case A	
	±25% Accuracy		Order of Magnitude Accuracy	
	Capacity	$ Cost Millions	Capacity	$ Cost Millions
Pyrite Handling (01)	267,400 MTPY	4.0	1,094,000 MTPY	10.0
Pyrite Roasting (02)	267,400 MTPY	21.5	1,094,000 MTPY	69.0
Sulfuric Acid Plant (03)	400,000 MTPY	18.0	1,694,000 MTPY	68.0
Phosphoric Acid-Diammonium Phosphate (04) and (05)	562,000 MTPY	45.5	1,572,000 MTPY	120.0
Iron Pellet Plant (06)	180,000 MTPY	11.4	718,000 MTPY	25.0
Nonferrous Metal Reclamation (07)		1.6		4.0
Offsites		43.0		104.0
TOTAL		145.0		400.0

Figure 8

PYRITE PROCESSING STUDY
CAPITAL COST ESTIMATES
COST BREAKDOWN BY PLANT COMPONENTS

DAP, Sulfuric Acid, Iron Pellets, Nonferrous Metal Reclamation (Figure 3)

	Base Case 267,400 MTPY Pyrite $ Cost Millions	Alternate Case A 1,094,000 MTPY Pyrite $ Cost Millions
Pyrite Handling		
Equipment	1.4	3.5
Bulk Materials	1.2	3.0
Construction	1.0	2.5
Home Office & Fees	0.4	1.0
Total	4.0	10.0
Roasting Plant		
Equipment	8.5	28.0
Bulks	5.4	17.0
Construction	5.5	17.0
Home Office & Fees	2.1	7.0
Total	21.5	69.0
Acid Plant		
Equipment	7.5	26.5
Bulks	5.0	19.0
Construction	4.0	15.5
Home Office & Fees	1.5	7.0
Total	18.0	68.0
Iron Pellets		
Equipment	4.5	10.0
Bulks	2.8	7.0
Construction	2.6	6.0
Home Office & Fees	1.5	2.0
Total	11.4	25.0
Nonferrous Reclamation		
Equipment	.56	1.4
Bulks	.47	1.0
Construction	.47	1.1
Home Office & Fees	.16	.5
Total	1.6	4.0

Figure 9

	Base Case 267,400 MTPY Pyrite $ Cost Millions	Alternate Case A 1,094,000 MTPY Pyrite $ Cost Millions
DAP		
Equipment	15.8	42.0
Bulks	13.5	35.0
Construction	11.2	33.0
Home Office & Fees	5.0	10.0
Total	45.5	120.0
Offsites		
Equipment & Services	14.0	34.0
Bulks	12.0	29.0
Construction	13.0	31.5
Home Office & Fees	4.0	9.5
Total	43.0	104.0
Plant Total	$145.0 Million	$400.0 Million

Figure 9 - Continued

PYRITE PROCESSING STUDY

CAPITAL COST ESTIMATES

DAP, Sulfuric Acid, Iron Pellets, Nonferrous Metals Reclamation (Figure 3)
No Zinc Refinery Sulfuric Acid

	Base Case B		Alternate Case B-1	
	±25% Accuracy		Order of Magnitude Accuracy	
	Capacity	$ Cost Millions	Capacity	$ Cost Millions
Pyrite Handling (01)	267,400 MTPY	4.0	1,094,000 MTPY	10.0
Pyrite Roasting Plant (02)	267,400 MTPY	21.5	1,094,000 MTPY	69.0
Sulfuric Acid Plant (03)	400,000 MTPY	18.0	1,694,000 MTPY	68.0
Phosphoric Acid-Diammonium Phosphate (04) and (05)	313,000 MTPY	33.5	1,322,228 MTPY	112.0
Iron Pellet Plant (06)	180,000 MTPY	11.4	718,000 MTPY	25.0
Nonferrous Reclamation (07)		1.6		4.0
Offsites		43.0		104.0
TOTAL		133.0		400.0

Figure 10

PYRITE PROCESSING STUDY
CAPITAL COST ESTIMATES
COST BREAKDOWN BY PLANT COMPONENTS

DAP, Sulfuric Acid, Iron Pellets, Nonferrous Metal Reclamation (Figure 3)

	Base Case B 267,400 MTPY Pyrite $ Cost Millions	Alternate Case B-1 1,094,000 MTPY Pyrite $ Cost Millions
Pyrite Handling		
Equipment	1.4	3.5
Bulk Materials	1.2	3.0
Construction	1.0	2.5
Home Office & Fees	0.4	1.0
Total	4.0	10.0
Roasting Plant		
Equipment	8.5	28.0
Bulks	5.4	17.0
Construction	5.5	17.0
Home Office & Fees	2.1	7.0
Total	21.5	69.0
Acid Plant		
Equipment	7.5	26.5
Bulks	5.0	19.0
Construction	4.0	15.5
Home Office & Fees	1.5	7.0
Total	18.0	68.0
Iron Pellets		
Equipment	4.5	10.0
Bulks	2.8	7.0
Construction	2.6	6.0
Home Office & Fees	1.5	2.0
Total	11.4	25.0
Nonferrous Reclamation		
Equipment	.56	1.4
Bulks	.47	1.0
Construction	.47	1.1
Home Office & Fees	.16	.5
Total	1.6	4.0

Figure 11

	Base Case B 267,400 MTPY Pyrite $ Cost Millions	Alternate Case B-1 1,094,000 MTPY Pyrite $ Cost Millions
DAP		
Equipment	11.8	39.2
Bulks	10.0	32.7
Construction	8.4	30.2
Home Office & Fees	3.3	9.9
Total	33.5	112.0
Offsites		
Equipment & Services	14.0	34.0
Bulks	12.0	29.0
Construction	13.0	31.5
Home Office & Fees	4.0	9.5
Total	43.0	104.0
Plant Total	$133.0 Million	$392.0 Million

Figure 11 - Continued

4. OPERATING COST ESTIMATES

Operating Cost Criteria

The criteria used in all of the operating cost estimates in Phase II of this study are as follows:

4.1 PROCESS MATERIALS

The process materials include raw materials, reagents and expendable materials with a dollar value large enough for identification. Non-identifiable items are included as miscellaneous operating supplies.

- Pyrite

  For in-house use, the pyrite is valued at no-cost plus transportation to destination. The freight rate from Crandon to Green Bay is $11.44/MT, and $24.43/MT to Evansville. A 15% moisture content in the pyrite material is assumed.

- Sulfuric Acid

  The sulfuric acid (400,000 MTPY) produced in the proposed pyrite roasting-acid facility is transferred at production costs. The sulfuric acid (320,000 MTPY) produced in the proposed zinc plant is charged out at $15.00/MT.

- Phosphate Rock

  Dry phosphate rock of 68-70 BPL (32% P_2O_5) F.O.B. Tampa is $27.50/MT. Freight rate Tampa to Green Bay is $15.08/MT, and to Evansville is $11.16/MT. The total cost to Green Bay destination is $42.58/MT, and to Evansville, $38.66/MT.

- Ammonia (Anhydrous)

  Delivered to plant site is $138.00/MT.

- Defoamer

  The defoamer used in the phosphoric acid/DAP plant, delivered cost is $0.65/kg.

- Grinding Balls

  Grinding balls in the Kowa Seiko process plant are a major cost item consuming approxiamtely 350 grams/MT of pellets. The delivered cost of grinding balls is $550/MT.

- Hydrated Lime

  In bags, delivered to plant site - $60.00/MT.

- Scrap Iron

  Light type, delivered to plant site - $110.00/MT.

- Limestone

  Fine ground, minus 1 millimeter (quarry residue), delivered to plant site - $20.00/MT.

- Miscellaneous Operating Supplies

  15% of the direct labor cost is used.

- Calcium Chloride

  Anhydrous, 94-97% pure, flake or pellets, 80 pound bags delivered to plant site - $150.00/MT.

- Hydrogen Sulfide

  Liquid, 97.5% minimum, seller's tanks, delivered to plant site - $0.22/kilogram.

4.2 UTILITIES

The utilities consumptions are based on energy balances, equipment sizing and experience.

- Electric Power

  The unit price utilized is $0.03/kWh.

- Fuel

  Rather than expressing the fuel requirements in weight or volume, we are using energy units. Each million kJ is $2.65, equivalent to $2.50/million Btu or thousand cubic feet of natural gas (1 kilo joule = 1.06 Btu).

- High Pressure Steam

  High pressure steam is generated in the roasting plant boiler and in an auxiliary boiler. This high pressure steam is charged out at $7.70/MT and is equivalent to $3.50/thousand pounds of steam.

- Low Pressure Steam

  Low pressure saturated steam is charged or credited at $6.60/MT equivalent to $3.00/thousand pounds.

- Water

  Make-up water including treatment, for the various process areas is charged out at $0.05 per cubic meter, equivalent to $0.19 per thousand gallons.

4.3 DIRECT LABOR

Direct labor costs are as follows:

o Foreman	$16.00 per hour
o Operator	$12.00 per hour
o Laborer	$8.00 per hour

These rates include all fringe benefits. One man-year is equivalent to 2080 man hours.

Supervision, above the foreman level is estimated at 15% of the labor cost.

4.4 MAINTENANCE

Maintenance costs are estimated on a percent of the individual plant capital cost, excluding offsites. The following percentages were used:

o Pyrite handling and roasting	3.0%
o Sulfuric acid plant	1.5%
o DAP plant	5.0%
o Iron pellets plant	5.0%

Total maintenance cost is split as follows:

o Labor	30%
o Materials	70%

4.5 PLANT OVERHEAD

Includes all personnel not involved directly in operation and maintenance activities, such as management, accounting, laboratory, etc., and its supplies. It is estimated at 80% of all labor, including operating and maintenance labor.

4.6 INDIRECT OVERHEAD

Management expenses and local administrative cost for items such as travel, communications, entertainment, etc., are estimated at 5% of the total operating costs.

4.7 FIXED COST

Fixed costs include insurance, taxes, depreciation and the cost of money. A 15 year plant life is used, and a 100% loan basis at 10% annual interest is assumed.

- o Insurance and taxes 3.00%
- o Depreciation 6.67% on total capital
- o Interest 5.57%

The plant investment used for the operating costs includes a prorated distribution of the offsites capital cost as follows:

	ORIGINAL CASE 267,400 MTPY		ALTERNATE CASE 1,084,000 MTPY	
	Capital $ Million	Offsites Distributed $ Million	Capital $ Million	Offsites Distributed $ Million
Sulfuric Acid	43.5	61.8	147.0	198.65
DAP	45.5	64.7	120.0	162.15
Iron Pellets	13.0	18.5	29.0	39.2
Offsites	43.0	-	104.0	-
TOTAL	145.0	145.0	400.0	400.0

The operating costs are summarized on the next page in both the original case and the alternate case. It quickly points out the sensitive areas of the operating costs.

4.8 WORKING CAPITAL

Working capital is estimated to be 25% of the total plant investment.

4.9 PRE-OPERATIONAL COSTS

Pre-operational costs are estimated at $3,000,000.

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

CRANDON'S PYRITE PROCESSING

OPERATING COSTS SUMMARIZED

All figures in dollars per metric ton

	Raw Materials	Utilities	Payroll	Materials & Supplies	Capital	Total
Sulfuric Acid						
1) Green Bay	9.00	(1.67)	3.95	2.54	26.21	40.03
1) Evansville	19.21	(1.67)	3.95	2.54	26.21	50.24
2) Green Bay	8.70	(1.61)	2.84	2.16	19.67	31.76
2) Evansville	18.57	(1.61)	2.84	2.16	19.67	41.62
DAP						
1) Green Bay	127.20	5.72	7.93	4.73	19.51	165.10
1) Evansville	128.82	5.72	7.93	4.73	19.51	166.71
2) Green Bay	127.03	5.78	4.88	4.17	17.31	159.12
2) Evansville	132.03	5.73	4.88	4.17	17.31	164.12
3) Green Bay	140.15	5.72	13.25	4.60	19.32	183.05
3) Evansville	147.57	5.72	13.25	5.35	19.32	191.21
4) Green Bay	130.71	5.69	5.63	3.73	19.38	165.15
4) Evansville	137.77	5.69	5.63	3.73	19.38	172.20
Iron Pellets						
1) 180,000 MTPY	-	8.19	11.96	6.17	15.66	41.98
2) 718,000 MTPY	-	8.18	6.02	4.27	8.32	26.79
Sulfur						
1) Green Bay	29.75	21.12	13.22	11.90	75.77	151.76
1) Evansville	61.17	21.12	13.22	11.90	75.77	183.17
2) Green Bay	29.67	17.43	11.35	8.33	53.74	120.82
2) Evansville	60.86	17.43	11.35	8.33	53.74	151.71

1) Base Case; 267,400 metric ton pyrite per year with zinc refinery acid
2) Alternate Case A; 1,094,800 metric ton pyrite per year with zinc refinery acid
3) Alternate Case B; no zinc refinery sulfuric acid (400,000 MTPY H_2SO_4)
4) Alternate Case B1; no zinc refinery sulfuric acid (1,694,000 MTPY H_2SO_4)

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SULFURIC ACID PRODUCTION
(GREEN BAY)

ANNUAL OPERATING COST SUMMARY
BASE CASE

Plant Capacity: 400,000 MTPY

Plant Investment: $61.8 Million
Working Capital & Pre-operational Cost 18.45 Million

Process Materials	Annual	Unit/MT	Unit Cost $	$ Million/ Year	$/MT Acid
Pyrite	267,400 MT	0.67	-	3.600	9.000
Misc. Supplies	-	-	-	0.080	0.200
					9.200
Utilities					
Electric Power	$12x10^6$ kWh	30	0.03/kWh	0.360	0.900
H.P. Steam	192,000 MT	0.48	7.70/MT	1.478	3.695
Process Water	594,000 MT		0.05/MT	0.030	0.075
L.P. Steam (credit)	384,000 MT	0.96	6.60/MT	-2.534	-6.335
					-1.665
Direct Labor					
Labor	47,840 m-h	0.12	10.96/m-h	0.524	1.310
Supervision (15% of labor)				0.080	0.200
					1.510
Maintenance (2.38% plant cost)					
Labor (30%)				0.310	0.775
Materials (70%)				0.723	1.808
					2.582
Plant Overhead (80% of total labor)				0.667	1.667
Indirect Overhead (5% of total production cost)				0.213	0.532
Total Operating Cost				5.531	13.827
Fixed Costs (15.24% on plant investment)				9.418	23.545
Working Capital (5.77% x 18.45 MM)				1.065	2.661
Total Annual Production Cost				16.014	40.035

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SULFURIC ACID PRODUCTION (GREEN BAY)

ANNUAL OPERATING COST SUMMARY

ALTERNATE CASE A

Plant Capacity: 1,694,000 MTPY

Plant Investment: $198.65 MM
Working Capital & Pre-operational Cost 52.66 MM

Process Materials	Consum Annual	Unit Cost $	$ MM/Yr	$/MT
Pyrite	1,094,800		14.735	8.698
Misc. Supplies			0.225	0.133
				8.831
Utilities				
Electric Power	49×10^6 kWh	0.03	1.470	0.868
HP Steam	785,000 MT	7.70	6.045	3.968
Water	2,430,000 MT	0.05	0.121	0.071
LP Steam (Credit)	1,570,000 MT	6.60	-10.362	-6.117
				-1.610
Direct Labor				
Labor	141,400 m-h	10.59	1.498	0.884
Supervision (15% labor)			0.225	0.133
				1.017
Maintenance (2.38% plant cost)				
Labor (30%)			1.050	0.620
Materials (70%)			2.449	1.446
				2.066
Plant Overhead (80% of total labor)			2.038	1.203
Indirect Overhead (5% of total production cost)			0.975	0.576
Total Operating Cost			20.469	12.083
Fixed Cost (15.24% on Plant Investment)			30.274	17.871
Working Capital (5.77% x 52.66 MM)			3.039	1.794
Total Annual Production Cost			53.882	31.785

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SULFURIC ACID PRODUCTION (EVANSVILLE)

ANNUAL OPERATING COST SUMMARY BASE CASE

Plant Capacity: 400,000 MTPY

Plant Investment: $61.8 Million
Working Capital & Pre-operational Cost: 18.45 Million

Process Materials	Annual	Unit/MT	Unit Cost $	$ Million/ Year	$/MT Acid
Pyrite	267,400 MT	0.67	-	7.685	19.21
Misc. Supplies	-	-	-	0.080	0.20
					19.410
Utilities					
Electric Power	$12x10^6$ kWh	30	0.03/kWh	0.360	0.90
H.P. Steam	192,000 MT	0.48	7.70/MT	1.478	3.69
Process Water	594,000 MT		0.05/MT	0.030	0.08
L.P. Steam (credit)	384,000 MT	0.96	6.60/MT	-2.534	-6.34
					-1.67
Direct Labor					
Labor	47,840 m-h	0.12	10.96/m-h	0.524	1.31
Supervision (15% of labor)				0.080	0.20
					1.51
Maintenance (2.38% plant cost)					
Labor (30%)				0.310	0.78
Materials (70%)				0.723	1.81
					2.59
Plant Overhead (80% of total labor)				0.667	1.67
Indirect Overhead (5% of total production cost)				0.213	0.53
Total Operating Cost				9.616	24.04
Fixed Costs (15.24% on plant investment)				9.418	23.55
Interest on Working Capital (5.77% x 18.45 MM)				1.065	2.66
Total Annual Production Cost				20.098	50.25

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SULFURIC ACID PRODUCTION (EVANSVILLE)

ANNUAL OPERATING COST SUMMARY

ALTERNATE CASE A

Plant Capacity: 1,694,000 MTPY

Plant Investment: $198.65 MM
Working Capital & Pre-operational Cost: 52.66 MM

Process Materials	Consum Annual	Unit Cost $	$ MM/Yr	$/MT
Pyrite	1,094,800		31.464	18.574
Misc. Supplies			0.225	0.133
				18.707
Utilities				
Electric Power	49×10^6 kWh	0.03	1.470	0.868
HP Steam	785,000 MT	7.70	6.045	3.568
Water	2,430,000 MT	0.05	0.121	0.071
LP Steam (Credits)	1,570,000 MT	6.60	10.362	-6.117
				-1.610
Direct Labor				
Labor	141,440 m-h	10.59	1.498	0.884
Supervision (15% labor)			0.225	0.133
				1.017
Maintenance				
Labor			1.050	0.620
Materials			2.449	1.446
				2.066
Plant Overhead (80% of total labor)			2.038	1.203
Indirect Overhead (5% of total production cost)			0.975	0.576
Total Operating Cost			37.198	21.959
Fixed Cost			30.274	17.871
Interest on Working Capital (5.77% x 52.66 MM)			3.038	1.793
Total Annual Production Cost			70.510	41.623

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

DIAMMONIUM PHOSPHATE PRODUCTION (GREEN BAY) ANNUAL OPERATING COST SUMMARY BASE CASE

Plant Capacity: 562,000 MTPY

Plant Investment: $64.7 Million
Working Capital & Pre-operational Cost 19.2 Million

Process Materials	Annual	Unit/MT	Unit Cost $	$ Million/ Year	$/MT DAP
Sulfuric Acid	720,000 MT	1.28	(1)	19.749	35.140
Phos. Rock	810,000 MT	1.44	42.58/MT	34.490	61.370
Ammonia	125,000 MT	0.22	138.00/MT	17.250	30.694
Defoamer	500,000 Kg	0.89	0.65/kg	0.325	0.578
Misc. Supplies				0.248	0.441
				72.062	128.224
Utilities					
Electric Power	$40x10^6$ kWh	71.2	0.03/kWh	1.200	2.135
Fuel	118×10^6 kJ	211,000	$2.65/10^6$ kJ	0.311	0.553
H.P. Steam	4,500 MT	0.008	7.70/MT	0.035	0.062
L.P. Steam	250,000 MT	0.445	6.60/MT	1.650	2.934
Process Water	310,000 MT	0.552	0.05/MT	0.016	0.028
				3.212	5.715
Direct Labor					
Labor	162.240 m-H	0.29	10.21/m-h	1.656	2.947
Supervision (15% of labor)				0.248	0.441
					3.388
Maintenance (5% of plant cost)					
Labor (30%)				0.682	1.214
Materials (70%)				1.593	2.834
					4.048
Plant Overhead (80% of total labor)				1.870	3.327
Indirect Overhead (5% of total production cost)				0.492	0.875
Total Operating Cost				81.815	145.578
Fixed Cost (15.24% on plant investment)				9.860	17.544
Interest on Working Capital (5.77% x 19.2 MM)				1.106	1.968
Total Annual Production Cost				92.781	165.091

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

DIAMMONIUM PHOSPHATE PRODUCTION
(GREEN BAY)
ANNUAL OPERATING COST SUMMARY
ALTERNATE CASE A

Plant Capacity: 1,572,000 MTPY

Plant Investment: $162.15 MM
Working Capital & Pre-operational Cost 43.54 MM

Process Materials	Consum Annual	Unit Cost $	$ MM/Yr	$/MT
Sulfuric Acid	2,014,000 MT	(1)	55.543	35.333
Phosphate Rock	2,264,000 MT	42.58	96.401	61.324
Ammonia	346,000 MT	138.00	47.748	30.374
Defoamer	1,400,000 Kg	0.65	0.910	0.579
Misc. Supplies			0.340	0.216
				127.826
Utilities				
Electric Power	112×10^6 kWh	0.03	3.360	2.137
Fuel	332×10^6 kJ	2.65×10^3	0.880	0.560
HP Steam	12,600 MT	7.70	0.097	0.062
LP Steam	700,000 MT	6.60	4.620	2.939
Water	868,000 MT	0.05	0.043	0.027
				5.725
Direct Labor				
Labor	222,560 m-h	10.20	2.271	1.445
Supervision (15% labor)			0.341	0.217
				1.662
Maintenance (5% of plant cost)				
Labor (30%)			1.800	1.145
Materials (70%)			4.200	2.672
				3.817
Plant Overhead (80% of total labor)			3.257	2.072
Indirect Overhead (5% of total production cost)			1.106	0.704
Total Operating Cost			222.917	141.806
Fixed Cost (15.24% on plant investment)			24.712	15.720
Interest on Working Capital & D.O.C. (5.77% x 43.54 MM)			2.512	1.591
Total Annual Production Cost			250.141	159.117

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

DIAMMONIUM PHOSPHATE PRODUCTION
(EVANSVILLE)
ANNUAL OPERATING COST SUMMARY
BASE CASE

Plant Capacity: 562,000 MTPY

Plant Investment: $64.7 Million
Working Capital & Pre-operational Cost 19.2 Million

Process Materials	Annual	Unit/MT	Unit Cost $	$ Million/ Year	$/MT DAP
Sulfuric Acid	720,000 MT	1.28	(1)	23.834	42.41
Phos. Rock	810,000 MT	1.44	38.66/MT	31.315	55.72
Ammonia	125,000 MT	0.22	138.00/MT	17.250	30.69
Defoamer	500,000 Kg	0.89	0.65/kg	0.325	0.58
Misc. Supplies				0.248	0.44
				72.972	129.84
Utilities					
Electric Power	40×10^6 kWh	71.2	0.03/kWh	1.200	2.14
Fuel	118×10^6 kJ	211,000	$2.65/10^6$ kJ	0.311	0.55
H.P. Steam	4,500 MT	0.008	7.70/MT	0.035	0.06
L.P. Steam	250,000 MT	0.445	6.60/MT	1.650	2.93
Process Water	310,000 MT	0.552	0.05/MT	0.016	0.03
				3.212	5.71
Direct Labor					
Labor	162.240 m-H	0.29	10.21/m-h	1.656	2.95
Supervision (15% of labor)				0.248	0.44
					3.39
Maintenance (5% of plant cost)					
Labor (30%)				0.682	1.21
Materials (70%)				1.593	2.83
					4.04
Plant Overhead (80% of total labor)				1.870	3.33
Indirect Overhead (5% of total production cost)				0.492	0.88
Total Operating Cost				82.725	147.20
Fixed Cost (15.24% on plant investment)				9.860	17.54
Interest on Working Capital (5.77% x 19.2 MM)				1.106	1.97
Total Annual Production Cost				93.691	166.71

