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# DEVELOPMENT DOCUMENT FOR EFFLUENT LIMITATIONS GUIDELINES AND NEW SOURCE PERFORMANCE STANDARDS

# FOR THE

# IRON AND STEEL FOUNDRY INDUSTRY

Contract No: 68-01-1507

Prepared for

Effluent Guidelines Division
Office of Water & Hazardous Materials
U.S. Environmental Protection Agency
Washington, DC 20460

JULY 1975

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# NOTICE

The attached document is a DRAFT CONTRACTOR'S REPORT. It includes technical information and recommendations submitted by the Contractor to the United States Environmental Protection Agency ("EPA") regarding the subject industry. It is being distributed for review and comment only. The report is not an official EPA publication and it has not been reviewed by the Agency.

The report, including the recommendations, will be undergoing extensive review by EPA, Federal and State agencies, public interest organizations and other interested groups and persons during the coming weeks. The report and in particular the contractor's recommended effluent limitations guidelines and standards of performance is subject to change in any and all respects.

The regulations to be published by EPA under Sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended will be based to a large extent on the report and the comments received on it. However, pursuant to Sections 304(b) and 306 of the Act, EPA will also consider additional pertinent technical and economic information which is developed in the course of review of this report by the public and within EPA. EPA is currently performing an economic impact analysis regarding the subject industry, which will be taken into account as part of the review of the report. Upon completion of the review process, and prior to final promulgation of regulations, an EPA report will be issued setting forth EPA's conclusions concerning the subject industry, effluent limitations guidelines and standards of performance applicable to such industry. Judgments necessary to promulgation of regulations under Sections 304(b) and 306 of the Act, of course, remain the responsibility of EPA. Subject to these limitations, EPA is making this draft contractor's report available in order to encourage the widest possible participation of interested persons in the decision making process at the earliest possible time.

The report shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the Contractor who studied the subject industry and prepared the information and recommendations. It cannot be cited, referenced, or represented in any respect in any such proceedings as a statement of EPA's views regarding the subject industry.

U. S. Environmental Protection Agency
Office of Water & Hazardous Materials
Effluent Guidelines Division
Washington, D. C. 20460

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Report prepared for EPA under
Contract Number 68-01-1507

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# ABSTRACT

This document presents the findings of an extensive study of the iron and steel foundry industry for the purpose of developing effluent limitations guidelines, Federal standards of performance, and pretreatment standards of the industry to implement Sections 304, 306, and 307 of the "Act."

Effluent limitations guidelines contained herein set forth the degree of effluent reduction attainable through the application of the best practicable control technology currently available and the degree of effluent reduction attainable through the application of the best available technology economically achievable which must be achieved by existing point sources by July 1, 1977, and July 1, 1983, respectively. The standards of performance for new sources contained herein set forth the degree of effluent reduction which is achievable through the application of the best available demonstrated control technology, processes, operating methods, or other alternatives.

Supporting data and rationale for development of the proposed effluent limitations guidelines and standards of performance are contained in this report.

This report was submitted in fulfillment of Contract #68-01-1507 under the sponsorship of the Effluent Guidelines Division, Environmental Protection Agency.

NOTICE: THESE ARE TENTATIVE RECOMMENDATIONS BASED UPON INFORMATION IN THIS REPORT AND ARE SUBJECT TO CHANGE BASED UPON COMMENTS RECEIVED AND FURTHER INTERNAL REVIEW BY EPA.

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FIGURES (CONTINUED)

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# SECTION I

# CONCLUSIONS

For the purpose of establishing effluent guidelines and standards of performance for foundry operations, the industry was divided into subcategories as follows:

I. Melting Operations
II. Molding and Cleaning Dust Collection Operations
III. Sand Washing Operations
IV. Multiple Operations

The selection of these subcategories was based upon distinct differences in production processes, raw materials used, wastewaters generated and control and treatment technologies employed. Subsequent waste characterizations of individual plants substantiated the validity of this subcategorization.

The waste characterizations of individual plants visited during this study, and the guidelines developed as a result of the data collected, relate only to the aqueous discharges from the facilities, excluding noncontact cooling waters.

The effluent guidelines established in this study are not dependent upon the raw water intake quality. The limitations were derived by determining the minimum flows, in volume per unit weight of product, that can be achieved by good water conservation techniques and by determining the effluent concentrations of the pollutant parameters that can be achieved by treatment technology. The product of these is the effluent limitations proposed.

The plant raw wasteloads however, are, out of necessity, a net number that reflects the pickup of contaminants across a production process in a single pass. It was necessary to establish the raw waste load in this manner in order to obtain a meaningful comparison of wastes generated during production from a range of plants surveyed. Some plants utilized once-through water systems, while many others used varying degrees of reuse and/or recycle. Since the gross waste load to be treated generally varied depending upon the extent of recycle used in the system, the only way a meaningful raw waste load for a production process could be determined was on a net basis.

As presented in Table 31, an initial capital investment of approximately $210 million with annual capital and operating costs of $50 million would be required by the industry to comply with the 1977 guidelines. An additional capital investment of approximately $187 million with added annual capital and operating costs of about $44 million would be needed to comply with the 1983 guidelines. Costs may vary depending upon such factors as location, availability of land and chemicals, flow to be treated, treatment technology selected where competing alternatives exist, and the extent of preliminary modifications required to accept the necessary control and treatment devices.

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SECTION II

RECOMMENDATIONS

The proposed effluent limitation guidelines for the iron and steel foundry industry representing the effluent quality obtainable by existing point sources through the application of the best practicable control technology currently available (BPCTCA or Level I) for each industry subcategory are as follows:

I. MELTING OPERATIONS

BPCTCA Effluent Limitations
Units: kg pollutant per kkg of product
or: lb pollutant per 1,000 lb of product

| Pollutant Parameter | Maximum for any One Day Period Shall Not Exceed | Maximum Average of Daily Values for any Period of 30 Consecutive Days |
|---|---|---|
| Suspended Solids | 0.750 | 0.250 |
| Oil and Grease | 0.282 | 0.0940 |
| Fluoride | 0.375 | 0.125 |
| Manganese | 0.0939 | 0.0313 |
| Lead | 0.0300 | 0.0100 |
| Zinc | 0.0939 | 0.0313 |
| pH | 6.0 to 9.0 | |

II. MOLDING AND CLEANING DUST COLLECTION OPERATIONS

BPCTCA Effluent Limitations
Units: kg pollutant per kkg of product
or: lb pollutant per 1,000 lb of product

| Pollutant Parameter | Maximum for any One Day Period Shall Not Exceed | Maximum Average of Daily Values for any Period of 30 Consecutive Days |
|---|---|---|
| Suspended Solids | 0.150 | 0.0500 |
| Oil and Grease | 0.0564 | 0.0188 |
| pH | 6.0 to 9.0 | |

III. SAND WASHING OPERATIONS

BPCTCA Effluent Limitations
Units: kg pollutant per kkg of product
or: lb pollutant per 1,000 lb of product

| Pollutant Parameter | Maximum for any One Day Period Shall Not Exceed | Maximum Average of Daily Values for any Period of 30 Consecutive Days |
|---|---|---|
| Suspended Solids | 0.501 | 0.167 |
| Oil and Grease | 0.188 | 0.0625 |
| pH | 6.0 to 9.0 | |

IV. MULTIPLE OPERATIONS

BPCTCA Effluent Limitations
Units: kg pollutant per kkg of product
or: lb pollutant per 1,000 lb of product

| Pollutant Parameter | Maximum for any One Day Period Shall Not Exceed | Maximum Average of Daily Values for any Period of 30 Consecutive Days |
|---|---|---|
| Suspended Solids<br>Oil and Grease | 3 times the sum of the lbs/1,000 lbs for each subcategory | The sum of the lbs/1,000 lbs for each subcategory |
| Fluoride | 0.375 | 0.125 |
| Manganese | 0.0939 | 0.0313 |
| Lead | 0.0300 | 0.0100 |
| Zinc | 0.0939 | 0.0313 |
| pH | 6.0 to 9.0 | |

The proposed effluent guidelines representing the effluent quality obtainable by existing point sources through the application of the best available technology economically achievable (BATEA or Level II) for each industry subcategory are as follows:

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I. MELTING OPERATIONS

BATEA Effluent Limitations
Units: kg pollutant per kkg of product
or: lb pollutant per 1,000 lb of product

| Pollutant Parameter | Maximum for any One Day Period Shall Not Exceed | Maximum Average of Daily Values for any Period of 30 Consecutive Days |
|---|---|---|
| Suspended Solids | 0.0939 | 0.0313 |
| Oil and Grease | 0.0375 | 0.0125 |
| Fluoride | 0.0471 | 0.0157 |
| Manganese | 0.0113 | 0.00375 |
| Lead | 0.00375 | 0.00125 |
| Sulfide | 0.00471 | 0.00157 |
| Zinc | 0.0113 | 0.00375 |
| pH | 6.0 to 9.0 | |

II. MOLDING AND CLEANING DUST COLLECTION OPERATIONS

BATEA Effluent Limitations
Units: kg pollutant per kkg of product
or: lb pollutant per 1,000 lb of product

| Pollutant Parameter | Maximum for any One Day Period Shall Not Exceed | Maximum Average of Daily Values for any Period of 30 Consecutive Days |
|---|---|---|
| Suspended Solids | 0.0312 | 0.0104 |
| Oil and Grease | 0.0125 | 0.00417 |
| pH | 6.0 to 9.0 | |

III. SAND WASHING OPERATIONS

BATEA Effluent Limitations
Units: kg pollutant per kkg of product
or: lb pollutant per 1,000 lb of product

| Pollutant Parameter | Maximum for any One Day Period Shall Not Exceed | Maximum Average of Daily Values for any Period of 30 Consecutive Days |
|---|---|---|
| Suspended Solids | 0.0939 | 0.0313 |
| Oil and Grease | 0.0375 | 0.0125 |
| pH | 6.0 to 9.0 | |

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## IV. MULTIPLE OPERATIONS

BATEA Effluent Limitations
Units: kg pollutant per kkg of product
or: lb pollutant per 1,000 lb of product

| Pollutant Parameter | Maximum for any One Day Period Shall Not Exceed | Maximum Average of Daily Values for any Period of 30 Consecutive Days |
|---|---|---|
| Suspended Solids Oil and Grease | 3 times 75% of the sum of the lbs/ton for each subcategory | 75% of the sum sum of the lbs/ ton for each subcategory |
| Fluoride | 0.0351 | 0.0117 |
| Manganese | 0.00843 | 0.00281 |
| Lead | 0.00281 | 0.000938 |
| Sulfide | 0.00351 | 0.00117 |
| Zinc | 0.00843 | 0.00281 |
| pH | 6.0 to 9.0 | |

The proposed effluent guidelines representing the effluent quality attainable by new sources (NSPS or Level III) through the application of the best available demonstrated control technology (BADCT), processes, operating methods or other alternatives for each industry subcategory are as follows:

Same as BATEA for all categories.

# SECTION III

# INTRODUCTION

## PURPOSE AND AUTHORITY

Section 301(b) of the Act requires the achievement by not later than July 1, 1977, of effluent limitations for point sources, other than publicly owned treatment works, which are based on the application of the best practicable control technology currently available as defined by the Administrator pursuant to Section 304(b) of the Act. Section 301(b) also requires the achievement by not later than July 1, 1983, of effluent limitations for point sources, other than publicly owned treatment works, which are based on the application of the best available technology economically achievable which will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants, as determined in accordance with regulations issued by the Administrator pursuant to Section 304(b) to the Act. Section 306 of the Act requires the achievement by new sources of a Federal standard of performance providing for the control of the discharge of pollutants which reflects the greatest degree of effluent reduction which the Administrator determines to be achievable through the application of the best available demonstrated control technology, processes, operating methods, or other alternatives, including, where practicable, a standard permitting no discharge of pollutants.

Section 304(b) of the Act requires the Administrator to publish within one year of enactment of the Act, regulations providing guidelines for effluent limitations setting forth the degree of practicable control technology currently available and the degree of effluent reduction attainable through the application of the best control measures and practices achievable including treatment techniques, process and procedure innovations, operation methods and other alternatives.

Section 306 of the Act requires the Administrator, within one year after a category of sources is included in a list published pursuant to Section 306(b)(1)(A) of the Act, to propose regulations establishing Federal standards of performances for new sources within such categories. The Administrator published in the Federal Register of January 16, 1973, a list of 27 source categories. Publication of the list constituted announcement of the Administrator's intention of establishing, under Section 306, standards of performance applicable to new sources within the iron and steel industry which was included within the list published January 16, 1973.

## SUMMARY OF METHODS USED FOR DEVELOPMENT OF THE EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS OF PERFORMANCE

The effluent limitations guidelines and standards of performance proposed herein were developed in the following manner. The point source category was first studied for the purpose of determining whether separate limitations and standards would be required for different segments within a point source category. The analysis was based upon raw material used, product produced, manufacturing process employed, and other factors. The raw waste characteristics for each subcategory were then identified. This included an analyses of (1) the source and volume of water used in the process employed and the sources of waste and wastewaters in the plant; and (2) the constituents (including thermal) of all wastewaters including toxic constituents and other constituents which result in taste, odor, and color in water. The constituents of wastewaters which should be subject to effluent limitations guidelines and standards of performance were identified.

The full range of control and treatment technologies existing within each subcategory was identified. This included an identification of each distinct control and treatment technology, including both inplant and end-of-process technologies, which are existent or capable of being designed for each subcategory. It also included an identification in terms of the amount of constituents (including thermal) and the chemical, physical, and biological characteristics of pollutants, of the effluent level resulting from the application of each of the treatment and control technologies. The problems, limitations and reliability of each treatment and control technology and the required implementation time was also identified. In addition, the nonwater quality environmental impact, such as the effects of the application of such technologies upon other pollution problems, including air, solid waste, noise and radiation were also identified. The energy requirements of each of the control and treatment technologies were identified as well as the cost of the application of such technologies.

The information, as outlined above, was then evaluated in order to determine what levels of technology constituted the "best practicable control technology currently available," "best available technology economically achievable" and the "best available demonstrated control technology, processes, operating methods, or other alternatives." In identifying such technologies, various factors were considered. These included the total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application, the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, nonwater quality environmental impact (including energy requirements) and other factors.

The data for identification and analyses were derived from a number of sources. These sources included EPA research information, EPA and State environmental personnel, trade associations, published literature, qualified technical consultation, and on-site visits including sampling programs and interviews at foundries throughout the United States which were known to have above average waste treatment facilities. All references used in developing the guidelines for effluent limitations and standards of performance for new sources reported herein are listed in Section XIII of this document.

Operating plants were visited and information and samples were obtained on from three to nine plants in each of the subcategories. Both in-process and end-of-pipe data were obtained as a basis for determining water use rates and capabilities and effluent loads. The permit application data was of limited value for the purposes of this study since most of this data is on outfalls serving more than one operation and frequently was deficient in one or more of the components needed to correlate the data. Forms requesting wastewater capital and operating costs, analytical data, production process information, and process water usage were provided to the plants at the time of the sampling visit. The plants were requested to complete the forms return this information to the study contractor.

## General Description of the Industry

The unique feature of the foundry industry is the pouring of molten metal into a mold. The cavity of the mold representing within close tolerances the final dimensions of the product.

One of the major advantages of this process is the intricate shapes of the metal that are not obtainable by any other method of fabrication. Another advantage is the rapid translation of a projected design into a finished article. New articles are easily standardized and duplicated by the casting method.

The foundry industry ranks sixth among all manufacturing industries based on "Value added by Manufacture" according to data issued by the United States Department of Commerce in 1970 (Survey of Manufacturers, SIC 29-30). Presently, the foundry industry in the United States totals over 4,300 foundries employing approximately 400,000 workers and producing over 17 million tons/year of cast metal products. This study will cover the 1,690 foundries that produce gray, ductile, malleable iron and carbon steel castings.

## Product Classification

The U. S. Bureau of Census, Census of Manufacturers classifies the steel industry under Major Group 33 - Primary Metal Industries. This phase of study includes the iron and steel foundries as included under SIC No. 3321, 3322, and 3323. This includes all processes, subprocesses, and alternate processes involved in the manufacture of intermediate or finished products in the above categories. A detailed list of product codes within the industry classification code 3321, 3322, and 3323 is included in Table 1.

## Anticipated Industry Growth

The past decade has seen a decline in the number of foundries producing gray, ductile, malleable iron and carbon steel castings. However, production has increased in this period from 12.7 million tons in 1961 to 16.3 million tons in 1971, an increase of 28.3%. (Source, Bureau of Census, Department of Commerce)

The dollar value of castings has shown a remarkable increase due to the inflation within our economy. The value of castings increased from $434/ton in 1961 to $652/ton in 1971, and $722/ton in 1975. This latest value reflects a 66% increase over the 1961 figure.

## General Description of the Operation

The basic foundry process is essentially the same regardless of method of melting, molding or finishing. The product flow of the typical foundry operation is shown in Figure 1. In all types of foundries, raw materials are assembled and stored in various material bins. These are usually outdoors and are bulk handling types.

From these bins, a "charge" is selected by using various amounts of the several materials. This material is "charged" into a melting furnace and through a heating process, the metal is made liquid.

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TABLE 1

PRODUCT CLASSIFICATION BY SIC CODE
(3321, 3322, and 3323)
FOR IRON AND STEEL FOUNDRIES

3321 - GRAY IRON FOUNDRIES

Establishments primarily engaged in manufacturing gray iron castings, including cast iron pressure and soil pipes and fittings.

Brake shoes, railroad: cast iron - made in foundries

Car wheels, railroad: chilled cast iron - made in foundries

Castings, gray iron and semi-steel

Cooking utensils, cast iron

Couplings, pipe: pressure and soil pipe, cast iron - made in foundries

Elbows, pipe: pressure and soil pipe, cast iron - made in foundries

Foundries, gray iron and semi-steel
Gas
Gas pipe, cast iron: made in foundries

Gray iron foundries

Hydrants, water: cast iron - made in foundries

Ingot molds and stools: made in foundries

Iron castings, nodular

Manhole covers, metal

Nipples, pipe: pressure and soil pipe, cast iron - made in foundries

Pipe and fittings, soil and pressure: cast iron - made in foundries

Railroad brake shoes, cast iron

Rolling mill rolls, iron: not machined

Sewer pipe, cast iron: made in foundries

Water pipe, cast iron: made in foundries

3322 - MALLEABLE IRON FOUNDRIES

Establishments primarily engaged in manufacturing malleable iron castings.

TABLE 1 (Cont'd.)

Castings, malleable iron

Foundries, malleable iron

Pearlitic castings, malleable iron

3323 - STEEL FOUNDRIES

Establishments primarily engaged in manufacturing steel castings.

Bushings, cast steel

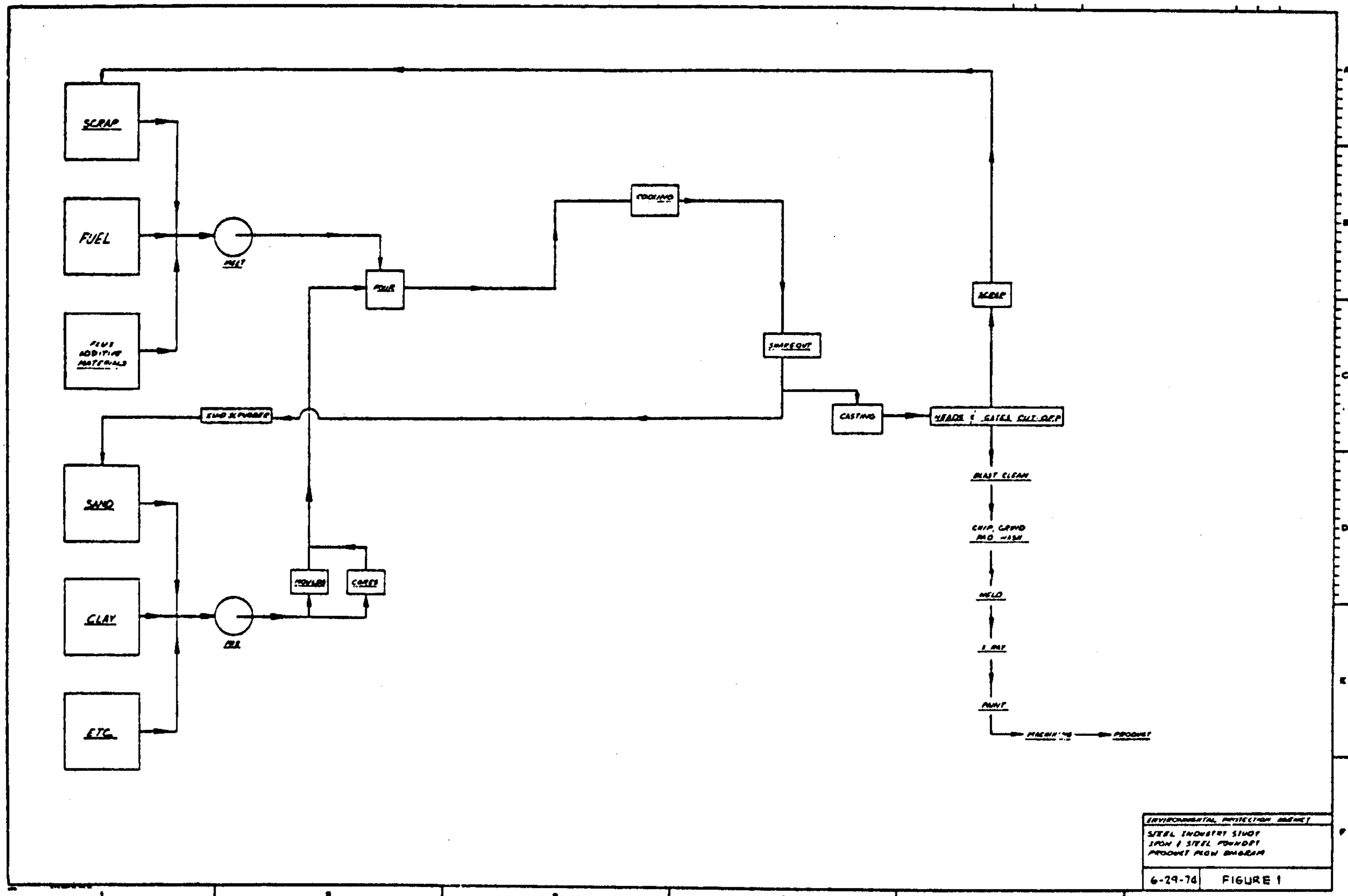
Castings, steel

Cast steel railroad car wheels

Foundries, steel

Investment castings, steel

Rolling mill rolls, steel: not machined



SCRAP
FUEL
FLUX ADDITIVE MATERIALS
MELT
POUR
COOLING
SHAKEOUT
CASTING
HEADS & GATES CUT-OFF
SCRAP
SAND SCRUBBER
SAND
CLAY
ETC.
MIX
MOLDS
CORES
BLAST CLEAN
CHIP, GRIND AND WASH
WELD
X-RAY
PAINT
MACHINING
PRODUCT
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
IRON & STEEL FOUNDRY
PRODUCT FLOW DIAGRAM
6-29-74
FIGURE 1

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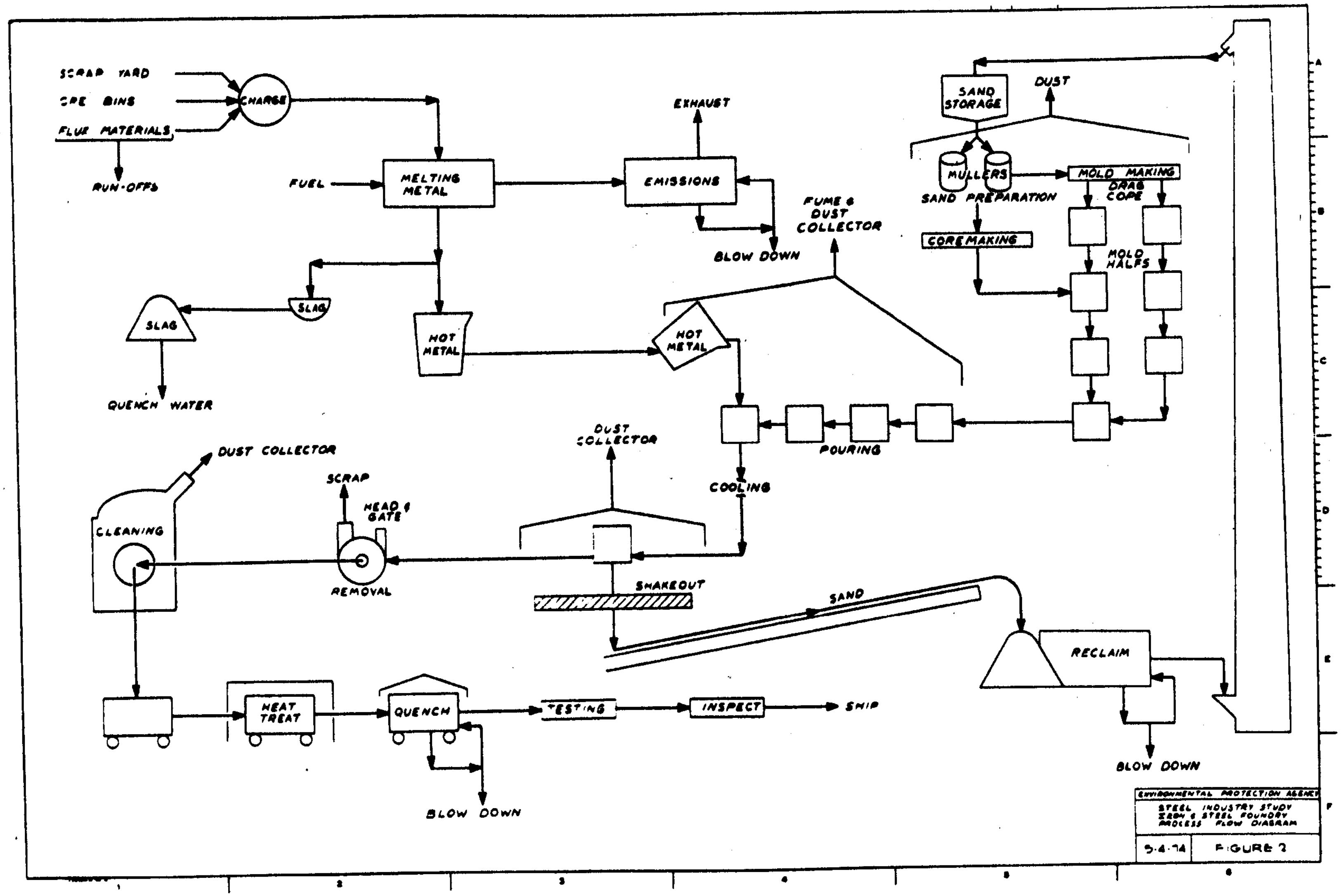
Simultaneously, molds are being prepared. This process begins by forming a pattern (usually of wood) to the approximate final shape of the product. This pattern is usually made in two pieces that will eventually match to form a single piece. Each part of the pattern is used to form a cavity in a moist sand media, and the two portions (called "cope" and "drag") are matched together to form a complete cavity in the sand media. An entrance hole (called a "sprue") is cut to provide the proper introduction of the molten metal into the cavity and the mold is ready to be poured.

The molten metal is now "tapped" from the furnace into the ladle. The ladle and molds are moved to a pouring area and the metal is poured into the molds. The molds are moved to a cooling area where the molten metal solidifies into the shape of the pattern. When sufficiently cooled, the molds are placed onto a "shake out". By violent shaking, the sand is loosened from around the metal and falls to a conveyor that returns it to the sand storage area.

The cast metal object (casting) is further processed by removing excess metal, and cleaned by various methods that complete the removal of the sand from its surface. Depending on the final use of the casting, further processing in the form of heat treatment, quenching, or chemical treatment may take place. After inspection, the casting is then ready for shipping. The process flow of the typical foundry operation is shown in Figure 2.


SCRAP YARD
ORE BINS
FLUX MATERIALS
CHARGE
RUN-OFFS
FUEL
MELTING METAL
EMISSIONS
EXHAUST
BLOW DOWN
FUME & DUST COLLECTOR
SLAG
SLAG
QUENCH WATER
HOT METAL
HOT METAL
SAND STORAGE
DUST
MULLERS
SAND PREPARATION
MOLD MAKING
DRAG
COPE
COREMAKING
MOLD HALFS
POURING
COOLING
DUST COLLECTOR
DUST COLLECTOR
SCRAP
HEAD & GATE
CLEANING
REMOVAL
SHAKEOUT
SAND
RECLAIM
BLOW DOWN
HEAT TREAT
QUENCH
TESTING
INSPECT
SHIP
BLOW DOWN
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
IRON & STEEL FOUNDRY
PROCESS FLOW DIAGRAM
5-4-74
FIGURE 2



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# SECTION IV

# INDUSTRY CATEGORIZATION

An evaluation of the foundry operations was necessary to determine whether or not subcategorization would be required in order to prepare effluent guidelines which would be broadly applicable and yet representative and appropriate for the operations and conditions to be controlled. Toward this end an understanding of the operations was required.

## DESCRIPTION OF FOUNDRY OPERATIONS

The unique feature of the foundry industry is the pouring of molten metal into a mold. The cavity of the mold representing within close tolerances the final dimensions of the product. One of the major advantages of this process is the intricate shapes of the metal that are not obtainable by any other method of fabrication. Another advantage is the rapid translation of a projected design into a finished article. New articles are easily standardized and duplicated by the casting method.

Historically, foundries have been classified by the types of metal that they produce. A classification of this nature may be ill defined as many foundries produce several types of metal. These metals are:

1. Gray Iron
2. Ductile Iron
3. Malleable Iron
4. Carbon Steel
5. Alloy Steel
6. Non-Ferrous Metals

A secondary method of classification has been by the melting process used. However, many foundries use three or four different methods of melting, and various metals are often melted in several types of furnaces. The furnace types are:

1. Cupola
2. Electric Arc
3. Electric Induction
4. Crucible
5. Reverbatory
6. Non-Crucible
7. Air Furnaces

In addition to the variety of metals and melting methods, there are several mold types that impart certain properties to the finished product. These mold types are:

1. Green Sand Molds
2. Dry Sand Molds
3. Shell Sand Molds
4. Permanent Molds
5. Centrifugal Molds
6. Plaster Molds
7. Investment Molds
8. Die Cast Molds

Others steps in the production of a casting that further contribute to the complexity of the foundry industry are: cleaning processes, heat treatment, and finishing.

## MELTING OPERATIONS

### Cupola Furnace

The cupola furnace is a vertical shaft furnace consisting of a cylindrical steel shell lined with refractories and equipped with a wind box and tuyeres for the admission of air. A charging opening is provided at an upper level for the introduction of melting stock and fuel. Near the bottom are holes and spouts for removal of molten metal and slag.

One of the outstanding features of a cupola is that the ascending gases come into intimate contact with the descending melting stock, and a direct and efficient exchange of heat takes place. The descending fuel replaces that burned from the original coke bed and thus maintains the height of this bed.

Operations begin with the laying of coke bed just above the tuyeres. A charge of melting stock and flux is placed above this, and then alternate layers of fuel and melting stock. When the coke bed is "lit off" the air blast is begun and heat is rapidly produced. The consumption of the fuel in the coke bed gradually reduces this bed thickness, and the burden above it moves down.

The ascending hot gases begin melting the scrap and flux. These materials run down the interior of the bed and collect in a pool below the tuyeres. The molten metal remains in the refractory-lined pool and is covered by the floating slag. Tapping is not begun until the molds are ready, as delays in pouring metal into the molds cannot be permitted.

Slags are drawn off periodically to keep the slag cover to proper dimensions. If slags get too high, they are chilled by the tuyeres and become unmanageable. Cold slags also reduce the metal temperature as they absorb heat from the metal as it runs through the slag.

Cupolas are operated at various ratios of iron to coke depending on local shop practice as well as final metal specifications. In general, ratios of 7-1/2:1 (7.5 lb metal per lb of coke) to 10.4:1 are used. Air blast is approximately 1,000 cu ft/min/ton of metal and can be reduced in larger melting furnaces. Tons of metal produced is a function of the cross-sectional area of the furnace and the air blast volumes. The coke ratio influences the melting temperature.

More specific details of typical cupola operations are presented on Figures 3, 4, and 5.

## Electric Arc Furnace

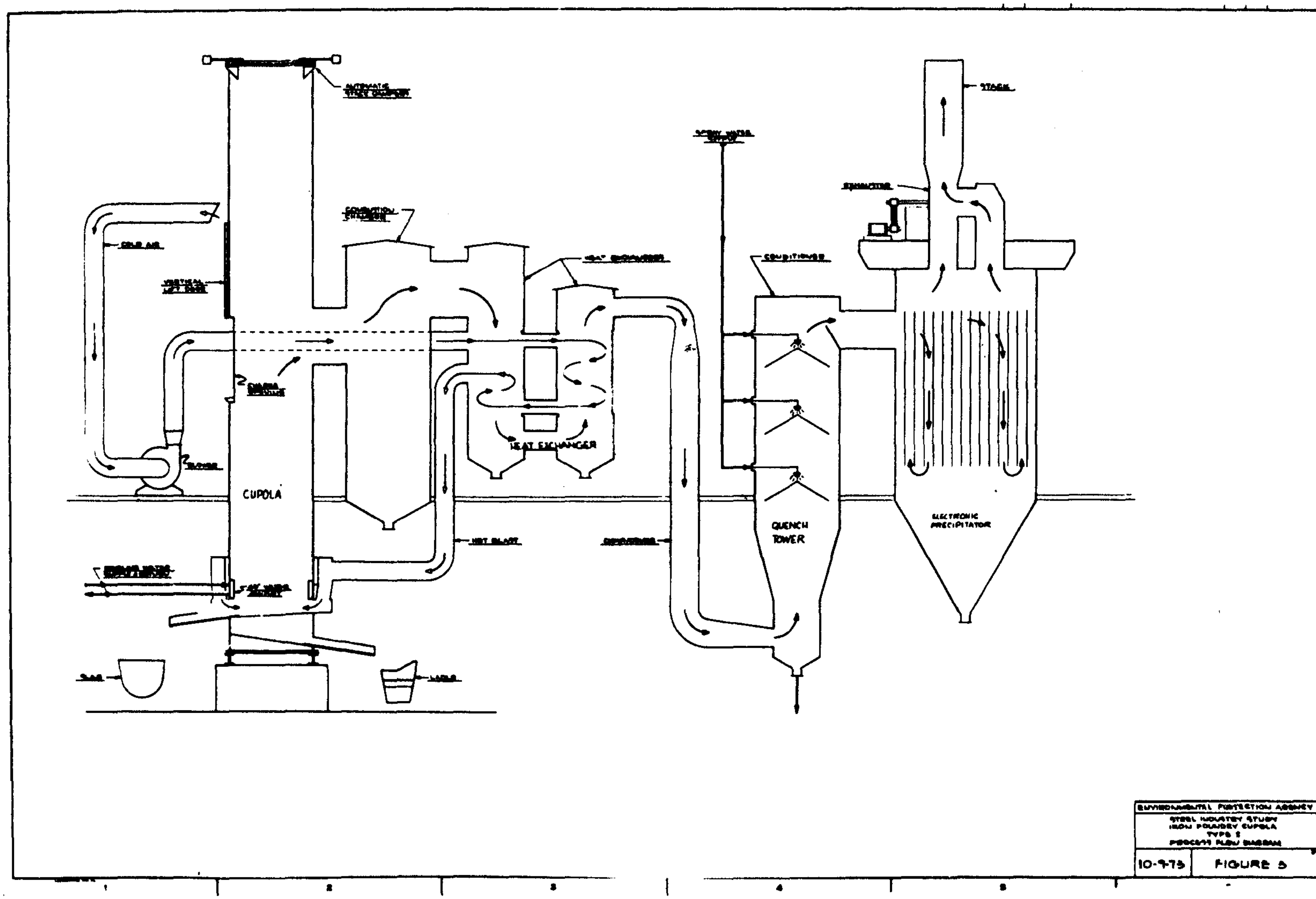
The electric arc furnace is mainly used in producing carbon steels and steel alloys. This study covers its use on carbon steel.

A refractory-lined cylindrical furnace is charged with a cold scrap charge and fluxes. The heat for melting is furnished by passing an electric current (arc) through the scrap and the melted metal by means of three triangularly arranged cylindrical carbon electrodes inserted through the roof.

The electrodes are consumed and oxidize at a rate of 5 to 8 kg/metric ton of steel. Large tonnage furnaces have hinged removable roofs for scrap addition, while smaller furnaces are charged through the furnace doors. Furnaces range in size from 250 kilograms to 35 metric tons per heat, and from 1 meter to 7 meters in diameter. Heat cycle time is generally three to four hours.

Production of some high quality steels require the use of two different slags, referred to as oxidizing and reducing slags. After the metal has been melted and oxidized, the first slag may be removed, and different fluxes are charged to obtain reduction of certain elements in the metal to the proper limits.

The heat cycle generally consists of charging, melt-down, molten metal period, oxidizing, refining, and tapping (pouring). Pure oxygen is usually lanced across the bath to speed up the oxidation cycle which in turn reduces electric current consumption.


CUPOLA
HEAT EXCHANGER
QUENCH TOWER
ELECTRONIC PRECIPITATOR
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
IRON FOUNDRY CUPOLA
PROCESS FLOW DIAGRAM
10-9-75
FIGURE 5

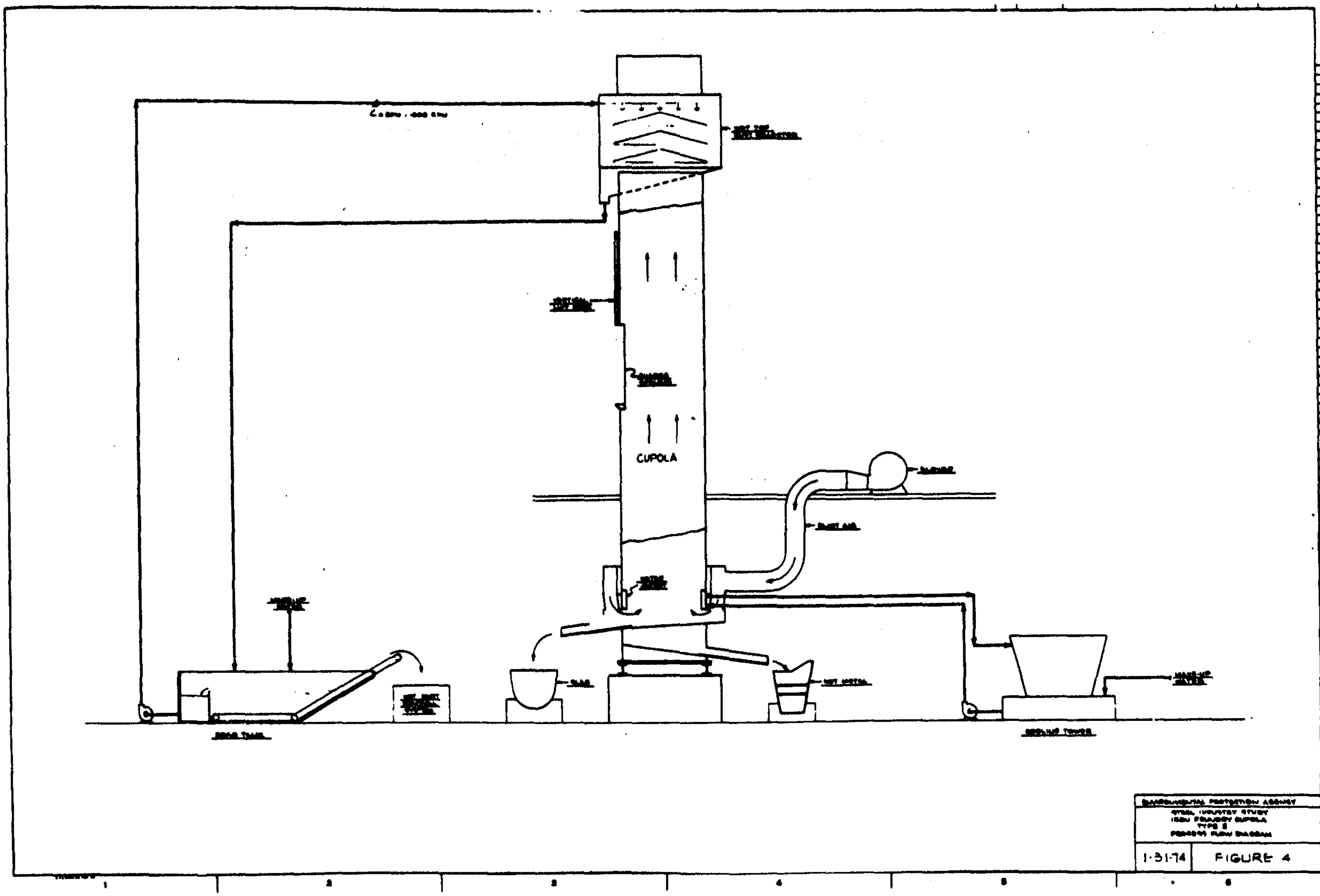
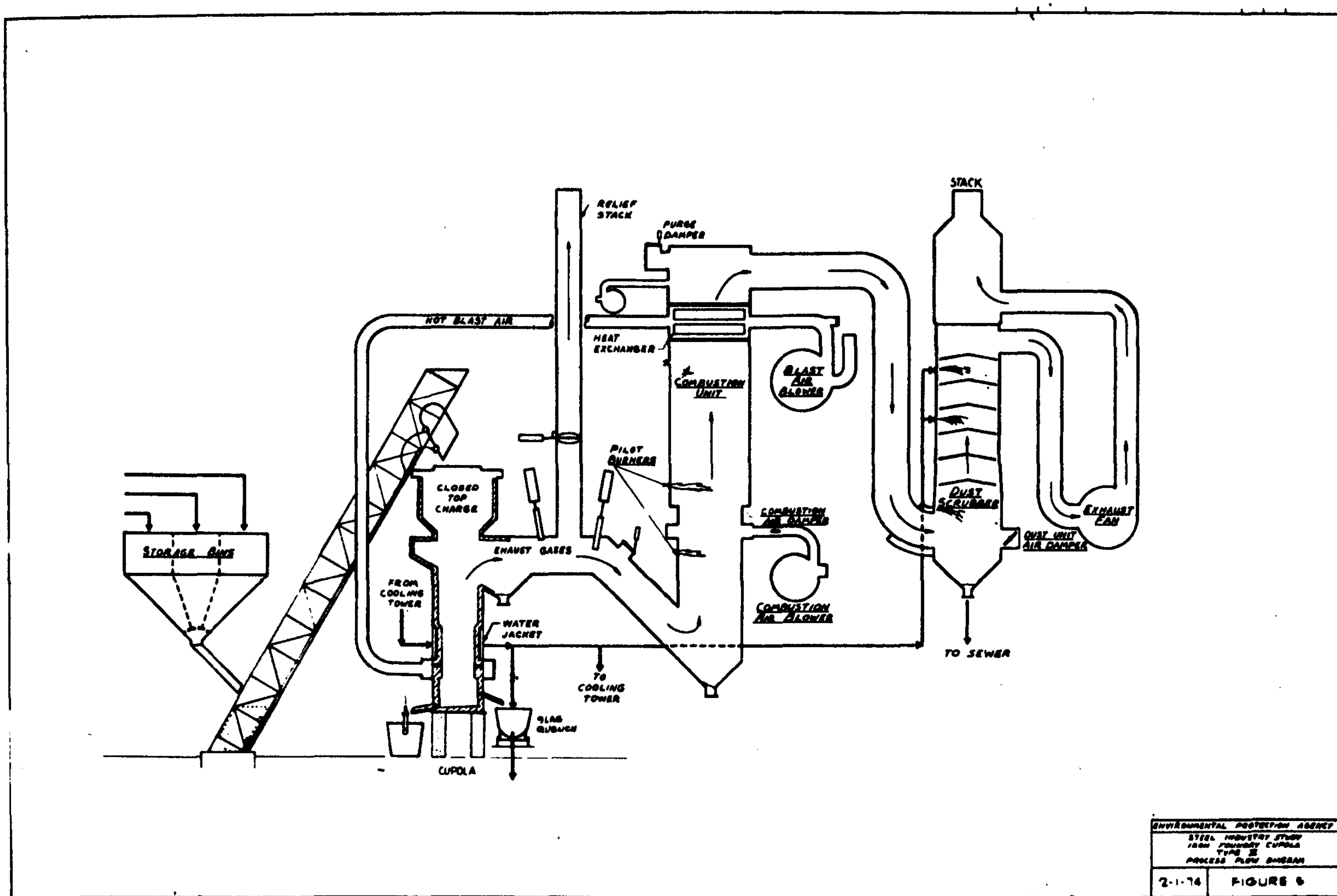


FIGURE 4


RELIEF STACK
PURGE DAMPER
HOT BLAST AIR
HEAT EXCHANGER
COMBUSTION UNIT
BLAST AIR BLOWER
PILOT BURNERS
COMBUSTION AIR DAMPER
COMBUSTION AIR BLOWER
STACK
DUST SCRUBBER
EXHAUST FAN
DUST UNIT AIR DAMPER
TO SEWER
STORAGE BINS
CLOSED TOP CHARGE
EXAUST GASES
FROM COOLING TOWER
WATER JACKET
TO COOLING TOWER
SLAG QUENCH
CUPOLA
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
IRON FOUNDRY CUPOLA
TYPE II
PROCESS FLOW DIAGRAM
2-1-74
FIGURE 6

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The waste products from the process are smoke, slag, carbon monoxide and dioxide gases, and oxides of iron emitted as submicron fumes. Other waste contaminants such as zinc oxides from galvanized scrap will be released depending on the quality of scrap charged. High oil bearing scrap, such as machine shop turnings and chips, will yield a high quantity of reddish-black smoke as the oils are burned off in the melt-down cycle. Oxides of nitrogen and ozone are released during the lancing of the bath. Generally, 5 kilograms of dust/metric ton (10 lb/ton) of steel is produced, but this may go as high as 15 kilograms per metric ton (30 lb/ton) if inferior quality scrap is used. These waste products are discharged and do not become waterborne unless some type of dust collector entraps them with water.

