PROTOTYPE MINERAL ABRASIVE RECLAIMER: SHIPYARD OPERATION

MARCH 1, 1987

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In Cooperation With
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FOREWORD

This project was performed under the National Shipbuilding Research Program. The project as part of the program was a cost-shared effort between the Maritime Administration and Avondale Shipyards. The overall objective of the program is improved productivity and reduced shipbuilding costs.

The program was conceived and defined by the Society of Naval Architects and Marine Engineers (SNAME), Ship Production Committee Panel 023-1 with Mr. J. W. Peart as Chairman and Program Manager, Avondale Shipyards.

The effort was contracted to Bethlehem Steel, Sparrows Point Shipyard. Mr. Dan Romanchuk, General Superintendent of Operations, served as Program Manager. The development and fabrication of the reclaimer was accomplished by Mr. H. M. Hendrick, II, Apache Abrasives, Inc. of Houston, Texas. The system was erected, operated and evaluated by Bethlehem Steel, Sparrows Point Shipyard.

Appreciation is expressed to Mr. Guy R. Ritterman and Mr. Kevin Brown. of Sparrows Point Shipyard for their efforts on the project.

Special gratitude is expressed to Mr. H. W. Hitzrot of Bethlehem Steel Corporation whose ideas and preliminary work served as the basis for the initiation of the program.

The report was written by Mr. J. W. Peart under contract to National Steel and Shipbuilding Company. Mr. James Ruecker of NASSCO, as Chairman of SP-3 (formerly 023-1), was responsible for the editing and publication of the final report.

EXECUTIVE SUMMARY

Reclamation of spent mineral abrasives is a new concept for shipyards. There is considerable value retained in spent abrasives, particularly with today's escalating procurement and disposal costs. The cost effectiveness of reclaiming abrasives in some operations is further enhanced in the jurisdictions where the spent material is classified as a hazardous waste.

The reclaim potential of abrasives is discussed, along with a quality comparison for reclaimed vs. virgin abrasive.

A prototype reclaimer is in operation at Bethlehem Steel, Sparrows Point Shipyard, under the auspices of the National Shipbuilding Research Program. The unit is described, and the operations data presented in this report, are the result of that effort.

The abrasive reclaimer operational costs and payoff are discussed, along with a review of design criteria. In conclusion, abrasive reclamation is extremely cost effective, and produces a superior product. A state-of-the-art reclaimer system is available to accomplish this task effectively.

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1.0 PROJECT RESULTS

The Ship Production Committee Panel 023-1 on Surface Preparation and Coatings, noting that shipyard sources of quality mineral materials were limited and procurement and disposal costs were consistently increasing, decided to investigate the feasibility of the reclamation and reuse of abrasives.

Preliminary studies concluded that reclamation of abrasives by individual shipyards was technically feasible and economically attractive. A development program was planned and implemented to produce a prototype abrasive reclamation system appropriate for this objective.

The system development was subcontracted to Apache Abrasives, Inc. of Houston, Texas. The reclaimer was installed at Bethlehem Steel, Sparrows Point Shipyard. The following conclusions are based upon an analysis of technical and cost data reported by Bethlehem Steel, Sparrows Point Shipyard. Their data was based on two years of intermittent operation due to reduced abrasive demand.

The results and conclusions of this effort are as follows:

1. Based upon the costs generated by the reduced production and less than efficient operation mode and a modest $42.00/ton for disposal cost for spent abrasive, mineral abrasive reclamation with the prototype system is cost effective.

2. When equipment utilization approaches the design capacity of 13 tons of useful product per hour on a single shift basis a dramatic reduction of the calculated operating cost will result.

3. The ever increasing disposal cost and the classification of the spent abrasive as a hazardous waste by some states make utilization of a reclaimer extremely economically attractive.

4. The prototype unit can be operated by shipyard personnel. The unit features a sequential start-up and operation procedure interlocked for safety.

5. Periodic sieve analysis of feed, product, intermediate fines and fines is required for efficient operation.

6. The reclaimed material has an increased blasting efficiency of 20-25%. The finer material produced results in a 2.0-2.5 mil profile which is excellent from both a quality coating and production viewpoint.

7. Trace element analysis of the reclaimed material at Sparrows Point Shipyard met EPA Solid Waste Leachate requirements.

8. The reclamation of spent abrasive has the potential for producing large cost savings to a blasting operation. A state-of-the-art system is available to efficiently accomplish this potential.

9. Using the economic analysis contained in this report as a guide, easy assessment of potential reclaimer cost savings on individual operation data can be made.

2.0 DEVELOPMENT AND IMPLEMENTATION

2.1 Feasibility Study Mineral Abrasive Reclaiming - Avondale Shipyards

A feasibility study was initiated by Avondale Shipyards to determine if mineral grit recycling was justifiable. The work was performed by Denson Engineers, Inc. of New Orleans, Louisiana with Mr. Charles E. Prewitt as principal investigator. The report is contained in Appendix A.

The object of the study was to investigate methods of mineral abrasive recycling, estimate cost involved in building such a facility, identify potential savings, and perform life cycle analysis of project economics to determine if recycling was justifiable.

The following tasks were accomplished.

A. A process schematic and a performance specification were prepared. Abrasive consumption rates and physical characteristics were determined. Reclaiming plants with designs. of 15 and 30 tons per hour capacities were reviewed for economic attractiveness.

B. Potential contractors were contacted for cost proposals. Estimated costs ranged from $200,000 to $1,140,000. Because of the wide discrepancy in costs, the contractor prepared his own cost estimate. His estimated cost was $522,200 and $703,000 for a 15 and 30 ton per hour plant respectively. These values were used in the economic analysis.

In addition to the reclaimer hardware the following additional equipment was included in the estimate:

1. Transport Truck
2. Front End Loader
3. Foundations
4. Auxiliary Hoppers and Bins
5. Electrical Service
6. Installation Labor

Table I itemizes these costs.

TABLE I

ABRASIVE RECLAIMING PLANT COST ESTIMATES (1982)

	Item	15 TPH Plant	30 TPH Plant
A.	Reclaiming Equipment		
	Rotary Dryer & Dust Control	$183,000	$305,000
	Material Handling Conveyors	24,400	29,400
	Hoppers and Bins	48,800	50,800
	Vibrating Screen(s)	12,600	25,200
	Grizzly and 1/2" Screen	4,900	4,900
B.	Misc. Hoppers and Bins	31,700	33,700
C.	Foundations	21,600	32,000
D.	Electrical and Controls	42,200	50,000
E.	Front End Loader	40,000	40,000
F.	Pneumatic Transport Truck	65,000	65,000
G.	Misc. and Contingency	48,000	64,000
	TOTAL ESTIMATED COST	$522,200	$703,000

C. Life cycle analysis was performed for several alternates with varied plant size, inflation rate, and operating hours. This analysis resulted in the computation of present value of savings, profitability, index, discounted payback, and percent return on investment of each alternative. The reason for using various alternates was to determine under which conditions the project would be justifiable.

Table II provides a summary of life cycle analysis calculations.

An initial abrasive of $40.00/ton, disposal cost of $3.00/ton, and a recovery rate of 43.8% for new abrasive cycled three times was used in the analysis. (For further details Ref. Appendix A).

TABLE II

SUMMARY OF LIFE CYCLE ANALYSIS CALCULATION (1982)

Assumptions:

Project Life	10 years
Cost of capital:	15%
Tax Rate:	46%
Depreciation:	Sum of Years Digits Method
Inflation Rate:	5%
Investment Tax:	10%

The base year is assumed to be the year of project completion. Start up is assumed to occur the first of the following year with a full year of operating **savings.**

TABLE II (Cont'd.)

	15 TPH Plant	30 TPH Plant
Initial Cost	$522,200	$703,000
Annual Operating Cost	163,750	212,875
Annual Savings	395,514	791,028
Investment Tax Credit	52,200	70,300
Present Value of Savings	* 919,020	* 2,138,728
	** 130,395	** 630,635
Equivalent Annualized Cash Flow	183,117	426,146
Profitability Index	1.76	3.04
Discounted Payback	* 3.99	* 2.03
	** 3.08	** 1.6
% Return on Investment	33.06	60.07

* Includes corporate taxes, depreciation, and 5% inflation.
** Includes corporate taxes, depreciation, and 10% inflation.

D. The report concluded that the 15 tons/hour plant operating 200 days/year at 7 hours per day producing 21,000 tons per year was economically justifiable. It warned that consumption requirements should be such that the plant should operate at least one shift per day. Analysis today, with the high disposal cost of used abrasives as hazardous material, the economics would be even more attractive.

Although the analysis was positive and the National Shipbuilding Research Program money was available for the project, other considerations precluded Avondale's further participation in the reclaimer development.

2.2 BETHLEHEM STEEL - SPARROWS POINT SHIPYARD

2.2.1 Participation Criteria

The participating yard uniquely had a large amount of stored used coal slag abrasive in an open area of their facility. A cost analysis confirmed the attractiveness of participating in the proposed program with the installation of a prototype reclaimer system. This analysis and conclusion were based upon the following:

a) A $50/ton purchase cost for new blasting.

b) The estimated cost to recycle material was $16 to $17/ton.

c) The reclaiming facility could produce its rated capacity of 20 tons/hour with a yield of 12-14 tons/hour of good recycled product.

d) The spent material in the north field could be recycled as it existed.

e) The recycled material could be an effective abrasive blasting medium that has an acceptable breakdown rate, operating mix and produces a surface profile of 2.0-2.5 mils (50-63 um). Although the reclaimed material is known to be a finer mix than the mineral abrasive now purchased, it was estimated that an acceptable surface profile could be achieved. while utilizing a finer material.

f) The proposed reclaiming system was essentially a closed system with few emission areas. A similar unit was being operated in California without environmental objections hence no emission problems were expected.

g) The recycle abrasive would meet Maryland's hazardous waste requirements.

h) An abrasive requirement of 12,000 tons per year would be maintained by the shipyard.

A prototype system designed by Mr. H.M. Hendrick, II of Apache Abrasives, Inc. was chosen. The reclamation equipment was available for $73,975, which was an extremely attractive price when compared to the facility estimates generated by the Avondale study. (Ref. 2.1).

2.2.2 Design Criteria

It was estimated that the annual consumption rate of mineral abrasives at the test shipyard was approximately 12,000 tons. An important design factor is peak demand. Sufficient reclaiming capacity must be available to meet both averages and the maximum. usage requirements, generated by accelerated and non-uniform production. Historically, shipyard abrasive requirements vary drastically because blasting and coating is usually done in a very concentrated timeframe within the overall schedule.

The reclamation production rate is governed by the drying capacity of the system. The prototype system was designed to dry twenty tons per hour at 4% moisture, which is typical of drained stockpiles. In the case of coal slag at the test shipyard, this means 65% of the tonnage processed, or 13 tons per hour usable product.

One eight hour shift operation will typically produce 80 tons of abrasive. A typical blaster utilizes 1/2 ton per hour, so assuming a "nozzle-on-time" of 6 hours in an eight hour shift, this production will support 26 blasters per shift.

The screen analysis of spent coal slag abrasive at the test shipyard indicated a typical yield of 65% reusable product. Screen analysis on spent copper slag at other facilities indicated a typical yield of 80% reusable product.

The reclaim potential can be calculated by applying in the geometric series ($1 + r + r^2 + \ldots$), which converges to 1/(1-r) for r<l. Specifically, for coal slag where r = .65, the reclaim potential over a long period of time is 2.88 recycles. Similarly, copper slag, for r = .80, gives 5 recycles.

2.2.3 System Description and Operation

The process of abrasive reclamation is simply one of drying and separating by size and density.

The Reclaimer System installed and operating at the test shipyard, is a proprietary configuration of drying, screening, and material handling equipment. It utilizes a rotary dryer with an automatic burner linked to material temperature. After drying, the material is classified to 3/16" by 50 mesh, and elevated for discharge into a 100 ton storage silo. The burner, material flow, and storage systems are completely interlocked for safe operation and quality control.

The plant is staffed with two operators. One worker operates the front end loader, and empties flo-bins (refuse) as required. The other worker monitors the plant controls, periodically checks the plant equipment for proper operation, and samples product for quality assurance.

The test shipyard facility is automated to permit this two-man operation. Sufficient production capacity is provided to allow down-time for refuse disposal, clean up, or preventative maintenance.

Delivery of reclaimed abrasive is accomplished by pneumatic trailer. The front end loader operator also perfor this delivery function.

2.2.4 <u>Installation Costs</u>

Neutral installation costs were somewhat higher than estimated (Ref. Table III).

The following item impacted the installation costs:

A. The fact that the facility sits on a land fill site required a foundation design larger than originally planned.

B. The installation was straightforward but some modifications were required because of both drawing and fabrication errors. The unit being a prototype, some modifications were expected.

C. The available front end loader could not reach the feed hopper, therefore, a ramp was built; this being a cheaper alternative than purchasing a new loader.

D. The reclaimer unit is equipped with a 6,000 cfm air pulse dust collector. The unit is designed to operate on quality yard air. Unfortunately, quality of air at the site was inadequate and a portable compressor had to be purchased; the major problem being low pressure and inadequate volume.

Table III compares estimated and actual installation costs.

TABLE III

ESTIMATED AND ACTUAL INSTALLATION COSTS

	Estimated Amount	Actual Amount
Apache Reclaiming System	$ 80,000	$ 73,975
Installation:		
Labor	12,000	60,048
Material	29,200	34,605
Freight	2,500	7,826
Grizzly & Vibrator	2,500	2,523
Inertial Separator	4,600	4,625
100T Silo	20,000	19,856
Transport Truck	14,000	9,215
Compressor	2,400	7,895
	$167,200	$ 220,568

2.2.5 Quality of Reclaimed Abrasive

Abrasive quality considerations include graduation, chemistry, cutting rates, friability or breakdown, and density.

Table IV compares size distribution of the as-received abrasive with reclaimed material at the test shipyard.

TABLE IV

SCREEN ANALYSIS

U.S. Sieve	Virgin Abrasive Weight Percent	Reclaimed Abrasive Weight Percent
8	0	1
12	15	8
20	60	42
30	20	19
40	4	14
50	1	10
70	0	5
PAN	0	1

The reclaimed abrasive tends to be finer in graduation which results in a reduced profile of 2.0-2.5 mils as compared to a profile of 3.0-3.5 mils for the virgin material. This reduced profile is superior for production and presents a good anchor pattern for coating adhesion. Increased cleaning production rates of 15-20% were experienced with the reclaimed material. The production rate increased for several reasons.

The reclaimed material is harder than the supplied material, because the softer particles fracture during blasting, and are removed as fines. When a particle fractures on impact, its energy is dissipated rather than utilized to scour the steel- surface. In addition, finer graduations give more impacts per unit of surface area, hence faster cleaning rates.