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

DIAMMONIUM PHOSPHATE PRODUCTION
(EVANSVILLE)
ANNUAL OPERATING COST SUMMARY
ALTERNATE CASE A

Plant Capacity: 1,572,000 MTPY

Plant Investment: $162.15 MM
Working Capital & Pre-operational Cost 43.54 MM

Process Materials	Consum Annual	Unit Cost $	$ MM/Yr	$/MT
Sulfuric Acid	2,014,000 MT	(1)	72.272	45.975
Phosphoric Rock	2,264,000 MT	38.66	87.526	55.678
Ammonia	346,000 MT	138.00	47.748	30.374
Defoamer	1,400,000 Kg	0.65	0.910	0.579
Misc. Supplies			0.340	0.216
				132.822
Utilities				
Electric Power	112×10^6 kWh	0.03	3.360	2.137
Fuel	332×10^6 kJ	2.65×10^3	0.880	0.560
HP Steam	12,600 MT	7.70	0.097	0.062
LP Steam	700,000 MT	6.60	4.620	2.939
Water	868,000 MT	0.05	0.043	0.027
				5.725
Direct Labor				
Labor	222,560 m-h	10.20	2.271	1.445
Supervision (15% labor)			0.341	0.217
				1.662
Maintenance (5% of plant cost)				
Labor (30%			1.800	1.145
Materials (70%			4.200	2.672
				3.817
Plant Overhead (80% of total labor)			3.257	2.072
Indirect Overhead (5% of total production cost)			1.106	0.704
Total Operating Cost			230.771	146.802
Fixed Cost			24.712	15.720
Interest on Working Capital (5.77% x 43.54 MM)			2.512	1.591
Total Annual Production Cost			257.995	164.113

2489/2
June 1981

EXXON MINERALS COMPANY,. U.S.A.
PYRITE PROCESSING STUDY

DIAMMONIUM PHOSPHATE PRODUCTION
(GREEN BAY)
ANNUAL OPERATING COST SUMMARY
BASE CASE - ALTERNATE B
No Refinery Acid

Plant Capacity: 313,000 MTPY

Plant Investment: 47.8 Million
Working Capital & Pre-operational Cost 15.0 Million

Process Materials	Annual	Unit/MT	Unit Cost $	$ Million/ Year	$/MT DAP
Sulfuric Acid	400,000 MT	1.28	(1)	14.949	47.760
Phos. Rock	450,000 MT	1.44	42.58/MT	19.161	61.217
Ammonia	68,000 MT	0.22	138.00/MT	9.380	29.960
Defoamer	277,000 Kg	0.89	0.65/Kg	0.180	0.575
Misc. Supplies				0.200	0.639
				43.870	140.151
Utilities					
Electric Power	$22x10^6$ kWh	71.2	0.03 kWh	0.660	2.136
Fuel	118×10^6 kJ	211,000	$2.65/10^6$ kJ	0.174	0.556
H.P. Steam	2,498 MT	0.008	7.70/MT	0.019	0.061
L.P. Steam	139,000 MT	0.445	6.60/MT	0.917	2.929
Process Water	172,000 MT	0.552	0.05/MT	0.009	0.028
				1.779	5.710
Direct Labor					
Labor	162,240 m-H	0.29	10.21/m-h	1.656	5.291
Supervision (15% of labor)				0.248	0.792
				1.904	6.083
Maintenance (5% of plant cost)					
Labor (30%)				.510	1.630
Materials (70%)				1.190	3.802
Plant Overhead (80% of total labor)				1.733	5.536
Indirect Overhead (5% of total production cost)				0.255	0.815
Total Operating Cost				51.241	163.725
Fixed Cost (15.24% on plant investment)				5.182	16.556
Interest on Working Capital (5.77% x 15.0 MM)				.866	2.765
Total Annual Production Cost				57.289	183.046

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

DIAMMONIUM PHOSPHATE PRODUCTION
EVANSVILLE
ANNUAL OPERATING COST SUMMARY
BASE CASE - ALTERNATE B
No Refinery Acid

Plant Capacity: 313,000 MTPY

Plant Investment: $47.8 Million
Working Capital & Pre-operational Cost: 15.0 Million

Process Materials	Annual	Unit/MT	Unit Cost $	$ Million/ Year	$/MT DAP
Sulfuric Acid	400,000 MT	1.28	(1)	19.034	60.812
Phos. Rock	450,000 MT	1.44	38.66/MT	17.397	55.581
Ammonia	68,000 MT	0.22	138.00/MT	9.380	29.960
Defoamer	277,000 Kg	0.89	0.65/Kg	0.180	0.575
Misc. Supplies				0.200	0.639
				46.191	147.567
Utilities					
Electric Power	22×10^6 kWh	71.2	0.03 kWh	0.660	2.136
Fuel	65.5×10^6 kJ	211,000	$2.65/10^6$ kJ	0.174	0.556
H.P. Steam	2,498 MT	0.008	7.70/MT	0.019	0.061
L.P. Steam	139,000 MT	0.445	6.60/MT	0.917	2.929
Process Water	172,000 MT	0.552	0.05/MT	0.009	0.028
				1.779	5.710
Direct Labor					
Labor	162,240 m-H	0.29	10.21/m-h	1.656	5.291
Supervision (15% of labor)				0.248	0.792
				1.904	6.083
Maintenance (5% of plant cost of 34.0 million)					
Labor (30%)				.510	1.630
Materials (70%)				1.190	0.792
				1.700	5.432
Plant Overhead (80% of total labor)				1.733	5.536
Indirect Overhead (5% of total production cost)				0.255	0.815
Total Operating Cost				82.725	171.890
Fixed Cost (15.24% on plant investment)				5.182	16.556
Interest on Working Capital (5.77% x 15.0 MM)				.866	2.765
Total Annual Production Cost				59.849	191.213

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

DIAMMONIUM PHOSPHATE PRODUCTION
(GREEN BAY)
ANNUAL OPERATING COST SUMMARY
ALTERNATE B-1 - NO REFINERY ACID

Plant Capacity: 1,322,228 MTPY

Plant Investment: $152.5 MM
Working Capital & Pre-operational Cost 41.2 MM

Process Materials	Consum Annual	Unit Cost $	$ MM/Yr	$/MT
Sulfuric Acid	1,694,760 MT	(1)	50.743	38.380
Phos. Rock	1,901,760 MT	42.58	80.987	61.261
Ammonia	290,000 MT	138.00	40.020	30.272
Defoamer	1,176,000 Kg	0.65	0.765	0.579
Misc. Supplies			0.286	0.216
			172.801	130.708
Utilities				
Electric Power	94×10^6 kWh	0.03	2.820	2.133
Fuel	278×10^6 kJ	2.65×10^3	0.739	0.559
H.P. Steam	10,584 MT	7.70	0.082	0.062
L.P. Steam	588,000 MT	6.60	3.881	2.936
Water	729,000 MT	0.05	0.036	0.026
				5.690
Direct Labor				
Labor	222,560 m-h	10.20	2.271	1.718
Supervision (15% of labor)				0.258
				1.976
Maintenance (5% of plant cost of 112 million)				
Labor (30%)			1.680	1.271
Materials (70%)			3.920	2.965
			5.600	4.236
Plant Overhead (80% of total labor)			3.161	2.391
Indirect Overhead (5% of total production cost)			1.005	0.760
Total Operating Cost			192.737	145.761
Fixed Cost (15.24% on plant investment)			23.241	17.580
Interest on Working Capital (5.77% x 41.2 MM)			2.377	1.798
Total Annual Production Cost			218.355	165.149

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

DIAMMONIUM PHOSPHATE PRODUCTION
EVANSVILLE
ANNUAL OPERATING COST SUMMARY
ALTERNATE B-1 - NO REFINERY ACID

Plant Capacity: 1,322,228 MTPY

Plant Investment: $152.5 MM
Working Capital & Pre-operational Cost: 41.2 MM

Process Materials	Consum Annual	Unit Cost $	$ MM/Yr	$/MT
Sulfuric Acid	1,691,760 MT	(1)	67.472	51.037
Phos. Rock	1,901,760 MT	38.66	73.522	55.598
Ammonia	290,000 MT	138.00	40.108	30.339
Defoamer	1,176,000 Kg	0.65	0.764	0.578
Misc. Supplies			0.286	0.216
				137.768
Utilities				
Electric Power	94×10^6 kWh	0.03	2.820	2.133
Fuel	278×10^6 kJ	2.65×10^3	0.739	0.559
H.P. Steam	10,584 MT	7.70	0.082	0.062
L.P. Steam	588,000 MT	6.60	3.881	2.936
Water	729,000 MT	0.05	0.036	0.027
				5.690
Direct Labor				
Labor	222,560 m-h	10.20	2.271	*1.718
Supervision (15% of labor)				0.258
				*1.976
Maintenance (5% of plant cost of 112 million)				
Labor (30%)			1.680	*1.271
Materials (70%)			3.920	2.965
			5.600	4.236
Plant Overhead (80% of total labor)			3.161	*2.391
Indirect Overhead (5% of total production cost)			1.005	0.760
Total Operating Cost			202.537	152.821
Fixed Cost (@ 15.24% of plant investment)			23.241	17.580
Interest on Working Capital (5.77% x 41.2 MM)			2.377	1.798
Total Annual Production Cost			228.355	172.199

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

IRON PELLETS PRODUCTION & MINOR METALS RECOVERY
(GREEN BAY or EVANSVILLE)

ANNUAL OPERATING COST SUMMARY
BASE CASE

Plant Capacity: 180,000 MTPY Pellets   Plant Investment: $18.5 Million

Process Materials	Annual	Unit/MT	Unit Cost $	$ Million/ Year	$/MT Pellets
Iron Cinders	180,000 MT	1.0	-	-	-
Calcium Chloride	270,000 Kg	1.5	0.15/Kg	0.041	0.228
Grinding Steel	63,000 Kg	0.35	0.55/Kg	0.035	0.194
Limestone	5,000 MT	-	20.00/MT	0.100	0.555
Scrap Iron	320 MT	-	110.00/MT	0.035	0.194
H_2S	45,000 Kg	-	0.22/Kg	0.010	0.056
Hydrated Lime	1,120 MT	-	60.00/MT	0.067	0.372
Misc. Supplies	-	-	-	0.139	0.792
				0.427	2.372
Utilities					
Electric Power	7.56×10^6 kWh	42	0.03/kWh	0.227	1.261
Fuel	451.8×10^9 kJ	2.5×10^6	$2.65/10^6$ kJ	1.197	6.650
L.P. Steam	7,680 MT	-	6.60/MT	0.051	0.283
				1.475	8.194
Direct Labor					
Labor	93,600 m-h	0.52	9.87/m-h	0.924	5.133
Supervision (15% of labor)				0.138	0.767
				1.062	5.900
Maintenance (5% of plant cost)					
Labor (30%)				0.195	1.083
Materials (70%)				0.455	2.528
				0.650	3.611
Plant Overhead (80% of total labor)				0.895	4.972
Indirect Overhead (5% of total production cost)				0.226	1.256
Total Operating Cost				4.735	26.306
Fixed Cost (15.24% on plant investment)				2.819	15.663
Working Capital in Other Products				-	-
Total Annual Production Cost				7.554	41.969

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

IRON PELLETS PRODUCTION & MINOR METALS RECOVERY
(GREEN BAY OR EVANSVILLE)
ANNUAL OPERATING COST SUMMARY
ALTERNATE CASE A

Plant Capacity: 718,000 MTPY   Plant Investment: $39.2 MM

Process Materials	Consum Annual	Unit Cost $	$ MM/Yr	$/MT
Iron Cinders	718,000 MT			
Calcium Chloride	1,077,000 Kg	0.15	0.162	0.226
Grinding Steel	251,300 Kg	0.55	0.138	0.193
Limestone	20,000 MT	20.00	0.400	0.557
Scrap Iron	1,270 MT	110.00	0.140	0.195
H_2S	180,000 Kg	0.22	0.040	0.056
Hydrated Lime	4,460 MT	60.00	0.267	0.372
Misc. Supplies			0.272	0.379
				1.978
Utilities				
Electric Power	30.15×10^6 kWh	0.03	0.904	1.259
Fuel	1800×10^6 kJ	2.65	4.770	6.643
LP Steam	30,600 MT	6.60	0.202	0.281
				8.183
Direct Labor				
Labor	180,960 m-h	10.02	1.814	2.526
Supervision (15% labor)			0.272	0.379
				2.905
Maintenance (5% of plant cost)				
Labor (30%)			0.435	0.606
Materials (70%)			1.015	1.414
				2.020
Plant Overhead (80% of total labor)			1.799	2.506
Indirect Overhead (5% of total production cost)			.632	0.880
Total Operating Cost			13.262	18.470
Fixed Cost (15.24% on plant investment)			5.974	8.320
Working Capital in Other Products			-	-
Total Annual Production Cost			19.236	26.790

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

ELEMENTAL SULFUR PRODUCTION
(GREEN BAY)

ANNUAL OPERATING COST SUMMARY
BASE CASE

Plant Capacity: 130,000 MTPY

Plant Investment: $58 Million
Working Capital & Pre-operational Cost: 17.5 Million

Process Materials	Annual	Unit/MT	Unit Cost $	$ Million/ Year	$/MT Sulfur
Pyrite	267,400 MT	2.06		3.600	27.69
Electrodes	534,000 Kg	4.1	0.35/Kg	0.187	1.44
Misc. Supplies				0.080	0.62
				3.867	29.75
Utilities					
Electric Power	96.26×10^6 kWh	740	0.03/kWh	2.888	22.22
Fuel (Nat Gas)	445×10^6 scf	3423	3.00/M-scf	1.335	10.27
Steam (credit)	192,000 MT	1.48	7.70/MT	-1.478	-11.37
				2.745	21.12
Direct Labor					
Labor	47,840 m-h	0.37	10.96/m-h	0.524	4.03
Supervision (15% of labor)				0.080	0.62
					4.65
Maintenance (2.30% plant cost)					
Labor (30%)				0.378	2.91
Materials (70%)				0.882	6.78
					9.69
Plant Overhead (80% of total labor)				0.736	5.66
Indirect Overhead (5% of total production cost)				0.665	5.12
Total Operating Cost				9.877	75.99
Fixed-Cost (15.24% plant investment)				8.839	67.99
Interest on Working Capital (5.77% x 17.5 MM)				1.001	7.78
Total Annual Production Cost				19.717	151.76

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

ELEMENTAL SULFUR PRODUCTION
(EVANSVILLE)

ANNUAL OPERATING COST SUMMARY
BASE CASE

Plant Capacity: 130,000 MTPY

Plant Investment: $58 Million
Working Capital & Pre-operational Cost: 17.5 Million

Process Materials	Annual	Unit/MT	Unit Cost $	$ Million/ Year	$/MT Sulfur
Pyrite	267,400 MT	2.06		7.685	59.12
Electrodes	534,000 Kg	4.1	0.35/Kg	0.187	1.44
Misc. Supplies				0.080	0.62
				7.952	61.17
Utilities					
Electric Power	96.26×10^6 kWh	740	0.03/kWh	2.888	22.22
Fuel (Nat Gas)	445×10^6 scf	3423	3.00/M-scf	1.335	10.27
Steam (credit)	192,000 MT	1.48	7.70/MT	-1.478	-11.37
				2.745	21.12
Direct Labor					
Labor	47,840 m-h	0.37	10.96/m-h	0.524	4.03
Supervision (15% of labor)				0.080	0.62
					4.65
Maintenance (2.30% plant cost)					
Labor (30%)				0.378	2.91
Materials (70%)				0.882	6.78
					9.69
Plant Overhead (80% of total labor)				0.736	5.66
Indirect Overhead (5% of total production cost)				0.665	5.12
Total Operating Cost				13.962	107.40
Fixed Cost (15.24% plant investment)				8.839	67.99
Interest on Working Capital (5.77% x 17.5 MM)				1.001	7.78
Total Annual Production Cost				23.802	183.17

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

ELEMENTAL SULFUR PRODUCTION
(GREEN BAY)

ANNUAL OPERATING COST SUMMARY
ALTERNATE CASE A

Plant Capacity: 531,000 MTPY

Plant Investment: $170 Million
Working Capital & Pre-operational Cost: 45.5 Million

Process Materials	Annual	Unit/MT	Unit Cost $	$ Million/ Year	$/MT Sulfur
Pyrite	1,094,000 MT	2.06		14.704	27.69
Electrodes	2,136,000 Kg	4.1	0.35/Kg	0.748	1.41
Misc. Supplies				0.320	0.58
				15.772	29.67
Utilities					
Electric Power	346.54×10^6 kWh	652	0.03/kWh	10.397	19.58
Fuel (Nat Gas)	1638×10^6 scf	3085	3.00/M-scf	4.914	9.25
Steam (credit)	785,280 MT	1.48	7.70/MT	-6.050	-11.40
				9.261	17.43
Direct Labor					
Labor	176,100 m-h	0.33	10.96/m-h	1.930	3.63
Supervision (15% of labor)				0.290	0.55
				2.220	4.18
Maintenance (2.30% plant cost)					
Labor (30%)				1.173	2.20
Materials (70%)				2.737	5.15
				3.910	7.35
Plant Overhead (80% of total labor)				2.642	4.97
Indirect Overhead (5% of total production cost)				1.690	3.48
Total Operating Cost				35.495	67.08
Fixed Cost (15.24% plant investment)				25.908	48.79
Interest on Working Capital (5.77% x 45.5 MM)				2.625	4.95
Total Annual Production Cost				64.028	120.82

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

ELEMENTAL SULFUR PRODUCTION
(EVANSVILLE)

ANNUAL OPERATING COST SUMMARY
ALTERNATE CASE A

Plant Capacity: 531,000 MTPY

Plant Investment: $170 Million
Working Capital & Pre-operational Cost: 45.5 Million

Process Materials	Annual	Unit/MT	Unit Cost $	$ Million/ Year	$/MT Sulfur
Pyrite	1,094,000 MT	2.06		31.393	59.12
Electrodes	2,136,000 Kg	4.1	0.35/Kg	0.748	1.42
Misc. Supplies				0.320	0.58
				32.461	60.86
Utilities					
Electric Power	346.54×10^6 kWh	740	0.03/kWh	10.397	19.58
Fuel (Nat Gas)	1638×10^6 scf	3085	3.00/M-scf	4.914	9.25
Steam (credit)	785,280 MT	1.48	7.70/MT	-6.050	-11.40
				9.261	17.43
Direct Labor					
Labor	176,100 m-h	0.33	10.96/m-h	1.930	3.63
Supervision (15% of labor)				0.290	0.55
				2.220	4.18
Maintenance (2.30% plant cost)					
Labor (30%)				1.173	2.20
Materials (70%)				2.737	5.15
				3.910	7.35
Plant Overhead (80% of total labor)				2.642	4.97
Indirect Overhead (5% of total production cost)				1.690	3.18
Total Operating Cost				52.194	97.79
Fixed-Cost (15.24% plant investment)				25.908	48.79
Interest on Working Capital (5.77% x 45.5 MM)				2.625	4.95
Total Annual Production Cost				80.727	151.71

5. REVENUES

Introduction

The sections of Phase I identified the following:

1. That pyrite concentrate might be marketable.

2. That certain pyrite products might be marketable utilizing commercial specifications.

3. That the market was assessed according to production site locations and usage areas.

4. That the cost of transportation will impact the potential revenues that may be received from the pyrite products that Exxon Minerals Company, U.S.A. might produce.

There is a possibility that some of the pyrite concentrate would be sold and shipped directly to White Pine, Michigan for use in a copper smelter. This potential use requires approximately 2000 MTPM or 24,000 MTPY which is less than 10% of Crandon's production. Exxon would, by necessity, have to seek other outlets for the remaining 240,000 MTPY.

Cities Service Corporation had expressed interest in purchasing approximately 300,000 STPY of pyrite in their Copperhill, Tennessee smelter complex. This along with White Pine's indicated usage would take care of the Crandon's pyrite concentrate production, however, during the course of the study, Cities Service indicated that they were no longer interested in the Crandon pyrite.

The transportation report indicates that the commodity rate for pyrite is extremely high. The truck rate from Crandon to White Pine is $15.50/MT (rail 16.50) and the rail rate to Copperhill, Tennessee is $31.72/MT which is the lowest rate. See Figure 5 for the revenues to be received.

Process Centers

Assuming that Crandon pyrite concentrates are unsalable, Exxon has selected two process sites served by both water and rail transportation. One in Wisconsin and the other in Indiana, to further process the pyrite concentrate into salable products.

Crandon, Wisconsin is the proposed location of the mine and concentrator where the basic zinc, lead, copper and pyrite concentrate would be produced.

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

The pyrite concentrates would be shipped from Crandon to either, but not both, of two proposed process centers:

Green Bay, Wisconsin Area
Evansville, Indiana Area

At the process center, the pyrite concentrate would be further processed to the following products:

- o Sulfuric acid alone. Discard pyrite cinders to waste (Figure 1)
- o Sulfuric acid, iron pellets and nonferrous metals residues, (Figure 2)
- o Sulfuric acid, iron pellets, nonferrous metals residues, phosphoric acid and diammonium phosphate (Figure 3)
- o Elemental sulfur and iron residue and nonferrous metal residues (Figure 4)

The products, so produced would be transported to the marketing areas at the following commodity values (see Figures 6 and 7) (1979 dollars):

Pyrite	2.00/MT F.O.B.
Sulfuric Acid	15.00/MT (net back to Exxon) F.O.B.
Iron Pellets	42.00/MT F.O.B.
Diammonium Phosphate	220.00/MT F.O.B.
Sulfur	75.00/MT F.O.B.
Nonferrous Metal Residue	
Copper $0.52/lb	1140.00/MT F.O.B.
Lead $0.26/lb	575.00/MT F.O.B.
Zinc $0.20/lb	460.00/MT F.O.B.
Precious Metal Residues	
Gold 300.00/oz	80000.00/kg F.O.B.
Silver 7.50/oz	200.00/kg F.O.B.

The recent wild fluctuations in the prices of gold and silver make it difficult to determine the market price. The values used are as follows:

Copper	87¢/lb	
Lead	43¢/lb	60% of market
Zinc	33¢/lb	
Gold	$375.00/oz	80% of market
Silver	$9.38/oz	

It should be noted that the metals produced in the proposed nonferrous metals plant will be in the form of sludges that will require further processing to obtain a final saleable product. A complicated formula involving smelting charges, refining charges, penalty charges due to detrimental elements that may be in sludges and finally the obtainable recoveries of each metal.

Sulfuric acid sale price is determined by many factors such as area of the country, transporation, sulfur price, smelter acid price and whether or not it is brokered. Traditionally, smelter gas acid is sold through a broker to insure that the production and storage of acid does not shut down the smelter during economic upsets, changes in markets, etc. The 1979 acid selling price varies from $37.50 to $55.00. The net back to the acid producer when selling to a broker varies from $4.00/MT to $16.00/MT. The prices are F.O.B. with the brokers paying the freight. As indicated in page 5-2, 15.00/MT F.O.B. for sulfuric acid was used in this study.

From the marketing study performed by CRU and the transportation study performed by Jones, Bardelmeier & Co. Ltd., we have selected the commodities, the marketing areas and the best mode of transportation to those areas, with back-up sheets as follows:

Commodity	267,400 MTPY Pryite	1,094,000 MTPY Pyrite
Sulfuric Acid	Figure 8	Figure 9
Iron Pellets	Figure 10	Figure 11
Diammonium Phosphate	Figure 12	Figure 13
Sulfur	Figure 14	----

These charts also show the relative transportation costs, the commodity revenue and the delivered costs to the consumer.

Revenues by Process Route

Utilizing all the information gathered and recorded in Figure 6 (Base Case) and Figure 7 (Alternate Case A), we have calculated the commodity revenues utilizing the values shown on 5-2 for the contemplated process routes as shown on page 5-2, Figures 1 through 4. This information is presented in Figures 15 through 22. Further, for each case, and each product, we have recorded the yearly commodity values versus the operating costs at both Green Bay and Evansville, the projected process centers. These are shown on Figures 23 through 26.

Sulfuric Acid Alone (Figure 1)

For sulfuric acid alone, the pyrite would be roasted to eliminate the sulfur as an SO_2 gas that would feed sulfuric acid plants. The pyrite cinder remaining from the roasting process would be discharged to waste, which means that the nonferrous metals and precious metals would also be lost.

