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CITRATE PROCESS FLUE GAS DESULFURIZATION DEMONSTRATION PLANT

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At the St. Joe Minerals Corp.'s zinc smelter powerplant, an SO_2 emission control program evolved into a cooperative program with the Bureau of Mines for installation and initial operation of a citrate process flue gas desulfurization demonstration plant. The demonstration plant was operated on an intermittent basis from November 1979 to September 1982. The citrate process proved capable of absorption of greater than 90% of the SO_2 from the flue gas with ultimate conversion to elemental sulfur. However, in order to overcome problems that severely restricted process ontime, demonstration plant modifications were made that resulted in lower SO_2 absorption--generally 50% to 70%. Analysis of the operating experience identified equipment areas where redesign was needed for achieving high SO_2 removal with reasonable levels of process equipment ontime. The additional investment for equipment could not be justified by anticipated smelter revenues. The recent availability of a bubble concept by the environmental regulatory agencies permitted an SO_2 emissions compliance program that could be implemented on a more timely basis and precluded St. Joe Corp.'s continued involvement in the citrate process flue gas desulfurization development.

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FOREWORD

This report was prepared by St. Joe Minerals Corporation, St. Joe Resources Company Zinc Smelting Division, Monaca, Pennsylvania, under USBM Contract number SO261008. The contract was initiated under the Minerals and Materials Research Program. It was administered under the technical direction of the Salt Lake City Research Center with William I. Nissen acting as Technical Project Officer. Charles L. Dozios was the contract administrator for the Bureau of Mines. This report is a summary of the work recently completed as a part of this contract during the period June 1, 1976,to April 1, 1983. This report was submitted by the authors on September 1, 1983.

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CITRATE PROCESS FLUE GAS DESULFURIZATION DEMONSTRATION PLANT

SUMMARY

In the early 1970's St. Joe Minerals Corporation investigated a number of alternatives for achieving compliance with the newly-promulgated sulfur dioxide emissions regulations. For control of the sulfur dioxide emissions at the Zinc Smelter Power Plant in Monaca, Pennsylvania, the most promising candidate in the mid-1970's was the US Bureau of Mines Citrate Process. In 1976 St. Joe and the Bureau agreed to jointly fund the engineering, construction, and the initial operation of a Flue Gas Desulfurization (FGD) Demonstration Plant at the St. Joe Power Plant based on the new technology.

The Citrate Process Demonstration Plant, which represents an $18 million investment, was operated intermittently over a period of nearly three years—from November 1979, to September 1982. Although the process did achieve the design level of 90% sulfur dioxide removal from flue gas for short portions of the test period, equipment limitations prevented maintaining high levels of sulfur dioxide removal or extended periods of system operations.

Many of the operating deficiencies were identified and resolved, but by the third quarter of 1982 the system operating reliability was only 30% at moderate sulfur dioxide removal levels. A key identified problem area was the unit process for removing precipitated sulfur from the Citrate solution. The projected modifications to achieve significant increases in sulfur dioxide removal and system reliability were estimated to require additional capital expenditures of greater than $5 million, coupled with a $2 million annual operating cost. It was also estimated that it would require at least an additional two years to achieve Power Plant sulfur dioxide emissions compliance.

In the third quarter of 1982, the Zinc Smelting Division determined that on the basis of present and projected operations economics, it could not financially support the required modifications and continued operation of the FGD system. Additionally, the environmental regulatory agencies pressed strongly for near-term compliance with the SO_2 emission regulations to prevent Federal Government sanctions being imposed on Pennsylvania. St. Joe was able to develop an alternative sulfur dioxide emissions compliance plan which is more timely and economical than continued development of the FGD system by combining the emissions of the Zinc Smelter and Power Plant. The combined sulfur dioxide emissions program plan has been submitted to the environmental agencies for approval, and its implementation is currently underway.

The Citrate Process is still potentially an attractive FGD system, but it requires some engineering modifications before it can be demonstrated commercially. Zinc industry economics, environmental pressures, and a combination of circumstances which made possible an alternate emissions control program at the specific site mitigated against further development of the Citrate Process Demonstration Plant at the Monaca Power Plant.

INTRODUCTION

In response to environmental regulations adopted in the 1970's for limitation of sulfur dioxide (SO_2) emissions, St. Joe Minerals assessed the potential technologies available for control of the emissions and the economic impact of the control strategies. After interaction with the Pennsylvania environmental regulatory agencies, St. Joe began implementing programs to control the SO_2 emissions from Zinc Smelter sources. The implemented Zinc Smelter control strategies for SO_2 emissions control were:

1. Roaster Plant — Installation of a contact sulfur acid plant to process the tail-gases from the then existing single-contact acid plants treating roaster process gases.

2. Sinter Plant — Modification of Roaster/Sinter Plant circuits and operations to eliminate more of the sulfur in roasting operations, controlling maximum sulfur levels in calcines fed to the sinter machines.

Control of the Power Plant SO_2 emissions on a reliable and economically-viable basis proved to be a greater challenge. This report details our Power Plant SO_2 emissions control program, including a discussion of our continual interactions with the environmental agencies charged with enforcement responsibilities for the emissions control regulations. These interactions played a key role in our adopting the Citrate Process for Power Plant SO_2 emissions control and, finally, being forced to abandon the process as part of our program. Our test experiences in employing the Citrate Process are discussed in the final Section dealing with the Citrate Demonstration Plant.

ST. JOE POWER PLANT SO_2 EMISSIONS CONTROL PROGRAM

Introduction

In 1956 St. Joe built a 120 megawatt coal-fired electric power generating station at its Monaca, Pennsylvania, zinc smelting operation. The power station consists of two identical parallel 600 million BTU-per hour pulverized coal-fired boilers and associated power generating equipment. From their inception the Power Plant boilers were fired almost exclusively with a Pennsylvania coal containing about 2% sulfur and 11% ash. At the time the plant was built it was equipped with the most modern mechanical and electrostatic precipitators.

In December 1971, Pennsylvania proposed air quality regulations for power plants. In late 1972, St. Joe commenced construction of additional electrostatic precipitator capacity. The installation to comply with the particulate emissions regulations was completed in March 1974.

The Pennsylvania Department of Environmental Resources (DER) regulations required that our SO_2 emissions be reduced by approximately 80% to achieve compliance. There were no readily-available satisfactory engineered systems, so St. Joe began work in 1972 to develop a SO_2 emissions control program which could be applied at the Power Plant.

Since the SO_2 emissions regulations for combustion units were adopted in the early 1970's, St. Joe has had continual interaction with the PA DER to arrive at mutually-acceptable control strategies and to keep the PA DER informed of our progress in working to achieve compliance with the regulations. Table 1 provides a chronological summary listing of St. Joe's interactions with the environmental regulatory agencies relative to the Power Plant SO_2 emissions control program. Table 2 gives a parallel summary statement of St. Joe's Power Plant SO_2 emissions control program.

As indicated in Table 2 the initial emphasis in the early 1970's in the SO_2 emissions control program was in identifying a suitable FGD system. The candidate system initially identified by our evaluation program (double alkalai) would produce a substantial qauntity of solid waste and the potential disposal problems could not be resolved with the PA DER, so further development of the initial FGD system was abandoned.

TABLE 1. - St. Joe Environmental Regulatory Interactions

Date	Interaction
DEC 1971	Pennsylvania air quality regulations initially proposed.
SEP 1972	St. Joe began development of a SO_2 emissions control program and filed a SO_2 emissions variance petition for the Power Plant.
DEC 1972-1978	St. Joe had continual interaction with the PA DER to present, discuss, and modify the planned SO_2 control program as our assessment of viable control programs changed.
SEP 1978	St. Joe entered into a consent agreement with the PA DER for Power Plant SO_2 emissions control specifying the following time schedule in working toward compliance and requiring periodic reporting of the status of the program: JAN 1979 - Complete installation of Citrate Demonstration Plant. APR 1979 - Commence Demonstration Year operation of Citrate Plant. APR 1980 - Complete Demonstration Year operation of Citrate Plant. Operate Power Plant Boiler No. 1 in compliance with SO_2 emissions regulations. JAN 1981 - Operate Power Plant in compliance with SO_2 emissions regulations.
1978-1981	St. Joe provided monthly reports to the PA DER on the status of the Power Plant SO_2 emissions control program and participated in periodic discussions with PA DER to supplement reports.
SEP 1981	PA DER scheduled and held a meeting with St. Joe to review the Power Plant SO_2 emissions control program. St. Joe reviewed the initial test operation of the Citrate Plant, primarily discussing equipment problems. St. Joe indicated it anticipated commencement of the Demonstration Year in early 1982.
APR 1982	PA DER scheduled and held a meeting with St. Joe and requested that St. Joe develop an updated compliance plan and schedule for SO_2 emissions control.

TABLE 1. - St. Joe Environmental Regulatory Interactions, continued

Date	Interaction
JUN 1982	St. Joe agreed to develop a SO_2 emissions compliance plan by SEP 1982.
AUG 1982	US EPA requested information on 1982 operation of Power Plant including SO_2 emissions to evaluate compliance status.
SEP 1982	St. Joe met with PA DER and US EPA to discuss its SO_2 emissions control program and propose a compliance plan based upon bubbling Smelter and Power Plant emissions. PA DER and US EPA representatives recommended that St. Joe submit a bubble proposal.
OCT 1982	St. Joe submitted a bubble proposal to the PA DER as its SO_2 emissions compliance plan.

TABLE 2. - St. Joe SO_2 Emissions Control Program

Date	Activity
DEC 1971	Pennsylvania air quality regulations initially proposed.
1972	St. Joe preliminary review of flue gas desulfurization (FGD) technologies.
1973-1974	St. Joe contractor identified potential FGD technologies. St. Joe conducted experimental work using FGD technologies.
1974-1975	St. Joe identified double-alkalai FGD process as primary candidate for Power Plant SO_2 emissions control and conducted small pilot plant tests. St. Joe could not obtain PA DER commitment for approval of process solid waste disposal and therefore abandoned double-alkalai FGD process.
	St. Joe conducted a low-sulfur coal search.
1975-1976	St. Joe conducted low-sulfur coal burning tests and identified one potential SO_2 emissions compliance coal, but it was expensive, caused Power Plant operating problems, and particulate emissions problems.
1975-1976	Initial interaction with US Bureau of Mines to consider new Citrate Process technology.
JUN 1976	St. Joe and US Bureau of Mines signed a contract for the construction and operation of a Citrate Process FGD Demonstration Plant at the St. Joe Power Plant.
OCT 1979	Construction of the Citrate Process Demonstration Plant completed.
NOV 1979	Initial operational testing of the Citrate Process Demonstration Plant began.
THIRD QUARTER 1982	St. Joe obtained assessments of modifications to the Citrate Process Demonstration Plant needed to overcome identified operating deficiencies.
THIRD QUARTER 1982	St. Joe investigated alternatives to Power Plant FGD for achieving SO_2 emissions compliance. St. Joe assessed its capability for achieving Zinc Smelter SO_2 reductions.
SEP 1982	Final operational test of the Citrate Process Demonstration Plant.
OCT 1982	St. Joe began implementing a program to convert to low-sulfur coal use at the Power Plant and reduce SO_2 emissions in the Zinc Smelter.

Low Sulfur Coal Assessment

In the mid-1970's the program primary emphasis was shifted to an attempt to identify a low-sulfur coal which could be burned in the Power Plant boilers and directly produce flue gases which would be acceptable environmentally. Because of the stringent SO_2 emissions regulations for the Pennsylvania Lower Beaver Valley Air Basin [25 PA Code, Section 123.22 (b) (2)] a high-heat content coal with a low sulfur level ($<0.5\%$ sulfur) was required to meet the regulations. After an extensive coal search, followed by combustion tests in the Power Plant boilers, only one coal was identified which might allow us to comply with the regulations. Unfortunately, the coal was from a mine in the western part of the United States. The coal would be extremely expensive, largely because of transportation charges, and the reliability of the source in delivering the required quantities for St. Joe's Power Plant operations was unproven. Additionally, the coal grindability and combustion characteristics would require modification of equipment at the Power Plant to permit generation of electric power at the required level and development of the techniques and equipment to improve particulate emissions collection efficiency so that the particulate emissions regulations could continue to be met.

Citrate Process FGD Control Program

At the time St. Joe was determining that burning an available low-sulfur coal was not a viable solution to achieving emissions compliance at the Power Plant, we became aware of the US Bureau of Mines developments with the Citrate Flue Gas Desulfurization Process. In 1975 the results of Citrate Process pilot plant flue gas desulfurization tests were very promising, and instead of producing a solid waste product which would be a major disposal problem, the Citrate FGD Process could convert the captured SO_2 from the flue gas into elemental sulfur. The elemental sulfur could then be treated in our Monaca site Zinc Smelter acid plant to produce additional quantities of commercial-grade sulfuric acid for sale. In June 1976, St. Joe entered into a contract with the US Bureau of Mines for the design, construction, and operation of a Citrate Process Flue Gas Desulfurization Demonstration System on St. Joe's coal-fired boiler flue gas.

In the late 1970's the Citrate Process became the focus of our Power Plant SO_2 emissions control program. After the system was designed and construction was well underway, St. Joe and the PA DER in September 1978 entered into a consent agreement for a Power Plant SO_2 emissions compliance program. The agreement specified the time schedule for the individual events listed in Table 1. St. Joe's compliance program was based on the Citrate Process FGD System eventually operating under design conditions, achieving 90% SO_2 removal efficiency, and the burning of a high quality Eastern US coal ($<1\%$ sulfur, 13,000 Btu/lb).

At the time of the signing of the consent agreement the installation of the Citrate Demonstration Plant was expected to be completed by January 1979. However, there were a number of equipment delivery and construction delays which prevented the completion of the installation until October 1979. The initial start-up of the Demonstration Plant took place in November 1979. The purpose of the initial operation was to debug the equipment, to gain operating experience, and to achieve system design conditions so that the year of demonstration testing could begin. Throughout the construction period and the years of test operation following the start-up, St. Joe kept the PA DER informed of the status of developments by means of monthly reports.

Because of various mechanical and operating problems discussed in the Section on Citrate FGD Demonstation Plant Operation, St. Joe was not able to achieve system design conditions and begin the Demonstration Year of operation of the plant. Over the twelve-month period beginning in September 1981, representatives of the PA DER and St. Joe met several times to discuss the SO_2 emissions control program status. The PA DER continued to press for obtaining a compliance program, including a specific schedule for achieving SO_2 emissions compliance.

The Lower Beaver Valley Air Basin has been designated as nonattainment for SO_2 under Section 107 of the Clean Air Act. In 1982, in order to prevent sanctions being imposed on Pennsylvania by the Federal Government, it was necessary for the PA DER to submit to the US EPA, a plan for attaining the National Ambient Air Quality Standards for SO_2. The PA DER indicated that one of the key requirements of its attainment strategy was the St. Joe SO_2 emissions compliance plan.

Until the third quarter of 1982 the cornerstone of St. Joe's SO_2 emissions compliance program was achieving design-condition operation of the Citrate Process FGD System, and then converting the entire Power Plant operation to the burning of a moderately-low sulfur coal (approximately 1% sulfur). The continual mechanical and test operating difficulties with the Citrate Demonstration Plant indicated that SO_2 emissions compliance operation could not be achieved without significant modifications being made to the plant. During the third quarter of 1982 an independant engineering assessment of the corrective measures needed to achieve compliance operation with the FGD Plant was made by Stauffer Chemical Company.* Stauffer estimated that capital modifications costing $7,200,000 would be required for Power Plant compliance. The modification program would require in excess of two years to achieve compliance operation. Of course, the flue gas desulfurization technology is still commercially unproven and there could be no guarantees that the modified plant would operate effectively and reliably. The Stauffer cost estimates were consistent with earlier St. Joe preliminary cost estimates.

The present and projected economics of St. Joe's zinc smelting operations indicated the FGD plant modifications and subsequent operating costs could not be supported out of smelter revenues. The additional two years to achieve compliance and the added feature of still dealing with a commercially-unproven control technology weighed heavily against continuing with the FGD emissions control program.

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*Reference to specific brands, equipment, trade names, or companies in this report is made to facilitate understanding and does not imply endorsement by the Bureau of Mines.

Zinc Smelter and Power Plant Emissions Sharing Compliance Program

In the third quarter of 1982 an alternate SO_2 emissions control strategy was investigated—one that involved emissions trading between the Zinc Smelter and the Power Plant. The program evolved was consistent with a US EPA policy statement of April 1982 (47 FR 15076 et. seq.). The proposed emissions trading between the two sources would result in an overall net decrease in SO_2 emissions for the combined sources, over that permitted by the regulations for the individual sources. The overall SO_2 emissions reduction could be achieved, even though a coal containing 0.7% sulfur would be burned in the Power Plant (rather than the 0.5% sulfur compliance coal) without FGD emissions control, because St. Joe would install additional equipment and modify operating practices in its Roaster/Sinter Plants to impose more stringent limitations on zinc calcine usage and sulfur content than that imposed by the existing Pennsylvania environmental regulations.

The revised program for SO_2 emissions compliance for the combined Zinc Smelter and Power Plant was presented to the PA DER (with US EPA representatives in attendance) in a meeting on September 9, 1982. It was projected that the program could be fully implemented in approximately six months. Details of the presentations, including a discussion of Zinc Smelting economics, are provided in Appendix A.

The revised program offers significant advantages in cost savings, timeliness, and reliability, over a continuation in developing the FGD technology and a considerable cost savings over burning a compliance coal. The revised emissions trading program had not been a viable option in the mid-to-late 1970's when a low-sulfur compliance coal was considered, and then the Citrate Process FGD System was selected for Power Plant SO_2 emissions control because of the following:

1. The US EPA had not adopted as its policy the concept of emissions trading among various sources so that the net overall effect might be an emissions reduction for the combined sources. When our SO_2 emissions control programs were formulated in the mid-to-late 1970's, they were predicated on individual compliance with regulations for the Zinc Smelter and the Power Plant sources, and not combined compliance. It was not until recently that emissions trading (bubbling) became a control strategy acceptable to the environmental agencies.

2. In the mid-to-late 1970's the Zinc Smelter had a smelting capacity approaching 250,000 annual tons of zinc products. The Roaster Plant and Sinter Plant circuits were complex operations utilizing a great deal of old equipment. The operating capability of the equipment was severely taxed to process the necessary amount of materials to achieve production goals. It was not until the Zinc Smelter reopened after the 1980 shutdown period that there was the opportunity for lowering SO_2 emissions. The much smaller Zinc Smelter (approximately 100,000 annual tons of zinc product) uses the more modern pieces of smelting equipment in a more streamlined, simpler fashion. Further modifications of process circuits, demonstrated by 1982 testwork, have pointed the way toward SO_2 emissions reductions below the levels dictated by existing environmental regulations.

3. In the mid-to-late 1970's good quality coals with sulfur levels well below 1% were only avaliable from the western United States. The reliability of the supply was unproven and the coals were so expensive that they could not be used in our Power Plant on an economical basis. Through St. Joe's A. T. Massey coal subsidiary St. Joe has found a coal in the eastern United States with a sulfur content of approximately 0.7%. Although the coal is more costly than coals burned in the past at the Power Plant, the coal in the bubble emissions program offers an attractive economic alternative to employing a FGD emissions control system.

The representatives of the environmental regulatory agencies in attendance at the September 1982 presentation of the emissions trading compliance program recommended that St. Joe consider a formal submittal of the proposal. On October 18, 1982, St. Joe submitted the proposal entitled "Alternative Emission Reduction Plan for the Power Plant and Zinc Smelter SO_2 Sources at the Monaca, Pennsylvania Facility of the St. Joe Resources Company" to the PA DER. The proposal is contained in Appendix B. The proposal is currently under review by the PA DER, and St. Joe is proceeding with the implementation of the program, anticipating eventually receiving PA DER approval of the proposal.

CITRATE FGD PROCESS AT ST. JOE

Introduction

In the third quarter of 1975 St. Joe Minerals Corporation began exploratory discussions with the US Bureau of Mines concerning possible use of the new Citrate Process technology for sulfur dioxide (SO_2) emissions control at its Zinc Smelter G. F. Weaton Power Station located in Monaca, Pennsylvania. A particularly appealing feature of the Citrate Process to St. Joe was that the process was of the regenerable solution type with the captured sulfur dioxide from the Power Plant flue gas recoverable as elemental sulfur. Rather than producing voluminous quantities of solid waste products that present serious disposal problems for many FGD process, the Citrate Process would produce sulfur which could be converted into product sulfuric acid in the Zinc Smelter acid plant.

The Bureau had conducted laboratory research to demonstrate the technical feasibility of using the Citrate Process for removal of SO_2 from industrial waste gasses. The process employs a solution of citric acid, sodium citrate, and sodium thiosulfate to absorb the SO_2 from the flue gas, followed by reaction of the absorbed SO_2 with gaseous hydrogen sulfide (H_2S) to precipitate sulfur and regenerate the citrate solution for recycle to the absorber. A portion of the precipitated sulfur can be reacted to form H_2S for cycling to the sulfur precipitation reactor.

In 1970 and 1971 the Bureau had constructed and operated a pilot plant for removal of SO_2 from copper reverberatory furnace flue gas at the Magma Copper Company smelter in San Manuel, Arizona. The initial pilot plant consistently removed in excess of 90% of the SO_2 from the flue gas (1).

To obtain data for an engineering evaluation of the Citrate Process the Bureau constructed a second pilot plant at the Bunker Hill Company Lead Smelter in Kellogg, Idaho. During 1974 and 1975 the Bureau and the Bunker Hill Company operated the pilot plant for a total of 4500 hours, with the longest continuous operating period being 265 hours. The pilot plant operation consistently demonstrated the ability of the process to capture over 95% of the SO_2 in the flue gas and convert it to elemental sulfur (2).

Citrate Process Demonstration Plant Program

With the background of promising results from the pilot plant programs the Bureau, with the support of the US Environmental Protection Agency, began a search to obtain a demonstration of the Citrate Process capability for coal-fired power plant flue gas desulfurization.

In response to the Bureau Request for Proposal No. SO261008, dated August 15, 1975, St. Joe Minerals Corporation, in October 1975, submitted its proposal to provide Engineering, Construction, Operations, and Managerial Services for the proposed Citrate Process Demonstration Plant. The technical and cost proposals (3) were prepared on St. Joe's behalf by the Morrison-Knudsen Company, Inc. and the Ralph M. Parsons Company.

In June 1976 the Bureau and St. Joe Minerals Corporation entered into a cost-sharing contract for a demonstration of the Citrate Process SO_2 removal system on St. Joe's Zinc Smelter coal-fired utility boiler flue gas. The Demonstration Plant work was divided into the following four phases:

Phase I	Process design and cost estimate.
Phase II	Engineering design, construction, and mechanical testing.
Phase III	Start-up and performance testing.
Phase IV	One year of operation and testing.

St. Joe completed the requirements of Phase I and presented the results in a November 1976 report prepared on its behalf by M-K National Corporation and the Ralph M. Parsons Company (4).

The Phase II activities were begun in 1977. Construction of the Demonstration Plant based upon the original engineering design was essentially completed by October 1979. The mechanical testing of component parts of the Citrate Plant took place in the latter stages of the construction—during the third and fourth quarters of 1979.

Operation of the Citrate Process Demonstration Plant

The initial operation of the Demonstration Plant commenced in November 1979. The first objectives were to gain initial operating experience, to debug the equipment, and to achieve operating level design conditions over a significant operating period. A critical design feature was the ability to remove a minimum of 90% of the SO_2 from the flue gas stream.

Between the initial start-up in mid-November 1979 and the final shutdown in mid-September 1982, the Citrate Process Demonstration Plant experienced 31 operating cycles. The operating periods ranged from a minimum of one hour to a maximum of 237 hours. (In this report operating time is defined as the period during which the absorber was being operated to remove SO_2 from the flue gas and H_2S was being generated to produce the reactant for precipitating sulfur from the SO_2 absorbed in the citrate solution.) The intervening shutdown periods ranged from three days to 138 days in duration.

The following is a brief description of the operating pattern on a calendar year basis:

1979 Operation

The initial operating period was for 42 hours starting on November 14. During the period of initial plant operation a variety of operating problems were encountered. All of the primary process steps were brought into operation, but significant data on performance were not generated because effort was concentrated on solving the problems. The most damaging problem was that the slurry tanks filled up with the sulfur precipitated from the citrate solution. The initial shutdown of the plant was dictated by a major overflow of the sulfur slurry tank resulting from a weir tank level adjustment problem.

The initial shutdown extended over a period of 135 days. An attempt made to start up the plant in January 1980 was aborted when a leak was discovered in the H_2S generator gas preheater. A number of factors contributed to the lengthy shutdown. The most significant of these are listed in the Appendix E Downtime Summary.

During the initial shutdown period there was a significant occurance. In December 1979, St. Joe shut down its Monaca Zinc Smelter because of the unprofitability of the operation. The workforce reduction associated with the shutdown of the Zinc Smelter resulted in a replacement of two-thirds of the original Citrate Demonstration Plant operators and a reduced demand for electrical energy from the Power Plant. The resulting low level boiler operation provided the Citrate Unit with a flue gas supply below design levels for a period of 1-2 years.

1980 Operation

After the initial long shutdown the plant experienced three moderate length operating periods (22-127 hours) during the second quarter. In these periods there was poor flotation of the precipitated sulfur. The sulfur which was entrained in the lean citrate solution was recycled to the absorber where it caused plugging of the 20-foot layer of plastic saddle packing. The resulting poor distribution of absorber citrate solution and channeled flue gas flow in the packed column caused low SO_2 absorptions from the flue gas (50%-70%).

Attempts to clean the absorber packing by solution circulation were only partially successful. During a long shutdown (109 days) in the third quarter the abosrber packing was removed and cleaned. Only a two-foot layer of packing was reinstalled in the abosrber in an attempt to counteract the sulfur-plugging problems.

In the last four months of the year there were five operating periods of moderate length (86-185 hours). Good SO_2 absorptions were achieved in Operating Periods Nos. 6 and 7 in October when SO_2 absorption values ranged from 84%-92%. At the end of Operating Period No. 7 the SO_2 absorption dropped to 72%-75%, when one of the sulfur precipitation reactors had to be removed from service. In the November run the SO_2 absorption dropped to the 70%-80% range because of low citrate solution strength and to the 40%-60% range when there were additional difficulties with one of the sulfur precipitation reactors.

The percentage of operating time of the plant for the year was approximately 10%. For the last four months of the year the plant operated slightly more than 20% of the time.

1981 Operation

At the beginning of the year there was a long shutdown (105 days). While a number of maintenance maneuvers were performed and system modifications were made, the one requiring the most time was the design, fabrication, and installation of a spray system for distribution of the lean citrate solution in the absorber in place of the tray distributor. The purpose of the spray system was to maintain good distribution of the citrate solution in hopes of achieving improved SO_2 absorption. With the tray distributors the suspended solids in the lean citrate solution plugged the tray system, resulting in poor solution distribution over the absorber cross-section.

In the initial run after the installation of the spray system, SO_2 absorption was good (>90%) and sulfur flotation had improved. However, a failure of the H_2S generator preconditioner and severe cracking of the main H_2S reactor resulted in an extensive shutdown (138 days) while replacement vessels were designed, fabricated, and installed.

Over the last four months of the year there was a series of seven runs. Three operating periods in October and November were of sufficient length (92-237 hours) to obtain data for characterizing the operation. While sulfur flotation normally improved with time during a run, there was sufficient sulfur entrained in the solution to cause plugging of the absorber packing. The final two-foot layer of packing was removed in October to avoid the plugging problems which were contributing to frequent unit shutdowns. After the packing was removed, SO_2 absorption decreased to values of less than 50%. A variety of failures, primarily in the sulfur transfer lines and the H_2S generator itself terminated the individual runs in the last quarter.

For the year the operating time averaged only 7% because of the two long down periods. Over the last four months the ontime averaged 18%.