The test shipyard is unique in having a huge stockpile of spent abrasive, and is satisfied with the blasting rates and profile obtained with one pass reclaimed material. In order to fully utilize the reclaim potential of a material, continual small additions of coarse material are necessary to maintain a consistent working mix.

The chemistry of reclaimed abrasive remains consistent with the original, except for small amounts of paint solids estimated to be less than one percent by weight. The reclamation process separates by size and density, so the vast majority of contaminants are removed as fines. The EPA Solid Waste Leachate test was performed and the reclaimed material proved to be non-hazardous (Ref. Appendix C, Figure 8).

2.2.6 Operation Costs

The unit was demonstrated to the SNAME, Panel 023-1, October 1983. A preliminary report and presentation was given by Mr. Kevin Brown, Sparrows Point Shipyard, who was responsible for the project (Ref. Appendix B).

He documented the history and operation to that date. Table V compares preliminary operating costs to estimated costs.

TABLE V

ESTIMATED COSTS VS. PRELIMINARY OPERATION COSTS

	Estimated	Preliminary
Power (fuel & electric)	$ 4.00/ton	$ 2.85/ton
Labor	3.90/ton	3.00/ton
Maintenance at 5% Initial Cost	.70/ton	1.40/ton
Depreciation	2.30/ton	2.30/ton
Disposal of Refuse	3.30/ton	3.30/ton
Handling of Reclaim	1.80/ton	2.20/ton
TOTAL COST	$16.00/ton	$15.05/ton

NOTE: 1) The estimates are based on annual consumption of 12,000 tons/year at a recoverable yield of 70%.

2) Refuse disposal had not been realized to date.

A final report was submitted September 6, 1985 by Bethlehem Steel, Sparrows Point Shipyard. Please reference Appendix C for details.

The cost data accumulated and documented in the final report to evaluate the performance of the reclaimer was significantly impacted by the low utilization rate of the reclaimer.

The yard abrasive consumption from September 1983 to August 1985 was only 4,943 tons of approximately 2,500 tons per year. This low demand had a very negative impact on production efficiency and escalated documented labor cost. Table VI compares estimated cost, actual cost and costs based on actual cost and extrapolated to 12,000 tons/year production. These estimated costs based on actual documented cost reflect the low production efficiencies due to spasmodic production.

TABLE VI

PRODUCTION COSTS

	Original Estimate	Revised Estimate	Actual cost
Volume (tons of recycled grit)	12,000	12,000	2,471
Cost per Ton			
Power (fuel & electric)	$4.00	$ 2.21	$2.42
Operating Labor	3.90	5.67	15.96
Maintenance	.70	1.35	11.36
Depreciation	2.30	1.83	8.93
Disposal of Refuse	3.30	18.00	18.00
In-Yard Handling of Abrasive	1.80	.78	4.20
AVERAGE COST PER TON	$16.00	$29.84	$60.87

NOTE : The original estimate was prior to installation based on a 70% yield. The revised estimate is based on actual operating costs extrapolated to a level of 12,000 tons annually. Actual cost represents the actual volume and costs per ton experience during the two year period of operation.

The rationale as presented in Appendix C for the costs documented in Figure VI is presented below. A discussion of the rationale is presented after each cost element.

A. Power

Estimated power costs were revised downward by 45%. The actual costs per ton for diesel fuel and electricity were $2.05, and $.37 respectively.

It should be noted that the quantities used were estimated not measured. Measured power costs for a similar reclaimer located in another rate area are documented as $.11/ton for electricity and $l.15/ton for fuel.

B. Operating Labor

A significant cost increase occurred in operating labor. During the two year period 4,638 hours were charged to the recycling operation costing $78,884. Down-time and low demand by the yard were the primary causes for the high rate per ton. The revised estimate projects a $5.67 rate per ton as:

$$\frac{4{,}000 \text{ hours (2men/day) X } \$17 = \$5.67/\text{ton}}{12{,}000 \text{ tons}}$$

This cost of labor at two men per day operation is the major cost element. If the reclaimer is operated at near capacity this figure would be significantly lower.

C. Maintenance

During the two years of operation, labor and materials costs for maintenance were $34,381 and $21,771 respectively. Most of the costs were start-up and operating problems which were not necessarily volume related. The revised estimate based on ongoing operations is $1.35 rate per ton or $16,200 per year.

The above costs included maintenance on the front end loader, abrasive delivery pneumatic tanker and tractor. This support equipment was quite old and required above average maintenance.

Major reclaimer maintenance cost was the result of two items:

1. Two bags were replaced in the baghouse. This was the result of using plant air for pulse air cleaning; both the pressure and volume were inadequate for this purpose. This problem has been rectified with the installation of a separate compressor for this purpose.

2. Dryer trunnions and tires had to be replaced prematurely because of excessive wear. This was the result of out of adjustment operations.

A similar dryer has processed 240,000 tons of abrasive with the replacement of a single trunnion.

D. Depreciation

The total cost to purchase and install the facility, including the transport truck was $220,568. Based on an estimated economic useful life of 10 years, the fixed annual amount of depreciation is $22,057. At volume levels of 12,000 (estimated) and 2,471 (actual) the rates per ton are $1.83 and $8.93 respectively.

As noted above the depreciation cost/ton of abrasive would calculate to $1.83/ton if the system were operated at design capacity.

E. Abrasive Handling Cost

Actual labor and material costs incurred for handling the abrasive materials were $12,445 and $8,329 respectively for the two year period. These costs were high due to low volume requirements, spasmodic operation and changes in facility personnel. The revised estimate at 12,000 tons/year calculate at $.78per ton or $9,360 yearly.

F. Refuse Disposal

Unrecycled blast material is stockpiled in the north field area of the yard, therefore, incurring no disposal costs to the yard. The approximate 30% waste from the recycling process must be disposed outside the yard. The rate per ton of disposed waste blast material is $42.00 per ton or $18.00 per ton of useable blast material ($42 X 30/70).

In actuality by reclaiming, the cost of disposal is reduced, therefore, the above should be calculated as a saving rather than a charge.

The in-house material cannot be used as is. 100% of the new material purchased if not recycled would have to be disposed of after use at a cost of $42.00 per ton.

The material being processed has a 60% yield, which means an effective reclaim potential of 2.5. If disposal costs are $42.00 per ton, the actual disposal cost on each ton processed would be (42/2.5) or $16.80. The net savings due to reclaiming would be $42.00 - $16.80 or $25.20 on every ton purchased.

At their present material and disposal cost of $53.20 and $42.00 per ton respectively they can achieve a savings of $34.33/ton and $65.36/ton based on their low efficiency production cost of $60.87 and the revised estimate at a production of 12,000 tons per year of $29.84.

The revised calculated cost of $29.84/ton as discussed above would seem inflated. The actual cost should be much nearer the original estimate of $16.00 per ton.

APPENDIX A

MINERAL ABRASIVE RECLAMATION; FEASIBILITY STUDY
AVONDALE SHIPYARDS

MARCH 2, 1982

By: Denson Engineers, Inc.
New Orleans, LA

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FEASIBILITY STUDY
MINERAL ABRASIVE RECLAIMING
AVONDALE SHIPYARDS, INC.

A. Statement of Problem:

Mineral abrasives are commonly used for blast cleaning of steel but unlike steel abrasives are generally-not recycled but are discarded. At a cost of approximately $40 per ton, the recycling of the spent mineral abrasive should result in a significant cost savings.

B. Object:

The object of this report is to investigate methods of mineral abrasive recycling, estimate costs involved in building such a facility, identify potential savings, and perform a life cycle analysis of project economics to determine if recycling is justifiable at Avondale Shipyards.

C. Procedure:

1. Several documents which discuss mineral abrasives and their recycling were received including:

    1. “Proposed System for Recycling Blast-Cleaning Abrasives”; H. W. Hitzrot; Bethlehem Steel Corporation.

    2. “Procedure Handbook - Surface Preparation and Painting of Tanks and Closed Areas”, U. S. Maritime Administration.

    These documents supplied essential background information and data used in preparation of preliminary design and project economics:

2. A process schematic and performance specification were prepared as a basis for design of a recycling plant. Historical consumption of mineral abrasives at Avondale were used to calculate proposed plant

capacities and operating hours. Lab testing was performed to obtain physical data on mineral slag abrasive. Reclaiming plants with design throughputs of 15 tons per hour and 30 tons per hour were reviewed to determine which plant size would be the most economical to install and operate.

3. Several companies were contacted to determine their interest in constructing a recycling unit. Three companies expressed an interest in constructing a complete recycling facility:

    1. CAB, Inc.; Kent, Washington
    2. Barber-Greene Company; Aurora, Illinois
    3. Lift & Equipment Service, Inc.; New Orleans, Louisiana

4. Costs to furnish the recycling equipment were reviewed and due to the wide range of estimates, an independent cost estimate was made. Several manufacturers were contacted to obtain major component prices. Additional cost for establishing a recycling facility were identified and estimates obtained. Those items include:

    1. Transport Truck
    2. Front End Loader
    3. Foundations
    4. Auxiliary Hoppers and Bins
    5. Electrical Service
    6. Installation Labor

5. Operating costs and estimated savings were calculated for the various options. Inputs for the economic analysis such as facility life, cost of capital, tax rates, and inflation were reviewed and selected.

6. Life cycle analyses were performed for several alternatives which varied plant size, inflation rate, and operating hours. The analyses resulted in the computation of present value of savings, profitability index, discounted payback, and percent return on investment of each

alternative. The reason for using various alternatives was to determine under which conditions the project would be justifiable.

D. Discussion:

1. The type of mineral abrasive used at Avondale Shipyards is a coal slag derivative that is a by-product of coal-fired utility plants. Various grades are currently available, however, the product currently being purchased is not usually consistent and contains excessive dust. This is probably due to breakdown during handling and transferring operations. Also the supply is potentially interruptible which makes recycling more attractive. It has been estimated that approximately 60 percent of the original material is suitable for reuse a second time and 30 percent of the twice-used abrasive may be used a third time, thus each ton of new abrasive will provide the effective use of 1.78 tons.

$$(1.0 \times 1) + (1.0 \times 0.6) + (0.6 \times 0.3) = 1.78$$

The overall recovery rate for new abrasive used three times is 43.8 percent.

$$[1 - (1/1.78)] \times 100 + 43.8\%$$

2. Plant performance specifications and a process schematic are shown in Appendix A. The key functions of the recycling plant are to remove metallic and large contaminants, to dry the material, to classify and recover desired particle sizes, to discard the undesirable particles, and to blend the reclaimed abrasive with new abrasive to achieve a uniform and consistent working mix.

There are broken hoses, buckets, wood, paper, welding stubs and other debris found in a typical stockpile of spent-abrasive. A magnetic "grizzly" or bar grating with 2-inch spaces and l/2-inch screen is used to separate this debris and metallic contaminants at the plant feed hopper. All the oversize from these two screens is to be discarded; The undersize from the hopper is transferred to the dryer prior to attempting further screening.

TWO types of dryers were reviewed--fluidized-bed and rotary. The fluidized-bed type dryer is ideal since de-dusting and drying are accomplished simultaneously and efficiently. A further advantage is that air does all the work, thereby minimizing wear on the heater and further breakdown of the abrasive. However, several problems exist with fluidized-bed units. Flow of material and uniform particle sizes are critical and problems with plugging and consistent performance have been experienced. The fluidized heater needs to be operated continuously to maintain air flow and temperatures for satisfactory operation. Due to these potential operational problems, the fluidized-bed dryer was not considered and no reliable costs for fluidized-bed units were obtained.

The rotary dryer offers a great deal of flexibility since its operating parameters are not as precise for proper operations. Potential problems with wear can be resolved by using a high alloy wear plate. Fuel consumption is less with the rotary dryer compared to the fluid-bed unit and de-dusting can be partially done with a dust collection system and completed by a vibrating screen.

Product screening is best done with dried product. Fine particles under l/4-inch in size tend to clog screens when wet. However, when dried, the fines under #100 mesh can be separated quite easily. A vibratory screen with two decks has been selected due to its compact size and ease of operation. When selecting the screen, test samples should be submitted to the various screen manufacturers for sizing and selection of the screening equipment. A dust-tight cover should be used to reduce the air pollution.

Blending of recycled product with new product is essential to provide a uniform abrasive. The recycled material will be harder and thus will provide some improvement in cleaning rates over the new material. It is therefore necessary to uniformly blend the recycled material with new material to provide the blaster a consistent grade of material with which to blast.

One alternative to the process described above provides for mixing the recycled and new materials ahead of the dryer which will permit removal of excess fines and softer particles in the abrasive from the final product. This option could be incorporated into a final plant design, but it is felt that it will result in additional product losses due to the extra handling, and will increase the operating costs of the plant by increasing the amount of product to be processed without further savings. However, separating the dust and soft particles may improve blasting productivity and offset some of the additional material losses and equipment costs.

4. The preliminary proposals for the recycling plant presented a range of costs from $200,000 to $1,140,000. A detailed examination of the quotes indicated that the greatest difference was in the prices of the dryers. The following dryer manufacturers were contacted:

   1. Combustion Engineering
   2. Feeco International
   3. Fuller
   4. Davenport Equipment

   They indicated that dryer prices depend upon material flow rate, materials of construction, moisture content, drive selection, process temperatures and auxiliaries. Some manufacturers offer a limited size range and in one case, the minimum-sized dryer quoted was larger than required for either of the plants being considered. Since the dryer .is the single most expensive component, it is worth close examination and study to properly select the one to be used.

5. . Cost estimates for the plants under consideration are summarized in Appendix B. Equipment costs, installation, foundations, auxiliary equipment, electrical service, and hoppers and bins are included. The estimated cost for a 15-ton per hour plant is $522,000 and $703,000 for a 30-ton per hour plant, installed and-operating. It is assumed that no additional property costs will be incurred and that the plant could be accommodated at existing facilities.

6. Operating costs were calculated and are shown in Appendix C. Annual cost to operate the 15 TPH plant is estimated to be $163,750 and $212,875 for the 30 TPH plant. The annual savings calculations are shown in Appendix D. The savings are assumed to be in the reduction of new material purchased and disposal costs. Annual savings are estimated to be $395,514 for the 15 TPH plant and $791,028 for the 30 TPH plant operating one shift per day, and before inflation. Varying operating hours will directly affect these savings,

7. Life cycle analyses were made for a 15 TPH plant and a 30 TPH plant while varying the inflation rate, varying the operating hours and varying the amount of initial stockpile with which to start. The results of the analyses, using a minimum of 5% inflation, are shown in Appendix E. The other results are discussed below but are not shown in the summary.

   If inflation increases to 10%, the present value of savings will increase about 23% for each case and payback will reduce to 3.08 for the 15 TPH plant and *to* 1.60 for the 30 TPH plant. If inflation reduces to zero then the project economics are less favorable with the 15 TPH plant being unjustified with an ROI of 26% and *a* payback of 5.2 years.