The commodity price for the sulfuric acid at 15.00/MT F.O.B. denotes the revenue to be received, the operating costs denote any gain or loss for this process route as follows:

	Green Bay		Evansville	
	267,400 MTPY	1,094,000 MTPY	267,400 MTPY	1,094,000 MTPY
Revenue	$ 6,000,000	$25,410,000	$ 6,000,000	$25,410,000
Operating Cost	16,016,000	52,835,320	20,100,000	70,504,280
Gain/(Loss)	(10,016,000)	(28,425,320)	(14,100,000)	(45,094,280)

See Figures 23 and 24

Sulfuric Acid, Iron Pellets and Nonferrous Metal Residues (Figure 2)

This process route utilizes pyrite roasting to produce sulfuric acid and pyrite cinders. The sulfuric acid would be marketed and the cinders further processed to produce iron pellets. The nonferrous and precious metals residues required from the iron pellets would be sold for reclaiming their values.

The total revenues to be received, including sulfuric acid, iron pellets, nonferrous metals and precious metals recovery versus their operating costs are as follows:

	Green Bay		Evansville	
	267,400 MTPY	1,094,000 MTPY	267,400 MTPY	1,094,000 MTPY
Revenue	17,258,975	70,720,750	17,258,000	70,720,750
Operating Cost	23,577,600	73,070,540	27,654,600	89,739,500
Gain/(Loss)	(6,318,625)	(2,349,790)	(10,395,625)	(19,018,750)

These revenues include the reclamation of the nonferrous metal residues and precious metals at 60% and 80% of their market values including delivery to destination. See Figures 27 and 28 for the total revenue, operating costs and loss of gain for this process route.

Sulfuric Acid, Iron Pellets, Nonferrous Metal Residues, Phosphoric Acid & Diammoniam Phosphate - (Figure 3)

This process route is identical to the previous process route with the utilization of the sulfuric acid produced above (400,000 MTPY and 1,694,000 MTPY) plus the sulfuric acid produced from the proposed Crandon zinc refinery (320,000 MTPY). The 720,000 and 2,014,000 metric tons of sulfuric acid would be utilized to manufacture phosphoric acid and subsequently diammonium phosphate as the marketable product.

The cinders produced by roasting the pyrite would be processed further to produce iron pellets and for the reclamation of the nonferrous metals and precious metals.

The total revenues to be received, including DAP, iron pellets, non-ferrous metals and precious metals versus their operating costs are as follows:

	Green Bay		Evansville	
	267,400 MTPY	1,094,000 MTPY	267,400 MTPY	1,094,000 MTPY
Revenue	134,898,975	391,150,750	134,898,975	391,150,750
Operating Cost	100,340,800	269,371,860	101,245,620	277,231,860
Gain/(Loss)	34,558,175	121,778,890	33,453,355	113,919,890

In this case we have utilized a commodity price for the sulfuric acid of 15.00/metric ton for the zinc refinery acid and the production costs for the pyrite sulfuric acid.

The nonferrous and precious metal residues are handled as in the previous route. See Figures 29 and 30.

As a further alternate, there is a possibility that the zinc refinery may not be built and the sulfuric acid to be obtained from that facility will not be available for the production of diammonium phosphate. If that is the case, the yearly revenues, operating costs and loss/gain are shown in Figures 31 and 32.

Elemental Sulfur, Iron Residue and Nonferrous Metals Residues (Figure 4)

Because the marketing study indicated that elemental sulfur would remain in tight supply, we have calculated the potential revenues for this product route.

The total revenues including sulfur, iron pellets, nonferrous metals and precious metals versus their operating costs are as follows:

	Green Bay		Evansville	
	267,400 MTPY	1,094,000 MTPY	267,400 MTPY	1,094,000 MTPY
Revenue	21,308,975	85,135,750	21,308,975	85,135,750
Operating Cost	27,890,440	83,231,340	32,099,380	99,697,650
Gain/(Loss)	(6,581,465)	1,904,410	(10,790,405)	(14,561,900)

The iron pellet, nonferrous metal and precious metal residues will be handled in the previous process routes.

See Figure 33 and 34.

The production of elemental sulfur at Green Bay, Wisconsin appears viable at the high production rate utilizing 1,094,000 MTPY of Crandon pyrite. However, when all costs are included it may not be.

Commodity Value Versus Production Costs

With the transportation costs, operating costs and the revenues accumulated for the pyrite products, we can compare the published prices with the operating costs by individual product units and by process routes. Finally we will compare the published prices including transportation costs from known sources of supply.

Figures 23 through 26 show the commodity values per metric ton (published prices) for each product, the yearly revenues from each product and the production costs per metric ton for each product both at Green Bay and Evansville.

Figures 27 and 28 show the process route of roasting, sulfuric acid, iron pellets and nonferrous and precious metal recovery, using commodity values per metric ton and the production costs per metric ton for both Green Bay and Evansville for the Base Case and Alternate Case A.

This product route, Figures 27 and 28, are not economically viable, because of high transportation costs for the pyrite concentrate from Crandon to Green Bay or Evansville impacts the sulfuric acid production costs. Even when the revenues from the nonferrous and precious metals, are included in the commodity revenues, the production costs exceed the revenues by $6,311,625 at Green Bay and by $10,395,625 at Evansville.

Alternate Case A, 1,094,000 MTPY of pyrite, looks somewhat better, showing a loss of $2,349,790 at Green Bay, and a loss of $19,018,750 at Evansville because of the transportation costs.

Figures 29 through 32 show the process route of roasting sulfuric acid, iron pellets, diammonium phosphate with nonferrous metal recovery. This process route looks attractive because of the nonferrous and precious metals and the selling price of DAP. The 1979 commodity prices per metric ton of diammonium phosphate F.O.B. Tampa is $220.00 and the production costs are $165.10/MT in Green Bay and $166.71/MT in Evansville.

The production cost of the DAP includes 400,000 MTPY of pyrite acid at $40.04/MT (Green Bay) and $50.25/MT (Evansville) and 320,000 MTPY of zinc refinery acid at $15.00/MT. The Alternate Case, includes 1,694,000 MTPY of pyrite acid at $31.78/MT (Green Bay) and $41.62/MT (Evansville) and 320,000 MTPY of zinc refinery acid at $15.00/MT.

This process route indicates a yearly gross return of $34,558,175 or alternately $121,778,890 in Green Bay and $33,653,355 or alternately $113,918,890 in Evansville over the published commodity values in the anticipated tonnages.

All of these returns include pre-development cost, working capital, and return on equity capital but no corporate overhead or profit. Therefore, we utilized Davy McKee's computer program that derives the discounted rate of return and present value profit. If the rate of return on the investment (ROI) is less than Exxon's "no go" at below 15% the program was adjusted to determine the total required price of the products to obtain a 15% ROI.

BASE CASE

562,000 MTPY DAP
180,000 MTPY IRON PELLETS

Market Price	Indicated ROI	Prices Necessary Obtain 15% ROI	Increase in Price
$220.00/MT - DAP	2.51%	$298.00	$78.00
42.00/MT - Iron Pellets		57.00	15.00
$262.00		$355.00	$93.00

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

ALTERNATE CASE A

1,572,000 MTPY DAP
780,000 MTPY IRON PELLETS

Market Price	Indicated ROI	Prices Necessary Obtain 15% ROI	Increase in Price
$220.00/MT - DAP	5.32%	$280.00	$60.00
42.00/MT - Iron Pellets		53.00	11.00
$262.00		$333.00	$71.00

ALTERNATE CASE B

313,000 MTPY DAP
180,000 MTPY IRON PELLETS

Market Price	Indicated ROI	Prices Necessary Obtain 15% ROI	Increase in Price
$220.00/MT - DAP	(7.44%)	$395.00	175.00
42.00/MT - Iron Pellets		75.00	33.00
$262.00		$470.00	208.00

ALTERNATE CASE B-1

1,322,228 MTPY DAP
718,000 MTPY IRON PELLETS

Market Price	Indicated ROI	Prices Necessary Obtain 15% ROI	Increase in Price
$220.00/MT - DAP	2.81%	$300.00	$80.00
42.00/MT - Iron Pellets		57.00	15.00
$262.00		$357.00	$95.00

See Computer Sheets, Figure 41-A1 through Figures 43-A1 through 43-C1 and 43-A2 through 43-F2.

Note that we have only computer read-outs on the Process Center at Green Bay, Wisconsin as there is no significant differences between the ROI at Evansville.

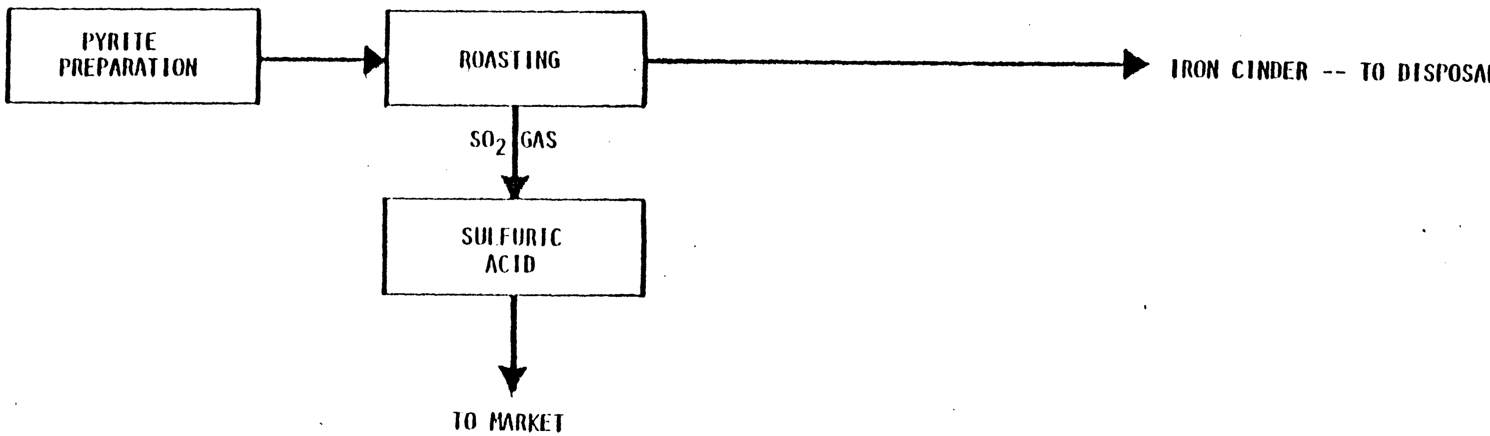
Even though these product routes may appear marginally viable, the risks and capital expenditure makes it a poor investment, also the environmental problems associated with gypsum disposal from the phosphoric acid plant becomes a major factor. Gypsum piles and gypsum ponds with water treatment must be and are provided in our capital costs. (See environmental considerations.)

Costs to Consumer

The competitive position of the Exxon Minerals Company USA's products versus the market depends on the originating areas plus the transportation costs. Figures 33 and 34 indicate the differential that can be attributed to location. For instance, iron pellets would originate at Escanaba, Michigan at $42.00/MT F.O.B. and DAP would originate in Tampa, Florida, at $220.00/MT F.O.B. In Exxon's case, the process centers are Green Bay, Wisconsin, or Evansville, Indiana which influence the delivered product cost.

Recapulation

In order to reveiw the Capital Costs, Operating Costs, Revenues and Gain/(Loss) for the four (4) process routes at both Green Bay, Wisconsin and Evansville, Indiana, including the Alternate Case A (1,094,000 MTPY pyrite), B and B-1 we include Figures 37 through 46.



PROCESS BLOCK FLOW DIAGRAM

SULFURIC ACID ONLY. IRON CINDER TO DISPOSAL

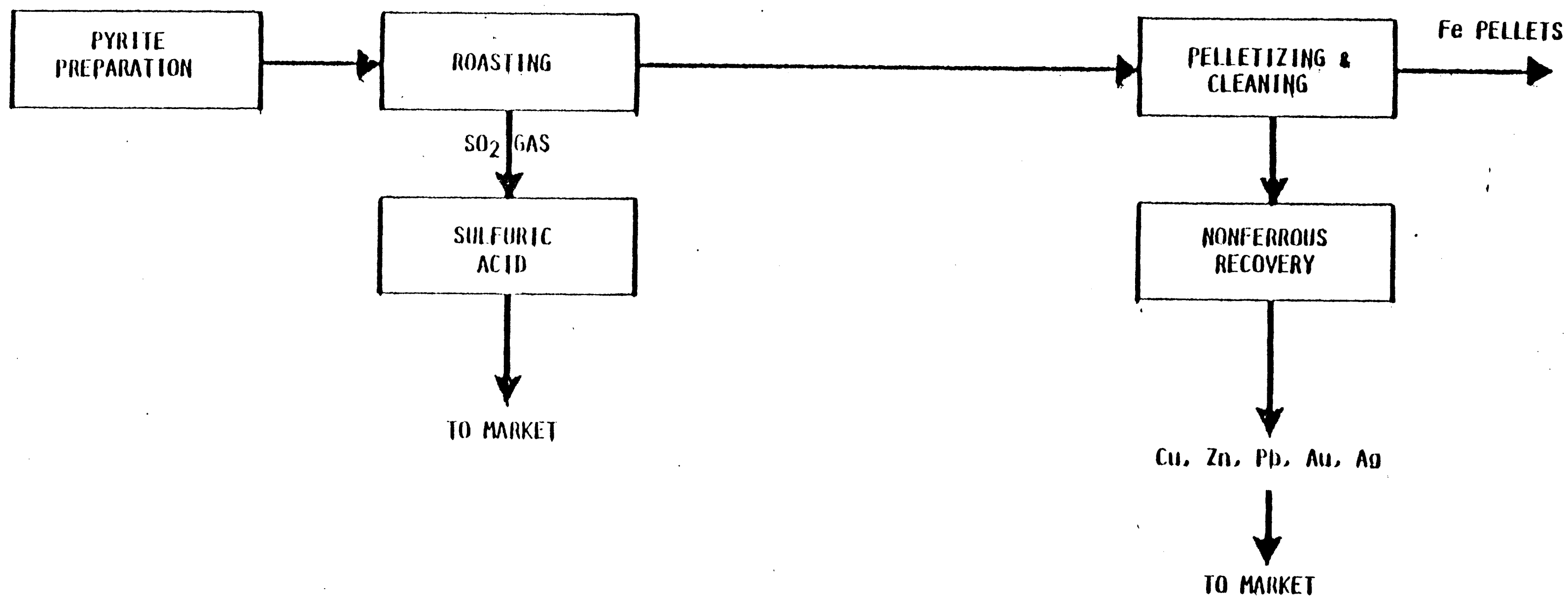
FIGURE 1

ALR 1/15/80

Davy McKee

EXXON MINERALS COMPANY, U.S.A.

PYRITE PROCESSING STUDY



PROCESS BLOCK FLOW DIAGRAM

SULFURIC ACID, IRON PELLETS
AND NONFERROUS METAL RECOVERY

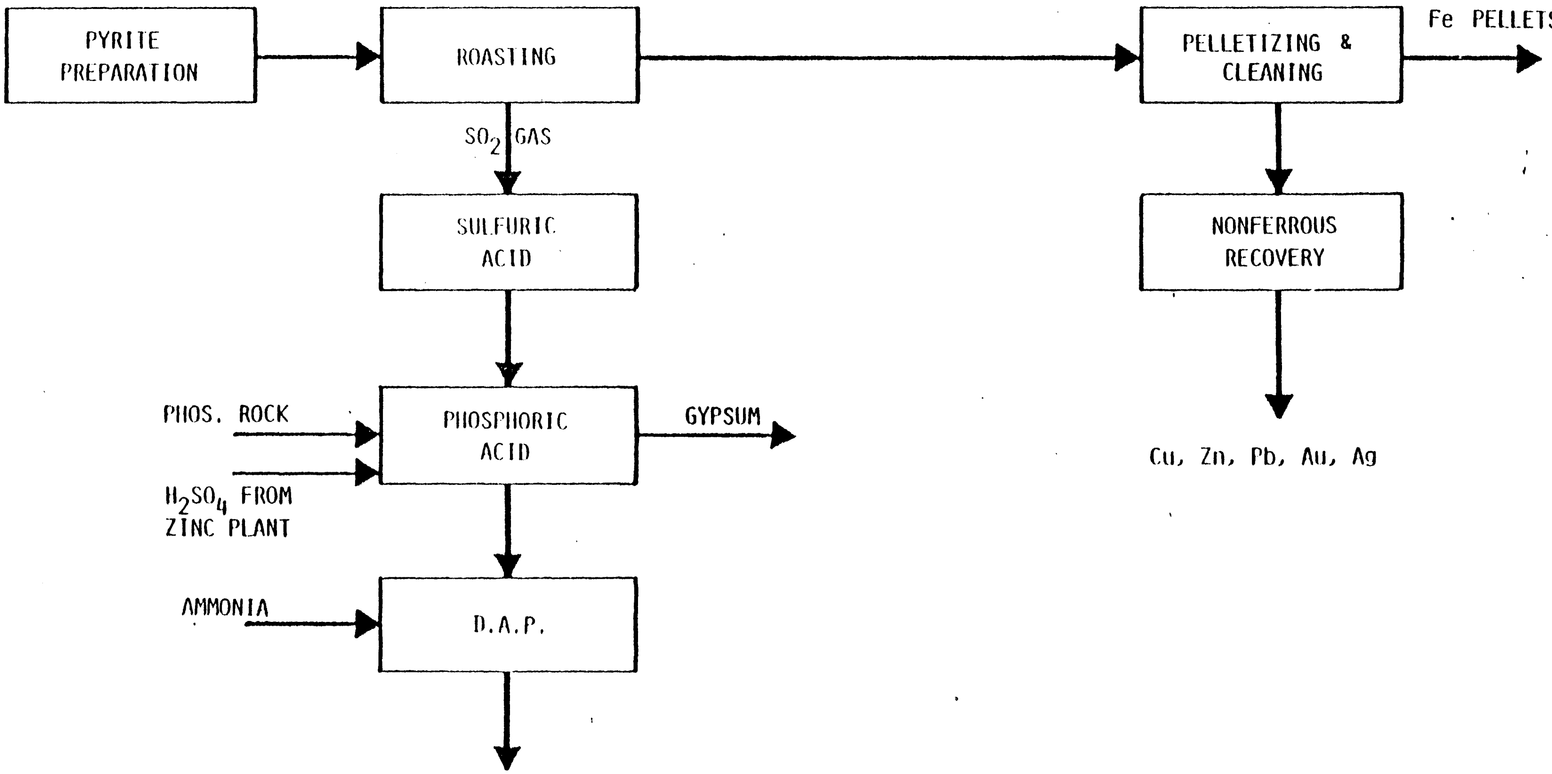
FIGURE 2

ALR 1/15/80

Davy McKee

EXXON MINERALS COMPANY, U.S.A.

PYRITE PROCESSING STUDY



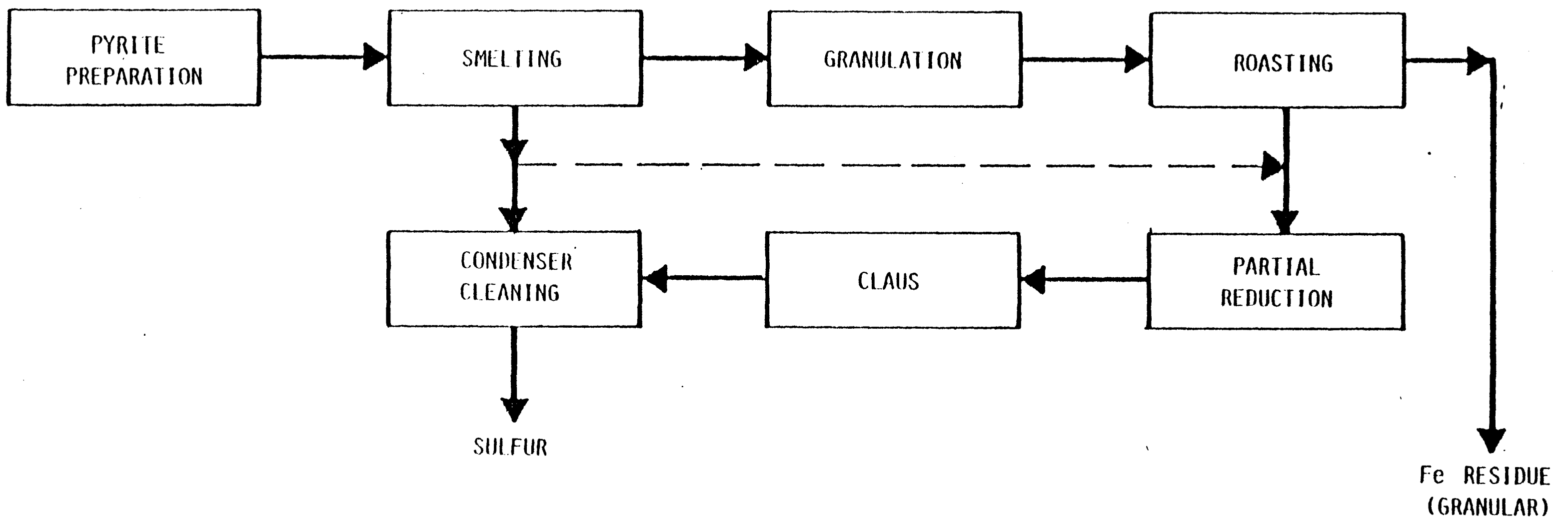
PROCESS BLOCK FLOW DIAGRAM
PELLET ROUTE
SULFURIC ACID, PHOSPHORIC ACID, D.A.P. AND IRON PELLETS
FIGURE # 3

ALR 1/15/80

Davy McKee

EXXON MINERALS COMPANY, U.S.A.

PYRITE PROCESSING STUDY



PROCESS BLOCK FLOW DIAGRAM
SULFUR RECOVERY & IRON RESIDUE

FIGURE # 4

ALR 1/15/80

Davy McKee

EXXON MINERALS COMPANY, U.S.A.

PYRITE PROCESSING STUDY

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES

Commodity: Pyrite Concentrates

Originator	Destination	Mode	Transportation $ Rate	Commodity $ Value	Metric Tons/Yr	Transporation $ Costs/Yr	Commodity $ Rev/Yr
1) Crandon	White Pine	Truck	15.50	2.00 F.O.B.	24,000 (dry)	427,800	48,000
2) Crandon	Copperhill	Rail	31.72	2.00 F.O.B.	267,400 (dry)	9,754,217	534,800

NOTES

Item 1) The net back to Exxon could be increased by selling the 24,000 tons/year at 5.00 or at a price equivalent to the price plus freight that White Pine now pays.

Transportation costs borne by the client.

Transportation costs include 15% moisture.

Figure 5

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
UNIT PRODUCT REVENUES
BASE CASE

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Commodity Revenue
Sulfuric Acid	400,000	15.00	6,000,000
Sulfur	134,000	75.00	10,050,000
Iron Pellets	180,000	42.00	7,560,000
DAP	562,000	220.00	123,640,000
Nonferrous Metals			
Copper	290	1,140.00	330,600
Lead	265	575.00	152,375
Zinc	1,600	460.00	736,000
Precious Metals			
Gold	200 Kg/Y	8,000/Kg	1,600,000
Silver	4,400 Kg/Y	200/Kg	880,000
			3,698,975

Notes: Metal values assigned on the following basis:

Copper Lead Zinc	60% of market
Gold Silver	80% of market

Sulfuric acid broker absorbs the transportation charges

Figure 6

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
UNIT PRODUCT REVENUES
ALTERNATE CASE A

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Commodity Revenue
Sulfuric Acid	1,694,000	15.00	25,410,000
Sulfru	531,000	75.00	39,825,000
Iron Pellets	728,000	42.00	30,156,000
DAP	1,572,000	220.00	345,840,000
Nonferrous Metals			
Copper	1870	1,140.00	2,131,800
Lead	1050	575.00	603,750
Zinc	3740	460.00	2,094,400
Precious Metals			
Gold	840 Kg/Y	8,000/Kg	6,720,000
Silver	18,024 Kg/Y	200/Kg	3,604,800
			15,154,750

Notes: Metal values assigned on the following basis:

Copper Lead Zinc	60% of market
Gold Silver	80% of market

Sulfuric acid broker absorbs the transportation charges

Figure 7

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES

Commodity: Sulfuric Acid

Originator	Destination	Mode	Transportation $ Rate	Commodity $ Value F.O.B.	Metric Tons/Yr	Transporation $ Costs/Yr	Commodity $ Rev/Yr	Delivered $* Costs
Evansville	Chicago	River	11.16	15.00	333,334	3,720,000		
		Rail	16.69		66,666	1,112,655		27.08/MT
					400,000	4,832,655	6,000,000	
Evansville	St. Louis	River	6.09	15.00	333,334	2,030,004		
		Rail	10.68		66,666	711,993		21.85/MT
					400,000	2,741,997	6,000,000	
Evansville	Burnside	River	14.59	15.00	333,334	4,863,343		
		Rail	16.99		66,666	1,113,655		29.94/MT
					400,000	5,976,998	6,000,000	
Green Bay	Chicago	Lake	6.60	15.00	266,667	1,760,002		
		Rail	11.65		133,333	1,552,000		23.28/MT
					400,000	3,312,002	6,000,000	
								34.98/MT
Green Bay	St. Louis	Rail	19.86	15.00	400,000	7,994,000	6,000,000	
								41.64/MT
Green Bay	Burnside	Rail	26.64	15.00	400,000	10,656,000	6,000,000	

Notes: From Evansville, Indiana - 10 months by river, 2 months by rail
From Green Bay, Wisconsin - 8 months by lake, 4 months by rail
Rail transportation from Green Bay to St. Louis and Burnside is cheapest rate, due to transfer costs from lake vessel to barge

*The marketing report indicates that when brokering sulfuric acid, the net back to the producer varies from $4.00/MT to $16.00/MT. We have used $15.00/MT.