Three types of dust collectors are used - baghouses, scrubbers, and dry precipitators. In addition to the type of dust collection, there are generally four means of exhausting these fumes from the electric arc furnace. These are:

1. Furnace building extracting
2. Local fume hoods
3. "Snorkel" or fourth hole extraction
4. Furnace canopy

Furnace building extraction requires that the shop openings be sealed and the installation of exhaust hoods in the roof trusses for exhausting the entire shop atmosphere. This air is filtered through a baghouse collector and requires handling of large volumes of air. Makeup air vents and heating of the makeup air must be provided to maintain the balance of air in the shop. A shop using this system will handle 125,000 cu ft/min of air. The system is readily adapted to electric furnace practice, and captures all emissions in the building.

Local fume hoods fitted to furnace door openings, electrode openings and junctures between the roof and furnace shell are widely used. A baghouse collector is used with this type of exhaust system, as sufficient air is bled into the system during fume entrapment to reduce the gas temperature to acceptable levels. These systems are not effective when hinged roof charging is used.

The third type "snorkel or fourth hole," keeps the furnace under negative pressure by withdrawing the furnace atmosphere. This prevents fumes from leaking through furnace openings. The extraction hole or "snorkel" must be refractory-lined and water cooled, as the gases will be about 1,345°C (2,500°F). A gap in the pipe immediately behind the snorkel permits a large infiltration of air that enables the combustion of gases to take place. It also enables furnace roof movement caused by charging, pouring, and slagging operations to proceed without special sophisticated arrangements between the furnace roof and the exhaust system. Both exhaust systems can be used with all three types of dust collectors. If a baghouse is used, a spray chamber is added to the gas cleaning system to condition the gas temperature to 135°C (275°F) and to eliminate any sparks to the baghouse.

If precipitators are used, a spark box is placed in the system to condition gases to 130°C (260°F) before entry into the precipitator. The spray chamber, spark box, and quenchers may discharge a water effluent.

When the steel from any of the electric furnaces is tapped (poured) into the ladles, it is quickly transported to the pouring area where it is either poured into molds, or into several smaller ladles for more effective pouring. Some ladle additions are made at this point to adjust the final chemistry of the steel and to stop the oxidation.

More specific details of the electric arc furnace operation are presented on Figures 6, 7, and 8.

Induction Furnaces

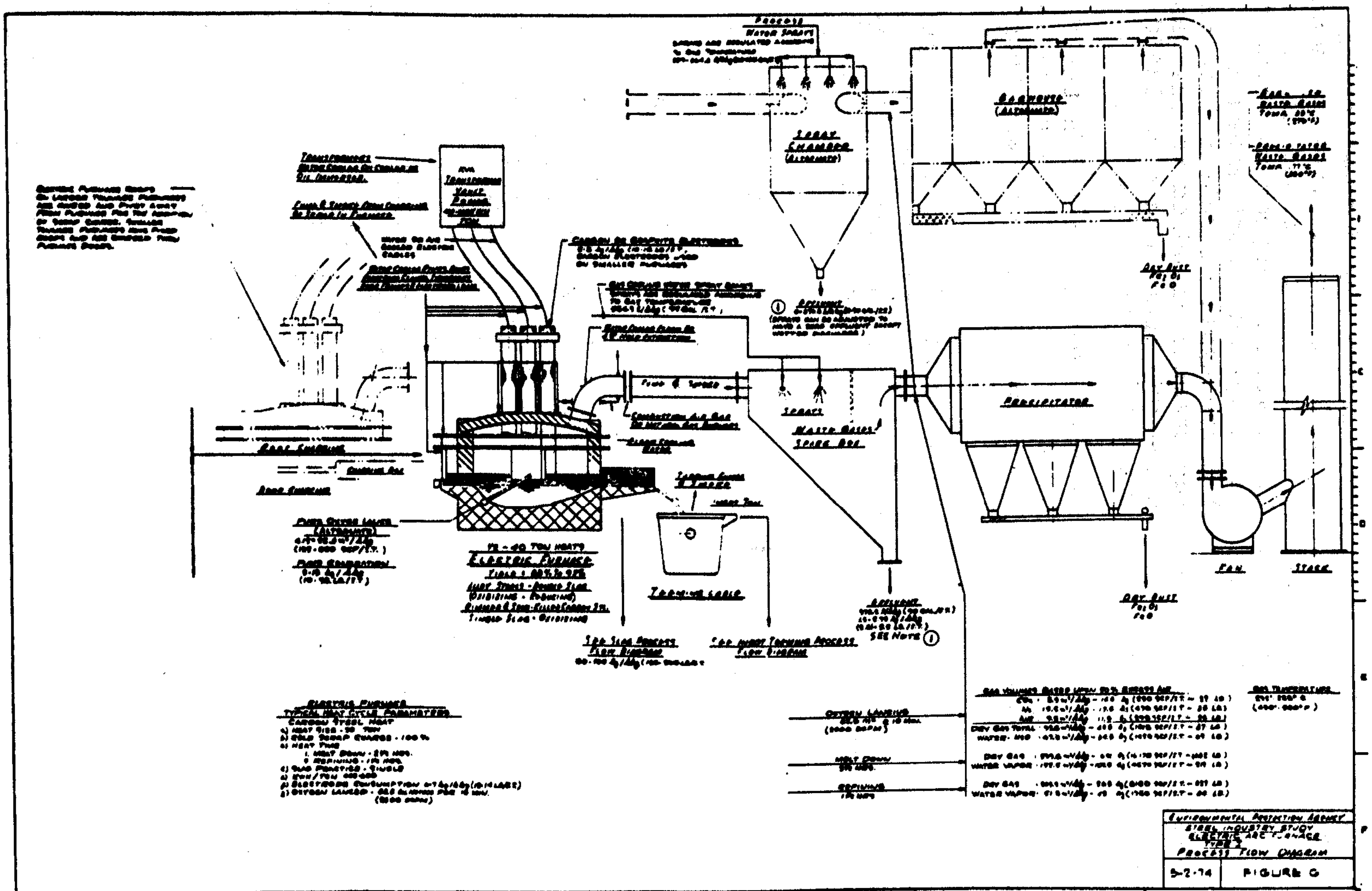
The induction furnace is generally used in producing special alloy iron and steel. In this type of furnace, a crucible is surrounded by the coils of a current conveying metal. An alternating current in this coil induces eddy currents in the metal that has been charged into the crucible. These currents cause heating of the charged metal.

This type of furnace provides good furnace atmosphere control, since no fuel is introduced into the crucible. As long as clean materials such as castings and clean metal scrap are used, no air pollution control equipment is necessary. If contaminated scrap is charged or magnesium is added to manufacture ductile iron, canopy type hoods are required.

There are no aqueous discharges from this type of furnace. Noncontact cooling water is used to keep furnace equipment at tolerable temperatures.

Reverbatory Furnace

A reverbatory furnace operates by radiating heat from the burner flame, roof, and walls onto the material to be heated. This type of furnace was developed particularly for melting



Spray Chamber (Alternate)
Baghouse (Alternate)
Precipitator
Electric Furnace
Teeming Ladle
Dry Dust
Fan
Stack
See Note 1
Environmental Protection Agency
Steel Industry Study
Electric Arc Furnace
Process Flow Diagram
5-2-74
FIGURE 6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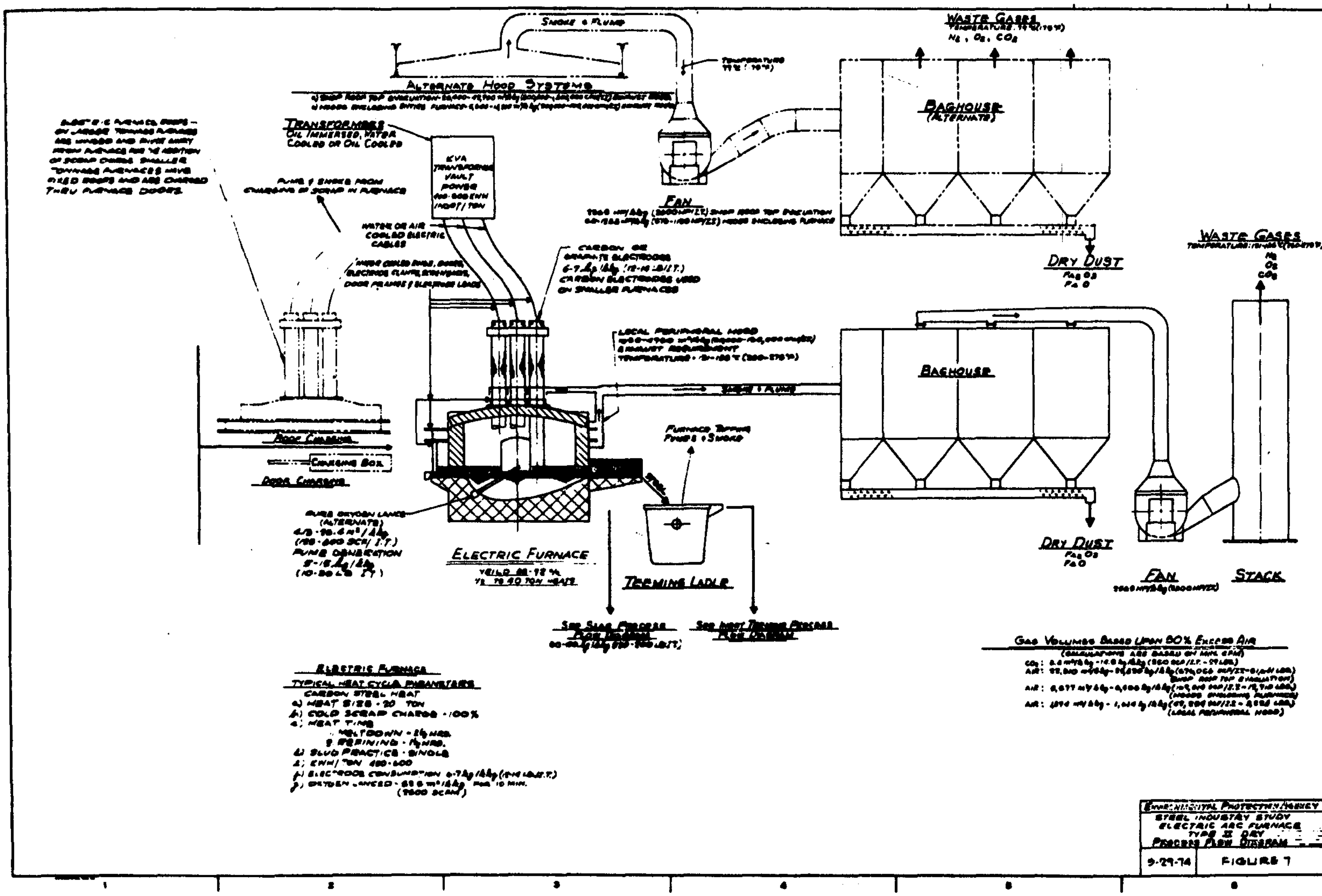
Alternate Hood Systems
Transformers
Fan
Waste Gases
Baghouse
(Alternate)
Dry Dust
Waste Gases
Baghouse
Roof Charging
Charging Box
Door Charging
Electric Furnace
Teeming Ladle
Dry Dust
Fan
Stack
Electric Furnace
Typical Heat Cycle Parameters
Gas Volumes Based Upon 80% Excess Air
Environmental Protection Agency
Steel Industry Study
Electric Arc Furnace
Type II Dry
Process Flow Diagram
9-29-74
FIGURE 7

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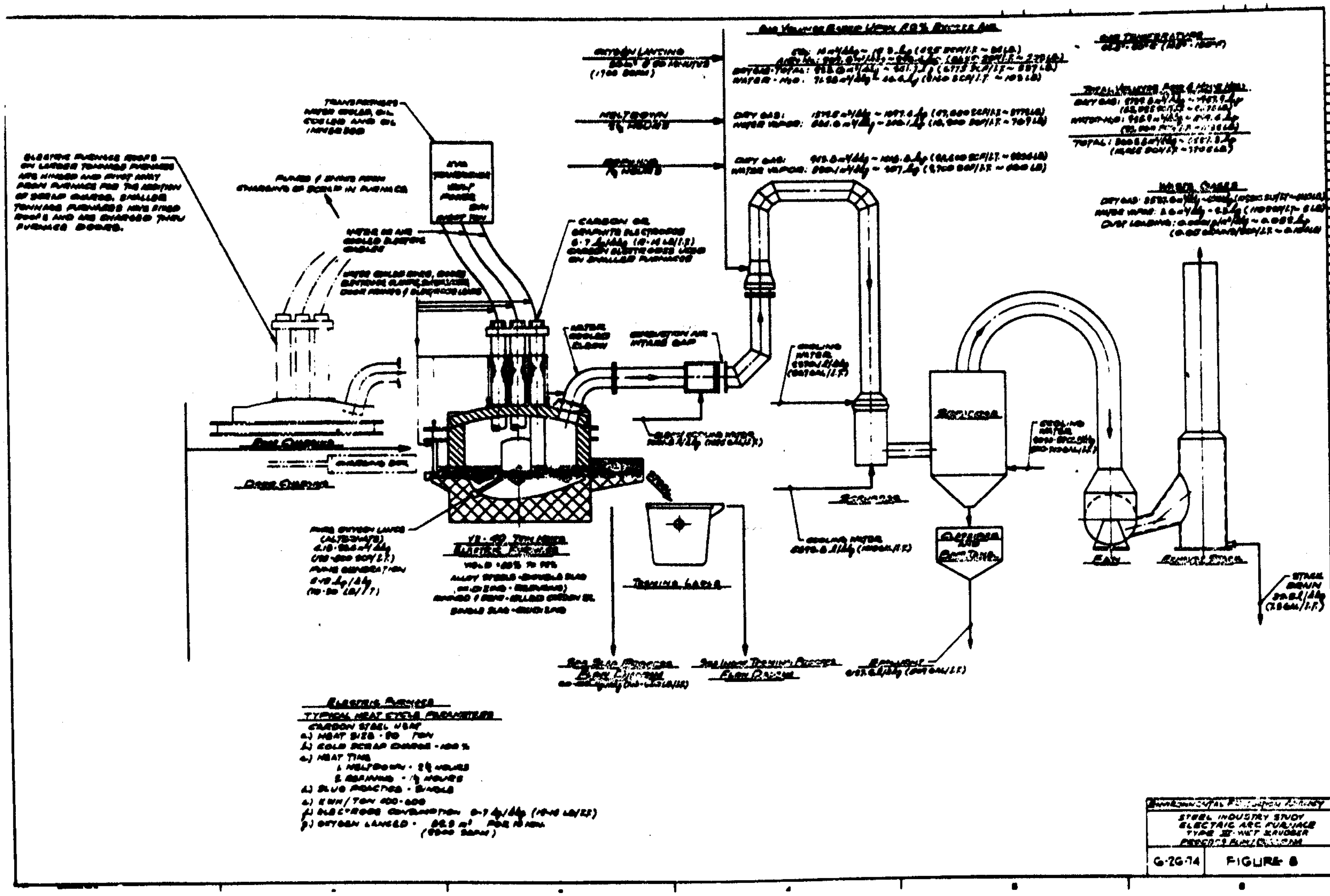




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solids and for refining and heating the resulting liquids. It is generally one of the least expensive methods of melting since the flames come into direct contact with the solids and molten metal.

A reverbatory furnace usually consists of a shallow, refractory-lined hearth for holding the charged metal. It is enclosed by vertical side and end walls, and covered with a low arched roof of refractories. Combustion of fuel occurs directly above the charge and the molten bath. The walls and roof receive heat from the flame and combustion products and re-radiate heat to the molten bath. Transfer of heat occurs almost solely by radiation.

There are many shapes of reverbatory furnaces; most common type is the open hearth style used in steel manufacture. However, the cost of pollution control equipment, as well as inefficiencies in handling the metal, have caused this type of furnace to be obsolete. Very few are still in use, and these are being phased out of production due to costs. No reverbatory furnaces were included in this study as none were found that produced a water stream as part of the furnace process.

## MOLDING OPERATIONS

The second major area of foundry operation is the preparation of molds. This operation has three subprocesses:

1. Sand Storage and Preparation
2. Mold Making
3. Core Making

A general rule of thumb in foundry operation is that it takes 8 lbs of sand to make 1 lb of casting. Thus a foundry producing 20 tons/day must have facilities to store, prepare and move 160 tons/day of molding sand. Generally, this calls for large storage silos or bins with bulk handling conveyors, screws, feeders, etc., for efficient handling.

It may be noted on the process flow diagram (Figure 2) that the sand moves from storage to mullers where it is wetted and mixed with binders that impart sufficient strength to permit packing the sand to a firm media for molding. The binders consist of various natural and synthetic materials that will add strength to the sand and not detract from its moldability.

Sand is carefully chosen for its grain size, shape, reliability of supply, and cost. Sand preparation consists of mechanically mixing the binders selected with the sand so that the sand grains are coated with a thin layer of binder. It is usually wetted with a small amount of water (3-5% moisture) to improve its moldability and green strength. The prepared sand is delivered to the mold maker who packs it around a pattern to form one-half of the final cavity for the metal. This is performed by having the half pattern mounted on a board. The pattern is then surrounded by a four-sided "flask" that is open on top and bottom. Sand is packed around the pattern and then rammed, vibrated or jolted to compact it to a uniform density. The packed flask is now inverted (rolled over) and the pattern is withdrawn from the sand leaving a cavity. This represents one-half of the final cavity.

The other half of the final cavity is formed in a similar manner and the two parts are fitted together by means of alignment pins to form a complete cavity.

Many castings require a cavity within the metal object. This is obtained by placing a "core" in the half cavity before joining it with the other half.

"Cores" are also made of sand. They usually are made with a stronger binder, as they are subjected to more heat and erosive metal flow than the main cavity. The sand preparation is similar to that of molding sand, and the cores are formed in a bi-parting box of wood or metal. Depending on the type of binder used, cores may require some type of curing before use to obtain the strengths necessary.

The bottom half of the mold is called a "drag" and the top is called a "cope." Before they are joined together, they are inspected and the core or cores are set in their proper place. After joining, they are held together by clamps on the flasks and weights on the cope. The metal entry hole (sprue) is in the cope half, and may be reinforced with a "sprue cup" to absorb the erosive effects of the poured metal striking the sprue.

The mold is now ready for pouring. It is transported (if not too large) to a pouring area where the molten metal will be poured into the sprue. In some cases where economics warrant, the sand mold can be replaced by a permanent mold. These molds are made of iron or steel. They must be capable of sustaining the heat cycle required in this service.

CLEANING OPERATIONS

After metal is poured into the molds, a period of time is necessary for the metal to cool and solidify. During this time, the metal cools from about 1,540°C (2,800°F) to 770°C (1,400°F). The binders in the molding sand have become heated and brittle and have lost their strength.

The casting is dumped onto a metal grating of heavy construction. This grating is vibrated and vigorously shakes the mold and casting causing the sand to fall away from the metal. Usually 95% of the sand falls from the casting in the "shakeout" operation.

This sand is returned to the storage area via a sand conveyor and usually through a sand reclaim operation. The reclamation can be wet or dry and will tend to cool the sand, screen out lumps, metal particles, core rods, nails, chills, etc.

SAND WASHING OPERATIONS

In a wet reclamation system, the sand is washed by high pressure water jets, and then sent through a classifier where fines, and spent binder particles are removed. The cleaned sand is dried and returned to the sand storage area for reuse.

One of the major methods of sand reclaiming is by washing the sand in water. There are many variations of this process, all of which include the following steps.

1. Reduce sand to grain size.

2. Thoroughly wet the grains.

3. Agitate wet sand mix to rub the grains together and remove the spent binder.

4. Separate the sand from the dirty water.

5. Dry the sand.

While these steps have been combined many ways using various pieces of equipment, three general systems can be identified. These are:

1. Crusher to agitator tank to dewater to dryer.
2. Water jet to slurry classifier to dewater to dryer.
3. Oversize screenings to slurry mixer to dewater to dryer.

In each of these systems the critical steps are agitation of the wet sand, and separation of the sand from the dirty water.

After separation, the sand is dried either naturally, or by a forced heat dryer. The sand is then sent to storage for reuse.

The development of the "no bake" and use of other special chemicals may force operators to replace wet reclaim systems with dry systems.

In a dry reclaimer, the sand is tumbled in an air stream to remove the fines and spent binder by air separation. The cleaned sand is then returned to storage.

After "shakeout," the casting is transported to an area where the heads and gates are removed. A "head" is a relatively large volume of metal projecting above the normal height of the casting. It is needed to assure adequate flow of metal to all parts of the casting as it cools and contracts. This liquid metal under a static head will supply areas subject to shrinkage and severe contracting stresses.

The gates and the runners are the passages needed to supply all parts of the casting with hot metal during pouring. These are no longer needed when the casting is cooled. The heads and gates are broken or cut from the final casting and returned for reprocessing as scrap. Heads and gates may be 50% of the metal poured.

The casting is moved to other cleaning stations where a thorough cleaning is performed. This can include shot blasting, sand blasting, grinding, chipping, crack or flaw repair by welding, chemical cleaning, etc., depending on the final requirements of the product. The potential for wastewater contaminants from these operations is small. Dust collectors may have water sprays to remove the particulates from the air.

## HEAT TREATMENT

Castings have been processed from the pouring station through cleaning with very little regard to final physical properties. The grain structure developed in the general cooling process may vary widely. To develop proper grain structure and the resulting physical properties, it may be necessary to heat treat the castings. This heat treating is accomplished in ovens that are programmed to give the correct thermal treatment to the metal. After the heat cycle, it may be necessary to quench the castings by means of a water or oil bath.

The heat from this quench operation can be rejected via air cooling towers, or heat exchangers with noncontact cooling water. The quench fluid is only a heat transfer medium. It does not require quality water. Quench tanks occasionally contain blowdown systems, but usually are used until the water is very turbid with suspended particles and then they are drained.

FOUNDRY EMISSION CONTROL

Various methods have been utilized to control the emissions from the foundry operations. These are:

1. Filtration or "Baghouse"
2. Electro-Static Precipitation
3. Semi-Wet (refinements to 1 & 2)
4. Wet Scrubbers
   a. Washing Cooler
   b. Wet Cap
5. High Energy Venturi Scrubbers
6. Mechanical Centrifugal Scrubbers
7. Cyclone Scrubber
8. Orifice Type Scrubbers

This study will discuss only those methods that use water in contact with the process materials (noncontact cooling water is excluded).

Generally, two problems are associated with foundry emissions. These are:

1. Particulate Matter
2. Gases

The particulate matter, or "dusts," can amount to 10 kg/kkg (20 lb/ton) of product, and depend largely on the type of charged material.

The amount and composition of gases is a function of the type of fuel, the fuel-air ratio, and the material charged. For a coke ratio of 7-1/2:1, the carbon monoxide will approximate 140 kg/kkg (275 lb/ton) of iron melted in a cupola furnace. If galvanized scrap metal is charged, zinc oxides can be expected, etc.

The hot furnace gases contain a sizeable amount of sensible and latent heat. This heat is often reclaimed by igniting the CO and burning to $CO_2$, and then using these hot gases to preheat the blast air by means of a recuperator. After the heat is reclaimed, the gases are either scrubbed and/or filtered and released. (See Figures 3 and 5)

## Filtration

The collection of particulate matter is achieved by entrapment of the particles in the fabric of a filter cloth that is placed across a flowing gas stream. These dust particles are removed from the cloth by shaking or back flushing the fabric with air.

Filtration does not remove gases from the furnace discharge gas stream. These gases are: CO, phenol, $CO_2$, HCl, $H_2$, $H_2S$, $N_2$, $NH_3$, and $H_2O$. Their quantities depend on type of fuel, furnace efficiency, and infiltration of air into the gas stream.

Filtering methods have been developed to a high degree of efficiency (97-99% removal of particulate matter). These methods coupled with recuperation of heat and ignition of the combustible gases have received considerable attention from industry and are useful processes.

Electric furnaces will have fewer gases than fossil fuel furnaces, since no gases are used in the heating process.

## Semi-Wet System

In many filter applications, the gases are very hot. If they entered the filter chamber, they would ignite the filter cloth. In order to cool these gases, they are first sent through a spray chamber where they are sprayed with water. This chamber usually is arranged to provide a sharp reversal in the gas stream direction and a sudden reduction in flow velocity. These features coupled with a cooling effect achieved by the evaporation of sufficient water causes the larger dust particles to be deposited on the chamber floor. The gas then flows to the filter chamber. The dust that is deposited is removed periodically.

## Wet Systems

Washing Coolers. Several general designs of washing coolers are used. All use some method to secure a long retention time to keep the gases in contact with the scrubbing liquor. In general, they consist of a large cylindrical vessel with the gases entering tangentially at the bottom and exiting through the top center. Several levels of sprays bring the liquor into contact with the rising gases. The bottom is usually conical with a large pipe outlet to return the dirty liquor to a settling area.

Some washers were built with internal fittings to give countercurrent exposure of gases and cleaning liquor. These tend to require considerable maintenance to keep the internal fittings clean and flowing. Other washers are designed without internal fittings and use spray nozzles at the periphery at several levels to inject the sprayed liquor into the gas stream.

Another type known as the bulk bed washer contains water sprayed gravel beds. The dusty gas enters in a downward or tangential direction and has a preliminary dust removal by inertia. The gases then flow upward through a wetted gravel bed. At the upper surface of this bed, the gas velocity causes a turbulent water zone that brings the finest dust particles into contact with the water. The water is sprayed in above this filter bed and continually washes it and is removed at the bottom as sludge. Above the spray heads is a droplet catcher that removes the droplets from the rising gas stream. This method requires approximately 10 in. w.c. of pressure drop and is not effective on particles smaller than 1 micron.

Wet Cap. The "wet cap" method is an early attempt to reduce the particulate emissions by passing the waste gases through a water stream or water curtain. This method operated with a low pressure drop could be added to existing cupolas with only minor changes to equipment and operations. The results achieved are only 80% effective at best.

Venturi Scrubber. This scrubber consists primarily of a venturi tube fitted with spray nozzles at the throat. The dust-laden gases flow axially into the throat where they are accelerated to 200 ft/sec. Water is sprayed into this throat by a ring of nozzles. This produces a dense mist-like water curtain. The water droplets of this curtain combine with the dust particles. In the subsequent diffuser, the velocity is reduced and inertia is used to separate the droplet and the gas stream.

Venturi scrubbers require 15-100 in. w.c. of pressure drop of the gas stream. They are very effective on particulate matter in the 1 micron range and readily adsorb many furnace gases in their water streams.

Mechanical-Centrifugal. A spray of water at the inlet to a fan becomes a mechanical-centrifugal collector. The collection efficiency is enhanced by the entrapment of dusts on the droplet surface, and impingement of the droplets on the rotating blades. The spray also flushes the blades of the collected dusts. This spray will substantially increase corrosion and wear on the fan.

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Cyclone Scrubbers. This type of dust collector ranges from the simple dry cyclone with spray nozzles to special multi-stage scrubbers with elaborate internal devices to promote counter flow contact. All feature a tangential entry to a cylindrical body. Attempts are made to increase exposure time of the water sprays with the gas stream. Since centrifugal force is the main separating mechanism, velocity increases improve the efficiency.

Orifice Scrubber. Orifice scrubbers use the velocity of the gas stream to provide gas/liquid contact. The air flows through a series of restricted passages that are partially submerged in water. This causes dispersion of the water with resulting wetting of the dust particles. The particles are then collected by inertial separation or contact with a wetted wall. The quantity of water in motion in the dust stream is large, and the water is recirculated without pumps.

## RATIONALE FOR CATEGORIZATION - FACTORS CONSIDERED

With respect to identifying any relevant, discrete categories for the foundry industry, the following factors were considered in determining industry subcategories for the purpose of the application of effluent limitation guidelines and standards of performance:

1. Manufacturing processes
2. Products
3. Wastewater constituents
4. Gas cleaning equipment
5. Waste treatability
6. Age and size
7. Land availability
8. Aqueous waste loads
9. Process water usage

After consideration of all these factors, it was concluded that the foundry industry is comprised of separate and distinct processes with enough variability in product and waste to require categorizing into more than one unit operation. The individual processes, products, and the wastewater constituents comprise the most significant factors in the categorization of this industry. Process descriptions are provided in this section of the report delineating the detailed processes along with their products and sources of wastewaters. The use of various gas cleaning equipment in the melting and molding subcategories warrants the need for process subcategorization. Gas cleaning is also discussed under process descriptions. Waste treatability in itself is of such magnitude that in some industries, categorization might be based strictly on the waste treatment process. However, with the categorization based primarily on the process with its products and wastes, it is more reasonable to treat each process waste treatment system under the individual category or subcategory. Waste treatability is discussed at length under Section VII, Control and Treatment Technology. Size and age of the plants has no direct bearing on the categorization. The processes and treatment systems are similar regardless of the age and size of the plant. Table 2 provides, in addition to the plant size, the geographic location of the plant along with the age of the plant and the treatment plant. Table 3 shows the range of production capacity of the plants visited during the study period. It was rather imperative that plants of varying sizes be studied. It can be noted that neither the wastes nor the treatment will vary in respect to the age or size factor. The aforementioned tables should be tied back to the discussion in Sections VII and VIII, related to raw waste loads, treatment systems and plant effluents. Therefore, age and size in itself would not substantiate industry categorization.

The number and type of pollutant parameters of significance varies with the operation being conducted and the raw materials used. The waste volumes and waste loads also vary with the operation. In order to prepare effluent limitation that would adequately reflect these variations in significant parameters and waste volumes the industry was subcategorized primarily along operational lines with permutations where necessary, as indicated in Table 4.

SELECTION OF CANDIDATE PLANTS FOR VISITS

A survey of existing treatment facilities and their performance was undertaken to develop a list of best plants for consideration for plant visits. Information was obtained from:

1. The Study Contractor's Personnel
2. State Environmental Agencies
3. EPA Personnel
4. Personal Contact
5. Literature Search
6. Trade Associations

Personal experiences and contacts provided information required to assess plant processes and treatment technology. Although an extensive literature search was conducted, the information was generally sketchy and could not be relied upon solely without further investigation.

TABLE 2

PLANT AGE AND SIZE

| Plant | Location | DAILY PRODUCTION KKg/D | DAILY PRODUCTION Tons/D | Metal Poured When Sampled Ton/D | Plant Age Yr. Built | Treatment Sys. Yr. Installed | Melting Operations | Molding and Cleaning Dust Collection Operations | Sand Washing Operations | Multiple Operations |
|---|---|---|---|---|---|---|---|---|---|---|
| VV-2 | Middle Atlantic | 360 | 400 | 458 | 1921-67 | 1973 | X | X | X | X |
| WW-2 | Midwest | 175 | 192 | 352 | 1925-65 | 1963-65 | X | X | | |
| XX-2 | Great Lakes | 83 | 92.5 | 93 | 1920-71 | 1972 | X | | | |
| XX-2A | Great Lakes | 162 | 180 | 193 | 1967 | 1971 | X | X | | |
| XX-2B | Great Lakes | 63 | 70 | 86 | 1969 | 1973 | X | | | |
| YY-2 | Midwest | 150 | 170 | 185 | 1911-69 | 1970 | X | X | | X |
| AAA-2 | Midwest | 594 | 660 | 819 | 1971 | 1971 | | X | | X |
| AAA-2A | Midwest | 656 | 729 | 842 | 1921-65 | 1965 | | X | X | |
| AAA-2B | Midwest | 452 | 503 | 459 | 1973 | 1973 | | X | | X |
| BBB-2 | Middle Atlantic | 8 | 9 | 9 | 1917-71 | 1974 | X | | | |
| ZZ-2 | Great Lakes | 76 | 85 | 185 | 1925-58 | 1958 | | X | X | X |
| HHH-2 | Great Lakes | 117 | 130 | 196 | 1955-65 | 1973 | X | | | X |
| HHH-2A | Great Lakes | 130 | 143 | 217 | 1968-73 | 1973 | X | X | | |
| HHH-2B | Great Lakes | 81 | 90 | 136 | 1969-74 | 1973 | X | | | |
| GGG-2 | New England | 36 | 40 | 40 | 1889-71 | 1971 | X | | | |
| CCC-2 | Middle Atlantic | 27 | 30 | 25 | 1948 | 1974 | X | X | | |
| EEE-2 | Middle Atlantic | 58 | 65 | 74 | 1953 | 1972 | X | | | |
| FFF-2 | Middle Atlantic | 31 | 35 | 35 | 1922-48 | 1947 | | | X | |
| DDD-2 | Great Lakes | 9 | 10 | 14 | 1946 | 1971 | X | X | | |

## TABLE 3

RANGE OF PRODUCTION CAPACITY SAMPLED (TONS/MONTH)

<100 T/M — <20,000 T/M

| PLANT | |
|---|---|
| AAA-2 | 13200 |
| AAA-2A | 14600 |
| AAA-2B | 10600 |
| XX-2 | 1840 |
| XX-2A | 3600 |
| XX-2B | 1400 |
| VV-2 | 18000 |
| WW-2 | 7000 |
| YY-2 | 3200 |
| ZZ-2 | 1700 |
| BBB-2 | 189 |
| FFF-2 | 700 |
| CCC-2 | 1300 |
| DDD-2 | 200 |
| EEE-2 | 1300 |
| GGG-2 | 560 |
| HHH-2 | 4000 |
| HHH-2A | 4300 |
| HHH-2B | 2700 |



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TABLE 4

SUBCATEGORIZATION OF THE
FOUNDRY OPERATIONS

I. Melting Operations

II. Molding and Cleaning Dust Collection

III. Sand Washing Operations

IV. Multiple Operations

Upon completion of this plant survey, the findings were compiled and preliminary candidate lists were prepared on those plants that were considered by more than one source to be providing the best waste treatment in one or more subcategory. These lists were submitted to the EPA by the study contractor for concurrence on sites to be visited. The rationale for plant selections is presented in Table 5. In several instances, changes had to be made because of the non-availability of the plant. Table 6 presents a summary of the requirements for the study.