1982 Operation

During the final nine months of operation there was a sequence of 13 runs. With two exceptions, the runs were of moderate length (47-224 hours). Despite some modest changes, sulfur flotation remained a problem throughout the year. With the absorber packing removed to avoid the sulfur plugging problems which could shut the operation down, the installed spray system could not provide sufficient gas-liquid contact to achieve high SO_2 absorption values. The installed spray system was also vulnerable to plugging by solids suspended in the citrate solution, although to a lesser degree than the previous tray system. The SO_2 absorption values were normally in the range of 40%-60% with occasional values as high as 70%. In the latter stages of operation it was primarily problems in the H_2S generator system which caused downtime.

Over the last nine months of operation the Demonstration Plant operated 20% of the time and for the final three months approximately 30% of the time. When the Demonstration Plant was shut down at the conclusion of Operating Period No. 31 in mid-September, a decision was made not to restart the system.

Discussion of Citrate Demonstration Plant Operation

Prior to the startup of the Citrate Demonstration Plant the system was charged with approximately 60 tons of sulfur to permit H_2S generation for the initial process operation. During various periods of operation there were a number of clean-outs and solution spillages, which accounted for scrap sulfur accumulations (losses from the Citrate Plant) totaling more than 50 tons. Even with the intermittent operation of the Citrate Plant and the low level operation of the Power Plant during 1980 and portions of 1981, significant amounts of sulfur were removed and recovered from the Power Plant flue gas. In the second quarter of 1982, 104 tons of sulfur was transported to the Zinc Smelter Acid Plant for conversion to sulfuric acid. In the fourth quarter of 1982—after the Citrate Plant shutdown—an additional 162 tons of sulfur was shipped to the Acid Plant.

As previously stated, there were 31 operating cycles during the nearly three year period of Citrate Process Demonstration Plant operation. The operating periods ranged from one hour to 237 hours and the shutdown periods ranged from three days to 138 days.

Summary information concerning the operating time is presented in Figure 1. The height of an individual bar indicates the percentage of time in a given month that the Demonstration Plant was in operation. Above the monthly bars is a row of numbers showing the operating periods which took place in each month. Summary information on the individual operating and shutdown periods is provided in the tabulations in Appendices C (Operating Summary), D (SO_2 Absorption Summary), and E (Downtime Summary).

Figure 1 provides some insight into the operating pattern of the Demonstration Plant. It shows the long gaps in the operation which occurred over the first two years when there were some major changes in equipment and some failures of key process equipment. The chart also illustrates the more consistent but still low level (20-25%) of plant operation over the last year of operation when most of the shutdown periods were characterized by clean-outs, replacing component parts of equipment, repairing linings, and similar maintenance maneuvers.

Over the course of the nearly three-year period of test operation of the Demonstration Plant the entire system had not been operated under design conditions. It became increasingly obvious that significant modifications in the equipment would be required to achieve the design flue gas emission control operating parameters. The SO_2 absorption levels of 40%-60% obtained with the lean solution spray system installed in 1981 had been accepted in order to gain a higher level of plant ontime. Some packed bed configuration is likely necessary to obtain the required 90% SO_2 absorption efficiencies. Improved sulfur flotation, probably combined with lean citrate solution clarification or filtration, would be required to decrease the sulfur circulating load and prevent the plugging of the lean solution distribution system in the absorber. Improvements would also be required in the sulfur treatment system in the H_2S generator to prevent the frequent maintenance cleanouts needed to keep the H_2S generator functioning properly.

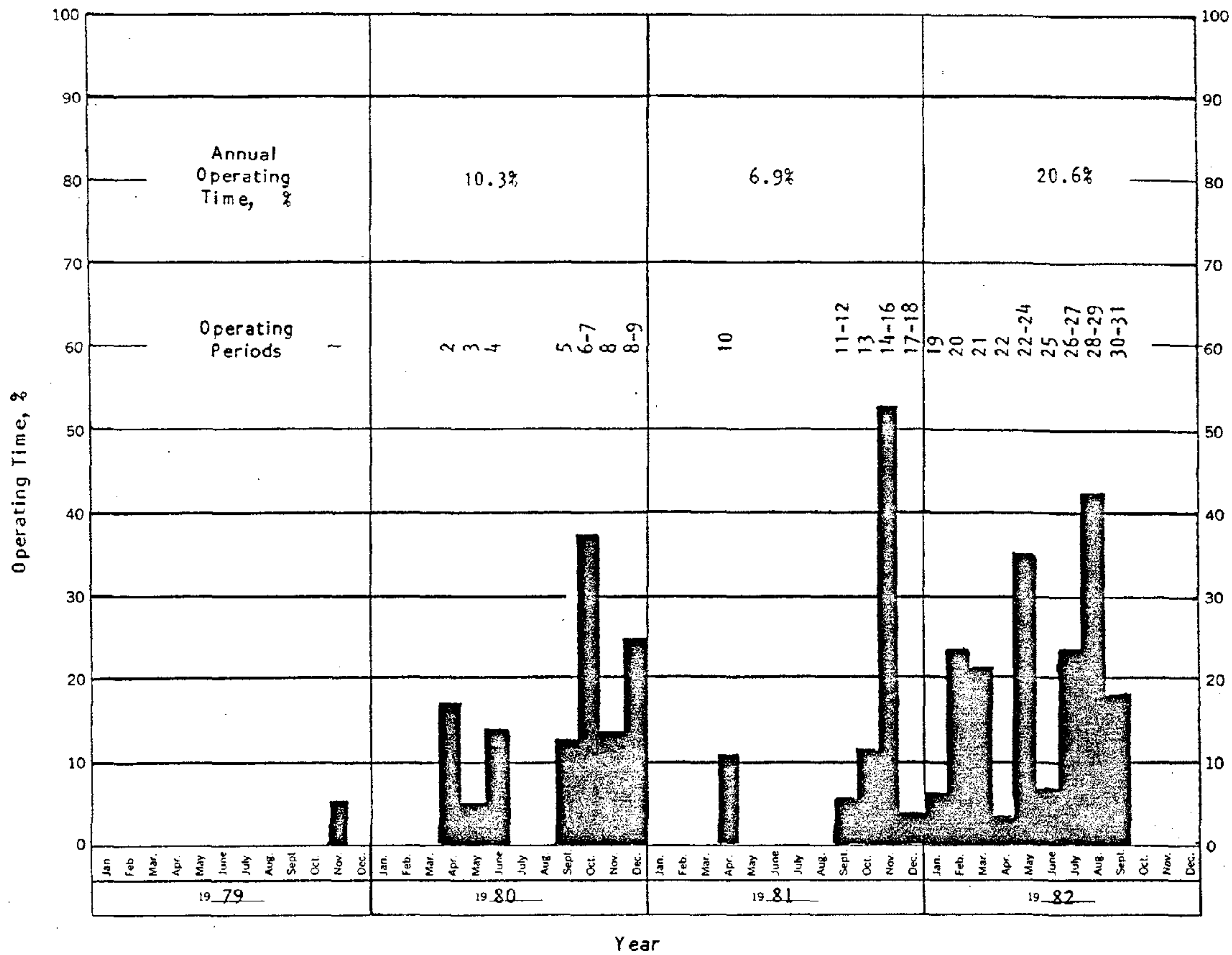

FIGURE 1. - Monthly Operating Time Summary for the Citrate Process Demonstration Plant

Modification Estimates for the Citrate Demonstration Plant

During the first quarter of 1982 St. Joe considered the operating experiences of 1980 and 1981 and estimated the modifications in the Demonstration Plant which would be required to achieve adequate system reliablility. The tablulated items and the cost estimate are provided in Appendix F. It was estimated that approximately $2,300,000 would be required to provide the additional equipment and modifications, for which there was at least a 50% probability of need. To supply the modification for which there was a 25% probability of need would require an additional $2,400,000, giving a total system modification cost of $4,700,000.

In the third quarter of 1982 Morrison-Knudsen Company, who designed, constructed, and served as technical and engineering consultants to St. Joe for the Demonstration Plant operation, provided St. Joe with the following:

1. A suggested list of Recommendations and Engineering Proposals for the Citrate Demonstration Plant.

2. A list of problems and suggested list of Plant Modifications and Major Repairs for the Citrate Demonstration Plant.

The two lists are presented in Appendix G. Morrison-Knudsen estimated that a $120,000 effort would be required to provide the engineering services needed to identify the corrective actions for plant problems and to determine the detailed designs for capital cost estimates and equipment specifications for those deficiency areas in the recommendations list. The area considered by M-K to be of highest priority concern was the sulfur flotation portion of the system. A solution to the poor sulfur flotation was considered to be the key initial objective to be achieved before the vital issue of absorber SO_2 efficiency could be addressed.

During the second quarter of 1982, Stauffer Chemical Company entered into discussions with St. Joe concerning the possibility of modifying the Citrate Demonstration Plant to achieve the capability of operating in compliance with SO_2 regulations. After an onsite engineering assessment of the Citrate Process Demonstration Plant, Stauffer made a presentation to St. Joe in August 1982, emphasizing the following two primary points:

1. Absorber design is inadequate and the type of packing (2" plastic saddles) must be changed.

2. Sulfur flotation and separation equipment is inadequate; newly designed and larger equipment must be provided, and to enhance flotation a phosphate buffer solution should replace the existing citrate solution.

Stauffer did not address the issue of H_2S generation, although we had encountered problems in that area during Demonstration Plant operating periods. The H_2S generation process used in the Demonstration Plant is proprietary, so information concerning it could not be made available for Stauffer's preliminary study. The Stauffer proposal presented to St. Joe is provided in Appendix H. As a follow-up to the discussions, it was determined that the estimated capital cost for modifications to achieve SO_2 compliance was $7,200,000. Stauffer estimated that it would require 19 months after the initiation of the program to achieve single-boiler emissions compliance, and an additional year to bring the entire Power Plant into emissions compliance.

Present Status of Citrate Demonstration Plant

In September 1982 St. Joe determined that it was impractical to continue to operate the Citrate Process Plant in its existing condition. Equipment limitation would continue to restrict the plant to short operating periods and prevent the achievement of operating design objectives. The costs for required system modifications and the system operating costs could not be supported by Zinc Smelter revenues. Additionally, the time required to modify the process system and achieve SO_2 emissions compliance was intolerable for the environmental regulatory agencies.

The operation of the Citrate Process Demonstration Plant was terminated on September 11, 1982. Since then steps have been taken to maintain the condition of the plant components. All of the lines have been drained and the tanks emptied. The utilities to the Citrate Plant have been shut off. The components for which there were interfaces with the Power Plant have been isolated; e.g., the flue gas duct leading from the Power Plant No. 1 Boiler flue gas discharge line to the Citrate Plant venturi scrubber has been blanked off.

At the Zinc Smelter and Power Plant St. Joe is proceeding with the implementation of the proposed "bubble" SO_2 emissions compliance program. This has involved reducing the sulfur level in calcine fed to the Sinter Plant, reducing the sulfur level in Power Plant coal, and implementing a program for conditioning the low-sulfur coal flue gas so that the collection efficiency of particulates in the flue gas can be maintained.

CONCLUSIONS

The Citrate Process Demonstration Plant was operated on an intermittent basis at the St. Joe Minerals Monaca Power Plant over a period of nearly three years. Prior to and throughout the course of the operating period the Citrate Process was the mainstay of St. Joe's program to achieve compliance with the SO_2 emissions regulations. On the basis of our operating experience with the Demonstration Plant and the continual interactions with environmental regulatory agencies, we have drawn the following conclusions:

1. In a few brief periods of operation of the plant there was a demonstration of the Citrate Process's capability to remove greater than 90% of the SO_2 from the Power Plant flue gas with subsequent conversion of the absorbed SO_2 to elemental sulfur and regeneration of the citrate absorber solution.

2. Process equipment deficiencies restricted the attainment of high SO_2 absorption levels to short operating periods. Absorber modifications to permit longer operating periods resulted in lower SO_2 absorption levels—generally 50% to 70% absorption.

3. All phases of the Citrate Process Plant were operated successfully from a technical standpoint. However, equipment deficiencies and materials of construction failures permitted only intermittent Citrate Plant operation. The longest period of operation was 237 hours. During the final quarter of operation the system had an operating reliability of 30%.

4. Many of the problems preventing longer operating periods of the Citrate Process Plant were identified. Chief among these was the inability to adequately remove precipitated sulfur from the citrate solution. A vastly improved sulfur flotation system, perhaps coupled with clarification or filtration of the recycle citrate stream, would be required.

5. Preliminary engineering estimates of capital expenditures to provide the modifications needed to deal with the problems thus far identified ranged to $7,200,000. This additional capital requirement, plus the $2,000,000 annual operating cost, could not be supported by present or anticipated future revenues of the Zinc Smelter. Assuming the modifications could correct the operating problems, it would require at least an additional two years to achieve Power Plant SO_2 emissions compliance.

6. Changes in environmental regulations to allow combining emissions from several sources for control purposes, coupled with modifications in the Zinc Smelter which permit lower levels of SO_2 emissions to be attained and the availability of a moderately low sulfur coal have made possible a new SO_2 emissions compliance program at the St. Joe Minerals Monaca Site. This program can be completely implemented by mid-1983. Since this is known technology, the chances of successful implementation to achieve compliance are very high.

7. The combined SO_2 emissions control strategy—Zinc Smelter plus Power Plant—is by far the more economical and timely approach to achieving emissions compliance at the Monaca Site. While the Citrate Process FGD has shown technically-promising operating results and has produced a commercially-usable sulfur product, its continued development to achieve a commercial process cannot be supported at the Monaca Site Power Plant. Accordingly, operation of the Citrate Process Demonstration Plant has been discontinued and equipment components have been isolated while their future disposition is being evaluated.

JMC/jfv

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3. St. Joe Minerals Corporation. Morrison–Knudsen Company, Inc. The Ralph M. Parsons Company. Proposal to the U.S. Bureau of Mines for a Citrate Demonstration Plant. October, 1975.

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APPENDIX A

PLAN FOR ST. JOE COMPLIANCE WITH PENNSYLVANIA SULFUR DIOXIDE EMISSION REGULATIONS

SEPTEMBER 1982

ST. JOE
RESOURCES COMPANY
P.O. BOX A
MONACA, PENNSYLVANIA 15061
TELEPHONE 412-774-1020

To: Pennsylvania Department of Environmental Resources

Subject: Plan for St. Joe Compliance with Pennsylvania Sulfur Dioxide Emission Regulations

Introduction:

In 1977, St. Joe presented a plan to the Pennsylvania Department of Environmental Resources (DER) for SO_2 compliance at St. Joe's George F. Weaton Power Station, a coal-fired electrical generating facility, near Monaca, Pennsylvania. This power plant is an essential component of the Zinc Smelting Division of St. Joe Resources Company. The key element in the St. Joe plan was the installation and operation of a flue gas desulfurization unit, known as the "Citrate Plant," using specialized technology developed by the U.S. Bureau of Mines (BOM). In a jointly funded demonstration project with the BOM and the U.S. Environmental Protection Agency, the Citrate Plant was constructed at the George F. Weaton Power Station.

As originally outlined, the compliance plan would have allowed orderly construction and testing of the Citrate Plant, with final compliance by December 31, 1980. However, economic conditions forced St. Joe to close its Zinc Smelting Division in December, 1979, interrupting the Citrate Plant project for more than one year.

In several meetings and in correspondence with the DER, St. Joe personnel have related the numerous mechanical and operating problems experienced with the Citrate Plant. From this experience, we have concluded that the Citrate Plant is most probably both economically and technically infeasible as a means for St. Joe to achieve compliance with the Pennsylvania SO_2 emission regulations.

The purpose of this document is to discuss details of our program results to date, to outline the current and projected economics of our industry, to explain the impact on St. Joe Resoures Company, and to support our request for a revised compliance plan for St. Joe's Monaca, Pennsylvania operations.

Progress of the St. Joe Compliance Plan

The cornerstone of the current St. Joe Resources Company compliance plan is the Citrate Process, a flue gas desulfurization technology developed by the U.S. Bureau of Mines (BOM). In cooperation with the BOM and the U.S. Environmental Protection Agency (EPA), St. Joe agreed to participate in a demonstration plant installation for the Citrate Process at its George F. Weaton Power Station.

Funding approval at St. Joe occurred in mid-1976 and groundbreaking for the $18 million plant was in early 1977. Following completion of construction in the Fall of 1979, process start-up was achieved on November 14, 1979. The plant initially operated for three days. In December 1979, work on debugging the plant was interrupted by the closure of the Monaca zinc smelter.

In total, St. Joe has achieved full operation of the Citrate Plant 24 times, with operating periods ranging from a few hours to as long as ten days. Numerous other start-up attempts have been aborted for a variety of reasons.

Appended to this document is a chronological summary of our attempts to operate the Citrate Plant. Our engineers have experienced equipment breakdowns which have repeatedly terminated operations and have precluded accurate definition of process problems. Extensive repair delays have further hampered progress.

We have concluded that significant process modifications and improvements will be required to achieve reliable operation of the Citrate Plant. Details of the modifications are outlined in a later section of this document.

Zinc Industry Profile and Economics

The U. S. Zinc Industry

Zinc is an internationally traded commodity and a strategic material for the United States, which imports nearly 70% of its zinc requirements. About ten companies mine zinc in fifteen states, principally Tennessee, Missouri and New York. Five companies produce zinc metal, from zinc concentrates produced at mining operations, at six plants located in Texas, Illinois, Oklahoma, Tennessee and Pennsylvania.

Zinc oxide and zinc dust are produced by two "primary" manufacturers (defined as using zinc concentrates) and more than ten "secondary" manufacturers (defined as using zinc bearing residues and scrap feed) at ten major plant sites.

Zinc Mining Statistics

(Tons Metal in Concentrate)

Company	1979	1980	1981	1982 Estimate
Amax	42,430	39,754	22,406	
Asarco	72,700	97,300	136,955	
Bunker Hill	26,076	25,757	28,370	
New Jersey Zinc Co.	130,841	144,883	100,283	
St. Joe Resources Co.	14,468	39,797	35,939	56,275

Zinc Metal Production Statistics

(Tons)

Company	1979	1980	1981	1982 Estimate
Amax	66,270	69,014	74,614	
Asarco	59,200	51,258	56,861	
Bunker Hill*	81,403	76,580	70,937	
Jersey Miniere Zinc Co.	76,555	84,970	90,281	
National Zinc Co.	49,918	43,578	49,613	
New Jersey Zinc Co.**	95,581	65,475	-	
St. Joe Resources Co.	143,112	2,030	49,387	71,683

*Bunker Hill ceased zinc smelting operations in 1981.

**New Jersey Zinc Company ceased metal operations at Palmerton, Pennsylvania in 1980.

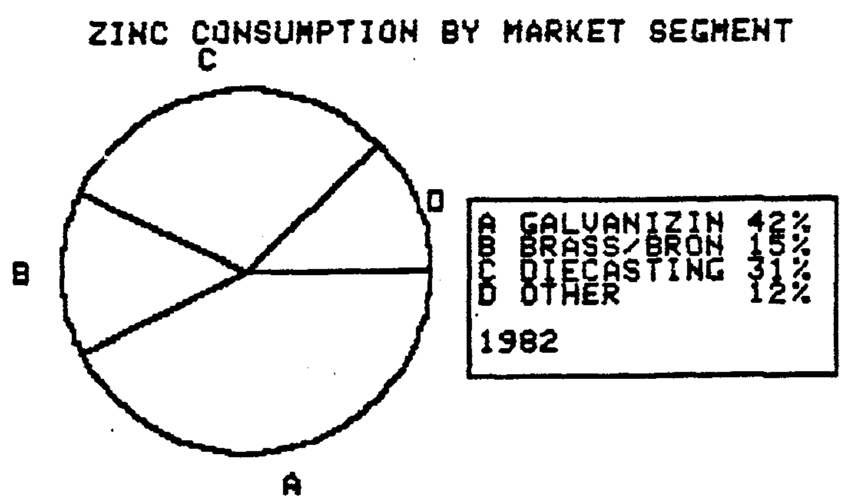
Competition

While competition is keen among the major U.S. zinc producers, foreign producers represent the major competitive threat. Imported zinc, principally from Canada, Australia and Mexico, supplies 69% of the U.S. requirement for zinc metal and 15% of the U.S. need for zinc oxide.

The U.S. was not always so heavily dependent on foreign zinc sources. Since 1969, import dependence has grown from 25% to 69% and could reach 73% by 1986. This dramatic shift in zinc sourcing resulted from the closure of eleven U.S. zinc smelters since 1969. Although the closed facilities were either obsolete or no longer well positioned with respect to either feed sources or markets, depressed prices seriously limited capital spending programs for the U.S. zinc industry. Overseas, several new plants were constructed during the same period.

The reluctance of the U.S. zinc industry to invest in new domestic capacity has been the global excess zinc metal production capacity. Many foreign producers maintained high outputs in spite of sagging markets in the mid-70's, with their excess metal flowing to the U.S. at distressed prices. Although the U.S. zinc industry brought a case before the International Trade Commission in 1977-78, we were denied relief. The ITC agreed that zinc metal imports were causing injury to U.S. producers, but refused to provide relief on the grounds that the coincident decline in U.S. zinc consumption was the principal cause of our industry's problems.

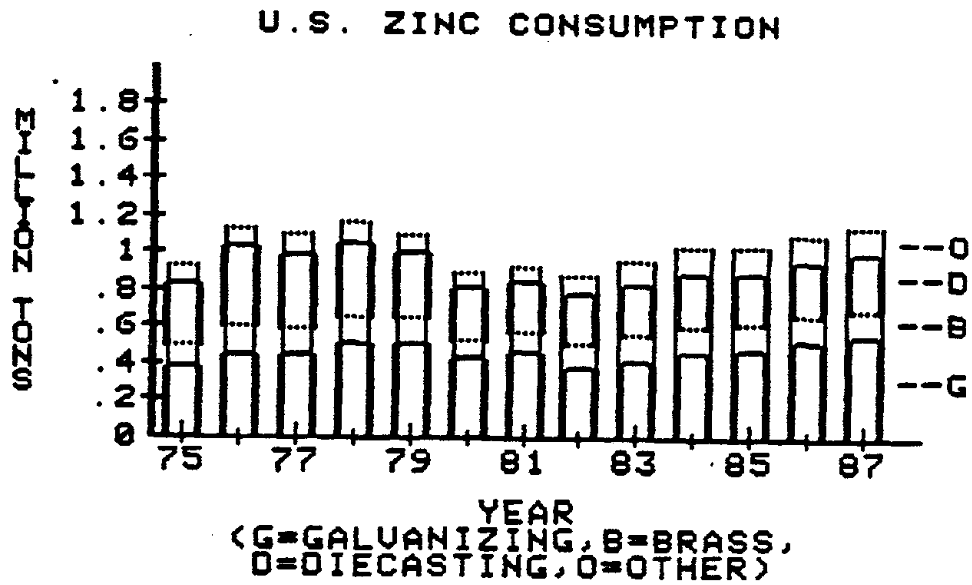
U. S. Zinc Consumption



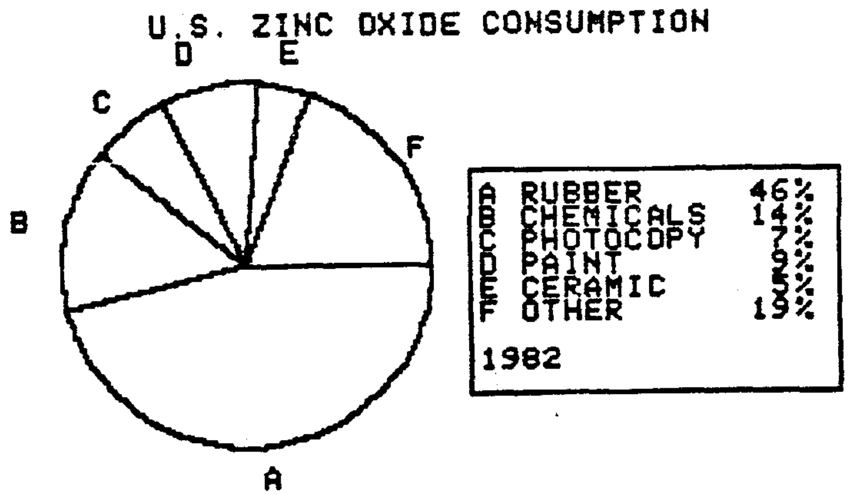
Galvanized steel is the principal market for zinc metal. Zinc imparts corrosion resistance to steel, a feature of importance to the chemical and construction industries. While we forecast an 8% compound annual growth rate for galvanizing consumption of zinc metal in the U.S., we do not expect galvanizing usage of zinc to rebound to the modest pre-recession consumption level until 1986.

Prior to 1970, the chief zinc metal market was **diecast parts,** consumed in great quantities by the auto industry for carburetors, handles, light housings and chrome-plated trim. The move to lighter materials (plastics, aluminum) and the auto downsizing trend reduced zinc demand by the diecasting industry by 56%. We are now forecasting 2% annual growth over the next five years for diecasting.

Zinc metal is used as an alloying element in the manufacture of brass and bronze. Small growth is anticipated for this minor zinc market.

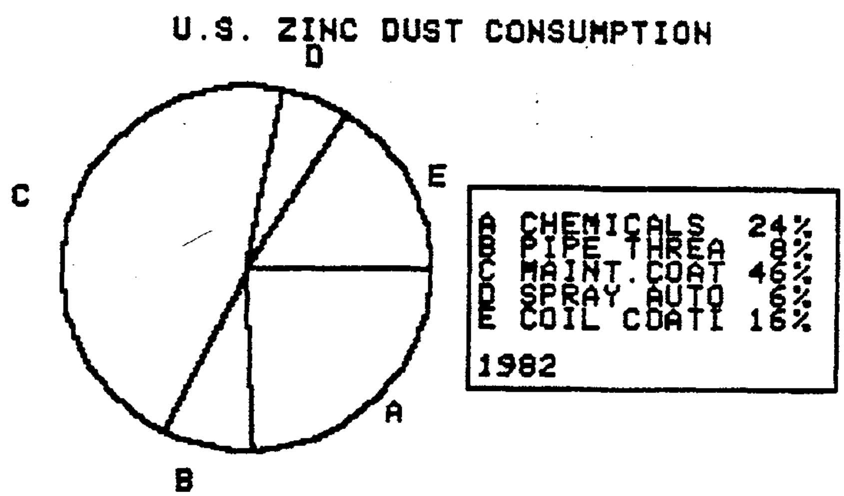


U. S. Zinc Oxide Consumption



Zinc oxide is a white chemical and pigment consumed by the rubber, photocopy paper, ceramics, chemical, paint and pharmaceutical industries in dozens of products. Rubber represents the chief zinc oxide user, and U.S. shipments to this market segment have severely suffered during the recession and as a result of auto downsizing (smaller cars use smaller tires, rubber belts, hoses, etc.).