   If the project starts with an initial stockpile of spent abrasive, then a portion of the first year's supply of replacement abrasive will be available. For example, if a 22,250 ton stockpile of spent abrasive is available, then the present value of savings is increased by approximately $365,000. The economics are improved to 2.62 years payback and 48% ROI for the 15 TPH plant and 1.7 years payback and 70.6% ROI for the 30 TPH plant. A larger stockpile would result in even greater savings and should be a part of the project planning. Changing the operating hours from one to two shifts per day will also result in improved economics. If substantially less volume is processed annually than was assumed, then neither plant will be economical. It is very important that the plant size be carefully selected to avoid installing a facility that is likely to be underutilized.

E. Result and Recommendations

It has been shown that construction of an abrasive recycling plant can be economically justified at Avondale providing that sufficient consumption exists to keep the plant running at least one shift daily. Establishing an initial stockpile prior to start-up will improve the economics and will help pay for the plant’s initial installation.

It is suggested that if Avondale chooses to proceed with this project, they construct a 15 TPH plant. It is sufficiently sized to process the amounts of abrasive used in recent years with only a slight increase in operating hours per year. Material could be hauled to the plant from other facilities to further reduce mineral abrasive costs for blasting operations and to keep the plant fully utilized.

SPECIFICATIONS
FOR
BLAST ABRASIVE RECOVERY SYSTEM

A. General

These specifications describe a facility for the recycling of spent mineral slag blasting abrasive. To be included is the design, selection and furnishing of all material conveying equipment, screening devices, hopperss silos, motorss controls, dryer-deduster, structural supports, fans, dust collectors, ducting and other items necessary to furnish a complete and operating facility. All components shall be suitable for outdoor industrial environment and for handling of the abrasive material.

The purpose of this facility is to reclaim used slag-type abrasive by separating trash, ferrous contaminants, moisture and dust from reusable abrasive. The following specifications describe the process which is shown schematically on the attached drawing.

B. Process Design

1. Removal of Contaminants

   As-received abrasive shall be screened on a 2-inch magnetic grizzly to remove large contaminants and metallic. The undersize from the grizzly shall then be screened on a l/2-inch screen for removal of smaller contaminants.

2. Drying and Dedusting

   Drying and dedusting shall be accomplished through a dryer sized to sufficiently dry the material to a moisture content no greater than 0.5% by weight. The dryer shall be supplied with a forced-draft blower, natural gas burner, combustion and ignition controls, high temperature shutdown and modulating thermostatic firing control. Either a fluidized-bed or a rotary type dryer shall be utilized.

3. Screening

   Product leaving the dryer shall be screened on a 2-deck vibrating screen. The screen shall separate #10 mesh oversize and #100 undersize for discard. The reusable material remaining shall be transferred to a storage bin.

4. Blending Process

   New product to replace losses shall be stored in a bin adjacent to the recycled product storage.

   A gravity flow mixing unit shall mix recycled product with new product to provide a suitable final product. Adjustments shall be provided to control blending ratio.

C. <u>Design Parameters</u>

Plant shall be designed to operate with the following parameters:

1. Composition of Plant Feed: (Weight %)

Reusable Size: #12 to #100 Sieve	60%
Fines #100 Sieve undersize	12%
Moisture	10%
Magnetics	4%
+2″ Trash	5%
+1/2″ Trash	5%
+ #10 Sieve Trash	4%

2. Composition of Dryer Feed: (Weight %)

Abrasive Product	70.0
Oversize (#10 Sieve)	5.0
Fines (#100 Sieve)	14.0
Moisture	11.0

3. Feed rate to plant = option #1 - 15 tons per hour
   option #2 - 30 tons per hour

4. Bulk density = 100#/ft.^{3}
   Hardness = equivalent to 50-58 Rc

FIGURE 1

BLAST ABRASIVE RECLAIM SYSTEM

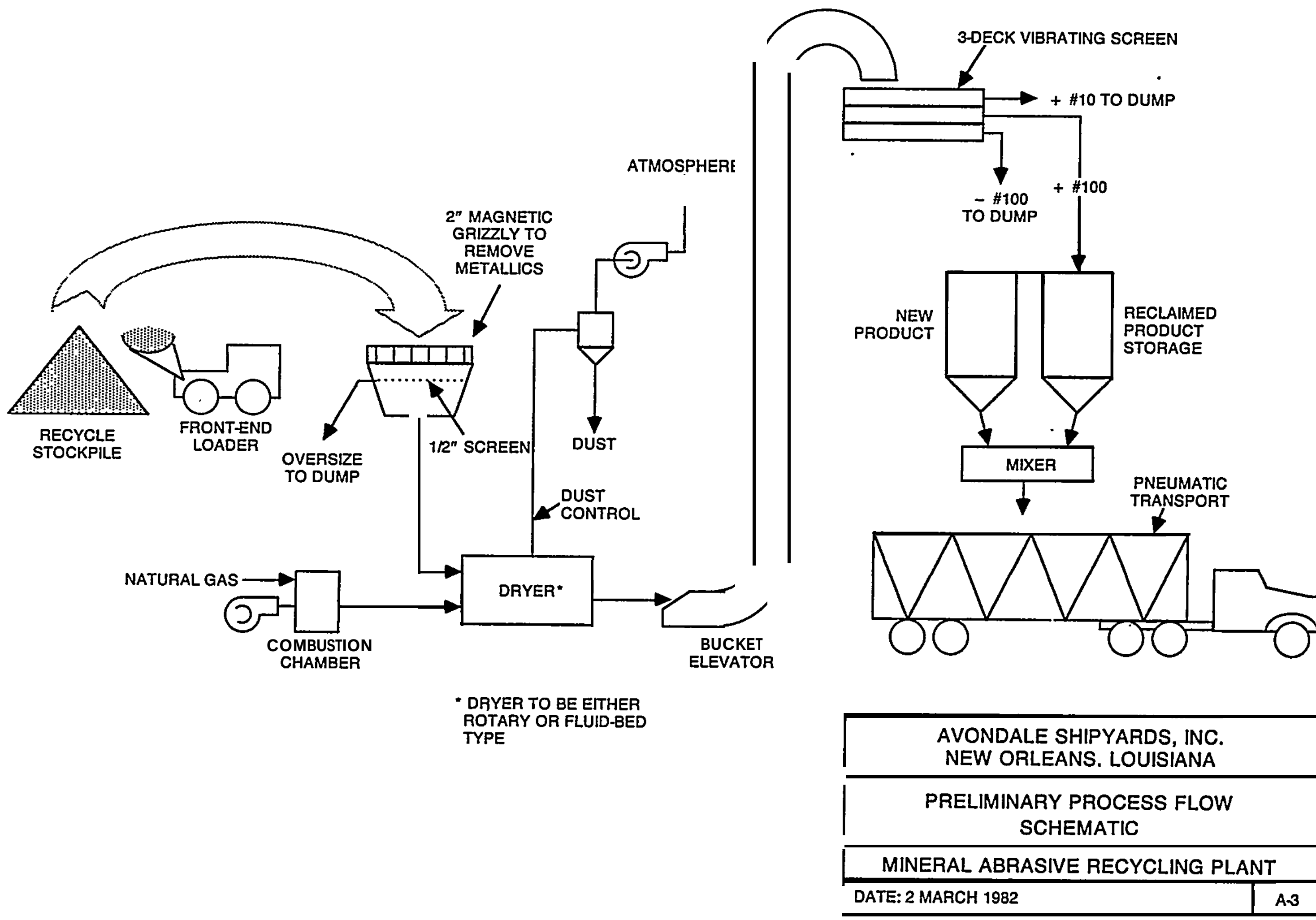


FIGURE 2

ABRASIVE RECLAIMING PLANT
COST ESTIMATES

ITEM		15 TPH Plant	30 TPH Plant
A.	Reclaiming Equipment		
	Rotary Dryer and Dust Control	$183,000	$305,000
	Material Handling Conveyors	24,400	29,400
	Hoppers and Bins	48,800	50,800
	Vibrating Screen(s)	12,600	25,200
	Grizzly and 1/2″ Screen	4,900	4,900
B.	Misc. Hoppers and Bins	31,700	33,700
C.	Foundations	21,600	32,000
D.	Electrical and Controls	42,000	50,000
E.	Front End Loader	.40,000	40,000
F.	Pneumatic Transport Truck	65,000	65,000
G.	Misc. and Contingency	48,000	64,000
	TOTAL ESTIMATED COST	$522,000	$703,000

FIGURE 3

OPERATING COST CALCULATIONS

Assumptions :

Plant Sizes	15 TPH and 30 TPH
Annual Operation	200 days per year, 7 hours per day
Total Production Output -	
’15 TPH -	21,000 tons per year
30 TPH -	42,000 tons per year
Natural Gas Cost	\$5.00 perMCF
Electricity Cost	\$0.045 perkwh
Labor Cost	\$20 per hour

Natural Gas

15 TPH - * 5.5 M^2 Btuh x 1400 hours = 7,700 M^2 Btu
Volume @ 1000 Btu/CF = 7.7 M^2 CF
Annual Cost @ \$5.00/McF= \$38,500

30 TPH - * 11.0 M^2 Btuh x 1400 hours = 15,400 $M^=$ Btu
Volume @ 1000 Btu/CF = 15.4 M^2 CF
Annual Cost @ \$5.00/MCF = \$77,000

* Furnished by dryer manufacturers

Electricity

15 TPH - Total requirements - 50 kw
Annual Cost = 50 kwx 1400 hours x \$0.045 per kwh = \$3,150

30 TPH - Total requirements - 75 kw
Annual Cost - 75 kw x 1400 hours x \$0.045 per kwh = \$4,725

Labor Costs

Annual Cost = 2 men x *2400 hours x \$20 per hour = \$96,000
* Includes overtime

Maintenance Costs - 5% of initial cost per year

15 TPH - Annual Cost = 0.5 x 522,000 = \$26,100

30 TPH - Annual Cost = 0.5 x 703,000 = \$35,150

Total Annual Operating Costs

15 TPH - \$163,750

30 TPH - \$212,875

FIGURE 4

ANNUAL COST-SAVINGS

Assumptions:

Recovery Rates:		60% of new 30% of twice used or each new ton is used 1+ (1 x .6) + (.6x .3) = 1.78 times
Effective Recovery Rate	=	[1 - (1/1.78)] x100 = 43.8%
Cost of New Abrasive	=	$40.00 per ton
Disposal Costs	=	$3.00 per ton
Annual Production Rates		
15 TPH	=	21,000 tons
30 TPH	=	42,000 tons

15 TPH Plant:

Savings in New Abrasive	= 21,000 tons x (1 - 0.562) x $40 =	$367,920
Savings in Disposal	= 21,000 tons x (1 - 0.562) x $3 =	$ 27,594
Total Annual Savings		$395,514

30 TPH Plant:

Savings in New Abrasive	= 42,000 tons x (1 - 0.562) x $40 =	$735,840
Savings in Disposal	= 42,000 tons x (1 - 0.562) x $3 =	$ 55,188
Total Annual Savings		$791,028

FIGURE 5

SUMMARY OF LIFE CYCLE ANALYSIS CALCULATIONS

Assumptions:

Project Life:	10 years
Cost of Capital:	15%
Tax Rate:	46X
Depreciation:	Sum of Years Digits Method
Inflation Rate:	5%
Investment Tax:	10%

The base year is assumed to be the year of project completion. Start-up is assumed to occur the first of the following year with a full year of operating savings.

	15 TPH Plant	30 TPH Plant
Initial Cost	$ 522,000	$ 703,000
Annual Operating Cost	$ 163,750	$ 212,875
Annual Savings	$ 395,514	$ 791,028
Investment Tax Credit	$ 52,200	$ 70,300
*present Value of Savings	$ 919,020	$2,138,728
Equivalent Annualized Cash Flow	$ 183,117	$ 426,146
Profitability Index	1.76	3.04
Discounted Payback	3.99	2.03
% Return on Investment	33.06	60.07

*Includes corporate taxes, depreciation, and 5% inflatiOn.