Figure 8

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES
Commodity: Sulfuric Acid
(Alternate Case)

Originator	Destination	Mode	Transportation $ Rate	Commodity $ Value F.O.B.	Metric Tons/Yr	Transporation $ Costs/Yr	Commodity $ Rev/Yr	Delivered $* Costs
Evansville	Chicago	River	11.16	15.00	1,411,667	15,754,203		
		Rail	16.69		282,333	4,712,138		27.08/MT
					1,694,000	20,466,341	25,410,000	
Evansville	St. Louis	River	6.09	15.00	1,411,667	8,597,052		
		Rail	10.68		282,333	711,993		20.49/MT
					1,694,000	9,309,045	25,410,000	
Evansville	Burnside	River	14.59	15.00	1,411,667	20,596,221		
		Rail	16.99		282,333	4,796,838		29.99/MT
					1,694,000	25,393,059	25,410,000	
Green Bay	Chicago	Lake	6.60	15.00	1,129,333	7,453,598		
		Rail	11.65		564,667	6,578,371		23.28/MT
					1,694,000	14,031,969	25,410,000	
								34.86/MT
Green Bay	St. Louis	Rail	19.86	15.00	1,694,000	33,642,800	25,410,000	
								41.64/MT
Green Bay	Burnside	Rail	26.64	15.00	1,694,000	45,128,160	25,410,000	

Notes: From Evansville, Indiana - 10 months by river, 2 months by rail
From Green Bay, Wisconsin - 8 months by lake, 4 months by rail
Rail transportation from Green Bay to St. Louis and Burnside is cheapest rate, due to transfer costs from lake vessel to barge

*The marketing report indicates that when brokering sulfuric acid, the net back to the producer varies from $4.00/MT to $16.00/MT. We have used $15.00/MT.

Figure 9

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES

Commodity: Iron Pellets

Originator	Destination	Mode	Transportation $ Rate	Commodity $ Value	Metric Tons/Yr	Transporation $ Costs/Yr	Commodity $ Rev/Yr	Delivered Costs
Evansville	Granite City	River	5.56	42.00	150,000	834,000		
		Rail	9.36		30,000	280,800		48.19/MT
					180,000	1,114,800	7,560,000	
Evansville	Chicago	River	10.73	42.00	150,000	1,609,500		
		Rail	14.04		30,000	421,200		53.28/MT
					180,000	2,030,700	7,560,000	
Evansville	Pittsburgh	River	11.19	42.00	150,000	1,678,500		
		Rail	20.48		30,000	614,400		54.74/MT
					180,000	2,292,900	7,560,000	
Green Bay	Granite City	Lake/River	11.63	42.00	120,000	1,395,600		
		Rail	19.21		60,000	1,152,600		56.15/MT
					180,000	2,548,200	7,560,000	
Green Bay	Chicago	Lake	3.38	42.00	120,000	405,600		
		Rail	10.38		60,000	722,800		47.71/MT
					180,000	1,028,400	7,560,000	
Green Bay	Pittsburgh	Lake/Rail	15.94	42.00	120,000	1,912,800		
		Rail	21.37		60,000	1,282,200		59.75/MT
					180,000	3,195,000	7,560,000	

Note: From Evansville, Indiana - 10 months by river, 2 months by rail
From Green Bay, Wisconsin - 8 months by lake/river, 4 months by rail
Transportation costs are on a dry weight basis (zero moisture)

Figure 10

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES

Commodity: Iron Pellets
(Alternate Case)

Originator	Destination	Mode	Transportation $ Rate	Commodity $ Value	Metric Tons/Yr	Transporation $ Costs/Yr	Commodity $ Rev/Yr	Delivered Costs
Evansville	Granite City	River	5.56	42.00	598,334	3,326,737		
		Rail	9.36		119,666	1,120,074		48.19/MT
					718,000	4,446,811	30,156,000	
Evansville	Chicago	River	10.73	42.00	598,334	6,420,124		
		Rail	14.04		119,666	1,680,111		53.28/MT
					718,000	8,100,235	30,156,000	
Evansville	Pittsburgh	River	11.19	42.00	598,334	6,695,357		
		Rail	20.48		119,666	2,450,760		54.74/MT
					718,000	9,146,117	30,156,000	
Green Bay	Granite City	Lake/River	11.63	42.00	478,667	5,566,897		
		Rail	19.21		239,333	4,597,587		56.16/MT
					718,000	10,164,484	30,156,000	
Green Bay	Chicago	Lake	3.38	42.00	478,667	1,617,894		
		Rail	10.38		239,333	2,484,277		47.71/MT
					718,000	4,102,171	30,156,000	
Green Bay	Pittsburgh	Lake/Rail	15.94	42.00	478,667	7,629,952		
		Rail	21.37		239,333	5,114,546		59.75/MT
					718,000	12,744,498	30,156,000	

Note: From Evansville, Indiana - 10 months by river, 2 months by rail
From Green Bay, Wisconsin - 8 months by lake/river, 4 months by rail
Transportation costs are on a dry weight basis (zero moisture)

Figure 11

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES

Commodity: Diammonium Phosphate (DAP)

Originator	Destination	Mode	Transportation $ Rate	Commodity $ Value	Metric Tons/Yr	Transporation $ Costs/Yr	Commodity $ Rev/Yr	Delivered Costs
Evansville	Ft. Madison, IA	River	5.37	220.00	468,334	2,341,670		
		Rail	11.50		93,666	1,077,155		226.08/MT
					562,000	3,418,829	123,640,000	
Evansville	Omaha, NB	River	12.79	220.00	468,334	5,989,992		
		Rail	13.88		93,666	1,300,084		232.97/MT
					562,000	7,290,076	123,640,000	
Evansville	Minneapolis, MN	River	9.39	220.00	468,334	4,397,656		
		Rail	15.60		93,666	1,461,189		230.43/MT
					562,000	5,858,845	123,640,000	
Green Bay	Ft. Madison, IA	Lake/River	10.10	220.00	374,666	3,784,127		
		Rail	16.12		187,334	3,019,824		232.11/MT
					562,000	6,803,951	123,640,000	
Green Bay	Omaha, NB	Lake/River	15.81	220.00	374,666	5,923,469		
		Rail	20.13		187,334	3,771,033		237.25/MT
					562,000	9,694,502	123,640,000	
Green Bay	Minneapolis, MN	Rail	14.29	220.00	562,000	8,030,980	123,640,000	234.29/MT

Note: From Evansville, Indiana - 10 months by river, 2 months by rail
From Green Bay, Wisconsin - 8 months by lake/river, 4 months by rail
Transportation costs are on a dry weight basis (zero moisture)

Figure 12

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES

Commodity: Diammonium Phosphate (DAP)
(Alternate Case)

Originator	Destination	Mode	Transportation $ Rate	Commodity $ Value	Metric Tons/Yr	Transporation $ Costs/Yr	Commodity $ Rev/Yr	Delivered Costs
Evansville	Ft. Madison, IA	River	5.37	220.00	1,310,000	7,034,700		
		Rail	11.50		262,000	3,013,000		226.08/MT
					1,572,000	10,047,700	345,840,000	
Evansville	Omaha, NB	River	12.79	220.00	1,310,000	16,754,900		
		Rail	13.88		262,000	4,087,200		230.39/MT
					1,572,000	16,388,100	345,840,000	
Evansville	Minneapolis, MN	River	9.39	220.00	1,310,000	12,300,900		
		Rail	15.60		262,000	4,087,200		230.43/MT
					1,572,000	16,388,100	345,840,000	
Green Bay	Ft. Madison, IA	Lake/River	10.10	220.00	1,048,000	10,584,800		
		Rail	16.12		524,000	8,446,880		232.11/MT
					1,572,000	19,031,680	345,840,000	
Green Bay	Omaha, NB	Lake/River	15.81	220.00	1,048,000	16,568,880		
		Rail	20.13		524,000	10,548,120		237.25/MT
					1,572,000	27,117,000	345,840,000	
Green Bay	Minneapolis, MN	Rail	14.29	220.00	1,572,000	22,463,880	345,840,000	234.29/MT

Note:
From Evansville, Indiana - 10 months by river, 2 months by rail
From Green Bay, Wisconsin - 8 months by lake/river, 4 months by rail
Transportation costs are on a dry weight basis (zero moisture)

Figure 13

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES

Commodity: Sulfur

Originator	Destination	Mode	Transportation $ Rate	Commodity $ Value	Metric Tons/Yr	Transporation $ Costs/Yr	Commodity $ Rev/Yr	Delivered Costs
Evansville	Chicago	River	7.43	75.00	111,666	829,678		
		Rail	15.82		22,334	353,324		83.82/MT
					134,000	1,183,002	10,050,000	
Evansville	E. St. Louis	River	3.51	75.00	111,666	391,948		
		Rail	11.49		22,334	256,618		79.84/MT
					134,000	648,566	10,050,000	
Green Bay	Chicago	Lake	5.00	75.00	89,333	446,666		
		Rail	10.84		44,667	484,190		81.95/MT
					134,000	930,856	10,050,000	

Note: From Evansville, Indiana - 10 months by river, 2 months by rail
From Green Bay, Wisconsin - 8 months by lake, 4 months by rail
Transportation costs are on a dry weight basis (zero moisture)

Figure 14

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES - TO SULFURIC ACID & IRON PELLETS

BASE CASE

Product	Metric Ton/Yr	Commodity $ Value/MT	Yearly Commodity Revenue
Sulfuric Acid*	400,000	15.00	6,000,000*
Iron Pellets	180,000	42.00	7,560,000
Nonferrous Metals			
Copper	290	1,140.00	330,600
Lead	265	575.00	152,375
Zinc	1,600	460.00	736,000
Precious Metals			
Gold	200 Kg/yr	8,000/Kg	1,600,000
Silver	4,400 Kg/yr	200/Kg	880,000
			17,258,975

*Sulfuric acid broker absorbs the transportation charges

Figure 15

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES - TO SULFURIC ACID & IRON PELLETS
ALTERNATE CASE A

Product	Metric Ton/Yr	Commodity $ Value/MT	Yearly Commodity Revenue
Sulfuric Acid*	1,694,000	15.00	25,410,000*
Iron Pellets	718,000	42.00	30,156,000
Nonferrous Metals			
Copper	1870	1,140.00	2,131,800
Lead	1050	575.00	603,750
Zinc	3740	460.00	2,094,400
Precious Metals			
Gold	840 Kg/yr	8,000/Kg	6,720,000
Silver	18,024 Kg/yr	200/Kg	3,604,800
			70,720,750

*Sulfuric acid broker absorbs the transportation charges

Figure 16

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES - TO SULFURIC ACID, DAP & IRON PELLETS

BASE CASE

Product	Metric Ton/Yr	Commodity $ Value/MT	Yearly Commodity Revenue	
DAP	562,000	220.00	123,640,000	
Iron Pellets	180,000	42.00	7,560,000	
Nonferrous Metals				
Copper	290	1,140.00	330,600	
Lead	265	575.00	152,375	
Zinc	1,600	460.00	736,000	
				3,698,975
Precious Metals				
Gold	200 Kg/yr	8,000/Kg	1,600,000	
Silver	4,400 Kg/yr	200/Kg	880,000	
			134,892,975	

Figure 17

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES - TO SULFURIC ACID, DAP & IRON PELLETS
ALTERNATE CASE A

Product	Metric Ton/Yr	Commodity $ Value/MT	Yearly Commodity Revenue	
DAP	1,572,000	220.00	345,840,000	
Iron Pellets	718,000	42.00	30,156,000	
Nonferrous Metals				
Copper	1870	1,140.00	2,131,800	
Lead	1050	575.00	603,750	
Zinc	3740	460.00	2,094,400	
				15,154,750
Precious Metals				
Gold	840 Kg/yr	$8,000/Kg	6,720,000	
Silver	18,204 Kg/yr	200/Kg	3,604,800	
			391,151,750	

Figure 18

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES - TO SULFURIC ACID, DAP & IRON PELLETS

NO ZINC REFINERY SULFURIC ACID

BASE CASE - ALTERNATE B

Product	Metric Ton/Yr	Commodity $ Value/MT	Yearly Commodity Revenue
DAP	313,000	220.00	68,860,000
Iron Pellets	180,000	42.00	7,560,000
Nonferrous Metals			
Copper	290	1,140.00	330,600
Lead	265	575.00	152,375
Zinc	1,600	460.00	736,000
Precious Metals			
Gold	200 Kg/yr	8,000/Kg	1,600,000
Silver	4,400 Kg/yr	200/Kg	880,000
			80,118,975

Figure 19

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES - TO SULFURIC ACID, DAP & IRON PELLETS

NO ZINC REFINERY SULFURIC ACID

ALTERNATE CASE B-1

Product	Metric Ton/Yr	Commodity $ Value/MT	Yearly Commodity Revenue
DAP	1,322,228	220.00	290,890,000
Iron Pellets	718,000	42.00	30,156,000
Nonferrous Metals			
Copper	2,870	1,140.00	2,131,800
Lead	1,050	575.00	603,750
Zinc	3,740	460.00	2,094,400
Precious Metals			
Gold	840 Kg/yr	$8,000/Kg	6,720,000
Silver	18,204 Kg/yr	200/Kg	3,604,800
			336,201,750

Figure 20

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES: SULFUR & IRON PELLETS

BASE CASE

Product	Metric Ton/Yr	Commodity $ Value/MT	Yearly Commodity Revenue
Sulfur	134,000	75.00	10,050,000
Iron Pellets	180,000	42.00	7,560,000
Nonferrous Metals			
Copper	290	1,140.00	330,600
Lead	265	575.00	152,375
Zinc	1,600	460.00	736,000
Precious Metals			
Gold	200 Kg/yr	8,000/Kg	1,600,000
Silver	4,400 Kg/yr	200/Kg	880,000
			21,308,975

Figure 21

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
REVENUES: SULFUR & IRON PELLETS

ALTERNATE CASE A

Product	Metric Ton/Yr	Commodity $ Value/MT	Yearly Commodity Revenue
Sulfur	531,000	75.00	39,825,000
Iron Pellets	718,000	42.00	30,156,000
Nonferrous Metals			
Copper	1,870	1,140.00	2,131,800
Lead	1,050	575.00	603,750
Zinc	3,740	460.00	2,094,400
Precious Metals			
Gold	840 Kg/yr	8,000/Kg	6,720,000
Silver	18,204 Kg/yr	200/Kg	3,604,800
			85,135,750

Figure 22

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
UNIT PRODUCT COSTS
BASE CASE

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Green Bay Operating Cost/MT F.O.B.	Green Bay Yearly Prod. Costs	Evansville Operating Cost/MT F.O.B.	Evansville Yearly Prod. Costs
Sulfuric Acid	400,000	15.00	6,000,000	40.04	16,016,000	50.25	20,100,000
Sulfur	134,000	75.00	10,050,000	151.76	20,335,840	183.17	24,544,780
Iron Pellets	180,000	42.00	7,560,000	41.97	7,554,600	41.97	7,554,600
DAP	562,000	220.00	123,640,000	165.10	92,786,200	166.71	93,691,020
Nonferrous Metals							
Copper	290	1,140.00					
Lead	265	575.00					
Zinc	1,600	460.00	3,698,975				
Precious Metals							
Gold	200 Kg/Yr	8,000/Kg					
Silver	4,400 Kg/Yr	200/Kg					

Notes: Metal values assigned on the following basis:

Copper, Lead, Zinc — 60% of market including transportation

Gold, Silver — 80% of market including transportation

Sulfuric acid broker absorbs the transportation charges.

Figure 23

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
UNIT PRODUCT COSTS
ALTERNATE CASE A

				Green Bay		Evansville	
Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Operating Cost/MT F.O.B.	Yearly Prod. Costs	Operating Cost/MT F.O.B.	Yearly Prod. Costs
Sulfuric Acid	1,694,000	15.00	25,410,000	31.78	53,835,320	41.62	70,504,280
Sulfur	531,000	75.00	39,825,000	120.52	63,996,120	151.53	80,462,430
Iron Pellets	718,000	42.00	30,156,000	26.79	19,235,220	26.79	19,285,220
DAP	1,572,000	220.00	345,840,000	159.12	250,136,640	164.12	257,996,640
Nonferrous Metals							
Copper	1870	1,140.00					
Lead	1050	575.00					
Zinc	3740	460.00	15,154,750				
Precious Metals							
Gold	840 Kg/Yr	8,000/Kg					
Silver	18,204 Kg/Yr	200/Kg					

Notes: Metal values assigned on the following basis:

Copper
Lead
Zinc — 60% of market including transportation

Gold
Silver — 80% of market including transportation

Sulfuric acid broker absorbs the transportation charges.

Figure 24

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
UNIT PRODUCT COSTS
ALTERNATE CASE B
No Zinc Refinery Sulfuric Acid

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Green Bay Operating Cost/MT F.O.B.	Green Bay Yearly Prod. Costs	Evansville Operating Cost/MT F.O.B.	Evansville Yearly Prod. Costs
Sulfuric Acid	400,000	15.00	6,000,000	40.04	16,016,000	50.25	20,100,000
Sulfur	134,000	75.00	10,050,000	151.76	20,335,840	183.17	24,544,780
Iron Pellets	180,000	42.00	7,560,000	41.97	7,554,600	41.97	7,554,600
DAP	313,000	220.00	68,860,000	183.05	57,294,650	191.21	59,848,730
Nonferrous Metals							
Copper	290	1,140.00					
Lead	265	575.00					
Zinc	1,600	460.00	3,698,975				
Precious Metals							
Gold	200 Kg/Yr	8,000/Kg					
Silver	4,400 Kg/Yr	200/Kg					

Notes: Metal values assigned on the following basis:

Copper
Lead
Zinc
60% of market including transportation

Gold
Silver
80% of market including transportation

Sulfuric acid broker absorbs the transportation charges.

Figure 25

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
UNIT PRODUCT COSTS
ALTERNATE CASE B-1
No Zinc Refinery Sulfuric Acid

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Green Bay Operating Cost/MT F.O.B.	Green Bay Yearly Prod. Costs	Evansville Operating Cost/MT F.O.B.	Evansville Yearly Prod. Costs
Sulfuric Acid	1,694,000	15.00	25,410,000	31.78	53,835,320	41.62	70,504,280
Iron Pellets	718,000	42.00	30,156,000	26.79	19,235,220	26.79	19,285,220
DAP	1,322,228	220.00	290,890,000	165.15	218,365,950	172.20	227,687,660
Nonferrous Metals							
Copper	1870	1,140.00					
Lead	1050	575.00					
Zinc	3740	460.00	15,154,750				
Precious Metals							
Gold	840 Kg/Yr	8,000/Kg					
Silver	18,204 Kg/Yr	200/Kg					

Notes: Metal values assigned on the following basis:

Copper
Lead
Zinc
60% of market including transportation

Gold
Silver
80% of market including transportation

Sulfuric acid broker absorbs the transportation charges.

Figure 26

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
SULFURIC ACID, IRON PELLETS & NONFERROUS METAL RECOVERY
BASE CASE

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Green Bay Prod Cost/MT F.O.B.	Green Bay Yearly Prod. Costs	Evansville Prod Cost/MT F.O.B.	Evansville Yearly Prod. Costs
Sulfuric Acid	400,000	15.00	6,000,000	40.04	16,016,000	50.25	20,100,000
Iron Pellets	180,000	42.00	7,560,000	41.97	7,554,600	41.97	7,554,600
Nonferrous	*	*	3,698,975	**		**	
			17,258,975		23,570,600		27,654,600
Gain/(Loss)				(6,318,625)		(10,395,625)	

*See Figures 23 and 24
**Included with Iron Pellets

Figure 27

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
SULFURIC ACID, IRON PELLETS & NONFERROUS METAL RECOVERY
ALTERNATE CASE A

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Green Bay Prod Cost/MT F.O.B.	Green Bay Yearly Prod. Costs	Evansville Prod Cost/MT F.O.B.	Evansville Yearly Prod. Costs
Sulfuric Acid	1,694,000	15.00	25,410,000	31.78	53,835,320	41.62	70,504,280
Iron Pellets	718,000	42.00	30,156,000	26.79	19,235,220	26.79	19,235,220
Nonferrous Metals & Precious Metals	*	-	15,154,750	**	-	**	-
Total			70,720,750		73,070,540		89,739,500
Gan/(Loss)				(2,349,790)		(19,018,750)	

*See Figures 23 and 24
**Included with Iron Pellets

Figure 28

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
DAP, IRON PELLETS & NONFERROUS METAL RECOVERY
BASE CASE

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Green Bay Prod Cost/MT F.O.B.	Green Bay Yearly Prod. Costs	Evansville Prod Cost/MT F.O.B.	Evansville Yearly Prod. Costs
Iron Pellets	180,000	42.00	7,560,000	41.97	7,554,600	41.97	7,554,600
DAP	562,000	220.00	123,640,000	165.10	92,786,200	166.71	93,691,020
Nonferrous Metals & Precious Metals	*	-	3,698,975	**	-	**	-
			134,898,975		100,340,800		101,245,620
Gain/(Loss)				34,558,175		33,453,355	

*See Figures 23 and 24
**Included with Iron Pellets

Figure 29

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
DAP, IRON PELLETS & NONFERROUS METAL RECOVERY
ALTERNATE CASE A

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Green Bay Prod Cost/MT F.O.B.	Green Bay Yearly Prod. Costs	Evansville Prod Cost/MT F.O.B.	Evansville Yearly Prod. Costs
Iron Pellets	718,000	42.00	30,156,000	26.79	19,235,220	26.79	19,235,220
DAP	1,572,000	220.00	345,840,000	159.12	250,136,640	164.12	257,996,640
Nonferrous Metals & Precious Metals	*	-	15,154,750	**	-	**	-
Total			391,150,750		269,371,860		277,231,860
Gain/(Loss)				121,778,890		113,919,890	

*See Figures 23 and 24
**Included in Iron Pellets

Figure 30

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
DAP, IRON PELLETS & NONFERROUS METAL RECOVERY

BASE CASE - ALTERNATE B

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Green Bay Prod Cost/MT F.O.B.	Green Bay Yearly Prod. Costs	Evansville Prod Cost/MT F.O.B.	Evansville Yearly Prod. Costs
Iron Pellets	180,000	42.00	7,560,000	41.97	7,554,600	41.97	7,554,600
DAP	313,000	220.00	68,860,000	183.05	57,294,650	191.21	59,848,730
Nonferrous Metals & Precious Metals	*	-	3,698,975	**	-	**	-
			80,118,975		64,849,250		67,403,330
Gain/(Loss)				15,269,725		12,715,645	

*See Figures 23 and 24
**Included with Iron Pellets

Figure 31

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
DAP, IRON PELLETS & NONFERROUS METAL RECOVERY
NO ZINC REFINERY SULFURIC ACID