U. S. Zinc Dust Consumption

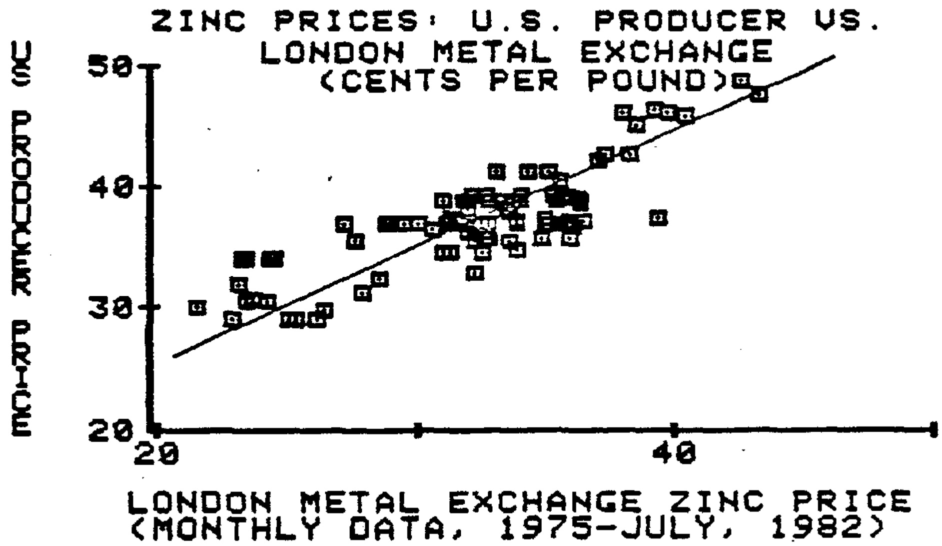


Zinc dust is a fine particle metallic zinc product tailored for specific applications, including corrosion-resistant coatings and chemicals. Overall growth in consumption for this specialty product is forecast to be about 5% per year over the next five years. The market segments include chemicals, pipe thread compounds, maintenance coatings, automotive spray coatings and steel coil coatings.

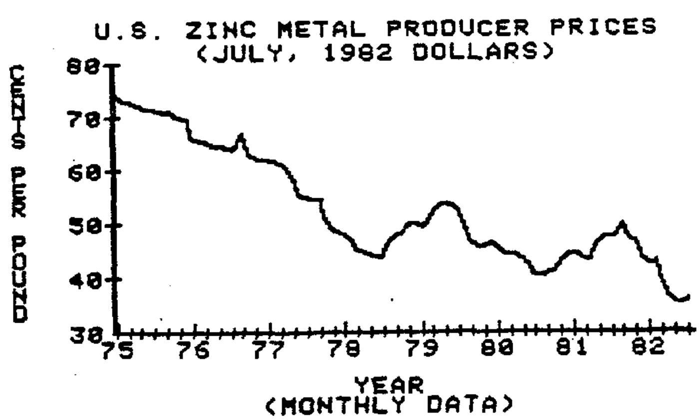
U. S. Zinc Industry Economics

The zinc scene in the U.S. is dominated by foreign producers, many of which are, in part, subsidized in their export activities. For this reason, zinc metal prices in the U.S. are more responsive to international market factors than to U.S. supply/demand characteristics.

Specifically, U.S. zinc prices have displayed little correlation to changes in either galvanizing demand or capacity utilization in the steel industry. U.S. prices have, however, shown a strong relationship to international prices, as shown below in the plot of U.S. Producer Prices vs. London Metal Exchange Prices.



On a historical basis, the price of zinc has performed very poorly in terms of real growth. The plot below depicts U.S. zinc prices expressed in July 1982 dollars for the past seven years. In constant dollar terms, the price for zinc metal in the U.S. today is only half of the price realized during the severe recession of 1975.



Zinc oxide and zinc dust prices follow the general trend of zinc metal prices, but fluctuate to a much lesser extent. This low volatility in zinc oxide and zinc dust prices is due to the fact these products are "specialty chemical" oriented, as opposed to the commodity nature of zinc metal. Zinc oxide and zinc dust are typically priced at a premium above zinc metal; zinc oxide premiums have ranged from one to eight cents over metal (standard grades) while zinc dust premiums have ranged from eight to twenty cents.

St. Joe Resources Profile and Economics

St. Joe Resources Company is the operating company for the zinc mining and smelting interests of St. Joe Minerals Corpration, a unit of Fluor Corporation. St. Joe Resources Company mining operations are centered at Balmat, in northern New York State, and the smelting operations are at Monaca, Pennsylvania.

For economic reasons, the 220,000 ton per year St. Joe zinc smelter at Monaca closed in 1979, laying off 1,500 workers. Following an extensive streamlining of the smelter flowsheet and the development of a new ore body near the existing New York mining district, St. Joe Resources Company opened as a fully integrated producer of 50,000 tons per year of zinc metal and zinc oxide. The revitalized Monaca plant initially employed 350 workers, but this number increased to 425 workers in September of 1980 when output expanded to 75,000 tons per year, and to 450 workers when the company reopened its zinc dust production line in August 1981. Employment now stands at 465 workers as the company gears up for production with its four new electric furnaces for zinc oxide and zinc dust production. Total employment should reach 490 workers when the production expansion is completed later this year.

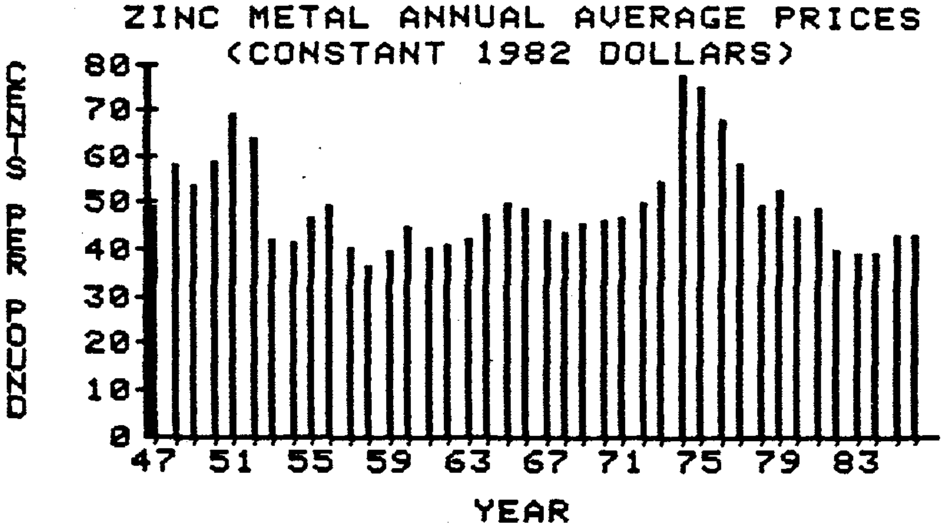
The decision by St. Joe to start up its Resources Company did not come lightly. We recognized four elements being essential for a viable zinc producer in today's zinc industry:

1. **An efficient plant with sound technology,**
2. **A skilled and experienced workforce,**
3. **An adequate source of low cost zinc raw materials, and**
4. **A plentiful supply of low cost energy.**

This very unique set of elements exists in St. Joe Resources Company. It was the basis for our corporation to invest several million dollars in reopening a zinc smelter which recently had yielded annual operating losses approaching $11 million.

St. Joe Resources Company Economics

When the decision was reached in August, 1980 to reopen the Monaca smelter, the market price for zinc metal was 36 cents per pound. Since then, we experienced price increases to 49 cents, followed by a steady decline during this recession to 34.5 cents in June, 1982. The current realized price is now about 36 cents per pound. We do not anticipate that zinc prices will increase during the next two years to the 49 cent level experienced last year. Our latest forecast shows a 9% per year compound annual growth rate in zinc metal prices for the 1983-1987 period, but this statistic is deceiving; since September, 1981, zinc prices have fallen 27%.



As displayed in the graph above, our price forecast shows prices will remain, on a real growth basis, well below the historical average. More importantly, during this same five-year period, St. Joe Resources is expected to experience a 10.6% per year increase in costs associated with producing zinc metal. This means we do not expect price growth at our operations to keep pace with escalating costs.

In terms of operating profit, St. Joe Resources has not as yet performed up to initial expectations. Although profitable, the company will experience an income before tax of less than $1 million in its fiscal year ending October 31, 1982. We anticipate profits for the four-year period, 1982-1985, will average less than $1 million each year, while the company's capital spending plans for investment back in the business for the same period show capital requirements in excess of $7 million.

The importance of the George F. Weaton Power Station to the economics of St. Joe Resources may be demonstrated by examining the impact of replacement power, that is, the additional costs which would be experienced if the Monaca Smelting Division purchased instead of produced its electrical energy.

Replacement Power Analysis

1982 Estimated Smelter Power Consumption:	321,591 MWH
1982 Estimated Power Plant Income Before Tax:	$1,700,000
Less Cost of Power to Smelter @ 22 Mils:	$7,075,000
Less Depreciation:	990,000
Plus Purchased Power @ 38.5 Mils:	(12,381,254)
Net Change:	($4,316,254)
Difference between Produced and Purchased Power:	$6,016,254

We estimate the George F. Weaton Power Station will contribute $1.7 million income before taxes to St. Joe Resources Company in 1982, while the consolidated Resources Company pretax income will be under $1 million. Absent the power plant, the income stream ($1.7 million) would be lost, the depreciation charges would be eliminated and purchased power, at $16.50 more per megawatt hour consumed, would be needed. From the above schedule, the pro-forma changes would be $4.3 million increased costs and $1.7 million eliminated income, for a total impact on the Resources Company of over $6 million.

The conclusion is that, while power sales represent a nominal income stream to St. Joe Resources Company, the absence of the power plant would place an additional $6 million annual burden on the company at a time when consolidated earnings will be under $1 million.

Compliance Alternatives

St. Joe Resources believes that three basic criteria must be employed in judging potential compliance alternatives, namely:

Timeliness

Technical Feasibility

Financial Viability

We fully recognize the mandate of Federal and State legislation, given the Department of Environmental Resources, to insure compliance by all parties with environmental standards. It has been, and will continue to be, St. Joe policy to cooperate with the DER in identifying and implementing suitable control measures for Monaca Smelting Division compliance with these regulations in a **timely manner.**

Where the compliance strategy involves capital investment and operating costs of any magnitude, it is critical that St. Joe Resources apply its limited capital resources to measures considered to have a high degree of potential **technical success.** And, in implementation of the technically feasible control strategy, it is vital that the **financial commitment**, in terms of both capital and operating costs should have the minimum possible impact on the viability of the company.

With these criteria in mind, we have examined three separate alternatives for achieving smelter compliance with SO_2 regulations:

1. Major Citrate Plant Modifications

An independent engineering investigation by an outside consulting firm (Stauffer Chemical) during 1982 examined the mechannical and operating problems of the Citrate Plant and recommended corrective measures.

Stauffer Chemical identified in their study three basic areas requiring major redesign and modifications. These were SO_2 absorption, sulfur separation after the precipitation reactors, and a series of process problem areas. The Stauffer proposal does not fully define the problem areas but those identified by St. Joe and Stauffer include:

Emergency liquor storage
Decanter quench plugging
Plugging of H_2S lines
Crystallizer sulfur carryover
Reactor H_2S distribution
Instrument additions
Need for filtering a slip stream fromfloat cell
Venturi design changes
Reactor linings changes
Materials of construction - piping and vessels
New agitator - sulfur slurry tank
Scrubbing liquid cooler
H_2S product cooler
Repair/replace fly ash line
Valve replacement program
Cooler and heat exchanger modification and repair
Sulfur melter development/repair
Sulfur filter replacement - add neutralization
Reline K-O drom vessel
H_2s product cooler development
Cold weather protection
Dual fuel system for superheater
$CaSO_4$ pit agitator
Alter quench system K-O drum
Sulfur feed tank modifications in H_2S system
Separate condensate system
Additional sulfur decanter
H_2S generation heat exchanger
Instrumentation improvements
Sulfur storage system repair
$CaSO_4$ pump replacement

The Stauffer study did not address the H_2S generation, as we employ a proprietary proces developed by Home Oil Company which could not be made available for Stauffer inspection.

Two major points were made by Stauffer in their discussions with St. Joe on their proposal:

- Absorber design is inadequate and the type of packing must be changed, and

- Sulfur floatation and separation equipment is inadequate; newly designed and larger equipment must be provided, and to enhance floation a phosphate buffer solution should replace the existing citrate solution.

Initially, Stauffer proposed capital costs exceeding $10 million. After followup discussions with St. Joe, the cost estimates were refined to $7.2 million. The Stauffer presentation is contained in Appendix H.

The "major modification of the Citrate Plant" alternative does not meet two, and possibly all three, of the basic criteria. First, implementation of the modifications may require in excess of two years. Second, having made the modifications recommended by either St. Joe or Stauffer Chemical there is no guarantee that the still unproven flue gas desulfurization (FGD) plant will operate reliably and effectively.

Thirdly, the modification strategy is definitely not financially viable. The $7.2 million exposure in capital for the Stauffer proposal is more than seven times the annual pretax earnings for St. Joe Resources Company expected for the period 1982 through 1984. Furthermore, the anticipated $2 million in operating costs for the modified FGD plant cannot be supported by the Monaca Smelting Division.

Of additional concern to St. Joe is its contract with the Bureau of Mines on the Citrate Plant. It appears that any abandonment of the original citrate process by St. Joe could place the company in technical default, allowing the government to institute the salvage and liquidation clauses contained in the agreement.

2. Permanent Shutdown of the George F. Weaton Power Station

While undeniably a "timely" and "technically feasible" option, shutdown of the Monaca power plant and a switch to purchased power is not a "financially viable" alternative. In the section on St. Joe Resources Company economics, we presented an exhibit outlining the pro-forma impact of replacement power on the financial performance of the company in 1982. The exercise demonstrated a net impact of over $6 million annually in increased costs and reduced earnings for the company. Clearly, continued production of low-cost power by St. Joe is essential for the smelter to survive.

3. Combined Power Plant and Smelter Reductions in SO_2 Emissions

The program involves "emission trading" between the St. Joe Smelter and Power Plant SO_2 sources -- a program of compliance which isconsistent with the EPA policy statement of April 1982 (47 FR 15076 et. seq.). In addition to meeting the three selfimposed St. Joe criteria of timeliness, technical feasibility, and financial viability, implementation of this program will also net an improvement in air quality for the Lower Beaver Valley Air Basin

(LBVAB). The basic program elements consist of :

1. A reduction in SO_2 emissions from St. Joe's Roaster/Sinter operations amounting to approximately 2,540 tpy through imposition of more stringent limitations on zinc calcine usage and sulfur content than that imposed by the existing SIP.

2. A simultaneous increase in SO_2 emissions beyond the current SIP limitation at St. Joe's Power Plant amounting to approximately 1,945 tpy.

SO_2 emission reductions at the Roaster/Sinter Plants will be accomplished by reducing the allowable quantity of zinc calcine (the sulfur-bearing feed source to sintering) used to produce an equivalent unit of zinc product from 1.40 tons of calcine per ton of product zinc equivalent to 1.06 Simultaneously, St. Joe will further limit the sulfur content of calcine to a level of 2.3% sulfur; a more stringent limitation by 0.4% than that currently imposed by regulation. This program will require St. Joe to install various additional equipment at its roasting facility and to rely on other sources of zinc-bearing feeds to make up for the loss of calcine zinc units imposed by this program.

The reduction in SO_2 emissions achieved at the Roaster/Sinter operations will in part be used to offset an increase in emissions from St. Joe's Power Plant. Power Plant SO_2 emissions will be limited through the combustion of low sulfur coals averaging 0.71% sulfur in lieu of operating the Citrate FGD System. St. Joe proposes to begin immediate purchase of these coals and to begin their exclusive use at the Power Plant as soon as an orderly transition in existing coal inventories can be achieved. St. Joe has also considered the potential for degradation of electrostatic precipitator performance resulting from exclusive use of low sulfur fuel. We have outlined a test program to assess the magnitude of such impact and are prepared to install such additional equipment as may be required to mitigate this issue.

Efficacy of the "emission trading" program described on the preceding page is fully supported by air modeling studies conducted by Enviroplan; a report of which appears in the Appendix III. The modeling studies examined two cases; a **base case** which contemplates Power Plant compliance through the use of the Citrate FCD System and Smelter operations consistent with the existing SIP; and the **"emission trading" case** in which low sulfur coal, in lieu of the FGD System, is incorporated at the Power Plant and calcine usage and sulfur restrictions are imposed at the Smelter. The modeling further assumed all non-St. Joe sources are operated at 1979 levels as defined in PEDS at controls equivalent to the SIP. Background levels from the H. E., Cramer study are also used to determine air basin compliance with the annual NAAQS. The model results show:

1. The "emission trading" case, as compared to the base case, improves air quality at 100% of the 448 receptors modeled.

2. The average immprovement in air quality across the 448 receptor grid is 0.46 ug/m^3 expressed as an annual average.

3. The "emissions trading" case causes 3 of 10 existing predicted violations of the annual NAAQS to be removed.

The "emission trading" program as herein described has a number of advantages to both St. Joe and the DER:

1. **Timeliness** - St. Joe can, and is prepared to, implement the "emission trading" compliance plan more rapidly than any alternate plan. As discussed previously, Power Plant compliance through the use of the Citrate FGD System will require at least two years of additional effort. The "emission trading" strategy is limited chiefly by the rate at which existing coal inventories can be rotated.

2. **Probability of Success** - St. Joe and the DER will both agree that performance of the Citrate FGD System to date has been poor. On the other hand, St. Joe's experience in zinc ore roasting and its current success in reducing calcine sulfur levels allows substantially more confidence in the success of this alternate strategy.

3. **Economics** - Air quality objectives are maintained and improved upon at a cost savings to St. Joe. From the DER's perspective, the "emission trading" strategy improves air quality beyond that which is predicted from compliance with the existing SIP and therefore occurs at no additional cost to the regulated community.

Summary

The St. Joe Resources Company proposal for achieving compliance with Pennsylvania SO_2 regulations encompasses a comprehensive program involving both power plant and smelting operations. The proposal satisfies the criteria of timeliness, technical feasibility and financial viability while serving to preserve the jobs of the nearly 500 workers employed at our Monaca Smelting Division.

The George F. Weaton Power Station is undoubtedly the chief asset of St. Joe Resources Company at its Monaca Smelting Division. Our continued electrical generating activity is the key to profitable zinc smelting operations, and the cornerstone of new business development being pursued by St. Joe Resources. Although proprietary, we are prepared to discuss with DER personnel the scope of our new business development projects and their potential for job creation in the Beaver Valley.

Finally, we recognize the above proposal will require the close cooperaion of the DER and St. Joe personnel to insure proper implementation. We are committed to providing the human and financial resources necessary for success of this project in achieving compliance with SO_2 regulations.

St. Joe Resources Company
Monaca, Pennsylvania

ATTACHMENT I

Chronology of Citrate Plant Events

Date	Event
November 14, 1979	First complete startup and operation.
November 16, 1979	Operational shutdown - Sulfur melter gasket leak flotation problem.
December 7, 1979	Startup aborted - plugged H_2 product line.
December 8, 1979	Startup aborted - waste heat boiler failure.
December 21, 1979	Completed waste heat boiler repairs.
December 26, 1979	Started training new Citrate employees.
January 3, 1980	Stopped circulation to change butterfly valve.
January 25, 1980	Startup aborted - product cooler/feed gas heater failed (a critical piping section of H_2S generator.
March 25, 1980	Repairs/revisions to H_2S generator complete. Commence warmup for startup.
March 27, 1980	Complete startup - seven hours later shutdown to repair vent pipe to boiler. Lining failed. Replaced with 6" PVC.
March 31, 1980	Commence startup.
April 8, 1980	Shutdown to repair leak in scrub water flange.
April 10-20, 1980	Dissolved sulfur in absorber packing.
April 17, 1980	Scrub water "T" failed (rubber lining in 18" pipe "T" absorbed through).
April 19, 1980	New 250 HP G.E. motor failed after 27 hours operation.
April 20, 1980	Broke drive shaft on No. 1 Rx dispenser Turbine (mixer).
April 28, 1980	Replaced rubber-lined "T" in scrub circuit, circulated scrub water and ran flue gas through absorber to dissolve more sulfur.
May 4, 1980	Lining failed in scrub pipe "T" (again!).
May 9, 1980	Scrub system back in service.
May 13, 1980	Orifice flange leak in scrub system.
May 15, 1980	Startup delayed because of another leak in scrub water orifice flange.
May 16, 1980	Startup - aborted with scrub water "T" failure.
May 27, 1980	New "T" installed in scrub system.
May 28, 1980	Startup.
May 29, 1980	Shutdown - leak in scrub water orifice flange (absorber pressure differential increasing!).

June 2, 1980	Startup commenced.
June 4, 1980	Shutdown - scrub pump bearing failure. Restart after moving good motor to good spare pump (six hour outage).
June 7, 1980	Shutdown - rubber lining failure in scrub pump suction piping.
June 8, 1980	Disassembled scrub pump to repair bearings. Reassembled No. 1 Rx agitator, repaired scrub pump piping, unpacked absorber, and replaced 3" steam feedpipe with 6".
July, 1980	Absorber packing removed. Work started on installation of 6" steam supply line to replace 4" main Citrate steam supply.
August, 1980	Repairs to Reactor #1202 flakeglass lining completed. Repairs completed on H_2S product gas pressure transmitter, quench pump pressure gauge, decanter pressure gauge, sulfur transfer pump pressure gauge, and seal for boiler feed water pump.
September 25, 1980	Startup commenced.
September 29, 1980	Shutdown due to buildup of relatively dry sulfur in slurry tank - contents emptied out.
October 11, 1980	Startup commenced.
October 15, 1980	Shutdown - repair scrub water piping.
October 20, 1980	Startup commenced.
October 24, 1980	Reactor #1202 agitator seal began leaking excessively - this reactor removed from service. Leak in manway cover on sulfur decanter repaired. Steam heater installed on scrubber makeup water line to conserve heat. Installed three isolation valves on condensate line from sulfur meters. Rupture disks replaced on West melter inlet line and decanter. Relief valve on West melter inlet line replaced. Sleeve for prescrubber circulating pump installed. Pump reassembled but not hooked up. Reactor #1202 shaft seal repaired. Also, lining repaired.
October 28, 1980	Shutdown due to leak in prescrubber circulating line.
November, 1980	#1202 Reactor agitator had broken shaft. Sent back to factory for repair. Repairs made to steam tracing lines. Insulation of new steam lines completed.
November 26, 1980	Startup commenced.

December 2, 1980	Glauber's salt crystallizer shutdown due to low salt removal rate and sulfate in solution diluted
December 3, 1980	Shutdown.
December 6, 1980	Startup commenced.
December 8, 1980	Power Plant switched operation to South boiler.
December 12, 1980	Demonstration Plant shutdown due to poor absorption due to dilute solution plus use of extra H_2S because of only one reactor being in service, plus leaky dump valve allowed some H_2S product to leak to flare. Also, additional leaks developed in scrubber recirculation system near inlet to Venturi scrubber. Discovered internal leaks in H_2S generator product coolers.
December, 1980	Five butterfly shutoff valves repaired - two reinstalled. Slurry pump disassembled for inspection and repair. Repairs made to decanter level control problem - caused by freezing of water purge lines.
January, 1981	Citrate solution cooler shutoff valves moved up to the main takeoff header to prevent solids accumulation on top of valves.
February, 1981	1" stainless steel line to crystallizer vibrating screen put into operation (replaced PVC line). Quench flowmeter for decanter quench and H_2S quench modified to include boiler feed water purge. Quench pump coupling replaced. Pressure gauge repaired.
February 20, 1981	Citrate solution recirculation started up. Section of vibrating screen replaced due to physical damage.
March 1, 1981	Melter shutdown.
March 5, 1981	Glauber's salt crystallizer started up. Spray-type absorber distributor installed. Broken shafts of two reactor agitators reinstalled. Spare neutralizer sump pump installed. Absorber inlet gas flowmeter element removed and found to be damaged. Sent to manufacturer for repair. 80 tons of sulfur recovered from Citrate circulation system.
April 14, 1981	Startup commenced.
April 20, 1981	Shutdown due to crack discovered in H_2S generator preconditioner vessel. Spare neutralizer pit pump repaired.

May, 1981	All four scrubber pumps removed for upgrading of shaft seals. Pressure switches installed to protect sulfur slurry pumps from over-pressure damage. Two butterfly valves in flare system replaced with 316 stainless steel jacketed plug valves. Two 20' sections of 12" polypropylene-lined pipe were replaced. H_2S knockout pot relief safety valve repaired and reset.
June, 1981	Fabrication of new preconditioner vessel completed. Rework of four scrubber pumps completed and pumps reassembled.
July, 1981	Larger seal water lines and pressure regulators installed on scrubber pumps. Prescrubber cooler repaired and reassembled. New transmitter installed on main feed gas flowmeter (annubar).
August, 1981	H_2S generator main reactor completed and installed. Refractory linings for preconditioner and main reactor completed and catalyst reinstalled in main reactor. H_2S generator pressure tested and heat-up of system begun. Relined piping from sulfur melter received and installed. Conductivity meter in sulfur melter condensate line installed. Two new H_2S generator product coolers were fabricated and installed.
September 16, 1981	Startup. Eight hours later shutdown due to faulty absorber level indicator.
September 17, 1981	Startup. Aborted because of plugged heat exchanger tubes.
September 28, 1981	Startup commenced. Shutdown 10/1: hole in sulfur feed pipe. Subsequent startup delayed by fouled sulfur in feed tank.
October 9, 1981	Startup.
October 13, 1981	Shutdown to replace Venturi nozzle. Slurry tank plugged with sulfur paste. Removed last of absorber packing.
October 23, 1981	Attempted startup. Found sulfur blockage in H_2S delivery lines. Repaired No. 2 Rx lining.
October 30, 1981	Startup.

November 2, 1981	Power Plant trip-out shutdown Citrate Process - restart cancelled by sulfur leak at H_2S generator.
November 6, 1981	Startup.
November 13, 1981	Shutdown H_2S distribution piping plugged with sulfur.
November 21, 1981	Startup. Ran for 10 days.
December 1, 1981	Shutdown. H_2S distribution piping plugged with sulfur. H_2S generator operation was erratic. Restart delayed by a series of problems; leak, freeze-ups and lining failures.
January 4, 1981	Startup.
January 6, 1982	Shutdown - plugged H_2S distribution lines.
February 2, 1982	Startup. H_2S generator operation stabilized. Flotation improvement noted.
February 9, 1982	Shutdown to repair agitator seal.
March 3, 1982	Startup.
March 10, 1982	Butterfly valve failure, made various repairs and revisions, including tank lining and expansion joint.
April 3, 1982	Startup.
May 7, 1982	No. 1 boiler outage.
May 20, 1982	Startup.
May 24, 1982	Plugged H_2S distribution, slurry tank filled, plugged absorber nozzle.
June 21, 1982	Startup.
June 23, 1982	H_2S plug-ups.
July 8, 1982	Startup.
July 15, 1982	Shutdown, H_2S leak into flare system.
July 30, 1982	Startup.
July 31, 1982	Shutdown.
August 4, 1982	Startup.
August 14, 1982	Shutdown, H_2S line plugged.
August 18-22, 1982	H_2S distribution plugged.

ST. JOE ALTERNATIVES - COSTS

Alternative	Cost: Capital ($M)	Cost: Operating ($M)	Effect on Smelter Before-Tax Profit ($M) [1,2]
1. Continue Citrate Plant Development			
with Stauffer	7	4.3	(1)
without Stauffer	6.5	4.3	(1)
2. Shut Down Power Plant			(6.8)
3. Bubble Smelter and Power Plant	0.6	2.5	1.5

[1] Effect represents difference from 1983 budget which included using low sulfur coal and operating Citrate Plant.

[2] Capital costs depreciated over ten years.