FIGURE 6

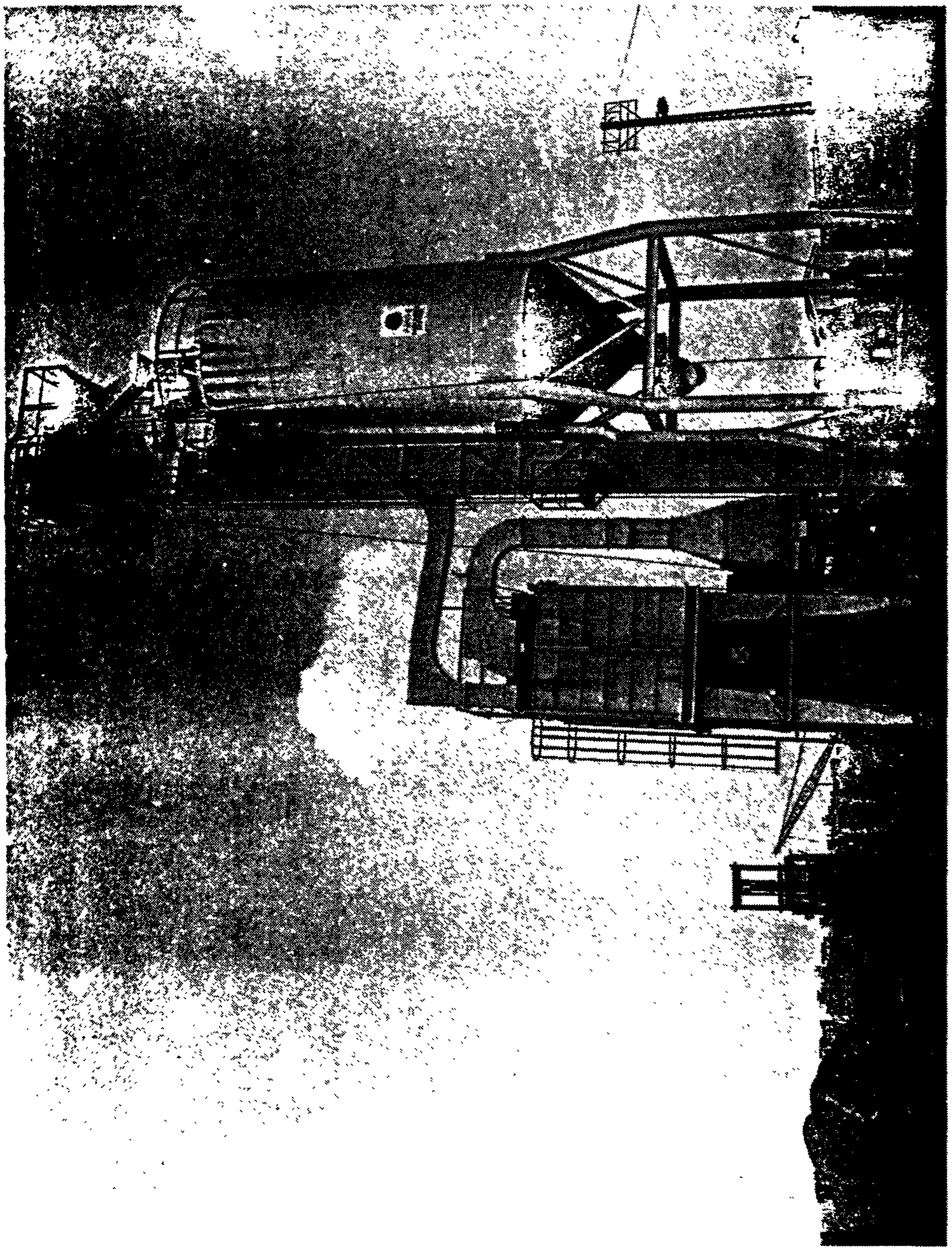


FIGURE 7

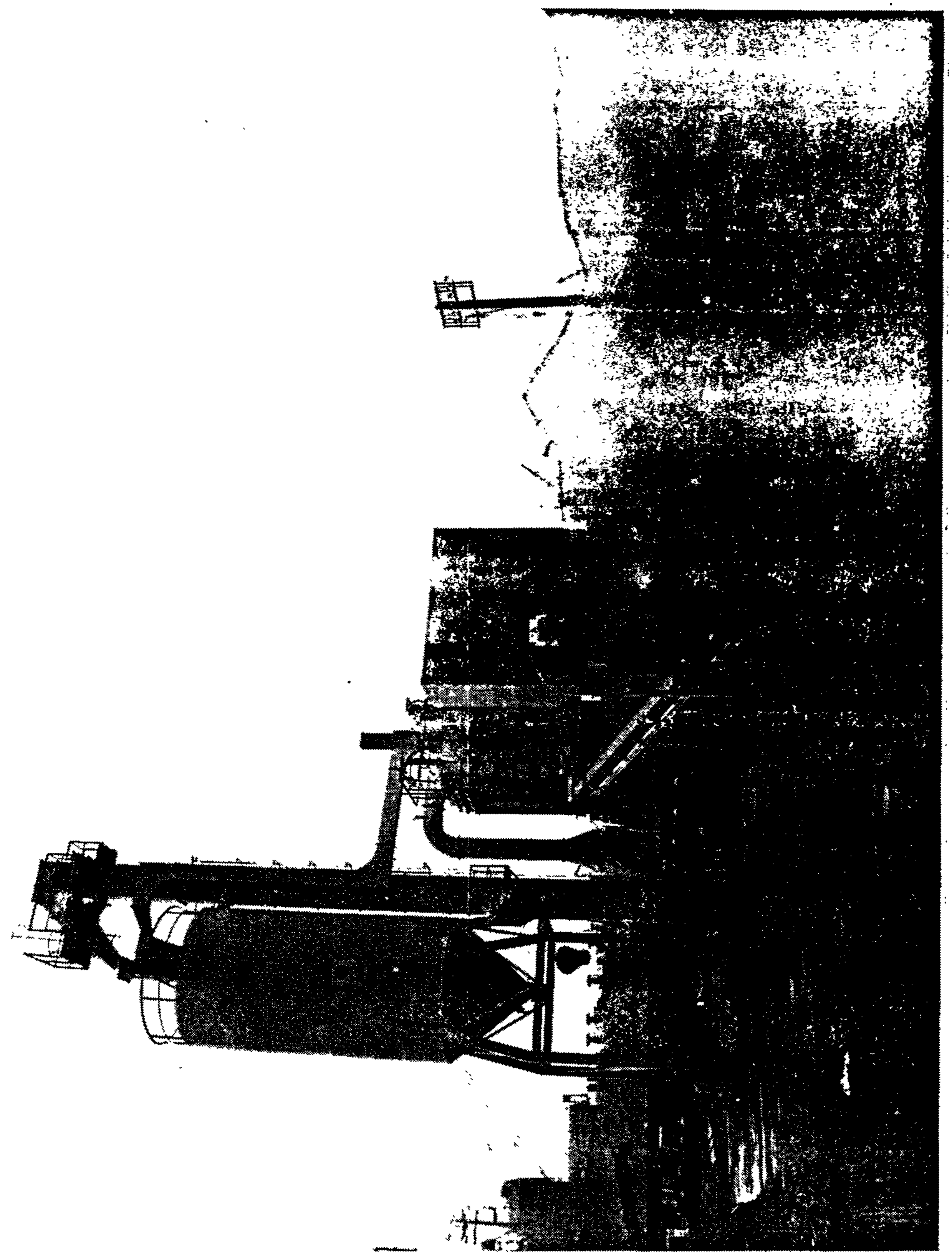
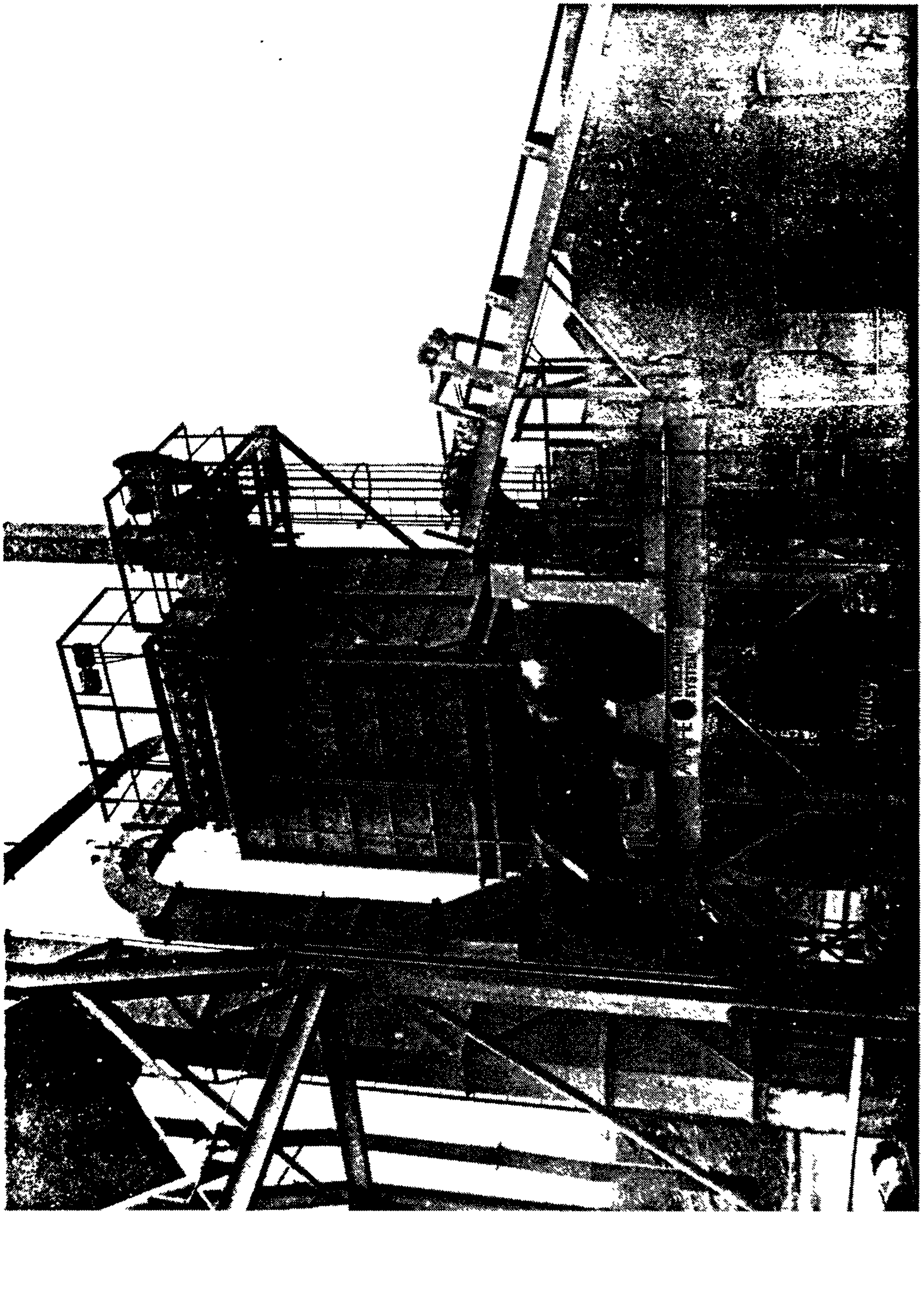


FIGURE 8



APPENDIX B

PROTOTYPE ABRASIVE RECLAIMING SYSTEM FOR SHIPYARDS
PRELIMINARY REPORT SUBMITTED TO SNAME 023-1 AND ASTM 25.02 PANELS

OCTOBER 7, 1983

By: Kevin F. Brown
Bethlehem Steel Corporation
Sparrows Point Shipyard

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ABSTRACT

As those in the shipbuilding industry are already aware, the need for implementing innovative and cost-efficient systems in this country's marine construction yards has never been greater. Indeed, all industries are affected by the increasing pressures that are brought to bear to reduce costs and increase quality. The U.S. Navy has also joined in this never ending battle, thereby inducing still greater demands on the shipbuilding industry. Simple deduction reveals the increased competition among the yards given the current state of affairs, and logic demands the need for swift and decisive action.

One such course of action is to transform previously useless material into a product which meets quality and productivity requirements. The reclamation of "spent" mineral abrasive can reap quite a large savings while satisfying the criteria of quality and productivity. The idea of reclaiming abrasive has been around for quite some time. The only stumbling blocks being cost and efficiency; quite formidable obstacles to be sure.

This paper dedicates itself to the role of the abrasive reclaiming system in the Sparrows Point Shipyard surface preparation processes. The system is discussed in such fashion as to fully explore the effectiveness and efficiency of the system in this regard.

GENERAL COMMENTS

A. DEFINITION OF PROBLEM

The Sparrows Point Shipyard has for many years considered the huge stockpile of "spent" mineral abrasive as something less than trash. It represents money--fifty dollars a ton--never to be utilized again: an unwanted residue of past abrasive blasting operations. The only use for the material was to continue the landfill program at this particular location.

The concept of reclaiming the abrasive was bandied about for many years, with no appreciable results. The ingredients for such an operation were obviously apparent: virtually inexhaustible supply; the will to process the material; etc. The only ingredient lacking was a systematic process where such work could be performed. This problem no longer exists given the reclaiming facility now operating at the Sparrows Point Shipyard.

B. DECISION CRITERIA

Having received the opportunity to submit a proposal for the MarAd program, a number of parameters were considered prior to the decision to bid for the project. These parameters and a relative description of the decision process are as follows:

1. ECONOMICS

The annual consumption of mineral abrasive at Sparrows Point Shipyard is in the neighborhood of 12,000 tons; at fifty dollars a ton this is a considerable sum. The spent abrasive stockpile consists of tens of thousands of tons of material. Thus, the supreme interest in the concept of abrasive reclaiming. Estimates as to the projected cost per ton to be absorbed by the yard was approximately seventeen dollars--a huge savings! Perhaps the most important aspect of this criterion was the MarAd grant enabling the yard to participate in the program for testing the prototype system.

2. EFFICIENCY

This criterion could arguably be included in the Economics section of this report, however, it is a system response so the need for differentiation is clear. The abrasive reclaiming system must--in order to be cost efficient--process a relatively high volume of material per period of times with a high yield percentage at a reasonable cost. Studies of the stockpiled mineral abrasive projected a yield of 60-70%. This magnitude of recovered abrasive is sufficient to meet the yard's yield percentage requirements. The reclaiming system is rated at a production capacity of 20 tons/hour while the rate of yield is 12-14 tons/hour. Given the abrasive requirements for the Sparrows Point Shipyard this production capacity meets the aforementioned measure. An estimate of the cost/ton to produce abrasive indicates a substantial savings given the abrasive requirements already stated. Figure 4

3. EFFECTIVENESS

Having theoretically produced a cost efficient mineral abrasive, the following consideration is of supreme importance, i.e., is the material an effective abrasive blasting medium. The reclaimed material must not have an excessive breakdown rate, it must have an acceptable operating mix and it must produce a surface profile of approximately 2.0-2.5 mils (50-63 um). Although the reclaimed material is known to be a finer mix than the mineral abrasive now purchased, it, is also known-that an acceptable surface profile can be achieved while utilizing the finer material. Studies have indicated a 2.5 times recovery rate for the coal slag material. Figures 1-2-3

4. ENVIRONMENTAL

The State of Maryland has rather stringent environmental regulations concerning the emission of particulates into the air. Since the reclaiming system proposed enjoys acceptance in the State of California no serious obstacles were thought to arise. The reclaiming system is essentially a closed system with few emission areas which could, through modification, essentially be closed.

The spent abrasive, if exceeding allowable concentrations of toxic elements, can pose a serious problem if considered a hazardous waste. Fortunately, the Sparrows Point Shipyard has, as a matter of course, eliminated the use of substances such as lead and chromates in the production coatings. An EPA toxicity test is to be performed on both spent and reclaimed abrasives for verification.

5. STAFFING

The reclaiming system as proposed requires two operators to efficiently produce abrasive. During operating periods, one man monitors the control booth and keeps a watchful eye over the facility ever diligent for a malfunction while the second operator devotes himself to the operation of the front end loader and the other various mobile equipment. The supervisor of the area is an operating engineer who monitors the control booth, performs all record keeping, and initiates the preventive maintenance program. The second operator is from the transportation department and is responsible for delivering the reclaimed abrasive and assisting the operating engineer in his duties. Figures 6-7

C. ABRASIVE RECLAIMING FACILITY

The reclaiming facility as designed by Apache Abrasives, Inc. is really quite simple in theory. It consists of few components which makes for both production and preventive maintenance ease. A brief summation of the process is provided as follows:

The spent abrasive is loaded into the input receptacle through a l-inch vibrating grizzly. The material is then transferred by conveyor at a rate of 20 tons/hour to the rotating dryer. The rotating dryer is heated by a diesel burner which eliminates moisture at this stage. At the end of the drying cycle the abrasive is transferred to one of three material chutes: the first chute is for oversized material of 3/16"-1" in size, the scalping screen at this point eliminates this coarse material; the second chute is to the 6,000 cfm baghouse which draws the talc material (140 mesh minus); the third chute transfers the acceptable material at this point to the bucket elevator. At this juncture the material temperature is monitored by a thermo-couple, the average temperature is 300°F. The material is transferred to the air wash and inertial separator where the fines (talc) and intermediate fines (80-140 mesh) are further reduced. The specified reclaimed abrasive is then stored in the 100 ton silo. Figures 8-9-10

The installation of the facility is rather straightforward, though a considerable amount of additional work was necessary due to fabrication and design errors--this will be discussed more fully later in the report. The foundation layout and the ramp are examples of structures deemed necessary due to the peculiarities of the yard. The facility sits on a landfill site. As such there is much concern with regard to settling; hence, the large foundation pad. Secondly, the shipyard is faced with a front end loader problem. That being, the one currently in use is a bit undersized for the work as is its replacement: the result is a ramp.