ALTERNATE CASE B-1

				Green Bay		Evansville	
Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Prod Cost/MT F.O.B.	Yearly Prod. Costs	Prod Cost/MT F.O.B.	Yearly Prod. Costs
Iron Pellets	718,000	42.00	30,156,000	26.79	19,235,220	26.79	19,235,220
DAP	1,322,228	220.00	290,890,000	165.15	218,365,954	172.20	227,687,662
Nonferrous Metals & Precious Metals	*	-	15,154,750	**	-	**	-
Total			336,200,750		237,601,174		246,922,882
Gain/(Loss)				98,599,576		89,277,868	

*See Figures 23 and 24
**Included in Iron Pellets

Figure 32

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
ELEMENTAL SULFUR, IRON PELLETS & NONFERROUS METAL RECOVERY
BASE CASE

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Green Bay Prod Cost/MT F.O.B.	Green Bay Yearly Prod. Costs	Evansville Prod Cost/MT F.O.B.	Evansville Yearly Prod. Costs
Sulfur	134,000	75.00	10,050,000	151.76	20,335,840	183.17	24,544,780
Iron Pellets	180,000	42.00	7,560,000	41.97	7,554,600	41.97	7,554,600
Nonferrous	*	-	3,698,975	**		**	
			21,308,975		27,890,440		32,099,380
Gain/(Loss)				(6,581,465)		(10,790,405)	

*See Figures 23 and 24
**Included with Iron Pellets

Figure 33

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
ELEMENTAL SULFUR, IRON PELLETS & NONFERROUS METAL RECOVERY
ALTERNATE CASE A

Product	Metric Ton/Yr	Commodity $ Value/MT F.O.B.	Yearly Revenues	Green Bay Prod Cost/MT F.O.B.	Green Bay Yearly Prod. Costs	Evansville Prod Cost/MT F.O.B.	Evansville Yearly Prod. Costs
Sulfur	531,000	75.00	39,825,000	120.52	63,996,120	151.53	80,462,430
Iron Pellets	718,000	42.00	30,156,000	26.79	19,235,220	26.79	19,235,220
Nonferrous Metals & Precious Metals	*	-	15,154,750	**	-	**	-
Total			85,135,750		83,231,340		99,697,650
Gain/(Loss)				1,904,410		(14,561,900)	

*See Figures 23 and 24
**Included with Iron Pellets

Figure 34

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
COSTS TO CONSUMER DEPENDING ON LOCATION

Commodity	Origin	Destination	Commodity Price	Transport Cost	Delivered Price	Differential
Iron Pellets	Escanaba	Chicago	42.00	3.70	45.70	
		Granite City	42.00	11.94	53.94	
	Green Bay	Chicago	42.00	3.38	45.38	0.32
		Granite City	42.00	11.63	53.63	0.31
	Evansville	Chicago	42.00	10.73	53.73	(8.03)
		Granite City	42.00	5.56	47.56	6.38
Diammonium Phosphate	Tampa	Ft. Madison	220.00	14.50	234.50	
	Green Bay	Ft. Madison	220.00	10.10	230.10	4.40
	Evansville	Ft. Madison	220.00	5.37	225.37	9.13

Figure 35

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
2489
COSTS TO CONSUMER DEPENDING ON LOCATION
ALTERNATE CASE

Commodity	Origin	Destination	Commodity Price	Transport Cost	Delivered Cost	Differential Price Cost
Iron Pellets	Escanaba	Chicago	42.00	3.70	45.70	
		Granite City	42.00	11.94	53.94	
	Green Bay	Chicago	42.00	3.38	45.38	0.32
		Granite City	42.00	11.63	53.63	0.31
	Evansville	Chicago	42.00	10.73	53.73	8.03
		Granite City	42.00	5.56	47.56	6.38
Diammonium Phosphate	Tampa	Ft. Madison	220.00	14.50	234.50	
	Green Bay	Ft. Madison	220.00	10.10	230.10	4.40
	Evansville	Ft. Madison	220.00	5.37	225.37	9.13

Figure 36

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

PROCESS ROUTE

Sulfuric Acid Only, Iron to Waste
Green Bay

	267,400 MTPY Pyrite	1,094,000 MTPY Pyrite
Capital Cost	$64,000,000	$210,000,000
Cost/Annual MT	$240.00	$192.00
Revenues/Yr	6,000,000	25,410,000
Revenues/MT	15.00	15.00
Operating Cost/Yr	16,016,000	53,835,320
Cost/MT	40.04	31.78
Gain/(loss)	(10,016,000)	(28,425,320)

Figure 37

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

PROCESS ROUTE

Sulfuric Acid Only, Iron to Waste
Evansville

	267,400 MTPY Pyrite	1,094,000 MTPY Pyrite
Capital Cost	$64,000,000	$210,000,000
Cost/Annual MT	$240.00	$192.00
Revenues/Yr	6,000,000	25,410,000
Revenues/MT	15.00	15.00
Operating Cost/Yr	20,100,000	70,504,280
Cost/MT	50.25	41.62
Gain/(loss)	(14,100,000)	(45,094,280)

Figure 38

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

PROCESS ROUTE

Sulfuric Acid, Iron Pellets, Nonferrous Metals Reclamation
Green Bay

	267,400 MTPY Pyrite	1,094,000 MTPY Pyrite
Capital Cost	$84,000,000	$250,000,000
Cost/Annual MT	$314.00	$229.00
Revenues/Yr*	17,258,975	70,720,750
Operating Cost/Yr	23,577,600	73,070,540
H_2SO_4 Cost/MT	40.04	31.78
Iron Cost/MT	41.97	26.79
Gain/(loss)	(6,318,625)	(2,349,790)

*Includes credit for nonferrous and precious metals

Refer to Figures 27 and 28

Figure 39

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

PROCESS ROUTE

Sulfuric Acid, Iron Pellets, Nonferrous Metals Reclamation
Evansville

	267,400 MTPY Pyrite	1,094,000 MTPY Pyrite
Capital Cost	$84,000,000	$250,000,000
Cost/Annual MT	$314.00	$229.00
Revenues/Yr*	17,258,975	89,739,500
Operating Cost/Yr	27,654,600	70,720,750
H_2SO_4 Cost/MT	50.25	41.62
Iron Cost/MT	41.97	26.79
Gain/(loss)	(10,395,625)	(19,018,750)

*Includes credit for nonferrous and precious metals

Refer to Figures 27 and 28

Figure 40

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

PROCESS ROUTE

DAP, Iron Pellets & Nonferrous Metal Recovery
Green Bay

	Base Case 267,400 MTPY Pyrite	Alternate Case A 1,094,000 MTPY Pyrite
Capital Cost	$145,000,000	$400,000,000
Cost/Annual MT	$542.00	$365.00
Revenues/Yr*	134,898,975	391,150,750
Operating Cost/Yr	100,340,000	269,371,860
Gain/(loss)	34,558,175	121,778,890

*Includes credit for nonferrous and precious metals

Refer to Figures 29 and 30

Figure 41

GREEN BAY

PYRITE PROCESSING STUDY (BASE CASE)
562,000 METRIC TONS/YEAR D.A.P. PRODUCT #1
180,000 METRIC TONS/YEAR IRON PELLETS PRODUCT #2

ZERO MONTH	ZERO YEAR	LAST YEAR	NUMBER PRODUCTS	TODAYS MONTH	TODAYS YEAR	NO.YRS. BEFORE YR. ZERO
1	1988	1999	2	1	1983	5

PRODUCT NUMBER 1

SALES VOLUME, M UNITS/YR

0.	0.	0.	0.	0.	562.	562.	562.	562.	562.	562.	562.
562.	562.	562.	562.	562.							

SALES PRICE, $/UNIT

.0000	.0000	.0000	.0000	.0000	220.0000	220.0000	220.0000	220.0000	220.0000	220.0000	220.0000
220.0000	220.0000	220.0000	220.0000	220.0000							

VARIABLE EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

DISTRIBUTION EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

MARKETING EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

PRODUCT NUMBER 2

SALES VOLUME, M UNITS/YR

0.	0.	0.	0.	0.	180.	180.	180.	180.	180.	180.	180.
180.	180.	180.	180.	180.							

SALES PRICE, $/UNIT

.0000	.0000	.0000	.0000	.0000	42.0000	42.0000	42.0000	42.0000	42.0000	42.0000	42.0000
42.0000	42.0000	42.0000	42.0000	42.0000							

VARIABLE EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

DISTRIBUTION EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

MARKETING EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

FIGURE 41-A1

FIXED EXPENSE, $M

0.	0.	0.	0.	0.	100341.	100341.	100341.	100341.	100341.	100341.	100341.
100341.	100341.	100341.	100341.	100341.							

FIGURE 41-B1

R + D EXPENSE, $M

0.	0.	0.	0.	0.	1000.	1000.	1000.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

PRLOP EXPENSE, $M

700.	700.	700.	700.	700.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

WORKING CAPITAL, $M

0.	0.	0.	0.	2750.	33500.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-36250.							

DEPLETION ALLOWANCE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPITAL EXPENDITURE, $M

7000.	35000.	50000.	35000.	18000.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

SALVAGE VALUE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPT. EXP.	DEPR. METH.	IN YEAR	OUT YEAR	VAL. OF K
145000.	1	1989	1999	.00

TAX RATE	TAX CREDIT	2ND PVP RATE
.48	.07	.00

EQUITY CAPT.	CAPT. INVEST.	IN YEAR	OUT YEAR	DEBT INT. RATE	INT. METHOD
0.	145000.	1988	1999	.00	1

FIGURE 41-C1

FOLLOWING VALUES ARE IN $M

YEAR	GROSS REVENUES	TOTAL EXPENSES	CASH INCOME BEFORE TAXES	DEPRECIATION FOR TAX PURPOSES	INTEREST ON DEBT	TAXABLE INCOME	INCOME TAX	TAX CREDITS	CASH INCOME AFTER TAXES	CASH FLOW	CUMULATIVE CASH FLOW
1983	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-7700.	-7700.
1984	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-35700.	-43400.
1985	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-50700.	-94100.
1986	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-35700.	-129800.
1987	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-21450.	-151250.
1988	131200.	114166.	17034.	12083.	0.	4951.	2376.	10150.	24808.	-8692.	-159942.
1989	131200.	114166.	17034.	12083.	0.	4951.	2376.	0.	14658.	14658.	-145285.
1990	131200.	114166.	17034.	12083.	0.	4951.	2376.	0.	14658.	14658.	-130627.
1991	131200.	113166.	18034.	12083.	0.	5951.	2856.	0.	15178.	15178.	-115450.
1992	131200.	113166.	18034.	12083.	0.	5951.	2856.	0.	15178.	15178.	-100272.
1993	131200.	113166.	18034.	12083.	0.	5951.	2856.	0.	15178.	15178.	-85094.
1994	131200.	113166.	18034.	12083.	0.	5951.	2856.	0.	15178.	15178.	-69917.
1995	131200.	113166.	18034.	12083.	0.	5951.	2856.	0.	15178.	15178.	-54739.
1996	131200.	113166.	18034.	12083.	0.	5951.	2856.	0.	15178.	15178.	-39562.
1997	131200.	113166.	18034.	12083.	0.	5951.	2856.	0.	15178.	15178.	-24384.
1998	131200.	113166.	18034.	12083.	0.	5951.	2856.	0.	15178.	15178.	-9206.
1999	131200.	113166.	18034.	12083.	0.	5951.	2856.	0.	15178.	51428.	42221.

EARNING POWER 2.51 PERCENT

PVP DISCOUNTED AT 8 PERCENT -48656.

PVP DISCOUNTED AT 15 PERCENT -69241.

STOP 77

FIGURE 41-D1

ROI 15%

GREEN BAY

PYRITE PROCESSING STUDY (BASE CASE)
562,000 METRIC TONS/YEAR D.A.P. PRODUCT #1
180,000 METRIC TONS/YEAR IRON PELLETS PRODUCT #2

ZERO MONTH	ZERO YEAR	LAST YEAR	NUMBER PRODUCTS	TODAYS MONTH	TODAYS YEAR	NO. YRS. BEFORE YR. ZERO
[illegible]	1988	1999	2	1	1983	5

PRODUCT NUMBER 1

SALES VOLUME, M UNITS/YR	0.	0.	0.	0.	0.	562.	562.	562.	562.	562.	562.	562.
	562.	562.	562.	562.	562.							
SALES PRICE, $/UNIT	.0000	.0000	.0000	.0000	.0000	298.0000	298.0000	298.0000	298.0000	298.0000	298.0000	298.0000
	298.0000	298.0000	298.0000	298.0000	298.0000							
VARIABLE EXPENSE, $/UNIT	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	.0000	.0000	.0000	.0000	.0000							
DISTRIBUTION EXPENSE, $/UNIT	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	.0000	.0000	.0000	.0000	.0000							
MARKETING EXPENSE, $/UNIT	.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	1.0000	1.0000	1.0000	1.0000	1.0000							

PRODUCT NUMBER 2

SALES VOLUME, M UNITS/YR	0.	0.	0.	0.	0.	180.	180.	180.	180.	180.	180.	180.
	180.	180.	180.	180.	180.							
SALES PRICE, $/UNIT	.0000	.0000	.0000	.0000	.0000	57.0000	57.0000	57.0000	57.0000	57.0000	57.0000	57.0000
	57.0000	57.0000	57.0000	57.0000	57.0000							
VARIABLE EXPENSE, $/UNIT	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	.0000	.0000	.0000	.0000	.0000							
DISTRIBUTION EXPENSE, $/UNIT	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
	.0000	.0000	.0000	.0000	.0000							
MARKETING EXPENSE, $/UNIT	.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	1.0000	1.0000	1.0000	1.0000	1.0000							

FIGURE 41-E1

[illegible]

. 0. 0. 0. 0. 100341. 100341. 100341. 100341. 100341. 100341. 100341.

100341. 100341. 100341. 100341. 100341.

FIGURE 41-F1

[illegible] EXPENSE, $M

0.	0.	0.	0.	0.	1000.	1000.	1000.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

[illegible] EXPENSE, $M

700.	700.	700.	700.	700.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

WORKING CAPITAL, $M

0.	0.	0.	0.	2750.	33500.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-36250.							

DEPLETION ALLOWANCE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPITAL EXPENDITURE, $M

[illegible]	75000.	50000.	15000.	10000.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

SALVAGE VALUE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPT. EXP.	DEPR. METH.	IN YEAR	OUT YEAR	VAL. OF K
14[illegible]000.	1	1988	1999	.00

TAX RATE	TAX CREDIT	2ND PVP RATE
.4[illegible]	.07	.00

EQUITY CAPT.	CAPT. INVEST.	IN YEAR	OUT YEAR	DEBT INT. RATE	INT. METHOD
0.	145000.	1988	1999	.00	1

FIGURE 41-G1

FOLLOWING VALUES ARE IN $M

YEAR	GROSS REVENUES	TOTAL EXPENSES	CASH INCOME BEFORE TAXES	DEPRECIATION FOR TAX PURPOSES	INTEREST ON DEBT	TAXABLE INCOME	INCOME TAX	TAX CREDITS	CASH INCOME AFTER TAXES	CASH FLOW	CUMULATIVE CASH FLOW
1983	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-7700.	-7700.
1984	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-35700.	-43400.
1985	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-50700.	-94100.
1986	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-35700.	-129800.
1987	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-21450.	-151250.
1988	177736.	114166.	63570.	12083.	0.	51487.	24714.	10150.	49006.	15506.	-135744.
1989	177736.	114166.	63570.	12083.	0.	51487.	24714.	0.	38856.	38856.	-96887.
1990	177736.	114166.	63570.	12083.	0.	51487.	24714.	0.	38856.	38856.	-58031.
1991	177736.	113166.	64570.	12083.	0.	52487.	25194.	0.	39376.	39376.	-18655.
1992	177736.	113166.	64570.	12083.	0.	52487.	25194.	0.	39376.	39376.	20722.
1993	177736.	113166.	64570.	12083.	0.	52487.	25194.	0.	39376.	39376.	60098.
1994	177736.	113166.	64570.	12083.	0.	52487.	25194.	0.	39376.	39376.	99474.
1995	177736.	113166.	64570.	12083.	0.	52487.	25194.	0.	39376.	39376.	138851.
1996	177736.	113166.	64570.	12083.	0.	52487.	25194.	0.	39376.	39376.	178227.
1997	177736.	113166.	64570.	12083.	0.	52487.	25194.	0.	39376.	39376.	217603.
1998	177736.	113166.	64570.	12083.	0.	52487.	25194.	0.	39376.	39376.	256980.
1999	177736.	113166.	64570.	12083.	0.	52487.	25194.	0.	39376.	75626.	332606.

EARNING POWER 15.11 PERCENT

PVP DISCOUNTED AT 3 PERCENT 60759.

PVP DISCOUNTED AT 15 PERCENT 752.

STOP [illegible]

[illegible] *TAPS.DCF

FIGURE 41-H1

GREEN BAY

PYRITE PROCESSING STUDY (ALTERNATE A)
1572,000 METRIC TONS/YEAR D.A.P. PRODUCT #1
718,000 METRIC TONS/YEAR IRON PELLETS PRODUCT #2

ZERO MONTH	ZERO YEAR	LAST YEAR	NUMBER PRODUCTS	TODAYS MONTH	TODAYS YEAR	NO.YRS. BEFORE YR. ZERO
1	1988	1999	2	1	1983	5

PRODUCT NUMBER 1

SALES VOLUME, M UNITS/YR

0.	0.	0.	0.	0.	1572.	1572.	1572.	1572.	1572.	1572.	1572.
1572.	1572.	1572.	1572.	1572.							

SALES PRICE, $/UNIT

.0000	.0000	.0000	.0000	.0000	220.0000	220.0000	220.0000	220.0000	220.0000	220.0000	220.0000
220.0000	220.0000	220.0000	220.0000	220.0000							

VARIABLE EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

DISTRIBUTION EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

MARKETING EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

PRODUCT NUMBER 2

SALES VOLUME, M UNITS/YR

0.	0.	0.	0.	0.	718.	718.	718.	718.	718.	718.	718.
718.	718.	718.	718.	718.							

SALES PRICE, $/UNIT

.0000	.0000	.0000	.0000	.0000	42.0000	42.0000	42.0000	42.0000	42.0000	42.0000	42.0000
42.0000	42.0000	42.0000	42.0000	42.0000							

VARIABLE EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

DISTRIBUTION EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

MARKETING EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

FIGURE 41-A2

FIXED EXPENSE, $M

```
       0.        0.         0.         0.         0.   269372.   269372.   269372.   269372.   269372.   269372.   269372.
269372.   269372.   269372.   269372.   269372.
```

FIGURE 41-B2

R + D EXPENSE, $M

0.	0.	0.	0.	0.	1000.	1000.	1000.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

PREOP EXPENSE, $M

700.	700.	700.	700.	700.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

WORKING CAPITAL, $M

0.	0.	0.	0.	4000.	96000.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-100000.							

DEPLETION ALLOWANCE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPITAL EXPENDITURE, $M

50000.	75000.	100000.	100000.	75000.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

SALVAGE VALUE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPT. EXP.	DEPR. METH.	IN YEAR	OUT YEAR	VAL. OF K
400000.	1	1988	1999	.00

TAX RATE	TAX CREDIT	2ND PVP RATE
.48	.07	.00

EQUITY CAPT.	CAPT. INVEST.	IN YEAR	OUT YEAR	DEBT INT. RATE	INT. METHOD
0.	400000.	1988	1999	.00	1

FIGURE 41-C2

FOLLOWING VALUES ARE IN $M

YEAR	GROSS REVENUES	TOTAL EXPENSES	CASH INCOME BEFORE TAXES	DEPRECIATION FOR TAX PURPOSES	INTEREST ON DEBT	TAXABLE INCOME	INCOME TAX	TAX CREDITS	CASH INCOME AFTER TAXES	CASH FLOW	CUMULATIVE CASH FLOW
1983	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-50700.	-50700.
1984	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-75700.	-126400.
1985	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-100700.	-227100.
1986	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-100700.	-327800.
1987	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-79700.	-407500.
1988	375996.	305995.	70001.	33333.	0.	36667.	17600.	28000.	80400.	-15600.	-423100.
1989	375996.	305995.	70001.	33333.	0.	36667.	17600.	0.	52400.	52400.	-370699.
1990	375996.	305995.	70001.	33333.	0.	36667.	17600.	0.	52400.	52400.	-318299.
1991	375996.	304995.	71001.	33333.	0.	37667.	18080.	0.	52920.	52920.	-265379.
1992	375996.	304995.	71001.	33333.	0.	37667.	18080.	0.	52920.	52920.	-212458.
1993	375996.	304995.	71001.	33333.	0.	37667.	18080.	0.	52920.	52920.	-159538.
1994	375996.	304995.	71001.	33333.	0.	37667.	18080.	0.	52920.	52920.	-106618.
1995	375996.	304995.	71001.	33333.	0.	37667.	18080.	0.	52920.	52920.	-53697.
1996	375996.	304995.	71001.	33333.	0.	37667.	18080.	0.	52920.	52920.	-777.
1997	375996.	304995.	71001.	33333.	0.	37667.	18080.	0.	52920.	52920.	52143.
1998	375996.	304995.	71001.	33333.	0.	37667.	18080.	0.	52920.	52920.	105064.
1999	375996.	304995.	71001.	33333.	0.	37667.	18080.	0.	52920.	152920.	257984.

EARNING POWER 5.32 PERCENT

PVP DISCOUNTED AT 8 PERCENT -67937.

PVP DISCOUNTED AT 15 PERCENT -153276.

STOP 77

FIGURE 41-D2

151

ROI 15%

PYRITE PROCESSING STUDY (ALTERNATE A) GREEN BAY
1572,000 METRIC TONS/YEAR D.A.P. PRODUCT #1
718,000 METRIC TONS/YEAR IRON PELLETS PRODUCT #2

ZERO MONTH	ZERO YEAR	LAST YEAR	NUMBER PRODUCTS	TODAYS MONTH	TODAYS YEAR	NO.YRS. BEFORE YR. ZERO
1	1988	[illegible]	2	1	1983	5

PRODUCT NUMBER 1

SALES VOLUME, M UNITS/YR											
0.	0.	0.	0.	0.	1572.	1572.	1572.	1572.	1572.	1572.	1572.
1572.	1572.	1572.	1572.	1572.							
SALES PRICE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	280.0000	280.0000	280.0000	280.0000	280.0000	280.0000	280.0000
280.0000	280.0000	280.0000	280.0000	280.0000							
VARIABLE EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
DISTRIBUTION EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
MARKETING EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

PRODUCT NUMBER 2

SALES VOLUME, M UNITS/YR											
0.	0.	0.	0.	0.	718.	718.	718.	718.	718.	718.	718.
718.	718.	718.	718.	718.							
SALES PRICE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	53.0000	53.0000	53.0000	53.0000	53.0000	53.0000	53.0000
53.0000	53.0000	53.0000	53.0000	53.0000							
VARIABLE EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
DISTRIBUTION EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
MARKETING EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

FIGURE 41-E2

FIXED EXPENSE, TV

0.	0.	0.	0.	0.	269372.	269372.	269372.	269372.	269372.	269372.	269372.
269372.	269372.	269372.	269372.	269372.							

FIGURE 41-F2

R + D EXPENSE, $M

0.	0.	0.	0.	0.	1000.	1000.	1000.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

[illegible] EXPENSE, $M

700.	700.	700.	700.	700.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

WORKING CAPITAL, $M

0.	0.	0.	0.	4000.	26000.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-100000.							