TIMETABLE FOR COMPLIANCE WITH SO_2 EMISSION REGULATIONS

BUBBLE SMELTER AND POWER PLANT

Milestone		By Date
Modify Roaster Feed System		Complete
Test Roaster Feed System		9-30-82
Solicit Bids for Lo S (.7) Coal		Complete
Sign Long-Term Contract for Lo S Coal		10-30-82
Initiate Switchover from Hi S to Lo S Coal		9-15-82
Engineering for:		
	Upgrading Coal Handling for Barge Unloading	10-1-82
	Power Plant Gas Conditioning	10-1-82
	Recycle of Roaster Dust	10-1-82
Start-up:	Upgrading Coal Handling for Barge Unloading	1-1-83
	Power Plant Gas Conditioning	12-1-82
	Recycle of Roaster Dust	12-1-82
Switchover from Hi S to Lo S Coal Complete		1-1-83
Power Plant Gas Conditioning Debugging Complete		2-1-83
Roaster Dust Recycle System Debugging Complete		3-1-83
Roaster Compliance Achieved		3-1-83

TIMETABLE FOR COMPLIANCE WITH SO_2 EMISSION REGULATIONS

CITRATE PLANT OPERATIONS

Phase I - Single Boiler

Milestone	By Date
Decision to Proceed with Stauffer Proposal	11-15-82
Agreement Signed with Stauffer - Start Project	11-30-82
Test H_2S Generator	5-30-83
H_2S Generation Proven	8-30-83
Civil and Demolition Work Complete	8-30-83
Major Equipment on Site	8-30-83
Tie-In, Hydrotest, Clean	9-30-83
Start-up Complete	12-30-83
Performance Test Complete	6-30-84

Phase II - Both Boilers

Engineering for Flue Gas Handling Equipment Expansion - Main Fan, Ducts, Venturi, Electrical	4-30-84
Order Major Equipment	6-30-84
Major Equipment On Site	12-30-84
Installation of Equipment Complete	3-30-85
Start-up and Performance Test Complete	6-30-85

APPENDIX B

ST. JOE POWER PLANT AND ZINC SMELTER

COMBINED SO_2 EMISSIONS COMPLIANCE PLAN

OCTOBER 1982

AN ALTERNATIVE EMISSION REDUCTION PLAN FOR THE POWER PLANT AND ZINC SMELTER SO_2 SOURCES AT THE MONACA, PA FACILITY OF THE ST. JOE RESOURCES COMPANY

INTRODUCTION

St. Joe Resources Company's proposal of an alternative emission reduction plan for SO_2 pursuant to 25 PA Code, Chapter 128 is a comprehensive program involving both Power Plant and Zinc Smelting SO_2 sources. The proposal is superior to other previously identified alternatives in technical feasibility, financial viability, and timeliness of implementation. While serving to preserve the jobs of nearly 500 employees at the Monaca Smelting Division, implementation of the proposal will also net an improvement in air quality for the Lower Beaver Valley Air Basin (LBVAB).

The George F. Weaton Power Station is undoubtedly the chief asset of the St. Joe Resources Company at its Monaca Smelting Division. Continued electrical generating activity is the key to profitable zinc smelting operations and is also the cornerstone of new business development for the Monaca site and attendant potential for job market growth in the Beaver Valley.

St. Joe is committed to providing the human and financial resources necessary for successful execution of this plan.

BASIC PROPOSAL ELEMENTS

The proposal involves "emission trading" between the St. Joe Zinc Smelter and Power Plant SO_2 sources -- a program of air emission compliance which is consistent with the EPA Policy Statement of April, 1982 (47 FR 15076 et. seq.). The basic program targets two of St. Joe's operations and consists of the following elements:

1. At the Sinter Plant, a reduction in SO_2 emissions amounting to approximately 2,540 tpy through imposition of more stringent limitations on zinc calcine usage and sulfur content than that imposed by the existing SIP.

2. At the Power Plant, a reduction in emissions from historic levels by the use of low-sulfur coal. At the decreased level of actual emissions from the Power Plant, emissions will be approximately 1,945 tpy in excess of present SIP requirements. Thus, the increase in allowed emissions is more than offset by the reduction in Sinter Plant emissions.

As will be described later, air modeling studies demonstrate such "emission trading" on the part of St. Joe will yield a net improvement in air quality for the LBVAB beyond that predicted if St. Joe were in compliance with existing SIP emission limitations for the Sinter and Power Plants.

The two subsections which immediately follow provide the basis and detail for the two components of St. Joe's "emission trading" proposal.

Sinter Plant Component

The current PA SIP limitation for zinc sintering operations is found at Section 123.24(b) of the Department's Title 25 Rules and Regulations. Specifically, this subsection states:

> "No person shall cause, suffer, or permit the emission into the outdoor atmosphere of sulfur oxides, from any zinc sintering operation, at any time in excess of the rate calculated by the following formula:
>
> $y = 0.54X$, where;
>
> x = calcine feed rate to the Sinter Plant (lbs/hr), and
>
> y = allowable sulfur oxide emissions (lbs/hr)."

For the present discussion, the above formula can be used to express the allowable sulfur concentration in calcine by multiplying the formula coeffient by the molecular weight ratio of sulfur to sulfur dioxide (i.e. 0.5). The mathematics lead to an allowable sulfur concentration in calcine of 2.7%.

The preceedings from which this regulation emerged focused on maximizing sulfur capture from the major zinc bearing feed source to the Smelter; namely, zinc concentrate, the sulfide base product of zinc mining and milling. While specifically fashioned as a sulfur emission restriction on zinc sintering, the effective result of the regulation is to maximize the sulfur elimination and capture from the roasting of the zinc concentrate prior to further processing of the roasted product -- calcine -- in the zinc sintering operation. The regulation established a limitation on each pound of roasted calcine used to produce an equivalent unit of product zinc. Based upon historical plant operating data, 1.40 tons of calcine have been consumed per ton of product zinc equivalent produced. The current SIP therefore allows St. Joe to emit SO_2 from its sintering operations up to 0.076 tons of SO_2 per ton of zinc equivalent produced.*

In the Sinter Plant portion of the "emission trading" proposal, St. Joe will accomplish a 2,540 tpy reduction in SO_2 emissions by limiting the allowable quantity of zinc calcine used to produce an equivalent unit of zinc product from the 1.40 level identified above to 1.06. Simultaneously, St. Joe will further limit the sulfur content of calcine to a level of 2.3% sulfur. Both actions represent more stringent limitations for St. Joe's sintering operation than those limitations imposed by the existing SIP. This program will require St. Joe to install various additional equipment at its roasting facility and to rely on other sources of zinc-bearing feeds to make up for the loss of calcine zinc units imposed by this program.

Power Plant Component

SO_2 emissions from St. Joe's George F. Weaton Power Plant are currently regulated by 25 PA Code § 123.22 (b) (2) and the Consent Order and Agreement between St. Joe and the DER. Specifically, Section 123.22 (b) (2) limits emissions from combustion sources to:

> "(2) The rate determined by the following formula:
>
> $A = 1.7E^{-.14}$, where;
>
> A = allowable emissions in pounds per million Btu of heat input, and
>
> E = heat input to the combustion unit in millions of Btu's per hour, when E is equal to or greater than 50 but less than 2,000."

*

$$\frac{1.40}{\text{tons calcine per ton zinc equivalent produced}} \times \frac{0.054}{\text{tons } SO_2 \text{ per ton calcine}} = \frac{0.076}{\text{tons } SO_2 \text{ per ton zinc equivalent produced}}$$

On 19 September 1978, St. Joe and the DER entered into a Consent Order and Agreement which specified a planned sequence of reductions in allowable SO_2 emissions during the construction, debugging, and demonstration phases of the Citrate Flue Gas Desulfurization Project -- a jointly funded demonstration project with the U.S. Bureau of Mines, the U.S. EPA, and St. Joe. A key element in this Consent Order and Agreement was the treatment of St. Joe's two boilers at its G. F. Weaton Power Station as a single source in judging emission compliance. Specifically, ultimate SO_2 emission compliance of combined Power Plant combustion gases was to be limited to 0.68 pounds SO_2 per million Btu's heat input when the combined heat input to the two boilers was less than or equal to 700 million Btu per hour. At heat inputs in excess of 700 million Btu per hour, Power Plant compliance would be judged by the sliding scale formula identified in Section 123.22(d)(2) as stated above.

The history of the Citrate project has been described to the Department on a number of occasions, the most recent being at our 9 September 1982 meeting with the Pittsburgh Regional Staff. Documents provided to the Department at that meeting contain a detailed discussion of the technological problems and economic impacts associated with continuation of the Citrate project. In summary, the citrate process is not capable of sustained operation at the present time, and it is believed that it would take until mid-1985 to make modifications to the project which have been suggested by engineering evaluation. Even if those modifications were made, there is no assurance that they would be sufficient to produce a system capable of compliance with existing SO_2 emissions regulations.

In lieu of the Citrate Flue Gas Desulfurization System, St. Joe proposes to utilize low-sulfur coal to reduce actual emissions from the Power Plant and to utilize the reduction in SO_2 emissions achieved in the sintering operations to offset the increase in SO_2 emissions from the Power Plant over those allowed under present regulations. To maintain Power Plant SO_2 emissions at as low a level as possible, St. Joe has exhaustively searched for low sulfur coal supplies that can be economically utilized at our Monaca facility. Through St. Joe's A.T. Massey coal subsidiary, St. Joe has found such low sulfur coals which we expect will average 0.71% sulfur. We are presently purchasing such coals on a spot basis in order to test their handling and processing characteristics at the G. F. Weaton

Power Station. St. Joe proposes to begin exclusive use of such coals as soon as an orderly transition in existing coal inventories can be achieved. This transition is expected to be completed on or about 1 January 1983. During the process of inventory rotation, St. Joe expects to fire its Power Station with coals exhibiting an average sulfur content of 2.0%.

One downside consideration to use of low sulfur coal is the potential for degradation of electrostatic precipitator performance. During the current trial burns of low sulfur coal, we are monitoring the impact of this coal on electrostatic precipitator performance in order to define whether such problems exist and how St. Joe may mitigate this issue. We are prepared to install such additional equipment as may be necessary to maintain TSP emissions within regulated limits.

AIR MODELING STUDIES

Efficacy of "emission trading" program herein described is fully supported by air modeling studies. St. Joe contracted with Enviroplan Inc. of West Orange, New Jersey to conduct a modeling demonstration for the "emission trading" program at St. Joe facilities. Enviroplan's study report entitled Air Quality Modeling Demonstration for a Sulfur Dioxide Emissions Trade at the St. Joe Minerals Corporation Zinc Smelting Facility was previously submitted to DER on 9 September 1982, and is herein incorporated by reference. This report fully describes the base operating conditions St. Joe contemplates for its Smelter and Power Plant, along with St. Joe's best estimate of SO_2 emissions from these sources. St. Joe/Enviroplan chose the LONGZ model to predict annual average SO_2 concentrations at the LBVAB receptors. This model is the same as that used by DER in the regulation development study for the LBVAB that is currently in progress. Annual average modeling was conducted for the "emission trading" demonstration because previous studies upon which DER bases their current regulation development shows that the annual ambient air quality standard is controlling for the LBVAB.

The modeling studies examined two cases: a base case which contemplates Power Plant compliance through the use of the Citrate FGD System and Smelter operations consistent with the existing SIP, and the "emission trading" case in which low sulfur coal is used at the Power Plant and calcine usage and sulfur restrictions are imposed at the Smelter. The modeling studies further assumed all non-St. Joe sources are operated at 1979 levels as defined in PEDS at controls equivalent to the SIP. Having predicted the air quality impacts associated with the non-St. Joe sources and the two cases associated with St. Joe's "emission trading" proposal, background levels from the H. E. Cramer study were added to the receptor predicted values to determine air basin compliance with the annual NAAQS. The modeling results show:

1. The "emission trading" case, as compared to the base case, causes an improvement in predicted air quality at 100% of the 448 modeled receptors.

2. The average predicted improvement in air quality across the 448 receptor grid is 0.46 ug/m^3 expressed as an annual average.

3. The "emissions trading" case causes three of ten existing predicted violations of the annual NAAQS to be removed.

The net effect, therefore, of St. Joe's "emission trading" proposal is to improve air quality in the LBVAB and to provide for continuing progress toward achieving the NAAQS for this air basin.

REGULATORY STANDARDS

In order for an environmental regulatory program to be effective it must also be readily enforceable. Reasonable compliance limits and methods for their monitoring must be available for the enforcement strategy to be effective. To this end, St. Joe views this proposal as establishing new regulatory limits at both its sintering and power generation facilities. These limits would take the form of new permit restrictions as follows:

1. At the sinter facilities, calcine usage would be limited to 95,000 annual tons and further restricted to an average sulfur content of 2.3%.

2. At the G. F. Weaton Power Plant, the coal burned would be restricted to an average sulfur concentration of 0.71% at an annual average gross generation capacity of 100 megawatts.

SUMMARY

The "emission trading" proposal as herein described has a number of advantages to both St. Joe and the DER:

1. Timeliness of implementation -- St. Joe can, and is prepared to, implement the proposed "emission trading" compliance plan more rapidly than any alternate plan. As previously discussed with the Department, Power Plant compliance through the use of the Citrate FGD System will require at least two years of additional effort. The "emission trading" strategy can be implemented by about 1 March 1983.

2. Probability of success -- St. Joe and the DER will both agree that performance of the Citrate FGD System to date has been poor. Furthermore, its chance of future success is questionable even given significant infusion of capital funding. On the other hand, St. Joe's experience in zinc ore roasting, and its current success in reducing calcine sulfur levels, allow substantially more confidence in the success of this alternate strategy.

3. Economics -- The "emission trading" proposal provides not merely for attainment of the ambient air quality predicted under the existing SIP, but for improvement at a substantial cost savings to St. Joe. Thus, this alternative emission reduction plan actually enhances air quality at a much reduced cost to the regulated community.

ER-AQ-16: REV. 3/79

Page ___ of ___

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF AIR QUALITY CONTROL
Application for Plan Approval to Construct, Modify or Reactivate an Air Contamination Source and/or Air Cleaning Device and for a Permit to Operate

Read the instruction carefully before completing this form. Submit duplicate copies.

Section A Identity and Location of Air Contamination Source

1A. Application is being made for:

- ☐ Construction of New Source/Operating Permit
- ☐ Reactivation of a Source/Operating Permit
- ☒ Modification of Existing Source/Operating Permit
- ☐ Installation of Air Cleaning Device/Operating Permit
- ☐ Amendment to a Previous Application Previous Application No. __-___-___

OFFICIAL USE ONLY

Application No. __-___-___
Plant Code ______ Unit ID ______
Date Received ______
Reviewed by ______

Potential Emissions (TPY)
PM ___ SO_2 ___ VOC ___
NOX ___ CO ___ Other ___

Actual Emissions (TPY)
PM ___ SO_2 ___ VOC ___
NOX ___ CO ___ Other ___

Change in Actual Emissions (+ or −)
PM ___ SO_2 ___ VOC ___
NOX ___ CO ___ Other ___

1B. Type of source Primary Zinc Smelter
Sinter Machine Windbox Off-gases

1C. Plant in which source is located ☐ NEW ☒ EXISTING

1D. If source is new, does it replace another source ☐ YES ☐ NO (describe source replaced) N/A

1E. Expected date of completion N/A

2A. Owner of source: St. Joe Resources Company

2B. Employer I.D. No. (Federal IRS No.) B - 1255630

3A. Owners designation of source and/or plant if any: Sintering Machines

3B. Location of source (Street address or Route No.): Route 18 — Political Subdivision (Township, etc.): Potter Township — County: Beaver County

3C. Mailing address (Street or P.O. Box, City, Zip Code): P.O. Box A Monaca, PA 15061

3D. Telephone No. (412) 774-1020

4A. Person to contact regarding this Application (name and title): James D. Reese

4B. Mailing address (Street of P.O. Box, City, State, Zip Code): P.O. Box A Monaca, PA 15061

4C. Telephone No. (412) 774-1020 X546

5. Official signing application must be an agent of the Company having primary responsibilities for operation of the facility to which this application applies. Although he may not have participated in the design of the facility he should be responsible for approval of the design.

AFFIDAVIT

I Robert L. Sunderman, being duly sworn according to law depose and say that I am the official having primary responsibility for the design and operation of the facilities to which this application applies and that the information included in the foregoing application is true to the best of my knowledge, information and belief.

Sworn to and subscribed before me this 18 day of October, 1982

George F. Saunders
Notary Public

GEORGE F. SAUNDERS, Notary Public
CENTER TWP., BEAVER COUNTY
MY COMMISSION EXPIRES MAR. 24, 1983
Member, Pennsylvania Association of Notaries

Robert L. Sunderman
Signature

Division Manager
Title

SECTION B
GENERAL SOURCE INFORMATION

Unit	1. SOURCE A. Type Source (Describe)	B. Manufacturer of Source	C. Model No.	D. Rated Capacity (Specify units)	E. Type of Materials Processed	2. NORMAL PROCESS OPERATING SCHEDULE A. Amount Processed/yr. (Specify units)	B. Average hr/day	C. Total hr/yr	D. % Thruput/Quarter 1st	2nd	3rd	4th
1	Three Down Draft Sinter Machines	St. Joe Minerals	'	125,600 TPY	Calcine	95,000 TPY	19	6925	27	27.2	18.3	27.5
2												
3												
4												
5												
6												
7												
8												
9												
10												

3. ESTIMATED FUEL USAGE (Specify units) A. Used in Unit	B. Type Fuel	C. Average Hourly Rate	D. Maximum Hourly Rate	E. Percent Sulfur	F. Percent Ash	G. Heating Value	4. ANNUAL FUEL USAGE A. Annual Amounts	B. Average hr/day	C. Total hr/yr	D. % Thruput/Quarter 1st	2nd	3rd	4th
	CO Gas	18,000cfh		0	0	260 Btu/cf	1.25×10^8 Ft^3	19	6925				
	Coke Breeze	.939TPH	2 TPH	0.6%	27.6	10047 Btu/#	6500 TPY	19	6925				
	Major Fuel Value is from metallic content of secondaries and recycle materials.												

5. IMPORTANT. Attach flow diagram of process giving all (gaseous, liquid, and solid) flow rates (attach separate sheet). Also list raw materials charged to process equipment and the amounts charged (tons/hour, etc.) at rated capacity (give maximum, minimum and average charges describing fully expected variations in production rates). Indicate (on diagram) all points where contaminants are controlled (location of water sprays, hoods or other pickup points, etc.).

3

Section 5 — Source Information Continued

6. Describe fully the facilities provided to monitor and record all operating conditions that may affect the emission of air contaminants. Provide detailed information to show that the facilities provided are adequate.

The collector pressure drop and inlet temperature will be monitored continuously. If the pressure drop increases beyond a value at which the collector can operate effectively or if a "dirty" stack indicates defective bags, immediate maintenance will be scheduled to correct the problem. Sulfur in calcine will be monitored to insure sulfur input to the Sinter Plant remains below 0.023# sulfur/# calcine.

7. Describe modifications to process equipment in detail.

The Sinter Plant equipment will require no physical changes. The Plant will be operated using nonsulfur-bearing feed materials so that calcine feed will be limited to 95,000 tpy. Total SO_2 emissions will be further reduced by reducing the quantity of sulfur in calcine through Roaster modifications. These modifications include lowering the feed screws and recycling the higher sulfur particulate collected from the off-gases back into the Roaster.

8. Type and method of disposal of all waste materials generated by this process

Collected particulate is re-entered into process. See Attachment "B".

Is a Solid Waste Disposal Permit Needed? ☐ Yes ☒ No

9. Briefly describe the method of handling the waste water from this process and its associated air pollution control equipment

All process water is treated by the smelter's process treatment system.

Is a Water Quality Management Permit needed? ☐ Yes ☒ No

10. Describe the economic or social benefits to be derived from the construction described in this application. This requirement applies only to new or modified sources which will increase actual emission rates of any regulated air contaminant in excess of 50 tons per year.

N/A

11. Attach any and all additional information necessary to adequately describe the process equipment and to perform a thorough evaluation of the extent and nature of its emissions.

None

Section C — Control Equipment

1. POTENTIAL PROCESS EMISSIONS (OUTLET FROM PROCESS, BEFORE ANY CONTROL EQUIPMENT)

A. Outlet particulate loading (lbs/hr or gr/SCF Dry)

670 lb/hr

B. Specific gravity of particulate (not bulk density)

5.5 approximate

C. Attach outlet particle size distribution information

Attachment "E"

D. Specify gaseous contaminants and concentration

	Contaminant	Concentration		VOC	Contaminants	Concentration	
(1)	SOx	509 ppm (Vol.)	1260 lbs/hr	(4)		ppm (Vol.)	lbs/hr
(2)	NOx	ppm (Vol.)	lbs/hr	(5)		ppm (Vol.)	lbs/hr
(3)	CO	ppm (Vol.)	lbs/hr	(6)		ppm (Vol.)	lbs/hr

2. GAS CONDITIONER (IF APPLICABLE)

Not applicable

A. Water quenching ☐ Yes ☐ No

Water injection rate ________ GPM

B. Radiation and convection cooling ☐ Yes ☐ No

C. Air dilution ☐ Yes ☐ No ________ CFM

D. Gas conditioner outlet

________ ACFM @ ________ °F

3. SETTLING CHAMBERS (IF APPLICABLE)

Existing Equipment Original Permit #04-308-023

A. Manufacturer

St. Joe Minerals Corporation — 2 units - modified conditioning chambers from old Cottrell units

B. Volume of gas handied: maximun 167,500 (each) ACFM @ 250 °F		C. Gas velocity: 210 FPM maximum
D. Length of expansion chamber (ft): 50'		E. Width of expansion chamber (ft): 32'
F. Height of expansion chamber (ft): 25'		G. Number of trays: None
H. Inlet concentration (lbs/hr or gr/SCF Dry): 1670#/hour	I. Outlet concentration (lbs/hr or gr/SCF Dry): 1600#/hour	J. Overall efficiency (%): 4%
K. Water injection: ☐ Yes ☒ No	L. Water injection rate (GPM)	M. Attach particle size Efficiency curve: Not available

Section C – Control Equipment, Continued

6. FABRIC COLLECTORS (IF APPLICABLE)
Existing equipment. Original Permit #04-308-023.

- A. Manufacturer: Fuller Company
- B. Model No.: ☐ Pressurized design ☒ Suction design
- C. Air to cloth ratio (actual conditions): Maximum 2.67 to 1
- D. Type of Fabric: Material Acrylic; Weight 10 oz/sq yd; Thickness ___ in; ☐ Felted ☒ Woven ☐ Felted-Woven
- E. Fabric Permeability (clean) @ 1/2" w.g. △ P: 60 CFM/ sq. ft.
- F. Pressure drop across collector (in. wg.): 8" wg. max.
- G. Volume of gases handled (ACFM): maximum 314,000
- H. Inlet gas temperature (°F): 205°F
- I. Design inlet volume (ACFM): 279,000 ACFM
- J. Inlet concentration (lbs/hr or gr/SCF Dry): 1600#/hour
- K. Outlet concentration (lbs/hr or gr/SCF Dry): <0.02 gr/SCF
- L. Overall efficiency (%): >97.3% minimum
- M. No. of compartments: 16
- N. No. of bags per compartment: 140
- O. Can each compartment be isolated for repairs and/or bag replacement? Yes
- P. Bag dimensions: Length 25 ft; Diameter (or width if envelope type bag) 8"
- Q. If multiple walled bags provide detail: N/A
- R. Method of bag cleaning: ☒ Shaker ☒ Reverse compartmental pulse ☐ Reverse bag pulse ☐ Reverse jet (blow ring) ☐ Reverse flow ☐ Other ___
- S. Cleaning initiated by: ☒ Timer ☐ Pressure drop ___ psig
  Frequency if timer actuated: Once every 10 minutes for 20 seconds.
- T. Shaker cleaning: ☒ Mechanical ☐ Manual ☒ One compartment shaken at a time ☐ All compartments shaken at once
- U. Reverse flow cleaning air supply: Source Centrifugal Fan; CFM 9200
- V. Others: Flushing pressure (psig) ___
- W. Are temperature controls provided? (Describe in detail)
  Gas stream temperature controls are provided to bleed in cooling air for over-temperature protection or heated make-up air to maintain proper inlet temperatures.
- X. Is baghouse insulated: Yes
- Y. Maximum temperature bags can withstand (°F): 275°F
- Z. Dew point at maximum Moisture (°F): 205°F

Section C — Control Equipment, Continued

11. COSTS

N/A No new control equipment is being installed.

A. Cost of all control equipment including installation costs (List individual controls separately)

B. Estimated annual operating costs of control equipment only

12. Describe modifications to control equipment in detail

None

13. Describe in detail the method of dust removal from the air cleaning device and methods of controlling fugitive emissions from dust removal, handling and disposal.

A screw flight in each compartment hopper discharges through a rotary airlock to a collect screw conveyor. The collected material is re-entered into the process circuit as described in Attachment "A".

14. Does air cleaning device employ hopper heaters, hopper vibrators or hopper level detectors? If so describe.

No

15. Attach manufacturer's performance guarantees and/or warrantees for each of the major components of the control system (or complete system).

The manufacturer's guarantee was included with our original (9/29/76) Plan Approval (Permit #04-308-023).

16. Attach the maintenance schedule for the control equipment and any part of the process equipment that if in disrepair would increase the air contaminant emissions. Periodic maintenance reports are to be submitted to the Department.

The particulate control equipment will be inspected at least weekly. The responsible Operating Department has personnel assigned to the maintenance of this equipment.

17. Attach any and all additional information necessary to thoroughly evaluate the control equipment.

Section D — Flue And Air Contaminant Emission Information

1. STACK AND EXHAUSTER

A. Exhauster static pressure 19 in w.g. 1228 HP @ 1180 RPM

B. Stack height above grade (ft)	C. Stack diameter (ft) or outlet duct area (sq ft)	D. Weather cap
400'	Bottom 25' 6"	
Grade elevation (ft) 787'	Top 18' 0"	☐ Yes ☒ No

E. Indicate on an attached sheet the location of sampling ports with respect to exhaust fans, breeching, etc. Give all necessary dimensions.

The 400' stack has two sampling ports at 90° to one another at the 200' level for testing the overall performance of the system by source sampling in a manner consistent with EPA procedures. Sampling facilities are installed after the collector so that the performance of the unit may be checked.

F. Can the control equipment be bypassed? (If Yes, explain) ☐ Yes ☒ No

2. ATMOSPHERIC EMISSIONS

A. Particulate matter emissions (lbs/hr or gr/SCF Dry)

<0.02 grains/SDCF

B. Gaseous contaminant emissions Sinter Plant

	Contaminants	Concentration			VOC Contaminants	Concentration	
(1)	SO_x	509 ppm (Vol.)	1260 lbs/hr	(4)		ppm (Vol.)	lbs/hr
(2)	NO_x	ppm (Vol.)	lbs/hr	(5)		ppm (Vol.)	lbs/hr
(3)	CO	ppm (Vol.)	lbs/hr	(6)		ppm (Vol.)	lbs/hr

C. Outlet volume of exhaust gases From 400' stack (includes 19,000 SCFM from #7 Acid Unit)

269,000 SCFM

@ 189 °F

______ % Moisture

Section E — Miscellaneous Information

1. Describe fully facilities to monitor and record the emission of air contaminants. Provide detailed information to show that the facilities provided are adequate. Include cost and maintenance information. Periodic maintenance reports are to be submitted to the Department.

- ☐ Opacity monitor
- ☐ SO_x monitor
- ☐ Other ___________________

If checked provide manufacturer name, model no. and pertinent technical specifications

Primary monitoring of the performance of the sinter machines particulate control facility will be by visual observation. Since a "clear" stack discharge is expected, a "dirty" stack will indicate equipment performance problems. Specific tests may then be run to determine the cause of the problem and define the required corrective action. SO_2 control will be monitored by a monthly average of a daily analysis of sulfur in calcine.

2. Attach Air Pollution Episode Strategy (if applicable)

3. Briefly describe the general nature of the area in which the source is lcoated.

The source is located in the Lower Beaver Valley Air Basin.

4. Attach calculations and any additional information necessary to thoroughly evaluate compliance with all the applicable requirements of Article III of the Rules and Regulations of the Department of Environmental Resources and those requirements promulgated by the Administrator of the United States Environmental Protection Agency pursuant to the provisions of the Clean Air Act.