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| Cupola 400 T/M | | All dry systems |
| Cupola 750 T/M | Wet dust collector on sand system. | Landfill dry dusts to city |
| 2 electric arc furnaces 1200 T/M | All dry systems | |
| Cupola 800 T/M | Venturi scrubber, slag quench and wet dust collectors, discharge to city sewer. | |
| 6000T/M Cupola | Venturi scrubber drains to large pond. Settling - recycle. No treatment. | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| Cupola 400 T/M | Exhaust cupola to baghouse. All systems dry. | |
| 2 arc furnaces 250 T/M | All dry systems. | |
| 250 T/M Electric furnace | All dry systems. | |
| 500 T/M Cupola | Venturi scrubber on cupola exhaust. Recycle, pH control-discharge to city sewer. | |
| 6000 T/M Cupola | High energy Venturi scrubber. Discharge to settling pond, overflow to holding pond, recycled.<br>(1) Water Quench Tank.<br>(2) Oil Quench Tank<br>Spillage to main settling pond to holding pond. Water recycled. | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 1 (CQT) arc furnace 550 T/M | All dry systems. | |
| Electric furnace 500 T/M | All dry systems. | |
| 1-30 ton basic arc furnace 5500 T/M | Sand scrubbing system to clarifiers. Chemical treatment. Recycle, solids to landfill. Several unit dust collector feed to central system. | Wastewater - discharge to clarifier. Recycle overflow. Underflow to storm sewer. |
| Cupola 500 T/M | Venturi scrubber discharge to city sewer. | |
| 2 arc furnaces 600 T/M | All dry systems. | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 1-10 ton acid electric furnace 400T/M | | No water discharge |
| Electric furnace channel indicator 750 T/M | All dry systems. | |
| Electric furnace 750 T/M | 2 wet dust collectors. Zero discharge. Recycle. | |
| 2 arc furnaces 4 induction furnaces Vacuum degasser 650 T/M | No treatment | 1 - quench tank, 2250 gal - overflow<br>1 - LPI booth |
| Electric arc furnace 600 T/M | All dry systems | |
| Cupola 4600T/M | All dry systems | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| Electric arc and induction furnace 1,000 to 12,000 lbs 900T/M | No systems | Furnace dry baghouse (2) wet dust coll. - 0 discharge No sand scrubbing, quenching |
| 650 T/M Cupola | Venturi scrubber to drag tank to settling tank - NaOH added for pH control 600 gpm makeup. Zero discharge. | |
| 220T/M | Wet scrubber on cupola - uses O/T cooling from A/comp. plus fresh. Recycles - adds dry caustic for pH control. Discharges after day's run - 400 g/d - to settling pond. Water percolates into soil. No other discharge | 38 + 6 employees |
| 1000 T/M | Venturi scrubber - drag tank - recycle drain system once a week. | |
| Cupola | Venturi scrubber on cupola not in compliance with local codes. Baghouse on dust call. No sand scrubbing | |

TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 1-6 ton basic electric furnace 385T/M | All dry systems | |
| 2 basic elec. furnaces 2500T/M | All dry systems | |
| 2 arc furnaces 150 T/M | All dry systems | |
| Electric arc furnace 1200T/M | All dry systems | |
| 8800 T/M | Closed loop on cooling systems. Wet dust collectors. | |
| Cupola 600T/M | Radiant burners and heat exchange to baghouse. Dry systems. | |
| 1 - 35 ton arc furnace 7000 T/M | Semi-wet exhaust to baghouse. Dust collectors and sand scrubber to settling tank. Add chemicals - recycle - blowdown | to river. |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 200 T/M cupola DDD-2 | Cupola - wet scrubber on gas discharge<br>Wastewater - discharge to settling basin, add soda ash - discharge (underflow) to creek recycle overflow | Effluent to creek. Reported good by industry representative. |
| Arc furnace 500 T/M | Wet scrubber to drag chain, recycle. Non-contact water to cooling tower. | No treatment system |
| Cupolas 30,000 T/M 5 plants HHH-2 HHH-2a HHH-25 | Venturi scrubbers to primary settling tank and/or lagoon. Recycle - zero discharge. | Large modern production foundries with good treatment facilities. |
| Cupola 200 T/M | Exhaust to baghouse - no water used. | |
| 2-25 ton arc furnaces 10,000 T/M | Gas cleaning - venturi scrubbers, solids settlement, once-thru system. | Once-thru system with solids settlement. |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 3 duplex cupolas | Central GM Foundry production complex. Has central water system that mixes from other industrial processes. | |
| Electric furnace 850 T/M | 2 wet dust collectors - recycle. | |
| Direct arc furnace 760T/M | All dry system | No water discharge. Closed loop on non-contact cooling and Hzd sys. |
| 2000T/M (est.) 2 cupolas | 2 cupolas with high energy scrubber. Treatment - to mixing tank add lime; to lagoon, to cooling lagoon to pump pond. Contains some carbon lampblack | Reported as good by industry representative |
| 4000T/M OH & Arc Furn. | No wet systems | OH's closed down.. Steel open only |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 4 Ind. furnaces 350 T/M | All dry systems | Plans future cupola with water loop. All cooling water is recir. and Bd to city sewers. Sand reclaim and dust coll. dry. |
| 2 arc furnaces 600 T/M | No wet systems | Non-contact cooling only all baghouse on dust coll. fce. and sand mixing etc. |
| 650 T/M Cupola | Venturi scrubber - recycle with pH control. Zero discharge. | |
| 1-5 ton acid electric furnace 225 T/M | No wet systems | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 4000 T/M cupola<br>YY-2 | Discharge from Venturi to cyclones, overflow recycled; underflow to settling tank.<br>Overflow to city sanitary sewer, underflow to landfill. | Treated discharge to city sanitary sewers. |
| 1600 T/M cupola | Dust collection system and sand scrubber are wet systems. Uses polymer for settling - pH treatment. | System not stabilized. |
| New venturi scrubber | Settling in drag tank. Recycle - blowdown daily. | |
| 2-9 ft arc furnaces 1600 T/M | 1 gpm blowdown to city sewer | Baghouse on furnace<br>(1) wet dust collection blowdown to sanitary sewer |
| Electric furnace 600 T/M | All dry systems | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 500 T/M cupola | All dry systems. | |
| 13,000 T/M gray iron electric arc AAA-2 | Water spray into cyclone for dust entrapment and gas cooling. Gas to baghouse. Wastewater to settling pond.<br>Wastewater from dust collectors - to settling pond, clarifiers and vacuum filter. Solids to land fill, recycle water. | Semi-wet electric arc furnace system. No discharge. |
| 4 cupolas 14,000 T/M AAA-2A | Large sand washing systems water used once thru and then to lagoon. Dust collectors (12) recycle & blowdown to lagoon. | Older plant with good facilities. |
| 4 electric arc furnaces 10,000 T/M AAA-2b | Extensive dust collection system used thru foundry w/wet collectors discharging to a central treatment system. | New-plant with good facilities. |
| Cupola 600 T/M | All dry systems | |
| Electric furnace | | No wet equipment (had a sand scrubber). |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 200 T/M<br>4 - cupola | Baghouse (semi-wet) slag quench, recycle water, overflow to city sewer - drag tank slag to landfill. No water treatment. | |
| Cupola<br>Electric furnace<br>1050 T/M | Slag quench system to lagoon. Recycle pH control & inhibitors | |
| 700 T/M<br>3-30 ton induction furnaces | No wet discharges | |
| 2 arc furnaces<br>7 induction furnaces<br>500 T/M | No treatment systems | Non-contact cooling is recycled thru CT - 0 discharge<br>No wet dust collection<br>Quench system - recycled thru CT. |
| 4 arc furnaces<br>5 induction furnaces<br>1700 T/M | No treatment systems | (1) wet scrubber |
| Electric arc furnaces<br>5600 T/M | All dry systems | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 85 T/M | Cupola - all dry - no water discharges. Dry dust collector. | 40 employees |
| 3 arc furnaces 2000 T/M | All dry systems | |
| 1 arc furnace 3 induction furnaces 360 T/M | All dry systems. Quench tanks O/F to river | |
| Cupola 800 T/M | Venturi scrubber being installed. Operating late in 75 | |
| Electric furnace 500 T/M | All dry systems. | |
| Cupola 800 T/M | Hydro-filter system. pH & poly drag tank - overflow to city storm sewer. | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 750 T/M Cupola | Venturi purchased. 9/75 installation. | |
| Cupola 3500 T/M | Venturi scrubber (2) wet dust collectors. Recycle - add NaOH to control pH | Automative and engineered castings |
| Cupola 600 T/M | Venturi scrubber primary settling, blowdown pH control only | |
| Cupola 550 T/M | All dry systems. | |
| 1 electric arc furnace 3 induction furnaces | Use spray towers for heat rejection. 5 wet dust collectors to central lagoon for settling. No treatment | New 300,000 $ft^2$ plant. Plant not in full production. |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| Cupola 1000 T/M | Exhaust to baghouse. (1) wet dust collector. | Closing foundry |
| Induction furnaces 425 T/M | No wet systems | |
| Cupola 3300 T/M WW-2 | Quench chamber (semi-wet) on cupola. 4 wet dust collectors discharge to city sanitary sewer. Slag quench to city sewer. | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 1400 T/M Coreless Ind. | Recirculate non-contact cooling water. 1 wet dust collector. Add chemical coagulant drag solids, recycle. | |
| Cupola 800 T/M | All dry systems. | |
| Electric arc furnace | N.c. cooling water recycled. | Citation on environmental improvement. No wet systems. |
| 1500 T/M | All dry systems. | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| Electric furnace 2850 T/M | No treatment system | Old sand scrubber |
| 70 T/M | Wet cap on cupola - recycle - no chemical. Fly ash to road fill. Zero discharge - no wet dust collectors. Less than 5T/hr. cupola. | 50 employees |
| 4-40 ton induction furnaces | Two dust collecting systems. Discharge to pond, add polymer, recycle to collector. Solids dewatered then to landfill. | Use polymers for treatment. |
| 1 induction furnace 1 wet dust collector 120 T/M | Water from dust collector to drag tank, add alum and polymer. Drag chain sludge to landfill. Recycle water. | Wet collection on pouring line and "shakeout". |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| Foundry & machine shop | Dust collectors and wet scrubber to lagoon then to river. Plans to install recycle loop. | $64mm expansion "Rotoclone" dust collector |
| Electric furnace 500 T/M | All dry systems. | |
| 1000 T/M | No response. | |
| Cupola 1350 T/M | Cupola with hydrofilter drains to sump - drag tank solids to landfill. Recycle water from air compressors as makeup overflow 11 gpm to city sewer. | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| Cupola 90 T/M | Wet scrubber on cupola 1 to 1-1/4 hrs/day operation. Discharge to sewer. No other discharges | 50 employees |
| Cupola to be replaced by electric furnace | Have washers on cupola. Going to electric furnaces and baghouse. 14 wet dust collectors, add polymers before 5 clarifiers. Recycle. | |
| Cupola 700 T/M | Venturi scrubber to drag tank. Recycle with blowdown to pond and overflow to stream. | |
| 3 arc furnaces 225 T/M | No wet systems | No water except NC cooling |
| 2 arc furnaces 5 induction furnaces 800 T/M | All dry | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 600 T/M | No response. | |
| 1-2 ton acid electric furnace 450 T/M | All dry | No water discharges - sand scrubber is air type - baghouse on furnace |
| Cupola 300 T/M | All dry systems | |
| Cupola 40 T/M BBB-2 | Venturi scrubber recycle - blowdown to city sewer | |
| Cupola 250 T/M | All dry systems | |
| 18,000 T/M Pipe (Centri) Shell Mold VV-2 | Cupola exhaust system to spark box and baghouse. Wastewater - dust collector with washer - sand reclaim system thru classifier - recycle and blowdown to lagoons. Slag quench to lagoons. | No aqueous discharge from spray chamber. |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| Cupola<br>700 T/M | All dry systems. | |
| 1-3 ton acid electric furnace<br>1-(1-1/2) ton acid electric furnace<br>630 T/M | All dry | |
| 400 T/M | No response | |
| 3 electric arc furnaces<br>1700 T/M<br>ZZ-2 | 3 wet dust collectors, sand washing system, wastewater treatment and recycle system. | Complete recycle system |
| 1-9 ton acid electric furnace<br>1-18 ton acid electric furnace<br>2400 T/M | All dry systems | No water discharges from foundry. |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 500 T/M | No response | |
| 750 T/M | No response | |
| | No response | |
| (1) 1-1/2 ton basic electric furnace<br>1-2 ton acid electric furnace<br>1000 T/M | Zero discharge from wet dust collectors | Non-contact cooling water only. Sand scrubber - air type. 4 wet dust collectors with 0 discharge. |
| electric furnaces<br>500 T/M | Baghouse. No wet discharges. | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| Induction furnaces 2400 T/M | Use cooling tower for heat rejection<br>1 wet dust collector. No sand reclaim | |
| cupola 1785 T/M | Venturi scrubber-to pond chemicals added. Recirculate 500 gpm system antiquated.<br>4 wet dust collectors - drag sludge O/F to Fox River to land fill. Sand scrubber not run. | |
| 2 electric arc furnaces 800 T/M | All dry systems | Plant closed 1972. |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 5 electric furnaces 4500 T/M | No waste treatment systems. | Non-contact cooling from cistern. All dry baghouse on furnace and dust system. Dry sand reclaim. Quench tank recycle to cooling cistern. |
| 8500 T/M cupola XX-2 XX-2A XX-2B | High energy scrubber on cupola. Wastewater - closed system - discharge to settling basin - drag chain solids removal - makeup and lime treatment - recycle | |
| 900 T/M | No response | |
| Electric furnace induction 110 T/M | Recirculate cooling water. No discharge, no wet dust collector. | 38 employees |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 700 T/M | No response | |
| 2 arc furnaces<br>2 induction furnaces<br>840 T/M | Sand scrubber and wet dust collector into central system settling tank and pumps to landfill - quench system - CT closed cycle | Baghouse on furnace |
| Cupola<br>3 electric furnaces<br>720 T/M | Exhausts to baghouse. No aqueous discharges. | |
| 125 T/M | No response | |
| 2 arc furnaces<br>5 induction furnaces<br>400 T/M | All dry systems. | Non-contact cooling water overflow to city storm sewer. |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 700 T/M | No response | |
| 450 T/M | All dry systems. | |
| 200 T/M | All dry systems | |
| 2-25 ton basic open hr. furnace<br>1-35 ton basic open hr. furn.<br>2-45 ton basic open hr. furn.<br>1-30 ton basic electric arc furnace<br>6000 T/M | All dry systems | Open hearth furnaces closed due to lack of air pollution equipment |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| High energy scrubber 700 T/M cupola | Venturi water to settlement pond - pH control (NaOH) recycle | Complete recycle. No aqueous discharge. |
| 9 electric induction furnaces 600 T/M | All dry | No wet equipment |
| Induction furnace | All dry systems | |
| 1 cupola 1100 T/M EEE-2 | Venturi scrubber and complex treatment system - zero discharge | Medium size foundry with zero discharge. |
| 25,000 T/M | High energy Venturi Wet scrubbers, discharge to lagoon and then to river. Dust collectors to lagoon also. | |
| | No response | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 2-10 ton electric arc furnaces 1800 T/M | No wet discharges | |
| 8 electric furnaces 1500 T/M | All dry systems | No wet systems - all baghouse |
| 1 cupola 55 T/M | Afterburner on cupola - to cyclone & baghouse. No wet discharge. 1 gpm cooling water on A/comp. | 24 employees |
| 600 T/M GGG-2 | Venturi scrubber. Recycle - zero discharge. | Recommended by state EPA |
| Cupola - hot molding & cleaning | Semi-wet system. Zero discharge. All dry to baghouse. | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| 150 T/M | All dry systems | New foundry |
| 500 T/M | All dry systems | New equipment |
| Electric furnace 700 T/M FFF-2 | Baghouse - wet sand reclaim | Sand reclaim to 3 part settling sump discharge to river |
| 400 T/M (estimated) cupola | Cupola - gas cleaner - Venturi scrubber Wastewater treatment - settling basin with thickeners to remove solids. Dewater solids to landfill | Completely recycle system no aqueous discharge |
| Cupola 280 T/M CCC-2 | High energy Venturi scrubber add polymer and NaOH recycle and blowdown - wet sand scrubber - add polymer, recycle. | |
| Cupola 5000 T/M | Cupola exhaust to spark box with spray chamber and then to baghouse - No aqueous discharge. | |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| Chatanooga, TN<br>Union City, CA<br>Bessemer, AL<br>Birmingham, AL<br>Burlington, NJ | Semi-wet systems at all plants | |
| 1500 T/M(est.) cupola and electric induction furnaces | High energy scrubber Wastewater - discharge to hydraulic cyclone to settling basins to clarifier solids to landfill - recycle | Recycle system - solids to landfill. No discharge. |
| 1200 T/M purchase hot metal | 1 - wet dust collector<br>1 - casting quench | Considered good by state EPA. |
| cupola 1400 T/M | Wet cap cupola. Discharge to settling tank and NaOH - de-water solids - recycle | Reported as good by industry representative |

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TABLE 5

RATIONALE FOR PLANT VISIT SELECTIONS

| PRODUCTION FACILITIES | WASTEWATER TREATMENT | REMARKS |
|---|---|---|
| Electric furnace induction 350 T/M | Baghouse dust collectors No other - cooling recycle - some blowdown. | 65 employees |
| 1 cupola 70 T/M | No water process. Cupola No wet dust collector, etc. | 40 employees |

TABLE 6

FOUNDRY OPERATIONS
INDUSTRIAL CATEGORIZATION AND SURVEY REQUIREMENTS

| Subcategory | Number of Locations Surveyed | Number of Samples Each Location | | | |
|---|---|---|---|---|---|
| | | Composite Samples | | Grab | |
| | | Raw Waste | Treated Effluent | Misc. | Intake |
| I. Melting Operations | 9 | 3 | 3 | 3 | 1 |
| II. Molding and Cleaning Dust Collection Operations | 7 | 2 | 2 | 2 | 1 |
| III. Sand Washing Operations | 3 | 2 | 2 | 2 | 1 |
| IV. Multiple Operations | 5 | 6 | 3 | 4 | 1 |

# SECTION V

# WATER USE AND WASTE CHARACTERIZATION

## GENERAL

The wastewater streams for the industry are described individually in their respective subcategories. Waste loads were developed by actual plant sampling programs at selected better plants on which EPA concurred. Raw waste loads are established as net plant raw waste loads. This is further defined as the contaminants attributable to the process of concern. It is the total or gross process load minus the contaminated load due to background (makeup). The basis for plant selection was primarily on their waste treatment practices. Therefore, further rationale for selection of the plant sites is presented under Section VII - Control and Treatment Technology.

The sources of water in the foundry are summarized as follows:

1. Melting operations - gas scrubbing and slag quench

2. Molding and cleaning dust collection operations - dusts and gases picked up by wet dust collection systems

3. Sand washing operations - wet sand cleaning

## MELTING OPERATIONS

### Fossil Fuel

General process and water flow schematics of typical cupola furnaces are presented on Figures 3, 4, and 5.

The cupola has two main water systems:

1. Cupola shell cooling
2. Dust scrubber sprays

In most applications, the shell cooling is either a once-through system that is then used as slag quench, or it is a closed recirculating loop system through a cooling tower for heat rejection. In either case, as shell cooling, it is noncontact cooling water.

When used as a once-through to slag quench, it is directed into the slag trough to chill and solidify the slag, and to convey it to a slag quench sump. In this sump, a chain drag

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continuously removes the slag to a solids disposal system, and the water is discharged after a short term settling and screening to remove the slag.

When a closed recirculated loop is employed, waste heat is rejected through a cooling tower, and water conditioning chemicals are added to permit high recycling.

The dust scrubber system may range from complete dry precipitation or cloth filtration (baghouse) systems to semi-wet to high energy venturi scrubbers. Each particular system has advantages in relation to plant characteristics.

The dry precipitator cannot handle gases over 260°C (500°F), and is usually located at considerable distance downstream from the cupola to permit gas cooling by radiation and convection. This is also true of cloth filters. Temperatures over 260°C (500°F) will destroy the fabric, and a bypass damper will operate to dump fumes directly to the atmosphere if this temperature is exceeded at the unit inlet.

In semi-wet operations, the gas stream is cooled by spraying water into the gas stream in a "spray tower" or "quench chamber" and causing the evaporation of the water. This cooling action reduces gas volume and velocity. It promotes agglomeration of particulate matter and the adsorption of some gases. When operated properly, the water sprayed into the gas stream is completely evaporated. This results in zero aqueous discharge. The water leaves as steam, or as moisture on the particulate matter that collects at the bottom of the spray chamber or quench tower. Water used in the gas scrubber system may be drained from slag quench or it may be clean water from other sources.

Venturi Scrubber

The gases exit the cupola at 1,000°C (1,832°F) and are drawn through a venturi where they are sprayed with atomized water. The turbulence of the gas stream and the high surface area of the spray droplets promote maximum contact. The gas stream is rapidly cooled, and even submicron particles are wetted. The gas stream next enters an expansion chamber where the velocity drops and the particulate matter and water droplets fall from the gas stream.

This expansion chamber or "De-Mister" can be arranged for tangential entry of the gas stream using the inertia of the particulate to separate them from the gas, or have a sudden directional change of the gas stream that promotes inertial separation. The gases leave the expansion chamber at temperatures of about 150°C (300°F).

The aqueous discharge is returned to a collection sump, and treated to keep the suspended solids under control. This treatment can be physical separation such as a hydraulic cyclone, a side stream settling basin with sludge blowdown, or chemically treated with a flocculant to promote solids removal via a drag chain.

These discharges are typically collected in a sump along with slag quench discharges and dust collector discharges. A drag chain operates to remove the heavier slag particles that settle out in this sump and a portion of the suspended solids that settle. This sump is the source of the recirculation water to the wet scrubber venturi, slag quench and De-Mister sprays. Losses are due to evaporation, leakage and blowdown to a final settling tank. Makeup is provided by cooling tower blowdown, dust collector blowdown and/or clean water.

ELECTRIC FURNACE OPERATIONS

General process and water flow schematics of electric furnace operations are presented on Figures 6, 7, and 8.

The electric furnace has two main plant water systems:

1. Noncontact cooling water for furnace door, electrode ring, roof ring, cable and transformer cooling water system.

2. Fume collection water system.

The noncontact furnace cooling water systems for the roof ring, electrode ring, and door cooling is generally a once-through system but can be a "closed recirculating" system. The resultant aqueous discharge from these cooling systems is heated water, generally with a temperature increase of 15-25°C (60-80°F).

The type of cooling water systems applied to the electric arc furnace are dependent on furnace size. The type of fume collection and hood exhaust system is not only dependent upon capital cost but also equated on other plant characteristics such as operating cost, plant location, availability of resources (power and water), and available pollution abatement facilities. The fume collection systems range from a complete dry to semi-wet to wet high energy venturi scrubbers. Each system has advantages in relation to plant characteristics.

The dry fume collection system consists of baghouses with local exhaust or plant rooftop exhaust hoods. The local hoods are located at the sources of fume generation (door, electrode openings, etc.). Enough cooling air is drawn into

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the hoods to temper the hot gases for a baghouse operation, to approximately 135°C. The rooftop exhaust system exhausts the entire furnace shop.

The semi-wet system employs a spark box or spray chamber to condition the hot gases for either a precipitator or baghouse. A spark box is generally used with a precipitator system and a spray chamber for a baghouse system. The spark box conditions the gases to 200°C (360°F) while spray chamber conditions gases to 135°C (275°F). A water cooled elbow is used as the exhaust ductwork and is directly connected to the electric furnace roof. The aqueous discharge from the water cooled elbow is heated cooling water. The systems are generally once-through with temperature differential of 15-25°C (60-80°F) in cooling waters.

The wet high energy venturi scrubber fume collection systems use the water cooled elbow for extracting the gases from the electric arc furnace. Combustion air gaps are always left between the water cooled elbow and fume collection ductwork to insure that all the CO gas burns to $CO_2$ before entering the high energy venturi scrubber or any other fume collection cleaning device. As the hot gases pass through the scrubber, the gases are conditioned and cooled to approximately 85°C (185°F).

Table 7 summarizes the net plant raw waste loads for melting operations for the plants studied.

## MOLDING AND CLEANING DUST COLLECTION OPERATIONS

The second source of pollution producing operations considered in foundries is molding operations. These include:

1. Sand storage and preparation
2. Mold and core making
3. Shakeout and casting cleaning

All of these operations are common for foundries. Typically they produce a dust that is collected and handled through a dry baghouse or a wet collection system. Wet dust collectors used in foundries for mold operation dust collecting are generally of the low energy type. These consist of a fan providing suction for airborne dusts. These dusts are wetted by sprays or by being drawn through submerged orifices, etc., upstream of the fan entrance. The liquid provides a collecting and entraping medium for the dusts. The liquid in turn is collected by impingement or inertial action and drains to a sump or basin.

The liquid in the basin is recycled directly or it drains to a larger basin where it may be treated to promote settling of solids before recycling.

Casting Cleaning

Previous operations have produced a metal object formed in a cavity in a sand media. After the molten metal has solidified, the sand media is not needed. The sand and casting are separated and the sand is returned for reuse. The casting needs further processing.

The operation that separates the sand and the casting is called "shakeout." The mold is dumped onto a large, rugged, metal grill work that is vigorously vibrated. This causes the sand to fall from the casting to a collecting conveyor beneath the vibrating bed. This method removes about 98% of the sand from the casting. The remaining sand is very tenacious and requires much additional attention. The shakeout process produces considerable dust and should be done in an area where the dust can be captured and collected.

The casting moves to a "head and gate" removal station. In cast iron, these excess metal parts of the casting can be broken from the product by a sharp blow. In steel castings, abrasive saws, oxyacetylene torches, and carbon arcs are required. Considerable fumes are produced in steel foundries at this stage.

Castings next are shot blast cleaned. This process occurs in a closed machine where streams of metal shot are directed at all parts of the casting to chip away any remaining sand.

The next cleaning step is the removal of any excess or unwanted metal. Fins caused by mismatch of mold halves, incomplete removal of heads and gates, etc., must be ground or chipped from the casting. Some defects in castings are ground or chipped out, and then repaired by welding.

Each of these operations produces some dust or fume. Proper shop atmosphere requires that these dusts and fumes be collected and removed.

The dust collection by wet scrubbers has been covered in the preceding section. Dust collection systems work equally well on molding operations and cleaning operations. Most foundries will combine operations to secure a larger more efficient dust collector.

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Table 7 summarizes the net plant raw waste loads for the molding and cleaning operations for the plants studied.

## SAND WASHING OPERATIONS

Another source of pollution from foundries is generated by wet sand cleaning operations.

Depending on economics, a foundry may clean all, part or none of its sand before reuse. Two methods of cleaning are available. One method is pneumatic and no water waste is generated. A second method is wet scrubbing. This method is more efficient and produces a better sand, but is expensive. To a large degree it has been displaced by the pneumatic method..

The wastewater generated by sand cleaning is usually high in bentonite. This is a clay normally used as a binder to give the mixed sand strength. This material can be settled by installation of properly designed sedimentation techniques.

Table 7 summarizes the net plant raw waste loads for the sand washing operations for the plants studied.

## HEAT TREATMENT

An additional source of water usage in foundries is that produced by the quenching of the casting.

The physical properties of the cast metal occasionally need alteration from the "as cast" condition. This can be achieved by heating and cooling the metal in special ways. The cooling is accomplished by "quenching" the heated casting in an oil or water media. This is done in a large tank but water usage is insignificant and no subcategory was established for this operation.

Water use in all the operations which have been established as subcategories is summarized in Table 8 for the various plants studied.

## SLAG QUENCH SYSTEM

Normal practice for this process is to permit the molten slag stream emitted from the furnace to be discharged into a swiftly moving stream of water for rapid cooling. This action causes the slag to expand in volume while breaking up into discrete particles called "popcorn slag." Such systems are commonly recycled with a small discharge. A slag pit or tank is provided with a drag chain for continuous removal of the "popcorn slag." The popcorn slag tends to float, but, in general, this offers no significant contaminant or removal problem. Often the entire raw waste load from the process is discharged directly into and/or combined with the total raw waste load from the furnace emission control system. Alternatively, just the slag quench wastewater blowdown itself can be combined with the recycled wastewater returned to the furnace emission control system.

The benefits of the above techniques are twofold. One is to provide a source of calcium to the furnace emission control system for fluoride control, while the other is to affect a zero aqueous discharge from the slag quench process.

The quality of the slag quench blowdown waste stream is far superior to that which is being recirculated back to the emission control system. Further, it compares quite favorably with the fresh makeup water applied to the furnace emission control stack gas quench ring used for both unit scrubber type systems as well as dry baghouse type systems. Water consumption of stack gas quench rings is normally equal to, or as much as five times greater than the wastewater discharged from the slag quench process in terms of gallons/ton of metal poured.

Hence, further uses of the slag quench process blowdown stream can be found in wet type furnace emission control systems as well as dry baghouse type furnace emission control systems. The cited alternatives may be used to affect a zero aqueous discharge from the slag quench process regardless of the type of emission control system employed.

TABLE 7

CHARACTERISTICS OF FOUNDRY OPERATIONS WASTES
NET PLANT RAW WASTE LOADS

| Plant Code | Flow Gal/Ton | mg/l SS | O&G | Pb | Mn | F | Phenol | S= | Zn | pH |
|---|---|---|---|---|---|---|---|---|---|---|
| **Melting Operations** | | | | | | | | | | |
| XX-2 | 4,983 | 21 | 2.6 | - | 0.40 | 3.1 | - | 0.6 | - | 9.2 |
| XX-2A | 298 | 526 | 25.3 | - | 32.0 | 14.6 | 0.67 | 3.6 | - | 7.2 |
| XX-2B | 6,139 | 32 | 2.1 | - | 0.37 | 34.7 | - | 2.44 | - | 9.2 |
| GGG-2 | 1,200 | 403 | 3.0 | 44.5 | 6.0 | - | - | - | 8.29 | 11.0 |
| BBB-2 | 142 | 1,257 | - | 41 | 120 | 36.8 | 15.9 | 39.3 | - | 8.1 |
| EEE-2 | 152 | 268 | - | 9.6 | 37 | 433 | 0.157 | 0.55 | 11.8 | 7.2 |
| CCC-2 | 722 | 236 | 3.48 | - | 14.7 | - | 0.48 | 21.3 | 21.0 | 9.3 |
| DDD-2 | 129 | 648 | 1.0 | - | 75 | 47 | 0.30 | 4.55 | 100 | 4.4 |
| **Molding and Cleaning Dust Collection Operations** | | | | | | | | | | |
| WW-2 | 74 | 12,880 | 138 | - | 2.1 | 0.30 | 3.35 | ≤0.02 | - | 7.6 |
| DDD-2 | 102 | 81 | 1.0 | - | 0.14 | 1.8 | 0.64 | 5.0 | 0.09 | 7.4 |
| HHH-2A | 4,557 | 6,600 | 23 | 0.63 | 6.1 | 13 | 0.21 | 0.5 | 3.3 | 7.8 |

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TABLE 7 (continued)

Sand Washing Operations

| Plant Code | Flow Gal/Ton | mg/l SS | O&G | Pb | Mn | F | Phenol | SS$^{--}$ | Zn | pH |
|---|---|---|---|---|---|---|---|---|---|---|
| FFF-2 | 240 | 8,199 | 11.6 | 2.0 | 3.6 | 65 | 2.08 | 11.6 | 4.3 | 6.3 |

Multiple Operations

| Plant Code | Flow Gal/Ton | mg/l SS | O&G | Pb | Mn | F | Phenol | SS$^{--}$ | Zn | pH |
|---|---|---|---|---|---|---|---|---|---|---|
| VV-2 | 301 | 226 | 3.6 | - | 0.32 | 0.091 | 0.008 | <0.02 | - | 7.5 |
| YY-2 | 32.3 | 40.8 | - | - | 40 | 0.75 | 0.53 | 4.07 | - | 7.0 |
| AAA-2 | 484 | 4,504 | 19.4 | - | 7.2 | 1.8 | - | 1.12 | 0.50 | 7.5 |
| AAA-2A | 1,140 | 5,891 | 7.99 | - | 1.6 | 2.4 | 0.58 | 0.50 | - | 7.6 |
| AAA-2B | 381 | 22,700 | 42 | 0.42 | 3.4 | 3.4 | 1.98 | 9.6 | 1.4 | 7.8 |
| ZZ-2 | 155 | 17,624 | 17.9 | 1.64 | 8.65 | 0.32 | - | 0.02 | 10.5 | 8.0 |
| HHH-2 | 270 | 72.2 | 1.03 | 1.5 | 6.1 | 3.72 | 0.085 | 0.045 | 0.842 | 8.3 |
| HHH-2A&2B | 720 | 1,569 | 6.0 | 16 | 26 | 19 | 0.132 | 2.7 | 28 | 8.8 |

TABLE 8

WATER APPLICATION AND DISCHARGE RATES OF PLANTS STUDIED

Melting Systems

| Code | Ton/Day Poured | Emission Control Gal/Ton | Slag Quench Gal/Ton | Application Rate Gal/Ton | Slag Quench | Venturi | Bag House | Other | Discharge Rate Gal/Ton | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| BBB-2 | 9 | 3,120 | - | 3,120 | | X | | | 147 | |
| DDD-2 | 14 | 2,314 | - | 2,314 | | X | | | 128 | |
| CCC-2 | 25 | 3,360 | - | 3,360 | | X | | | 168 | |
| GGG-2 | 40 | 788 | - | 788 | | X | | | 0 | |
| EEE-2 | 74 | 3,081 | - | 3,081 | | X | | | 0 | |
| XX-2B | 86 | 13,395 | 6,139 | 19,534 | X | X | | | 6,139 | Non-contact cooling water is used for slag quench and transport, and then discharged thru treatment system. |
| XX-2 | 105 | 10,917 | 4,982 | 15,899 | X | X | | | 4,982 | |
| HHH-2B | 136 | 1,576 | - | 1,576 | | X | | | 0 | |
| YY-2 | 185 | 2,854 | 2,143 | 4,997 | X | X | | | 32 | |
| XX-2A | 193 | 5,969 | 298 | 6,267 | X | X | | | 298 | |
| HHH-2 | 196 | 3,085 | 4,898 | 7,983 | X | X | | | 264 | |
| HHH-2A | 217 | 1,207 | 3,041 | 4,248 | X | X | | | 0 | |
| WW-2 | 352 | 218 | 141 | 359 | X | | X | QC | 141 | |
| VV-2 | 458 | 104 | 305 | 409 | X | | X | QC | 305 | |

TABLE 8. (continued)

Dust Collection Systems

| Code | Ton Sand Used/Day | Application Gal/Ton Sand | Type of System* RC | OT | BD | Further Treatment | Discharge Rate Gal/Ton |
|---|---|---|---|---|---|---|---|
| DDD-2 | 65 | 1,107 | X | | 3 | | 44 |
| CCC-2 | 38.5 | 1,942 | X | | 20 | | 218 |
| YY-2 | 2,880 | 110 | X | | 15 | X | 4.9 |
| XX-2A | 2,510 | 191 | X | | 52 | | 19.8 |
| WW-2 | 2,000 | 48 | X | | 100 | | 48 |
| HHH-2A | 640 | 251 | X | | 0 | | 0 |
| HHH-2B | 209 | 267 | X | | 0 | | 0 |
| VV-2 | 265 | 271 | X | | 1 | X | 1.8 |
| ZZ-2 | 680 | 529 | X | | 8 | X | 8.4 |
| AAA-2 | 8,547 | 303 | X | | 275 | X | 46.3 |
| AAA-2A | 7,020 | 96 | X | | 700 | | 90 |
| AAA-2B | 1,200 | 1,600 | X | | 200 | X | 160 |

*RC - Recycle systems
OT - Once thru systems
BD - Blowdown from RC system

TABLE 8 (continued)

## Sand Washing Systems

| Code | Sand Washed Ton/Day | Application Rate Gal/Ton Sand | Type of System* RC | OT | BD | Further Treatment | Discharge Rate Gal/Ton |
|---|---|---|---|---|---|---|---|
| VV-2 | 50 | 2,880 | X | | 200 | X | 200 |
| ZZ-2 | 108 | 213 | | X | | X | 213 |
| FFF-2 | 32 | 240 | | X | | | 240 |
| AAA-2A | 176 | 5,454 | | X | | X | 5,454 |

*RC - Recycle systems
OT - Once thru systems
BD - Blowdown from RC system

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# SECTION VI

# SELECTION OF POLLUTANT PARAMETERS

## INTRODUCTION

The selection of the control parameters was accomplished by a three step process. First, a broad list of pollutant parameters to be tested for was established. Second, the list of anticipated control parameters and procedures for analyses of these critical parameters was established. Third, the data from the field sampling program was evaluated to establish the need to deviate from the anticipated list based on the field experience.

## BROAD LIST OF POLLUTANTS

Prior to the initiation of the plant visiting and sampling phase of the study it was necessary to establish the list of pollutant parameters that were anticipated to be treated in each type of waste source. These parameters were selected primarily on the basis of a knowledge of the materials used or generated in the operations and on the basis of pollutants known to be present as indicated by previously reported analyses. The purpose of the broad list was to identify those pollutants present in a significant amount but not normally reported or known to be present to such an extent. The parameters that may be present in foundry wastewater streams are presented in table form as follows:

Table 9 - Melting Operations
Table 10 - Molding and Cleaning Dust Collection and Sand Washing Operations

## RATIONALE FOR SELECTION OF CONTROL PARAMETERS

On the basis of prior analyses and experience the major wastewater parameters that were generally considered of pollutional significance for the foundry operations included suspended solids, oil, lead, and zinc. Other parameters are present in significant amounts but were not established as control parameters because their presence in the effluent is not as signficant and the cost of treatment and technology for removal in these operations is considered to be beyond the scope of best practicable or best available technology at this time. In addition, some parameters cannot be designated as control parameters until sufficient data is made available on which to base effluent limitations or until sufficient data on treatment capabilities is developed.

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TABLE 9

MELTING OPERATION
PARAMETERS

Acidity (Free and Total)
Alkalinity (Pht. and M.O.)
Aluminum
Ammonia
$BOD_5$
Beryllium
Chloride
COD
Color
Copper
Cyanide
Dissolved Solids
*Flow
*Fluoride
Hardness, Total
Heat
Iron, Total
*Lead
*Manganese
Mercury
Nitrate
Nitrogen, Kjeldahl
*Oil and Grease
*pH
Phenol
Phosphorus, Total
Potassium
Silica, Total
Sodium
Sulfate
*Sulfide
*Suspended Solids
Thiocyanate
TOC
T.O.N.
Total Solids
*Zinc

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TABLE 10

MOLDING AND CLEANING - SAND WASHING OPERATIONS
PARAMETERS

Acidity (Free and Total)
Alkalinity (Pht. and M.O.)
Aluminum
Chloride
Color
Copper
Dissolved Solids
*Flow
*Fluoride
Hardness, Total
Heat
Iron, Total
Lead
Manganese
Mercury
Nickel
Nitrate
*Oil and Grease
*pH
Phosphorus, Total
Potassium
Silica, Total
Sodium
Sulfate
Sulfide
*Suspended Solids
Tin
T.O.N.
Total Solids
Zinc

Standard raw waste loads and guidelines are developed only on the critical parameters which were starred in the tables. Multiple analyses of these anticipated control parameters were provided for to give added accuracy to the data.

SELECTION OF ADDITIONAL CONTROL PARAMETERS

The plant studies indicated that consideration should be given to additional parameters as control parameters in certain subcategories because of the quantities found or likely to be present and the pollutional significance of the material. These parameters are enumerated in their respective subcategories and include fluoride and manganese.

SELECTION OF CRITICAL PARAMETERS BY OPERATION

The rationale for selection of the major waste parameters is given below.

Foundry wastewaters emanate principally from collection methods attached to gas cleaning from the melting operations, wet dust collection in sand preparation, mold shakeout, and cleaning operations.

Contaminants may occur in wastewater streams from the melting operation when water is used as a means of scrubbing furnace gases. Mold operations include sand preparation and sand reclaim, pouring, shakeout, and coremaking. The sand preparation occurs in a mixing activity where dusts and gases are picked up by a wet dust collection system.

Shakeout is a direct source of solids and gases when a wet dust collection system is used. The use of wet dust collectors in the cleaning room is an added source of solids from casting operations and the sand additives. These come from such cleaning room operations as tumbling, shot blasting, sand blasting, chipping, grinding, gate cutting, and welding.

When sand reclaiming is done by the wet method, it may be a direct source of solids (silica, metals, sand additives) and soluble compounds that are used in the sand and core preparation.

ENVIRONMENTAL IMPACT OF POLLUTANTS

pH, Acidity and Alkalinity

Acidity and alkalinity are reciprocal terms. Acidity is produced by substances that yield hydrogen ions upon hydrolysis and alkalinity is produced by substances that yield hydroxyl ions. The terms "total acidity" and "total alkalinity" are often used to express the buffering capacity of a solution. Acidity in natural waters is caused by carbon dioxide, mineral acids, weakly dissociated acids, and the salts of strong acids and weak bases. Alkalinity is caused by strong bases and the salts of strong alkalies and weak acids.

The term pH is a logarithmic expression of the concentration of hydrogen ions. At a pH of 7, the hydrogen and hydroxyl ion concentrations are essentially equal and the water is neutral. Lower pH values indicate acidity while higher values indicate alkalinity. The relationship between pH and acidity or alkalinity is not necessarily linear or direct.

Waters with a pH below 6.0 are corrosive to water works structures, distribution lines, and household plumbing fixtures and can thus add such constituents to drinking water as iron, copper, zinc, cadmium and lead. The hydrogen ion concentration can affect the "taste" of the water. At a low pH water tastes "sour." The bactericidal effect of chlorine is weakened as the pH increases, and it is advantageous to keep the pH close to 7. This is very significant for providing safe drinking water.

Extremes of pH or rapid pH changes can exert stress conditions or kill aquatic life outright. Dead fish, associated algal blooms, and foul stenches are aesthetic liabilities of any waterway. Even moderate changes from "acceptable" criteria limits of pH are deleterious to some species. The relative toxicity to aquatic life of many materials is increased by changes in the water pH. Metalocyanide complexes can increase a thousandfold in toxicity with a drop of 1.5 pH units. The availability of many nutrient substances varies with the alkalinity and acidity. Ammonia is more lethal with a higher pH.

The lacrimal fluid of the human eye has a pH of approximately 7.0 and a deviation of 0.1 pH unit from the norm may result in eye irritation for the swimmer. Appreciable irritation will cause severe pain.

<u>Total Suspended Solids</u>

Suspended solids include both organic and inorganic materials. The inorganic components include sand, silt, and clay. The organic fraction includes such materials as grease, oil, tar, animal and vegetable fats, various fibers, sawdust, hair, and various materials from sewers. These solids may settle out rapidly and bottom deposits are often a mixture of both organic and inorganic solids. They adversely affect fisheries by covering the bottom of the stream or lake with a blanket of material that destroys the fish-food bottom fauna or the spawning ground of fish. Deposits containing organic materials may deplete bottom oxygen supplies and produce hydrogen sulfite, carbon dioxide, methane, and other noxious gases.

In raw water sources for domestic use, state and regional agencies generally specify that suspended solids in streams shall not be present in sufficient concentration to be objectionable or to interfere with normal treatment processes. Suspended solids in water may interfere with many industrial processes, and cause foaming in boilers, or encrustations on equipment exposed to water, especially as the temperature rises. Suspended solids are undesirable in water for textile industries; paper and pulp; beverages; dairy products; laundries; dyeing; photography; cooling systems; and power plants. Suspended particles also serve as a transport mechanism for pesticides and other substances which are readily sorbed into or onto clay particles.

Solids may be suspended in water for a time, and then settle to the bed of the stream or lake. These settleable solids discharged with man's wastes may be inert, slowly biodegradable materials, or rapidly decomposable substances. While in suspension, they increase the turbidity of the water, reduce light penetration and impair the photosynthetic activity of aquatic plants.

Solids in suspension are aesthetically displeasing. When they settle to form sludge deposits on the stream or lake bed, they are often much more damaging to the life in water, and they retain the capacity to displease the senses. Solids, when transformed to sludge deposits, may do a variety of damaging things, including blanketing the stream or lake bed and thereby destroying the living spaces for those benthic organisms that would otherwise occupy the habitat. When of an organic and therefore decomposable nature, solids use a portion or all of the dissolved oxygen available in the area. Organic materials also serve as a seemingly inexhaustible food source for sludgeworms and associated organisms.

Turbidity is principally a measure of the light absorbing properties of suspended solids. It is frequently used as a substitute method of quickly estimating the total suspended solids when the concentration is relatively low.

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## Zinc

Occurring abundantly in rocks and ores, zinc is readily refined into a stable pure metal and is used extensively for galvanizing, in alloys, for electrical purposes, in printing plates, for dye manufacture and for dyeing processes, and for many other industrial purposes. Zinc salts are used in paint pigments, cosmetics, pharmaceuticals, dyes, insecticides, and other products too numerous to list herein. Many of these salts (e.g., zinc chloride and zinc sulfate) are highly soluble in water; hence, it is to be expected that zinc might occur in many industrial wastes. On the other hand, some zinc salts (zinc carbonate, zinc oxide, zinc sulfide) are insoluble in water and consequently it is to be expected that some zinc will precipitate and be removed readily in most natural waters.

In zinc-mining areas, zinc has been found in waters in concentrations as high as 50 mg/l and in effluent from metal-plating works and small-arms ammunition plants it may occur in significant concentrations. In most surface and groundwaters, it is present only in trace amounts. There is some evidence that zinc ions are adsorbed strongly and permanently on silt, resulting in inactivation of the zinc.

Concentrations of zinc in excess of 5 mg/l in raw water used for drinking water supplies cause an undesirable taste which persists through conventional treatment. Zinc can have an adverse effect on man and animals at high concentrations.

In soft water, concentrations of zinc ranging from 0.1 to 1.0 mg/l have been reported to be lethal to fish. Zinc is thought to exert its toxic action by forming insoluble compounds with the mucous that covers the gills, by damage to the gill epithelium, or possibly by acting as an internal poison. The sensitivity of fish to zinc varies with species, age and condition, as well as with the physical and chemical characteristics of the water. Some acclimatization to the presence of zinc is possible. It has also been observed that the effects of zinc poisoning may not become apparent immediately, so that fish removed from zinc-contaminated to zinc-free water (after 4-6 hours of exposure to zinc) may die 48 hours later. The presence of copper in water may increase the toxicity of zinc to aquatic organisms, but the presence of calcium or hardness may decrease the relative toxicity.

Observed values for the distribution of zinc in ocean waters vary widely. The major concern with zinc compounds in marine waters is not one of acute toxicity, but rather of the long-term sublethal effects of the metallic compounds and complexes. From an acute toxicity point of view, invertebrate marine animals seem to be the most sensitive organisms tested. The growth of the sea urchin, for example, has been retarded by as little as 30 ug/l of zinc.

Zinc sulfate has also been found to be lethal to many plants, and it could impair agricultural uses of the water in which it is present.

## Fluorides

As the most reactive non-metal, fluorine is never found free in nature. However, it is found as a constituent of fluorite (fluorspar or calcium fluoride) in sedimentary rocks, and also as a constituent of cryolite (sodium aluminum fluoride) in igneous rocks. Owing to their origin only in certain types of rocks and only in a few regions, fluorides in high concentrations are not a common constituent of natural surface waters, but they may occur in detrimental concentrations in groundwaters.

Fluorides are used as insecticides, for disinfecting brewery apparatus, as a flux in the manufacture of steel, for preserving wood and mucilages, for the manufacture of glass and enamels, in chemical industries, for water treatment, and for other uses.

Fluorides in sufficient quantity are toxic to humans, with doses of 250 to 450 mg giving severe symptoms or causing death.

There are numerous articles describing the effects of fluoride-bearing waters on dental enamel of children; these studies lead to the generalization that water containing less than 0.9 to 1.0 mg/l of fluoride will seldom cause mottled enamel in children, and for adults, concentrations less than 3 or 4 mg/l are not likely to cause endemic cumulative fluorosis and skeletal effects. Abundant literature is also available describing the advantages of maintaining 0.8 to 1.5 mg/l of fluoride ion in drinking water to aid in the reduction of dental decay, especially among children.

Chronic fluoride poisoning of livestock has been observed in areas where water contained 10 to 15 mg/l fluoride. Concentrations of 30 to 50 mg/l of fluoride in the total ration of dairy cows is considered the upper safe limit. Fluoride from waters apparently does not accumulate in soft tissue to a significant degree and it is transferred to a very small extent into the milk and to a somewhat greater degree into eggs. Data for fresh water indicate that fluorides are toxic to fish at concentrations higher than 1.5 mg/l.

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Manganese,

The presence of manganese may interfere with water usage, since manganese stains materials, especially when the pH is raised as in laundering, scouring, or other washing operations. These stains, if not masked by iron, may be dirty brown, gray or black in color and usually occur in spots and streaks. Waters containing manganeous bicarbonate cannot be used in the textile industries, in dyeing, tanning, laundering, or in hosts of other industrial uses. In the pulp and paper industry, waters containing above 0.05 ppm manganese cannot be tolerated except for low-grade products. Very small amounts of manganese (0.2 to 0.3 ppm) may form heavy encrustations in piping, while even smaller amounts may form noticeable black deposits.