The reclaiming facility is located beside the abrasive stockpile for production purposes. The location is ideal for this type of operation; far from the bustling operations normally found in the shipyard. Much thought must be given to site selection, since the process can interfere with some production areas. Careful consideration must be given to the elimination of airborne dust in these areas.

Since the inception of the facility as a viable unit, great pains have been taken to work the abrasive reclaiming proces into the yard processes. This has been a multi-step progressive system, gradually-mainstreaming the unit into the yard’s blasting processes. At this writing the reclaimer services three of the four major abrasive blasting locations. This service is not exclusive, since the facility has experienced considerable down-time due to the inherent difficulties associated with any new facility. The applications have varied from preparing mill scale and rust plates to commercial blasting and underwater hull coating system. In each instance the abrasive has performed admirably.

D. OPERATIONS

Although the reclaimer system produces abrasive at an extremely low cost, there still exists a fine line between profitability and loss. There must not be excessive down-time if the facility is to be an efficient operating unit. A process such as this, is—by nature--a self-destructive one. Being cognizant of this, preventive maintenance must be adopted as a formal, continuing program which is strictly adhered to. The importance of such a program cannot be emphasized too strongly. Preventive maintenance and quick minor repairs must be made on site by the facility operators. This approach has already reaped benefits for the Sparrows Point Shipyard where the facility operators have been able to elicit these repairs without the assistance of the plant maintenance group. Figure 11

The actual operation of the system is rather straightforward with few complicated procedures. While operating, it is imperative that a watchful eye be kept on the refuse bins to prevent overfilling. This is especially true of the coarse receptacle which is closed and under vacuum. The system has many safeguards including-high temperature limits and alarms which reduce the possibility of aggregarious error. The production rate of the system is 20 tons/hour which necessitates almost constant use of the front end loader during production periods.

This brings us to the staffing of the facility. As previously discussed, the two operators at Sparrows point are an operating engineer and a transportation worker respectively. The operating engineer was selected to facilitate the preventive maintenance program in its early stages and provide expertise-in machinery and its attendant repairs. This has been especially useful during the “de-bugging” stages of operation. Ultimately, it is hoped the second operator can gradually assume the engineer’s duties through experience and training. This is desirable as a great percentage of the duties performed are of a transportation nature. If the second operator can assume those duties, and a second transportation worker can assist, then the unit will become a more productive one with shared duties.

The problem of refuse disposal has not yet arisens because of the Sparrows Point requirements for coating selection. Toxic elements such as lead and chromates are as a rule disallowed as ingredients in the paint formulations currently in use at the Sparrows Point Shipyard. However, EPA toxicity tests have been performed for confirmation of this hypothesis. These same tests will be performed periodically so as to remain fully aware of the chemical composition of the reprocessed material.

During an eight hour period, the operating process is segregated into three major job functions. The primary job function is, of course, operations which consist of both the front end loader operation and control monitoring. This function comprises approximately five hours of an eight hour period. The next function of the facility operators is site cleaning which includes general cleanup and refuse removal. Given the percentage of yield for the product, an operating continuum may be maintained for approximately 2 hours at which time the refuse receptacles must be emptied. This function comprises approximately two hours of an eight hour work period. The remaining function of the facility operators is preventive maintenance which is further delineated into time period functions. This function comprises approximately one. hour of an eight hour work period. The remaining function is the transfer and transport of the reclaimed material. This function is performed primarily outside the normal eight hour work period. In order to avoid interference of the yard's abrasive blasting process, this work is completed prior to the start of the shift or between shifts . The associated premium time has not resulted in a significant cost per ton ratio. Figures 12-13-14

CONCLUDING REMARKS

The paramount test of any product is its utilization in its respective production process. In this instance the ultimate trial of performance is abrasive blasting. Whether the material looks good or feels good is immaterial, the performance is the acid test. Is there excessive dust? Does the abrasive produce an acceptable profile? Does the abrasive increase productivity? Will the abrasive have limited applicability? These are the questions which must be asked and answered in order to measure the viability of the product. It can be stated with complete confidence that the reclaimed material outperforms our greatest expectations. The reclaimed abrasive yields a surface profile of 2.0-2.5 mils which is a more efficient surface profile than is obtained from contracted abrasive (3.0-3.5 mils). It produces this profile more quickly; estimated production increase of 15-20%. The applications have been varied, ranging from abrasive blasting mill scale rust plates, preconstruction primed plates to an underwater hull. coating system. The reclaimed abrasive has consistently outperformed the contracted abrasive in all applications. The Apache reclaimer system is indeed an effective process producing a superior abrasive. Figures 2-3

Is the Apache system an efficient system? This question can only be answered in time. At this time, the yard is only now beginning to iron out all the “bugs”. Even laboring under these difficulties, the reclaimer system is still a profitable operation. All indications point to a potentially enormous savings. When contracted abrasive approaches fifty dollars per ton it is inconceivable that money cannot be saved if the process can maintain some semblance of a continuum of operation. It is imperative that down-time is kept to a minimum. If this can be achieved, the-potentially enormous savings <u>will</u> be realized. Figure 5

Since the reclaiming system has been in operation for a relatively short period, the reported data does not provide an exceptional statistical measure of final results. It is not believed, however, the absence of the statistical readings required shall significantly affect the data or the attendant conclusions. As can be readily seen the estimate for the actual opertion of the facility has been reduced and the validity of this preliminary estimate will be borne out in time. Figures 4-5

The Apache Reclaiming System is a prototype facility for shipyards. As such, there are intrinsic design and fabricated errors. These errors have ranged from inaccurate foundation plans to undersized ductwork. These errors have--through operation--been discovered and rectified. The difficulties faced thus far have not been insurmountable, and the project has sustained a fairly even keel.

Material management for the facilty requires constant monitoring so as to avoid the reclamation of processed material without benefit of mixing. Allowing this situation to occur would do two things: first, it would induce an operating mix which would be too fine; second, it reduces the efficiency of the process. Ideally, the reclaimer will satisfy 90-95% of the abrasive demands with the remainder supplied by an outside contractor. This is an acceptable situation, since it provides for unusually high demand periods and provides an influx of fresh material.

During the one year experimental trial period, it is the intention of the Sparrows Point Shipyard to further pursue relevant. testing to fully document the effectiveness and efficiency of the abrasive reclaiming system in a marine construction yard. The evaluation program is to include the following pertinent tests:

1) scheduled sieve analyses performed on the reclaimed material and refuse to ensure proper screening of materials

2) time and motion studies to corroborate alleged productivity gains

3) cost studies to obtain actual operating costs and revenues

4) periodic inspection of prepared substrate to affirm the performance of the abrasive as a blasting medium

5) periodic EPA approved toxicity tests to determine concentration of appropriate toxins

As this is the preliminary report for this program, it will serve as a foundation for future reporting. The final report shall include the results of the proposed testing and furnish a documented statement of the practicability of the abrasive reclaiming system in the nation's shipyards. A detailed report on the program cost will be submitted to Mr. J. Peart and the Maritime Administration prior to publication of the final report.

FIGURE 1

The mineral abrasive presently in use at the Sparrows Point Shipyard is a coal slag. This coal slag is a by-product of coal burning power plants, etc. The specification for the purchase of mineral abrasives is as follows:

Sieve Analysis

Sieve	Preferred Wt. % Size Dist.	Acceptable Wt. % Range
#8	100	< 1
#12	95	93-97
#20	80	75-85
#30	55	50-60
#40	30	25-35
#50	15	13-17
#70	10	8-12
#l00	5	
#140	0.-<1	0.-<%
Pan	<0.5 "	Trace

Trace =<0.5%

Chemical Analysis

Free Silica	5% Max.
Sulfur	0.02% Max.
Chlorides	<10 PPM
Free Carbon	None
PH	5 - 6.5
Moisture	<0.01%

Physical Properties

Bulk Density (Dry Rodded)	- >85 lbs. /cu. ft.
Mobs Hardness	>6
Breakdown Rate	Max. 30% Passing #70 Sieve*
Particle Shape	Particles must be angular

(*) Blasting against steel plate, 45° to the vertical, at 12 inches using 100 PSI air pressure.

FIGURE 2

RECLAIMED ABRASIVE
SIEVE ANALYSIS

Mesh	Wt. in grams	% by weight
8	33	1.17
10	96	3.42
20	1164	41.44
30	423	15.06
50	806	28.69
70	153	5.45
70-	134	4.77

Density 90 lbs./cu.ft.

Recovery Rate 1st 70% 2nd 30%

1+ [(1 x .7) + (.7x .30] = 1.91 Times

Effective Recovery Rate [(1-(1/1.91)] X 100 = 47.6%

FIGURE 3

INTERMEDIATE FINES AND FINES SIEVE ANALYSIS

Intermediate Fines

Mesh	Wt. in grams	% by Weight
35	1.9	1.8
50	5.2	4.9
70	15.9	15.0
80	16.7	15.9
100	14.0	13.3
140	28.1	26.7
200	12.8	12.2
PAN	10.6	10.1

Fines

Mesh	Wt. in grams	% by Weight
50	3.6	2.7
70	8.8	6.6
80	12.9	9.7
100	15.9	11.-9
140	23.0	17.3
200	22.7	17.1
PAN	46.0	34.6

FIGURE 4

ORIGINAL ESTIMATE OF OPERATIONAL COST

Power Cost (Fuel and Electric)	$ 4.00/ton
Labor @ $18/hour	$ 3.90/ton
Maintenance @ 5% of Initial Cost ‘	$ 0.70/ton
Depreciation	$ 2.30/ton
Disposal of Refuse	$ 3.30/ton
In-Yard Handlingf Reclaimed Abrasive	$ 1.80/ton
TOTAL COST	$16.00/ton

NOTE : These estimates are based upon an annual consumption of 12,000 tons of mineral abrasive and a recoverable yield of 70%

FIGURE 5

PRELIMINARY OPERATIONS ESTIMATE

Power (Fuel and Electric) "	$ 2.85/ton
Labor @ $18/hour and $24/hour	$ 3.00/ton
Maintenance @ 10% of Initial Cost	$ 1.40/ton
Depreciation	$ 2.30/ton
Disposal of Refuse	$ 3.30/ton
In-Yard Handling of Reclaimed Abrasive	$ 2.20/ton
TOTAL COST	$ 15.05/ton

NOTE :

1) These estimates are based upon an annual consumption of 12,000 tons of mineral abrasive and a recoverable yield of 70%

2) To date the disposal of refuse expenses have not been realized.

FIGURE 6

JOB DESCRIPTION

ABRASIVE RECLAIMING FACILITY - SUPERVISOR - OPERATOR #1

Scope:

The following job description for the abrasive reclaiming facility shall provide a comprehensive description of activities and responsibilities for the efficient operation of the reclaiming facility.

Job Description:

1) Operator #1shall operate and monitor control panels in the operations booth.

2) Operator #1 shall be responsible for conducting the preventive maintenance program.

3) **Operator #1 shall be responsible** for supervision of the assisting operator and the facility area

4) Operator #1 shall be responsible for completion of operation forms.

5) Operator #1 shall be responsible for notification of related departments with regard to time charges, material charges, etc.

6) Operator #1 shall be responsible for the coordination of deliveries with the transportation and paint departments.

7) Operator #1 shall assist the project leader in scheduling down-time and determining operational status.

FIGURE 7

JOB DESCRIPTION
ABRASIVE RECLAIMING FACILITY - OPERATOR #2 .

Scope:

The following job description for the abrasive reclaiming facility shall provide a comprehensive description of activities and responsibilities for the efficient operation of the reclaiming facility.

Job Description:

1) Operator #2 shall operate the front end loader for the purpose of charging the facility with spent abrasive.

2) Operator #2 shall operate a forklift for the purpose of dispensing non-reclaimable materials.

3) Operator #2 shall be responsible for the general cleaning of the facility site. Cleaning may be accomplished through use of the front end loader and broom.

4) Operator #2 shall assist, when necessary, Operator #1 with the preventive maintenance program designed for the reclaiming facility.

5) Operator #2 shall operate the pneumatic transport trailer for the transport and transfer of the reclaimed abrasive.