5. List all attachments made to this Application.

ATTACHMENT AA

List of Attachments to Permit Application

ATTACHMENT A

ST. JOE RESOURCES COMPANY

Zinc Smelting Process Description

The St. Joe Resources Company, Smelting Division, operates a primary zinc smelter in Potter Township, Beaver County, Pennsylvania. The smelter is located adjacent to the Ohio River, about 30 miles downstream from Pittsburgh. Employing the unique St. Joe-developed electrothermic zinc furnace, the smelter produces zinc metal and zinc oxide and by-product sulfuric acid. Zinc sulfide concentrate, produced at captive mines in upper New York state, provides the major source of zinc feed to the smelter. Smelter zinc input is further supplemented through use of purchased and in-plant generated secondary materials.

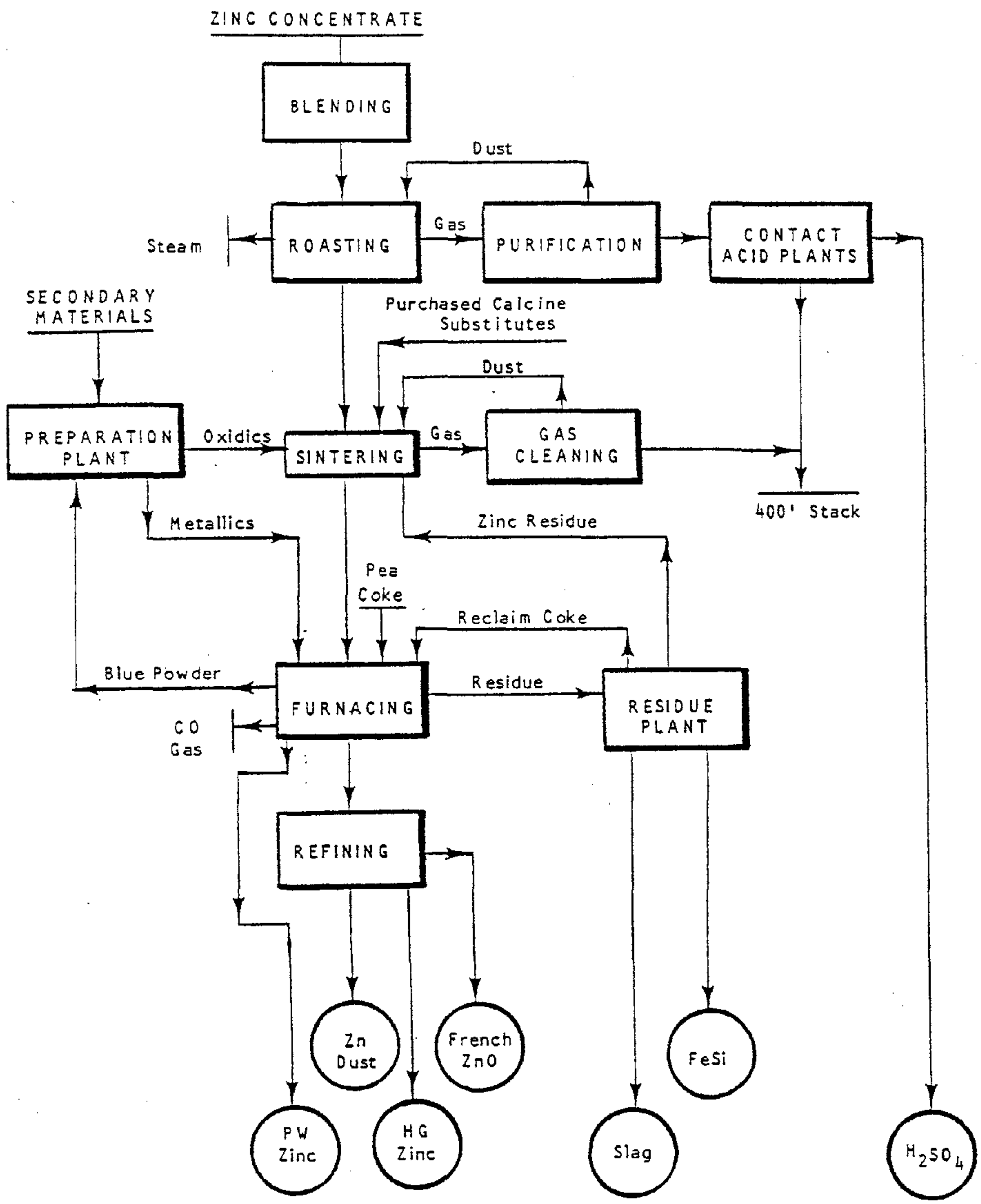
Zinc concentrates are received by rail and unloaded by overhead crane in a covered receiving and storage building. Concentrates are blended as necessary and then dried in a rotary dryer; off-gases from which are treated by a venturi scrubber before release to the atmosphere.

Dry concentrates are fed to a single fluid bed roaster which converts the zinc sulfide concentrates to a crude form of zinc oxide, called calcine. The calcine is collected and ground in a ball mill prior to transfer to the sintering circuit. During the roasting operation, the sulfur contained in the concentrate is oxidized to sulfur dioxide, which is further processed for sulfuric acid recovery in a conventional contact sulfuric acid plant.

Calcine from roasting, along with other purchased calcine substitutes (when commercially and economically available), are mixed with sand, returned sinter fines, coke breeze, furnace residue, and secondary zinc-bearing materials and pelletized prior to sintering. The purpose of sintering is to produce a hard porous mass that is suitable for feed to the electrothermic furnaces and also to remove certain impurities. Three Dwight-Lloyd down-draft sinter machines are currently employed. The product sinter is crushed and sized prior to transport to the furnace circuit. Sinter fines produced in the crushing and sizing operation are recirculated to the feed circuit of the sinter machine. Off-gases from the three sinter machines are directed to a common baghouse. Collected baghouse dust is recycled to the sinter mix.

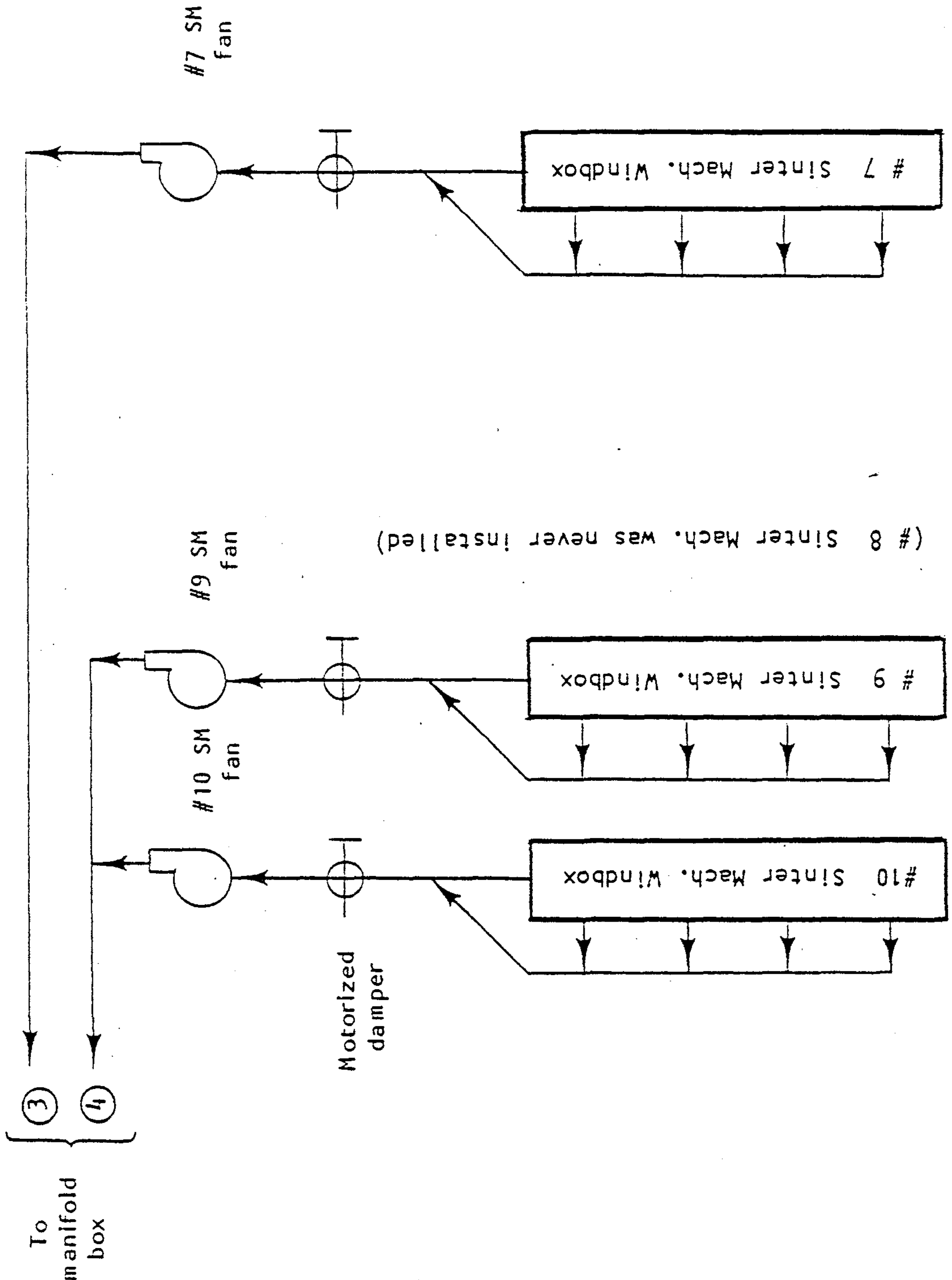
The reduction circuit (smelting) consists of three St. Joe-designed electrothermic furnaces. Sinter, coke, and purchased or recycled secondary materials are charged to the top of the furnace, which resembles a vertical cylinder. Electricity is passed through the furnace charge. The charge is of sufficient resistance to develop the heat required for reduction of zinc oxide to zinc vapor. Zinc vapors are drawn through a molten zinc bath contained in a U-shaped condenser. The condensed product is either cast for sale or conveyed in the molten state to the refinery plant, where it is further processed to high-purity zinc oxide or zinc metal. Gases venting from the upleg of the furnace condenser are cleaned by high-velocity impinger scrubbers. The clean gas is primarily carbon monoxide and used as smelter fuel. Uncondensed zinc, which is scrubbed from the condenser gases, is recovered in a sedimentation system and recycled to the sintering operation. Furnace residue is discharged on a rotary table at the base of the furnace and is further treated for recovery of coke and unsmelted zinc, both of which are returned to the smelting circuit.

A portion of the molten zinc produced in the furnace circuit is fed to the zinc refinery for production of high-purity zinc and zinc oxide. The refinery employs refractory distillation columns, which yield a high-purity zinc vapor. This vapor is then either condensed to metal or oxidized in a combustion chamber to zinc oxide.



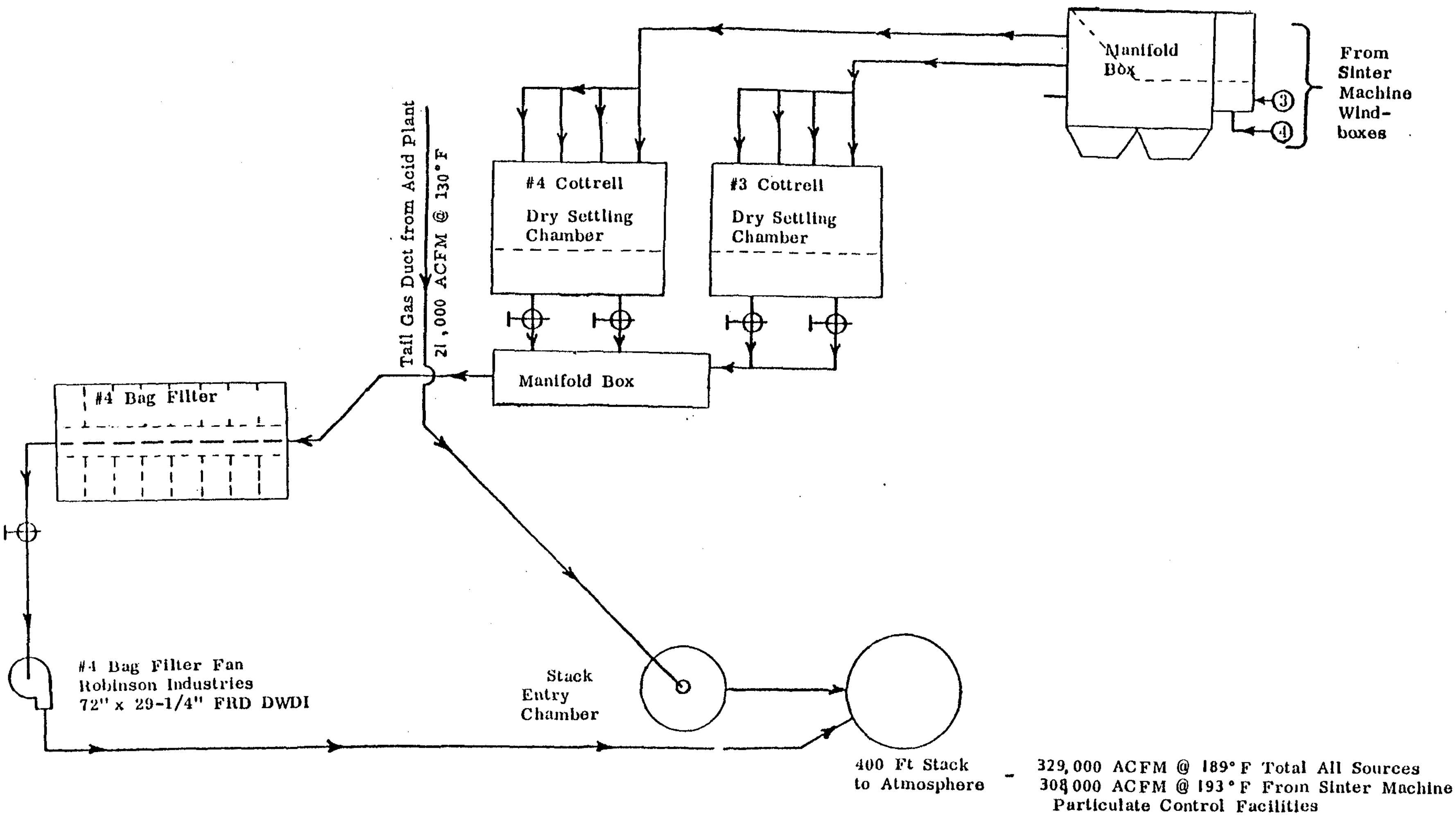
Attachment B

Josephtown Smelter Flow Sheet



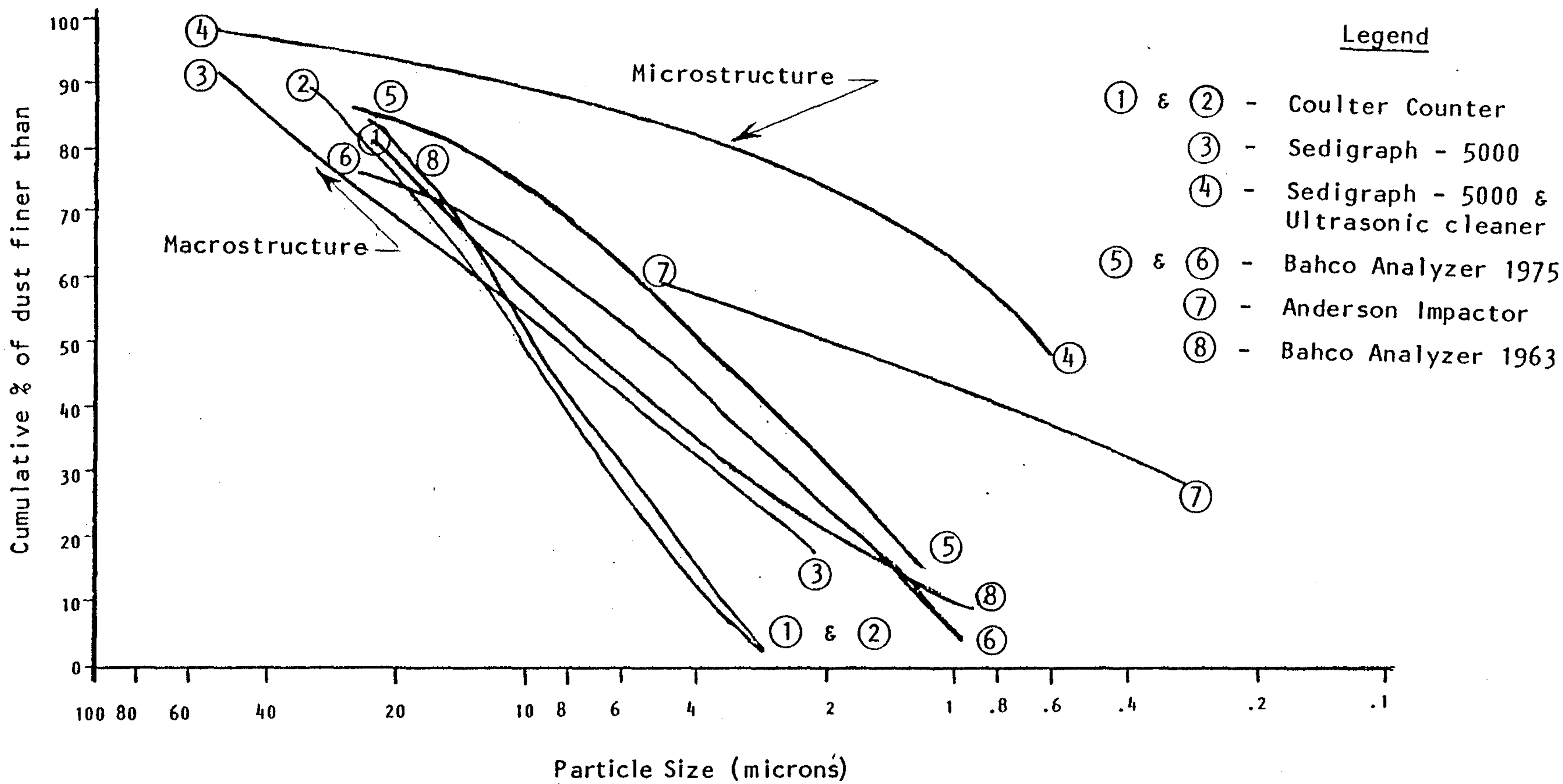
Attachment C

Sinter Machine Off-Gas Control Equipment



Attachment D

Sinter Plant Sinter Machine Pollution Control Facility



Attachment E

Figure 1: Size Distribution of Spray Chamber Inlet Dust

No. SS-72FRD-0001

INDUSTRIES INC.

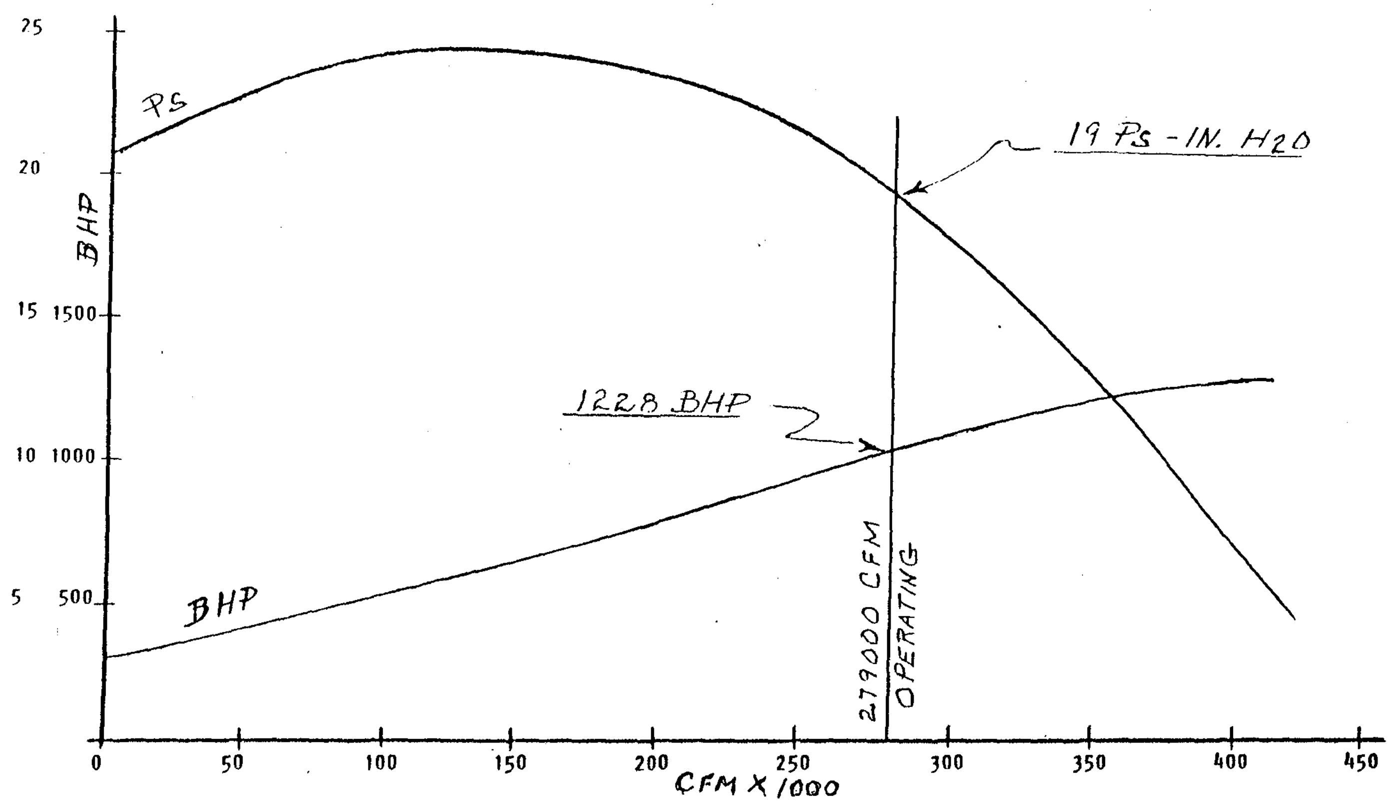
ZELIENOPLE, PA. 16063

QUO#: PC-178-76

For: ST. JOE MINERALS CO.

Type: FRD Size: 72" x 29 1/4" .0581 Den. Lbs. per Cu. Ft. By: H

Speed: 1180 RPM Temp: 205°F Date: 6/14/76



Attachment F

No. 4 Bag Filter Fan Curve

ST.JOE
MINERALS CORPORATION
7733 FORSYTH BOULEVARD
CLAYTON, MISSOURI 63105

JOHN A. WRIGHT
EXECUTIVE VICE PRESIDENT
314 726-9505

December 2, 1981

TO WHOM IT MAY CONCERN:

This letter will serve as authorization for R. L. Sunderman, Division Manager of the Zinc Smelting Division of St. Joe Resources Company, a division of St. Joe Minerals Corporation, to sign on behalf of said Zinc Smelting Division of St. Joe Resources Company all applications, reports and other instruments pertaining to or in connection with any air, water or other environmental permit required by any governmental agency.

Sincerely,

John A. Wright

JAW:mms

ER-AQ-16: REV. 3/79

Page ____ of ____

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF AIR QUALITY CONTROL
Application for Plan Approval to Construct,
Modify or Reactivate an Air Contamination Source
and/or Air Cleaning Device and for a Permit to Operate

Read the instruction carefully before completing this form. Submit duplicate copies.

Section A Identity and Location of Air Contamination Source

1A. Application is being made for:

- ☐ Construction of New Source/Operating Permit
- ☐ Reactivation of a Source/Operating Permit
- ☒ Modification of Existing Source/Operating Permit
- ☐ Installation of Air Cleaning Device/Operating Permit
- ☐ Amendment to a Previous Application Previous Application No. __-___-___

1B. Type of source: Coal Fired Electric Power Generating Station

1C. Plant in which source is located: ☐ NEW ☒ EXISTING

OFFICIAL USE ONLY

Application No. __-___-___
Plant Code ________ Unit ID ________
Date Received ________
Reviewed by ________

Potential Emissions (TPY)
PM ____ SO_2 ____ VOC ____
NOX ____ CO ____ Other ____

Actual Emissions (TPY)
PM ____ SO_2 ____ VOC ____
NOX ____ CO ____ Other ____

Change in Actual Emissions (+ or –)
PM ____ SO_2 ____ VOC ____
NOX ____ CO ____ Other ____

1D. If source is new, does it replace another source ☐ YES ☐ NO (describe source replaced) N/A

1E. Expected date of completion

2A. Owner of source: St. Joe Resources Company

2B. Employer I.D. No. (Federal IRS No.): B_-1255630

3A. Owners designation of source and/or plant if any: G. F. Weaton Power Station

3B. Location of source (Street address or Route No.): Route 18 — Political Subdivision (Township, etc.): Potter — County: Beaver

3C. Mailing address (Street or P.O. Box, City, Zip Code): P.O. Box A Monaca, PA 15061

3D. Telephone No.: (412) 774-1020

4A. Person to contact regarding this Application (name and title): James D. Reese

4B. Mailing address (Street of P.O. Box, City, State, Zip Code): P.O. Box A Monaca, PA 15061

4C. Telephone No.: (412) 774-1020 X546

5. Official signing application must be an agent of the Company having primary responsibilities for operation of the facility to which this application applies. Although he may not have participated in the design of the facility he should be responsible for approval of the design.

AFFIDAVIT

I Robert L. Sunderman, being duly sworn according to law depose and say that I am the official having primary responsibility for the design and operation of the facilities to which this application applies and that the information included in the foregoing application is true to the best of my knowledge, information and belief.

Sworn to and subscribed before me this 18 day of October 1982.

George J. Saunders
Notary Public — GEORGE F. SAUNDERS, Notary Public, CENTER TWP., BEAVER COUNTY, MY COMMISSION EXPIRES [illegible]

Robert L. Sunderman
Signature

Division Manager
Title

ER AO 14 (3/75)

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Section B 2 Combustion Units Information

1. COMBUSTION UNITS

A. Manufacturer	B. Model No.	C. No. of units
Combustion Engineering	Contract CE-10256	2
D. Rated heat input (BTU/hr.)	E. Peak heat input (BTU/hr.)	F. Use
525 x 10^6 Btu/hr (each)	638 x 10^6 Btu/hr (each)	Power Generation

G. Method of firing: Pulverized coal

2. FUEL REQUIREMENTS

TYPE	QUANTITY HOURLY	QUANTITY ANNUALLY	SULFUR	% ASH (WEIGHT)	BTU CONTENT
OIL NUMBER 2	27.2 GPH @ 60°F	75 x10^3 Gal.	0.5 % by wt.		135,000 BTU/Gal. & 7.21 lbs./Gal. @ 60°F
NATURAL GAS	SCFH	x10^6 SCF	gr/100 SCF		BTU/SCF
GAS (OTHER)	SCFH	x10^6SCF	gr/100 SCF		BTU/SCF
COAL	42 TPH	368,550 Tons	0.71 % by wt.	10-12%	12,500 BTU/lb.
OTHER					

3. COMBUSTION AIDS, CONTROLS, AND MONITORS

[ ] A. Overfire jets: None	Type	Number	Height above grate
[ ] B. Draft controls: Yes	Type: Hagan Diaphragm Regulator - Modulate ID Fan Louvres		
[ ] C. Oil preheat: None	Temperature (°F): N/A		
[ ] D. Soot cleaning: Copes-Vulcan 18 Wall Deslaggers, 5 Long Retractibles	Method: Steam (625 PSI 750°F)	Frequency: 1-6 Blows/Day Depending on Location	
[ ] E. Stack Sprays: None			
[ ] F. Opacity monitoring device: None	Type	Method	Cost
[ ] G. Sulfur oxides monitoring device: None	Type	Method	Cost
[ ] H. Nitrogen oxides monitoring device: None	Type	Method	Cost
[ ] I. Fuel metering and/or recording devices: Integrating Scale	Type: Toledo	Method: Daily Coal wt. Totalizer	Cost
[ ] J. Atomization interlocking device: None	Type	Method	Cost
[ ] K. Collected flyash re-entrainment preventative device: None	Type		
[ ] L. Modulating Controls	[ ] Step	[ ] Automatic	

4. [ ] Flyash reinjection — Describe operation

None

5. Describe method of supplying make-up air to the furnace room

None (Boilers Outside)

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PAGE 3 OF

Section B.2 Combustion Units Information

6. OPERATING SCHEDULE

24 hours/day 7 days/week 52 weeks/year

7. SEASONAL PERIODS (MONTHS)

Operating using primary fuel Coal

year round to

Operating using secondary fuel

to

Non-operating

to

8. If heat input is in excess of 250×10^6 BTU/hr., describe fully the facilities provided to record the following: rate of fuel burned; heating value, sulfur and ash content of fuels; smoke, sulfur oxides and nitrogen oxides emissions; and if electric generating plant, the average electrical output and the minimum and maximum hourly generation rate.