Sulfides

Sulfides are oxidizable and therefore can exert an oxygen demand on the receiving stream. Their presence in amounts which consume oxygen at a rate exceeding the oxygen uptake of the stream can produce a condition of insufficient dissolved oxygen in the receiving water. Sulfides also impart an unpleasant taste and odor to the water and can render the water unfit for other uses.

Sulfides are constituents of many industrial wastes such as those from tanneries, paper mills, chemical plants, and gas works; but they are also generated in sewage and some natural waters by the anaerobic decomposition or organic matter. When added to water, soluble sulfide salts such as $Na_2S$ dissociate into sulfide ions which in turn react with the hydrogen ions in the water to form $HS^-$ or $H_2S$, the proportion of each depending upon the resulting pH value. Thus, when reference is made to sulfides in water, the reader should bear in mind that the sulfide is probably in the form of $HS^-$ or $H_2S$.

Owing to the unpleasant taste and odor which result when sulfides occur in water, it is unlikely that any person or animals will consume a harmful dose. The thresholds of taste and smell were reported to be 0.2 mg/l of sulfides in pulp-mill wastes. For industrial uses, however, even small traces of sulfides are often detrimental. Sulfides are of little importance in irrigation waters.

The toxicity of solutions of sulfides toward fish increases as the pH value is lowered, i.e., the $H_2S$ or $HS^-$ rather than the sulfide ion, appears to be the principle toxic agent. In water containing 3.2 mg/l of sodium sulfite, trout overturned

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in two hours at pH 9.0, in ten minutes at pH 7.8, and in four minutes at pH 6.0. Inorganic sulfides have provided fatal to sensitive fish such as trout at concentrations between 0.5 and 1.0 mg/l as sulfide, even in neutral and somewhat alkaline solutions.

Lead

Some natural waters contain lead in solution, as much as 0.4 to 0.8 mg/l, where mountain limestone and galena are found. In the U.S.A., lead concentrations in surface and groundwaters used for domestic supplies range from traces to 0.04 mg/l averaging about 0.01 mg/l.

Foreign to the human body, lead is a cumulative poison. It tends to be deposited in bone as a cumulative poison. The intake that can be regarded as safe for everyone cannot be stated definitely, because the sensitivity of individuals to lead differs considerably. Lead poisoning usually results from the cumulative toxic effects of lead after continuous consumption over a long period of time, rather than from occasional small doses. Lead is not among the metals considered essential to the nutrition of animals or human beings.

Lead may enter the body through food, air, and tobacco smoke as well as from water and other beverages. The exact level at which the intake of lead by the human body will exceed the amount excreted has not been established, but it probably lies between 0.3 and 1.0 mg per day. The mean daily intake of lead by adults in North America is about 0.33 mg. Of this quantity, 0.01 to 0.03 mg per day are derived from water used for cooking and drinking.

Lead in an amount of 0.1 mg ingested daily over a period of years has been reported to cause lead poisoning. On the other hand one reference considered 0.5 mg per day safe for human beings, and a daily dose of 2.0 mg for a one year period apparently did not affect the health of one adult.

Lead poisoning among human beings is reported to have been caused by the drinking of water containing lead in concentrations varying from 0.042 mg/l to 1.0 mg/l or more. On the other hand, other instances of drinking water at concentrations of 0.01 to 0.16 mg/l over long periods of time have apparently been nonpoisonous. The mandatory limit for lead in the USPHS Drinking Water Standards is 0.05 mg/l. Several countries use 0.1 mg/l as a standard.

Traces of lead in metal-plating baths will affect the smoothness and brightness of deposits. Inorganic lead salts in irrigation water may be toxic to plants and should be investigated further. It is not unusual for cattle to be poisoned by lead in the water; the lead need not necessarily be in solution, but may be in suspension, as, for example, oxycarbonate. Chronic lead poisoning among animals has been caused by 0.18 mg/l of lead in soft water. Most authorities agree that 0.5 mg/l of lead is the maximum safe limit for lead in a potable supply for animals. The toxic concentration of lead for aerobic bacteria is reported to be 1.0 mg/l; for flagellates and infusoria, 0.5 mg/l. The bacterial decomposition of organic matter is inhibited by 0.1 to 0.5 mg/l of lead.

Studies indicate that in water containing lead salts, a film of coagulated mucous forms, first over the gills, and then over the whole body of the fish, probably as a result of a reaction between lead and an organic constituent of mucous. The death of the fish is caused by suffocation due to this obstructive layer. In soft water, lead may be very toxic; in hard water equivalent concentrations of lead are less toxic. Concentrations of lead as low as 0.1 mg/l have been reported toxic or lethal to fish. Other studies have shown that the toxicity of lead toward rainbow trout increases with a reduction of the dissolved oxygen concentration of the water.

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# SECTION VII

# CONTROL AND TREATMENT TECHNOLOGY

## INTRODUCTION

Plant studies were conducted at plants that were deemed to be the best relative to performance levels attained by their treatment facilities. The plants visited were selected by the EPA from the candidate plants listed in Table 5. Table 11 presents a brief summary of treatment practices employed at all plants visited in this study and shows the variability of treatment techniques employed in the industry. Included in each subcategory are tables presenting the size, location, and ages of the plants that were visited.

A survey was made of the foundry industry to obtain a more specific knowledge of water usage and wastewater practices than available from literature. Noncontact cooling water was excluded.

One hundred thirty-nine contacts were made covering all sizes of foundries (see Table 5). From the responses, the following data was developed.

| | | |
|---|---|---|
| All dry operations | 65 | 46.7% |
| Wet systems - Melt operations only | 33 | 23.7 |
| Wet systems - Dust collection only | 17 | 12.2 |
| Wet systems - Sand washing only | 1 | 0.7 |
| Wet systems - Melting & dust coll. | 8 | 5.7* |
| Wet systems - Melting & sand wash | 0 | 0 |
| Wet systems - Dust coll. & sand wash | 5 | 3.6* |
| Semi-wet melting - Wet dust coll. & sand wash | 1 | 0.7* |
| Semi-wet melting only | 9 | 6.4 |
| | 139 | 100% |

*These type plant wastewater systems are covered under the subcategory Multiple Operations.

## RANGE AND PERMUTATIONS OF TREATMENT TECHNOLOGY AND CURRENT PRACTICE AS EXEMPLIFIED BY PLANTS VISITED DURING THE STUDY

In each subcategory, a discussion is presented on the full range of technology employed within the industry followed by a discussion on the treatment practices, effluent loads, and reduction benefits at the plants that were visited. The effluent is stated in terms of gross plant effluent waste load.

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TABLE 11

SUMMARY OF WASTEWATER TREATMENT
PRACTICE OF PLANTS VISITED

## I. Melting Operations

| Plant | Practice |
|---|---|
| VV-2 | Slag quench water only, once-thru (OT) drained to lagoon for settlement. |
| WW-2 | Slag quench water only, OT and drained to city sewers. |
| BBB-2<br>CCC-2<br>DDD-2 | Scrubber wastewaters to a primary settling tank with solids removal. Chemical additions, recycle to process and blowdown to city sewers. |
| XX-2<br>XX-2A<br>XX-2B | Slag quench and scrubber wastewaters to a primary settling tank with solids removal. Chemical additions and recycle to process. Side stream to clarifier with solids removal. System blowdown to city sewer. |
| GGG-2 | Scrubber wastewaters collected to sump for settlement and solids removal. Recycle to process with zero discharge. |
| EEE-2 | Scrubber wastewaters to classifier, chemical additions, recycle and blowdown to drag tank. Solids removal at drag tank and recycle. Zero discharge. |
| HHH-2A<br>HHH-2B | Scrubber wastewaters to large lagoon, chemical additions, solids removal, recycle to process, zero discharge. |
| HHH-2 | Scrubber wastewaters to drag tank with solids removal and chemical additions. Side stream to clarifier system with blowdown to second clarifier - chemical additions, underflow to landfill and overflow discharge to sanitary sewer. Slag quench water settled and discharged to sanitary sewer. |

TABLE 11 (continued)

| | |
|---|---|
| YY-2 | Slag quench scrubber wastewaters and dust collector blowdown collected in drag tank with chemical additions. Solids removed. Recycle to process and side stream clarifier. Blowdown to second clarifier with underflow to landfill and overflow to city sanitary sewer. |
| **II. Molding and Cleaning Dust Collection Operations** | |
| VV-2 | Washing cooler with recycle. Blowdown dewatered and drained to lagoon for settlement. |
| WW-2<br>XX-2A | Orifice scrubber - recycled - blowdown to city sanitary sewer. |
| CCC-2 | Dust collector wastewaters to drag tank with chemical additions. |
| DDD-2 | Solids removal - recycle to dust collectors. Overflow to sanitary sewer. |
| AAA-2<br>AAA-2B | Wastewaters from commercial dust collectors sent to central system for chemical addition, clarification, solids removal and recycle to process. Blowdown from clarifier to second clarifier for further treatment. Underflow from second clarifier to vacuum filter for solids removal. Overflow available for reuse or discharge. |
| **III. Sand Washing Operations** | |
| FFF-2<br>ZZ-2<br>AAA-2B | Once-thru systems discharge to multi unit waste treatment system. |
| VV-2 | Recycle thru hydraulic multiclone system with heavy blowdown to lagoon for further treatment. |

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MELTING OPERATIONS

Fossil Fuel Furnace

In general, three systems of gas collection utilizing water are practiced for cupola emission control. These are:

1. Washing Coolers
2. Wet Caps
3. Venturi Scrubbers

Each of these methods has its advantages and limitations.

Washing Cooler Type I

Washing coolers are large cylindrical vessels with the gases entering tangentially near the bottom. The gas stream is sprayed with scrubbing liquor which removes the larger particulate matter. The gas velocity is reduced and moves upward through fluidized bed section that is packed with perforated plastic spheres. These spheres are flooded with scrubbing liquor flowing downward. The reduction of flow area through the spheres and between their interstices increases the gas and dust velocity. Bubbles and water droplets created by the intense agitation of the fluidized bed, trap the dust particles and serve to condense any water vapor originally in the gas stream.

Cleaned gas and some dirty water droplets rise to the demist elements where the water droplets collect and are returned to the fluidized bed. Cleaned gas exits through the top of the scrubber while dirty water collects below the gas inlet and some of the solids settle out while the liquor is recycled. A blowdown valve relieves the system of a slurry of the trapped dusts and water.

This equipment has high efficiency resulting from intimate gas-water mixing over a long contact time. Simple design, reduced maintenance, and low power cost are the features of this system. High variations in dust loading and volume variations do not affect efficiency. There is little collection of dusts less than 1 micron.

Washing Cooler Type II

The dirty gas is drawn through a tapered duct to increase the velocity. At the point of maximum velocity, a spray of water is introduced into the gas stream. This is drawn into a moisture separation chamber with a sudden change or reversal of direction. The gas goes through a cyclone separator that separates the dust laden water from the gas, and the gas rises through the top outlet. The water descends to a sludge outlet where it can be treated and recycled.

The Type II washer is used where hot gases occur (1,800°F). The spray action cools the gas stream as well as wetting and coalescing the dust particles.

The pressure drop is very small usually 2-3 in. w.c. and efficiency is poor, especially for smaller particles less than 1 micron.

Wet Cap

The wet cap was developed in England as a method of eliminating the flame of a cupola as a target for Nazi bombers. It consists of a water cooled, cylindrical shell placed on the top of an existing cupola. Internal cones permit water to be cascaded, while the cupola gas exits through the cascading water.

The efficiency of the wet cap as a particulate remover is 80%. However, very little of the dusts in the size range of 10 micron and smaller are removed and little of the gaseous components are removed.

Wet caps are of a simple, rugged design that remove the coarser particulates and claim low capital and reduced operating costs.

Venturi Scrubbers

Venturi scrubbers consist of a converging duct, the narrowest point containing spray nozzles where atomized water is injected into the gas stream, and a diverging duct downstream of the injection point. The gas stream is then subjected to a sudden expansion and/or a sharp reversal of direction. Dust particles in the gas stream are wetted by the fine mist, and coalesce to permit inertial separation from the gas stream.

The most efficient designs of venturi scrubbers include a water separator or "de-mister" before releasing the gas stream to the atmosphere. Some designs reclaim heat from the cupola gases before spray cooling. This reduces the gas volume.

Venturi scrubbers require considerable horsepower as large volumes of gas are handled. Pressure drops of 60 to 100 in. water column are required for best collection efficiency.

## Electric Furnace

The baghouse or dry dust cleaning techniques are generally utilized for electric furnace dust and fume collection. In a few instances, water sprays are used for cooling before a precipitator or baghouse. Although this is called a semi-wet system, with proper design and operation this system has no aqueous discharge.

A more thorough discussion of the wet dust collecting techniques is presented in Section V. Wet type systems are used for these operations regardless if melting is done by fossil fuel or electric furnace melting operations.

## WATER TREATMENT TECHNOLOGY

### Melting Operations

The wastewater produced is the result of the fume collector system employed. Where dry baghouse or dry type precipitators are used, there is no discharge of wastewater and no water treatment is involved.

The wet systems involved with high energy scrubbers use either fixed or variable orifice high energy units closely connected to quenchers and mist eliminating hoods.

The basic type water treatment consists of a steel or concrete rectangular tank with a motorized drag chain to remove settled solids. The water is permitted to settle some heavier solids, and then is recycled to secondary tanks for clarification of finer particles, usually with addition of chemical flocculants. The settled material is blown down to the first sump or to a solids removal system. Recycle is generally practiced with makeup water replacing that evaporated in the quencher and venturi.

In semi-wet systems the quencher is operated to obtain zero aqueous discharge. Normal operation is upstream of a baghouse or precipitator where the finer particulate matter is removed.

Solids removed as moist material at the quencher are landfilled along with baghouse dusts.

### Molding and Cleaning Dust Collection Operations

In most foundries, the molding operations that produce wastewaters are associated with dust control, sand reclamation, or cooling of permanent molds. These operations are combined

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with cleaning department operations of a similar nature. As a result, it is necessary to view molding operations and cleaning operations as common since the wastewater treatment systems are common.

Treatment of wastewaters vary from the simplest form of settlement to elaborate vacuum filtration and recycle systems.

Settlement ponds which treat a variety of wastewaters consist simply of lagoons where particle settlement occur. With adequate detention time, these give good results.

Generally, the wastewater treatment used throughout the industry for molding and cleaning wastes consists of a concrete or steel rectangular tank with a motorized flight conveyor to remove settled solids. Chemical flocculation for improved control is used, but costs are cautiously eyed. The overflow is recycled and a continuous "blowdown" is used to reduce the system suspended solids. Makeup water replaces evaporation and blowdown losses.

Sophisticated plants have upgraded these systems to include sidestream thickeners and in some cases vacuum filters with partial or complete recycle of the thickener overflow.

## Sand Washing Operations

In general, sand washing wastes are combined with other operation wastes and treated in a combined system. Only one plant visited had a separate treatment system for these wastes, and this was the only wastewater system in the plant.

Improved treatment is possible in lagoons with adequate retention time and/or settling tanks with added chemical treatment.

## Heat Treat Operations

Due to the limited volume and intermittent flow, little water treatment is practiced in this area. Most plants may have no overflow from the quench tank and losses occur from evaporation, carryover and splashing.

In cases where plants may have a small discharge, this small and intermittent flow may be combined with wastewater for treatment from other foundry operations.

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## PLANT VISITS

Nineteen foundries were visited in the study. Visits were made to plants with better treatment systems and with multiple wastewater systems where possible. Plants were also selected for specific operations and/or treatment systems.

Table 2 presents a summary of the plants visited with respect to geographic location, daily production, plant age, and age of treatment facility.

Brief descriptions and schematic drawings of the individual wastewater systems are presented.

### Plant VV-2 - Figure 9

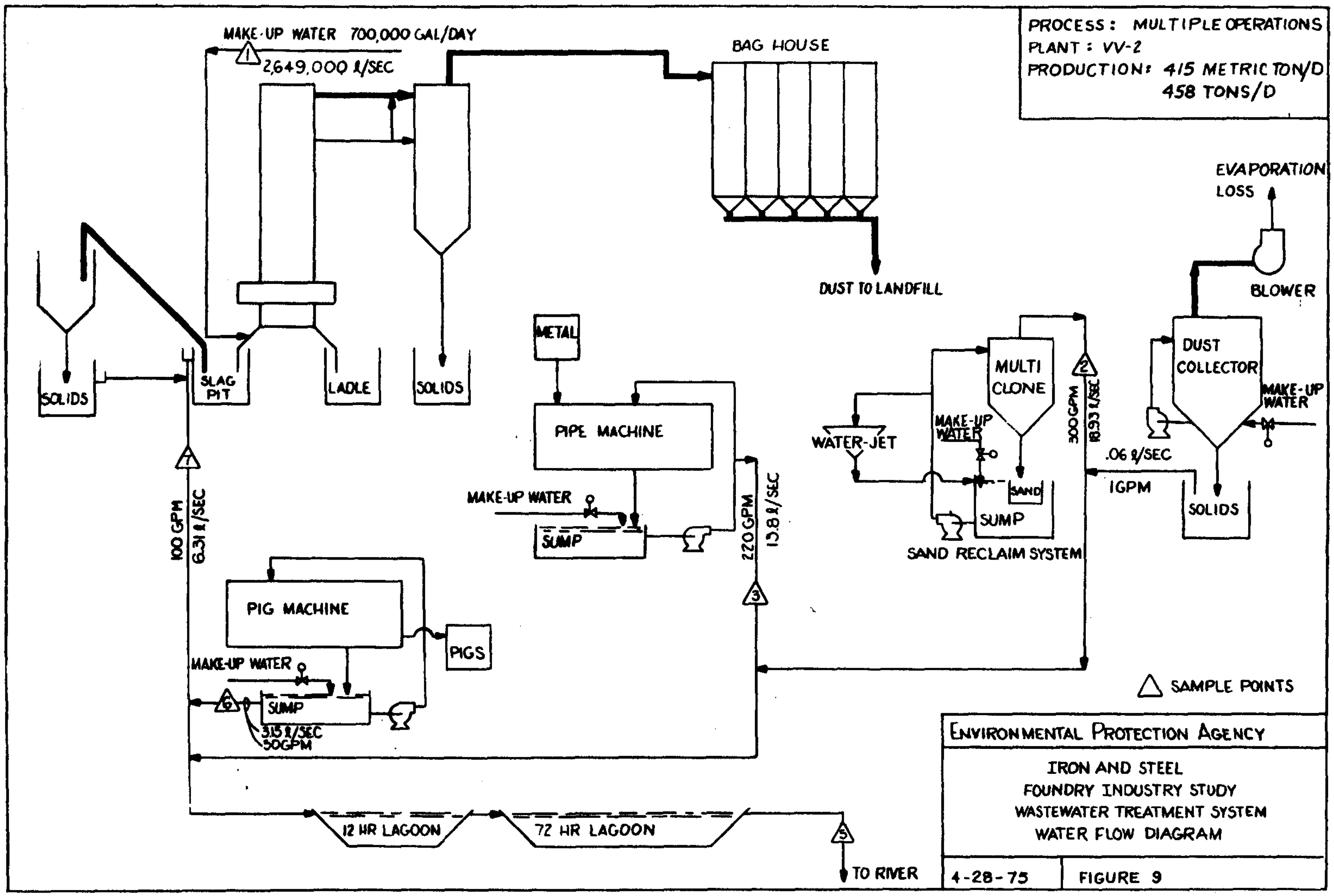
The cupola gas stream was cooled (quenched) by sprays of water. This spray system was closely monitored to completely evaporate all of the spray water. The resulting discharge from the system was a moist (3 to 5%) solid consisting of particulate matter that had been wetted and inertially separated from the gas stream. The gas stream was then filtered by fabric bags before release to the atmosphere. The system had zero aqueous discharge.

This plant has washing type dust collector serving a large shakeout machine in the cleaning department.

Dusts created by the vigorous shaking of large sand covered castings are drawn into the tower via two 36 in. diameter ducts. The air is drawn through a bed of plastic spheres that are continuously wetted by sprays above the bed.

The washing water drains to a conical sump where some settling takes place. The bottom of the cone is connected to a valve that is pneumatically operated. The valve action is controlled by means of a circuit that senses the resistance to a slow speed paddle located near the point of the cone. As a sludge develops around this paddle, the torque required to turn the paddle increases, and when a set point is reached, the valve is operated for five seconds discharging the sludge to a dewatering pit. This pit is emptied weekly to a landfill. The water drains from the pit to a sewer that carries it to the retention pond. A float valve in the tower basin operates to makeup water lost via blowdown and water carried out through the fan.

Sand washing operations consist of a jet of water flushing the sand from a casting to the sump. A pump delivers it to a classifier (multiclone type). The underflow goes to a


PROCESS: MULTIPLE OPERATIONS
PLANT: VV-2
PRODUCTION: 415 METRIC TON/D
458 TONS/D
MAKE-UP WATER 700,000 GAL/DAY
2,649,000 ℓ/SEC
BAG HOUSE
DUST TO LANDFILL
EVAPORATION LOSS
BLOWER
SOLIDS
SLAG PIT
LADLE
SOLIDS
METAL
PIPE MACHINE
MAKE-UP WATER
SUMP
220 GPM
13.8 ℓ/SEC
100 GPM
6.31 ℓ/SEC
PIG MACHINE
PIGS
MAKE-UP WATER
SUMP
3.15 ℓ/SEC
50GPM
WATER-JET
MAKE-UP WATER
MULTI CLONE
SAND
SUMP
SAND RECLAIM SYSTEM
300 GPM
18.93 ℓ/SEC
.06 ℓ/SEC
1GPM
DUST COLLECTOR
MAKE-UP WATER
SOLIDS
SAMPLE POINTS
12 HR LAGOON
72 HR LAGOON
TO RIVER
ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL
FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
4-28-75
FIGURE 9

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sand bucket where the sand is dewatered, and then reused. The dewater returns to the sump. The overflow of the classifier goes to the plant lagoons.

The pipe machine system has a water system used to cool the permanent molds. This system is blown down to the lagoons.

The lagoons are designed to give 12 hours detention, and then 72 hours detention. The two smaller lagoons are used alternately, and provide continuous service while being cleaned.

Plant WW-2 - Figure 10

The cupola gas stream was cooled (quenched) by sprays of water. This spray system was closely monitored to completely evaporate all of the spray water. The resulting discharge from the system was a moist (3 to-5%) solid consisting of particulate matter that had been wetted and inertially separated from the gas stream. The gas stream was then filtered by fabric bags before release to the atmosphere. The system had zero aqueous discharge.

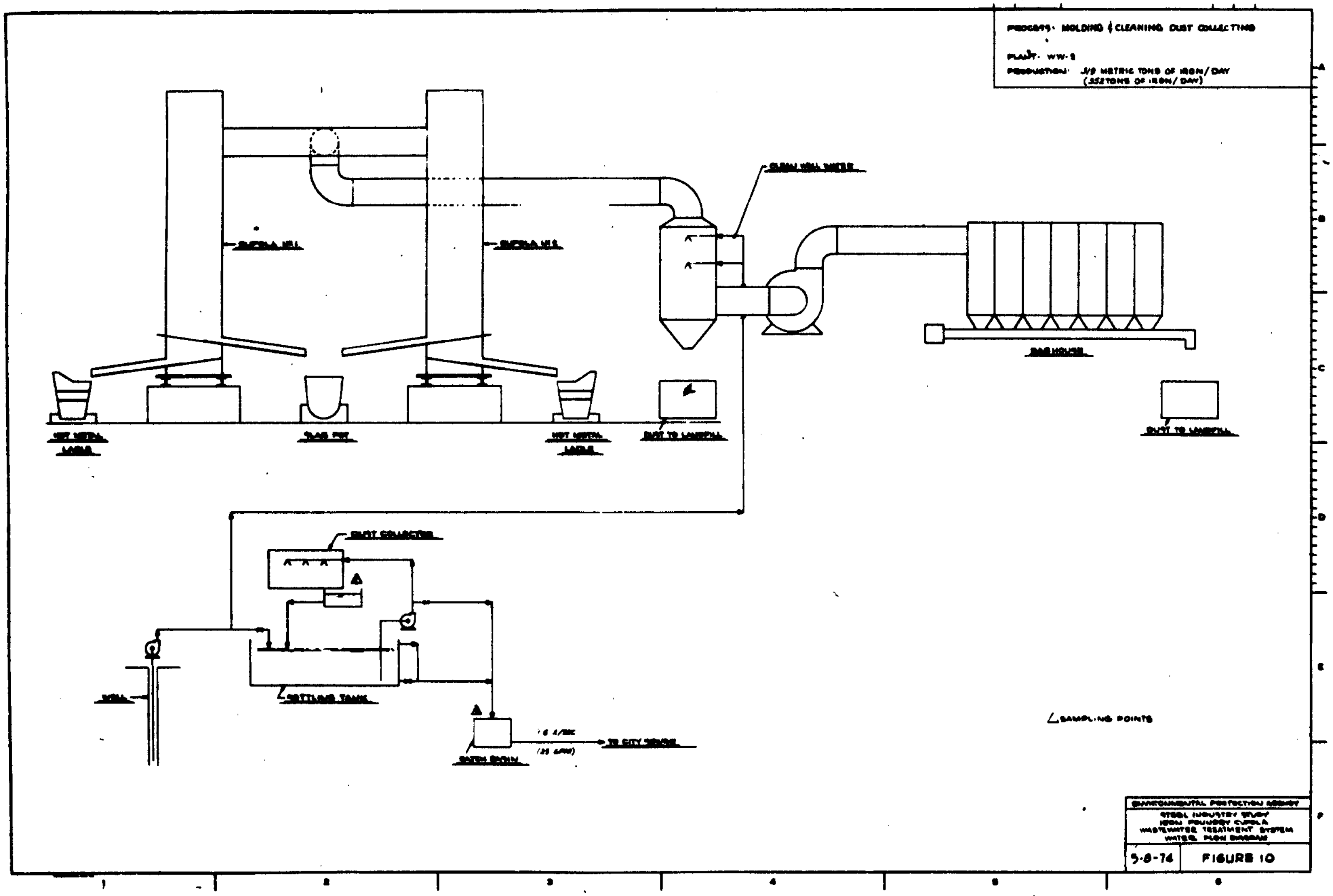
This plant has four wet type dust collectors to collect dust from sand mixing, mold shakeout, and shot blast cleaning operations. They are mechanical-centrifugal type collectors.

After settling, a portion of the water is recycled back to the dust collector. The remainder is discharged to the municipal sanitary treatment plant.

Plant XX-2 - Figure 11

This plant has a high energy venturi scrubber for gas cleaning on the duplex cupolas. The cupola is unlined and has a water cooled shell. Shell cooling water is used once through and then acts as slag quench and transport water delivering the slag to a drag tank. Pumps recycle the emission control water from this sump to the venturi, a quench chamber, and to a sidestream classifier. Solids are removed from the drag tank, and by the underflow stream from the classifier. Hydrated lime is added to the drag tank.

Overflow from the drag tank flows through a trap, and then is discharged to the city storm sewer.


PROCESS: MOLDING & CLEANING DUST COLLECTING
PLANT: WW-2
PRODUCTION: 319 METRIC TONS OF IRON/DAY
(352 TONS OF IRON/DAY)
SAMPLING POINTS
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
IRON FOUNDRY CUPOLA
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
5-8-74
FIGURE 10



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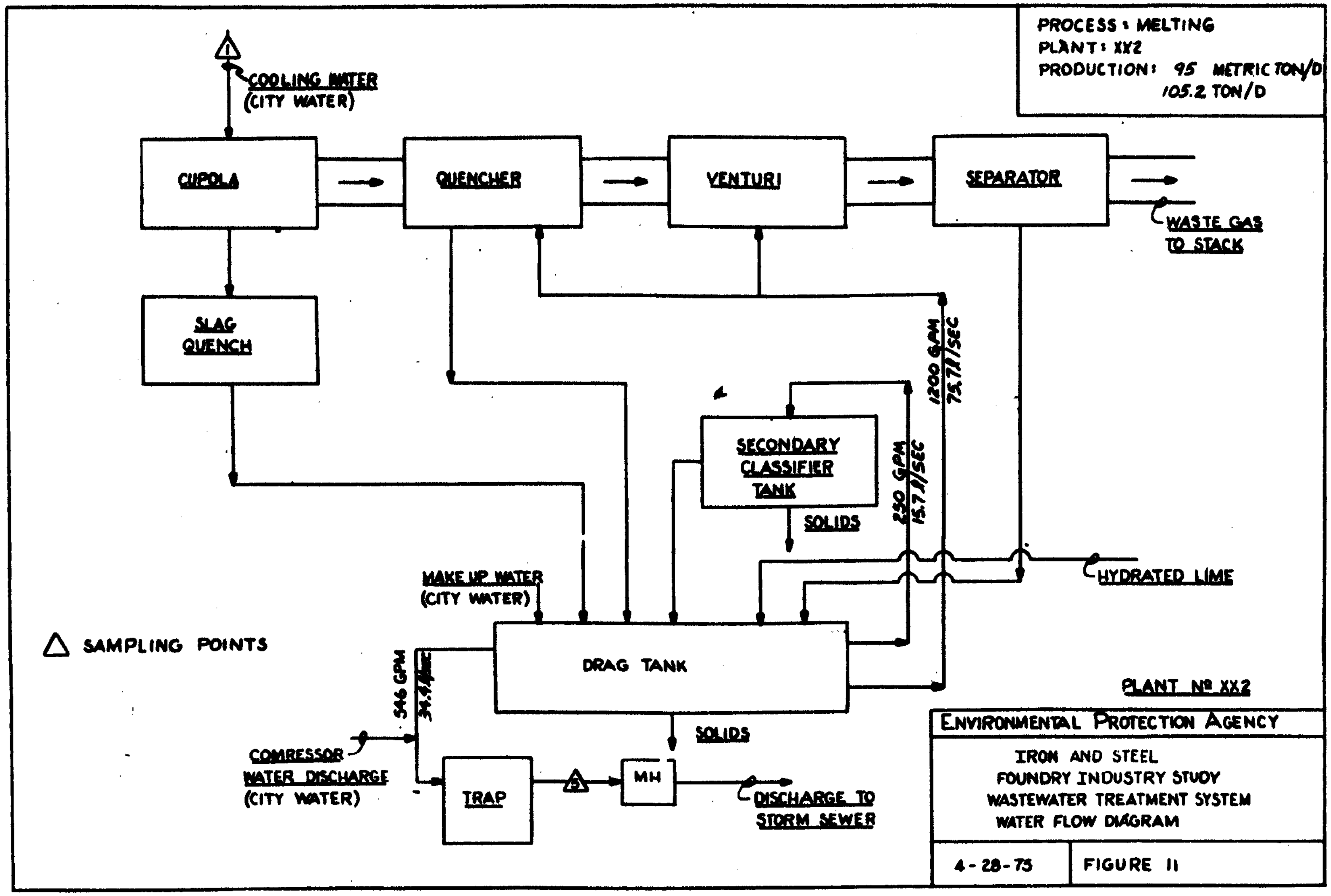
PROCESS: MELTING
PLANT: XX2
PRODUCTION: 95 METRIC TON/D
105.2 TON/D
COOLING WATER
(CITY WATER)
CUPOLA
QUENCHER
VENTURI
SEPARATOR
WASTE GAS
TO STACK
SLAG
QUENCH
1200 GPM
75.7 l/SEC
SECONDARY
CLASSIFIER
TANK
250 GPM
15.7 l/SEC
SOLIDS
HYDRATED LIME
MAKE UP WATER
(CITY WATER)
SAMPLING POINTS
DRAG TANK
546 GPM
34.4 l/SEC
COMPRESSOR
WATER DISCHARGE
(CITY WATER)
SOLIDS
TRAP
MH
DISCHARGE TO
STORM SEWER
PLANT Nº XX2
ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL
FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
4-28-75
FIGURE 11

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Plant XX-2a - Figure 12

This plant has a high energy venturi scrubber for gas cleaning on the duplex cupolas. The cupola is lined and has a water cooled shell. The cooling water is used once, and then becomes slag quench and transport water delivering slag to the drag tank.

Recycle pumps circulate the drag tank water to the quencher and venturi, and to a sidestream classifier underflow. Hydrated lime is added to the drag tank.

Overflow from the drag tank flows through a trap and is discharged to a plant sewer which goes through two additional traps before release to the city storm sewers.

The separator on the gas stream discharge has an aftercooler and cooling tower to reduce stack temperature and carryover from the venturi. The heat is rejected through a cooling tower in a closed loop system. The blowdown from this cooling tower goes to the drag tank sump.

This plant has a wet dust collection system on the molding, core room, shakeout, and cleaning areas. These wastewaters are collected in a drag tank for solids removal, chemical additions and recycle. The system blowdown goes to municipal sanitary sewers.

Plant XX-2b - Figure 13

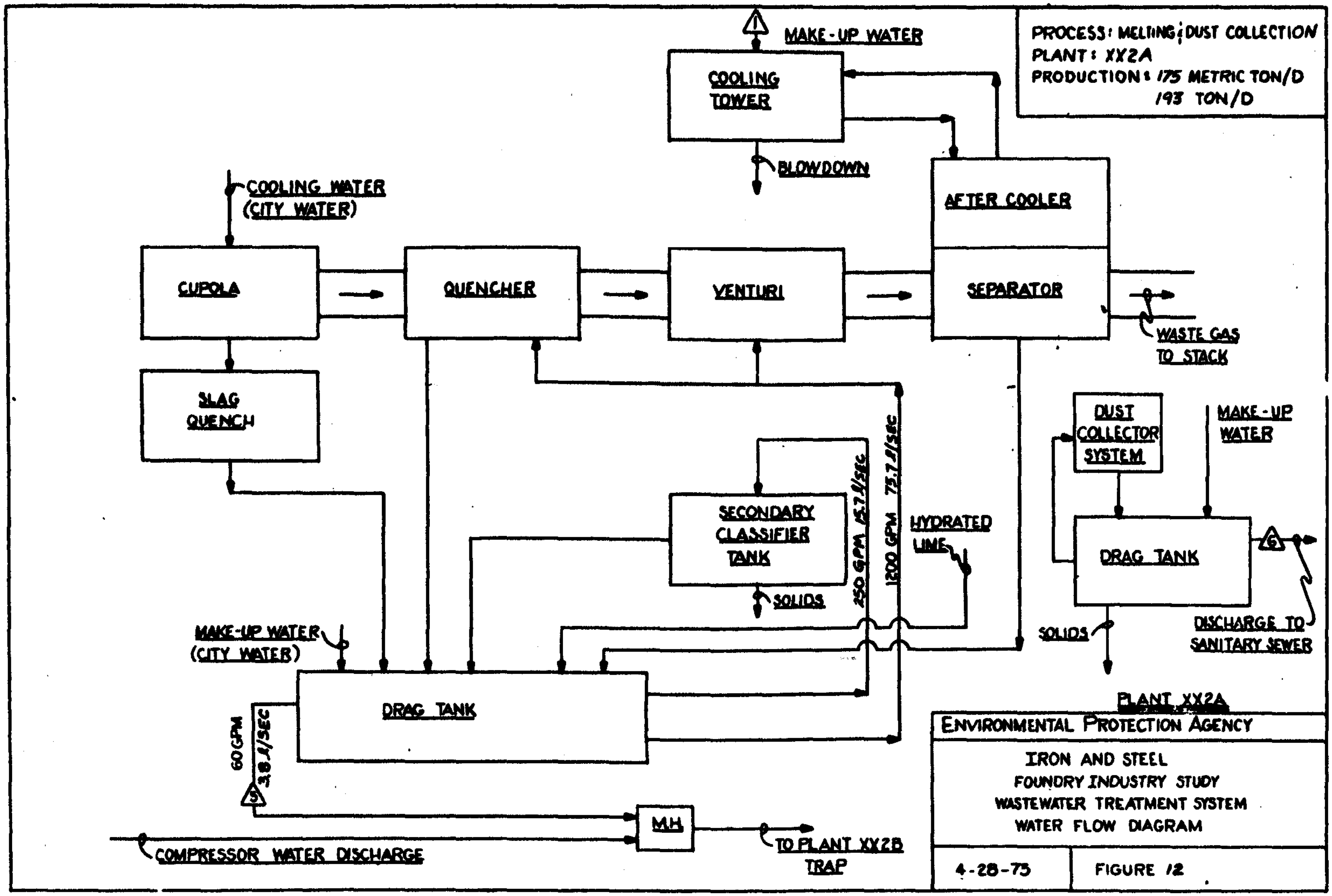
This plant has a high energy venturi scrubber for gas cleaning on the duplex cupolas. The cupola is unlined and has a water cooled shell. Cooling water is used "once through" and then becomes slag quench and transport water delivering the slag to a drag tank.

Recycle pumps circulate the drag tank water to the quencher and venturi and to a sidestream classifier. Solids are removed at the drag tank and classifier underflow. Hydrated lime is added to the drag tank.

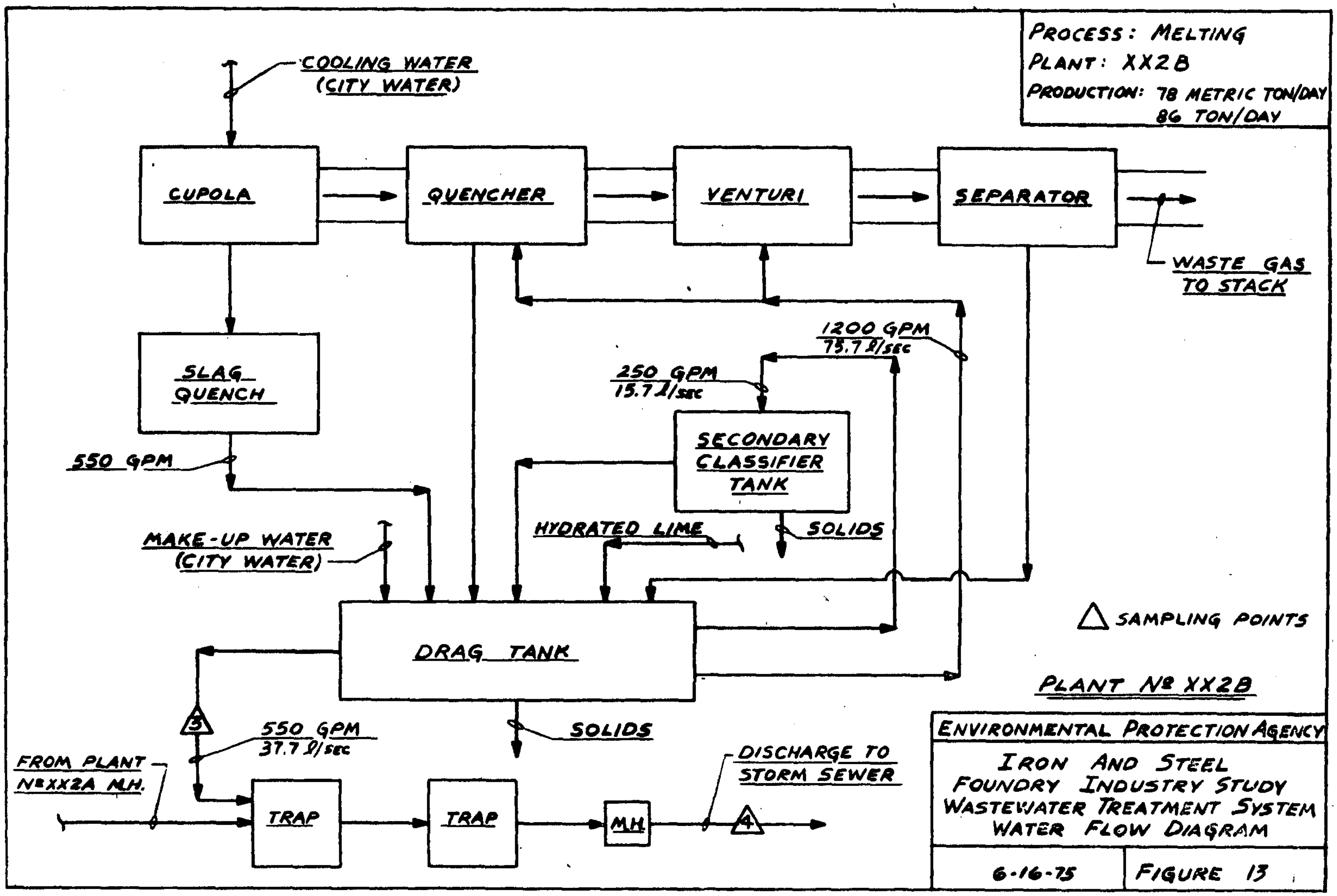
Overflow from the drag tank flows through two traps to discharge into a city storm sewer.