DEPLETION ALLOWANCE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPITAL EXPENDITURE, $M

50000.	75000.	100000.	100000.	75000.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

SALVAGE VALUE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPT. EXP.	DEPR. METH.	IN YEAR	OUT YEAR	VAL. OF K
400000.	1	1989	1999	.00

TAX RATE	TAX CREDIT	2ND EXP RATE
.45	.07	.00

EQUITY CAPT.	CAPT. INVEST.	IN YEAR	OUT YEAR	DEBT INT. RATE	INT. METHOD
0.	400000.	1988	1999	.00	1

FIGURE 41-G2

FOLLOWING VALUES ARE IN 1M

YEAR	GROSS REVENUES	TOTAL EXPENSES	CASH INCOME BEFORE TAXES	DEPRECIA-TION FOR TAX PURPOSES	INTEREST ON DEBT	TAXABLE INCOME	INCOME TAX	TAX CREDITS	CASH INCOME AFTER TAXES	CASH FLOW	CUMULA-TIVE CASH FLOW
1983	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-50700.	-50700.
1984	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-75700.	-126400.
1985	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-100700.	-227100.
1986	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-100700.	-327800.
1987	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-79700.	-407500.
1988	478214.	305995.	172219.	33333.	0.	138885.	66665.	28000.	133554.	37554.	-369946.
1989	478214.	305995.	172219.	33333.	0.	138885.	66665.	0.	105554.	105554.	-264393.
1990	478214.	305995.	172219.	33333.	0.	138885.	66665.	0.	105554.	105554.	-158839.
1991	478214.	304995.	173219.	33333.	0.	139885.	67145.	0.	106074.	106074.	-52765.
1992	478214.	304995.	173219.	33333.	0.	139885.	67145.	0.	106074.	106074.	53309.
1993	478214.	304995.	173219.	33333.	0.	139885.	67145.	0.	106074.	106074.	159382.
1994	478214.	304995.	173219.	33333.	0.	139885.	67145.	0.	106074.	106074.	265456.
1995	478214.	304995.	173219.	33333.	0.	139885.	67145.	0.	106074.	106074.	371530.
1996	478214.	304995.	173219.	33333.	0.	139885.	67145.	0.	106074.	106074.	477603.
1997	478214.	304995.	173219.	33333.	0.	139885.	67145.	0.	106074.	106074.	583677.
1998	478214.	304995.	173219.	33333.	0.	139885.	67145.	0.	106074.	106074.	689751.
1999	478214.	304995.	173219.	33333.	0.	139885.	67145.	0.	106074.	206074.	895824.

EARNING POWER 15.02 PERCENT

EVP DISCOUNTED AT 5 PERCENT 215463.

EVP DISCOUNTED AT 15 PERCENT 463.

STOP 77

@XQT *TAPS.BCF

FIGURE 41-H2

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

PROCESS ROUTE

DAP, Iron Pellets & Nonferrous Metal Recovery
Evansville

	Base Case 267,400 MTPY Pyrite	Alternate Case A 1,094,000 MTPY Pyrite
Capital Cost	$145,000,000	$400,000,000
Cost/Annual MT	$542.00	$365.00
Revenues/Yr*	134,898,975	391,150,750
Operating Cost/Yr	101,245,620	277,231,860
Iron pellets/MT	41.97	41.97
DAP	166.71	164.12
Gain/(loss)	33,653,355	113,918,890

*Includes credit for nonferrous and precious metals

Refer to Figures 29 and 30

Figure 42

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

PROCESS ROUTE

DAP, Iron Pellets & Nonferrous Metal Recovery
GREEN BAY
NO ZINC REFINERY SULFURIC ACID

ALTERNATE CASE B & B-1

	Alternate Case B 400,000 MTPY Sulfuric Acid 180,000 MTPY Iron Pellets 313,000 MTPY DAP	Alternate Case B-1 1,694,000 MTPY Sulfuric Acid 718,000 MTPY Iron Pellets 1,322,228 MTPY DAP
Capital Cost	$133,000,000	$392,000,000
Revenues/Yr*	80,118,375	336,200,750
Operating Cost/Yr	64,849,250	237,601,174
Iron Pellets/MT	41.97	26.79
DAP/MT	191.21	165.15
Gain/(loss)	15,269,725	98,599,576

*Includes credit for nonferrous and precious metals
267,400 MTPY Pyrite - $3,698,925
1,094,000 MTPY Pyrite - $15,154,750

Refer to Figures 31 and 32

Figure 43

GREEN BAY

PYRITE PROCESSING STUDY (ALTERNATE B)
313,000 METRIC TONS/YEAR D.A.P. PRODUCT #1
180,000 METRIC TONS/YEAR IRON PELLETS PRODUCT #2

ZERO MONTH	ZERO YEAR	LAST YEAR	NUMBER PRODUCTS	TODAYS MONTH	TODAYS YEAR	NO.YRS. BEFORE YR. ZERO
1	1988	1999	2	1	1983	5

PRODUCT NUMBER 1

SALES VOLUME, M UNITS/YR											
0.	0.	0.	0.	0.	313.	313.	313.	313.	313.	313.	313.
313.	313.	313.	313.	313.							
SALES PRICE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	220.0000	220.0000	220.0000	220.0000	220.0000	220.0000	220.0000
220.0000	220.0000	220.0000	220.0000	220.0000							
VARIABLE EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
DISTRIBUTION EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
MARKETING EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

PRODUCT NUMBER 2

SALES VOLUME, M UNITS/YR											
0.	0.	0.	0.	0.	180.	180.	180.	180.	180.	180.	180.
180.	180.	180.	180.	180.							
SALES PRICE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	42.0000	42.0000	42.0000	42.0000	42.0000	42.0000	42.0000
42.0000	42.0000	42.0000	42.0000	42.0000							
VARIABLE EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
DISTRIBUTION EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
MARKETING EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

FIGURE 43-A1

FIXED EXPENSE, $M

0.	0.	0.	0.	0.	64849.	64849.	64849.	64849.	64849.	64849.	64849.
64849.	64849.	64849.	64849.	64849.							

FIGURE 43-B1

R + D EXPENSE, $M

0.	0.	0.	0.	0.	1000.	1000.	1000.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

PREOP EXPENSE, $M

700.	700.	700.	700.	700.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

WORKING CAPITAL, $M

0.	0.	0.	0.	2750.	33750.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-36250.							

DEPLETION ALLOWANCE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPITAL EXPENDITURE, $M

7000.	35000.	38000.	35000.	18000.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

SALVAGE VALUE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPT. EXP.	DEPR. METH.	IN YEAR	OUT YEAR	VAL. OF K
133000.	1	1988	1999	.00

TAX RATE	TAX CREDIT	2ND PVP RATE
.48	.07	.00

EQUITY CAPT.	CAPT. INVEST.	IN YEAR	OUT YEAR	DEBT INT. RATE	INT. METHOD
0.	133000.	1988	1999	.00	1

FIGURE 43-C1

FOLLOWING VALUES ARE IN $M

YEAR	GROSS REVENUES	TOTAL EXPENSES	CASH INCOME BEFORE TAXES	DEPRECIATION FOR TAX PURPOSES	INTEREST ON DEBT	TAXABLE INCOME	INCOME TAX	TAX CREDITS	CASH INCOME AFTER TAXES	CASH FLOW	CUMULATIVE CASH FLOW
1983	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-7700.	-7700.
1984	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-35700.	-43400.
1985	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-38700.	-82100.
1986	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-35700.	-117800.
1987	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-21450.	-139250.
1988	76420.	77425.	-1005.	11083.	0.	-12089.	0.	9310.	8305.	-25445.	-164695.
1989	76420.	77425.	-1005.	11083.	0.	-12089.	0.	0.	-1005.	-1005.	-165701.
1990	76420.	77425.	-1005.	11083.	0.	-12089.	0.	0.	-1005.	-1005.	-166706.
1991	76420.	76425.	-5.	11083.	0.	-11089.	0.	0.	-5.	-5.	-166711.
1992	76420.	76425.	-5.	11083.	0.	-11089.	0.	0.	-5.	-5.	-166717.
1993	76420.	76425.	-5.	11083.	0.	-11089.	0.	0.	-5.	-5.	-166722.
1994	76420.	76425.	-5.	11083.	0.	-11089.	0.	0.	-5.	-5.	-166727.
1995	76420.	76425.	-5.	11083.	0.	-11089.	0.	0.	-5.	-5.	-166733.
1996	76420.	76425.	-5.	11083.	0.	-11089.	0.	0.	-5.	-5.	-166738.
1997	76420.	76425.	-5.	11083.	0.	-11089.	0.	0.	-5.	-5.	-166743.
1998	76420.	76425.	-5.	11083.	0.	-11089.	0.	0.	-5.	-5.	-166749.
1999	76420.	76425.	-5.	11083.	0.	-11089.	0.	0.	-5.	36245.	-130504.

EARNING POWER -7.44 PERCENT

PVP DISCOUNTED AT 8 PERCENT -121290.

PVP DISCOUNTED AT 15 PERCENT -105779.

STOP 77

FIGURE 43-D1

ROI 15%

GREEN BAY

PYRITE PROCESSING STUDY (ALTERNATE D)
313,000 METRIC TONS/YEAR D.A.P. PRODUCT #1
180,000 METRIC TONS/YEAR IRON PELLETS PRODUCT #2

ZERO MONTH	ZERO YEAR	LAST YEAR	NUMBER PRODUCTS	TODAYS MONTH	TODAYS YEAR	NO.YRS. BEFORE YR. ZERO
1	1988	1999	2	1	1983	5

PRODUCT NUMBER 1

SALES VOLUME, M UNITS/YR

0.	0.	0.	0.	0.	313.	313.	313.	313.	313.	313.	313.
313.	313.	313.	313.	313.							

SALES PRICE, $/UNIT

.0000	.0000	.0000	.0000	.0000	395.0000	395.0000	395.0000	395.0000	395.0000	395.0000	395.0000
395.0000	395.0000	395.0000	395.0000	395.0000							

VARIABLE EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

DISTRIBUTION EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

MARKETING EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

PRODUCT NUMBER 2

SALES VOLUME, M UNITS/YR

0.	0.	0.	0.	0.	180.	180.	180.	180.	180.	180.	180.
180.	180.	180.	180.	180.							

SALES PRICE, $/UNIT

.0000	.0000	.0000	.0000	.0000	75.0000	75.0000	75.0000	75.0000	75.0000	75.0000	75.0000
75.0000	75.0000	75.0000	75.0000	75.0000							

VARIABLE EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

DISTRIBUTION EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

MARKETING EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

FIGURE 43-E1

FIXED EXPENSE, IN

0.	0.	0.	0.	0.	64849.	64849.	64849.	64849.	64849.	64849.	64849.
64849.	64849.	64849.	64849.	64849.							

FIGURE 43-F1

R + D EXPENSE, $M

0.	0.	0.	0.	0.	1000.	1000.	1000.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

LEASE EXPENSE, $M

700.	700.	700.	700.	700.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

WORKING CAPITAL, $M

0.	0.	0.	0.	2750.	33750.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-36250.							

DEPLETION ALLOWANCE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPITAL EXPENDITURE, $M

7000.	35000.	37000.	35000.	18000.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

SALVAGE VALUE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPT. EXP.	DEPR. METH.	IN YEAR	OUT YEAR	VAL. OF K
[illegible]	1	1988	1999	.00

TAX RATE	TAX CREDIT	END EVE RATE
[illegible]	.07	.00

EQUITY CAPT.	CAPT. INVEST.	IN YEAR	OUT YEAR	DEBT INT. RATE	INT. METHOD
.	[illegible]	1988	1999	.00	1

FIGURE 43-G1

FOLLOWING VALUES ARE IN $M

YEAR	GROSS REVENUES	TOTAL EXPENSES	CASH INCOME BEFORE TAXES	DEPRECIATION FOR TAX PURPOSES	INTEREST ON DEBT	TAXABLE INCOME	INCOME TAX	TAX CREDITS	CASH INCOME AFTER TAXES	CASH FLOW	CUMULATIVE CASH FLOW
1983	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-7700.	-7700.
1984	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-35700.	-43400.
1985	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-38700.	-82100.
1986	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-35700.	-117800.
1987	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-21450.	-139250.
1988	137135.	77425.	59710.	11083.	0.	48626.	23341.	9310.	45679.	11929.	-127321.
1989	137135.	77425.	59710.	11083.	0.	48626.	23341.	0.	36369.	36369.	-90952.
1990	137135.	77425.	59710.	11083.	0.	48626.	23341.	0.	36369.	36369.	-54583.
1991	137135.	76425.	60710.	11083.	0.	49626.	23821.	0.	36889.	36889.	-17694.
1992	137135.	76425.	60710.	11083.	0.	49626.	23821.	0.	36889.	36889.	19195.
1993	137135.	76425.	60710.	11083.	0.	49626.	23821.	0.	36889.	36889.	56084.
1994	137135.	76425.	60710.	11083.	0.	49626.	23821.	0.	36889.	36889.	92973.
1995	137135.	76425.	60710.	11083.	0.	49626.	23821.	0.	36889.	36889.	129862.
1996	137135.	76425.	60710.	11083.	0.	49626.	23821.	0.	36889.	36889.	166751.
1997	137135.	76425.	60710.	11083.	0.	49626.	23821.	0.	36889.	36889.	203640.
1998	137135.	76425.	60710.	11083.	0.	49626.	23821.	0.	36889.	36889.	240529.
1999	137135.	76425.	60710.	11083.	0.	49626.	23821.	0.	36889.	73139.	313668.

EARNING POWER 15.24 PERCENT

NPV DISCOUNTED AT 3 PERCENT 76286.

NPV DISCOUNTED AT 15 PERCENT 1579.

```
STOP 77
EXQT .TAPS.DCF
```

FIGURE 43-III

PYRITE PROCESSING STUDY (ALTERNATE-B1)

1,322,228 METRIC TONS/YEAR D.A.P. PRODUCT #1

718,000 METRIC TONS/YEAR IRON PELLETS PRODUCT #2

GREEN BAY

ZERO MONTH	ZERO YEAR	LAST YEAR	NUMBER PRODUCTS	TODAYS MONTH	TODAYS YEAR	NO.YRS. BEFORE YR. ZERO
1	1988	1999	2	1	1983	5

PRODUCT NUMBER 1

SALES VOLUME, M UNITS/YR

0.	0.	0.	0.	0.	1322.	1322.	1322.	1322.	1322.	1322.	1322.
1322.	1322.	1322.	1322.	1322.							

SALES PRICE, $/UNIT

.0000	.0000	.0000	.0000	.0000	220.0000	220.0000	220.0000	220.0000	220.0000	220.0000	220.0000
220.0000	220.0000	220.0000	220.0000	220.0000							

VARIABLE EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

DISTRIBUTION EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

MARKETING EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

PRODUCT NUMBER 2

SALES VOLUME, M UNITS/YR

0.	0.	0.	0.	0.	718.	718.	718.	718.	718.	718.	718.
718.	718.	718.	718.	718.							

SALES PRICE, $/UNIT

.0000	.0000	.0000	.0000	.0000	42.0000	42.0000	42.0000	42.0000	42.0000	42.0000	42.0000
42.0000	42.0000	42.0000	42.0000	42.0000							

VARIABLE EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

DISTRIBUTION EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							

MARKETING EXPENSE, $/UNIT

.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

FIGURE 43-A2

FIXED EXPENSE, $M

0.	0.	0.	0.	0.	237501.	237601.	237601.	237601.	237601.	237601.	237601.
237601.	237601.	237601.	237601.	237501.							

FIGURE 43-B2

R + D EXPENSE, $M

0.	0.	0.	0.	0.	1000.	1000.	1000.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

PREOP EXPENSE, $M

700.	700.	700.	700.	700.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

WORKING CAPITAL, $M

0.	0.	0.	0.	3200.	85000.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-88200.							

DEPLETION ALLOWANCE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPITAL EXPENDITURE, $M

42000.	75000.	100000.	100000.	75000.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

SALVAGE VALUE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPT. EXP.	DEPR. METH.	IN YEAR	OUT YEAR	VAL. OF K
392000.	1	1988	1999	.00

TAX RATE	TAX CREDIT	2ND PVP RATE
.48	.07	.00

EQUITY CAPT.	CAPT. INVEST.	IN YEAR	OUT YEAR	DEBT INT. RATE	INT. METHOD
0.	392000.	1988	1999	.00	1

FIGURE 43-C2

FOLLOWING VALUES ARE IN $M

YEAR	GROSS REVENUES	TOTAL EXPENSES	CASH INCOME BEFORE TAXES	DEPRECIATION FOR TAX PURPOSES	INTEREST ON DEBT	TAXABLE INCOME	INCOME TAX	TAX CREDITS	CASH INCOME AFTER TAXES	CASH FLOW	CUMULATIVE CASH FLOW
1983	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-42700.	-42700.
1984	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-75700.	-118400.
1985	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-100700.	-219100.
1986	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-100700.	-319800.
1987	0.	700.	-700.	0.	0.	0.	0.	0.	-700.	-78900.	-398700.
1988	321046.	273308.	47738.	32667.	0.	15072.	7234.	27440.	67944.	-17056.	-415756.
1989	321046.	273308.	47738.	32667.	0.	15072.	7234.	0.	40504.	40504.	-375252.
1990	321046.	273308.	47738.	32667.	0.	15072.	7234.	0.	40504.	40504.	-334748.
1991	321046.	272308.	48738.	32667.	0.	16072.	7714.	0.	41024.	41024.	-293724.
1992	321046.	272308.	48738.	32667.	0.	16072.	7714.	0.	41024.	41024.	-252701.
1993	321046.	272308.	48738.	32667.	0.	16072.	7714.	0.	41024.	41024.	-211677.
1994	321046.	272308.	48738.	32667.	0.	16072.	7714.	0.	41024.	41024.	-170653.
1995	321046.	272308.	48738.	32667.	0.	16072.	7714.	0.	41024.	41024.	-129629.
1996	321046.	272308.	48738.	32667.	0.	16072.	7714.	0.	41024.	41024.	-88605.
1997	321046.	272308.	48738.	32667.	0.	16072.	7714.	0.	41024.	41024.	-47581.
1998	321046.	272308.	48738.	32667.	0.	16072.	7714.	0.	41024.	41024.	-6557.
1999	321046.	272308.	48738.	32667.	0.	16072.	7714.	0.	41024.	129224.	122667.

EARNING POWER 2.81 PERCENT

PVP DISCOUNTED AT 8 PERCENT -119572.

PVP DISCOUNTED AT 15 PERCENT -176126.

STOP 77

FIGURE 43-D2

1576

ROI 15%

GREEN BAY

PYRITE PROCESSING STUDY (ALTERNATE-P1)
1,322,22[illegible] METRIC TONS/YEAR D.A.P. PRODUCT #1
71[illegible],000 METRIC TONS/YEAR IRON PELLETS PRODUCT #2

ZERO MONTH	ZERO YEAR	LAST YEAR	NUMBER PRODUCTS	TODAYS MONTH	TODAYS YEAR	NO.YRS. BEFORE YR. ZERO
[illegible]	1988	1999	2	1	1983	5

PRODUCT NUMBER 1

SALES VOLUME, M UNITS/YR											
0.	0.	0.	0.	0.	1322.	1322.	1322.	1322.	1322.	1322.	1322.
1322.	1322.	1322.	1322.	1322.							
SALES PRICE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	300.0000	300.0000	300.0000	300.0000	300.0000	300.0000	300.0000
300.0000	300.0000	300.0000	300.0000	300.0000							
VARIABLE EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
DISTRIBUTION EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
MARKETING EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

PRODUCT NUMBER 2

SALES VOLUME, M UNITS/YR											
0.	0.	0.	0.	0.	718.	718.	718.	718.	718.	718.	718.
718.	718.	718.	718.	718.							
SALES PRICE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	57.0000	57.0000	57.0000	57.0000	57.0000	57.0000	57.0000
57.0000	57.0000	57.0000	57.0000	57.0000							
VARIABLE EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
DISTRIBUTION EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
.0000	.0000	.0000	.0000	.0000							
MARKETING EXPENSE, $/UNIT											
.0000	.0000	.0000	.0000	.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1.0000	1.0000	1.0000	1.0000	1.0000							

FIGURE 43-E2

[illegible]
0. 0. 0. 0. 0. 237601. 237601. 237601. 237601. 237601. 237601. 237601.
237601. 237601. 237601. 237601. 237601.

FIGURE 43-F2

R + D EXPENSE, $M

0.	0.	0.	0.	0.	1000.	1000.	1000.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

[illegible] EXPENSE, $M

700.	700.	700.	700.	700.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

WORKING CAPITAL, $M

0.	0.	0.	0.	3200.	85000.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-88200.							

DEPLETION ALLOWANCE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPITAL EXPENDITURE, $M

42000.	75000.	100000.	100000.	75000.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

SALVAGE VALUE, $M

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.							

CAPT. EXP.	DEPR. METH.	IN YEAR	OUT YEAR	VAL. OF K
[illegible]2000.	1	198[illegible]	1999	.00

TAX RATE	TAX CREDIT	2ND RVP RATE
.4	.07	.00

EQUITY CAPT.	CAPT. INVEST.	IN YEAR	OUT YEAR	DEBT INT. RATE	INT. METHOD
0.	3[illegible]2000.	1983	1999	.00	1

FIGURE 43-G2

FOLLOWING VALUES ARE IN $M

YEAR	GROSS REVENUES	TOTAL EXPENSES	CASH INCOME BEFORE TAXES	DEPRECIATION FOR TAX PURPOSES	INTEREST ON DEBT	TAXABLE INCOME	INCOME TAX	TAX CREDITS	CASH INCOME AFTER TAXES	CASH FLOW	CUMULATIVE CASH FLOW
1983	[illegible]	700.	-700.	0.	0.	0.	0.	0.	-700.	-42700.	-42700.
1984	[illegible]	700.	-700.	0.	0.	0.	0.	0.	-700.	-75700.	-118400.
1985	[illegible]	700.	-700.	0.	0.	0.	0.	0.	-700.	-100700.	-219100.
1986	[illegible]	700.	-700.	0.	0.	0.	0.	0.	-700.	-100700.	-319800.
1987	[illegible]	700.	-700.	0.	0.	0.	0.	0.	-700.	-78900.	-398700.
1988	437594.	273708.	164287.	32667.	0.	131620.	63178.	27440.	128549.	43549.	-355151.
1989	437594.	273708.	164287.	32667.	0.	131620.	63178.	0.	101109.	101109.	-254042.
1990	437594.	273708.	164287.	32667.	0.	131620.	63178.	0.	101109.	101109.	-152933.
1991	437594.	272708.	165287.	32667.	0.	132620.	63658.	0.	101629.	101629.	-51304.
1992	437594.	272708.	165287.	32667.	0.	132620.	63658.	0.	101629.	101629.	50325.
1993	437594.	272708.	165287.	32667.	0.	132620.	63658.	0.	101629.	101629.	151954.
1994	437594.	272708.	165287.	32667.	0.	132620.	63658.	0.	101629.	101629.	253583.
1995	437594.	272708.	165287.	32667.	0.	132620.	63658.	0.	101629.	101629.	355212.
1996	437594.	272708.	165287.	32667.	0.	132620.	63658.	0.	101629.	101629.	456841.
1997	437594.	272708.	165287.	32667.	0.	132620.	63658.	0.	101629.	101629.	558470.
1998	437594.	272708.	165287.	32667.	0.	132620.	63658.	0.	101629.	101629.	660099.
1999	437594.	272708.	165287.	32667.	0.	132620.	63658.	0.	101629.	189829.	849928.

EARNING POWER 14.96 PERCENT

NPV DISCOUNTED AT 8 PERCENT 203541.

NPV DISCOUNTED AT 15 PERCENT -830.