FIGURE 8

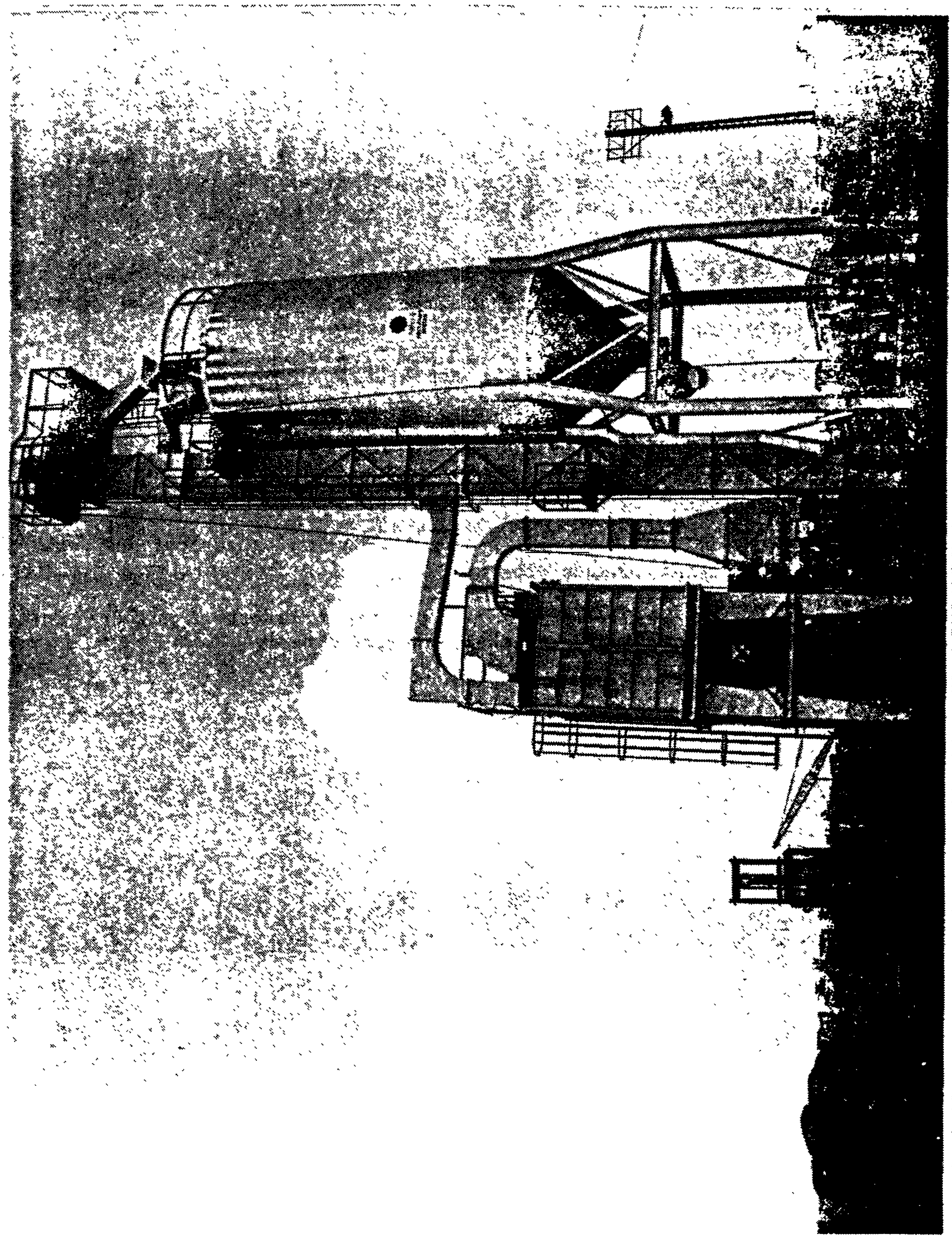

FIGURE 9

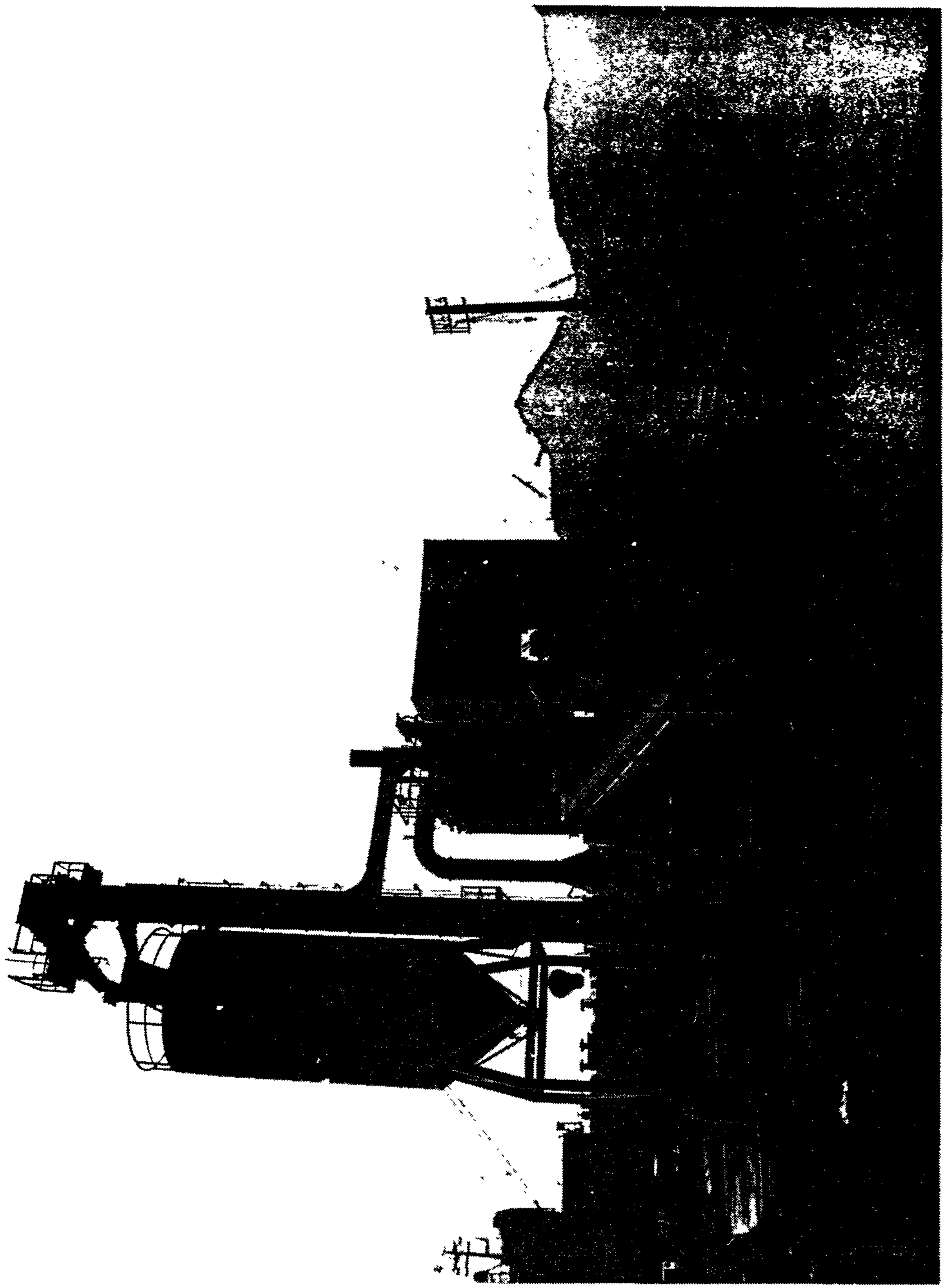

FIGURE 10

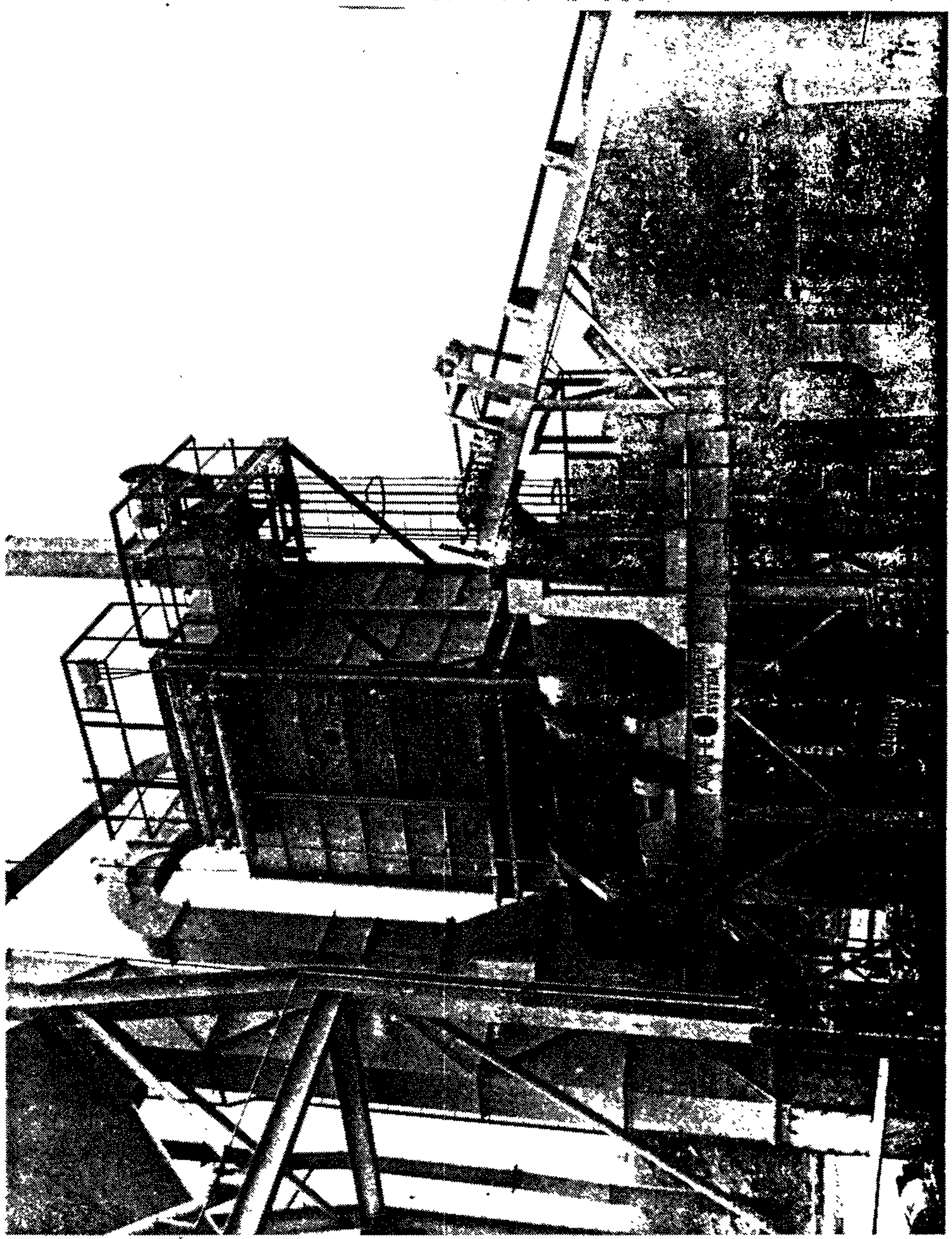

FIGURE 11

DAILY PREVENTIVE MAINTENANCE PROGRAM FOR GRIT RECYCLING PLANT

Air Line

Blow moisture out of line before starting plant.

Fuel Oil and Propane Tanks

1) Check fuel levels and fill as required.
2) Check valves on feed lines of oil tanks. Both valves should be open.

Feed Bin and Vibrator

1) Check vibrating screen for binding.
2j Check connection of legs to foundation for cracked welds.

Feed Conveyor

1) Check feed belt for tension and alignment on drive rolls. If necessary make adjustments.
2) Listen for squealing sheave belts on drive assembly and if necessary make adjustments.
3) Tweak all pillow block bearings with grease.
4) Check all belt rollers for freeness.

Fuel Oil. Pump

1) Inspect seals for leaks.
2j Check for low oil pressure to burner.
3) Pressure should be between 40 and 60 PSI (if pressure is low adjust pressure relief valve).

Bucket Elevator

1) Tweak all bearings with grease.
2) Listen for squealing belts on drive assembly located at the top of the elevator and if necessary make adjustments.

Baghouse

1) Check manometer reading for pressure drop across baghouse. (Drop shouldbe no larger than 5" of water column. If pressure drop is larger than 5", adjust pulse time off to a lower setting to Increase frequency of bag cleaning.) Call Maintenance Department if pressure drop cannot be reduced.
2) Listen for squealing belts and if necessary make adjustments.

FIGURE 11 (Cont'd)

WEEKLY PREVENTIVE MAINTENANCE FOR GRIT RECYCLING PLANT

Feed Conveyor

1) Check tension belts on drive sheave assembly and if necessary make adjustments.

Bucket Elevator

1) Open inspection plates (top and bottom) and check tension and alignment of belt. (If belts are not centered on rollers call Maintenance Department). Check wear plates located on sides and bottom of elevator shaft.
2) Check tension of belts on drive sheave assembly and if necessary make adjustments.

Baghouse

1) Check tension of belts on drive sheave assembly and if necessary make adjustments.

Aspirator/Separator

1) Open side doors and inspect sheaves for wear. (If worn, call Maintenance Department.)

FIGURE 11 (Cont'd)

MONTHLY PREVENTIVE MAINTENANCE FOR GRIT RECYCLING PLAN

1) Tweak all motor bearings with grease (on vibrator, converyor dryer, oil pump burner blower, bucket elevator, and baghouse motors).
2) Check oil level of all gear reducers (on dryer, etc.).
3) Check torque on all pillow" block bearing set screws (on conveyor, bucket elevator, etc.).
4) Visually inspect bags in baghouse for tears. Inspect baghouse for water leaks.

ABRASIVE RECLAIMING ‘OPERATION FORM

ENTRY	OPERATOR	DATE	TIME A.M.	1 LOAOS A.M.	STACK T A.M.	BIIRNER T A.M.	SILO LEVEL A.M.	TIME P.M.	/ LOADS P.M.	STACK T P.M.	BURNER T P.M.	SILO LEVEL P.M.
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
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35												
36												
37												
38												
39												
40												

FIGURE 12

ABRASIVE DELIVERY FORM

ENTRY	OPERATOR	DATE	TIME REQUEST	TIME DELIVERY	LOCATION 1	LOCATION 2	LOCATION 3	LOCATION 4	SILO LEVEL BEFORE	SILO LEVEL AFTER	WEIGHT BEFORE	WEIGHT AFTER	HULL CHARGE
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
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34													
35													
36													
37													
38													
39													
40													

FIGURE 13

FIGURE 14

ABRASIVE DELIVERY TICKET

1. DATE ____________

2. TIME ____________

3. INITIAL WEIGHT __________ LBS.

4. FINAL WEIGHT ____________ LBS.

5. DELIVERY LOCATIONS ____

6. DRIVER'S SIGNATURE AND BADGE NO. ________________________________

ITEMS 1-6 TO BE COMPLETED BY DRIVER

7. DATE ___________

8. TIME ___________

9. HULL CHARGE ______________

10. RECEIVED BY (NAME AND BADGE NO.) ______________________________

ITEMS 7-10 TO BE COMPLETED BY 75 DEPT. SUPERVISOR

11. DATE __________

12. TIME __________

13. CONFIRMATION SIGNATURE ____

ITEMS 11-13 TO BE COMPLETED BY FACILITY OPERATOR

TICKET TO BE COMPLETED IN TRIPLICATE:

ONE COPY TO BE RETAINED BY 75 DEPT.
ONE COPY TO BE RETAINED BY FACILITY OPERATOR
ONE COPY TO BE SENT TO ACCOUNTING

APPENDIX C

PROTOTYPE ABRASIVE RECLAIM SYSTEM FOR SHIPYARDS

FINAL REPORT

SEPTEMBER 6, 1985

TABLE OF CONTENTS

INTRODUCTION

The. purpose of this project was to erect a prototype abrasive plant in the shipyard 'and to evaluate its cost effectiveness and viability in the shipbuilding industry.

The project is a part of the national shipbuilding research program, which is cost-shared between the U. S. Maritime Administration and the U. S. Shipbuilding Industry. The project was coordinated by Bethlehem Steel Corporation, Marine Construction Group, Sparrows Point, Maryland under contract to Avondale Shipyards,Inc., New Orleans, LA 70150.

The abrasive recycling system selected for this purpose was one provided by Apache. Apache provided the unit for a cost of $107,000. The system consisted of "on the shelf" components that required field modifications and adjustments for use in the yard.

DISCUSSION

1. Problem

The material to be recycled consists of a mineral coal slag blast abrasive known as Black Beauty which has been used at least once in a blasting operation, loaded into a pan with scrap material and deposited in a storage location known as "the north field". The north field currently contains a large amount of this recyclable material. Prior to recycling, the only use for the material was to continue the landfill program at the north field.

2. Solution

The concept of recycling material is an old one, but with the opportunity to erect a prototype facility whose cost would be shared by the MarAd program came a possible solution to the growing stockpile of spent mineral abrasive in the north field.