Plant YY-2 - Figure 14

This plant had progressed from a wet cap to a venturi system, as the air quality requirements became more stringent and the treatment system was altered to meet these requirements. The hot gases are drawn through the cupola wet cap to the

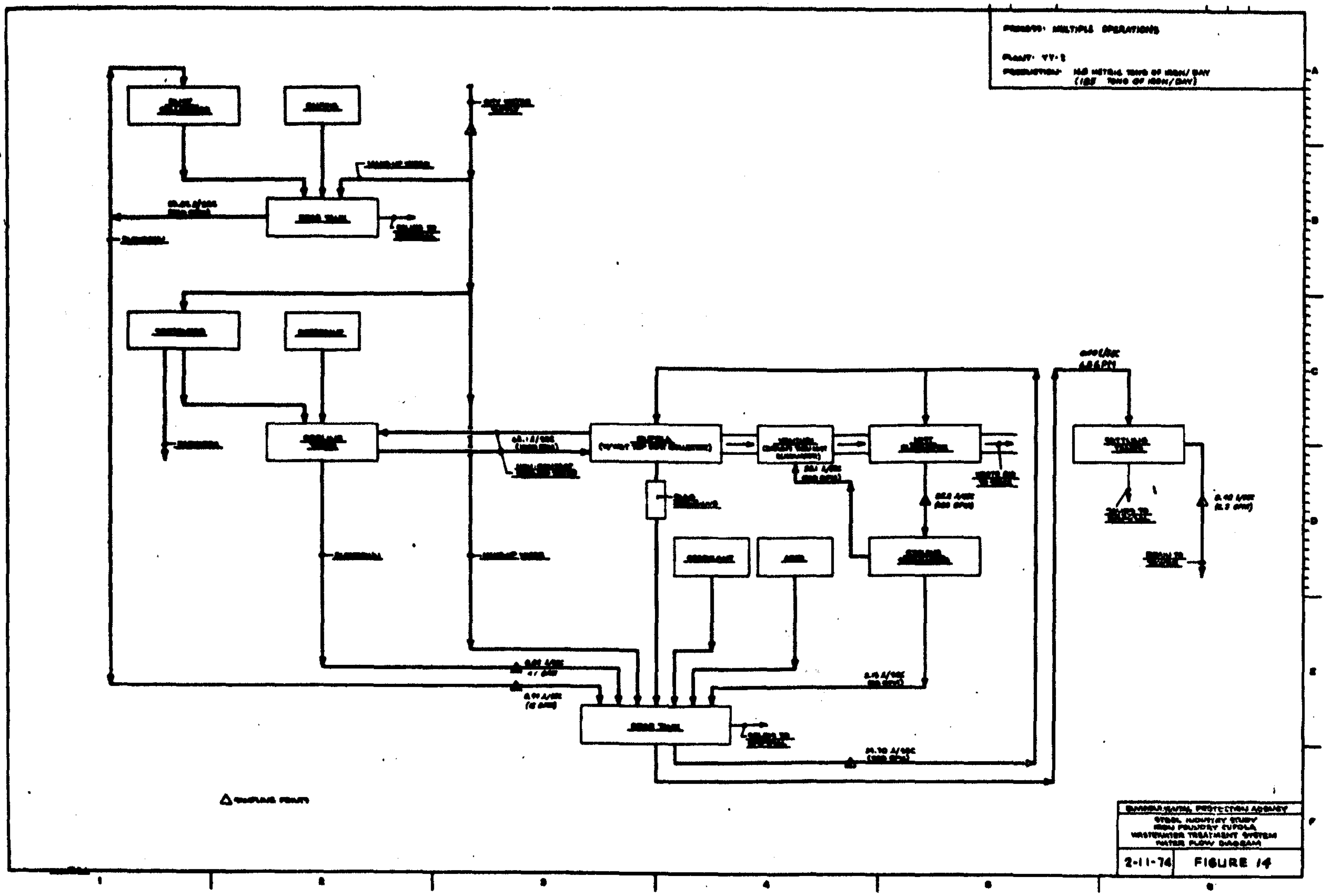


PROCESS: MELTING & DUST COLLECTION
PLANT: XX2A
PRODUCTION: 175 METRIC TON/D
193 TON/D
MAKE-UP WATER
COOLING TOWER
BLOWDOWN
AFTER COOLER
COOLING WATER (CITY WATER)
CUPOLA
QUENCHER
VENTURI
SEPARATOR
WASTE GAS TO STACK
SLAG QUENCH
DUST COLLECTOR SYSTEM
MAKE-UP WATER
SECONDARY CLASSIFIER TANK
SOLIDS
250 GPM 15.7 l/SEC
1800 GPM 75.7 l/SEC
HYDRATED LIME
DRAG TANK
DISCHARGE TO SANITARY SEWER
SOLIDS
MAKE-UP WATER (CITY WATER)
DRAG TANK
60 GPM 3.8 l/SEC
MH
TO PLANT XX2B TRAP
COMPRESSOR WATER DISCHARGE
PLANT XX2A
ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
4-28-75
FIGURE 12


PROCESS: MELTING
PLANT: XX2B
PRODUCTION: 78 METRIC TON/DAY
86 TON/DAY
COOLING WATER
(CITY WATER)
CUPOLA
QUENCHER
VENTURI
SEPARATOR
WASTE GAS
TO STACK
SLAG
QUENCH
1200 GPM
75.7 l/sec
250 GPM
15.7 l/sec
SECONDARY
CLASSIFIER
TANK
550 GPM
MAKE-UP WATER
(CITY WATER)
HYDRATED LIME
SOLIDS
DRAG TANK
SAMPLING POINTS
PLANT Nº XX2B
550 GPM
37.7 l/sec
SOLIDS
FROM PLANT
NºXX2A M.H.
DISCHARGE TO
STORM SEWER
TRAP
TRAP
M.H.
ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL
FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
6-16-75
FIGURE 13



LEFT


MULTIPLE OPERATIONS
2-11-74
FIGURE 14

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venturi, and then through the mist eliminator to the fan, and then exhausted through a stack. A pre-cleaning by the wet cap removes the coarse particulates. This pre-cleaning water is then used as a slag quench stream that cools and transports the slag to the drag tank.

The venturi wets the dust particles remaining in the gas stream. The venturi scrubber water drains from the "mist eliminator." The mist eliminator is supplied with additional water that is sprayed into the chamber to cool and condense the mist developed in the scrubber. This combined drain water is pumped through two cyclone separators and the overflow or cleaner water is returned to the venturi scrubber. The underflow or dirtier water is drained to the drag tank.

The drag tank is treated with acid to control the pH and with a coagulant to assist in the settling of suspended matter. The drag tank is the source of water for the wet cap and mist eliminator.

Water is pumped from the drag tank to a classifier tank where settled solids are "blown down" to a dewater box, and the overflow is discharged to city sewers. The solids are sent to landfill.

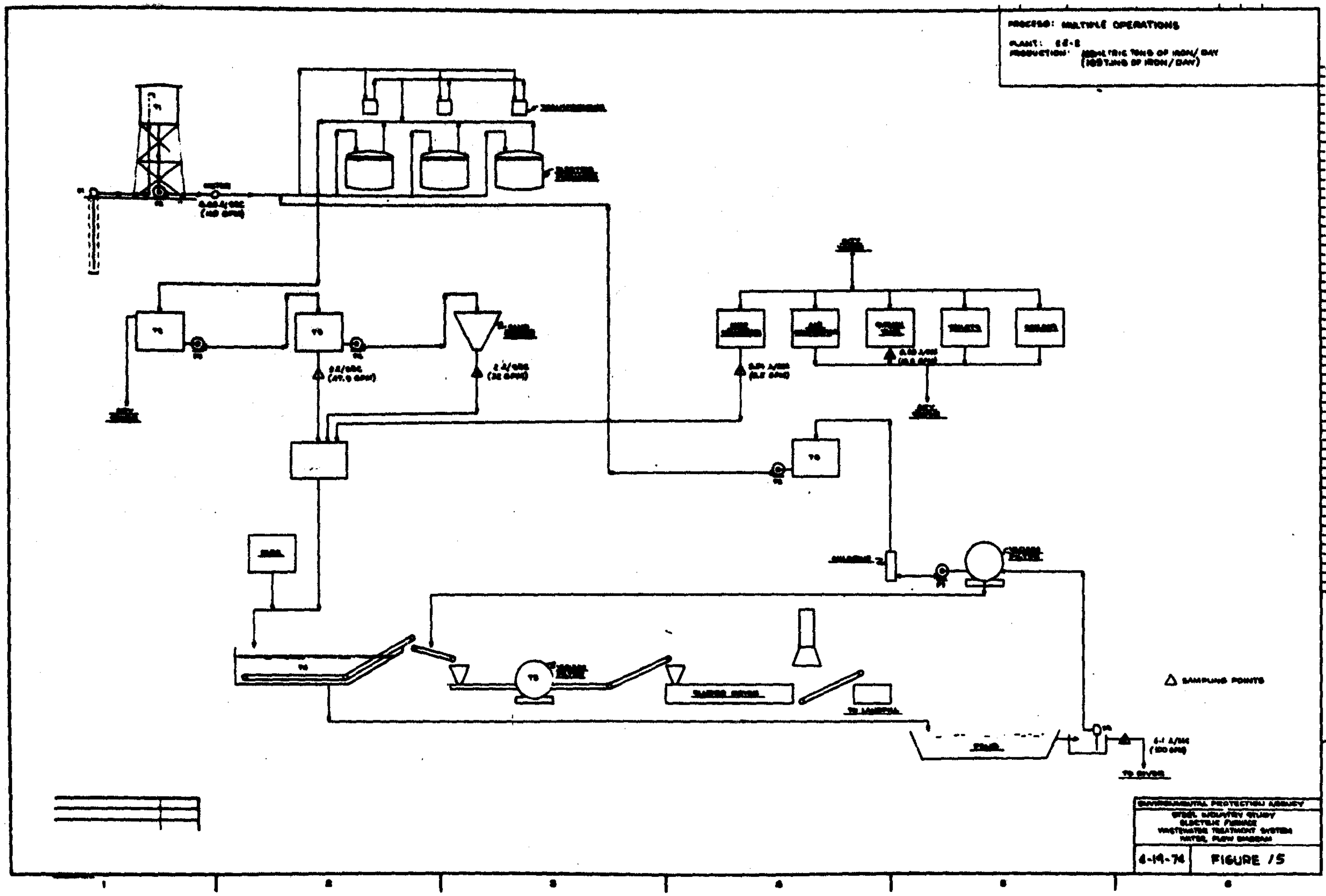
Three large countercurrent centrifugal impingement type scrubbers serve the molding and core making operations of this large foundry. The dirty water is drained to a settling basin and drag tank where it is treated with caustic to control corrosion. Solids are removed by drag chain and dewatered before disposal to landfill. A continuous blowdown operates to remove solids also. This blowdown goes to the cupola drag tank, and to the classifier tank for final clarification before being released to municipal sewers.

Plant ZZ-2 - Figure 15

This plant air cools and filters furnace gases through a baghouse. Noncontact furnace cooling water is "once through" and then dumped to the plant process treatment system.

Three mechanical, centrifugal collectors served the sand preparation, mold and core making areas of this foundry. The collectors use approximately 8 gpm of city water which is drained to the plant water clarification operation.

This plant had the most elaborate water treatment operation of all plants visited. The system is designed to collect all wastewaters from dust collectors, sand washers, and noncontact cooling systems. This water is treated with

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flocculant and proceeds through a settling basin. Solids are removed at about 25% and processed through a vacuum filter to achieve 50 to 60% solids. These are next processed through a dryer and then sent to landfill at about 95% solids.

The supernatant and filtrate were drained to a pond where additional settling occurred. The pond had an overflow weir and a return pump. The system is designed to have a pump return the pond overflow to a vacuum filter. The filter cake is delivered to the discharge point of the main settling basin while the filtrate is pumped through the chlorinator and to a chlorine contact tank. From here, it is pumped to a point just downstream from the stand pipe. The pump at the pond overflow was inoperative at the time of the plant visit. The pond overflow was discharged to a natural water course.

Plant AAA-2 - Figure 16

This plant utilizes the semi-wet method for cooling and coalescing furnace emissions before the baghouse. Hence, operated as designed the spray chamber or spark box has no aqueous discharge.

This plant used a central water treatment plant to remove the collected material from wet dust collectors in the sand preparation, mold, and core making areas as well as pouring, cooling, shakeout, and cleaning areas.

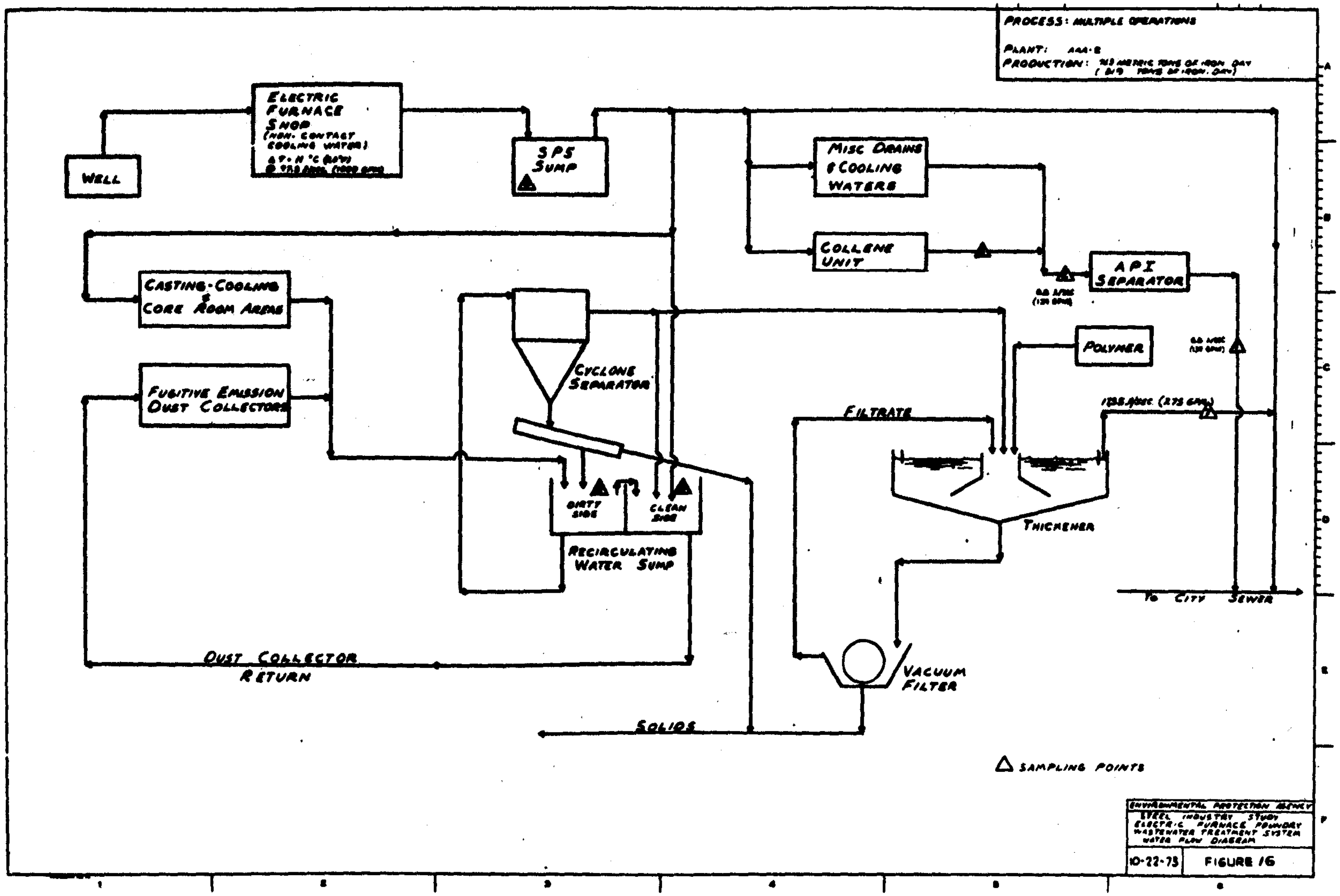
Water from the various dust collectors is pumped to a "dirty side" sump. From there it is pumped into a cyclone separator. The cyclone separates the heavier solids which are dewatered by a vibrated screen and collected for disposal to landfill. The dewater returns to the dirty side sump.

The lighter portion of the cyclone goes to a thickener. Polymer is added and promotes settling. The underflow from the thickener is vacuum filtered with the cake going to landfill, and the liquid returned to the thickener. The overflow is reused, or goes to city sewers.

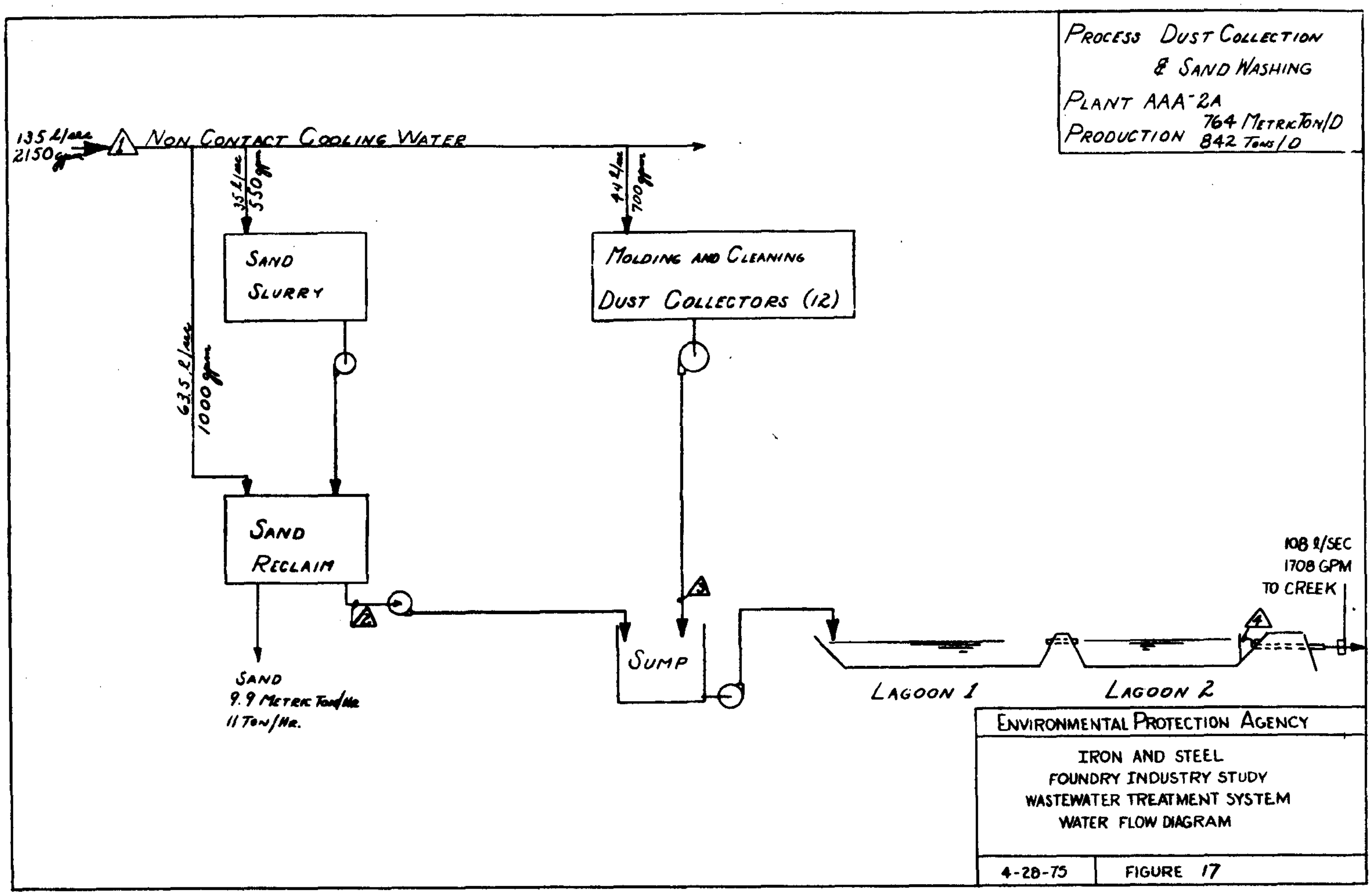
Plant AAA-2a - Figure 17

This plant had a series of 12 bulk bed washer type dust collectors in the foundry for molding and cleaning dusts. The blowdown from these units was pumped to a collection sump and then to a lagoon.

This plant also had a sand washing system to clean sand for reuse. The wastewater from this operation also went to the lagoons.



PROCESS: MULTIPLE OPERATIONS
PLANT: AAA-E
WELL
ELECTRIC FURNACE SHOP (NON-CONTACT COOLING WATER)
SPS SUMP
MISC DRAINS & COOLING WATERS
COLLENE UNIT
API SEPARATOR
CASTING-COOLING & CORE ROOM AREAS
FUGITIVE EMISSION DUST COLLECTORS
CYCLONE SEPARATOR
DIRTY SIDE
CLEAN SIDE
RECIRCULATING WATER SUMP
POLYMER
FILTRATE
THICKENER
TO CITY SEWER
VACUUM FILTER
DUST COLLECTOR RETURN
SOLIDS
SAMPLING POINTS
ENVIRONMENTAL PROTECTION AGENCY
STEEL INDUSTRY STUDY
ELECTRIC FURNACE FOUNDRY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
10-22-75
FIGURE 16


PROCESS DUST COLLECTION
& SAND WASHING
PLANT AAA-2A
PRODUCTION 764 METRIC TON/D
842 TONS/D
135 l/sec
2150 gpm
1
NON CONTACT COOLING WATER
35 l/sec
550 gpm
44 l/sec
700 gpm
SAND
SLURRY
MOLDING AND CLEANING
DUST COLLECTORS (12)
63.5 l/sec
1000 gpm
SAND
RECLAIM
2
3
SAND
9.9 METRIC TON/HR.
11 TON/HR.
SUMP
LAGOON 1
LAGOON 2
4
108 l/SEC
1708 GPM
TO CREEK
ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL
FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
4-28-75
FIGURE 17



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The lagoons were arranged to give maximum use of the land area. The inlet to the first lagoon was arranged so that the heavy solids could be removed readily. This was a daily routine.

Plant AAA-2b - Figure 18

This plant had a wet dust collection system for the dusts collected in the molding, core room, pouring, cooling and cleaning areas. The wastewater treatment consisted of a primary tank with lime addition that was pumped to a cyclone separator. The cyclone underflow went to a classifier for dewatering and removal of solids with the dewater returned to the primary tank.

The upflow from the cyclones went to a second tank for recycle, with a blowdown (10%) to a thickener. Alum and poly were added. The underflow went to a vacuum filter. The cake went to landfill and the filtrate was returned to the thickener.

The thickener overflow was available for reuse or discharge to the river.

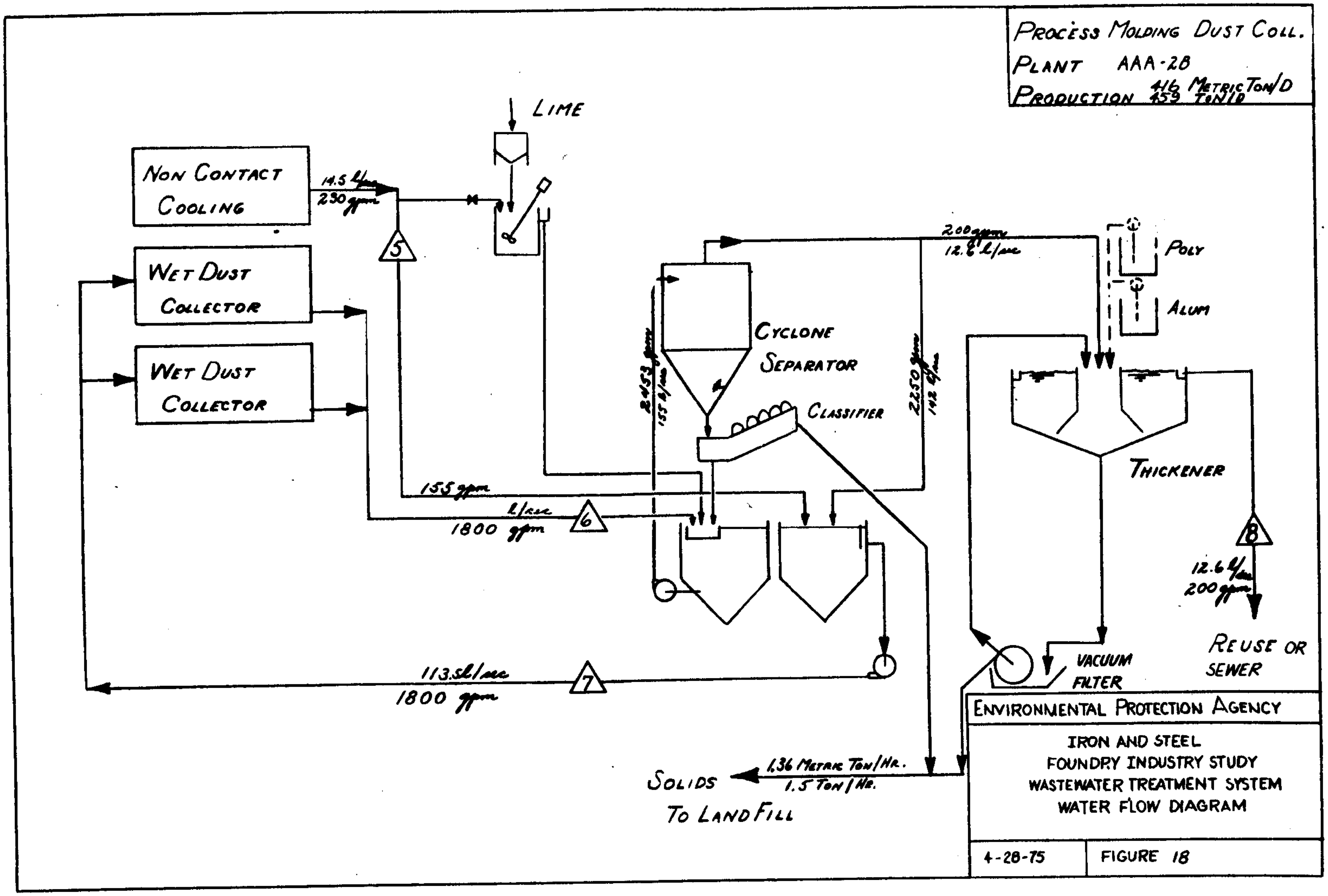
Plant BBB-2 - Figure 19

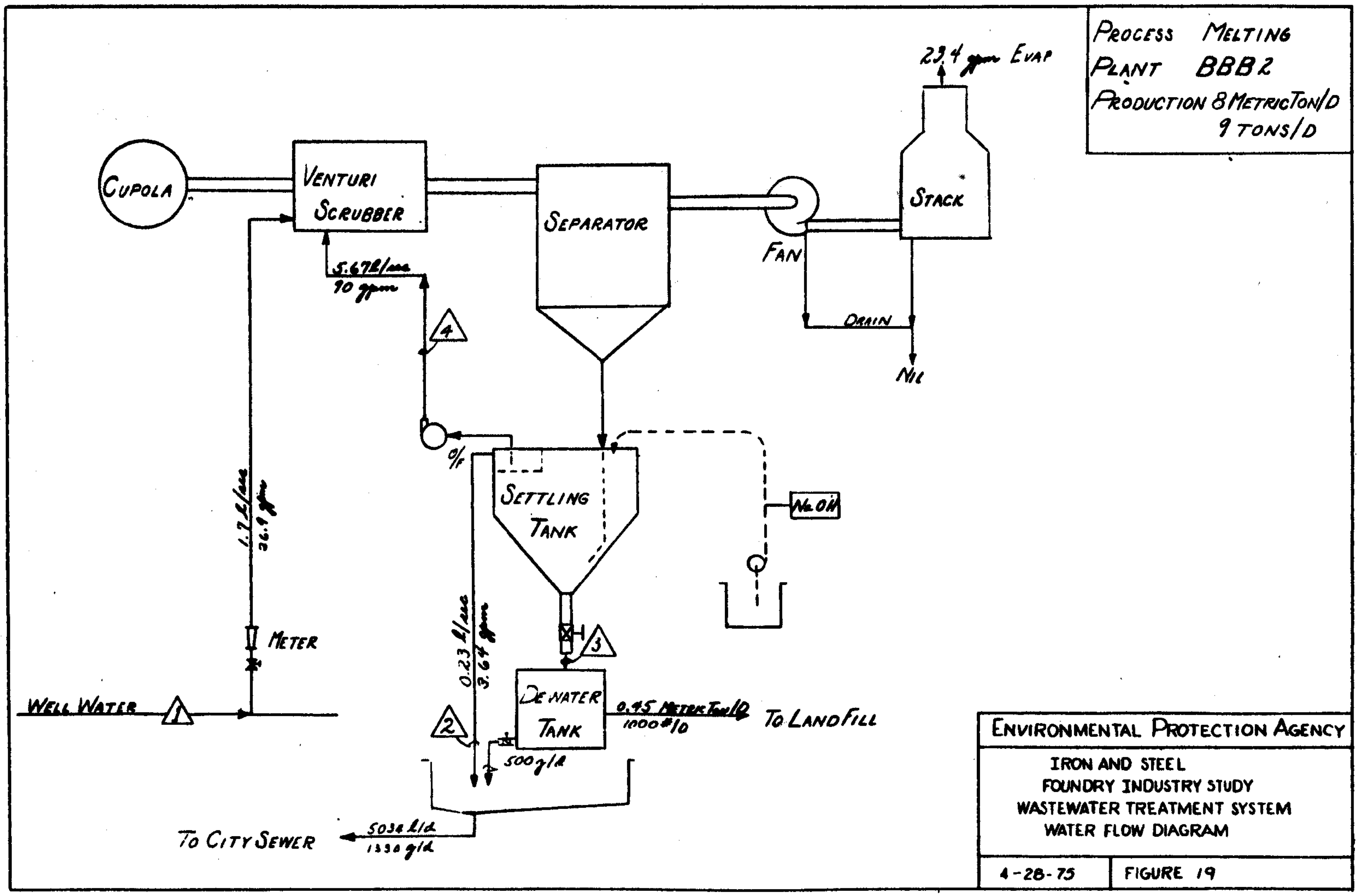
This plant had a venturi scrubber on the cupola emissions. The wastewater was collected in a settling tank where caustic was added. The overflow was recycled to the venturi. Makeup was from a well and was adjusted to give a slight surplus of return water in the settling tank. This surplus was blown down to the city sewer. The settling tank was dumped daily to a dewater box. The dewater went to the city sewer, and solids were landfilled.

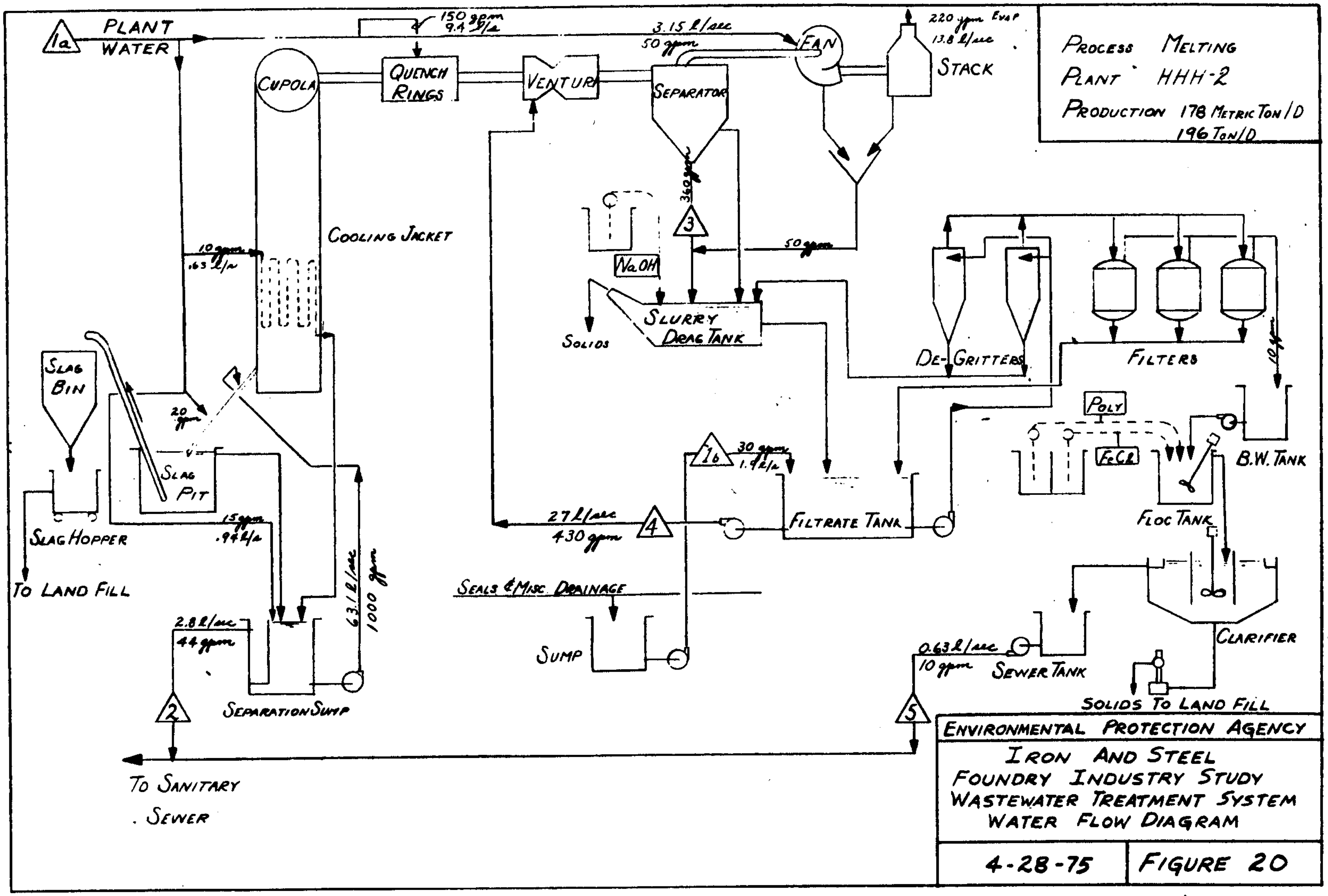
Plant HHH-2 - Figure 20

This plant collected venturi scrubber waters in a drag tank where caustic was added and heavy solids were removed.

The overflow from this tank went to a second tank for recycle to the process. A sidestream from this second tank went through cyclone classifiers and then to pressure sand filters. The filter backwash was blown down to a surge tank and then to a floc tank where chemical additions were made. This tank overflowed to a contact clarifier. The clarifier underflow was pumped to landfill, and the overflow was discharged to municipal sanitary sewers. The slag quench water was settled through two sumps, and then released to the same sewer system.


PROCESS MOLDING DUST COLL.
PLANT AAA-28
PRODUCTION 416 METRIC TON/D 459 TON/D
LIME
NON CONTACT COOLING
14.5 l/sec
230 gpm
WET DUST COLLECTOR
WET DUST COLLECTOR
5
200 gpm
12.6 l/sec
POLY
ALUM
CYCLONE SEPARATOR
CLASSIFIER
2453 gpm
155 l/sec
2250 gpm
142 l/sec
THICKENER
155 gpm
l/sec
1800 gpm
6
8
12.6 l/sec
200 gpm
REUSE OR SEWER
113.5 l/sec
1800 gpm
7
VACUUM FILTER
1.36 METRIC TON/HR.
1.5 TON/HR.
SOLIDS TO LANDFILL
ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL
FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
4-28-75
FIGURE 18


PROCESS MELTING
PLANT BBB2
PRODUCTION 8 METRIC TON/D
9 TONS/D
23.4 gpm EVAP
CUPOLA
VENTURI SCRUBBER
SEPARATOR
FAN
STACK
DRAIN
NIL
5.67 l/sec
90 gpm
4
O/F
SETTLING TANK
NaOH
1.7 l/sec
26.9 gpm
METER
WELL WATER
1
0.23 l/sec
3.64 gpm
3
DEWATER TANK
0.45 METRIC TON/D
1000#/D
TO LANDFILL
2
500 g/d
5034 l/d
1330 g/d
TO CITY SEWER
ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL
FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
4-28-75
FIGURE 19



PROCESS MELTING
PLANT HHH-2
PRODUCTION 178 METRIC TON/D
196 TON/D
1a PLANT WATER
150 gpm
9.4 l/s
3.15 l/sec
50 gpm
220 gpm EVAP
13.8 l/sec
CUPOLA
QUENCH RINGS
VENTURI
SEPARATOR
FAN
STACK
COOLING JACKET
10 gpm
.63 l/s
360 gpm
3
50 gpm
NaOH
SOLIDS
SLURRY DRAG TANK
DE-GRITTERS
FILTERS
10 gpm
POLY
FeCl
B.W. TANK
FLOC TANK
SLAG BIN
SLAG HOPPER
TO LAND FILL
20 gpm
SLAG PIT
15 gpm
.94 l/s
1b
30 gpm
1.9 l/s
27 l/sec
430 gpm
4
FILTRATE TANK
SEALS & MISC DRAINAGE
SUMP
63.1 l/sec
1000 gpm
2.8 l/sec
44 gpm
SEPARATION SUMP
2
0.63 l/sec
10 gpm
SEWER TANK
CLARIFIER
SOLIDS TO LAND FILL
5
TO SANITARY SEWER
ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
4-28-75
FIGURE 20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Plant HHH-2a - Figure 21

This plant collected the wastewater from a venturi scrubber on a triplex cupola arrangement into a slurry tank. Caustic was added, and the water was pumped to a large lagoon that was shared with another plant. The lagoon water was recycled to the venturi.

Slag quench water was "blown down" from a cooling tower and was discharged to the lagoon from the slag pit.

The plant had a wet dust collector system that discharged to a separate lagoon, and was recycled to the dust collectors. There was zero discharge from the system.

Plant HHH-2b - Figure 22

This plant drained wastewater from the venturi scrubbers and separator to a large lagoon. The water was recycled from the lagoon to the quencher.

The wet dust collectors also drained to the lagoon and was recycled. There was zero discharge from the lagoon.

Plant GGG-2 - Figure 23

The venturi and quench chamber water was collected in a separator, and then pumped to a large sump. After settling overnight, the sump was syphoned to a second sump. Water from this second sump was recycled to the quench chamber the next day. This plant had zero discharge. Solids were removed from the first sump bimonthly.

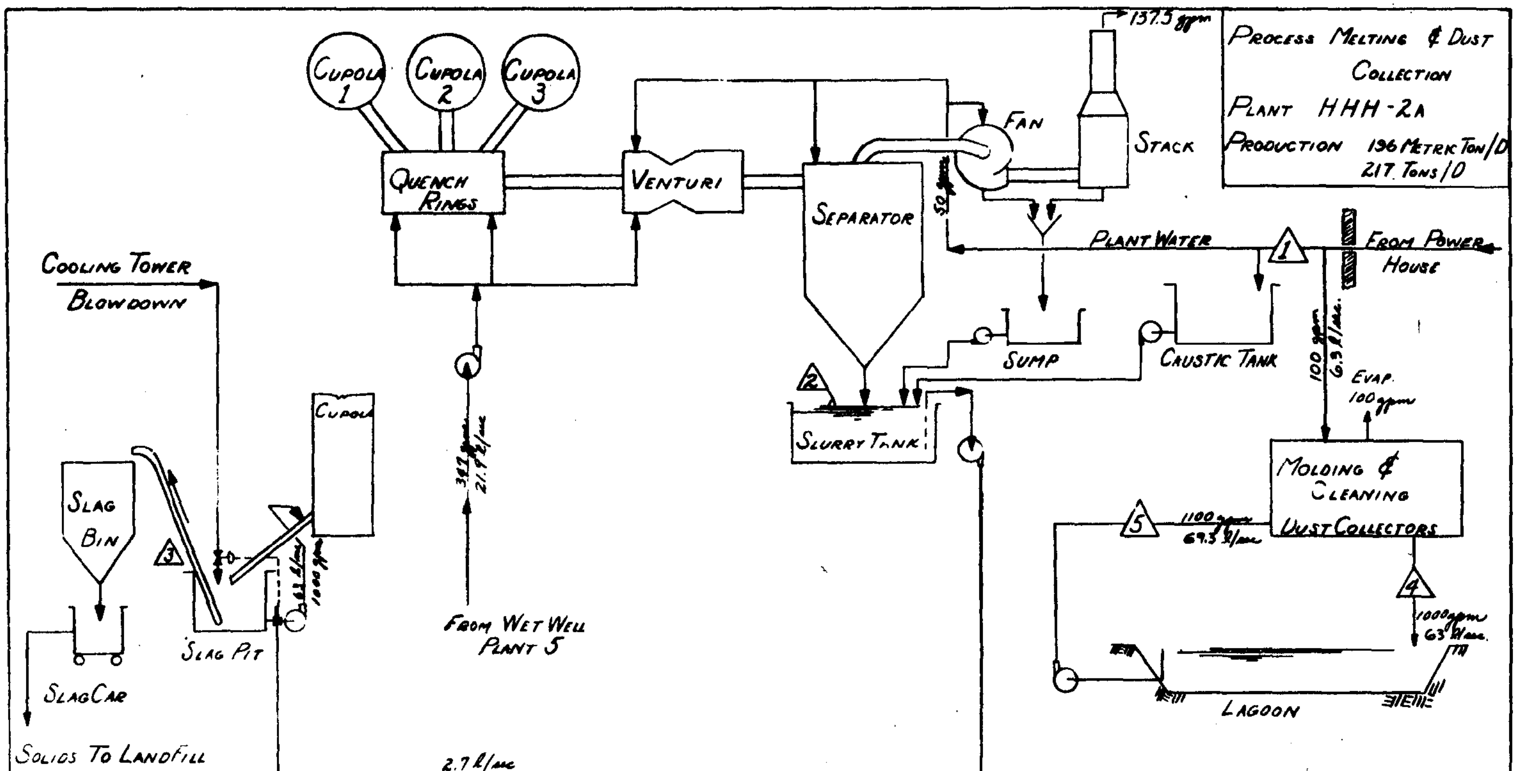
Plant CCC-2 - Figure 24

The wastewater from the venturi and separator drained into a drag tank. Caustic and flocculant were added and solids were removed. Water was recycled to the venturi. Overflow drained to the city sewer.

This plant also had a wet dust collector that had a similar drag tank and chemical addition system. Overflow was discharged to city sewers.

Plant EEE-2 - Figure 25

The venturi and separator wastewaters drained to a classifier tank where caustic and polyelectrolytes were added. The underflow went to a drag tank where solids were settled and removed. The drag tank overflow was recycled to the classifier, and excess was drained to a transfer tank. Water was recycled from the classifier to the process.




ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
4 28-75
FIGURE 21

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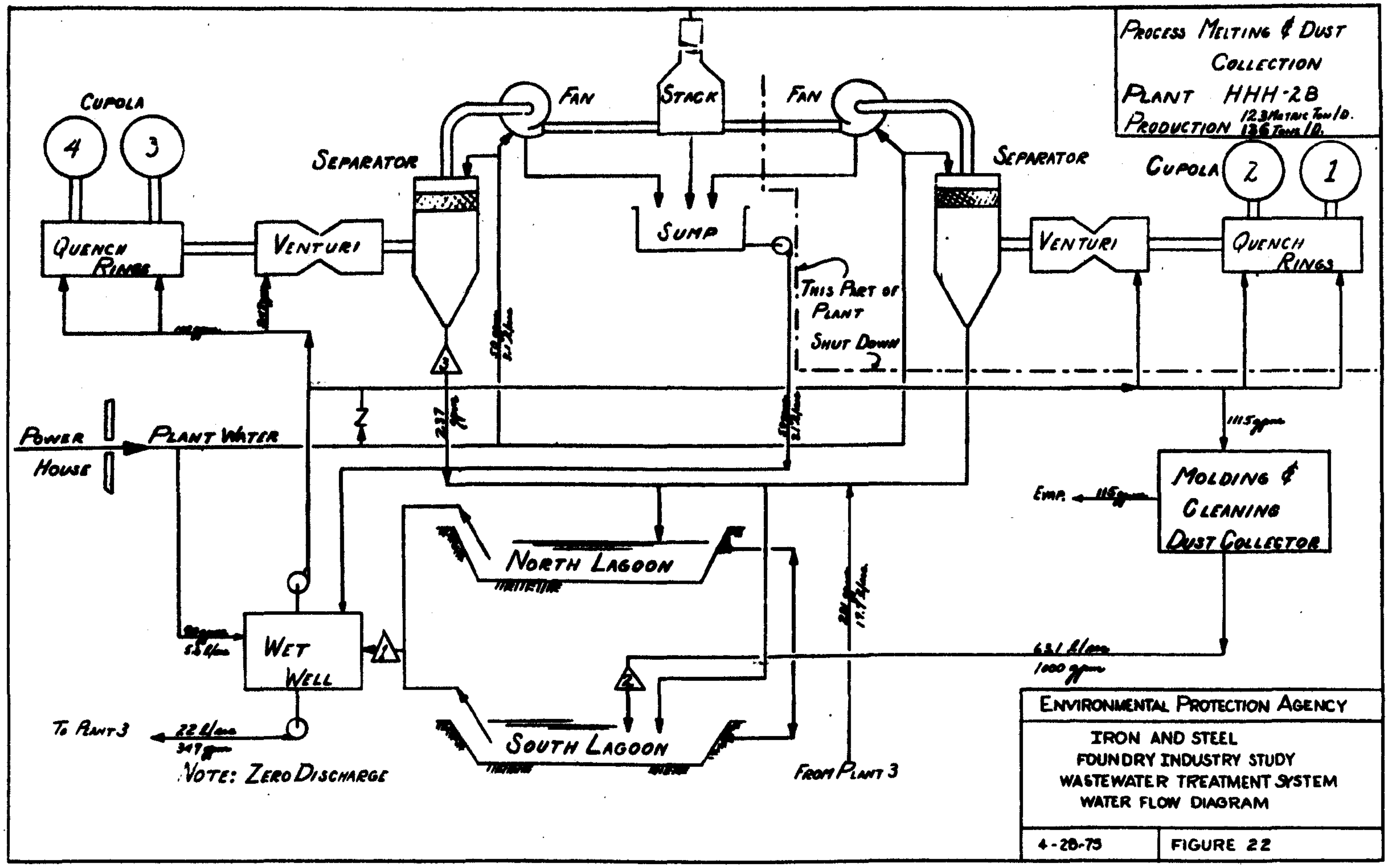

Process Melting & Dust Collection
Plant HHH-28
Production 12.3 Metric Tons/D. 13.6 Tons/D.
Cupola
4
3
2
1
Quench Rings
Venturi
Separator
Fan
Stack
Sump
This Part of Plant Shut Down
Power House
Plant Water
Wet Well
North Lagoon
South Lagoon
Molding & Cleaning Dust Collector
1115 gpm
Evap. 115 gpm
631 l/min
1000 gpm
To Plant 3
22 l/min
347 gpm
From Plant 3
Note: Zero Discharge
Environmental Protection Agency
Iron and Steel Foundry Industry Study
Wastewater Treatment System
Water Flow Diagram
4-28-75
Figure 22


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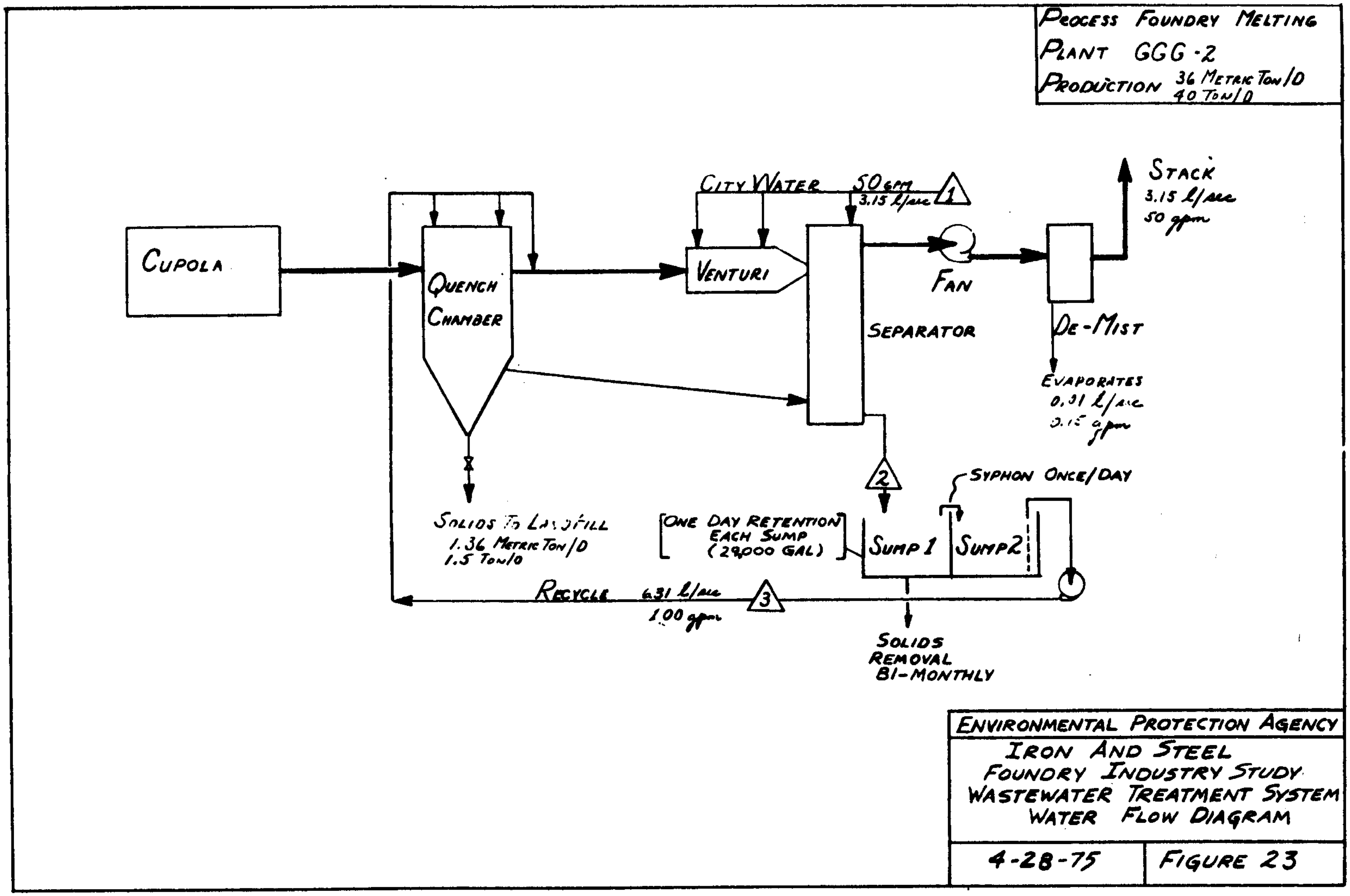

Process Foundry Melting
Plant GGG-2
Production 36 Metric Ton/D
40 Ton/D
Cupola
Quench Chamber
City Water 50 gpm
3.15 l/sec
1
Venturi
Separator
Fan
Stack
3.15 l/sec
50 gpm
De-Mist
Evaporates
0.31 l/sec
2
Syphon Once/Day
Solids To
1.36 Metric Ton/D
1.5 Ton/D
One Day Retention
Each Sump
(29,000 GAL)
Sump 1
Sump 2
Recycle 6.31 l/sec
100 gpm
3
Solids Removal
Bi-Monthly
Environmental Protection Agency
Iron And Steel
Foundry Industry Study
Wastewater Treatment System
Water Flow Diagram
4-28-75
Figure 23




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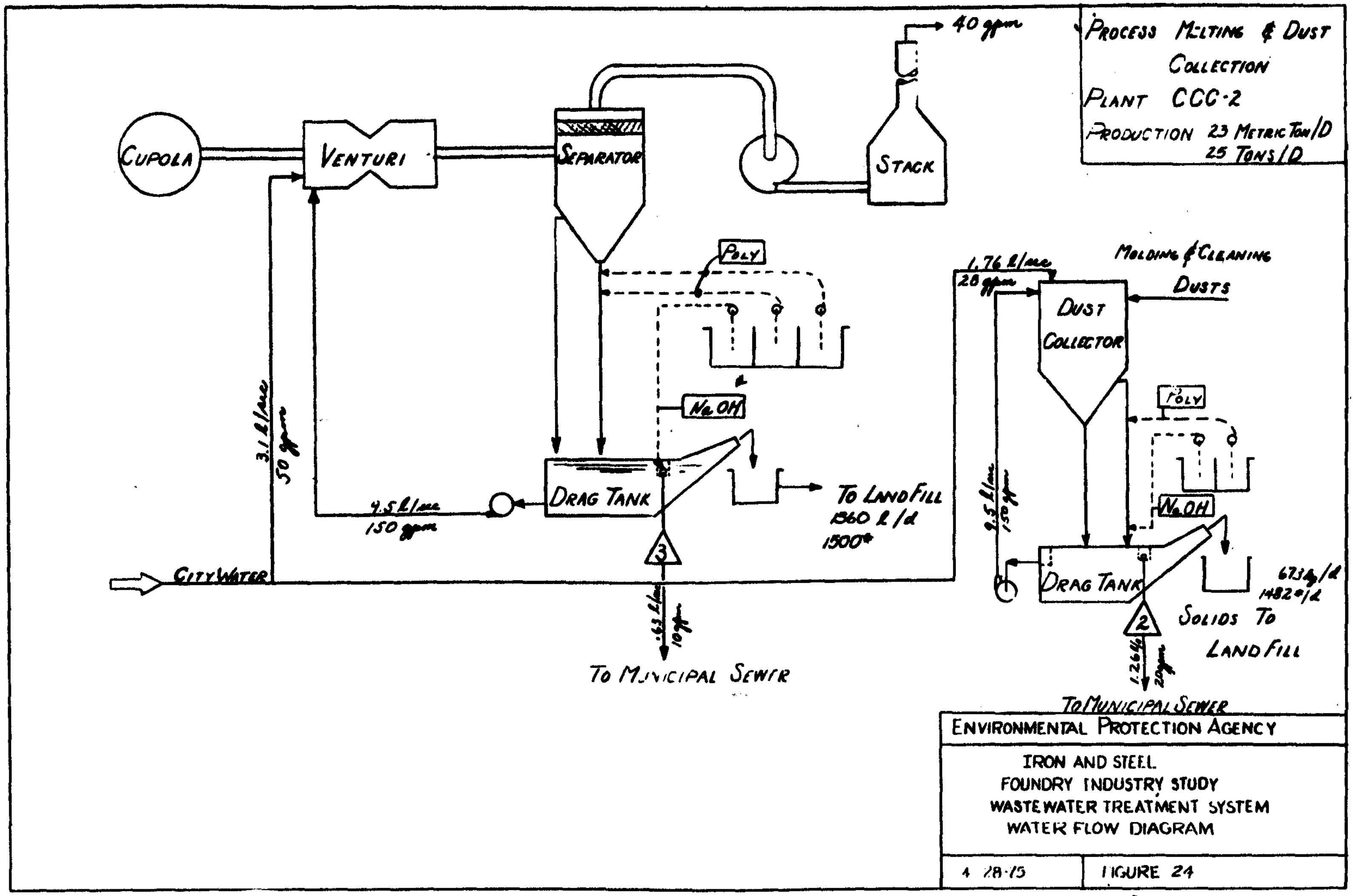


ENVIRONMENTAL PROTECTION AGENCY

IRON AND STEEL FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM

4 28 75 | FIGURE 24



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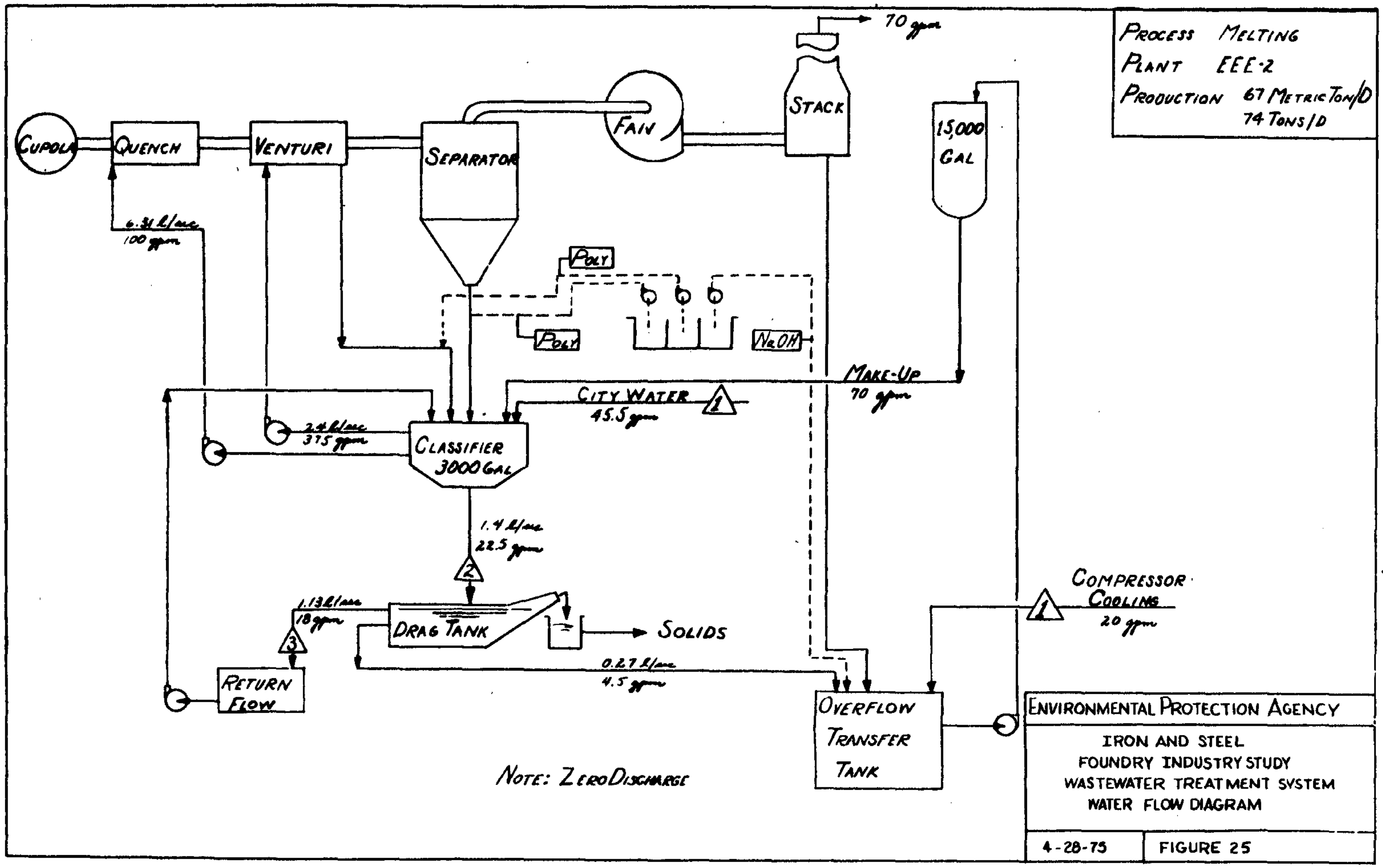


ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
4-28-75 FIGURE 25

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The overflow tank collected noncontact cooling water from the air compressors, and pumped it and the drag tank overflow water to a head tank for makeup to the system. Caustic was also added at this tank for corrosion control.

This plant had zero discharge.

Plant FFF-2 - Figure 26

This plant had a sand washing system. The sand from shakeout was conveyed to a screen. A magnetic separator removed all metallic items from the sand.

The screen oversize (+3/8 in.) went to a mixer vessel where city water was added. This was thoroughly agitated, and then pumped to a slurry tank. The slurry tank metered the mix to a dewater table where the solids were screw conveyed to a rotary dryer. The underflow from the dewater table was pumped to a settling tank.

The settling tank is cleaned out on a weekly schedule and solids are removed to landfill. The settled water drains to the river.

Plant DDD-2 - Figure 27

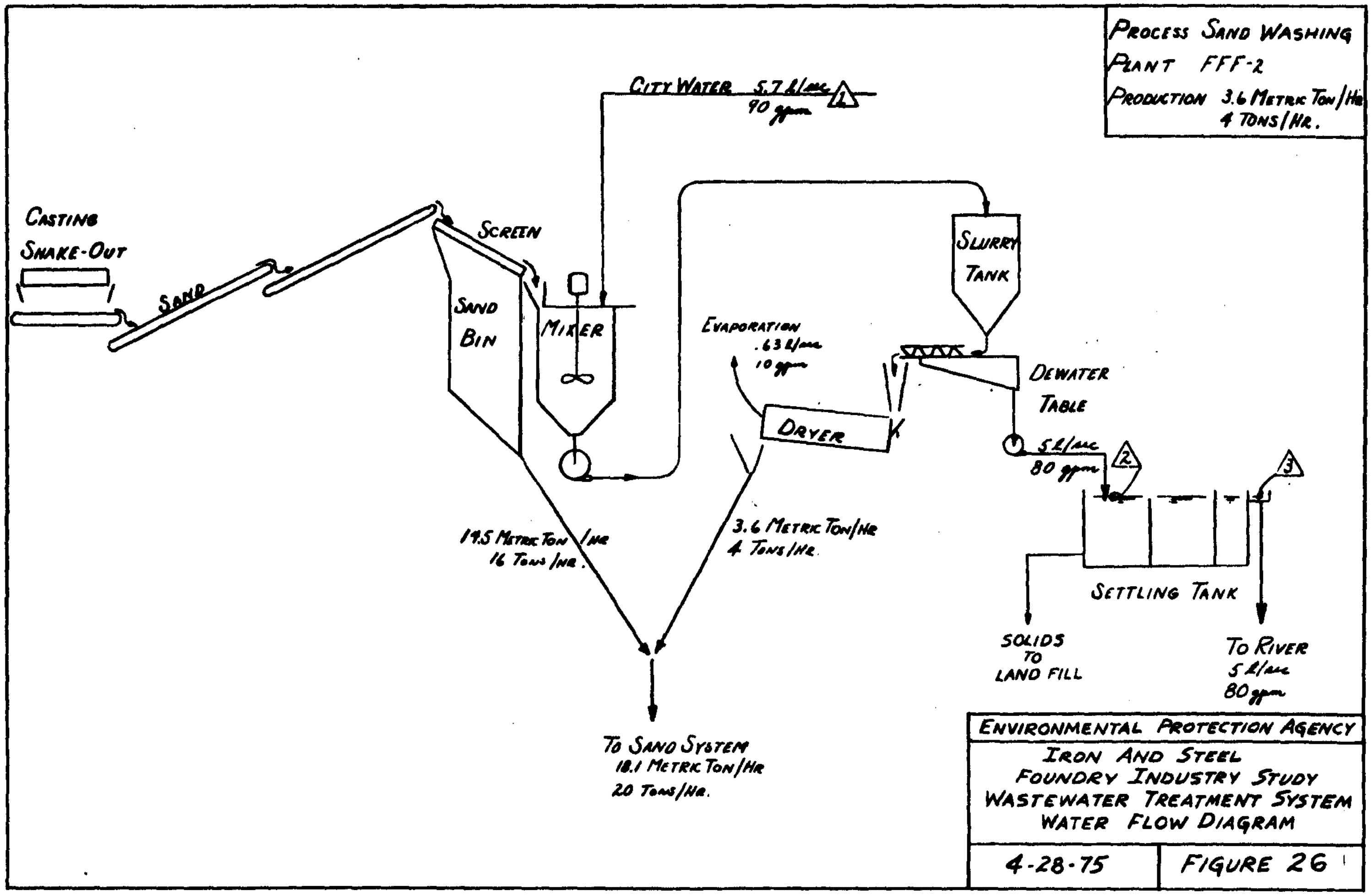
This plant had a venturi scrubber and a separator on the cupola. The separator had a conical bottom that collected heavy solids. Caustic was added to the separator via a pump from a mixing tank. Water was pumped from the separator to the process, and an overflow from the separator discharged to the sanitary sewers.

The separator was drained, at the end of the cupola run, to a dewatering tank, and the solids were sent to landfill.

The plant had a wet dust collector that drained wastewaters to a drag tank where a flocculant was added, and solids were removed. The water was recycled to the collector, and the overflow went to the sanitary sewer.

Table 12 gives the water effluent treatment costs for melting wastewater systems, as well as net raw waste loads and unit effluent loads of these systems.

Tables 13, 14, and 15 give similar information on dust collection systems, sand washing systems and multi-unit systems.


PROCESS SAND WASHING
PLANT FFF-2
PRODUCTION 3.6 METRIC TON/HR
4 TONS/HR.
CITY WATER 5.7 l/sec
90 gpm
1
CASTING
SHAKE-OUT
SAND
SCREEN
SAND
BIN
MIXER
SLURRY
TANK
EVAPORATION
.63 l/sec
10 gpm
DEWATER
TABLE
DRYER
5 l/sec
80 gpm
2
3
19.5 METRIC TON/HR
16 TONS/HR.
3.6 METRIC TON/HR
4 TONS/HR.
SETTLING TANK
SOLIDS
TO
LAND FILL
TO RIVER
5 l/sec
80 gpm
TO SAND SYSTEM
18.1 METRIC TON/HR
20 TONS/HR.
ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL
FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
4-28-75
FIGURE 26

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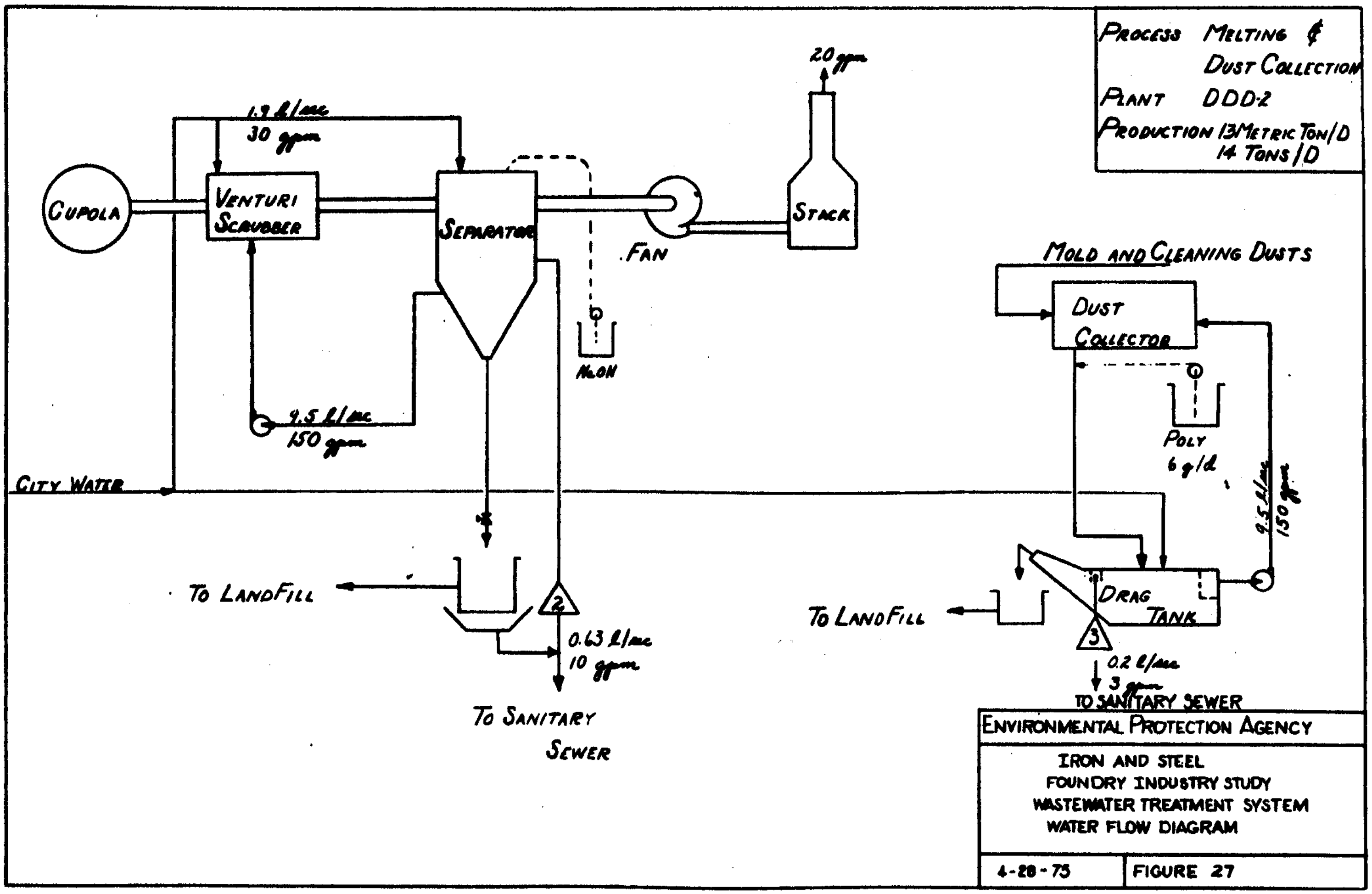
PROCESS MELTING & DUST COLLECTION
PLANT DDD-2
PRODUCTION 13 METRIC TON/D
14 TONS/D
CUPOLA
VENTURI SCRUBBER
SEPARATOR
FAN
STACK
20 gpm
1.9 l/sec
30 gpm
9.5 l/sec
150 gpm
NaOH
CITY WATER
TO LANDFILL
0.63 l/sec
10 gpm
TO SANITARY SEWER
MOLD AND CLEANING DUSTS
DUST COLLECTOR
POLY
6 g/d
9.5 l/sec
150 gpm
DRAG TANK
TO LANDFILL
0.2 l/sec
3 gpm
TO SANITARY SEWER
ENVIRONMENTAL PROTECTION AGENCY
IRON AND STEEL
FOUNDRY INDUSTRY STUDY
WASTEWATER TREATMENT SYSTEM
WATER FLOW DIAGRAM
4-28-75
FIGURE 27



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## BASE LEVEL OF TREATMENT

In developing the technology, guidelines, and incremental costs associated with the application of the technologies subsequently to be selected and designated as one approach to the treatment of effluents to achieve the BPCTCA, BATEA, and NSPS effluent qualities, it was necessary to determine what base or minimum level of treatment was already in existence for practically all plants within the industry in any given subcategory. The different technology levels were then formulated in an "add-on" fashion to these base levels. The various treatment levels and corresponding effluent volumes and characteristics are listed in Tables 15 through 17. Since these tables also list the corresponding costs for the average size plant, these tables are presented in Section VIII.

It was obvious from the plant visits that many of the plants in existence today have treatment and control facilities with capabilities that exceed the technologies chosen to be the base levels of treatment. Even though many plants may be superior to the base technology it was necessary, in order to be all inclusive of the industry as a whole, to start at the base level of technology in the development of treatment models and incremental costs.

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# SECTION VIII

## COST, ENERGY, AND NON-WATER QUALITY ASPECTS

### INTRODUCTION

This section will discuss the incremental costs incurred in applying the different levels of pollution control technology. The analysis will also describe energy requirements, non-water quality aspects (including sludge disposal, by-product recovery, etc.), and their techniques, magnitude, and costs for each level of technology.

It must be noted that some of the technology beyond the base level may already be in use. Also many possible combinations and/or permutations of various treatment methods are possible. Thus, not all plants will be required to add all of the treatment capabilities or incur all of the incremental costs indicated to bring the base level facilities into compliance with the effluent limitations.

### COSTS

The water pollution control costs for the plants visited during the study are presented in Tables 12 through 15. The treatment systems, gross effluent loads, and reduction benefits were described in Section VII. The costs were estimated from data supplied by the plants. Costs are based on 1972 casting production.

| Subcategory | Plant | Cost per unit weight of product | |
|---|---|---|---|
| | | $/kkg | $/ton |
| Melting | XX-2b | 4.95 | 4.50 |
| | XX-2 | 4.67 | 4.25 |
| | XX-2a | 1.95 | 1.77 |
| | GGG-2 | 9.78 | 8.88 |
| | BBB-2 | 12.85 | 11.68 |
| | EEE-2 | 1.75 | 1.59 |
| | CCC-2 | 3.40 | 3.09 |
| | DDD-2 | 8.28 | 7.53 |
| Molding & Cleaning Dust Collection | WW-2 | 0.09 | 0.08 |
| | DDD-2 | 6.43 | 5.85 |
| | HHH-2a | 1.47 | 1.34 |

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| | | | |
|---|---|---|---|
| Sand Washing | FFF-2 | 8.15 | 7.41 |
| Multiple Process | VV-2 | 0.22 | 0.20 |
| | YY-2 | 2.09 | 1.90 |
| | AAA-2 | 1.20 | 1.09 |
| | AAA-2b | 1.67 | 1.52 |
| | ZZ-2 | 10.89 | 9.90 |
| | AAA-2a | 0.36 | 0.33 |
| | HHH-2 | 3.21 | 2.92 |
| | HHH-2a&2b | 4.61 | 4.19 |

## BASE LEVEL AND INTERMEDIATE TECHNOLOGY, ENERGY, AND NON-WATER IMPACT

The base levels of treatment and the energy requirements and non-water quality aspects associated with intermediate levels of treatment are discussed below by subcategories.

### Melting Operations

Base Level of Treatment. Implementation of good housekeeping practices with in-process separation in a settling tank and slag quench water treated in a drag tank. Periodic solids removal. Once-through use of water.

Additional Power Requirements. To meet the anticipated 1977 standard in cleaning the emissions from the melting operations will require modifications to the wastewater treatment system. The additional energy consumed will be 56.7 kwh/kkg (51.5 kwh/ton) of metal produced. For the typical 36.3 kkg/day (40 tons/day) melting operation, 85.8 kw (115 hp) will have to be added. The annual operating cost for the additional equipment will be $8,625.

Non-Water Quality Aspects.

1. Air Pollution: The main air pollution problem associated with the melting operation will be suspended particulate matter. Although the exhaust gases will be passed through a wash, 0.1 kkg of particulate emission per kkg (lb/1,000 lb) of exhaust gas will be emitted into the atmosphere.

2. Solid Waste Disposal: A portion of the solid waste from the waste system may be collected and recycled to the melting operations whereas the remainder may be clamshelled and landfilled.

TABLE 12

**WATER EFFLUENT TREATMENT COSTS FOR FOUNDRIES**

Melting Operations

| | XX-2 | XX-2A | XX-2B | BBB-2 | Range |
|---|---|---|---|---|---|
| Initial Investment (1971 $) | $135,758 | $151,560 | $124,320 | $ 92,540 | 9161-225,000 |
| Annual Costs | | | | | |
| Operating Labor | 0 | 0 | 0 | 1,613 | |
| Utilities | 89,000 | 62,100 | 77,320 | 8,455 | |
| Maintenance | 3,600 | 1,800 | 1,800 | 2,074 | |
| Depreciation | 13,576 | 15,156 | 12,432 | 9,254 | |
| Cost of Capital | 5,701 | 6,365 | 5,221 | 3,886 | |
| Other | - | - | - | - | |
| Total | 111,827 | 85,421 | 96,773 | 26,282 | |
| 1972 Tons Product | 26,300 | 48,200 | 21,500 | 2,250 | |
| $/Ton | 4.252 | 1.772 | 4.501 | 11.68 | $1.59-11.68 |
| 1000 gal treated | $1.44 \times 10^6$ | $1.584 \times 10^3$ | $1.162 \times 10^5$ | $3.24 \times 10^3$ | |
| $/1000 gal treated | 0.775 | 54.064 | 0.833 | 8.1111 | $0.77-54.06 |

AVERAGE NET RAW WASTE LOAD

| Parameters | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 15,900 | - | 6267 | - | 19,534 | - | 3,120 | - | 788 to 19,534 | |
| Suspended solids | $8.73^{-1}$ | 21 | 1.31 | 526 | 1.64 | 32 | 26.02 | 1300 | $6.95^{-1}$ to 26.02 | 21 to 1300 |
| Oil and Grease | $1.08^{-1}$ | 2.6 | $6.29^{-2}$ | 25.3 | $1.07^{-1}$ | 2.1 | $1.602^{-1}$ | 8 | $2.15^{-3}$ to $6.29^{-2}$ | 2 to 25.3 |
| pH | 9.1 | - | 7.2 | - | 9.2 | - | 7.9 | - | 7.2 to 11 | |
| Fluoride | $1.29^{-1}$ | 3.1 | $3.65^{-2}$ | 14.6 | 1.776 | 34.7 | $7.606^{-1}$ | 38 | | |
| Lead | - | - | - | - | - | - | - | - | $1.22^{-2}$ to $2.68^{-1}$ | 9.6 to 44.5 |
| Manganese | $1.58^{-1}$ | 0.4 | $7.95^{-2}$ | 32 | $1.89^{-2}$ | 0.37 | 2.402 | 120 | $1.89^{-2}$ to 2.40 | 0.37 to 120 |
| Sulfide | $2.83^{-1}$ | 0.6 | $9.02^{-3}$ | 3.6 | $1.25^{-1}$ | 2.44 | 1.241 | 62 | $6.97^{-4}$ to 1.241 | 0.6 to 62 |
| Zinc | - | - | - | - | - | - | - | - | $1.51^{-2}$ to $1.07^{-1}$ | 8.3 to 100 |

AVERAGE GROSS EFFLUENT WASTE LOAD

| Parameters | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 4982 | - | 298 | - | 6139 | - | 147 | - | 0 to 6139 | |
| Suspended solids | $9.42^{-1}$ | 22 | 1.310 | 526 | 1.997 | 39 | 1.55 | 1262 | 0 to 1.99 | 0 to 1262 |
| Oil and Grease | $1.45^{-1}$ | 35 | $6.51^{-2}$ | 26.2 | $1.690^{-1}$ | 3.3 | $1.110^{-2}$ | 9 | 0 to $1.69^{-1}$ | 0 to 35 |
| pH | 9.1 | - | 9.5 | - | 9.2 | - | 8.1 | - | 8.1 to 9.5 | |
| Fluoride | $1.828^{-1}$ | 4.4 | $3.976^{-2}$ | 16 | 2.151 | 42 | $4.57^{-2}$ | 36.8 | 0 to 2.15 | 0 to 59 |
| Lead | - | - | - | - | - | - | - | - | 0 to $4.39^{-2}$ | 0 to 45 |
| Manganese | $1.579^{-2}$ | 0.38 | $7.953^{-2}$ | 32 | $2.304^{-2}$ | 0.45 | $1.480^{-1}$ | 119.9 | 0 to $1.48^{-1}$ | 0 to 120 |
| Sulfide | $2.909^{-2}$ | 0.7 | $9.022^{-3}$ | 3.63 | $1.705^{-1}$ | 3.33 | $5.432^{-2}$ | 44.3 | 0 to $1.70^{-1}$ | 0 to 44.3 |
| Zinc | - | - | - | - | - | - | - | - | 0 to $1.26^{-1}$ | 0 to 100 |

TABLE 12
(continued)
WATER EFFLUENT TREATMENT COSTS FOR FOUNDRIES

Melting Operations

| | CCC-2 | DDD-2 | EEE-2 | GGG-2 | Range |
|---|---|---|---|---|---|
| Initial Investment (1971 $) | $ 9,161 | $105,000 | $ 21,621 | $225,000 | 9161-225,000 |
| Annual Costs | | | | | |
| Operating Labor | 381 | 900 | 1,152 | 12,570 | |
| Utilities | 10,448 | 3,525 | 14,149 | 3,445 | |
| Maintenance | 801 | 3,700 | 3,459 | 8,034 | |
| Depreciation | 916 | 10,500 | 2,162 | 22,500 | |
| Cost of Capital | 384 | 4,410 | 908 | 9,450 | |
| Other | | | | | |
| Total | 12,930 | 23,035 | 21,830 | 55,999 | |
| 1972 Tons Product | 4,194 | 3,060 | 13,750 | 6,300 | |
| $/Ton | 3.09 | 7.53 | 1.59 | 8.88 | 1.59-11.68 |
| 1000 gal treated | $1.104 \times 10^3$ | 432 | $13.8 \times 10^3$ | $2.88 \times 10^3$ | |
| $/1000 gal treated | $11.72 | $53.32 | $1.58 | $19.44 | 0.77-54.06 |

AVERAGE NET RAW WASTE LOAD

| Parameters | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 3360 | - | 2314 | - | 3081 | - | 788 | - | 788 to 19,534 | |
| Suspended solids | 1.422 | 236 | $6.949^{-1}$ | 648 | 3.39 | 268 | 4.03 | 403 | $6.95^{-1}$ to 26.02 | 21 to 1300 |
| Oil and Grease | $4.515^{-2}$ | 7.5 | $2145^{-3}$ | 2 | Neg | - | $2.00^{-2}$ | 3.0 | $2.15^{-3}$ to $6.29^{-2}$ | 2 to 25.3 |
| pH | 9.1 | - | 8.1 | - | 7.2 | - | 11 | - | 7.2 to 11 | |
| Fluoride | $3.555^{-1}$ | 59 | $5.040^{-2}$ | 47 | $5.49^{-1}$ | 433 | Neg | - | | |
| Lead | $2.081^{-1}$ | 44.5 | $4.397^{-2}$ | 41 | $1.22^{-2}$ | 9.6 | - | - | $1.22^{-2}$ to $2.68^{-1}$ | 9.6 to 44.5 |
| Manganese | $3.600^{-2}$ | 5.99 | $8.043^{-2}$ | 75 | $4.69^{-2}$ | 37 | $1.43^{-1}$ | 14.7 | $1.89^{-2}$ to 2.40 | 0.37 to 120 |
| Sulfide | $1.289^{-1}$ | 21.3 | $5.630^{-3}$ | 5.25 | $6.97^{-4}$ | 0.55 | Neg | - | $6.97^{-4}$ to 1.241 | 0.6 to 62 |
| Zinc | $1.264^{-1}$ | 21.0 | $1.072^{-1}$ | 100 | $1.51^{-2}$ | 11.8 | $8.18^{-2}$ | 8.29 | $1.51^{-2}$ to $1.07^{-1}$ | 8.3 to 100 |

AVERAGE GROSS EFFLUENT WASTE LOAD

| Parameters | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 168 | - | 128 | - | ZERO DISCHARGE | | ZERO DISCHARGE | | 0 to 6139 | |
| Suspended solids | 1.422 | 236 | $6.949^{-1}$ | 648 | | | | | 0 to 1.99 | 0 to 1262 |
| Oil and Grease | $4.515^{-2}$ | 7.5 | $2.145^{-3}$ | 2 | | | | | 0 to $1.69^{-1}$ | 0 to 35 |
| pH | 9.1 | - | 8.1 | - | | | | | 8.1 to 9.5 | |
| Fluoride | $3.555^{-1}$ | 59 | $5.040^{-2}$ | 47 | | | | | 0 to 2.15 | 0 to 59 |
| Lead | $2.681^{-1}$ | 44.5 | $4.397^{-2}$ | 41 | | | | | 0 to $4.39^{-2}$ | 0 to 45 |
| Manganese | $3.606^{-2}$ | 5.99 | $8.043^{-2}$ | 75 | | | | | 0 to $1.48^{-1}$ | 0 to 120 |
| Sulfide | $1.289^{-1}$ | 21.3 | $5.630^{-3}$ | 5.25 | | | | | 0 to $1.70^{-1}$ | 0 to 44.3 |
| Zinc | $1.204^{-1}$ | 21.0 | $1.072^{-1}$ | 100 | | | | | 0 to $1.26^{-1}$ | 0 to 100 |

TABLE 13

WATER EFFLUENT TREATMENT COSTS FOR FOUNDRIES

Molding and Cleaning Dust Collection Operations

| | WW-2 | DDD-2 | HHH-2A | | Range |
|---|---|---|---|---|---|
| Initial Investment (1971 $) | $ 25,000 | $ 41,989 | $ 268,632 | | 25,000 to 268,000 |
| Annual Costs | | | | | |
| Operating Labor | 0 | 580 | 17,544 | | 0 to 17,544 |
| Utilities | 2,625 | 9,211 | 24,900 | | 9,211 to 25,000 |
| Maintenance | 875 | 2,156 | 26,316 | | 875 to 26,316 |
| Depreciation | 2,500 | 4,199 | 26,863 | | 2500 to 26,863 |
| Cost of Capital | 1,050 | 1,763 | 11,282 | | |
| Other | 0 | 0 | 0 | | |
| Total | 7,050 | 17,909 | 106,905 | | 7,000 to 106,900 |
| 1972 Tons Product | 88,000 | 3,060 | 80,000 | | 3,000 to 88,000 |
| $/Ton | 0.080 | 5.85 | 1.34 | | 0.08 to 5.85 |
| 1000 gal treated | $3.6 \times 10^{4}$ | $3.456 \times 10^{2}$ | $1.58 \times 10^{4}$ | | |
| $/1000 gal treated | 0.196 | 51.82 | 6.75 | | 0.19 to 52 |

AVERAGE NET RAW WASTE LOAD

| Parameters | #/ton* | mg/l | #/ton* | mg/l | #/ton* | mg/l | #/ton | mg/l | #/ton | mg/l |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 60 | - | 1870 | - | 347 | - | | | 60 to 1870 | |
| Suspended solids | 2.69 | 5380 | $2.537^{-2}$ | 82 | 19.11 | 6600 | | | $2.5^{-2}$ to 19 | 82 to 6600 |
| Oil and Grease | $7.50^{-2}$ | 150 | $6.336^{-4}$ | 2 | $6.66^{-2}$ | 23 | | | $6.3^{-4}$ to $7.5^{-2}$ | 2 to 150 |
| pH | 7.5 | - | 7.5 | - | 7.8 | - | | | 7.5 to 7.8 | |
| Fluoride | $1.50^{-4}$ | 0.3 | $5.861^{-4}$ | 1.85 | $3.76^{-2}$ | 13 | | | $1.5^{-4}$ to $3.7^{-2}$ | 0.3 to 13 |
| Lead | - | - | - | - | $1.82^{-3}$ | 0.63 | | | $1.82^{-3}$ | 0.63 |
| Manganese | $1.20^{-3}$ | 2.4 | $5.386^{-5}$ | 0.17 | $1.708^{-2}$ | 5.9 | | | $5.3^{-5}$ to $1.7^{-2}$ | 0.17 to 5.9 |
| Sulfide | $1.000^{-5}$ | <0.02 | $1.84^{-3}$ | 5.8 | $1.447^{-3}$ | <0.5 | | | $1.0^{-5}$ to $1.8^{-3}$ | 0.02 to 5.8 |
| Zinc | - | - | - | - | $9.55^{-3}$ | 3.3 | | | $9.5^{-3}$ | 3.3 |

AVERAGE GROSS EFFLUENT WASTE LOAD

| Parameters | #/ton* | mg/l | #/ton* | mg/l | #/ton* | mg/l | #/ton | mg/l | #/ton | mg/l |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 48 | - | 37.4 | - | Zero Discharge | | | | 0 to 48 | |
| Suspended solids | 5.152 | 12800 | $1.514^{-2}$ | 82 | | | | | 0 to 5.15 | 0 to 12,800 |
| Oil and Grease | $5.52^{-2}$ | 138 | $3.694^{-4}$ | 2 | | | | | 0 to $5.5^{-2}$ | 0 to 138 |
| pH | 7.6 | - | 7.4 | - | | | | | 7.4 to 7.6 | |
| Fluoride | $4.80^{-4}$ | 0.3 | $3.417^{-4}$ | 1.85 | | | | | 0 to $4.8^{-4}$ | 0 to 1.85 |
| Lead | - | - | - | - | | | | | - | |
| Manganese | $3.364^{-3}$ | 2.1 | $3.14^{-5}$ | 0.17 | | | | | 0 to $3.3^{-3}$ | 0 to 2.1 |
| Sulfide | $<3.2^{-5}$ | <0.02 | $1.064^{-2}$ | 5.8 | | | | | 0 to $1.0^{-2}$ | 0 to 5.8 |
| Zinc | - | - | - | - | | | | | - | |