See Attachment "B"

9. Describe modifications to boiler in detail

None

10. Type and method of disposal of all waste materials generated by this boiler
(Is a Solid Waste Disposal Permit needed? ☐ Yes ☒ No)

Fly ash is disposed of on St. Joe property. Application for the expansion of our fly ash landfill has been made. (Fly Ash Landfill ID 300102).

11. Briefly describe the method of handling the waste water from this boiler and its associated air pollution control equipment
(Is a Water Quality Management Permit needed? ☒ Yes ☐ No)

Waste water from our fly ash handling system following retention in settling lagoons is discharged into Poor House Run. The settling lagoons and waste water discharge are operated in accord with NPDES Permit PA 0002208.

12. Attach any and all additional information necessary to perform a thorough evaluation of this boiler.

Details of existing secondary electrostatic precipitators were included in our plan approval application dated March 6, 1973 (Permit #04-306-004).

Section D   Flue And Air Contaminant Emission Information

1. STACK AND EXHAUSTER

A. Exhauster (attach fan curves) 885 HP @ 1250 RPM

B. Stack height (ft)	C. Stack diameter (ft)	D. Weather cap
275'	11' ID	☐ Yes ☒ No

E. Indicate on an attached sheet the location of sampling ports with respect to exhaust fans, breeching, etc. Give all necessary dimensions.

SO_2 levels in pounds per million Btu will continue to be determined through a monthly average of daily composite coal samples.

F. Can the control equipment be bypassed? (If Yes, explain) ☐ Yes ☒ No

The secondary electrostatic precipitators can be bypassed. Isolating dampers are provided so that gases can be diverted directly to the stack and the secondary precipitator isolated for emergency maintenance if required.

2. ATMOSPHERIC EMISSIONS

A. Particulate matter emissions (lbs/hr or gr/SCF Dry)

See Attachment "C"

B. Gaseous contaminant emissions

	Contaminants	Concentration		
(1)	SO_2	433 ppm (Vol.)	1194	lbs/hr
(2)		ppm (Vol.)		lbs/hr
(3)		ppm (Vol.)		lbs/hr

C. Outlet volume of exhaust gases

398,800 CFM

@ 300 °F

Unknown % Moisture

Section E Miscellaneous Information

1. Describe fully facilities to monitor and record the emission of air contaminants. Provide detailed information to show that the facilities provided are adequate. Include cost and maintenance information. Periodic maintenance reports are to be submitted to the Department.

See Attachment "B"

2. Attach Air Pollution Episode Strategy (if applicable)

Episode Strategy has been submitted and approved (Sources 034 and 035 Approval No. B-007).

3. Briefly describe the general nature of the area in which the source is located.

The G. F. Weaton Station is located in the Beaver Valley Air Basin.

4. Attach calculations and any additional information necessary to thoroughly evaluate compliance with all the applicable requirements of Article III of the Rules and Regulations of the Department of Environmental Resources and those requirements promulgated by the Administrator of the United States Environmental Protection Agency pursuant to the provisions of the Clean Air Act.

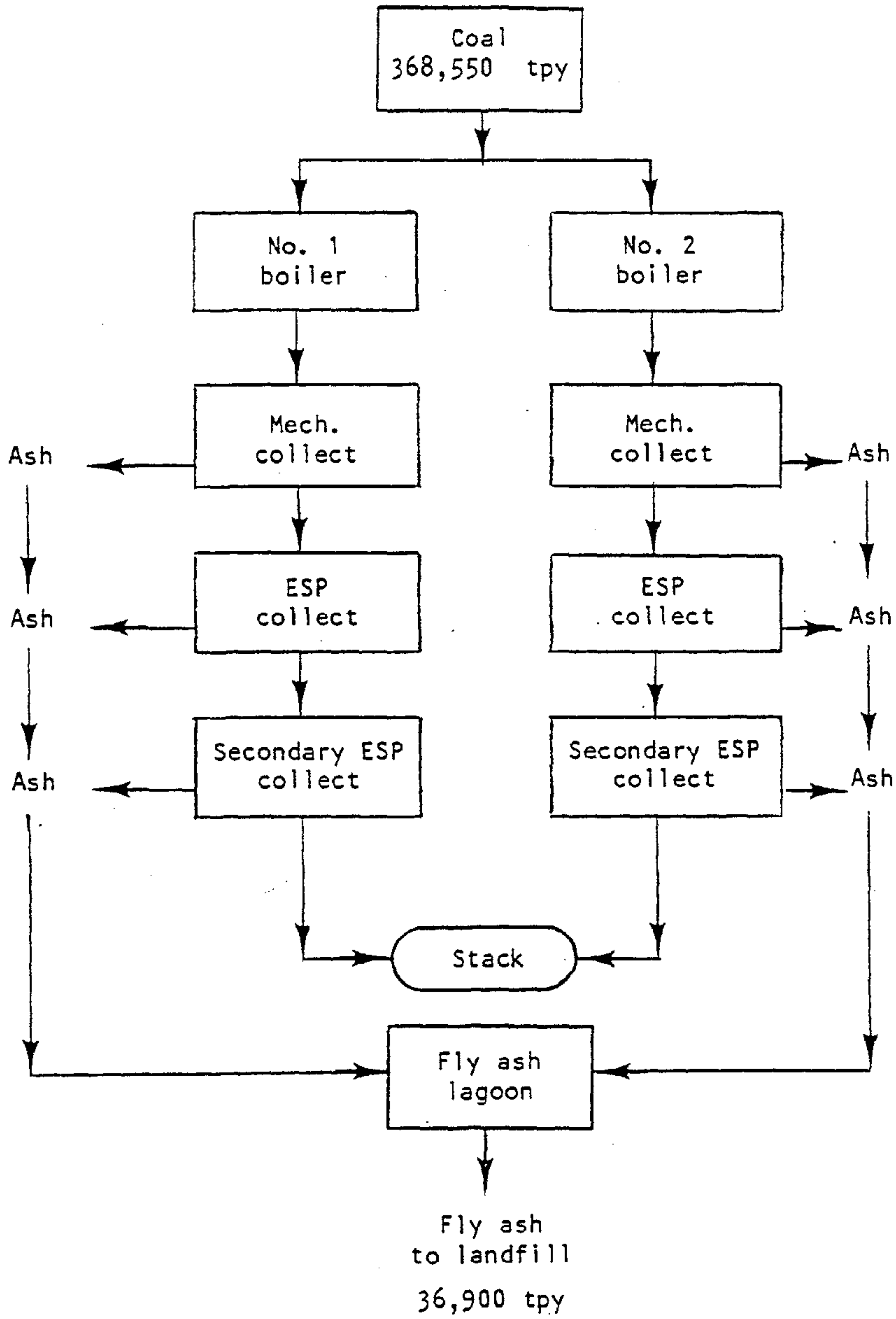
The attached Enviroplan report of September 1982 shows the proposed bubble provides a net decrease of 593 tons per year SO_2 with no new violations of the annual NAAQS.

5. List all attachments made to this Application.

Attachment A	Typical Material Flow Diagram
Attachment B	Monitoring and Recording Facilities
Attachment C	Outlet Particulate Loading

ATTACHMENT A

Typical Material Flow Diagram



ATTACHMENT B

G. F. Weaton Station

Monitoring and Recording Facilities

The G. F. Weaton Station is a fully integrated pulverized coal fired electrical generating plant. When commissioned in 1958, the station was, and is, equipped with the most comprehensive and sophisticated controls available. Using the central control room concept, the station operators have virtually all operating parameters instrumented and, in many cases, recorded at the control room. Additionally, the control room operators have the ease of performing all critical operational adjustments from the control room. There are no critical operating parameters that lack the benefit of monitoring and recording instrumentation at the Station.

Daily composite coal samples are taken for determination of sulfur and ash content and heating values. A monthly report is sent to the DER giving the daily average pounds of SO_2 per million Btu's of heat input.

Precipitator power (DC amps, inlet and outlet; primary side precipitator current; AC amps, inlet and outlet) are checked and if necessary adjusted four times per shift. Precipitator power readings are recorded one time per shift. Precipitator power outage is alarmed (horn and light in control room). Precipitators wire and plate rappers and vibrators frequency and intensity are checked two times per shift. Precipitator rectifier tubes are inspected one time per shift. Flue gas conditioning system is checked two times per shift. For all inspections, any malfunction is recorded in the operators log so that corrective action will be taken as quickly as possible.

ATTACHMENT C

Outlet Particulate Loading

The particulate matter emissions from the secondary electrostatic precipitators has in the past met the 0.020 grains/SDCF performance guarantee. The guarantee, however, was based upon a minimum coal sulfur content of 1.65%. Operation of the units on 0.71% sulfur coal may require gas conditioning to meet the 113.4 lb/hour when operating at 100 MW gross average capacity.

APPENDIX C

CITRATE PROCESS DEMONSTRATION PLANT

OPERATING PERIOD SUMMARY

Appendix C

Citrate Demonstration Plant Operating Period Summary,

Year	Operating Period	Operating Dates	Operating Hours	Operations Summary	Reason for Plant Shutdown
1979	1	11/14/11/16	42	Initial plant operation and no significant operating data obtained. Variety of operating problems occurred, including slurry tank fill-up with sulfur.	Sulfur slurry tank overflow because of weir tank level adjustment problems.
1980	2	4/1-4/8	127	Operation of Citrate Unit with boiler power output of 20 to 30 MW. SO_2 absorption averaged 60%. Problems in floating sulfur to obtain clear citrate solution.	Leak in scrubber circulation line at the orifice meter flange.
	3	5/27-5/29	22	Sulfur flotation was poor. Difficulties with H_2S generator operation—insufficient steam and problems with sulfur feed to generator.	Scrubber solution leak at orifice flange.

Citrate Demonstration Plant Operating Period Summary, continued

Year	Operating Period	Operating Dates	Operating Hours	Operations Summary	Reason for Plant Shutdown
1980	4	6/2-6/7	103	Flotation improved over previous run. Lean solution fairly clear. Absorber pressure drop high at 9" and pressure building up. Sulfur forming in the absorber. SO_2 absorption averaged 66%.	Leak in scrubber pump suction piping.
	5	9/25-9/29	86	Initial SO_2 absorption of 80% decreased rapidly to 50%. Flotation improved during the course of the run. Encountered some problems in sulfur melting.	Build-up of sulfur in the slurry tank.
	6	10/11-10/15	94	Initial sulfur carryover to absorber but flotation improved during the run. Initial SO_2 absorption of 94% decreased to 84% as absorber distributor became partially plugged.	Leak in prescrubber rubber lined piping.

Citrate Demonstration Plant Operating Period Summary, continued

Year	Operating Period	Operating Dates	Operating Hours	Operations Summary	Reason for Plant Shutdown
1980	7	10/20-10/28	185	Initial SO_2 absorption of 87% decreased to 70%-75% by end of run. Removal of a reactor in the middle of the run because of an agitator seal leak contributed to the lower final absorption. Higher H_2S generator reactor temperature resulted in good operation of the unit.	Leak in prescrubber rubber lined piping.
	8	11/26-12/3	152	Initial SO_2 absorption of 84% decreased with time.	Methane flow for H_2S generator stopped — sulfur backup in control valve.
	9	12/6-12/12	133	SO_2 absorption continued its drop from previous run levels to initial value of 65%. When one of the reactors was removed from service because of agitator failure, SO_2 absorption dropped to 51%. Additional decrease of SO_2 absorption to 40%-45% occurred as plugging of absorber by sulfur progressed.	Leaks in H_2S generator product cooler, leaks in scrubber solution line to venture, low sulfur availability, poor final SO_2 absorption.

Citrate Demonstration Plant Operating Period Summary, continued

Year	Operating Period	Operating Dates	Operating Hours	Operations Summary	Reason for Plant Shutdown
1981	10	4/15-4/18	76	Average SO_2 absorption—91%. Sulfur flotation initially poor but improved with time. Sulfur melting satisfactory.	Failure of scrubber pump packing and leak in H_2S generator preconditioner.
	11	9/16	10	Operating period too short for achievement of good operating conditions.	Failure of absorber level control.
	12	9/28-9/29	25	H_2S product quality poor because H_2S generator did not reach proper operating temperature. Average SO_2 absorption was 76%.	Leak in jacketed sulfur line to the H_2S generator sulfur preheater.
	13	10/9-10/13	90	Average SO_2 absorption—73% Plugging of absorber packing.) Sulfur flotation improved throughout the run.	High pressure drop in absorber. Poor SO_2 absorption. Venturi nozzle corroded away. Leak in the scrubber cooler.

Citrate Demonstration Plant Operating Period Summary, continued

Year	Operating Period	Operating Dates	Operating Hours	Operations Summary	Reason for Plant Shutdown
1981	14	11/2	8	Short operating period—no significant data.	Power failure, sulfur leak into condensate.
	15	11/6-11/13	158	SO_2 absorption low. Sulfur flotation unsatisfactory.	Plugging in H_2S gas line and plugging in H_2S knockout drum with sulfur.
	16	11/20-12/1	237	Sulfur absorption low (Average for Periods 15 & 16 of less than 50%.) Sulfur flotation unsatisfactory.	Plugging of H_2S line to regeneration reactors with sulfur.
	17	12/12	1	Very short operating period—no significant data.	H_2S leak because of failed H_2S quench tee lining.
	18	12/26	3	Very short operating period—no significant data.	Sulfur flow to H_2S generator superheater was stopped by blockage.
1982	19	1/4-1/6	47	Sulfur flotation much improved. SO_2 absorption ranged from 38% to 43%.	Blockage in H_2S line to reactors.

Citrate Demonstration Plant Operating Period Summary, continued

Year	Operating Period	Operating Dates	Operating Hours	Operations Summary	Reason for Plant Shutdown
1982	20	2/2-2/9	158	SO_2 absorption averaged less than 30%. Low citrate solution flow.	Leaking H_2S generator reactor agitator seal. Plugging of inlet to H_2S knockout drum.
	21	3/2-3/10	166	Sulfur flotation improved throughput the run. SO_2 absorption ranged from 41% to 67%.	Leak because of broken valve to lean citrate solution cooler.
	22	4/30-5/7	177	SO_2 absorption ranged from 45% to 60%. Sulfur flotation not as good as in previous run. Sulfur accumulated in citrate storage tank because of failed agitator.	Scheduled maintenance on Power Plant boiler.
	23	5/20-5/24	103	SO_2 absorption ranged from 50% to 65%. Sulfur flotation was poor.	Caked sulfur build-up in the slurry tank.
	24	5/28	6	Very short operating period—no significant data.	Pressure build-up in the H_2S line to the regeneration reactors.
	25	6/20-6/23	55	SO_2 absorption ranged from 45% to 60%. Sulfur build-up in citrate solution storage tank.	Plugging problems in H_2S line to the regeneration reactors.

Citrate Demonstration Plant Operating Period Summary, continued

Year	Operating Period	Operating Dates	Operating Hours	Operations Summary	Reason for Plant Shutdown
1982	26	7/8-7/15	178	SO_2 absorption ranged from 43% to 60%. Sulfur flotation was poor, varying from 2% to 60%. Sulfur continued to accumulate in citrate solution storage tank.	Bad rupture disc in the H_2S knockout drum.
	27	7/30-7/31	9	Very short operating period—no significant data.	Plugging of H_2S gas manifold.
	28	8/4-8/13	224	SO_2 absorption moderate—50% to 70%. Sulfur accumulated in citrate solution storage tank. Sulfur flotation remained poor.	Sulfur plugging of H_2S knockout drum inlet line.
	29	8/18-8/22	94	Short downtime resulted in resumption of similar performance. SO_2 absorption ranged from 55% to 65%. Sulfur accumulated in citrate solution storage tank and sulfur flotation remained poor.	Planned shutdown to repair weir operator and revise H_2S quench tee.
	30	9/2-9/5	88	Sulfur flotation was poor. SO_2 absorption continued at moderate levels of 55%—65.	Failure of scrubber level control and quench plum discharge valve.
	31	9/9-9/11	49		Failure of flotation tank agitator blade.

APPENDIX D

CITRATE PROCESS DEMONSTRATION PLANT

SULFUR DIOXIDE ABSORPTION SUMMARY

Appendix D

Citrate Demonstration Plant Sulfur Dioxide Absorption Summary

Year	Operating Period	Operating Dates	SO_2 Absorption Percent	Absorber Design	Operating Deficiencies
1980	2	4/5	67	Tray Distributor, 20' Packing	
		4/6	57		
		4/7	55		
	4	6/3	66	Tray Distributor, 20' Packing	
		6/5	60		
	5	9/25	61	Tray Distributor, 2' Packing	
		9/26	53		
		9/27	54		
		9/28	51		
	6	10/11	92	Tray Distributor, 2' Packing	
		10/12	90		
		10/13	84		
		10/14	86		
	7	10/20	88	Tray Distributor, 2' Packing	
		10/21	88		
		10/22	87		
		10/24	88		
		10/25	75	Tray Distributor, 2' Packing	Only one reactor in service.
		10/26	72		
		10/27	75		

Citrate Demonstration Plant Sulfur Dioxide Absorption Summary, continued

Year	Operating Period	Operating Dates	SO_2 Absorption Percent	Absorber Design	Operating Deficiencies
1980	8	11/27	81	Tray Distributor, 2' Packing	Low strength citrate solution.
		11/28	71		
		11/29	74		
		11/30	76		
		12/1	77		
		12/2	71		
	9	12/8	58	Tray Distributor, 2' Packing	Low strength citrate solution, Only one reactor in service.
		12/9	51		
		12/10	46		
		12/11	44		
1981	10	4/15-4/18	91	Spray Distributor, 2' Packing	
	13	10/9	70	Spray Distributor, 2' Packing	
		10/10	80		
		10/11	69		
		10/12	73		
		10/13	75		
	16	11/22	45	Spray Distributor, No Packing	
		11/23	49		
		11/24	56		
		11/25	45		
		11/26	53		
		11/27	49		
		11/28	42		
		11/29	46		
		11/30	69		
1982	19	1/4	42	Spray Distributor, No Packing	
		1/5	43		
		1/6	38		

Citrate Demonstration Plant Sulfur Dioxide Absorption Summary, continued

Year	Operating Period	Operating Dates	SO_2 Absorption Percent	Absorber Design	Operating Deficiencies
1982	20	2/2	29	Spray Distributor, No Packing	Low citrate solution flow.
		2/3	26		
		2/4	30		
		2/5	27		
		2/6	22		
		2/7	23		
		2/8	29		
	21	3/3	41	Spray Distributor, No Packing	
		3/4	51		
		3/5	67		
		3/6	66		
		3/7	66		
		3/8	60		
		3/9	56		
	22	4/30	56	Spray Distributor, No Packing	
		5/1	59		
		5/2	58		
		5/3	50		
		5/4	43		
		5/5	51		
	23	5/20	48	Spray Distributor, No Packing	
		5/21	53		
		5/22	64		
		5/23	63		
		5/24	65		
	24	5/28	40	Spray Distributor, No Packing	
	25	6/20	60	Spray Distributor, No Packing	
		6/21	51		
		6/22	45		

Citrate Demonstration Plant Sulfur Dioxide Absorption Summary, continued

Year	Operating Period	Operating Dates	SO_2 Absorption Percent	Absorber Design	Operating Deficiencies
1982	26	7/8	43	Spray Distributor, No Packing	
		7/9	48		
		7/10	57		
		7/11	53		
		7/12	48		
		7/13	58		
		7/14	60		
		7/15	60		
	28	8/4	66	Spray Distributor, No Packing	
		8/5	68		
		8/6	71		
		8/7	68		
		8/8	60		
		8/9	55		
		8/10	60		
		8/11	51		
		8/12	51		
		8/13	48		
	29	8/18	55	Spray Distributor, No Packing	
		8/19	59		
		8/20	64		
		8/21	66		
	30	9/2	63	Spray Distributor, No Packing	
		9/3	57		
		9/4	62		
		9/5	64		

APPENDIX E

CITRATE PROCESS DEMONSTRATION PLANT

DOWNTIME SUMMARY

Appendix E

Citrate Demonstration Plant Downtime Summary

Year	Downtime Period	Downtime Dates	Downtime Days	Downtime Summary
1979-80	1	11/16-3/31	135	1. Repaired two H_2S generator heat exchangers. 2. Replaced failed Teflon-lined piping. 3. Repaired rubber-lined pumps. 4. Corrected cold-weather problems of pumps, agitators, process control instruments, etc. 5. Replaced and trained two-thirds of original operators (Resulted from December 1979 zinc smelter shutdown).
	2	4/8-5/26	49	1. Attempt to unplug absorber packing by removing sulfur with circulating citrate solution. 2. Repaired scrubber recirculating line leaks.
	3	5/29-6/1	4	1. Repaired orifice flange leak in pre-scrub system.
	4	6/7-9/24	109	1. Continued cleaning of absorber packing by solution circulation—was unsuccessful. 2. Removed and washed absorber packing. Replaced only two-foot layer of packing. 3. Replaced 3"-4" steam supply line with a 6" line. 4. Repaired damaged flake glass lining in the absorber. 5. Installed steam line to heat rich citrate solution to improve flotation.
	5	9/29-10/10	12	1. Removed sulfur accumulation from slurry tank. 2. Clean absorber distributor.
	6	10/15-10/19	5	1. Repaired scrubber piping leak.

Citrate Demonstration Plant Downtime Summary, continued

Year	Downtime Period	Downtime Dates	Downtime Days	Downtime Summary
1980	7	10/29-11/25	29	1. Cleaned liquid distributor in absorber. 2. Installed a sleeve on prescrubber circulating pump. 3. Made a cold shutdown of H_2S generator for steam drum inspection.
	8	12/3-12/5	3	1. Conducted miscellaneous minor maintenance.
1980-81	9	12/12-4/15	105	1. Drained lines to prevent freezing. 2. Designed, fabricated, and installed a citrate solution spray system for the absorber. 3. Repaired agitators, scrubber piping, and butterfly valves. 4. Replaced the corroded venturi nozzle.
1981	10	4/18-9/15	138	1. Fabricated and installed a new refractory-lined carbon steel H_2S generator preconditioner. 2. Fabricated and installed a new refractory-lined carbon steel H_2S generator main reactor vessel. 3. Fabricated and installed replacement H_2S generator product coolers. 4. Revised scrubber pump packing glands and reworked pumps. 5. Relined sulfur melter piping. 6. Repaired the flakeglass lining in citrate reactor.
	11	9/16-9/27	12	1. Replaced the level control instrument in the absorber.
	12	9/29-10/8	10	1. Cleaned sulfur feed tank and sulfur transfer lines. 2. Reconditioned the H_2S generator sulfur feed pump.
	13	10/13-11/1	19	1. Removed the final two-foot layer of absorber packing. 2. Replaced the venturi scrubber nozzle.

Citrate Demonstration Plant Downtime Summary, continued

Year	Downtime Period	Downtime Dates	Downtime Days	Downtime Summary
1981	14	11/2-11/5	4	1. Repaired the leak at the sulfur steam inlet to the superheater.
	15	11/13-11/19	7	1. Cleaned the H_2S knockout drum. 2. Cleaned the absorber spray nozzles and demister.
	16	12/1-12/11	11	1. Cleaned sulfur from H_2S system.
	17	12/12-12/25	14	1. Fabricated and installed a new steam jacketed quench tee. 2. Installed strainers in citrate solution circulating lines. 3. Installed baffles in sulfur flotation tank.
1981-82	18	12/26-1/3	9	1. Filtered the circulating sulfur. 2. Cleaned the sulfur filter.
1982	19	1/6-1/21	16	1. Replaced cold weather problems, e.g., thawed solutions in frozen lines, etc.
	20	2/9-3/11	21	1. Cleaned spray nozzles in absorber. 2. Repaired flakeglas lining in H_2S knockout drum. 3. Replaced venturi nozzle. 4. Repaired the reactor agitator seal in the H_2S generator. 5. Cleaned sulfur from the H_2S generator system.
	21	3/10-4/29	51	1. Relined No. 2 reactor tank and downcomer with flakeglas. 2. Relocated an inlet nozzle in the flotation tank. 3. Cleaned sulfur from the H_2S knockout drum. 4. Handled a series of miscellaneous maintenance problems.
	22	5/7-5/19	13	1. Repair citrate tank agitator. 2. Crystallized Glauber Salts from citrate solution.

Citrate Demonstration Plant Downtime Summary, continued

Year	Downtime Period	Downtime Dates	Downtime Days	Downtime Summary
1982	23	5/24-5/27	4	1. Removed portions of sulfur build-up from slurry tank.
	24	5/28-6/19	23	1. Repaired flakeglas linings in reactor tanks. 2. Made temporary repairs to the venturi spray nozzle. 3. Balanced the flue gas fan.
	25	6/23-7/7	15	1. Removed sulfur build-up from the citrate storage tank. 2. Installed larger agitator blades in the citrate storage tank. 3. Repaired the citrate storage tank lining.
	26	7/15-7/29	15	1. Cleaned and relined the H_2S knockout drum. 2. Installed a new venturi scrubber nozzle. 3. Repaired the acid-brick lining in the venturi scrubber.
	27	7/31-8/3	4	1. Repaired the H_2S gas manifold.
	28	8/13-8/17	5	1. Cleaned the H_2S knockout drum. 2. Cleaned the spray nozzles in the absorber.
	29	8/22-9/1	9	1. Revised the H_2S quench tee. 2. Cleaned the H_2S knockout drum.
	30	9/5-9/8	4	1. Repaired critical level instrumentation. 2. Replaced quench pump discharge valve. 3. Replaced gaskets in H_2S distribution piping.
	31	9/11-present		1. Prepaired Citrate Unit equipment for extended shutdown.