The original decision to bid on the MarAd project was based on the following assumptions:

a) A $50/ton purchase cost for new blasting grit.

b) The cost to recycle material would be $16 to $17/ton.

c) The reclaiming facility could produce its rated capacity of 20 tons/hour with a yield of 12-14 tons/hour of good recycled product.

d) The spent material in the north field could be recycled as it exists.

e) The recycled material could be an effective abrasive blasting medium that has an acceptable breakdown rate, operating mix (see Figures 1, 2 & 3) and produce a surface profile of 2.0-2.5 roils (50-63 um). Although the reclaimed material is known to be a finer mix than the mineral abrasive now purchased, it was estimated that an acceptable surface profile could be achieved while utilizing a finer material.

f) The State of Maryland has rather stringent environmental regulations concerning the emission of particulate into the air. Since the reclaiming system proposed enjoys acceptance in the State of California, no serious obstacles were expected to arise. The reclaiming system is essentially a closed system with few emission areas which could, through modification, essentially be contained. The spent abrasive, if exceeding allowable concentrations of toxic elements, could pose a serious problem if considered a hazardous waste. Fortunately, the Sparrows Point Shipyard has, as a matter of course, eliminated the use of substances such as lead and chromates in the production coatings. An EPA toxicity test would have to be performed on both spent and reclaimed abrasive for verification.

g) The annual consumption of material abrasive at the Sparrows Point Shipyard would remain at 12,000 tons.

ABOUT THE PROCESS

The reclaiming facility consists of a vibrating scalping screen, belt conveyor, drying drum, bucket elevator, 6000 cfm dust collector, aspirator separator, inertial separator, 100-ton silo, and several small storage bins.

The process starts with a 3/4 yard front end loader that scoops up a load of materials drives up a ramp and dumps the material onto the vibrating screen. The vibrating screen allows material smaller than 1" square to fall into a feed hopper while the larger particles such as trash are shaken off the screen into a chute leading to a waste bin. The material from the feed hopper is transported by a belt conveyor to a dryer drum which is heated by an oil burner.

While it is being rotated and screened through and out the end of the dryer drum, the material is heated to about 350°F. At the end of the drum, the material is again separated into particles whose cross section is either more or less than 3/16" square. The particles larger than 3/16" square are deposited into another scrap bin. Particles smaller than 3/16" square, other than the dust which is drawn up by the dust collector, are lifted by a bucket elevator and dumped into an aspirator and inertial separator. Here, more dust and unwanted intermediate fines (80-140 mesh) are pulled out and the final (see Figures 1 & 2) designed particle distribution is dropped into a 100-ton silo for storage.

a 20-ton transport truck was purchased and is used to haul the recycled blast material from the 100-ton silo to the yard blasting tanks for loading. Once the transport truck hose is connected to a blasting tank fill pipe, the truck's tank is pressurized to' approximately 10 psi and the material is blown into the blasting tank.

INSTALLATION

Problems

1. The installation of the facility was rather straightforward although a considerable amount of additional work was necessary due to fabrication and design errors (See Figure 5).

2. The facility sits on a landfill site so that the foundation had to be designed larger than planned to allow for lower soil pressures.

3. The yard's front end loader could not reach the feed hopper for loading so a ramp had to be constructed. The ramp was less costly than purchasing a new front end loader and provided better operator visibility and maintenance accessibility.

4. The 6000 cfm dust collector required dry compressed air above 100 psi. The yard's air compressor station is approximately 1.2 miles away from the dust collector. consequently, the air picks up an unacceptable amount of moisture and the air pressure is only about 90 psi by the time it reaches the dust collector (sometimes referred to as the baghouse). A new compressor had to be purchased and installed.

Location

The reclaiming facility is located beside the abrasive stockpile for production purposes. The location is ideal for this type of operation; far from the bustling operations normally found in the shipyard. Much thought was given to site selection. Since the process can interfere with production areas, careful consideration was given to the elimination of airborne dust in these areas.

THE FACILITY AS IT EXISTS TODAY

Staffing

The facility requires two operators to efficiently produce abrasive. During operating periods one man monitors the control booth and keeps a watchful eye over the facility for a malfunction while the second operator devotes himself to the operation of the front end loader and the other mobile equipment. Operator #1 is a supervisor (operating engineer by trade) who monitors the control booth, performs all record keeping, and initiates the preventive maintenance program. Operator #2 is from the transportation department and is responsible for operating the mobile equipment and making deliveries. See Figures 6 & 7 for job descriptions.

Operation

The facility was placed in service in September of 1983. Due to fluctuations in our workforce, the position of Operator #1 has been held by 4 different individuals. The yard's demand for blast material has not been consistent and at times the opertors were left with nothing to do except cleaning. In 1984 the yard required only 2,953 tons and 643 so far in 1985. Our projected need for 1986 is around 3000 tons. Because the demand for the blast material is at the beginning of the yard's daylight shift, all blasting tanks could only be filled on off shifts, requiring overtime payments to operators. Until July 1985, the dust collector was operated on yard air which contributed a lower production rate and higher maintenance cost. A new compressor supplying adequate pressure and dry air was installed in July of 1985.

Efficiency

Since the inception of the facility, great pains have been taken to work the abrasive reclaiming process into the yard processes. This has been a multi-step progressive system gradually mainstreaming the unit into the yard's abrasive blasting locations. The applications have varied from removing mill scale and rust from plates to commercial blasting an existing underwater hull coating system. Except for a few complaints of excessive dust during interior blasting of tanks, the abrasive has performed admirably.

The Apache system model A-2000 was designed to yield 12-14 tons/hour. Currently we have averaged only 8 tons/hour or 2/3 of the design capacity. Many of the above problems have contributed to the low production rate. The weather has a significant effect on the production rate also. During the sumer months we averaged 10+ tons/hour and during the winter we averaged only about 7 tons/hour.

Environmental

Two EPA toxicity tests were performed on the reclaimed and spent abrasive (see Figure 8), the fine dust and intermediate fines. All levels were found to be acceptable and well below the allowed concentrateions.

ECONOMIC ANALYSIS

Installation Costs

Funding for this project was provided by the U. S. Maritime Administration through Avondale Shipyards, Inc. in the amount of $167,800. Costs incurred at Sparrows Point Shipyard to install the facility were $220,568. An overrun of $52,768 or 31.4% was experienced on the project. Figure 9 compares the contract amount to the actual costs.

One of the most significant overruns was the cost of labor required to install the reclaiming system. As identified in Figure 5, considerable additional work was necessary due to fabrication and design errors. Approximately $8,000 of the labor and material was attributable to the modifications which had to be made to the Apache Reclaiming system. The labor overruns were partially offset by a negotiated settlement with Apache reducing the purchase price of the system by $6,000. Additional labor overruns were caused by design changes to the foundation, construction of a ramp to enable loading, and underestimated actual installation costs in the-original proposal.

Operating Costs

The original estimate of annual operating costs for the recycling facility and related operations was $192,000 or $16.00 per ton. This was based on an annual consumption of 12,000 tons per year and a recoverable yield of 70%. Figure 10 presents the original estimate.

A revised estimate for the same operating volume is also presented i'n Figure 10 Revisions were made based on two years of operating experience and the specific operating characteristics for the facility and yard. The revised estimate projects operating costs of $358,080 or $29.84 per ton based on a volume of 12,000 tons.

The cost data actually accumulated by the yard to measure the performance of the recycler was significantly impacted by the actual volume of abrasive recycled. From September 1983 to August 1985, only 4,943 tons of recycled product were consumed. Though the low volume was partially caused by down-time during the early period of operation, it was primarily due to low demand for abrasive. The actual cost per ton experienced by the yard during this two-year period was $60.87.

A more detailed analysis of operating cost elements as compared on Figure 10 is noted below:

A. Power - Estimated power costs were revised downward by 45%. The actual costs per ton for diesel fuel and electricity were $2.05, and $.37 respectively. This cost element is primarily variable with volume and therefore a significant rate difference does not exist in the revised estimate at 12,000 tons.

B. Operating Labor - A significant cost increase occurred in operating labor, During the two year period 4,638 hours were "charged to the recycling operation costing $78,884. Down-time and low demand by the yard were the primary causes for the high rate per ton. The revised estimate projects a $5.67 rate per ton as:

$$\frac{\text{4000 hrs (2men/day) x \$17}}{\text{12,000 tons}} = 5.67\text{/ton}$$

C. Maintenance - During the two years of operation, labor and materials costs for maintenance were $34,381 and $21,771 respectively. Most of the costs were start-up and operating problems which were not necessarily volume related. The revised estimate based on ongoing operations is $1.35 rate per ton or $16,200 per year.

D. Depreciation - The total cost to purchase and install the facility, including the transport truck was $220,568. Based on an estimated economic useful life of 10 years, the fixed annual amount of depreciation is $22,057. At volume levels of 12,000 (estimated) and 2,471 (actual) the rates per ton are $1.83 and $8.93 respectively.

E. Disposal of Refuse - Unrecycled blast material is stockpiled in the north field area of the yard, therefore, incurriqg no disposal costs to the yard. The approximate 30% waste from the recycling process must be disposed outside the yard. The rate per ton of disposed waste blast material is $42.00 per ton or $18.00 per ton of usable blast material ($42 x 30/70) . This cost is totally volume related and is, therefore, the same rate for actual and projected costs per ton.,

F. In-Yard Handling of Abrasive - Actual labor and material costs incurred for handling the abrasive materials were $12,445 and $8,329 respectively for the two-year period. We believe. that these costs were high due to the low volume, fluctuations in facility operators and problems associated with start-up. The revised estimate at a 12,000 tons/year is $0.78 per ton or $9,360.

CONCLUSION

The cost to purchase the blast material is $53.20/ton. Since we cannot " continue the land filling program, we will have to dispose of each ton of purchased material at a cost of $42.00 per ton or a total cost of $53.20 + $42.00 per ton or $95.20/ton. The cost to recycle existing material based on current low volume requirements (less than 2500/tons/year) is $60.87/ton or a savings of $34.33/ton.

The projected 1986 yard demand for blast material is 3000 tons. If the material is obtained from the recycling plant, about $103,000 will be saved.

FIGURE 1

The mineral abrasive presently in use at the Sparrows Point Shipyard is a coal slag. This coal slag is a by-product of coal burning power plants, etc. The specification for the purchase of mineral abrasives is as follows:

Sieve Analysis

Sieve	Preferred Wt. % Size Dist.	Acceptable Wt. % Range
#8	100	<1
#12	95	93-97
#20	80	75-85
#30	55	50-60
#40	30	25-35
#50	15	13-17
#70	10	8-12
#l00		
#140	0.-:1	0.- <1
Pan	<0.5	Trace

Trace =<0.5%

Chemical Analysis

Free Silica	5% Max.
Sulfur	0.02% Max.
Chlorides	<10 PPM
Free Carbon	None
PH	5 - 6.5
Moisture	<0.01%

Physical Properties

Bulk Density (Dry Rodded)	>85 lbs./cu.ft.
Mobs Hardness	>6
Breakdown Rate	Max. 30% Passing #70 Sieve*
Particle Shape	Particles must be angular

(*) Blasting against steel plate, 45° to the vertical, at 12 inches using 100 PSI air pressure.

FIGURE 2

RECLAIMED ABRASIVE
SIEVE ANALYSIS

Mesh	Wt. in grams	% by weight
8	33	1.17
10	96	3.42
20	1164	41.44
30	423	15.06
50	806	28.69
70	153	5.45
70-	134	4.77

Density 90 lbs. /cu. ft.

Recovery Rate 1st 70% 2nd 30%

1 + [(1 X .7) + (.7x .30] = 1.91 Times

Effective Recovery Rate [(1-(1/1.91)] X 100 = 47.6%

FIGURE 3

INTERMEDIATE FINES AND FINES SIEVE ANALYSIS

Intermediate Fines

Mesh	Wt. in grams	% by Weight
35	1.9	1.8
50	5.2	4.9
70	15.9	15.0
80	16.7	15.9
100	14.0	13.3
140	28.1	26.7
200	12.8	12.2
PAN	10.6	10.1