STOP 77

FIGURE 43-H2

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

PROCESS ROUTE

DAP, Iron Pellets & Nonferrous Metal Recovery
Evansville
NO ZINC REFINERY SULFURIC ACID

ALTERNATE CASE B & B-1

	Alternate Case B 400,000 MTPY Sulfuric Acid 180,000 MTPY Iron Pellets 313,000 MTPY DAP	Alternate Case B-1 1,694,000 MTPY Sulfuric Acid 718,000 MTPY Iron Pellets 1,322,228 MTPY DAP
Capital Cost	$133,000,000	$392,000,000
Revenues/Yr*	80,118,975	336,200,750
Operating Cost/Yr	67,403,330	246,922,882
Iron Pellets/MT	41.97	26.79
DAP/MT	191.21	172.20
Gain/(loss)	12,715,640	89,277,868

*Includes credit for nonferrous and precious metals
267,400 MTPY Pyrite - $3,698,925
1,094,000 MTPY Pyrite - $15,154,750

Refer to Figures 31 and 32

Figure 44

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

PROCESS ROUTE

Elemental Sulfur, Iron Pellets, Nonferrous Metals Reclamation
Green Bay

	267,400 MTPY Pyrite 134,000 MTPY Sulfur	1,094,000 MTPY Pyrite 531,000 MTPY Sulfur
Capital Cost	$58,000,000	$170,000,000
Cost/Annual MT		
Revenues/Yr	21,308,975	85,135,750
Operating Cost/Yr	27,890,440	83,231,340
Sulfur Cost/MT	151.76	120.52
Iron Cost/MT	41.97	26.79
Gain/(loss)	(6,581,465)	1,904,410

Refer to Figures 33 and 34

Figure 45

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

PROCESS ROUTE

Elemental Sulfur, Iron Pellets, Nonferrous Metals Reclamation
Evansville

	267,400 MTPY Pyrite 134,000 MTPY Sulfur	1,094,000 MTPY Pyrite 531,000 MTPY Sulfur
Capital Cost	$58,000,000	$170,000,000
Cost/Annual MT		
Revenues/Yr*	21,308,975	85,135,750
Operating Cost/Yr	32,099,380	99,697,650
Sulfur Cost/MT	183.17	151.53
Iron Cost/MT	41.97	26.79
Gain/(loss)	(10,790,405)	(14,561,900)

*Includes credit for nonferrous and precious metals

Refer to Figures 33 and 34

Figure 46

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SECTION 6

EQUIPMENT LIST

Introduction

This section of the pyrite processing study includes the major equipment required for each processing area. The equipment lists are utilized in the estimating procedure and in the flowsheets as well as to assess the reader of the magnitude of the process or project. The areas included are as follows:

Area 01 - Pyrite Receiving, Stockpiling & Reclaiming
Area 02 - Roasting Plant(s)
Area 03 - Sulfuric Acid Plant(s)
Area 04 - Phosphoric Acid Plant(s)
Area 05 - DAP Plant(s)
Area 06 - Iron Pelletizing & Cleaning Plant
Area 07 - Nonferrous Metals Recovery

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SECTION 6

PYRITE RECEIVING, STOCKPILING & RECLAIMING - AREA 01

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
01-01	1	Railroad Car Rotary Dumper
02	1	Receiving Hopper
03	1	Apron Feeder
04	1	Stockpiling Conveyor
05	1	Covered Storage
06	1	Reclaimer
07	1	Reclaimer Conveyor
08	1	Desintegrator
09	1	Transfer Conveyor

SECTION 6

ROASTING PLANT - AREA 02

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
02-01 A,B	2	Surge Bin
02 A,B	2	Weigh Belt Feeder
03 A,B	2	Rotary Valve Feeder
04 A,B	2	Roaster
05 A,B	2	Air Blower
06 A,B	2	Combustion Air Blower
07 A,B	2	Waste Heat Boiler
08 A-H	8	Primary Cyclones
09 A-H	8	Secondary Cyclones
10 A,B	2	Electrostatic Precipitator
11	1	Fine Cinders Conveying System
12 A,B	2	Screw Feeder
13 A,B	2	Rotary Cooler
14	1	Cinders Conveyor

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SECTION 6

SULFURIC ACID PLANT - AREA 03

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
03-01	1	Scrubbing Tower
02	1	Scrubber Pump Tank
03 A,B	2	Scrubbing Tower Pump
04	1	Purge Stripper
05	1	Stripper Fan
06 A,B	2	Purge Stripper Pump
07	1	Gas Cooler
09	1	Mist Precipitator
09	1	Drying Tower
10	1	D.T. Entrainment Separator
11	1	Main Blower
12	1	D.T. Pump Tank
13	1	D.T. Pump
14	1	D. T. Acid Cooler
15	1	No. 1 Heat Exchanger
16	1	No. 2 Heat Exchanger
17	1	No. 3 Heat Exchanger
18 A,B	2	No. 4 Heat Exchanger
19	1	Start-Up Heater
20	1	Converter
21	1	Intermediate Absorption Tower
22	1	Intermediate Tower Acid Cooler
23	1	Intermediate Tower Pump Tank
24	1	Intermediate Tower Pump
25	1	Absorption Tower
26	1	A.T. Mist Eliminator
27	1	A.T. Acid Cooler
28	1	A.T. Pump Tank
29	1	A.T. Pump
30	1	Acid Stripper
31 A,B	2	Product Acid Pump
32	1	Product Acid Cooler
33	1	Stack

Davy McKee

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SECTION 6

PHOSPHORIC ACID PLANT - AREA 04

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
04-01 A,B	2	Phosphate Rock Elevator
02 A-D	4	Storage Tank
03 A,B	2	Ball Mill
04 A,B	2	Pump Box
05 A,B	2	Slurry Pump
06 A-H	8	Cyclone
07 A,B	2	Slurry Tank
08 A,B	2	Agitator
09 A-D	4	Rock Slurry Feed Pump
10 A,B	2	Reactor
11 A,B	2	Vacuum Cooler System
12 A,B	2	Scrubber
13 A,B	2	Filter
14 A-H	8	Receiver
15 A,B	2	Seal Tank
16 A,B	2	Vacuum Pump
17 A,B	2	Concentrator System
18 A-D	4	Storage Tanks 30% Acid
19 A-D	5	Storage Tanks 54% Acid
20	1	Gypsum Lagoon
21	1	Cooling Pond
22 A,B	2	Effluent Treatment System

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SECTION 6

DAP PLANT - AREA 05

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
05-01	1	Reactor
02	1	Reactor Agitator
03 A,B	2	Slurry Pump
04	1	Granulator
05	1	Dryer
06	1	Dryer Burner Blower
07	1	Combustion Chamber
08	1	Screen Feed Elevator
09	1	Screen Feed Conveyor
10 A-D	4	Process Screen
11	1	Product Surge Bin
12 A-D	4	Process Screen Mills
13	1	Weigh Belt Feeder
14	1	Product Cooler
15	1	Product Elevator
16 A,B	2	Product Screen
17	1	Product Storage Transfer Conveyor
18	1	Product Weigh Scale
19	1	Product Fines Conveyor
20	1	Recycle Flight Conveyor
21	1	Recycle Elevator
22	1	Cooler Cyclone
23	1	Dryer Cyclone
24	1	RGCV Scrubber
25	1	Dryer Scrubber
26	1	RGCV Tail Gas Scrubber
27	1	RGCV Scrubber Fan
28	1	Dryer Tail Gas Scrubber
29	1	Dryer Scrubber Fan
30	1	Scrubber Seal Tank
31	1	Scrubber Seal Tank Agitator
32 A,B	2	Dryer Scrubber Pump
33 A,B	2	RGCV Scrubber Pump
34	1	Tail Gas Stack

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SECTION 6

DAP PLANT - AREA 05

EQUIPMENT LIST (Cont'd.)

ITEM	NO. REQUIRED	DESCRIPTION
05-35	1	Effluent Sump
36 A,B	2	Effluent Sump Pump
37	1	Product Storage Building
38	1	Product Storage Distribution Conveyor
39	1	Automatic Reclaimer (100 - 1000 MTPH)
40	1	Product Reclaim Conveyor (100 - 1000 MTPH)
41	1	Product Reclaim Diverter
42	1	Railcar Loadout Bucket Elevator (100 MTPH)
43	1	Railcar Loadout Scalping Screen
44	1	Railcar Loadout Surge Bin
45	1	Railcar Loadout Discharge System
46	1	Railcar Puller
47	1	Barge Loadout Transfer Conveyor
48	1	Barge Loadout Conveyor
49	1	Barge Loadout Boom Conveyor
50	1	Product Oil Tank
51	1	Product Oil Spray System
52	1	Railcar Loadout Dust Collector Fan
53	1	Railcar Loadout Dust Collector
54	1	Rotary Air Lock Valve

2489/2
June 1981

EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SECTION 6

IRON PELLETIZING & CLEANING PLANT - AREA 06

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
06-01 A-D	4	Blending Bin
02	1	Blending Conveyor
03 A,B	2	Ball Mill Feed Conveyor
04 A,B	2	Ball Mill
05 A,B	2	Pug Mill Feed Conveyor
06 A,B	2	Pug Mill
07 A,B	2	Balling Disk Feed Conveyor
08 A,B	2	Balling Disk
09	1	Conveyor Dryer Feed Conveyor
10	1	Conveyor Dryer
11	1	Transfer Conveyor
12	1	Rotary Kiln Feed System
13	1	Rotary Kiln
14	1	Shaft Cooler
15	1	Shaft Cooler Air Blower
16	1	Cool Pellets Transfer Conveyor
17	1	Pellets Distribution Conveyor
18 A-D	4	Pellets Bin
19	1	Dust Chamber
20	1	Dust Conveyor
21	1	Cooling Tower
22	1	Cooling Tower Pump Tank
23 A,B	2	Cooling Tower Pump
24	1	Wash Tower
25	1	Wash Tower Pump Tank
26 A,B	2	Wash Tower Pump
27 A,B	2	Air Cooler Liquor Pump
28	1	Air Cooler
29	1	Air Cooler Blower
30	1	Wash Tower Liquor Settler
31 A,B	2	Mist Cottrell
32	1	Stack Blower
33	1	Stack

Davy McKee

2489/2
June 1981

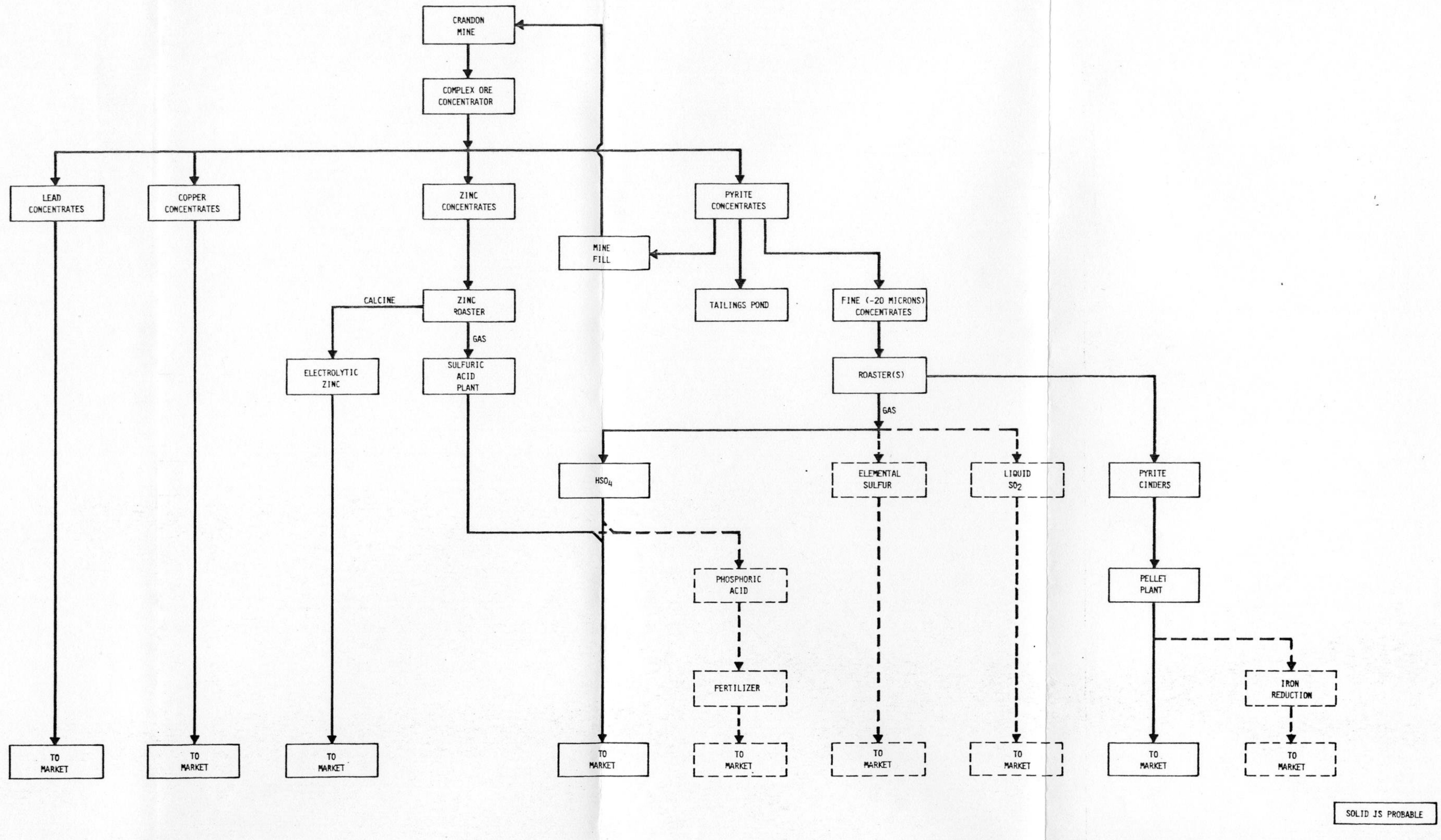
EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY

SECTION 6

NONFERROUS METALS RECOVERY & $CaCl_2$ RECYCLING PLANT - AREA 07

EQUIPMENT LIST

ITEM	NO. REQUIRED	DESCRIPTION
07-01	1	Pelletizing Plant Bleed Thickener
02	1	Settler Slurry Pump
03 A,B	2	Mixing Tank
04	1	Retention Tank
05 A,B	2	Mixing Tank Agitator
06	1	Retention Tank Agitator
07	1	Gypsum Slurry Pump
08	1	Gypsum Thickener
09	1	Thick Gypsum Slurry Pump
10	1	Gypsum Filter
11	1	Gypsum Filtrate Pump
12	1	Surge Tank
13	1	Metals Solution Pump
14	1	Copper Cementation Tank
15	1	Cement Copper Slurry
16	1	Cement Copper Filter
17	1	H_2S Addition Tank
18	1	H_2S Addition Tank Agitator
19	1	PbS Settler
20	1	Pb Filter
21	1	Fe-Zn Solution Pump
22 A-C	3	Iron Precipitation Tank
23 A-C	3	Iron Precipitation Tank Agitator
24	1	Precipitated Iron Settler
25	1	Iron Precipitate Slurry Pump
26	1	Iron Precipitate Filter
27	1	Zinc Precipitation Tank
28	1	Zinc Precipitation Tank Agitator
29	1	Zinc Precipitate Thickener
30	1	Zinc Slurry Pump
31	1	Zinc Filter
32	1	Filtrate Pump
33	1	$CaCl_2$ Solution Surge Tank
-34	1	$CaCl_2$ Solution Pump
35	1	Fine Limestone Feeder
36	1	Very Fine Limestone Feeder
37	1	Oxidation Air Blower



Davy McKee
ENGINEERS AND CONSTRUCTORS

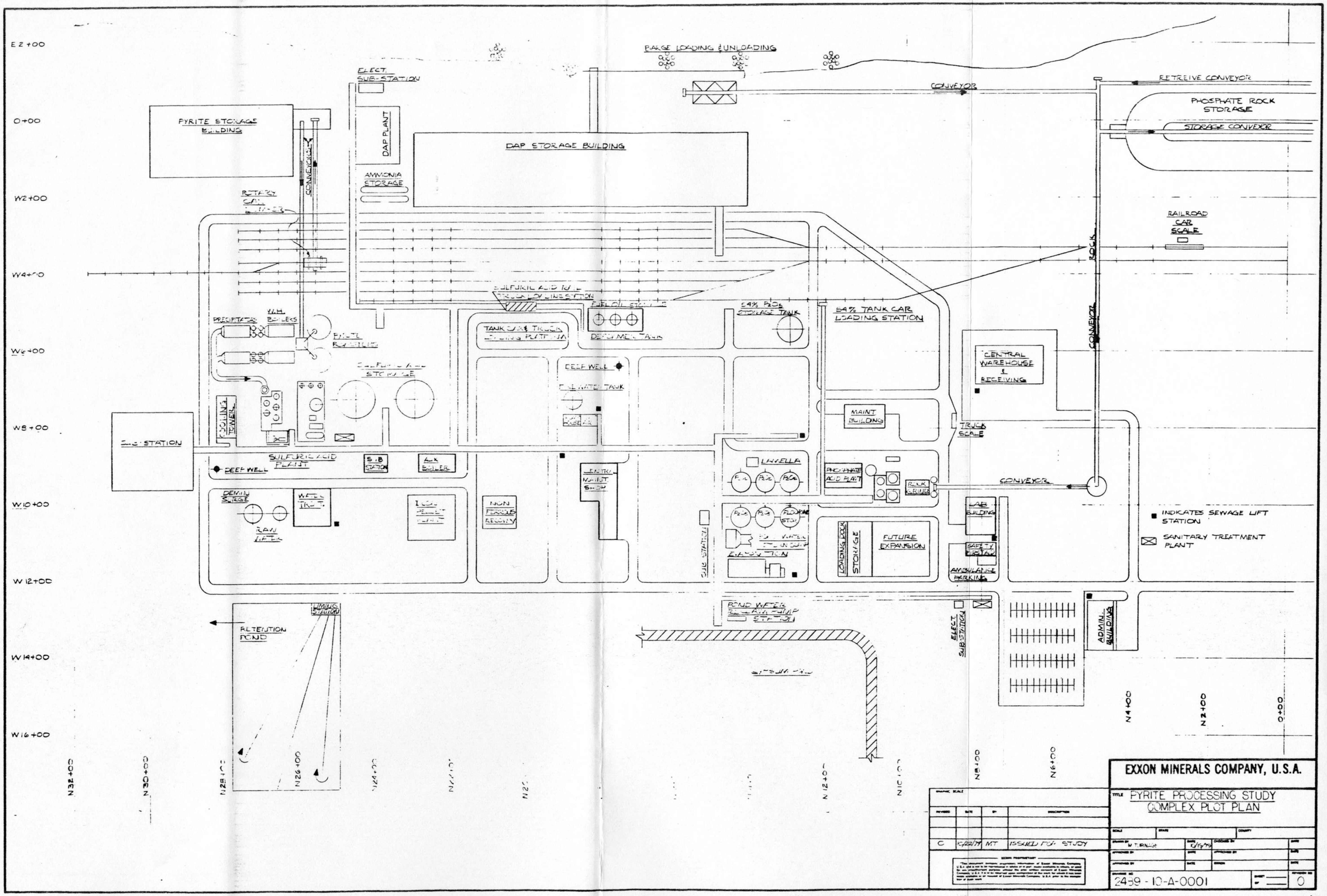
EXXON MINERALS COMPANY, U.S.A.

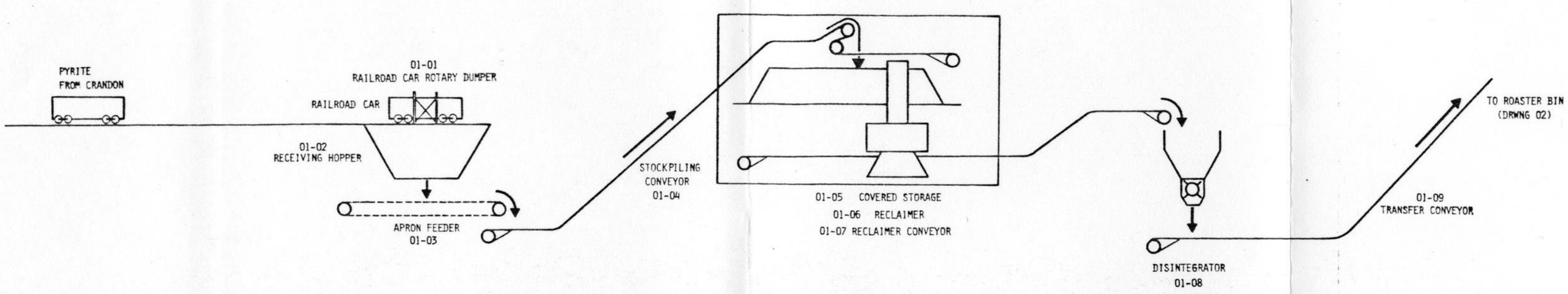
TITLE
CRANDON PROJECT
PYRITE PROCESSING STUDY
BASIC BLOCK FLOW DIAGRAM

SCALE NONE

DATE 8-2-79

DRAWING NO 2489 - 81570 - 00427


EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
COMPLEX PLOT PLAN
2439 - 10-A-0001
ISSUED FOR STUDY
BARGE LOADING & UNLOADING
CONVEYOR
RETREIVE CONVEYOR
PHOSPHATE ROCK STORAGE
STORAGE CONVEYOR
ELECT. SUB-STATION
PYRITE STORAGE BUILDING
DAP PLANT
DAP STORAGE BUILDING
AMMONIA STORAGE
ROTARY CAR DUMPER
RAILROAD CAR SCALE
ROCK CONVEYOR
54% TANK CAR LOADING STATION
54% P2O5 STORAGE TANK
PRECIPITATOR
W.H. BOILERS
COOLING TOWER
S.B STATION
AUX BOILER
DEEP WELL
SULFURIC ACID PLANT
FIRE WATER TANK
CENTRAL WAREHOUSE & RECEIVING
MAINT BUILDING
TRUCK SCALE
PHOSPHATE ACID PLANT
ROCK GRIND
LAB BUILDING
SAFETY FIRST AID
AMBULANCE PARKING
LOADING DOCK
STORAGE
FUTURE EXPANSION
NON FERROUS RECOVERY
DEMIN SURGE
RAW WATER
WATER TREAT.
SUB STATION
POND WATER RECLAIM PUMP STATION
LIMING STATION
RETENTION POND
ADMIN. BUILDING
INDICATES SEWAGE LIFT STATION
SANITARY TREATMENT PLANT
E2+00
0+00
W2+00
W4+00
W6+00
W8+00
W10+00
W12+00
W14+00
W16+00
N32+00
N30+00
N28+00
N26+00
N8+00
N6+00
N4+00
N2+00
0+00

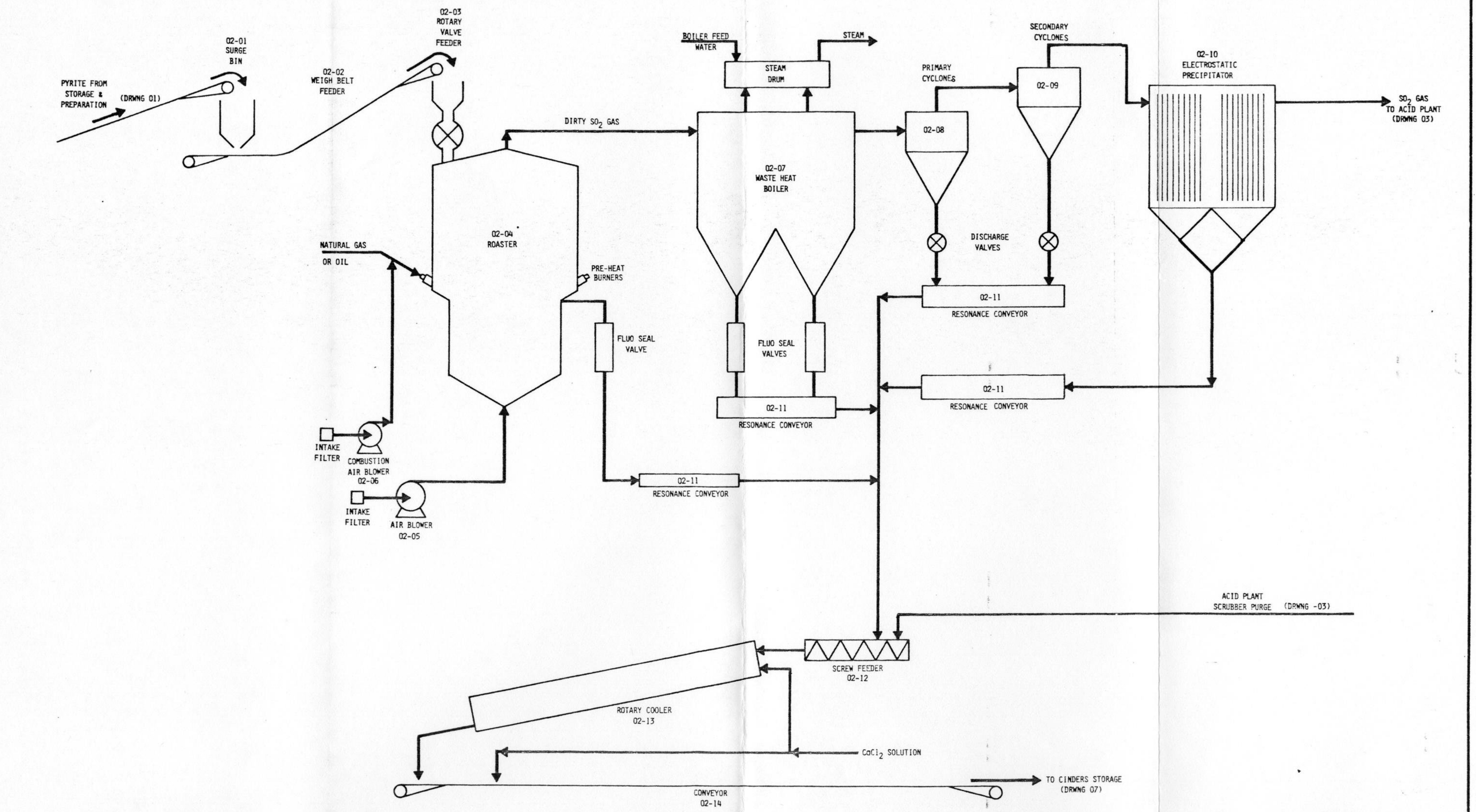


Davy McKee

EXXON MINERALS COMPANY, U.S.A.