JMC/jfv

APPENDIX F

ST. JOE PRELIMINARY ESTIMATE OF COSTS

FOR CITRATE DEMONSTRATION PLANT MODIFICATIONS

FEBRUARY 1982

APPENDIX F

CITRATE PLANT DEVELOPMENT PROJECTS

ORDER OF MAGNITUDE COSTS; CLASSIFICATION; TECHNICAL SUPPORT REQUIRED

Class 1 Jobs - 100% Probability of Need

	Tech (M-D)	Cost ($)
I. Gas Cooling		
1. Venturi Nozzle	8	$ 25,000
2. New Duct Expansion Joint	-	9,000
3. Duct Damper Repair	2	5,000
4. Repair/Replace Fly Ash Line	12	40,000
II. SO_2 Absorption		
1. Mist Eliminator		$ 2,000
2. Liner Repair	3	5,000
3. Spray Modifications		6,000
4. Repack Absorber - Full Pack with New Saddles	12	100,000
5. Valve Replacement Program	-	18,000
6. Cooler and Heat Exchanger Modification and Repair		
a. Wash water cooler	27	100,000
b. Lean solution		
III. Sulfur Recovery		
1. Sulfur Melter Development/Repair	24	$ 75,000
2. Flotation System Improvement	18	70,000
3. Sulfur Filter Replacement - Add Neutralization	32	140,000
IV. Sulfur Precipitation		
1. Reactors Seal Spare and Improvement	7	$ 22,000
2. Prevent H_2S Quench System Back Flow	3	8,000
3. Reline Reactor and K-O Drum Vessels	5	75,000
V. H_2S Generation		
1. Sulfur Feed System	7	$ 25,000
2. H_2S Product Cooler Development	33	117,000
3. Cold Weather Protection	4	12,000
4. Dual Fuel System for Superheater	10	35,000
VI. Sodium Sulfate System	-	-
VII. Off-Sites/Utilities		
1. Separate Condensate System for Melder	20	$ 90,000
Total Class 1	227	$979,000

Class 2 Jobs - 75% Probability of Need

	Tech (M-D)	Cost ($)
I. Gas Cooling		
1. Ca SO_4 Pit Agitator	6	$ 20,000
II. SO_2 Absorption		
III. Sulfur Recovery		
IV. Sulfur Precipitation		
1. Alter Quench System K-O Drum	10	25,000
V. H_2S Generation		
1. Sulfur Feed Tank Modifications	3	9,000
VI. Off-Sites/Utilities		
1. Separate Condensate System II	20	90,000
2. Weatherproofing Buildings throughout Plant	20	60,000
3. Drain Systems - Citrate Underground	50	150,000
VII. Sodium Sulfate System		
1. General Process Improvement	10	40,000
Total Class 2	119	$394,000

Class 3 Jobs - 50% Probability of Need

	Tech (M-D)	Cost ($)
I. Gas Cooling		
II. SO_2 Absorption		
1. Replace plastic lined pipe for Citrate	60	$325,000
III. Sulfur Recovery		
1. Additional sulfur decanter	50	150,000
IV. Sulfur Precipitation		
1. Install Sparger System	8	23,000
2. Add Second Flotation Tank in Series	40	165,000
3. Quench Solution Filtration	32	95,000
V. H_2S Generation		
1. H_2S Generation Heat Exchanger	27	100,000
VI. Off-Sites/Utilities/General		
1. Instrumentation Improvements	40	100,000
Total Class 3	257	$958,000

APPENDIX F (Continued)

Class 4 Jobs - 25% Probability of Need

	Tech (M-D)	Cost ($)
I. Gas Cooling	-	-
II. SO_2 Absorption		
1. Citrate Storage Tank 100,000 gal.	30	$100,000
III. Sulfur Recovery		
1. Sulfur Storage System Repair	30	150,000
IV. Sulfur Precipitation		
1. Add Filter to Flotation Circuit	500	2,000,000
V. H_2S Generation	-	-
VI. Off-Sites/Utilities/General		
1. Instrument Air System	4	10,000
2. Supplemental Cooling Water System	3	7,000
3. $CaSO_4$ Pump Replacement	5	20,000
4. Instrumentation Improvements	50	100,000
Class 4 Totals	622	$2,387,000
Grand Total: All Classes	1225	$4,718,000

APPENDIX G

MORRISON KNUDSEN ENGINEERING PROPOSAL

AND

PLANT MODIFICATIONS AND MAJOR REPAIRS REPORT

FOR THE

CITRATE PROCESS DEMONSTRATION PLANT

AUGUST 1982

CONTRACTORS
ENGINEERS
DEVELOPERS

MORRISON-KNUDSEN COMPANY, INC.

EXECUTIVE OFFICE
TWO MORRISON-KNUDSEN PLAZA
P.O. BOX 7808 / BOISE, IDAHO 83729 / U.S.A.
PHONE: (208) 345-5000 / TELEX: 368439

RALPH A. NEAL
VICE PRESIDENT - OPERATIONS
POWER GROUP

August 18, 1982

Mr. Roger Williams
St. Joe Rewources Co.
Box A
Monaca, Pennsylvania 15061

Dear Roger:

Enclosed are the major recommendation topics by Morrison-Knudsen to St. Joe Zinc for upgrading the quality of operation at the Wheaton Powerhouse Citrate Demonstration Plant to meet design desulfurization of the powerhouse flue gas. The engineering needed to identify corrective action and to determine detailed design for capital cost estimates and equipment specifications will require approximately 3000 manhours at $40 per manhour. Included will be field supervision of equipment installation and/or unit modification and field testing of unit performance. St. Joe will be responsible for procurement and delivery of equipment plus construction and installation.

The work presented here will be on a direct cost reimbursible basis, less fee. The original working agreement specified this principle and we would like to continue our relationship with St. Joe by presenting our proposal on the same basis. M-K would, of course, work closely with St. Joe on each item to determine St. Joe's needs.

Also enclosed is the "Plant Modifications and Major Repairs" list updated approximately to May, 1982. Major detailed documentation for most changes can be found in the updated P&ID for the plant, which is in St. Joe's possession. If further documentation is desired, please contact M-K.

The citrate process is still an innovative approach to flue gas desulferization. By verifying the viability of the process, all parties concerned can feel they have contributed to the quality of our environment.

Sincerely yours,

Ralph A. Neal

RAN:gc

Enclosure

SUGGESTED LIST OF RECOMMENDATIONS AND ENGINEERING PROPOSAL FOR THE ST. JOE CITRATE PLANT

1. Flotation Vessel (10-1901)

The flotation vessel has the highest priority for modifications. Before originating any detailed engineering studies on the flotation vessel, two minor modifications could be tried to improve the sulfur flotation: 1) introduce fine air bubbles in with the feedstream to the vessel to give smaller bubbles and possible better bubble coverage for flotation; 2) modify the flow pattern of the distribution turbine by turning the turbine blades over to correct possible localized down flow tendencies.

An engineering study by M-K would look at different approaches to the problem:

- o An approach similar to the first minor modification, but would include a much larger quantity of air mixed in with the incoming citrate solution and would be pumped through a static mixer to ensure proper air distribution before introduction into the flotation vessel.
- o Blanket the bottom of the flotation vessel with a grid system of pipes with small bubble air holes to give adequate coverage and lifting for the sulfur particles.
- o If justified, a complete redesign of the flotation vessel may be needed. The Ralph M. Parson Company is available on a consultant basis, at cost, for input.

Each approach would be weighed on a cost/benefit basis. Total sulfur removal will probably not be achieved unless a large capital intensive process is used such as vacuum filtration or sludge-type clarification.

2. H_2S GENERATOR INTERREACTOR EXCHANGER (10-1351)

Replacement of the present 16"D spool with an adequately-designed heat exchanger is required to meet design rates and quality of H_2S generation. A redesign by M-K of the original

10-1351 exchanger with modification for vertical orientation and associated piping changes would be needed to relieve the differential expansion problems. Requirements in the overall design would be simplified by the elimination of the CO mode, other changes should be minimal.

3. H_2S Generator Product Coolers (10-1353, 1354, and new design)

The new product coolers are suspected of passing excessive amounts of sulfur to the citrate system causing sulfur deposition and plug-ups. Two plans are suggested:

- Re-examination of the original 10-1353 and 1354 product coolers by either St. Joe or M-K and determine possible repairs and reinstallation at either a 45-60° incline or totally vertical orientation with the associated piping changes.

- If warranted, a redesign by M-K of the product coolers and associated piping.

4. H_2S Generator Trim Reactor (10-1253)

With operating temperatures approaching 900°F for the trim reactor, it's suspected that deactivated alumina catalyst is causing the unusually high COS, CS_2 and unreacted methane levels detected in the product H_2S gas. The catalyst should be checked by St. Joe and damaged catalyst replaced. If operating temperatures persist around 900°F, catalyst should be checked at least annually.

5. SO_2 Absorber (10-1102)

The SO_2 absorber recommendations will follow closely the progress in substantially reducing sulfur content in the lean citrate solution. Two cases are presented:

- If essentially complete sulfur removal is achieved in the lean solution (i.e., flotation problem solved), packing can be replaced, no engineering would be involved.

- If sulfur persists in the lean solution, the level of sulfur will dictate the type of modification required by M-K engineering. Continued excessive sulfur may require extensive absorber modifications to a multi-stage system or a complete redesign of the absorber system. Moderate sulfur levels may require modification of the absorber internal packing system to a slats, grate, or "egg shell" packing system.

6. Venturi Scrubber (10-2801)

Excessive pressure drop across the venturi system has caused lower than design flue gas flow rates. Suspected cause is the venturi scrubber water nozzle designed by The Spray Engineering Company. There is also reason to believe that the venturi vessel also may be contributing to the pressure drop problem. M-K would interface with the unit vendors (The Spray Engineering Company and Environmental Elements) to redesign the venturi scrubber to reduce pressure drop.

7. Sulfur Melter System (10-1303, 1304 for melters; 10-1507, 1508 for sulfur slurry pumps; 10-1203 for decanter)

Pressure drop across the melters is limiting sulfur slurry flow to the decanters. At present, the combined melters would probably not meet design sulfur slurry flow rates. M-K would engineer the system for probable upgrading of the progressive cavity sulfur slurry pump and provide an engineering review of the sulfur melters.

8. H_2S/Citrate K.O. Drum (10-1207)

Shortening of the line and a reduced pipe diameter in the line between the quench tee and K.O. drum has been initiated by St. Joe to partially solve the sulfur plugging problems. If product H_2S gas sulfur impurities does not improve substantially, M-K can offer engineering to solve downleg and K.O. vessel sulfur plugging problems. Elimination of the K.O. drum and quench system entirely would be investigated, with direct hot H_2S introduction to the preciptation reactors.

9. Steam Traps

M-K recommends St. Joe to continue to change all steam traps to bucket types. This should lower steam usage and condensate return rate.

10. Upgrade Flue Gas Capacity

One long-term concern is how to desulfurize the flue gas above original design rates. M-K would initiate a study to evaluate the possibility of using most of the existing process vessels (mainly, the gas absorption section) to process higher flue gas rate.

PLANT MODIFICATIONS AND MAJOR REPAIRS FOR THE CITRATE DEMONSTRATION PLANT

1. Sulfur Precipitation Reactors Disperser Turbines (10-2401, 2402)

   Manufacturer: Chemineer Company, Model 9HTN-100, Dayton, Ohio

   Subject: Reactor agitator, shafts

   Problem: Both sulfur precipitation reactor agitators had broken twice since operations began at the citrate plant. Failures occurred on the pipe shafts immediately adjacent to the weld heat sensitive zone (December, 1980, 2402), in the welded area where the shaft is attached to the drive assembly (found January, 1981, 2401), and weld failure in the shaft weld below the connecting flange (December, 1979, 2402) and (April, 1980, 2401).

   Remedy or Solution: On all occasions, failure was related to manufacturer's defects and design inadequacy. The defective parts were sent back to the manufacturer for repair. After the last time the shafts were found broken (December, 1980, January, 1981), the manufacturer reevaluated their design and repaired the shaft with a 4 ft. long solid carbon steel core within the original 6" nominal (6.625" OD, 0.375" wall thickness) inconel 625 pipe shaft. Plug welds were used to hold the solid core in place.

2. H_2S Generator Preconditioner (10-1251)
   H_2S Generator Main Reactor (10-1252)

   Manufacturer: Alloy Crafts Co., Delphi, Indiana

   Subject: 304 SS vessel material

   Problem: Major catastrophic failure of the reactor vessels was due to sensitizing of the stainless steel vessel followed by sulfide induced stress corrosion cracking. Sensitizing was most likely caused by batt insulation placed on the outside of the vessel, thus preventing excess heat to escape to ambient and raising the temperature of the vessel shell to well above the 400°F design maximum temperature (sensitizing occurs at 800-1500°F). Once sensitized, the vessel was susceptible to intergranular corrosion by sulfide attack, probably due to H_2S saturated condensate from the steam, especially during frequent start-ups and shutdowns.

Solution: New vessels were fabricated with carbon steel (stainless steel is especially susceptible to sensitizing, where carbon steel is not) with a sufficient allowance for corrosion above structural requirement (½ inch corrosion allowance recommended by the U.S. Bureau of Mines Albany Research Center, for a total of one inch thickness). The vessels were refractory lined (higher crushing strength than originally specified), but were not insulated. An external shroud for weather and personnel protection covers the vessels.

New Equipment: Carbon steel preconditioner.
Carbon steel main reactor.
New refractory (thicker in preconditioner).
New outer shroud (also included for trim reactor).

3. SO_2 Absorber (10-1102)

Manufacturer: Valley Steel Co., Tallulah, Mississippi (Main Absorber)

Subject: Absorber-gas liquid contact

Problem: Excessively high pressure drop (9-14" W.C.) across scrubber and absorber system and decreasing SO_2 absorption into the citrate solution. Most all runs showed a decrease in SO_2 removal efficiency as the run progressed. It was eventually determined that sulfur was depositing in the packed section of the tower, hindering good gas-liquid contact. Also, sulfur was found in the lean citrate solution distribution tray at the top of the absorber, which prohibited the even distribution of solution.

Remedy or Solution: The main source of the sulfur in the absorber is traced back to poor separation of sulfur in the sulfur flotation tank, due to inadequate float tank design and low process citrate temperatures. This resulted in sulfur appearing in the lean citrate solution going to the absorber. Absorber design did not provide for a large influx of sulfur, thus sulfur plugging (consistency described as thick pancake batter) occurred. Another factor contributing to the problem was H_2S product gas was off specification and out of ratio with SO_2 capture, which caused improper solution regeneration and excessive H_2S gas production (due, in part, to the decreased output of the powerplant) for what was required by the citrate process, resulting in possible liquid phase Claus reaction in the absorber (sulfur precipitation) instead of within the precipitation reactors.

The sequence of actions taken to eliminate the problem began during the April 1980 run when SO_2 removal had dropped to 50-60%, and pressure drop across the absorber climbed to 14" W.C. Inspection of the tower revealed sulfur in the distribution tray and the packed column. During the rest of April and May, 1980, the absorber was chemically treated with caustic and SO_2 (from the flue gas) to convert the sulfur to a soluable sulfate form. Pressure drop across the absorber fell to 6" W.C., and visual inspection showed the top of the packing to be relatively clean.

Operation was restarted late May, 1980, and by early June, 1980, pressure drop across the absorber increased to over 12" W.C. Even though the lean citrate solution was relatively clear, sulfur buildup continued in the packing and SO_2 absorption averaged only 66%. The unit was shut down June 7, 1980.

The decision was made that chemical cleaning was ineffective, and the best alternative was to completely unload the packing in the absorber, clean the packing and repair the packing support damaged by the extra weight of the sulfur. The washing and removal of packing took two weeks (by Mainco Industrial Cleaning Co.).

The plant was restarted in late September with 3-4 feet of packing. SO_2 removal deteriorated from 80% at the start to 50% some eighty hours later due to poor flow distribution of the lean citrate solution within the absorber. Again, packing and distribution tray plugging with sulfur hindered operations.

In October, 1980, two runs showed better SO_2 removal (70-90%). Two changes which affected the SO_2 removal efficiency were reducing the packing to two feet and improved sulfur flotation which improved lean citrate solution clarity to the absorber. The absorber still observed deterioration of SO_2 removal as each run progressed (plugging of distribution trays). During each shutdown the packing was cleaned with a firehose.

December, 1980 operations fared worse than the October, 1980 runs (42-84% SO_2 removal) caused by, among other factors, the absorber distribution tray fouling again with sulfur. As a result, the absorber was retrofitted with a nonplugging spray header and nozzle system to replace the tray distributors.

Start-up in April, 1981 with the new lean citrate distribution system in the absorber showed distinct improvement over previous runs. The 80-hour run showed overall 91% SO_2 removal (design was 90%, and maximum SO_2 removal was 97%) and 2" W.C. pressure drop, but pressure drop and absorption quality still deteriorated through the run.

In October of 1981, the rest of the packing was removed so that remedies to the sulfur flotation problem could be attended without having to deal with absorber packing plugging problems. With the spray system and an empty absorber chamber, absorption averaged 40-60% SO_2 removal with essentially no pressure drop. A major problem with the spray system has been the nozzles plugging with debris from broken plastic packing and sulfur carryover. Eventually an in-line strainer independent of the lean cooler system should solve this problem.

To obtain a design 90% SO_2 removal, plans are to first minimize sulfur in the lean solution by modifying the float tank design and then adding back packing (probably larger sized packing) until the design SO_2 removal is achieved.

New Equipment: Pigtail spray header and nozzle system.
Removal of all packing (size 2 intalox saddles, 20 ft. bed) to give a spray tower absorber.

4. Venturi Scrubber System

(Venturi scrubber 10-2801, prescrubber circulation pumps 10-1521 to 1524, scrubb water cooler 10-1301)

Manufacturers: Environmental Elements Corp. (Koppers Co.) for the venturi scrubber.
Ingersall-Rand, Type 400 for the pumps (with a General Electric 250 HP motor).
American Heat Reclaiming Corp., New York City, New York for the scrub water cooler.

Subject: Scrubber System

Problems: The scrubber system has brought the citrate demonstration plant down the most times and has been a continual problem since the original plant start-up. A chronological sequence of the problems follows:

September, 1979 - During mechanical hydrotesting, a water leak was detected through the rubber liner of the 10-1524 recycle pump - the liner was replaced by the vendor. Storeroom spare rubber liners were also provided by the vendor for the other recycle pumps.

December, 1979 - The north low pressure pump motor (1522) shaft failed in torsional sheer (the motor shaft broke off), damaging the motor beyond repair - the motor was replaced in April, 1980.

April, 1980 - The process was shut down to repair a leaking Victaulic fitting on the scrub water recycle line. After replacement of the north low pressure pump motor (1522), it failed again within 27 hours, due to seizing of the outboard bearing. A rubber lined "tee" on the recycle line was found defective due to manufacturer's poor lining application.

May-June, 1980 - The plant was shut down June 7, 1980 due to various failures in the rubber lining of the scrubber recycle system. Most failures occurred in areas of high turbulence and velocity such as immediately downstream of the throttling of valves, so the pumps were operated at full flow output of 5400 gpm. The rubber liner manufacturer (Akron Rubber Co.) also recommended a double thickness of rubber lining at all high turbulence areas. It should be noted that the rubber lining material (natural rubber) was satisfactory for the process equipment; failures are attributed to poor application, highly turbulent operation, and abrupt piping configuration changes.

Excessive pressure drop across the venturi eductor indicated a damaged venturi spray nozzle. Further investigation gave suspicion to loose corrosion test coupons breaking the original silicon carbide refractory at the nozzle. A new ceramic coated stainless steel nozzle was ordered as an expedient; a replacement silicone carbide nozzle was also procured.

October, 1980 - Again, the plant was shut down due to a leak in the scrubber recycle system rubber lined piping, probably caused by dislodged corrosion coupons.

December, 1980 - Additional leaks were found in the recycle system, this time near the inlet to the venturi scrubber. The cause was victaulic flange gasket leaks at the lining interface.

April, 1981 - Major revisions to the four scrubber recycle pumps were undertaken due to the numerous leaks in the packing. Modifications included repair of the existing Hastelloy C-276 shaft sleeves, replacement of the 304 stainless steel throat bushing with Hastelloy C-276, and replacement of the pump packing and sleeve (at exterior of packing gland area) with Hastelloy. Additionally, the water seal line to each pump was upgraded and a pressure regulator installed.

October, 1981 - The replacement ceramic coated stainless steel nozzle was found to be corroded away. It was replaced by a spare silicon carbide nozzle. Also, two extra silicon carbide nozzles were put on order to Sprayco. The scrub cooler was shut down due to numerous leaks that have developed since April, 1981.

January, 1982 - The silicon carbide nozzle was found to have damaged vanes and was replaced by a previously used silicon carbide nozzle that had only one broken vane.

A major problem with the spray nozzles besides corrosion and breakage has been the spray angle. Suspicion is that the nozzles manufactured by Sprayco are not giving the correct spray angle to clear the scrubber "throat" causing high pressure drop across the scrubber. Spray patterns on the inside sides of the venturi section seem to confirm this.

June, 1982 - The silicon carbide spray nozzle was discovered with a split flange causing low pH scrub water to spray into the main fan area. A "hybrid" replacement nozzle of silicon carbide and inconel 625 was installed.

Remedy or Solution: The many problems of failure and leakage of the rubber lined scrubber recycle piping were related to the many fittings and valves, not to the pipe rubber material itself. Apparent inadequate support of Victaulic fittings caused many leaks due to the low pH water seeping underneath the rubber lining at the fittings. As mentioned earlier, turbulence at valves also caused erosion of the rubber lining and the corrosion of piping.

The rubber lining problems were repaired through a local rubber lining manufacturer. The piping system was modified with one less joint and permanent flanges replacing victaulic fittings at the orifice plates. The Hastelloy C-276 replacement parts to the four pumps should give good corrosion resistance.

To remedy the spray nozzle breakage problem, Sprayco has offered to manufacture a new nozzle with inconel vane rings. New nozzles ordered in November, 1981, will be a "new design" by Sprayco to give the correct spray angle. Installation is expected in July, 1982.

New Equipment:
- Venturi nozzle - ceramic lined SS (temporary replacement).
- Hastelloy - C-276 replacement parts for the four scrubber pumps.
- Upgrade of the seal water system to the four pumps - new pressure regulator.
- Numerous repairs to the rubber lined piping and pipe modifications.

5. Sulfur Float Tank (10-1901), Kerosene Injection Package (10-2804)

Manufacturers: Valley Steel Products, Tallulah, Mississippi - sulfur float tank.
Charles P. Crowley Co., Los Angeles, California - kerosene injection package, with the pump provided by BIF, model 1270, Providence, Rhode Island.

Subject: Sulfur flotation and separation.

Problem: Poor sulfur recovery due to poor flotation of sulfur froth.

Discussion: Poor flotation of the sulfur froth was related to a variety of problems:

- Low process liquid and gas temperatures of 105-120°F (design of 131°F) due to lower flue gas temperatures (200-250°F, design 300°F) caused by reduced load operation at the powerplant.
- H_2S product gas was off specification causing improper solution regeneration. The H_2S gas had, at times, high COS, CS_2, and unconverted CH_4 levels. Part of the H_2S generator problems were related to low turndown of the generator caused by low demand of the citrate process and inadequately sized steam flow orifice -- H_2S process was steam limited.
- Excessive and erratic addition of flotation additive (kerosene) due to inadequate procedures and over-sizing of injection pump.
- Numerous start-up and shutdown cycles due to other problems.
- Inadequate flotation vessel design.

The effects of poor sulfur flotation were:

- Carryover of sulfur into the absorber, eventually plugging the absorber packing and the citrate distribution try.
- Carryover of sulfur into the citrate storage tank, at times causing excessive accumulation of sulfur at the bottom of the tank.
- Overall poor SO_2 removal and sulfur recovery.

Remedy or Solution: The sulfur precipitation reactor agitators are discussed in Item 1. To temporarily elevate the flue gas temperature, a 2" steam line was piped to the venturi scrubber inlet for direct injection of steam heat (October, 1980). This was discontinued shortly thereafter because of shortage of deionized makeup water for steam. Near design levels of load operations in April, 1981 for the powerplant improved both flue gas temperatures and H_2S generator gas quality, thus giving improved sulfur flotation.

In December, 1981, baffles were installed inside the float tank which again improved flotation. In March, 1982, the inlet nozzle was installed 69 inches above the old inlet and the inlet baffle was removed. Present evaluation of flotation efficiency is uncertain until packing is replaced in the absorber. Absorber performance concerning sulfur plugging should determine the flotation level of efficiency.

New Equipment:

- New steam line to venturi scrubber (since discontinued).
- Revised kerosene addition procedure and feed rate.
- Adjusted float tank Weir because of slippage.
- Baffle addition and inlet nozzle modification to float tank.

6. Steam Source to Citrate Plant

Subject: 125# steam

Problem: Additional 125# steam was needed for:

- o Steam supply to the inlet of the venturi scrubber for heating up the flue gas to near design conditions (since discontinued).
- o Steam supply to Glauber salt crystallizer unit for adequate operation. The crystallizer needed sufficient motive steam to the steam ejectors for adequate vacuum. Running the crystallizer reduces sulfate concentrations thereby preventing Glauber salt plugging of cold sections of the plant.
- o Adequate steam purging to instruments and vessels.
- o Steam heating of scrubber makeup water line. (Discontinued)
- o Overall plant steam shortage, especially during cold weather.

Remedy or Solution: Replaced existing 3-4" Ø steam supply line to citrate plant with a 6" Ø line (completed in August, 1980).

New Equipment: 6" Ø line from powerplant plus insulation by McCarls Co.

7. H_2S Generator Steam/Methane Preheater/Cooler (10-1351)

Manufacturer: The Pfaudler Co., Elyria, Ohio

Subject: Preheater exchanger

Problem: In mid-January, 1980, external steam leakage was noted. Inspection revealed failure of the shell side expansion joint and failure of 17 tubes at the tube/tubesheet interface at the hot end of the preheater. Causes of the failure are suspected to be the hot start-up air from the reactor (1200°F) combining with a pool of water on the bottom of the cool exchanger (probably condensed from the moisture of the preheat air) causing stress failure, and shutdown condensation of H_2S laden steam which led to corrosion at the interface.

Solution: An interim solution of replacing the preheater with a 16" diameter 316 stainless steel pipe spool (fabricated by M-K) was decided upon because the preheater manufacturer (Pfaudler Co.) indicated repair would take three to six months. Steam and methane injections were routed directly to process without preheating. An air fan was installed to help convective cooling of the H_2S product gas at the pipe spool. As higher flue gas rates and higher SO_2 absorption has been accomplished in the last two major runs, March, 1982 and May, 1982, higher usage of H_2S was needed, pushing the H_2S generator to higher rates. This has caused inadequate cooling in the interreactor replacement spool exchanger. Future exchanger design changes are needed before design H_2S production rates can be achieved.

New Equipment: 16" Ø stainless steel pipe spool.
Rerouting of steam and methane feed.

8. H_2S Generator Waste Heat Recovery System (10-1451, part of sulfur superheater) and 10-1254, steam drum.

Manufacturers: Selas Corp., Dresher, Pennsylvania - economizer (part of the sulfur superheater).
Missouri Boiler and Tank Co., St. Louis, Missouri - steam drum.

Subject: Waste heat recovery system and design.

Problems: During inspection of the H_2S generator by St. Joe's industrial underwriter, Factory Mutual Engineering, they determined that the waste heat recovery system did not meet requirements of the Pennsylvania Boiler Code. Items needing correction were:

- o Steam drum low level alarm audible in the control room.
- o A platform constructed for access to the steam drum manway.
- o A new relief valve to be compatible with the pressure rating of the system.
- o Additional steam stop valve, drain on safety valve, and uncovering of insulation from safety valve.
- o A master code stamping prepared for the whole waste heat recovery system.

Solution: All deficiencies of the Pennsylvania Boiler Code were corrected. The master code stamping was approved. The Pennsylvania Industrial Board approved the petition to remove the steam boiler stamping, and all problems were resolved with the insurer.

New Equipment: Relief valve (new press. rating).
Additional steam stop valve and drain valve.
Platform for access to steam drum.
Steam drum low level alarm (remote).

9. Sulfur Slurry Tank (10-1902) and Agitator (10-2404)

Manufacturers: Valley Steel Products Co., Tallulah, Louisiana - sulfur slurry tank.
Chemineer, Inc., Dayton, Ohio - agitator, Model HTD-5.

Subject: Sulfur accumulation

Problem: Early problems (November, 1979) with the sulfur melters (gasket leaks on double pipe exchanger) and the decanter (differential level feed failure) and the slurry tank itself (weir tank level adjustment problems) caused the slurry tank to overflow on November 16, 1979, causing a shutdown of the plant.

A continual problem has been sulfur accumulation and suspension within the slurry tank. The suspected cause of the problem is the design of the slurry agitator (10-2404). The agitator blades have been lowered, and the liquid level has been lowered (September, 1980) in attempts to keep the sulfur in suspension. Another problem has been oversuspension of sulfur where only citrate solution is carried out by the Moyno pumps. This may be caused by over-application of kerosene in the flotation tank.