*Sand used/day

TABLE 14

WATER EFFLUENT TREATMENT COSTS FOR FOUNDRIES

Sand Washing Operations

| | FFF-2 | | | | Range |
|---|---|---|---|---|---|
| Initial Investment (1971 $) | $174,769 | | | | |
| Annual Costs | | | | | |
| Operating Labor | 10,400 | | | | |
| Utilities | 4,755 | | | | |
| Maintenance | 14,568 | | | | |
| Depreciation | 17,477 | | | | |
| Cost of Capital | 7,340 | | | | |
| Other | | | | | |
| Total | 54,540 | | | | |
| 1972 Tons Product | 7,360 | | | | |
| $/Ton | 7.41 | | | | |
| 1000 gal treated | $8.832 \times 10^3$ | | | | |
| $/1000 gal treated | 6.18 | | | | |

AVERAGE NET RAW WASTE LOAD

| Parameters | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | |
|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 1200 | - | | | | | | | |
| Suspended solids | 16.41 | 8199 | | | | | | | |
| Oil and Grease | $3.53^{-2}$ | 17.6 | | | | | | | |
| pH | 6.3 | - | | | | | | | |
| Fluoride | $1.19^{-2}$ | 6.0 | | | | | | | |
| Lead | $3.89^{-3}$ | 1.94 | | | | | | | |
| Manganese | $7.09^{-3}$ | 3.54 | | | | | | | |
| Sulfide | Neg. | Neg. | | | | | | | |
| Zinc | $8.58^{-3}$ | 4.3 | | | | | | | |

AVERAGE GROSS EFFLUENT WASTE LOAD

| Parameters | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | |
|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 1200 | - | | | | | | | |
| Suspended solids | 2.201 | 1100 | | | | | | | |
| Oil and Grease | $3.803^{-3}$ | 19 | | | | | | | |
| pH | 6.3 | - | | | | | | | |
| Fluoride | 1.501 | 7.5 | | | | | | | |
| Lead | $3.203^{-3}$ | 1.6 | | | | | | | |
| Manganese | $5.604^{-3}$ | 2.8 | | | | | | | |
| Sulfide | $1.601^{-3}$ | 0.8 | | | | | | | |
| Zinc | $6.605^{-3}$ | 3.3 | | | | | | | |

TABLE 15

WATER EFFLUENT TREATMENT COSTS FOR FOUNDRIES

Multiple Operations

| | VV-2 | YY-2 | ZZ-2 | AAA-2 | Range |
|---|---|---|---|---|---|
| Initial Investment (1971 $) | $87,960 | $109,200 | $ 707,190 | $ 329,500 | 87,000-1,668,000 |
| Annual Costs | | | | | |
| Operating Labor | 0 | 32,000 | 18,043 | 42,187 | 0-73,000 |
| Utilities | 7,410 | 13,540 | 30,948 | 41,968 | |
| Maintenance | 0 | 9,630 | 3,617 | 26,153 | |
| Depreciation | 8,796 | 10,920 | 70,719 | 32,950 | |
| Cost of Capital | 3,694 | 4,590 | 29,701 | 13,844 | |
| Other | 0 | | 1,407 | 1,743 | |
| Total | 19,900 | 70,680 | 154,435 | 158,847 | 19,900-494,000 |
| 1972 Tons Product | 100,237 | 37,103 | 15,600 | 145,708 | |
| $/Ton | 0.198 | 1.90 | 9.90 | 1.09 | 0.33-9.90 |
| 1000 gal treated | $4.025 \times 10^5$ | $1.435 \times 10^3$ | $5.225 \times 10^4$ | $1.053 \times 10^5$ | |
| $/1000 gal treated | 0.0494 | 49.25 | 2.955 | 1.508 | 0.04-49.25 |

AVERAGE NET RAW WASTE LOAD

| Parameters | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 1014 | - | 32.3 | - | 389 | - | 322 | - | 32 to 1884 | |
| Suspended solids | $5.673^{-1}$ | 226 | $3.446^{-1}$ | 1280 | 17.77 | 4679 | 1.740 | 4504 | $3.4^{-1}$ to 127 | 226 to 22,700 |
| Oil and Grease | $1.024^{-1}$ | 40.8 | $2.446^{-3}$ | 9.1 | $2.385^{-2}$ | 6.28 | $7.496^{-3}$ | 19.4 | $2.44^{-3}$ to $8.25^{-1}$ | 6 to 47 |
| pH | 7.5 | - | 7.5 | - | 8.1 | - | 7.6 | - | 7.5 to 8.8 | |
| Fluoride | $2.284^{-4}$ | 0.091 | $1.064^{-3}$ | 3.9 | $4.789^{-4}$ | 0.126 | $6.955^{-4}$ | 1.8 | $2.28^{-4}$ to $5.09^{-1}$ | 0.09 to 29 |
| Lead | - | - | - | - | $1.851^{-5}$ | 0.005 | - | - | $1.85^{-5}$ to 3.96 | 0.005 to 226 |
| Manganese | $8.033^{-4}$ | 0.32 | $1.075^{-2}$ | 40 | $8.672^{-3}$ | 2.28 | $2.782^{-3}$ | 7.2 | $8.03^{-4}$ to 1.89 | 0.32 to 108 |
| Sulfide | $5.020^{-5}$ | <0.02 | $1.532^{-3}$ | 5.7 | $3.618^{-5}$ | 0.009 | $4.327^{-4}$ | 1.12 | $3.62^{-5}$ to $6.85^{-2}$ | 0.009 to 9.6 |
| Zinc | - | - | - | - | $1.103^{-2}$ | 2.90 | - | - | $4.45^{-3}$ to 21.8 | 1.4 to 1244 |

AVERAGE GROSS EFFLUENT WASTE LOAD

| Parameters | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 301 | - | 32.3 | - | 389 | - | 322 | - | | |
| Suspended solids | $4.312^{-1}$ | 16 | $1.213^{-2}$ | 45 | $2.404^{-1}$ | 29.6 | $1.081^{-2}$ | 28 | 0 to $4.31^{-1}$ | 0 to 46 |
| Oil and Grease | $5.390^{-2}$ | 2 | $4.583^{-4}$ | 1.7 | $3.005^{-2}$ | 3.7 | $6.955^{-4}$ | 1.8 | 0 to $3.00^{-2}$ | 0 to 9 |
| pH | 7.6 | - | 7.5 | | 7.5 | - | 7.4 | - | 7.4 to 8.7 | |
| Fluoride | $4.851^{-3}$ | 0.18 | $2.426^{-3}$ | 9 | $3.950^{-4}$ | 0.49 | $8.114^{-4}$ | 2.1 | 0 to $1.20^{-2}$ | 0 to 9 |
| Lead | - | - | - | - | $<4.061^{-4}$ | <0.05 | - | - | 0 to $4.0^{-4}$ | 0 to 0.9 |
| Manganese | $1.886^{-3}$ | 0.07 | $8.357^{-4}$ | 3.1 | $1.299^{-3}$ | 0.16 | $4.637^{-5}$ | 0.12 | 0 to $1.30^{-3}$ | 0 to 3.1 |
| Sulfide | $5.390^{-4}$ | 0.02 | $1.105^{-3}$ | 4.1 | $1.462^{-3}$ | 0.18 | $<7.728^{-5}$ | <0.2 | 0 to $9.40^{-3}$ | 0 to 23 |
| Zinc | - | - | - | - | $4.061^{-4}$ | 0.053 | - | - | 0 to $1.43^{-3}$ | 0 to 3.5 |

TABLE 15
(continued)
WATER EFFLUENT TREATMENT COSTS FOR FOUNDRIES

Multiple Operations

| | AAA-2A | AAA-2B | HHH-2 | HHH-2A & 2B | Range |
|---|---|---|---|---|---|
| Initial Investment (1971 $) | $ 345,540 | $291,368 | $ 541,474 | $1,668,283 | 87,000 - 1,168,000 |
| Annual Costs | | | | | |
| Operating Labor | 0 | 31,966 | 17,544 | 73,029 | 0 - 73,000 |
| Utilities | 19,050 | 24,101 | 45,684 | 118,414 | |
| Maintenance | 2,144 | 8,909 | 35,088 | 65,790 | |
| Depreciation | 34,554 | 29,137 | 54,147 | 166,828 | |
| Cost of Capital | 14,512 | 12,237 | 22,742 | 70,068 | |
| Other | 0 | 0 | 0 | 0 | |
| Total | 76,260 | 106,350 | 175,505 | 494,129 | 19,900 - 494,000 |
| 1972 Tons Product | 210,706 | 69,768 | 60,000 | 118,000('73) | |
| $/Ton | 0.333 | 1.52 | 2.925 | 4.19 | 0.33 - 9.90 |
| 1000 gal treated | $3.917 \times 10^5$ | $5.107 \times 10^4$ | $4.608 \times 10^4$ | $2.6 \times 10^4$ | |
| $/1000 gal treated | 0.180 | 2.08 | $3.808^{-3}$ | 19.04 | 0.04 - 49.25 |

AVERAGE NET RAW WASTE LOAD

| Parameters | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 1938 | - | 381 | - | 270 | - | 1884 | - | 32 to 1884 | |
| Suspended solids | 56.0 | 5891 | 72.26 | 22,700 | 127.3 | 7250 | 10.80 | 1569 | $3.4^{-1}$ to 127 | 226 to 22,700 |
| Oil and Grease | $7.606^{-2}$ | 8.0 | $1.337^{-1}$ | 42 | $8.255^{-1}$ | 47 | $4.131^{-2}$ | 6 | $2.44^{-3}$ to $8.25^{-1}$ | 6 to 47 |
| pH | 7.6 | - | 7.8 | - | 8.5 | - | 8.8 | - | 7.5 to 8.8 | |
| Fluoride | $3.232^{-2}$ | 3.4 | $1.082^{-2}$ | 3.4 | $5.093^{-1}$ | 29 | $1.308^{-1}$ | 19 | $2.28^{-4}$ to $5.09^{-1}$ | 0.09 to 29 |
| Lead | - | - | $1.337^{-3}$ | 0.42 | 3.969 | 226 | $1.101^{-1}$ | 16 | $1.85^{-5}$ to 3.96 | 0.005 to 226 |
| Manganese | $1.521^{-2}$ | 1.6 | $1.082^{-2}$ | 3.4 | 1.893 | 108 | $1.789^{-1}$ | 26 | $8.03^{-4}$ to 1.89 | 0.32 to 108 |
| Sulfide | $4.753^{-3}$ | 0.5 | $3.050^{-2}$ | 9.6 | $6.850^{-2}$ | 3.9 | $1.858^{-2}$ | 2.7 | $3.62^{-5}$ to $6.85^{-2}$ | 0.009 to 9.6 |
| Zinc | - | - | $4.450^{-3}$ | 1.4 | 21.849 | 1244 | $1.927^{-1}$ | 28 | $4.45^{-3}$ to 21.8 | 1.4 to 1244 |

AVERAGE GROSS EFFLUENT WASTE LOAD

| Parameters | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | #/ton | mg/l | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Flow gal/ton | 1938 | - | 381 | - | 264 | - | NO DISCHARGE | | | |
| Suspended solids | $1.221^{-2}$ | 6.3 | $6.138^{-2}$ | 46 | $5.311^{-3}$ | 13 | | | 0 to $4.31^{-1}$ | 0 to 46 |
| Oil and Grease | $1.745^{-2}$ | 9 | $8.006^{-3}$ | 6 | $1.430^{-3}$ | 3.5 | | | 0 to $3.00^{-2}$ | 0 to 9 |
| pH | 8.1 | - | 8.7 | - | 7.7 | - | | | 7.4 to 8.7 | |
| Fluoride | $1.202^{-1}$ | 6.2 | $1.161^{-3}$ | 0.87 | $1.178^{-2}$ | 7.88 | | | 0 to $1.20^{-2}$ | 0 to 9 |
| Lead | - | - | - | - | $3.799^{-4}$ | 0.93 | | | 0 to $4.0^{-4}$ | 0 to 0.9 |
| Manganese | $2.714^{-4}$ | 0.14 | $1.870^{-4}$ | 0.14 | $8.784^{-4}$ | 2.15 | | | 0 to $1.30^{-3}$ | 0 to 3.1 |
| Sulfide | $<9.694^{-4}$ | <0.5 | $1.134^{-3}$ | 0.85 | $9.40^{-3}$ | 23 | | | 0 to $9.40^{-3}$ | 0 to 23 |
| Zinc | - | - | - | - | $1.43^{-3}$ | 3.5 | | | 0 to $1.43^{-3}$ | 0 to 3.5 |



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Molding and Dust Collection Operations

Base Level of Treatment. Implementation of good housekeeping practices with settling and periodic solids removal. Once-through use of water.

Additional Power Requirements. In order to meet the anticipated standard the emissions from the molding and cleaning dust collection operations will require additional equipment for the wastewater treatment system. The additional energy consumed will be 2.77 kwh/kkg (2.52 kwh/ton) of sand processed. For the typical 290.2 kkg/day (320 tons/day) molding and cleaning dust collection operations, 33.6 kw (45 hp) will have to be added. The annual operating cost for the additional equipment will be $3,375.

Non-Water Quality Aspects.

1. Air Pollution: The main air pollution problem will be suspended particulate matter. Although the exhaust gases will be passed through a wash, 0.1 kkg of particulate emission per kkg (lb/1,000 lb) of exhaust gas will be emitted into the atmosphere.

2. Solid Waste Disposal: A portion of the solid waste from the waste system may be collected and recycled to the melting operations and the remainder may be clamshelled and landfilled.

Sand Washing Operations

Base Level of Treatment. Implementation of good housekeeping practices with treatment of wastewater in settling tank with period solids removal. Once-through use of water.

Additional Power Requirements. Additional equipment will be required in order to meet the anticipated standard of 1977 for the sand washing operations. The additional energy consumed will be 12.3 kwh/kkg (11.2 kwh/ton) of metal produced. 18.6 kw (25 hp) will have to be added to the typical 36.3 kkg/day (40 ton/day) sand washing operations. The annual operating cost for the additional equipment will be $1,875.

Non-Water Quality Aspects.

1. Solid Waste Disposal: The solid waste from the waste system may be clamshelled and landfilled.

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## Multiple Operations

Base Level of Treatment. Implementation of good housekeeping practices combining wastewater from all systems in a common settling tank, with periodic solids removal. Once-through use of water.

Additional Power Requirements. In order to meet the anticipated standard utilizing a wet system in cleaning the emissions from the multiple foundry operations will require additional equipment for the wastewater treatment system. The additional energy consumed will range from 15.1 to 71.8 kwh/kkg (13.7 to 65.2 kwh/ton) of metal produced, depending on the combination of multiple operations used. For the typical 36.3 kkg/day (40 tons/day) foundry multiple operations, 52.2 to 138.0 kw (70 to 185 hp) will have to be added. The annual operating cost for the additional equipment will range from $5,250 to $13,875.

Non-Water Quality Aspects.

1. Air Pollution: The main air pollution problem will be suspended particulate matter. Although the exhaust gases will be passed through a wash, 0.1 kkg of particulate emission per kkg (lbs/1,000 lbs) of exhaust gas will be emitted into the atmosphere.

2. Solid Waste Disposal: A portion of the solid waste may be recycled to the melting system whereas the remainder may be clamshelled and landfilled.

## ADVANCED TECHNOLOGY, ENERGY, AND NON-WATER IMPACT

The energy requirements and non-water quality aspects associated with the advanced treatment technology for each subcategory are discussed below:

## Melting Operations

Additional Power Requirements. Additional equipment will be required to improve the water to meet the anticipated 1983 standard. The additional energy consumption will be 98.7 kwh/kkg (89.5 kwh/ton) of metal produced. The additional power requirements will be 149.2 kw (200 hp) for the typical 36.3 kkg/day (40 ton/day) melting operations. The annual operating cost due to the addition of this equipment will be $15,000.

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Non-Water Quality Aspects.

1. Air Pollution: Same as 1977.
2. Solid Waste Disposal: Same as 1977.

Molding and Cleaning Dust Collection Operations

Additional Power Requirements. Additional equipment will be necessary to improve the quality of the water to meet the 1983 standard. The additional energy consumed will be 9.25 kwh/kkg (8.39 kwh/ton) of metal produced. The additional power requirements will be 111.9 kw (150 hp) for the typical 290.2 kkg/day (320 ton/day) molding and cleaning dust collection operations. The annual operating cost due to the addition of this equipment will be $11,250.

Non-Water Quality Aspects.

1. Air Pollution: Same as 1977.
2. Solid Waste Disposal: Same as 1977.

Sand Washing Operations

Additional Power Requirements. In order to improve the quality of the water to meet the 1983 standard, additional equipment will be necessary. The additional energy consumed will be 98.7 kwh/kkg (89.5 kwh/ton) of metal produced. The additional power requirements will be 149.2 kw (200 hp) for the typical 36.3 kkg/day (40 ton/day) sand washing operations. The annual operating cost due to the addition of this equipment will be $15,000.

Non-Water Quality Aspects.

1. Air Pollution: Same as 1977.
2. Solid Waste Disposal: Same as 1977.

Multiple Operations - Melting and Molding and Cleaning

Additional Power Requirements. Additional equipment will be required to improve the water to meet the anticipated 1983 standard. The additional energy consumption will be 39.5 kwh/kkg (35.8 kwh/ton) of metal produced. The additional power requirements will be 59.7 kw (80 hp) for the typical 36.3 kkg/day (40 ton/day) foundry utilizing melting and molding and cleaning dust collection operations. The annual operating cost due to the addition of this equipment will be $6,000.

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Non-Water Quality Aspects.

1. Air Pollution: Same as 1977.
2. Solid Waste Disposal: Same as 1977.

Multiple Operations - Melting and Sand Washing

Additional Power Requirements. Additional equipment will be required to improve the water to meet the anticipated 1983 standard. The additional energy consumption will be 37.0 kwh/kkg (33.6 kwh/ton) of metal produced. The additional power requirement will be 55.9 kw (75 hp) for the typical 36.3 kkg/day (40 ton/day) foundry with melting and sand washing operations. The annual operating cost due to the addition of this equipment will be $5,625.

Non-Water Quality Aspects.

1. Air Pollution: Same as 1977.
2. Solid Waste Disposal: Same as 1977.

Multiple Operations - Molding and Cleaning and Sand Washing

Additional Power Requirements. Additional equipment will be required to improve the water to meet the anticipated 1983 standard. The additional energy consumption will be 29.6 kwh/kkg (26.8 kwh/ton) of metal produced. The additional power requirements will be 44.7 kw (60 hp) for the typical 36.3 kkg/day (40 ton/day) foundry with molding and cleaning dust collection and sand washing operations. The annual operating cost due to the addition of this equipment will be $4,500.

Non-Water Quality Aspects.

1. Air Pollution: Same as 1977.
2. Solid Waste Disposal: Same as 1977.

Multiple Operations - All Subcategories

Additional Power Requirements. Additional equipment will be required to improve the water to meet the anticipated 1983 standard. The additional energy consumption will be 49.3 kwh/kkg (44.7 kwh/ton) of metal produced. The additional power requirements will be 74.6 kw (100 hp) for the typical 36.3 kkg/day (40 ton/day) foundry using wet collection systems on all operations. The annual operating cost due to the addition of this equipment will be $7,500.

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Non-Water Quality Aspects.

1. Air Pollution: Same as 1977.
2. Solid Waste Disposal: Same as 1977.

## FULL RANGE OF TECHNOLOGY IN USE OR AVAILABLE TO THE FOUNDRY INDUSTRY

The full range of technology in use or available to the foundry industry today is presented in Tables 16 through 22. In addition to presenting the range of treatment methods available, these tables also describe for each method:

1. Resulting effluent levels for critical constituents
2. Status and reliability
3. Problems and limitations
4. Implementation time
5. Land requirements
6. Environmental impacts other than water
7. Solid waste generation

## BASIS OF COST ESTIMATES

Costs associated with the full range of treatment technology including investment, capital depreciation, operating and maintenance, and energy and power are presented on water effluent cost tables corresponding to the appropriate category technology Tables 16 through 22.

Costs were developed as follows:

1, National annual production rate data was collected and tabulated along with the number of plants in each subcategory. From this, an "average" size plant was established.

2. Flow rates were established based on the data accumulated during the survey portion of this study and from knowledge of what flow reductions could be obtained with minor modifications. The flow is here expressed in l/kkg or gal./ton of product.

3. Then a treatment process model and flow diagram was developed for each subcategory.

This was based on knowledge of how most industries in a certain subcategory handle their wastes, and on the flow rates established by 1 and 2 above.

4. Finally, a quasi-detailed cost estimate was made on the developed flow diagram.

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Total annual costs in August, 1971 dollars were calculated on total operating costs (including all chemicals, maintenance, labor, energy, and power) and the capital recovery costs. Capital recovery costs were then subdivided into straight-line ten-year depreciation and the cost of capital at a 7% annual interest rate for ten years.

The capital recovery factor (CRF) is normally used in industry to help allocate the initial investment and the interest to the total operating cost of a facility. The CRF is equal to i plus i divided by a -1, where a is equal to (1 + i) to the power n. The CRF is multiplied by the initial investment to obtain the annual capital recovery. That is: (CRF) (P) = ACR. The annual depreciation is found by dividing the initial investment by the depreciation period (n = 10 years). That is: P/10 = annual depreciation. Then the annual cost of capital has been assumed to be the total annual capital recovery minus the annual depreciation. That is: ACR - P/10 = annual cost of capital.

Construction costs are dependent upon many different variable conditions and in order to determine definitive costs the following parameters are established as the basis of estimates. In addition, the cost estimates as developed reflect only average costs.

1. The treatment facilities are contained within a "battery limit" site location and are erected on a "green field" site. Site clearance costs such as existing plant equipment relocation, etc., are not included in cost estimates.

2. Equipment costs are based on specific effluent water rates. A change in water flow rates will affect costs.

3. The treatment facilities are located in close proximity to the foundry processing areas. Piping and other utility costs for interconnecting utility runs between the treatment facilities battery limits and process equipment areas are not included in cost estimates.

4. Sales and use taxes or freight charges are not included in cost estimates.

5. Land acquisition costs are not included in cost estimates.

6. Expansion of existing supporting utilities such as sewage, river water pumping stations, increased boiler capacity are not included in cost estimates.

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7. Potable water, fire lines, and sewage lines to service treatment facilities are not included in cost estimates.

8. Limited instrumentation has been included for pH control, but no automatic samplers, temperature indicators, flow meters, recorders, etc., are included in cost estimates.

9. The site conditions are based on:

a. No hardpan or rock excavation, blasting. etc.

b. No pilings or spread footing foundations for poor soil conditions.

c. No well pointing.

d. No dams, channels, or site drainage required.

e. No cut and fill or grading of site.

f. No seeding or planting of grasses and only minor site grubbing and small shrubs clearance; no tree removal.

10. Control buildings are prefabricated buildings, not brick or block type.

11. No painting, pipe insulation, and steam or electric heat tracing are included.

12. No special guardrails, buildings, lab test facilities, signs, docks are included.

Other factors that affect costs but cannot be evaluated:

1. Geographic location in United States.

2. Metropolitan or rural areas.

3. Labor rates, local union rules, regulations, and restrictions.

4. Manpower requirements.

5. Type of contract.

6. Weather conditions or season.

7. Transportation of men, materials, and equipment.

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8. Building code requirements.

9. Safety requirements.

10. General business conditions.

The cost estimates do reflect an on-site "battery limit" treatment plant with electrical substation and equipment for powering the facilities, all necessary pumps, treatment plant interconnecting feed pipe lines, chemical treatment facilities, foundations, structural steel, and control house. Access roadways within battery limits area are included in estimates based upon 3.65 cm (1.5 in.) thick bituminous wearing course and 10 cm (4 in.) thick sub-base with sealer, binder, and gravel surfacing. A nine gage chain link fence with three strand barbed wire and one truck gate was included for fencing in treatment facilities area.

The cost estimates also include a 15% contingency, 10% contractor's overhead and profit, and engineering fees of 15%.

TABLE 16
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Melting Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|---|
| A. Wastewater from furnace emission control system collected in water separator with minimal suspended solid removal followed by direct discharge. Once-through water usage.<br>Wastewater from slag quenching collected in slag quench pit (drag tank) minimal suspended solids removal followed by direct discharge. Once-through water usage. | pH<br>SS<br>O&G<br>Pb<br>Mn<br>Zn<br>$S^{--}$<br>F | 5-9<br>3000-5000<br>10-60<br>10-500<br>10-400<br>10-2000<br>5-50<br>15-90 | Ineffective if not maintained | Gross discharge of solids | 1 month | 10' x 10' | Solid waste disposal | Silica and iron oxide |
| A-1 Common collection of all raw waste for solids removal and direct discharge. Once-through usage. | | | | | | | | |
| B. Same as A with effluents from air water separator discharged to settling tank with weir overflow for improved suspended solids removal. Overflow to direct discharge solids removed periodically. | pH<br>SS<br>O&G<br>Pb<br>Mn<br>Zn<br>$S^{--}$<br>F | 5-9<br>200-1500<br>10-40<br>5-100<br>5-200<br>10-500<br>5-50<br>15-70 | Erratic performance if flow fluctuates | Same as A | 2 months | 30' x 30' | Same as A | Same as A |

*Listed in order of increasing effectiveness

TABLE 16 (cont.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Melting Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|---|
| C. Same as B with partial recycle of settling tank effluent back to furnace emission control system. Caustic or lime addition for corrosion control. High solids underflow continuously discharged to drag tank for dewatering.<br><br>Same as B with partial recycle of slag quench drag tank effluent back to slag quench system.<br><br>Effluents from slag quench drag tank, and settling tank overflow combined for direct discharge. | pH<br>SS<br>O&G<br>Pb<br>Mn<br>Zn<br>$S^{--}$<br>F | 6-9<br>150-700<br>10-40<br>5-40<br>5-50<br>10-50<br>5-25<br>15-45 | Fair - same as in B. Significant solids reduction. | Requires continuous removal of solids. Requires instrumentation for chemical addition | 6 months | 60' x 60' | Increase in solid waste for disposal | Solid waste contains less water |
| D. Same as C with addition of polyelectrolyte to furnace emission control system settling tank for improved suspended solids removal.<br><br>Same as C with all the effluent from the slag quench discharge incorporated with or used as makeup water applied to furnace emission control system. This affects a zero aqueous discharge from the slag quench process. | pH<br>SS<br>O&G<br>Pb<br>Mn<br>Zn<br>$S^{--}$<br>F | 6-9<br>50-250<br>10-30<br>5-20<br>5-25<br>5-35<br>5-25<br>5-45 | Fair to good - significant reduction in solids. Tends to be stable | Same as C - requires additional chemicals | 6 months | 100' x 100' | Same as C | Same as C |

TABLE 16 (cont.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Melting Operation

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| D-1 Same as A-1 with discharge of all raw waste from slag quench and furnace emission control discharged to large drag tank for solid removal. Addition of caustic or lime for corrosion control. Polyelectrolyte addition for improved solids removal. Partial recycle of drag tank effluent to slagging and emission control systems. | | | | | | | |
| E. Same as D with discharge to common settling basin for further solids removal. Oil skimming followed by direct discharge. | pH 6-9<br>SS 40<br>O&G 15<br>Pb 1.6<br>Mn 5<br>Zn 5<br>$S^{--}$ 2<br>F 20 | Good - shows considerable stability at constant flow | Requires large capacity. Requires maintenance and frequent solids removal | 6 months to 1 year | 1/8 - 3 acres | Same as C | Same as C |
| F. Same as E with addition of recirculating sidestream chemical treatment, settling tank, degritter, clarification and/or filtration for further solids removal thus upgrading the quality of the discharge stream. Complete recycle of the effluent from settling basin. Discharge of sidestream effluent blowdown or back wash thus affecting a | pH 6-9<br>SS 25<br>O&G 10<br>Pb 1<br>Mn 3<br>Zn 3<br>$S^{--}$ 1.25<br>F 12.5 | Very good - little tendency to upset | Requires close control and increased maintenance | 6 months to 1 year | Same as E | Same as C | Same as C |



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TABLE 16 (cont.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Melting Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| significant reduction in volume of wastewater discharged. Discharge of slide line effluent to polyelectrolyte or other coagulant addition follow by flash mixing, clarification and direct discharge. | | | | | | | |
| G. Same as B with complete recycle of wastewater and zero aqueous discharge. Requires sufficient detention time for settling of solids and equilibration of wastewater. Caustic addition for corrosion control. | | Very good - zero discharge | Requires large area | 6 months to 1 year | Same as C | Same as C | Same as C |



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TABLE 16

WATER EFFLUENT TREATMENT COSTS
FOUNDRY INDUSTRY

MELTING SUBCATEGORY

| Treatment of Control Technologies Identified under Item III of the Scope of Work: | A | B | BATEA C | BATEA D | BATEA E | BATEA F |
|---|---|---|---|---|---|---|
| Investment | | $211,800 | $121,500 | $ 29,200 | $ 18,300 | $198,000 |
| Annual Costs: | | | | | | |
| Capital | | 9,100 | 5,200 | 1,300 | 800 | 8,500 |
| Depreciation | | 21,200 | 12,100 | 2,900 | 1,800 | 19,800 |
| Operation & Maintenance | | 7,400 | 4,300 | 1,000 | 600 | 6,900 |
| Sludge Disposal | | | 1,300 | | | |
| Energy & Power | | | 7,500 | 800 | 400 | 15,000 |
| Oil Disposal | | | | | 700 | |
| Chemical Costs | | | 100 | 2,000 | | 200 |
| TOTAL | | $37,700 | $ 30,500 | $ 8,000 | $ 4,300 | $50,400 |

| Effluent Quality: Effluent Constituents Parameters - units | Resulting Effluent Levels | | | | | |
|---|---|---|---|---|---|---|
| Flow, gal./ton | 6000 | 6000 | 1700 | 1500 | 1500 | 300 |
| Suspended Solids, mg/l | 3000-5000 | 200-1500 | 150-700 | 50-250 | 40 | 25 |
| Oil and Grease, mg/l | 10-60 | 10-40 | 10-40 | 10-30 | 15 | 10 |
| Fluoride, mg/l | 15-90 | 15-70 | 15-45 | 5-45 | 20 | 12.5 |
| Manganese, mg/l | 10-400 | 5-200 | 5-50 | 5-25 | 5 | 3 |
| Lead, mg/l | 10-500 | 5-100 | 5-40 | 5-20 | 1.6 | 1.0 |
| Zinc, mg/l | 10-2000 | 10-500 | 10-50 | 5-35 | 5 | 3 |
| Sulfide, mg/l | 5-50 | 5-50 | 5-25 | 5-25 | 2 | 1.25 |
| pH, units | 5-9 | 5-9 | 6-9 | 6-9 | 6-9 | 6-9 |

TABLE 17
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Molding and Cleaning Dust Collection Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|---|
| A. Wastewater collected in settling tank or small impoundment for bulk reduction of suspended solids. Solids removed periodically with direct discharge of wastewater. Once-through water usage. | pH<br>SS<br>O&G | 6-8<br>5,000-15,000<br>20-200 | Ineffective if poorly maintained | Gross discharge of solids | 1 month | 30' X 30' | Solid waste disposal | Silica and iron |
| B. Same as A with partial recycle of wastewater. Continuous solids removal by full flow Cyclone separators, drag tank with bottom drag chain or larger impoundment. Addition of caustic or lime for pH control. | pH<br>SS<br>O&G | 6-9<br>1000-6000<br>20-150 | Erratic performance if flow fluctuates | Gross discharge of solids | 2 months | 60' X 60' | Solid waste disposal | Silica and metallic iron |
| C. Same as B with discharge of wastewater to large impoundment for improved solids removal followed by direct discharge. | pH<br>SS<br>O&G<br>F | 6-9<br>80-1000<br>20-50<br>10-20 | Fair to good significant solids reduction | Requires continuous removal of solids and instrumentation for chemical addition | 6 months | 80' X 80' | Additional solid waste disposal | Same as B |
| D. Same as C with addition of polyelectrolyte and flash mixing followed discharge to impoundment. Oil skimming and discharge. | pH<br>SS<br>O&G | 6-9<br>40<br>15 | Good - shows considerable stability of constant flow | Requires large capacity maintaining and frequent solids removal | 6 months to 1 year | 1/8-3 acres | Same as C | Same as B |

*Listed in order of increasing effectiveness

TABLE 17 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Molding and Cleaning Dust Collection Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| E. Same as D with addition of recirculating sidestream chemical treatment. Settling tank, degritting, clarification and or filtration for further solids removal thus upgrading the quality of the discharge stream. 60% return of sidestream flow to dust collection process. Blowdown of sidestream to existing blowdown treatment followed by direct discharge to existing blowdown treatment system. | pH 6-9<br>SS 25<br>O&G 10 | Very good - little tendency towards upset | Requires close control and increased maintainence | 6 months to 1 year | Same as D | Same as C | Same as B |
| F. Same as B with complete recycle of wastewater and zero aqueous discharge requires large impoundment for settling of solids and equalibration of wastewater. | pH --<br>SS --<br>O&G -- | Very good - zero discharge | Requires large area | 6 months to 1 year | Same as D | Same as C | Same as B |



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TABLE 17

WATER EFFLUENT TREATMENT COSTS
FOUNDRY INDUSTRY

MOLDING AND CLEANING DUST COLLECTION SUBCATEGORY

| Treatment of Control Technologies Identified under Item III of the Scope of Work: | | BPCTCA | | | BATEA |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| Investment | $309,100 | $244,000 | $ 24,000 | $ 39,700 | $274,900 |
| Annual Costs: | | | | | |
| Capital | 13,300 | 10,500 | 1,000 | 1,700 | 11,800 |
| Depreciation | 30,900 | 24,400 | 2,400 | 4,000 | 27,500 |
| Operation & Maintenance | 10,800 | 8,500 | 800 | 1,400 | 9,600 |
| Sludge Disposal | | 8,700 | | | |
| Energy & Power | | 2,300 | | 1,100 | 11,300 |
| Oil Disposal | | | | 1,200 | |
| Chemical Costs | | 200 | | 1,600 | |
| TOTAL | $ 55,000 | $ 54,600 | $ 4,200 | $ 11,000 | $ 60,200 |

| Effluent Quality: Effluent Constituents Parameters - units | Resulting Effluent Levels | | | | |
|---|---|---|---|---|---|
| Flow, gal./ton | 1,700 | 300 | 300 | 300 | 100 |
| Suspended Solids, mg/l | 5,000-15,000 | 1,000-6,000 | 80-1,000 | 40 | 25 |
| Oil and Grease, mg/l | 20-200 | 20-150 | 20-50 | 15 | 10 |
| pH, units | 6-8 | 6-9 | 6-9 | 6-9 | 6-9 |

TABLE 18
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Sand Washing Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|---|
| A. Wastewater effluent from product separator discharged to small settling tank with weir overflow, for suspended solids removal followed by direct discharge. Once - through usage. Periodic removal of solids. | pH<br>SS<br>O&G | 6-9<br>1000-2000<br>40-150 | Ineffective if poorly maintained | Gross discharge of solids | 1 month | 30' X 30' | Solid waste disposal | Silica and iron |
| B. Same as A with underflow to drag tank for improved solids removal followed by direct discharge of combined effluents. | pH<br>SS<br>O&G | 6-9<br>300-1000<br>40-150 | Erratic performance if flow fluctuates | Same as A | 2 months | 60' X 60' | Same as A | Same as A |
| C. Same as B with addition of polyelectrolyte to settling tank for improved solids settling; addition of caustic for pH control; partial discharge back to sand washing process. Overflow to direct discharge. | pH<br>SS<br>O&G | 6-9<br>100-300<br>40-150 | Fair to good significant solids reduction | Requires removal of solids and instrumentation for chemical addition | 6 months | 80' X 80' | Additional solid waste disposal | Same as A |
| D. Same as C with discharge to impoundment oil skimming followed by discharge. | pH<br>SS<br>O&G | 6-9<br>40<br>15 | Good shows considerable stability at constant flow | Requires large capacity maintenance and frequent solid removal | 6 months to 1 year | 1/8 to 3 acres | Same as C | Same as A |

*Listed in order of effectiveness



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TABLE 18 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Sand Washing Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| E. Same as D with addition of recirculating side stream chemical treatment. Settling tank, degritter, clarifier, and/or filtration for further solids removal thus upgrading the quality of the discharge stream. 80% return of side-stream flow to sand washing process. Blowdown of side-stream to existing blowdown treatment followed by direct discharge. | pH 6-9<br>SS 25<br>O&G 10 | Very good, little tendency to upset | Requires close control and increased maintenance | 6 months to 1 year | Same as D | Increase in solid waste for disposal | Solid waste contains less water |
| F. Same as B with complete recycle of wastewater and zero aqueous discharge figures large impoundment for settling of solids and equalibration of wastewater.<br><br>Polyelectrolyte addition for improved solids removal and caustic addition for pH control. | pH --<br>SS --<br>O&G -- | Very good, zero discharge | Requires large area | 6 months to 1 year | Same as D | Same as E | Same as E |

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TABLE 18

WATER EFFLUENT TREATMENT COSTS
FOUNDRY INDUSTRY

SAND WASHING SUBCATEGORY

| Treatment of Control Technologies Identified under Item III of the Scope of Work: | | BPCTCA | | | BATEA |
|---|---|---|---|---|---|
| | A | B | C | D | E |
| Investment | $211,800 | $ 17,000 | $ 87,000 | $ 18,300 | $197,300 |
| Annual Costs: | | | | | |
| Capital | 9,100 | 700 | 3,800 | 800 | 8,500 |
| Depreciation | 21,200 | 1,700 | 8,700 | 1,800 | 19,700 |
| Operation & Maintenance | 7,400 | 600 | 3,000 | 600 | 6,900 |
| Sludge Disposal | | 300 | | | |
| Energy & Power | | | 1,500 | 400 | 15,000 |
| Oil Disposal | | | | 1,300 | |
| Chemical Costs | | | 3,000 | | 2,700 |
| TOTAL | $ 37,700 | $ 3,300 | $ 20,000 | $ 4,900 | $ 52,800 |

| Effluent Quality: Effluent Constituents Parameters - units | Resulting Effluent Levels | | | | |
|---|---|---|---|---|---|
| Flow, gal./ton | 3000 | 3000 | 1000 | 1000 | 300 |
| Suspended Solids, mg/l | 1000-2000 | 300-1000 | 100-300 | 40 | 25 |
| Oil and Grease, mg/l | 40-150 | 40-150 | 40-150 | 15 | 10 |
| pH, units | 6-9 | 6-9 | 6-9 | 6-9 | 6-9 |

TABLE 19
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Melting & Molding & Cleaning
Dust Collection Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| A. | | | | | | | |
| I. Wastewater collected in settling tank or small impoundment for bulk reduction of suspended solids. Solids removed with direct discharge of wastewater. Once-through wastewater usage. | pH 5-9<br>SS 3000-5000<br>O&G 10-60<br>Pb 10-500<br>Mn 10-400<br>Zn 10-2000<br>$S^{--}$ 5-50<br>F 15-90 | Ineffective if not maintained | Gross discharge of solids | 1 month | 10' x 10' | Solid waste disposal | Silica iron oxide |
| II. Wastewater collected in settling tank or small impoundment for bulk reduction of suspended solids. Solids removed periodically with direct discharge of wastewater. Once-through water usage. | pH 6-9<br>SS 5000-15000<br>O&G 20-200 | Ineffective if not maintained | Gross discharge of solids | 1 month | 10' x 10' | Solid waste disposal | Silica iron oxide |
| BPCTCA | | | | | | | |
| B. | | | | | | | |
| I. Blowdown from slag quenching operation used as makeup water to furnace emission control system with zero aqueous discharge. Addition of lime or caustic and polyelectrolyte to furnace emission control system recycled wastewater for suspended solids removal with discharge of blowdown to further clarification and oil skimming. | pH 6-9<br>SS 40<br>O&G 15<br>Pb 1.6<br>Mn 5<br>Zn 5<br>$S^{--}$ 2<br>F 20 | Good - shows considerable stability at constant flow | Requires large capacity and maintenance frequent solids removal. | 6 months to 1 year | 1/8 to 3 acres | Increased solid waste disposal | Same as A |

*Listed in order of increasing effectiveness



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TABLE 19 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Melting & Molding & Cleaning
Dust Collection Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| **BPCTCA** | | | | | | | |
| B. II. Addition of lime or caustic and polyelectrolyte to recycled wash water for suspended solids removal with discharge of blowdown to further clarification and oil skimming. | pH 6-9<br>SS 40<br>O&G 15 | Good - shows considerable stability at constant flow | Requires large capacity, maintenance and frequent solids removal | 6 months to 1 year | 1/8 to 3 acres | Increased solid waste disposal | Same as A |
| B[1] Combine discharged effluents from I and II in common discharge. | | | | | | | |
| **BATEA** | | | | | | | |
| C. - I & II | | | | | | | |
| Same as level B but with combining waste streams from I and II for solids removal and oil skimming. Addition of recirculating sidestream chemical treatment, settling tanks, degritters, clarification and/or filtration for further solids removal thus upgrading the quality of the discharge stream. Complete recycle of the effluent from the settling basin back to the unit melting operation and molding and cleaning | pH 6-9<br>SS 25<br>O&G 10<br>Pb <1<br>Mn <3<br>Zn <3<br>$S^{--}$ <1.25<br>F <12.5 | Very good - little tendency to upset | Requires close control and increased maintenance | 6 months to 1 year | Same as BPCTCA | Same as BPCTCA | Same as A |

TABLE 19 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Melting & Molding & Cleaning
Dust Collection Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| BATEA (Cont.) | | | | | | | |
| C. - I & II | | | | | | | |
| dust collection operation. Discharge of sidestream blowdown or backwash to polyelectrolyte addition followed by flash mixing, clarification and discharge. Thus affecting a significant reduction in the waste load and volume of wastewater discharged through the benefits of combined treatment of wastewaters from the two unit operation. | pH 6-9<br>SS 25<br>O&G 10<br>Pb <1<br>Mn <3<br>Zn <3<br>$S^{--}$ <1.25<br>F <12.5 | Very good - little tendency to upset | Requires close control and increased maintenance | 6 months to 1 year | Same as BPCTCA | Same as BPCTCA | Same as A |
| $C^1$ - I & II | | | | | | | |
| Same as level B with discharge of blowdown from unit molding and cleaning dust collection operation discharged to solids separation drag tank of melting operation. Unit molding and cleaning dust collection operation has now affected a zero aqueous discharge as the blowdown wastewater is used as makeup water to unit melting operation. Discharge of unit | pH 6-9<br>SS 25<br>O&G 10<br>Pb <1<br>Mn <3<br>Zn <3<br>$S^{--}$ <1.25<br>F <12.5 | Very good - economical | Requires closer control and increased maintenance | 6 months to 1 year | Same as BPCTCA | Same as BPCTCA | Same as A |