TITLE
PYRITE PROCESSING STUDY
PROCESS FLOW DIAGRAM
PYRITE RECEIVING, STOCKPILING & RECLAIMING

2489 - 81530 - 00427 - 01

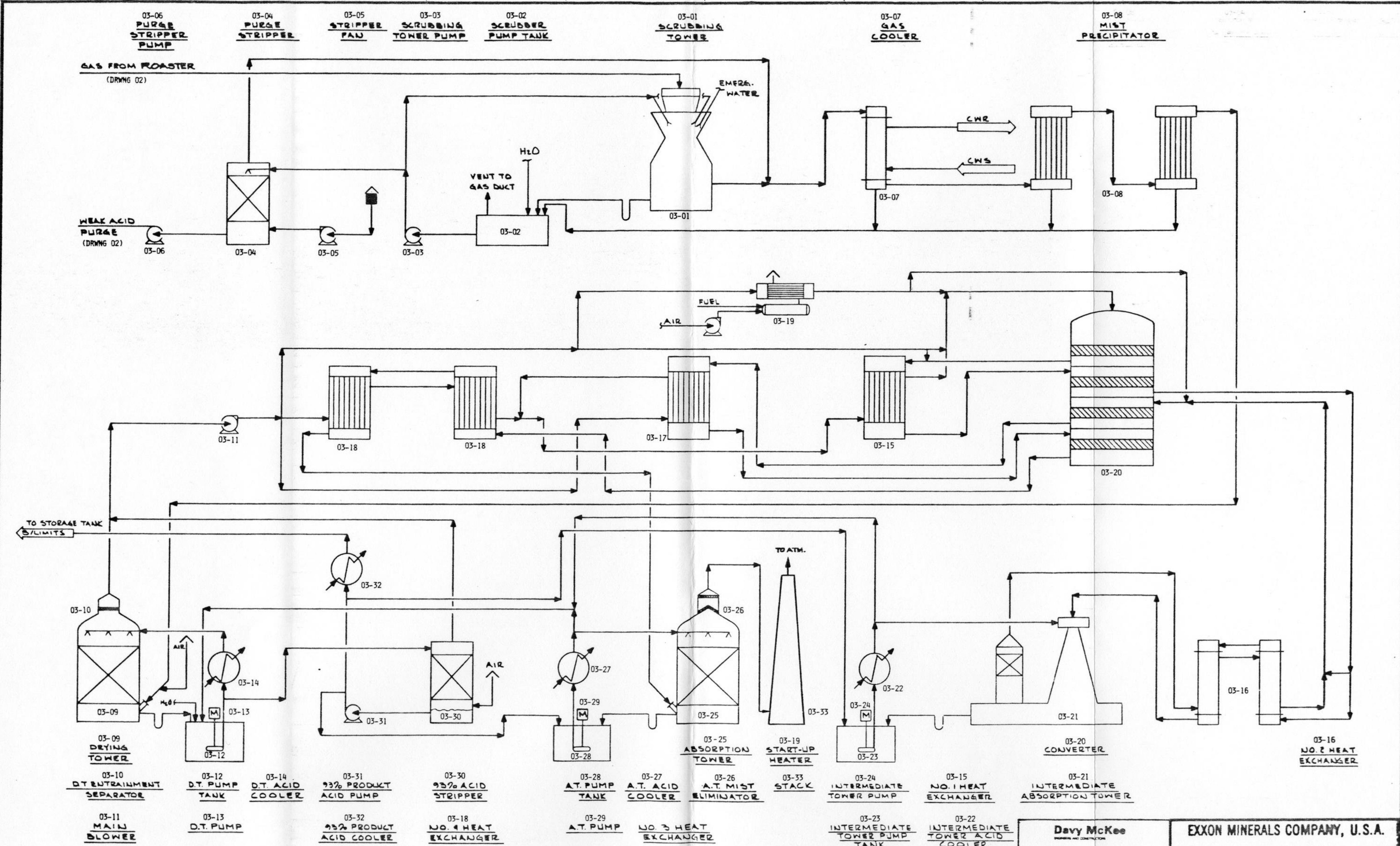


Davy McKee
ENGINEERS AND CONSTRUCTORS

EXXON MINERALS COMPANY, U.S.A.

TITLE
PYRITE PROCESSING STUDY
PROCESS FLOW DIAGRAM
ROASTING PLANT

2489 - 81530 - 00427 - 02



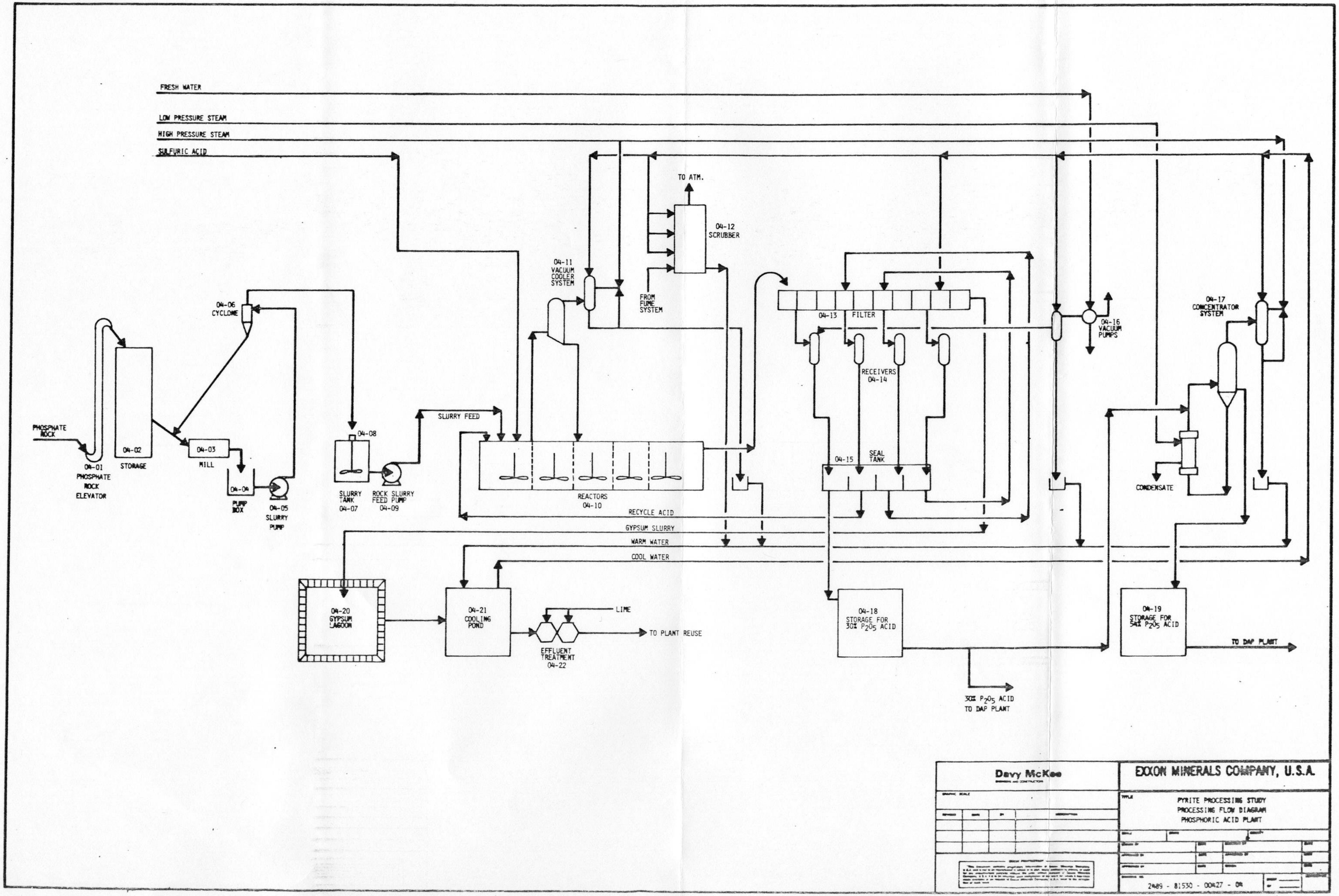
Davy McKee

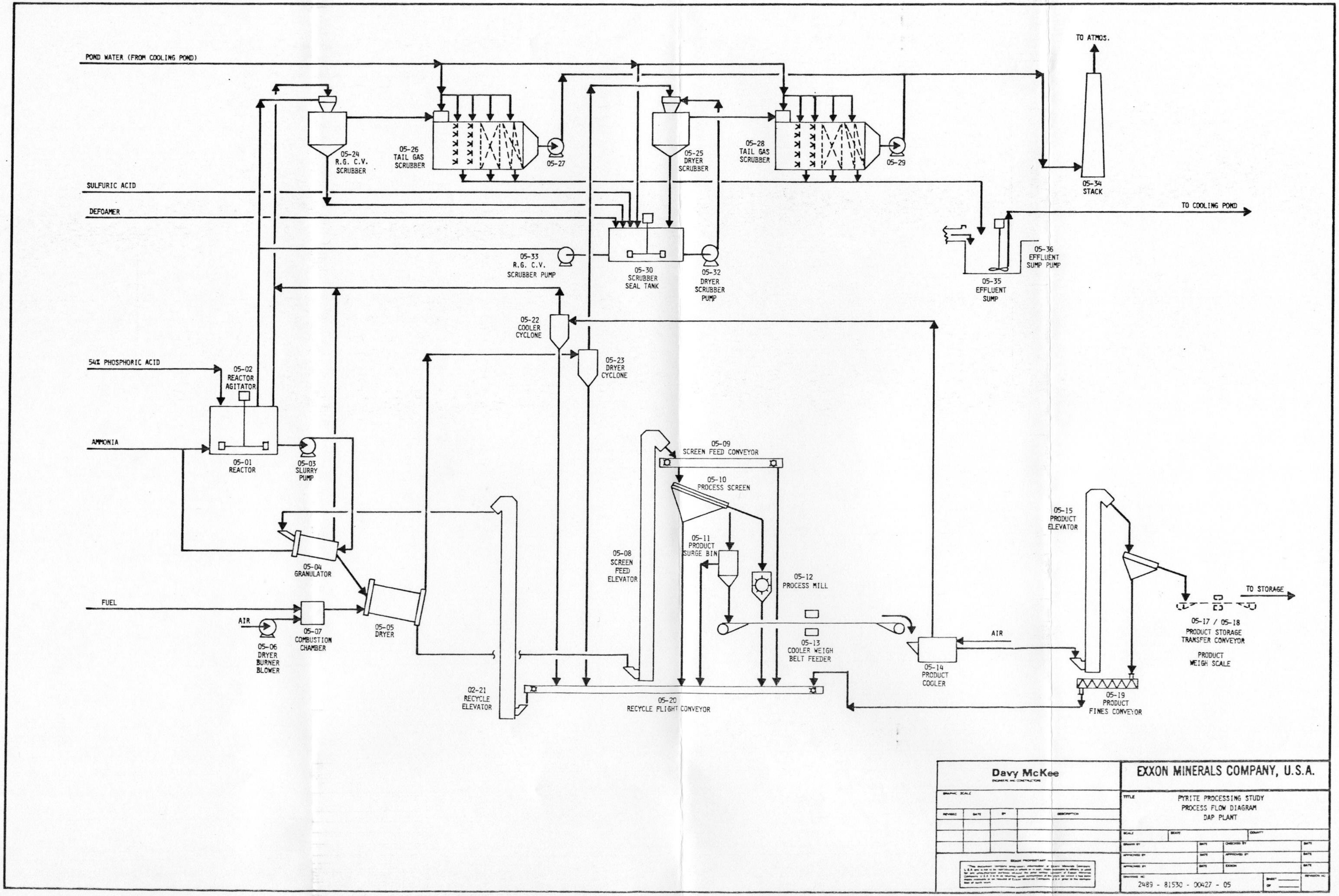
EXXON MINERALS COMPANY, U.S.A.

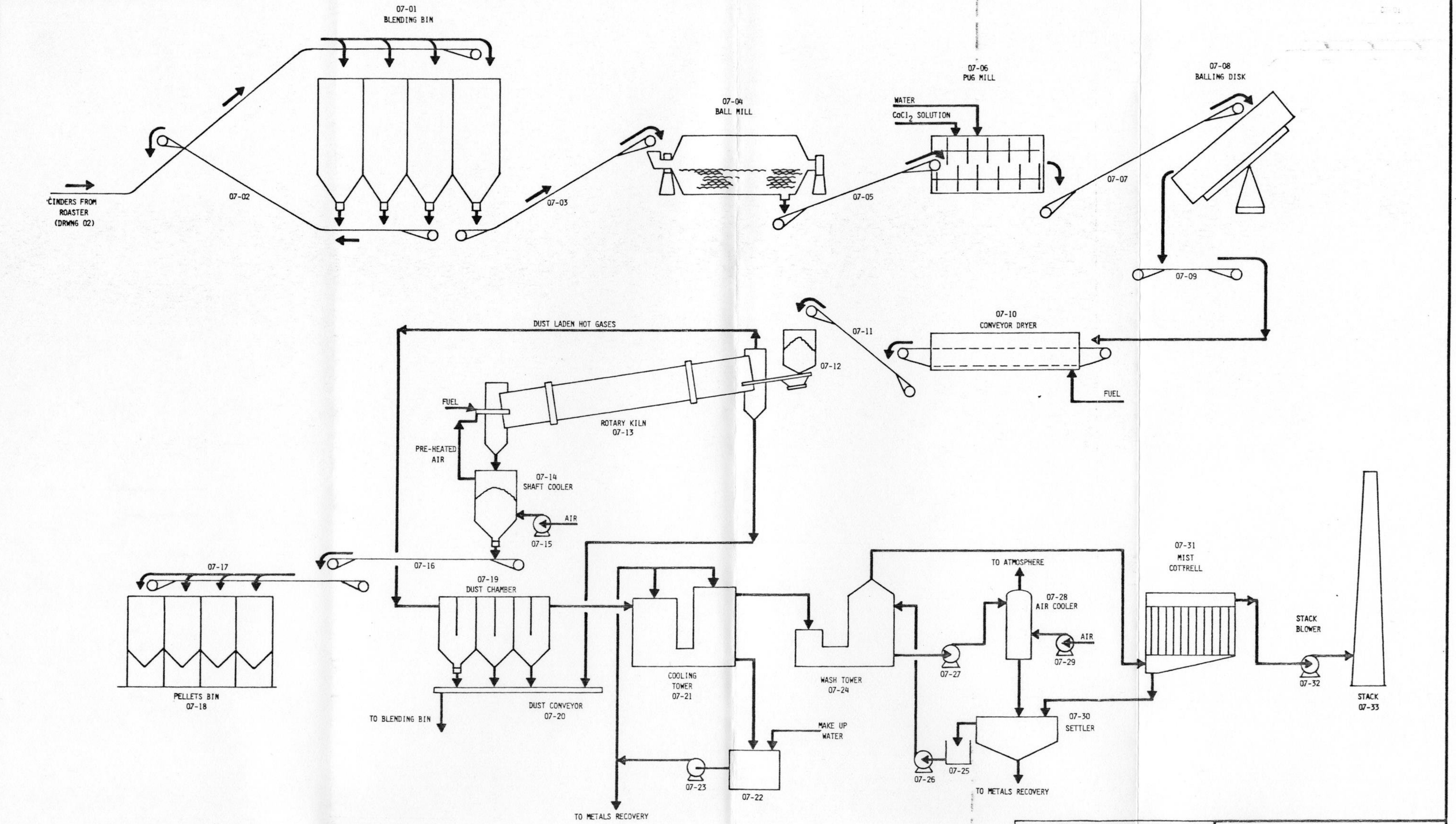
TITLE
PYRITE PROCESSING STUDY
PROCESS FLOW DIAGRAM
DOUBLE ABSORBTION ACID PLANT

2489 - 81530 - 00427 - 03

NO.	TITLE
	REFERENCE DRAWINGS


FRESH WATER
LOW PRESSURE STEAM
HIGH PRESSURE STEAM
SULFURIC ACID
TO ATM.
04-12
SCRUBBER
FROM
FUME
SYSTEM
04-11
VACUUM
COOLER
SYSTEM
04-06
CYCLONE
PHOSPHATE
ROCK
04-01
PHOSPHATE
ROCK
ELEVATOR
04-02
STORAGE
04-03
MILL
04-04
PUMP
BOX
04-05
SLURRY
PUMP
04-08
SLURRY
TANK
04-07
ROCK SLURRY
FEED PUMP
04-09
SLURRY FEED
REACTORS
04-10
04-13
FILTER
RECEIVERS
04-14
04-15
SEAL
TANK
04-16
VACUUM
PUMPS
04-17
CONCENTRATOR
SYSTEM
CONDENSATE
RECYCLE ACID
GYPSUM SLURRY
WARM WATER
COOL WATER
04-20
GYPSUM
LAGOON
04-21
COOLING
POND
LIME
EFFLUENT
TREATMENT
04-22
TO PLANT REUSE
04-18
STORAGE FOR
30% P2O5 ACID
30% P2O5 ACID
TO DAP PLANT
04-19
STORAGE FOR
54% P2O5 ACID
TO DAP PLANT
Davy McKee
EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
PROCESSING FLOW DIAGRAM
PHOSPHORIC ACID PLANT
2489 - 81530 - 00427 - 04


POND WATER (FROM COOLING POND)
TO ATMOS.
05-24
R.G. C.V.
SCRUBBER
05-26
TAIL GAS
SCRUBBER
05-27
05-25
DRYER
SCRUBBER
05-28
TAIL GAS
SCRUBBER
05-29
05-34
STACK
SULFURIC ACID
DEFOAMER
TO COOLING POND
05-33
R.G. C.V.
SCRUBBER PUMP
05-30
SCRUBBER
SEAL TANK
05-32
DRYER
SCRUBBER
PUMP
05-36
EFFLUENT
SUMP PUMP
05-35
EFFLUENT
SUMP
05-22
COOLER
CYCLONE
05-23
DRYER
CYCLONE
54% PHOSPHORIC ACID
05-02
REACTOR
AGITATOR
AMMONIA
05-01
REACTOR
05-03
SLURRY
PUMP
05-09
SCREEN FEED CONVEYOR
05-10
PROCESS SCREEN
05-15
PRODUCT
ELEVATOR
05-04
GRANULATOR
05-08
SCREEN
FEED
ELEVATOR
05-11
PRODUCT
SURGE BIN
05-12
PROCESS MILL
TO STORAGE
FUEL
AIR
05-06
DRYER
BURNER
BLOWER
05-07
COMBUSTION
CHAMBER
05-05
DRYER
05-13
COOLER WEIGH
BELT FEEDER
AIR
05-14
PRODUCT
COOLER
05-17 / 05-18
PRODUCT STORAGE
TRANSFER CONVEYOR
PRODUCT
WEIGH SCALE
02-21
RECYCLE
ELEVATOR
05-20
RECYCLE FLIGHT CONVEYOR
05-19
PRODUCT
FINES CONVEYOR
Davy McKee
EXXON MINERALS COMPANY, U.S.A.
PYRITE PROCESSING STUDY
PROCESS FLOW DIAGRAM
DAP PLANT
2489 - 81530 - 00427 - 05



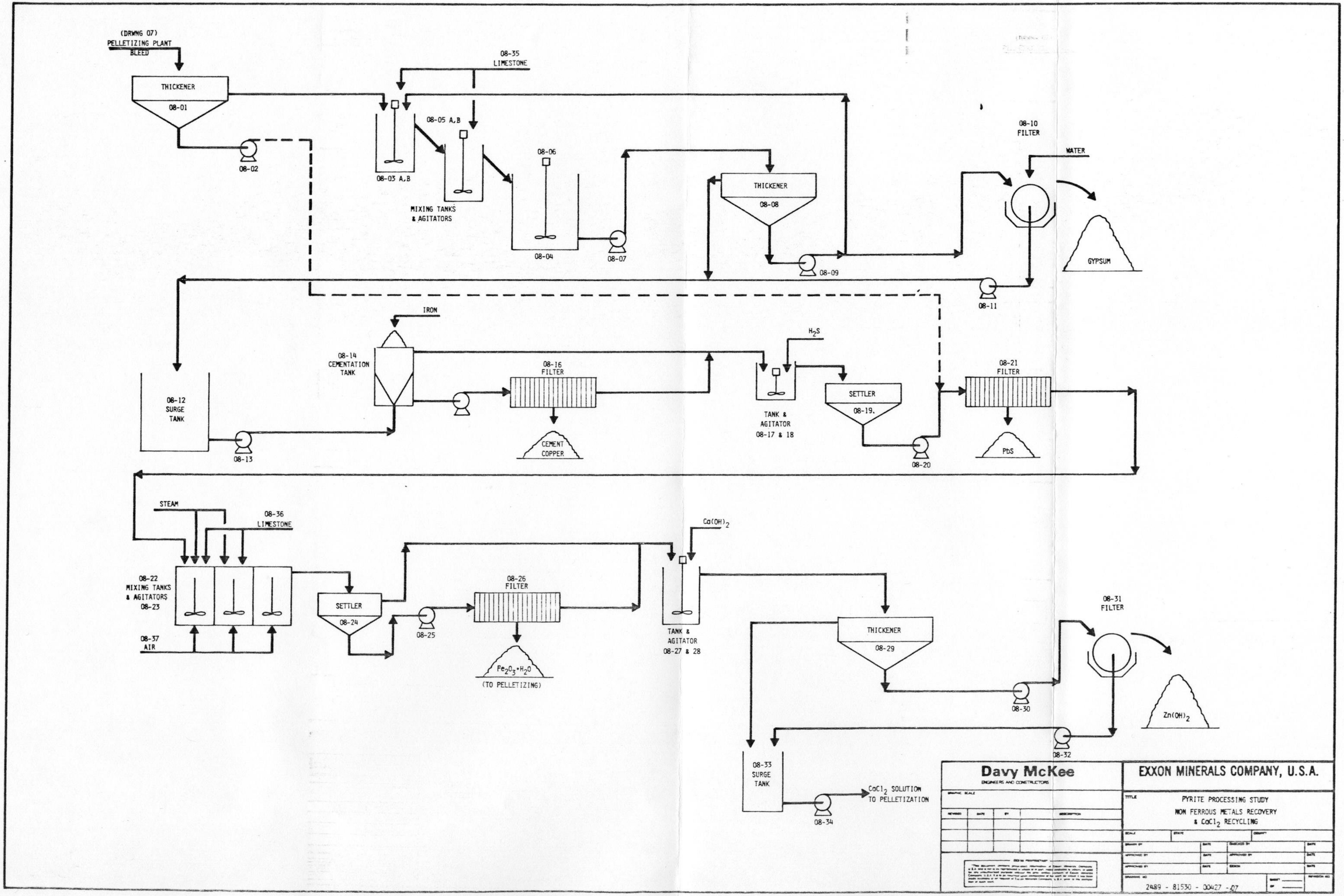
Davy McKee
ENGINEERS AND CONSTRUCTORS

REVISED	DATE	BY	DESCRIPTION

EXXON MINERALS COMPANY, U.S.A.

TITLE: PYRITE PROCESSING STUDY
PROCESS FLOW DIAGRAM
IRON PELLETIZING & CLEANING PLANT

DRAWING NO. 2489 - 81530 - 00427 - 06



Davy McKee
ENGINEERS AND CONSTRUCTORS

EXXON MINERALS COMPANY, U.S.A.

TITLE: PYRITE PROCESSING STUDY
NON FERROUS METALS RECOVERY
& $CoCl_2$ RECYCLING

DRAWING NO. 2489 - 81530 - 00427 - 07