Solution: The agitation manufacturer, Chemineer Corp., recommends changing the agitator blade from a radial to an axial blade for better sulfur dispersion. This was installed in June, 1982.

Kerosene addition is being reevaluated.

10. Sulfate Crystallizer Package (10-2806)

Subject: Glauber salt removal

Problems: In June, 1980, the sulfate crystallizer unit startup was attempted. Because of low motive steam pressure for the steam ejectors, sufficient vacuum could not be maintained. The solution could not be cooled below 80°F (design is 39°F).

In August, 1980, the sulfate crystallizer was finally started up after completion of the new 6" steam supply line. Operation was continued to lower the level of sulfate below 50 grams/liter in the citrate solution. Higher levels of sulfate increased chances of plugging in cold sections with Glauber salt. By mid-October, over 155 tons of impure salt were produced, but relatively high (85 grams/liter) levels of sulfate remain in solution. High sulfate levels are suspected from above design levels of excess air in the flue gas because of low powerplant load and insufficient H_2S for proper regeneration. Oxidation rates were estimated at four or five times higher than expected.

Remedy or Solution: Low steam pressure to the sulfate crystallized was alleviated by completion of the new 6" steam supply line (replacing the 3-4" supply line) in August, 1980.

The sulfate crystallizer was operated heavily from August, 1980 to December, 1980 to lower sulfate concentration in the citrate solution. The large sulfate levels also led to losses of citrate solution. Lower oxidation rate, hopefully by near design operation of the powerplants (for load and excess air), should lower excess sulfate formation.

Other problems:

1. One inch stainless steel line to crystallizer vibrating screen was installed to replace a one-inch PVC line,

which failed due to heat deformation during heat tracing.

2. Level control instrument modified to DI water purge; also modified to continuous readout (November, 1980).

3. Lean citrate flowmeter not working, repairs continuing.

4. Automatic valve for lean citrate feed not working, modification continuing.

5. Vibrating screen section replaced because of physical damage.

11. Butterfly Valves in the Citrate Solution Recirculation Circuit

Manufacturer: Keystone

Subject: Butterfly valve failures

Problem: Numerous rubber-lined butterfly valves had their shaft twisted during the November, 1979 to April, 1980 runs due to hanging up on the rubber spacer between the valve and the flange. Some of the spacer material was cut in many instances to increase the internal diameter so that the valves operated freely, thereby eliminating mechanical interference.

In December, 1980, five butterfly valve discs were found damaged. They were repaired and reinstalled. Damage was the result of Glauber salt buildup and settled sulfur which restricted opening and closing the valves. Later, several more valves were found damaged and would not shut off.

Solution: In critical locations, a wafer-type gate valve (Dezurik) was tried. Performance was not satisfactory. It was finally decided to replace all Keystone valves with a more rugged Mosite butterfly valve. The replacements would be accomplished sequentially based upon damage to existing valves.

New Equipment: New butterfly valves - Mosite.
New wafer-type gate valves, Dezurik, to be abandoned.

12. Sulfur Melter Circuit - Sulfur Melter (10-1303, 1304), Sulfur Decanter (10-1203), Sulfur Slurry Pumps (10-1507, 1508), and Lines.

Manufacturers: Smithco Engineering, Inc., Tulsa, Oklahoma - sulfur melters.
Valley Steel Products Co., Tallulah, Louisiana - sulfur decanter.
Moyno Pump, Model 2M10H, Springfield, Ohio, and Reliance Motors - sulfur slurry pumps.

Subject: Teflon-lined jacketed line failure

Problem: Upon initial start-up in November, 1979, several leaks were found in the sulfur melters and lines to the decanter. Some five FEP lined jacketed spools were found defective. Defective lines were sent back to the manufacturer for repair. Also, the differential level failed in the decanter.

During April, 1980 runs, there was again failure of the FEP lined piping in the sulfur melter circuit. A continual problem with plugging of the decanter pressure letdown line to the rich solution header has been partially solved by installing an isolation valve in August, 1980, at the connection to the rich solution header so the line can be cleaned and normal citrate circulation continued.

In December, 1980, it was noted that the sulfur melter circuit was down due to repair of fittings and pipe. Slurry pump problems were also noted. The decanter level gauge freeze-up caused molten sulfur clogs in the quench lines and decanter pressure letdown lines.

By the nature of the piping configuration of the decanter lines, molten sulfur was able to backflow all the way back to the slurry pumps and plugged the pump with sulfur. Subsequent examination in February, 1981 showed both stators in each pump did not hold a positive pressure seal, and each stator was sent back to the manufacturer for relining.

Remedy or Solution: Both slurry pumps have been installed with pressure activated shut-off switches to protect the pumps from overpressuring (primarily very high sulfur content situations).

Finally, in April, 1981, the sulfur melting circuit was revised so that sulfur/citrate enters the top of the melter and exits at the bottom. It is hoped that this piping modification has prevented backflow of molten sulfur. One circuit's piping was also relined with a more resistant type of teflon -- fluorobrown PFA. The other circuit is also revised and piping replaced with 316 stainless steel from the melter to the decanter.

The u-bends in the melter circuits still give an occasional leaking and corrosion problem. Symptoms are improper alignment of u-bends with the lines and the u-bends not faced off for uniform gasket gaps. The installation of new stainless steel bolting and jacking screws with nuts welded on is improving sealing capabilities.

13. H_2S Generator Product Coolers (10-1353, 1354)

Manufacturer: The Pfauldler Co., Elyria, Ohio

Subject: Product cooler structure and design

Problem: Initial hydrostatic testing of the coolers showed a weld leak in the head of the 1354 cooler. This was repaired by the manufacturer.

In December, 1980 during operation, internal leaks were found in both product coolers, allowing water and steam to enter the H_2S product gas stream. Speculation is that both coolers developed leaks at the tube/tubesheet interface.

Probable cause relates to the thermal cycle each cooler goes through during normal plant operation. Normal operation of the shell and tube exchanger is to have cooling water on the shell side which condenses entrained sulfur in the H_2S product gas and retains the sulfur on the inner tube walls. Periodically, one cooler is blocked out of service, and the shell side is heated with steam to melt the sulfur on the walls and gravity drain the sulfur back to the sulfur feed tank. The differential expansion/contraction resulting from these rapid temperature changes probably caused the failure.

Solution: After the April, 1981 run, it was decided to replace both H_2S product coolers with a concentric jacketed and baffled pipe better suited for the wide temperature ranges of the process. The coolers were fabricated locally out of carbon steel and installed August, 1981.

Experience up to March, 1982 has been that the new cooler may not be taking out sufficient sulfur. Plugging problems with sulfur has been experienced in the H_2S KO drum downstream. Thoughts are to examine the original product coolers, repair them, and install at a 45-60° angle to minimize differential expansion.

New Equipment: New H_2S product coolers.

14. Instrumentation on Various Units

Subject: Instrument malfunctions

Problem: A variety of instruments malfunctioned over the past two years (since start-up in November, 1979). Some malfunctions were quite serious and are covered in other sections of this report. Many did not directly affect process control (such as pressure transmitters and gauges), but were nonetheless irritating. Problems are listed below:

- Beckman H_2S analyzer - steam jet air mover blocked at discharge causing moisture backup in analyzer. The sample and discharge lines were both enlarged, steam jet replaced with an air jet and another filter installed. The ejector was exhausted to the fan system (November, 1979 - March, 1980).

- Instrument air dryer - installed December, 1979 to dry out instrument air preventing airbound moisture freezing of instrument lines.

- Steam feed flowmeter (H_2S generator) - an error was found in the flow orifice sizing that feeds steam to the H_2S generator reactors causing high COS, low reaction to H_2S, and also gave poor regeneration of citrate solution. The orifice was redrilled to design specification (April, 1980).

- Pressure transmitters - sulfur decanter, H_2S product line pressure transmitters and sulfur feed line each failed twice. The diaphragms were either repaired or replaced and the capillary systems refilled (May-June, 1980).

- Pressure gauges - failure in pressure gauges: quench pumps, decanter, sulfur transfer pump, caustic transfer pump (May-June, 1980; repaired August, 1980).

- Main flue gas flowmeter (annubar) - zero shift causing considerable operational problems (May-June, 1980).

- Sulfur flowmeter - a repair was made on the sulfur flowmeter located between the sulfur filter and the H_2S generator (August, 1980).

- Level indicator instruments - many solution tank level indicators are unreliable during very cold weather. Part of the problems were freezing of the air and water purge lines (December, 1980).

Solution: The ideal solution would be H_2S generator operation at design conditions; i.e., maximum process turndown to 60% of design.

In February, 1982, a leak was found in a valve in the sulfur pumping circuit. When the valve was isolated, sulfur pumping performance improved considerably.

16. Lean Solution Cooler (10-1302)

Manufacturer: American Heat Reclaiming Corp., New York, New York

Subject: Modifications

Problems: In December, 1980, the cooler was inoperative due to plugging of the inlet and outlet with Glauber salt and sulfur.

Solutions: In December, 1980, the cooler shut off valves were moved to the main take-off header. Hopefully, this will prevent sulfur and Glauber salt accumulation on the top of the valves and help with draining of the system when the unit is bypassed.

In February, 1981, a 4" crossover line from the condensate header for heating of the cooler gave an interim solution to providing heat to the system when the sulfur melters are not in use and heat for the system is not provided from the flue gas. Lean solution heating was needed in February-March, 1981 to evaporate excess water out of the solution in the absorber. This occurred during nonoperational recirculation of solution.

Cooler plugging with sulfur and Glauber salt still remains a problem. A secondary problem when the cooler is isolated is that the stainless steel strainers to filter the lean solution going to the spray nozzles are also isolated. The strainers have been moved out of the lean cooler circuit, but is currently non-functional due to a rupture in the strainer.

17. Citrate Storage Tank (10-1903) and Agitator (10-2405)

Manufacturers: Valley Steel Products Co., Tallulah, Louisiana - citrate storage tank.
Philadelphia Mixers, sub. of Philadelphia Gears, King of Prussia, Pennsylvania - agitator.

Subject: General

Problems: In December, 1979 run, the agitator seized due to misalignment of the mechanical seal (repaired by January, 1980). Problems have been continual with the side mount agitator primarily due to corrosion.

In January, 1981 during a down period, agitators were left on in many tanks to prevent freezing. The agitator for the citrate storage tank was out of service, which caused tank solution temperatures to fall to 34°F. A stainless steel steam coil was dropped in the tank and heated the solution to 70-80°F. During installation of the coil, it was discovered that a huge mound of sulfur (estimated at 100 tons) had settled at the bottom of the tank.

Solution: To recover the settled sulfur in the tank, the circulation system was started up in February, 1981, bypassing the absorber. About 44 tons were recovered. In March, 1981, the sulfur melter was shut down, and the lean solution cooler was modified to heat the citrate solution. Circulation to the absorber was started so the solution could be evaporated to a volume that the citrate storage tank liquid could be drained into other existing vessels and cleanup operations of the remaining sulfur in the tank could be initiated. Circulation was continued until early April, 1981. Emptying the tank yielded about 25 tons of sulfur. Fire hoses were used to slurry the sulfur and the slurry was pumped to the slurry tank. The tank was again cleaned in July, 1982, with about 25 tons of sulfur recovered. Also, the mechanical seal for the tank agitator was replaced with an alloy 20 seal cartridge in May, 1982, after the old seal cartridge corroded through.

18. Process Lines

Subject: Line failures

Problems: Besides the two major areas of process line problems -- the scrubber system and the sulfur melter circuit -- other piping systems experienced problems. They are listed below:

- Venturi scrubber to absorber connecting spool - gas crossover 10 ft. diameter line was found leaking at expansion joint. Repair in October, 1979 involved application of new rubber on the external flanged surfaces.

- H_2S line to citrate reactors - the December, 1979 run was curtailed due to a plug of the H_2S line to the citrate reactors just before the quench tee. The cause was carbonized citrate solution. The line was cleaned out.

- o KF Polymer lined fittings - before the first two runs (November-December, 1979), all 26 KF Polymer lined fittings failed in the circulating citrate system. The manufacturer repaired some fittings with a composite KF Polymer liner or polypropylene liner and furnished standby replacements for critical areas.

- o Steam tracing (including steam traps) - numerous repairs to steam tracing throughout period of initial plant operation. Plus some extra tracing was required and installed. Impulse steam traps are being replaced by bucket traps.

- o Citrate tank makeup line - a 20 ft. section of 4" line was replaced between the makeup pump and the citrate storage tank due to improperly formed lining (January, 1981).

- o H_2S quench line - modified the quench flowmeter to include boiler feed water purge (February, 1981).

- o Emergency quench line - this line was modified from the lean solution pump to the quench line so it can be drained in cold weather and isolated from the normal quench line to prevent plugging and freezing.

- o Lean solution pump - the discharge line had a lining failure and was replaced (January, 1981).

- o An expansion joint on the venturi inlet duct failed due to erosion and heat. It was repaired in the fall of 1981. New holes appeared as of December, 1981. The expansion joint was replaced in March, 1982. In June, 1982, two splits in the newly-replaced expansion joint was discovered. The manufacturer will repair the splits at the first convenient downtime.

19. Vent and Flare Gas Lines

Subject: General

Problems:

- o Tank vents to boiler - the line, though insulated, was found to be blocked with water and ice. A low point was identified in the line. A drain valve was installed and periodic draining is required (January-March, 1980).

- o H_2S vent to boiler - an expansion joint, rubber lined valve, and polypropylene lining failed due to excessive heat (June, 1980; repaired August, 1980).

- o H_2S vent valve to flare - due to leaks in the valve, a new disc and shaft were installed January, 1981.

- o H_2S vent valve to flare - continued leaking of this butterfly valve necessitated replacement with a jacketed plug valve in April, 1981.

20. Citrate Circulation System

Subject: Downtime problems

Problems: During downtimes early in the project and in winter (January-February, 1980), there were problems with keeping the citrate solution circulating and above freezing. Also, especially during downtime, excess water could build up in the system due to DI water seals and purge on all circulating pumps, some instruments (like flowmeters) and agitator seals. Besides capacity problems of the water, the excess water would dilute the citrate concentration, reducing SO_2 absorption capacity.

Solution: Heat input during downtime was solved by putting 35# steam or hot condensate through the lean solution cooler or by running one of the sulfur melters on clear solution. Excess water from the DI water seal and purge was evaporated by downtime circulation through the absorber.

21. Various System Pumps

Subject: Pump breakdown

Problems:

- o Lean solution pumps - the west pump flexible coupling broke; the east pump seals needed repair, both were back in service by late December, 1979.

- o Neutralizer pit - both pit pumps were not operative (due to corrosion), and the overflow line failed (due to corrosion). One pump was fixed and a PVC overflow line installed (June, 1980). The spare pump was installed in February, 1980 and a program started to alternate pump usage to prevent plug-ups caused by settled solids in the bottom of the pit.

- o Quench pump - seal damage due to freezing (repaired June, 1980), coupling replaced and pressure gauge repaired (February, 1981).
- o Drain sump pump and makeup pump - failed and repaired June, 1980 and again in January, 1982.

22. Process Tanks and Vessels

Subject: Flake glass lining

Problem: During hydrostatic testing of the plant during the fall of 1979, numerous rust spots through the flake glass lining of various tanks were noticed. The two sulfur precipitation reactors (10-1201, 1202) were the worst, with the digestor (10-1205), flotation tank (10-1901), slurry tank (10-1902), and citrate storage tank (10-1903) also sustaining minor damage. Only the absorber (10-1102) did not have noticeable damage. The lining contractor repaired the linings in October, 1979.

Various problems with the linings continued on most vessels. The worst were the reactors; 10-1202 was repaired in August, 1980, again in October, 1980 due to numerous failures, again in February, 1981; plus, at the time, some touch-up repair to 10-1201. Again, repairs were made in August, 1981, to 10-1202. In April, 1982, 10-1202 was completely relined. The absorber lining was repaired in August, 1980 due to damage during packing unloading. Digestor (10-1205) needed repair to the dome lining in October, 1980. The H_2S KO drum lining was repaired in November, 1981 and February, 1982.

Solution: Most all failures appear due to improper application of flake glass lining to its surface. Better application procedures are being followed.

Note: The sulfur precipitation reactors, especially 10-1202, need to be inspected frequently for future lining failures.

23. H_2S Generator Waste Heat Boiler (10-1352)

Problem: The waste heat boiler developed numerous tube leaks at the tube/tubesheet interface (December, 1979). The cause is suspected to be either from a low water level from a defective tube weld or by level controller operational problems. The level controller was repositioned to assure a flooded tube condition.

Solution: The waste heat boiler was repaired by the exchanger manufacturer (Phauldler Co.) and subsequently hydrostatically tested and freon leak tested.

APPENDIX H

STAUFFER CHEMICAL COMPANY

FGD PROPOSAL PRESENTATION

TO

ST. JOE RESOURCES COMPANY

AUGUST 1982

FGD PROPOSAL PRESENTATION

TO

ST. JOE RESOURCES COMPANY

MONACA, PENNSYLVANIA

STAUFFER CHEMICAL COMPANY

WESTPORT, CONNECTICUT

APPROACH TO THE WORK

- LONG TERM DEPENDABILITY
  (SCC WANTS TO OPERATE)

- FULFILL ST. JOE'S NEEDS
  - MEET PA. REGS.
  - COST EFFECTIVE EXPANDABILITY

- COOPERATIVE ENDEAVOR

ANALYSIS OF PROCESS PROBLEMS

SULFUR SEPARATION

SO_2 ABSORPTION

MISCELLANEOUS

ANALYSIS OF PROCESS PROBLEMS

SULFUR SEPARATION

PROBLEM: EQUIPMENT IS INAPPROPRIATE

- OVERFLOW LIP LENGTH
- LIP POSITIONING
- FROTH DRAG
- STAGING
- GEOMETRY
- FROTH CONVEYING
- NON-FLOATING SULFUR

ANALYSIS OF PROCESS PROBLEMS

SULFUR SEPARATION

SOLUTION: REPLACE FLOTATION CELL

REPLACE FROTH CONVEYING SYSTEM

CONVERT TO PHOSPHATE BUFFER

FILTER SLIP STREAM

ANALYSIS OF PROCESS PROBLEMS

SO_2 ABSORPTION

PROBLEMS: ORIGINAL PACKING INADEQUATE
SINGLE STAGE SPRAY INADEQUATE

ANALYSIS OF PROCESS PROBLEMS

SO_2 ABSORPTION

SOLUTION: INSTALL SPECIAL PACKING
PERFORM MODIFICATIONS LEADING TO EXPANSION

ANALYSIS OF PROCESS PROBLEMS

OTHER PROBLEMS ADDRESSED

- EMERGENCY LIQUOR STORAGE
- DECANTER QUENCH PLUGGING
- H_2S LINES PLUGGING
- CRYSTALLIZER SULFUR CARRYOVER
- REACTOR H_2S DISTRIBUTION
- INSTRUMENTATION ADDITIONS

STAUFFER PHASED PROPOSAL

PHASE I

1. ABATED CAPACITY: 60 MW
2. STAUFFER COST: $4 - 4.5 MM
3. ST. JOE'S COST $750 M

   - NEW SULFUR SEPARATION SCHEME - SCC
   - FLOTATION CELL RATED AT 8 T/D (1/2 OF FINAL) - SCC
   - ABSORBER PARTIALLY MODIFIED (MEETS PA. REGS.) - SCC
   - MISC. PROCESS CHANGES - SCC
   - MISC. MECHANICAL CORRECTIONS - STJ
   - BURN 1.8% SULFUR COAL

PHASE II

1. ABATED CAPACITY 2 X 60 MW
2. PROJECT COST: $4.5 - 5.5 MM
   - ADD TWIN FLOTATION CELL
   - COMPLETE ABSORBER MODIFICATIONS
   - MEET PA. REGS. WITH 1.8% S COAL

STAUFFER COSTS ($M)

	DIRECT	INDIRECT	TOTAL
SULFUR SEPARATION	1647	632	2279
ABSORBER	175	65	240
OTHER	154	212	366
SUBTOTAL	1976	909	2885
STARTUP *			215
INTEREST			250
PROFIT & LICENSE			600
PROBABLE ACTUAL COST			3950
CONTINGENCY			610
MAXIMUM ST. JOE EXPOSURE			4560

* INCLUDING DETAILED OPERATING MANUALS

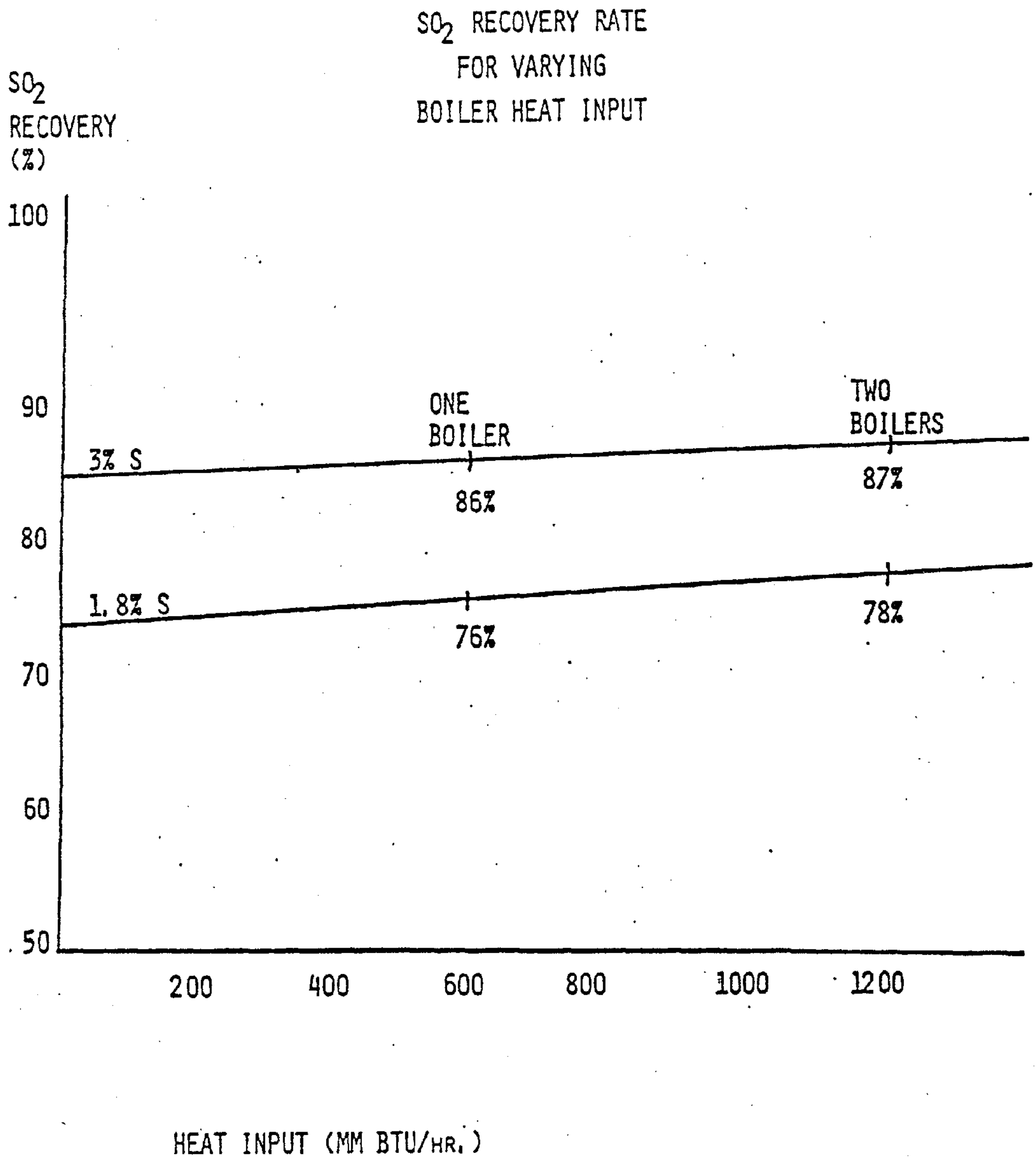
BASIS FOR ALLOWABLE EMISSIONS

HEAT INPUT: 600 MM BTU/HR. PER BOILER

HEAT CONTENT OF COAL: 12500 BTU/LB.

ALLOWABLE EMISSIONS (LB. SO_2/MM BTU OF HEAT INPUT) =

$$1.7\ (\text{HEAT INPUT})^{-0.14}$$


SO2 RECOVERY RATE
FOR VARYING
BOILER HEAT INPUT
SO2
RECOVERY
(%)
100
90
80
70
60
50
ONE
BOILER
TWO
BOILERS
3% S
86%
87%
1.8% S
76%
78%
200
400
600
800
1000
1200
HEAT INPUT (MM BTU/HR.)

STAUFFER GUARANTEES

PREMISE: 1.8% S COAL - 60 MW

ABATEMENT LEVEL

80% SO_2 REMOVAL - (76% NEEDED)

CAPACITY

156M SCFM OF FLUE GAS

SULFUR QUALITY

99.9% PURITY

TEST PERIOD

30 DAY RUN

ST. JOE SCOPE OF WORK

1. PUNCH LIST ITEMS
2. GENERAL SUPPORT ITEMS
3. H_2S SYSTEM

ST. JOE SCOPE OF WORK

1. PUNCH LIST ITEMS

- STOP SULFUR MELTER LEAKS	- (SCC SKETCH)
CORRECT VENTURI NOZZLE	- (SCC SKETCH)
REPAIR PRE-SCRUBBER COOLER	- STJ/VENDOR
REPAIR REACTOR LINING	- SCC SPEC./SUPERV.
REPAIR EXISTING INSTRUMENTATION	- SCC LIST
INSTALL WINTERIZATION ENCLOSURES	- SCC DESIGN
POND AND NEUTRALIZE CITRATE SOL'N.	- STJ
CLEAN OUT EQ. & LINES	- (PRE-STARTUP)
SAURIZING CEMENT WORK	- SCC LIST

ST. JOE SCOPE OF WORK

2. GENERAL SUPPORT ITEMS

   - INCREASE FGD MAINTENANCE TO

     3 MECHANICAL
     2 INSTRUMENT

   - STOCK CRITICAL SPARE PARTS (SCC LIST)

   - PROVIDE ANALYTICAL SUPPORT (RADIAN?)

   - CORRECT FUTURE DETERIORATION (AS NEEDED)

   - MECHANICAL & HYDROTESTING (PRE-STARTUP)

ST. JOE SCOPE OF WORK

3. H_2S SYSTEM

- RESTORE TO ORIGINAL EQUIVALENCY
- TEST CAPACITY & QUALITY
- CORRECTIVE ACTION (IF REQUIRED)

PHASE I MILESTONES

1982 - 1984

	8/17/82	NON-CONFIDENTIAL PROPOSAL - SCC
BY	8/30/82	INTENT TO PROCEED - STJ
"	"	CONFIDENTIAL DISCLOSURE - SCC
"	9/15/82	DECISION TO PROCEED - STJ
"	9/30/82	AGREEMENT-IN-PRINCIPLE: PROJECT START
"	3/30/83	TEST H_2S GENERATOR - STJ (SOME SCC)
"	6/30/83	H_2S GENERATION PROVEN - STJ/HOME
"	"	CIVIL & DEMOLITION WORK DONE - SCC
"	"	MAJOR EQ. ON SITE - SCC
"	7/30/83	TIE-IN, PACK HYDROTEST, CLEAN - SCC/STJ
"	10/30/83	START-UP COMPLETE
"	4/30/84	PERFORMANCE TEST COMPLETE

PAYMENT CONDITIONS

- PAYMENT AFTER PERFORMANCE DEMONSTRATION
- PAYMENT COVERS ACTUAL COSTS PLUS
  INTEREST DURING CONSTRUCTION PLUS FIXED PROFIT
- PAYMENT NOT TO EXCEED $4.6 MM
- NO PERFORMANCE - NO PAYMENT