Fines

50	3.6	2.7
70	8.8	6.6
80	12.9	9.7
100	15.9	11.9
140	23.0	17.3
200	22.7	17.1
PAN	46.0	34.6

FIGURE 4

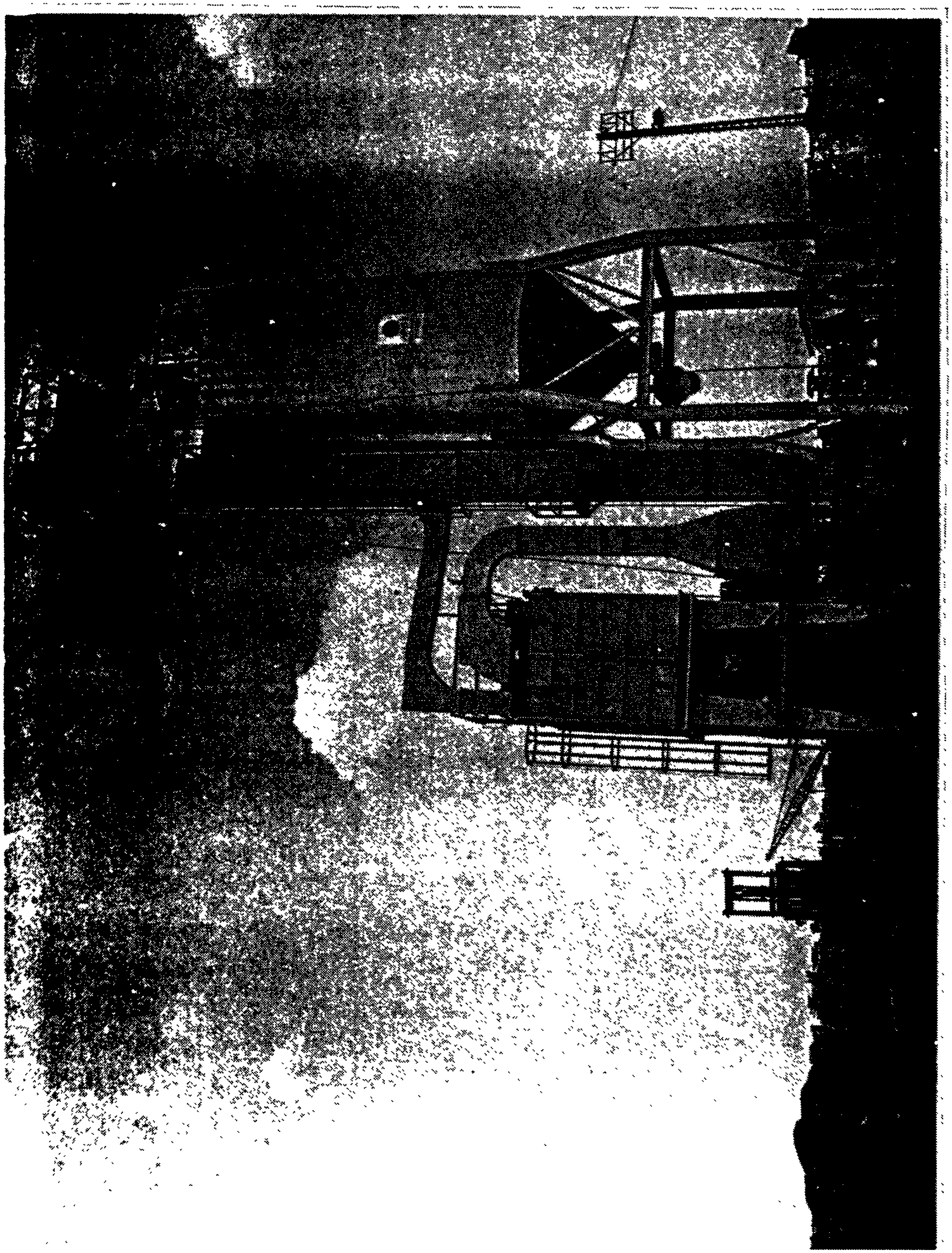

FIGURE 4

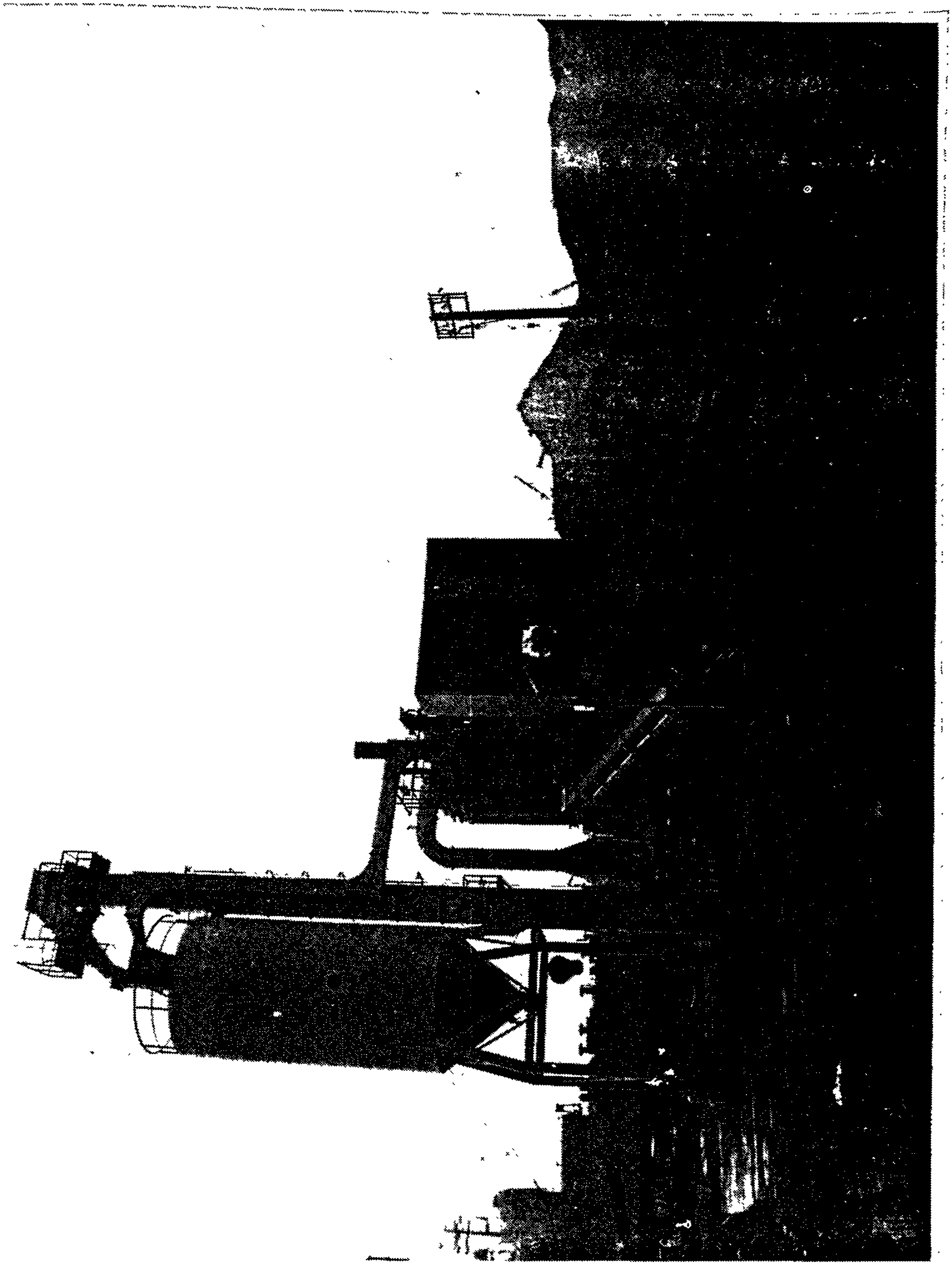

FIGURE "4

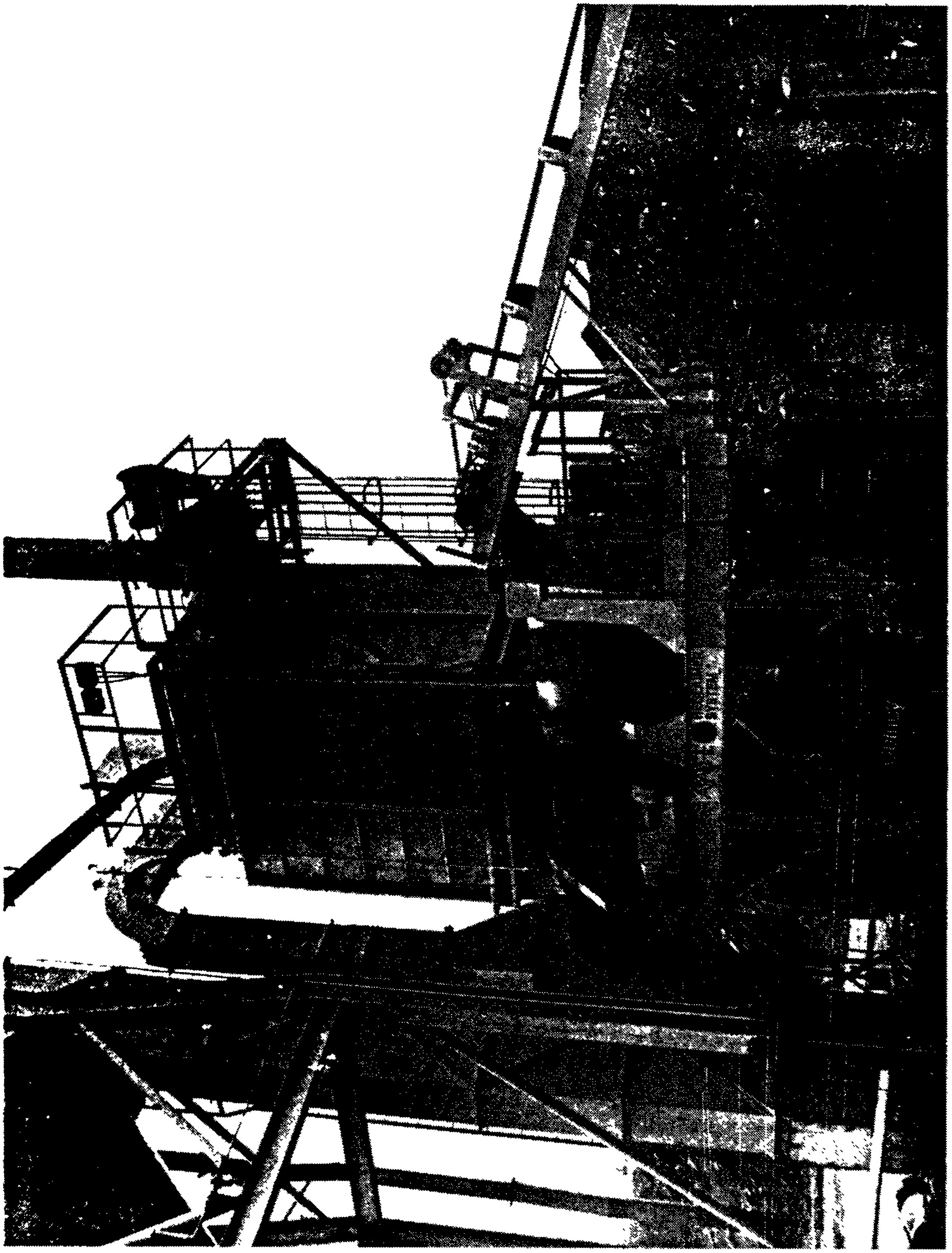

FIGURE 5

B E T H L E H E M S T E E L
Sparrows Point Shipyard

Interoffice Correspondence
Marine Construction Group .

August 10, 1983

From: G. A. Ritterman

To: Record

Subject: MODIFICATION TO APACHE RECLAIM SYSTEM

SILO

(1) Foundation anchor pattern on drawing 83-110 did not match that of the silo that was shipped to Bethlehem. Base plates of silo had to be modified while a rented crane waited.

BAGHOUSE

(1) Foundation anchor pattern on drawing 83-110 did not match that of the baghouse. The base plates of the baghouse had to be modified and a come-a-long used to set the baghouse in position because the baghouse's legs were out of square.

(2) An exhaust limit was located in wrong place and had to be relocated.

(3) New damper for large 10" duct had to be installed and welded. Old damper was removed by burning.

(4) New duct did not fit and had to be removed and new dimensions taken and forwarded to Esstee.

(5) A second new duct was reinstalled.

ASPIRATOR

(1) Doors were installed backwards and welded in place. Doors were removed and new doors fabricated. Weather stripping was also installed. Support for aspirator was installed.

(2) A 3/8" x 2" x 8" rig was installed in the intermediate fine aspirator chute.

(3) A sheetmetal cover will have to be installed to keep water out of aspirator slots.

(4) The duct carrying intermediate fines and located at the bottom bf the large silo interfered with the ladder attached to the bucket elevator. Duct was redesigned, fabricated, and installed.

FIGURE 6

JOB DESCRIPTION
ABRASIVE RECLAIMING FACILITY - SUPERVISOR - OPERATOR #1

Scope:

The following job description for the abrasive reclaiming facility shall provide a comprehensive description of activities and responsibilities for the efficient operation of the reclaiming facility.

Job Description:

1) Operator #1 shall operate and monitor control panels in the operations booth.

2) Operator #1 shall be responsible for conducting the preventive maintenance program.

3) Operator #1 shall be responsible for supervision of the assisting operator and the facility area

4) Operator #1 shall be responsible for completion of operation forms.

5) Operator #1 shall be responsible for notification of related departments with regard to time charges, material charges, etc.

6) Operator #1 shall be responsible for the coordination of deliveries with the transportation and paint departments.

7) Operator #1 shall assist the project leader in scheduling down-time and determining operational status.

FIGURE 7

JOB DESCRIPTION
ABRASIVE RECLAIMING FACILITY - OPERATOR #2

Scope:

The following job description for the abrasive reclaiming facility shall provide a comprehensive description of activities and responsibilities for the efficient operation of the reclaiming facility.

Job Description:

1) Operator #2 shall operate the front end loader for the purpose of charging the facility with spent abrasive.

2) Operator #2 shall operate a forklift for the purpose of dispensing non-reclaimable materials.

3) Operator #2 shall be responsible for the general cleaning of the facility site. Cleaning may be accomplished through use of the front end loader and broom.

4) Operator #2 shall assist, when necessary, Operator #1 with the preventive maintenance program designed for the reclaiming facility.

5) Operator #2 shall operate the pneumatic transport trailer for the transport and transfer of the reclaimed abrasive.

FIGURE 8

PENNIMAN & BROWNE, INC.

CHEMISTS-ENGINEERS-INSPECTORS

6252 FALLS ROAD

BALTIMORE, MARYLAND 21209

PHILIP M. AIDT
W. THOMPSON
G. BERETTA
ALAN BUTT
DONALD W. SMITH

CABLE ADDRESS
"BALTEST"
TELEPHONE
825-4131
AREA CODE 301

ANALYTICAL DIVISION

REPORT OF ANALYSIS

P.O. 1560-103-9821-D October 14, 1983

No.	832029
Sample of	Two GRIT Samples
From	Bethlehem Steel Corp. - Sparrows Point
Marked	Sub-Order No. X-11 - For EPA Toxicity Testing

	"SPENT ABRASIVE" Sample A, mg/l	"RECLAIMED ABRASIVE" Sample B, mg/l	Max., mg/l
Arsenic	*0.004	*0.004	5.0
Barium	*0.13	*0.13	100.0
Cadmium	*0.008	*0.008	1.0
Chromium	*0.01	*0.01	5.0
Lead	*0.04	*0.04	5.0
Mercury	0.0014	0.0005	0.2
Selenium	*0.006	*0.006	1.0
Silver	*0.02	*0.02	5.0

*less than

FACILITIES ENGINEERING
SPARROWS POINT SHIPYARD
OCT 17 '83

H. J. J.	
M. MCN.	
G. A. R.	
R. A. B.	
R. W. F.	
B. G.	
D. M.	✓
[illegible]	
[illegible]	
P. B.	
PLANNERS	
[illegible] ROOM	
SECTY.	
FILE	

TO: KEVIN BROWN

21

Philip M. Aidt

FIGURE 9

INSTALLATION COSTS

	Contract Amount	Actual
Apache Reclaiming System	$80,000	$73,975
Installation:		
Labor	12,600	60,048
Material	29,200	34,605
Freight	2,500	7,826
Grizzly and Vibrator	2,500	2,523
Inertial Separator	4,600	4,625
100 T Silo	20,000	19,856
Transport Truck	14,000	9,215
Compressor	2,400	7,895
	$167,800	$220,568

FIGURE 10

ANNUAL OPERATING COSTS

	Original Estimate	Revised Estimate	Actual cost
Volume (Tons of recycled Grit)	12,000	12,000	2,471
cost per Ton			
Power (Fuel and Electric)	$ 4.00	$ 2.21	$2.42
Operating Labor	3.90	5.67	15.96
Maintenance	.70	1.35	11.36
Depreciation	2.30	1.83	8.93
Disposal of Refuse	3.30	18.00	18.00
In-Yard Handling of Abrasive	1.80	.78	4.20
Average Cost per Ton	$16.00	$29.84	$60.87

NOTE : The original estimate was prior to installation based on a 70% yield. The revised estimate is based on actual operating experience projected to a level of 12,000 tons annually. Actual cost represents the actual volume and cost per ton experience during the two-year period of operation.