TABLE 19 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Melting & Molding & Cleaning
Dust Collection Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| BATEA (Cont.) | | | | | | | |
| $C^1$ - I & II | | | | | | | |
| melting operation blowdown to further suspended solids removal and oil skimming. Addition of recirculating sidestream chemical treatment, settling tanks, degritter, clarification and/or filtration for further solids removal thus upgrading the quality of the discharge stream. Complete recycle of the effluent from the settling basin back to the unit melting operation and unit molding and cleaning dust collection operation. Discharge of the sidestream blowdown, or backwash to polyelectrolyte addition followed by flash mixing, clarification and discharge. Thus affecting a significant reduction of the waste load and volume of the discharge from the two unit operation through the benefits of combined treatment of the waste from the two unit operation. | pH 6-9<br>SS 25<br>O&G 10<br>Pb <1<br>Mn <3<br>Zn <3<br>$S^{--}$ <1.25<br>F <12.5 | Very good - economical | Requires closer control and increased maintenance | 6 months to 1 year | Same as BPCTCA | Same as BPCTCA | Same as A |



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TABLE 19 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Melting & Molding & Cleaning
Dust Collection Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| D. - I & II<br><br>Discharge of all untreated raw waste to form unit molding and cleaning dust collection operation and unit melting operation to a common settling basin or drag tank. Addition of caustic and lime for pH adjustment. Addition of polyelectrolyte for improved solids removal and oil skimming with complete recycle and zero aqueous discharge. | pH --<br>SS --<br>O&G --<br>Pb --<br>Mn --<br>Zn --<br>$S^{--}$ --<br>F -- | Very good | Requires large area | 6 months to 1 year | Same as BATEA | Same as BATEA | Same as A |

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TABLE 19

WATER EFFLUENT TREATMENT COSTS
FOUNDRY INDUSTRY

MULTIPLE OPERATIONS
MELTING AND MOLDING AND CLEANING DUST COLLECTION SUBCATEGORY

| Treatment of Control Technologies Identified under Item III of the Scope of Work: | A | BPCTCA<br>B | BATEA<br>C | D | E |
|---|---|---|---|---|---|
| Investment | $520,900 | $476,700 | $327,000 | | |
| Annual Costs: | | | | | |
| Capital | 22,400 | 20,500 | 14,000 | | |
| Depreciation | 52,100 | 47,600 | 32,700 | | |
| Operation & Maintenance | 18,200 | 16,600 | 11,400 | | |
| Sludge Disposal | | 10,000 | | | |
| Energy & Power | | 12,100 | 6,000 | | |
| Oil Disposal | | 1,900 | | | |
| Chemical Costs | | 3,900 | 7,600 | | |
| TOTAL | $ 92,700 | $112,600 | $ 71,700 | | |

| Effluent Quality:<br>Effluent Constituents<br>Parameters - units | Resulting Effluent Levels | | | | |
|---|---|---|---|---|---|
| Flow, gal./ton | 19,600 | 3,900 | 825 | | |
| Suspended Solids, mg/l | 6,000-10,000 | 40 | 25 | | |
| Oil and Grease, mg/l | 15-160 | 15 | 10 | | |
| Fluoride, mg/l | 15-45 | 7.7 | 3.4 | | |
| Manganese, mg/l | 10-100 | 1.9 | 0.8 | | |
| Lead, mg/l | 10-150 | 0.62 | 0.27 | | |
| Zinc, mg/l | 10-500 | 1.9 | 0.8 | | |
| Sulfide, mg/l | 5-15 | 0.77 | 0.34 | | |
| pH, units | 5-9 | 6-9 | 6-9 | | |

TABLE 20
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Melting and Sand Washing Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|---|
| A. | | | | | | | | |
| I. Wastewater collected in settling tank or small impoundment for bulk reduction of suspended solids. Solids removed with direct discharge of wastewater. Once-through wastewater usage. | pH<br>SS<br>O&G<br>Pb<br>Mn<br>Zn<br>S<br>F | 5-9<br>3000-5000<br>10-60<br>10-500<br>10-400<br>10-2000<br>5-50<br>15-90 | Ineffective if not maintained | Gross discharge of solids | 1 month | 10' X 10' | Solid waste disposal | Silica and iron |
| III. Wastewater collected in settling tank or small impoundment for bulk reduction of suspended solids. Solids removed periodically with direct discharge of wastewater. Once-through water usage. | pH<br>SS<br>O&G | 6-9<br>1000-2000<br>40-150 | Ineffective if not maintained | Gross discharge of solids | 1 month | 10' X 10" | Solid waste disposal | Silica and iron |
| BPCTCA | | | | | | | | |
| B. | | | | | | | | |
| I. Blowdown from slag quenching operation used as make-up water to furnace emission control system with zero aqueous discharge. Addition of lime or caustic and polyelectrolyte to furnace emission control system recycled wastewater for suspended solids removal with discharge of blowdown to further clarification and oil skimming. | pH<br>SS<br>O&G<br>Pb<br>Mn<br>Zn<br>S<br>F | 6-9<br>40<br>15<br>1.6<br>5<br>5<br>2<br>20 | Good - shows considerable stability at constant flow | Requires large capacity and maintenance frequent solids removal | 6 months to 1 year | 1/8 to 3 acres | Increased solid waste disposal | Silica and iron |

*Listed in order of increasing effectiveness



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TABLE 20 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Melting and Sand Washing Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|---|
| III. Addition of lime or caustic and polyelectrolyte to recycled wastewater for suspended solids removal with discharge of blowdown to further clarification and oil skimming. | pH<br>SS<br>O&G | 6-9<br>40<br>15 | Good - shows considerable stability at constant flow | Requires large capacity, maintenance and frequent solids removal | 6 months to 1 year | 1/8-3 acres | Increased solid waste disposal | Silica and iron |
| B[1] Combine discharged effluents from I and III in common discharge. | | | | | | | | |
| C. BATEA | | | | | | | | |
| I & III | | | | | | | | |
| Same as level B but with combining waste streams from I and III for solids removal and oil skimming. Addition of recirculating sidestream chemical treatment, settling tanks, degritters, clarification and/or filtration for further solids removal thus upgrading the quality of the discharge stream. Complete recycle of the effluent from the settling basin back to the unit melting operation and unit sand washing operation Discharge of sidestream blowdown or backwash to | pH<br>SS<br>O&G<br>Pb<br>Mn<br>Zn<br>S<br>F | 6-9<br>25<br>10<br><1<br><3<br><3<br><1.25<br><1.25 | Very good - little tendency to upset | Requires close control and increased maintenance | 6 months to 1 year | 1/8-3 acres | Increased solid waste disposal | Same as A |

TABLE 20 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Melting and Sand Washing Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| C. BATEA, I & III (CONT.)<br>polyelectrolyte addition followed by flash mixing, clarification and discharge. Thus effecting a significant reduction in the wasteload and volume of wastewater discharged through the benefits of combined treatment of waste water from the two unit operation. | | | | | | | |
| C[1] BATEA<br>I & III<br>Same as level B with discharge of blowdown from unit sand washing operation discharged to solids separation-recycle drag tank or impoundment. Unit sand washing operation has now affected a zero aqueous discharge as the blowdown wastewater is used as furnace immersion control system makeup water. Discharge of unit melting operation blowdown to further suspended solids removal and oil skimming. Addition | pH 6-9<br>SS 25<br>O&G 10<br>Pb <1<br>Mn <3<br>Zn <3<br>S <1.25<br>F <12.5 | Very good, economical | Requires close control and increased maintenance | 6 months to 1 year | Same as BPCTCA | Same as BPCTCA | Same as B. |



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TABLE 20 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Melting and Sand Washing Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| C[1] BATEA, I & III (CONT.)<br>of recirculating sidestream chemical treatment, settling tanks, degritter, clarification and/or filtration for further solids removal thus upgrading the quality of the discharge stream. Complete recycle of the effluent from the settling basin back to the unit melting operation and unit sand washing operation. Discharge of the sidestream blowdown or backwash to polyelectrolyte addition followed by flash mixing, clarification and discharge. Thus, affecting a significant reduction of the waste load and volume of the discharge from the two unit operation through the benefits at combined treatment of the waste from the two unit operations. | | | | | | | |



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TABLE 20 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Melting and Sand Washing Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| D. BATEA | | | | | | | |
| I & II | | | | | | | |
| Discharge of all untreated raw waste from unit sand washing operation and unit melting operation to a common settling basin or drag tank. Addition of caustic and lime for pH adjustment. Addition of polyelectrolyte for improved solids removal oil skimming with complete recycle and zero aqueous discharge. | pH --<br>SS --<br>O&G --<br>Pb --<br>Mn --<br>Zn --<br>S --<br>F -- | Very good | Requires large area | 6 months to 1 year | Same as BPCTCA | Same as BPCTCA | Same as A |



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TABLE 20

WATER EFFLUENT TREATMENT COSTS
FOUNDRY INDUSTRY

MULTIPLE OPERATIONS
MELTING AND SAND WASHING SUBCATEGORY

| Treatment of Control Technologies Identified under Item III of the Scope of Work: | A | BPCTCA B | BATEA C | D | E |
|---|---|---|---|---|---|
| Investment | $423,600 | $291,300 | $300,600 | | |
| Annual Costs: | | | | | |
| Capital | 18,200 | 12,600 | 12,900 | | |
| Depreciation | 42,400 | 29,100 | 30,100 | | |
| Operation & Maintenance | 14,800 | 10,100 | 10,500 | | |
| Sludge Disposal | | 1,600 | | | |
| Energy & Power | | 10,500 | 5,600 | | |
| Oil Disposal | | 2,000 | | | |
| Chemical Costs | | 5,100 | 6,400 | | |
| TOTAL | $ 75,400 | $ 71,000 | $ 65,500 | | |

| Effluent Quality: Effluent Constituents Parameters - units | Resulting Effluent Levels | | | | |
|---|---|---|---|---|---|
| Flow, gal./ton | 9000 | 2500 | 450 | | |
| Suspended Solids, mg/l | 1000-5000 | 40 | 25 | | |
| Oil and Grease, mg/l | 10-100 | 15 | 10 | | |
| Fluoride, mg/l | 10-60 | 12 | 6.25 | | |
| Manganese, mg/l | 10-300 | 3 | 1.5 | | |
| Lead, mg/l | 10-350 | 1.0 | 0.5 | | |
| Zinc, mg/l | 10-1250 | 3 | 1.5 | | |
| Sulfide, mg/l | 5-35 | 1.2 | 0.6 | | |
| pH, units | 5-9 | 6-9 | 6-9 | | |

TABLE 21
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Molding & Cleaning Dust Collection and Sand Washing Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| A. | | | | | | | |
| II. Wastewater collected in settling tank or small impoundment for bulk reduction of suspended solids. Solids removed periodically with direct discharge of wastewater. Once-through water usage. | pH 6-9<br>SS 5000-15000<br>O&G 20-200 | Ineffective if not maintained | Gross discharge of solids | 1 month | 10' x 10' | Solid waste disposal | Silica and iron oxide |
| III. Wastewater collected in settling tank or small impoundment for bulk reduction of suspended solids. Solids removed periodically with direct discharge of wastewater. Once-through water usage. | pH 6-9<br>SS 1000-2000<br>O&G 40-150 | Ineffective if not maintained | Gross discharge of solids | 1 month | 30' x 30' | Solid waste disposal | Silica and iron oxide |
| BPCTCA | | | | | | | |
| B. | | | | | | | |
| II. Addition of lime or caustic and polyelectrolyte to recycle wastewater for suspended solids removal with discharge of blowdown to further clarification and oil skimming. | pH 6-9<br>SS 40<br>O&G 15 | Good - shows considerable stability at constant flow | Requires large capacity and maintenance frequent solids removal | 6 months to 1 year | 1/8 to 3 acres | Increased solid waste disposal | Silica and iron oxide |

*Listed in order of increasing effectiveness

TABLE 21 (cont.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations

Molding & Cleaning Dust Collection and Sand Washing Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| BPCTCA (continued) | | | | | | | |
| B. III. Addition of lime or caustic and polyelectrolyte to recycle wastewater for suspended solids removed with blowdown to further clarification and oil skimming. | pH 6-9<br>SS 40<br>O&G 15 | Good - shows considerable stability at constant flow | Requires large capacity and maintenance frequen solids removal | 6 months to 1 year | 1/8 to 3 acres | Increased solid waste disposal | Silica and iron oxide |
| B[1] Combine discharge effluents from II and III in common discharge. | | | | | | | |
| BATEA | | | | | | | |
| C. - II AND III | | | | | | | |
| Same as level B but with combining waste streams from II and III for solids removal and oil skimming. Addition of recirculating side stream chemical treatment, settling tanks, degritters, clarification and or filtration for further solids removal thus upgrading the quality of the discharge stream. Complete recycle of the effluent from molding and cleaning dust collection operation. Discharge of sidestream blowdown or backwash to poly electrolyte addition | pH 6-9<br>SS 25<br>O&G 15 | Very good - little tendency to upset | Requires close control and increased maintenance | 6 months to 1 year | Same as BPCTCA | Increased solid waste disposal | Same as A |

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TABLE 21 (cont.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
Molding & Cleaning Dust Collection and Sand Washing Operations

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| BATEA (continued) followed by flash mixing, clarification and discharge. This combination will affect a significant reduction in the waste load and volume of wastewater discharged through the benefits of combined treatment of wastewater from the two unit operations. | | | | | | | |
| D. - II AND III Discharge of all untreated raw waste from unit sand washing operations and unit molding and cleaning. Dust collection operation to a common settling basin or drag tank. Addition of caustic or lime for pH control. Addition of polyelectrolyte for improved solids removal and oil skimming with complete recycle and zero aqueous discharge. | pH -<br>SS -<br>O&G - | Very good | Requires large area | 6 months to 1 year | Same as BATEA | Same as BATEA | Same as A |



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TABLE 21

WATER EFFLUENT TREATMENT COSTS
FOUNDRY INDUSTRY

MULTIPLE OPERATIONS
MOLDING AND CLEANING DUST COLLECTION AND SAND WASHING SUBCATEGORY

| Treatment of Control Technologies Identified under Item III of the Scope of Work: | A | BPCTCA B | BATEA C | D | E |
|---|---|---|---|---|---|
| Investment | $520,900 | $430,000 | $192,000 | | |
| Annual Costs: | | | | | |
| Capital | 22,400 | 18,500 | 8,300 | | |
| Depreciation | 52,100 | 43,000 | 19,200 | | |
| Operation & Maintenance | 18,200 | 15,000 | 6,700 | | |
| Sludge Disposal | | 9,000 | | | |
| Energy & Power | | 5,300 | 4,500 | | |
| Oil Disposal | | 2,500 | | | |
| Chemical Costs | | 4,700 | 3,500 | | |
| TOTAL | $ 92,700 | $ 98,000 | $ 42,200 | | |

Effluent Quality:
Effluent Constituents Parameters - units | Resulting Effluent Levels

| Effluent Constituents Parameters - units | A | B | C | D | E |
|---|---|---|---|---|---|
| Flow, gal./ton | 16,600 | 3,400 | 825 | | |
| Suspended Solids, mg/l | 4,000-12,000 | 40 | 25 | | |
| Oil and Grease, mg/l | 30-200 | 15 | 10 | | |
| pH, units | 6-9 | 6-9 | 6-9 | | |

## TABLE 22
## FOUNDRY OPERATIONS
## CONTROL AND TREATMENT TECHNOLOGY
## FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
All Subcategories

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|---|
| A. | | | | | | | | |
| I. Wastewater collected in settling tank or small impoundment for bulk reduction of suspended solids. Solids removed with direct discharge of wastewater. Once-through wastewater usage. | pH<br>SS<br>O&G<br>Pb<br>Mn<br>Zn<br>$S^{--}$<br>F | 5-9<br>3000-5000<br>10-60<br>10-500<br>10-400<br>10-2000<br>5-50<br>15-90 | Ineffective if not maintained | Gross discharge of solid | 1 month | 10' x 10' | Solid waste disposal | Silica and iron |
| II. Wastewater collected in settling tank or small impoundment for bulk reduction of suspended solids. Solids removed periodically with direct discharge of wastewater. Once-through water usage. | pH<br>SS<br>O&G | 6-9<br>5000-15000<br>20-200 | Ineffective if not maintained | Gross discharge of solid | 1 month | 30' x 30' | Solid waste disposal | Silica and iron |
| III. Wastewater collected in settling tank or small impoundment for bulk reduction of suspended solids. Solids removed periodically with direct discharge of wastewater once-through water usage. | pH<br>SS<br>O&G | 6-9<br>1000-2000<br>40-150 | Ineffective if not maintained | Gross discharged. | 1 month | 30' x 30' | Solid waste disposal | Silica and iron |

*Listed in order of increasing effectiveness

TABLE 22 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
All Subcategories

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| BPCTCA<br>B. | | | | | | | |
| I. Blowdown from slag quench operation used as makeup water to furnace emission control system with zero aqueous discharge. Addition of lime or caustic and polyelectrolyte to furnace emission control system. Recycle wastewater for suspended solids removal with discharge of blowdown to further clarification and oil skimming. | pH 6-9<br>SS 40<br>O&G 15<br>Pb 1.6<br>Mn 5<br>Zn 5<br>$S^{--}$ 2<br>F 20 | Good - shows considerable stability at constant flow | Requires large capacity frequent solids removal | 6 months to 1 year | 1/8 to 3 acres | Solid waste disposal | Silica and iron |
| II. Addition of lime or caustic and polyelectrolyte to recycled wastewater for suspended solids removal with discharge of blowdown to further clarification and oil skimming. | pH 6-9<br>SS 40<br>O&G 15 | Good - shows considerable stability at constant flow | Requires large capacity and frequent solids removal | 6 months to 1 year | 1/8 to 3 acres | Solid waste disposal | Silica and metallic iron |
| III. Addition of lime or caustic and polyelectrolyte to recycled wastewater for suspended solids removal with discharge of blowdown to further clarification and oil skimming. | pH 6-9<br>SS 40<br>O&G 15 | Good - shows considerable stability at constant flow | Requires large capacity and frequent solids removal | 6 months to 1 year | 1/8 to 3 acres | Solid waste disposal | Silica and metallic iron |

*Listed in order of increasing effectiveness

TABLE 22 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
All Subcategories

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|
| C. BATEA<br>I, II, III<br><br>Same as level B but with combining waste stream from I, II and III for solids removal and oil skimming. Addition of recirculating sidestream chemical treatment, settling tanks, degritter, clarification and filtration for further solids removal thus upgrading the quality of the discharge stream. Complete recycle of the effluent from the settling basin back to the unit melting operation, unit molding operation and the unit sand washing operation. Discharge of sidestream blowdown or backwash to polyelectrolyte addition followed by flash mixing, clarification and discharge. Thus affecting a significant reduction in the waste load and the volume of wastewater discharged through the benefits of combined treatment of wastewater from the three unit operations. | pH 6-9<br>SS 25<br>O&G 10<br>Pb <1<br>Mn <3<br>Zn <3<br>$S^{--}$ <1.25<br>F <12.5 | Very good - little tendency toward upset | Requires close control and increased maintenance | 6 months to 1 year | Same as B | Increased solid waste disposal | Same as B |

*Listed in order of increasing effectiveness



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TABLE 22 (CONT.)
FOUNDRY OPERATIONS
CONTROL AND TREATMENT TECHNOLOGY
FOR RELATED CATEGORIES AND SUBCATEGORIES

CATEGORY/SUBCATEGORY: Multiple Operations
All Subcategories

| Treatment and/or control methods employed* | Resulting Effluent Levels for Critical Constituents | | Status and Reliability | Problems and Limitations | Implementation Time | Land Requirements | Environmental Impact Other than Water | Solid Waste Generation & Primary Constituents |
|---|---|---|---|---|---|---|---|---|
| D. I, II, III | | | | | | | | |
| Discharge of all untreated raw waste from unit melting operation, unit molding operation and unit sand washing operation to a common settling basin or drag tank. Addition of caustic or lime for pH adjustment. Addition of polyelectrolyte for improved solids removal, oil skimming with complete recycle and zero aqueous discharge. | pH<br>SS<br>O&G<br>Pb<br>Mn<br>Zn<br>$S^{--}$<br>F | --<br>--<br>--<br>--<br>--<br>--<br>--<br>-- | Very good | Requires large area | 6 months to 1 year | Same as BPCTCA | Same as BPCTCA | Same as BPCTCA |

*Listed in order of increasing effectiveness

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TABLE 22

WATER EFFLUENT TREATMENT COSTS
FOUNDRY INDUSTRY

MULTIPLE OPERATIONS
ALL SUBCATEGORIES

| Treatment of Control Technologies Identified under Item III of the Scope of Work: | A | BPCTCA B | BATEA C | D | E |
|---|---|---|---|---|---|
| Investment | $732,700 | $599,000 | $385,500 | | |
| Annual Costs: | | | | | |
| Capital | 31,500 | 25,800 | 16,500 | | |
| Depreciation | 73,300 | 59,900 | 38,600 | | |
| Operation & Maintenance | 25,600 | 21,000 | 13,500 | | |
| Sludge Disposal | | 10,300 | | | |
| Energy & Power | | 14,000 | 7,500 | | |
| Oil Disposal | | 3,100 | | | |
| Chemical Costs | | 6,700 | 8,800 | | |
| TOTAL | $130,400 | $140,800 | $ 84,900 | | |

| Effluent Quality: Effluent Constituents Parameters - units | Resulting Effluent Levels | | | | |
|---|---|---|---|---|---|
| Flow, gal./ton | 22,600 | 4,900 | 1,050 | | |
| Suspended Solids, mg/l | 3,000-10,000 | 40 | 25 | | |
| Oil and Grease, mg/l | 20-160 | 15 | 10 | | |
| Fluoride, mg/l | 5-25 | 6.1 | 2.7 | | |
| Manganese, mg/l | 5-100 | 1.5 | 0.64 | | |
| Lead, mg/l | 5-125 | 0.5 | 0.21 | | |
| Zinc, mg/l | 5-500 | 1.5 | 0.64 | | |
| Sulfide, mg/l | 2-12 | 0.6 | 0.27 | | |
| pH, units | 5-9 | 6-9 | 6-9 | | |

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# SECTION IX

## EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

## EFFLUENT LIMITATIONS GUIDELINES

## INTRODUCTION

The effluent limitations which must be achieved July 1, 1977 are to specify the effluent quality attainable through the application of the Best Practicable Control Technology Currently Available. Best Practicable Control Technology Currently Available is generally based upon the average of the best existing performance by plants of various sizes, ages, and unit processes within the industrial subcategory. This average is not based upon a broad range of plants within the foundry industry, but based upon performance levels achieved by plants purported by the industry or by regulatory agencies to be equipped with the best treatment facilities. Experience demonstrated that in some instances these facilities were exemplary only in the control of a portion of the waste parameters present. In those industrial categories where present control and treatment practices are uniformly inadequate, a higher level of control than any currently in place may be required if the technology to achieve such higher level can be practicably applied by July 1, 1977.

Considerations must also be given to:

1. The size and age of equipment and facilities involved

2. The processes employed

3. Non-water quality environmental impact (including energy requirements)

4. The engineering aspects of the application of various types of control techniques

5. Process changes

6. The total cost of application of technology in relation to the effluent reduction benefits to be achieved from such application

Also, Best Practicable Control Technology Currently Available emphasizes treatment facilities at the end of a manufacturing process but includes the control technologies within the process itself when the latter are considered to be normal practice within an industry.

A further consideration is the degree of economic and engineering reliability which must be established for the technology to be "currently available." As a result of demonstration projects, pilot plants and general use, there must exist a high degree of confidence in the engineering and economic practicability of the technology at the time of commencement of construction or installation of the control facilities.

## RATIONALE FOR SELECTION OF BPCTCA

The following paragraph summarized factors that were considered in selecting the categorization, water use rates, level of treatment technology, effluent concentrations attainable by the technology, and hence the establishment of the effluent limitations for BPCTCA.

### Size and Age of Facilities and Land Availability Considerations

As discussed in Section IV, the age and size of the iron and steel foundry industry facilities has little direct bearing in the quantity or quality of wastewater generated. Thus, the ELG for a given subcategory of waste source applies equally to all plants regardless of size or age. Land availability for installation of add-on treatment facilities can influence the type of technology utilized to meet the ELGs. This is one of the considerations which can account for a range in the costs that might be incurred.

### Consideration of Processes Employed

All plants in a given subcategory use the same or similar production methods, giving similar discharges. There is no evidence that operation of any current process or subprocess will substantially affect capabilities to implement the best practicable control technology currently available. At such time that new processes appear imminent for broad application the ELGs should be amended to cover these new sources. No changes in process employed are envisioned as necessary for implementation of this technology for plants in any subcategory. The treatment technologies to achieve BPCTCA are end-of-process methods which can be added onto the existing treatment facilities.

## Consideration of Non-Water Quality Environmental Impact

Impact of Proposed Limitations on Air Quality. The increased use of recycle systems have the potential for increasing the loss of volatile substances to the atmosphere. Recycle systems are so effective in reducing wastewater volumes and hence waste loads to and from treatment system and in reducing the size and cost of treatment systems that a trade-off must be accepted. Recycle systems requiring the use of cooling towers have contributed significantly to reductions of effluent loads while contributing only minimally to air pollution problems. Careful operation of such a system can avoid or minimize air pollution problems.

Impact of Proposed Limitations on Solid Waste Problems. Consideration has also been given to the solid waste aspects of water pollution controls. The processes for treating the wastewaters from this industry produce considerable volumes of sludges. Much of this material is inert sand and iron oxide which can be reused profitably. Other sludges not suitable for reuse must be disposed of to landfills since most of them are chemical precipitates which could be little reduced by incineration. Being precipitates, they are by nature relatively insoluble and nonhazardous substances requiring minimal custodial care.

In order to ensure long-term protection of the environment from harmful constituents, special consideration of disposal sites should be made. All landfill sites should be selected so as to prevent horizontal and vertical migration of these contaminants to ground or surface waters. In cases where geologic conditions may not reasonably ensure this, adequate mechanical precautions (e.g., impervious liners) should be taken to ensure long-term protection to the environment. A program of routine periodic sampling and analysis of leachates is advisable. Where appropriate the location of solid hazardous materials disposal sites, if any, should be permanently recorded in the appropriate office of legal jurisdiction.

Impact of Proposed Limitations on Energy Requirements. The effects of water pollution control measures on energy requirements has also been determined. The additional energy required in the form of electric power to achieve the effluent limitations proposed for BPCTCA and BATEA amounts to approximately 1.3% of the 51.6 billion kwh of electrical energy used by the total iron and steel industry in 1972.

The enhancement to water quality management provided by these proposed effluent limitations substantially outweighs the impact on air, solid waste, and energy requirements.

Consideration of the Engineering Aspects of the Application of Various Types of Control Techniques

The level of technology selected as the basis for BPCTCA limitations is considered to be practicable in that the concepts are proven and are currently available for implementation and may be readily applied as "add-ons" to existing treatment facilities.

Consideration of Process Changes

No in-process changes will be required to achieve the BPCTCA limitations although recycle water quality changes may occur as a result of efforts to reduce effluent discharge rates. Some plants are already employing recycle, or treatment and recycle as a means to minimizing water use and the volume of effluents discharged. The limitations are load limitations (unit weight of pollutant discharged per unit weight of product) only and not volume or concentration limitations. The limitations can be achieved by extensive treatment of large flows; however, an evaluation of costs indicates that the limitations can usually be achieved most economically by minimizing effluent volumes.

Consideration of Costs Versus Effluent Reduction Benefits

In consideration of the costs of implementing the BPCTCA limitations relative to the benefits to be derived, the limitations were set at values which would not result in excessive capital or operating costs to the industry.

To accomplish this economic evaluation, it was necessary to establish the treatment technologies that could be applied to each subcategory in an add-on fashion, the effluent qualities attainable with each technology, and the costs. In order to determine the added costs, it was necessary to determine what treatment processes were already in place and currently being utilized by most of the plants. This was established as the base level of treatment.

Treatment systems were then envisioned which, as add-ons to existing facilities, would achieve significant waste load reductions. Capital and operating costs for these systems were then developed for the average size facility. The average size was determined by dividing the total industry production by the number of operating facilities. The capital costs were developed from a quasi-detailed engineering estimate of the cost of the components of each of the systems. The annual operating cost for each of the facilities was determined by summing the capital recovery (basis ten year straight line depreciation) and capital use (basis 7% interest) charges, operating and maintenance costs, chemical costs, and utility costs.

Cost effectiveness diagrams were then prepared to show the pollution reduction benefits derived relative to the costs incurred. As expected, the diagrams show an increasing cost for treatment per percent reduction obtained as the percent of the initial pollutional load remaining decreased. The BPCTCA limitations were set at the point where the costs per percent pollutant reduction took a sharp break upward toward higher costs per percent of pollutant removed.

The initial capital investment and annual expenditures required of the industry to achieve BPCTCA were developed by multiplying the costs (capital or annual) for the average size facility by the number of facilities operating for each subcategory. These costs are summarized in Table 31 in Section X.

After selection was made of the treatment technology to be designated as a means to achieve the BPCTCA limitations for each subcategory, a sketch of each treatment model was prepared. The sketch for each subcategory is presented following the table presenting the BPCTCA limitations for the subcategory.

## IDENTIFICATION OF BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE - BPCTCA

Based on the information contained in Sections III through VIII of this report, a determination has been made that the quality of effluent attainable through the application of the Best Practicable Control Technology Currently Available is as listed in Tables 23 through 26. These tables set forth the ELGs for the following subcategories of the iron and steel foundry industry:

I. Melting Operations
II. Molding and Cleaning Dust Collection Operations
III. Sand Washing Operations
IV. Multiple Operations

In establishing the subject guidelines, it should be noted that the resulting limitations or standards are applicable to aqueous waste discharge only, exclusive of noncontact

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cooling waters. In the section of this report which discusses control and treatment technology for the iron and steel foundry industry as a whole, a qualitative reference has been given regarding "the environmental impact other than water" for the subcategories investigated.

The effluent guidelines established herein take into account only those aqueous constituents considered to be major pollutants in each of the subcategories investigated. In general, the critical parameters were selected for each subcategory on the basis of those waste constituents known to be generated in the specific manufacturing process and also known to be present in sufficient quantitiy to be inimical to the environment. Certain general parameters such as suspended solids naturally include the oxides of iron and silica; however, these latter specific constituents were not included as critical parameters, since adequate removal of the general parameter (suspended solids) in turn provides for adequate removal of the more specific parameters indicated. This does not hold true when certain of the parameters are in the dissolved state; however, in the case of sand and iron oxides generated in the iron and steel foundry processes, they are for the most part insoluble in the relatively neutral effluents in which they are contained. The absence of apparent less important parameters from the guidelines in no way endorses unrestricted discharge of same.

The recommended effluent limitations guidelines resulting from this study for BPCTCA are summarized in Tables 23 to 26. These tables also list the control and treatment technology applicable or normally utilized to reach the constituent levels indicated. These effluent limitations proposed herein are by no means the absolute lowest values attainable (except where no discharge of process wastewater pollutant is recommended) by the indicated technology, but moreover they represent values which can be readily controlled around on a day-by-day basis.

It should be noted that these effluent limitations represent values not to be exceeded by any 30 continuous day average. The maximum daily effluent loads per unit of production should not exceed these values by a factor of more than three. In the absence of sufficient performance data from the industry to establish these factors on a statistical basis, the factor of three was chosen in consideration of the operating variations allowed for in selecting the 30 continuous day average limitations.

## DISCUSSION BY SUBCATEGORIES

The rationale used for developing the BPCTCA effluent limitations guidelines is summarized below for each of the subcategories. All effluent limitations guidelines are presented on a "gross" basis since for the most part, removals are relatively independent of initial concentrations of contaminants. The ELGs are in kilograms of pollutant per metric ton of product or in pounds of pollutant per 1,000 lbs of product and in these terms only. The ELGs are not a limitation on flow, type of technology to be utilized, or concentrations to be achieved. These items are listed only as a guide to show the basis for the ELGs and may be varied as the discharger desires so long as the ELG loads per unit of production are met.

### Melting Operations

Following is a summary of the factors used to establish the BPCTCA effluent limitation guidelines (ELGs) applying to the Melting Operations subcategory. As far as possible, the stated limits are based upon performance levels attained by the selected plants surveyed during this study. Where treatment levels can be improved by application of additional currently available control and treatment technology, the anticipated reduction of waste loads was included in the estimates.

The BPCTCA ELGs for the Melting Operations subcategory, and the control and treatment technology to achieve these limits, are summarized in Table 23.

Flow. Nine unit melting operations were surveyed in this study, with an average furnace emission control process water applied flow rate of 13,280 l/kkg (3,187 gal./ton) of hot metal poured. Of the nine units surveyed, seven were utilizing partial recycle, with blowdown rates ranging between 534 l/kkg (128 gal./ton) and 25,600 l/kkg (6,139 gal./ton) of metal poured. The two remaining units had total recycle systems with zero aqueous discharge.

Because of the extremely wide range of effluent flows observed, the BPCTCA ELG are based on flow rates set at slightly more than the median flow of the seven units discharging wastes, or 6,250 l/kkg (1,500 gal./ton) of metal poured, excluding all noncontact cooling water. This mid-range value is well within the capability of current technology to achieve, as evidenced by those plants already well below this level. At the same time, this value will provide the impetus for once-through water users to develop recycle systems while at the

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same time allowing them to achieve this end by 1977 in a cost effective manner. It is anticipated that as the once-through users begin to convert to recycle systems, they will find it economically advantageous to go all the way to tight recycle with minimal blowdown rather than approach this end in a stepwise manner.

Suspended Solids. Nine unit operations were surveyed in this study. Suspended solids effluent loads in treated wastewater ranged from 0.0835 kg/kkg (0.167 lbs/ton) of metal poured to 1.000 kg/kkg (1.997 lbs/ton) of metal poured. Units practicing polyelectrolyte addition with suspended solids removal or tight recycle had effluent loads in treated wastewater ranging from 0.0835 kg/kkg (0.167 lbs/ton) of metal poured to 0.348 kg/kkg (0.6949 lbs/ton) of metal poured with an average value of 0.221 kg/kkg (0.441 lbs/ton) of metal poured. Unit operation exceeding the value can achieve this level by utilization of polyelectrolyte addition and plain sedimentation or clarification. Therefore, the BPCTCA ELG for suspended solids removal is conservatively set at 0.250 kg/kkg (0.500 lbs suspended solids/ton) of metal poured, equivalent to 40 mg/l in a discharge flow of 1,500 gal./ton of metal poured.

Oil and Grease. Of the nine unit operations surveyed, oil and grease effluent loads in treated wastewater ranged from 0.00107 kg/kkg (0.00215 lbs/ton) of metal poured to 0.0847 kg/kkg (1.690 lbs/ton) of metal poured with an average of 0.111 kg/kkg (0.222 lbs/ton) of metal poured. However, seven of the nine units were discharging below this average. The two units exceeding the value could readily discharge less than the average also by the use of oil skimming equipment. Therefore, the BPCTCA limit for oil and grease is conservatively set slightly less than the average at 0.0937 kg/kkg (0.187 lbs oil and grease/ton) of metal poured, equivalent to 15 mg/l in a discharge flow of 1,500 gal./ton of metal poured.

Lead. Of the units surveyed, lead effluent loads in treated wastewater ranged from 0.000777 kg/kkg (0.00155 lbs/ton) of metal poured to 0.134 kg/kkg (0.268 lbs/ton) of metal poured with an average of 0.0348 kg/kkg (0.0696 lbs/ton) of metal poured. However, one unit had insufficient solids removal. The remaining plants showed an average of 0.00998 kg/kkg (0.0199 lbs/ton) of metal poured. Therefore, the BPCTCA limit for lead is conservatively set at 0.0100 kg/kkg (0.0200 lbs lead/ton) of metal poured, equivalent to 1.6 mg/l in a discharge flow of 1,500 gal./ton of metal poured.

Manganese. Of the nine units surveyed, manganese effluent loads in treated wastewater ranged from 0.00149 kg/kkg (0.00297 lbs/ton) of metal poured, to 0.0741 kg/kkg (0.148 lbs/ton) of metal poured with an average of 0.0250 kg/kkg (0.0500 lbs/ton) of metal poured. Therefore, the BPCTCA ELG for manganese is conservatively set slightly higher than the average at 0.0316 kg/kkg (0.0630 lbs of manganese/ton) of metal poured, equivalent to 5 mg/l in a discharge flow of 1,500 gal./ton of metal poured. Any unit exceeding this value could readily achieve it by adequate pH control, polyelectrolyte addition followed by plain sedimentation or clarification.

Zinc. Of the unit operations surveyed, zinc effluent loads in treated wastewater ranged from 0.00252 kg/kkg (0.00503 lbs/ton) of metal poured to 0.0633 kg/kkg (0.126 lbs/ton) of metal poured, with an average of 0.0262 kg/kkg (0.0523 lbs/ton) of metal poured. Therefore, the BPCTCA ELG for zinc is conservatively set slightly higher than the average at 0.0316 kg/kkg (0.063 lbs zinc/ton) of metal poured, equivalent to 5 mg/l in a discharge flow of 1,500 gal./ton of metal poured. Any unit exceeding this value could readily achieve it by adequate pH control, polyelectrolyte addition followed by plain sedimentation or clarification.

Fluoride. Of the nine units surveyed, fluoride loads in treated wastewater ranged from 0.00478 kg/kkg (0.00955 lbs/ton) of metal poured to 0.245 kg/kkg (0.549 lbs/ton) of metal poured, with an average of 0.193 kg/kkg (0.386 lbs/ton) of metal poured. The average of five of the units was 0.0879 kg/kkg (0.176 lbs/ton) of metal poured. Therefore, the BPCTCA ELG for fluoride is very conservatively set slightly higher than this average at 0.125 kg/kkg (0.250 lbs/ton) of metal poured, equivalent to 20 mg/l in a discharge flow of 1,500 gal./ton of metal poured.

Any unit exceeding this value could readily achieve it through addition of lime for pH control followed by plain sedimentation or clarification.

pH. All of the units surveyed fell within the pH constraint range of 6.0 to 9.0, thus providing a basis for establishing this range as BPCTCA ELG for pH. Any unit falling outside of this range can readily remedy the situation by applying appropriate neutralization procedures in the treatment process.

Molding and Cleaning Dust Collection Operations

Following is a summary of the factors used to establish the BPCTCA effluent limitation guidelines (ELGs) applying to the

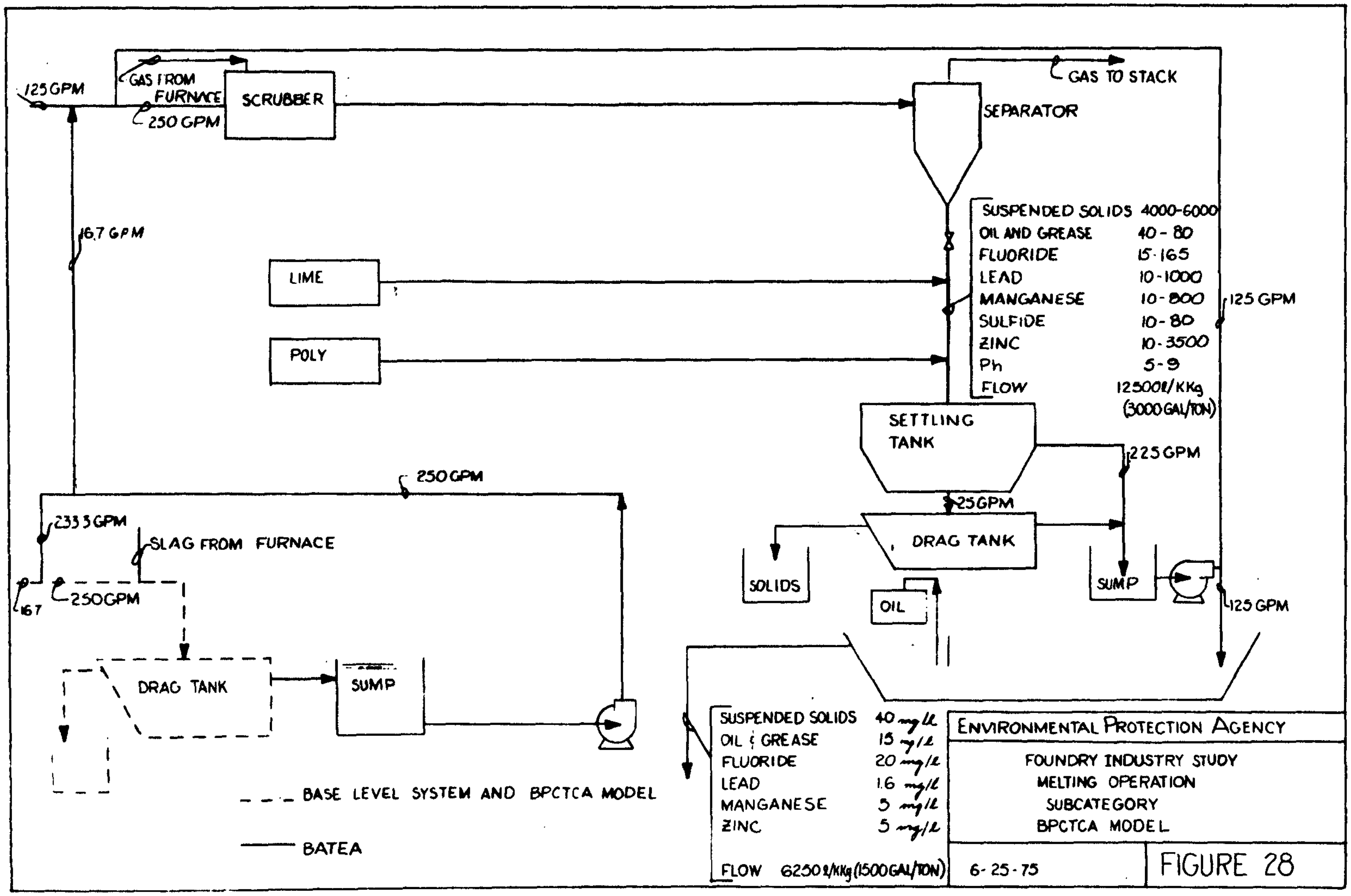
## TABLE 23

### BPCTCA - EFFLUENT LIMITATIONS GUIDELINES

SUBCATEGORY Melting Operations

| CRITICAL PARAMETERS | BPCTCA LIMITATIONS Kg/KKg[1] (LB/1000 LB) | mg/l[2] | CONTROL & TREATMENT TECHNOLOGY[3] | ESTIMATED[4] TOTAL COST $/KKg | $/TON |
|---|---|---|---|---|---|
| Suspended Solids | 0.250 | 40 | Slag quench water recycled, with discharge to emission system; emission system recycles, with lime and polymer addition within the loop; drag tanks on both systems for continuous solids removal; oil skimming and additional settling for blowdown from emission system. | 4.54 | 4.12 |
| Oil & Grease | 0.0940 | 15 | | | |
| Fluoride | 0.125 | 20 | | | |
| Manganese | 0.0313 | 5 | | | |
| Lead | 0.0100 | 1.6 | | | |
| Zinc | 0.0313 | 5 | | | |
| pH | 6.0-9.0 | | | | |
| Flow | Most probable value for moderately tight recycle system is 6250 liters of effluent per kkg of product (1500 gal/ton); excluding all non-contact cooling water. | | | | |

(1) Kilograms per metric ton of metal poured or pounds per 1000 pounds of metal poured.
(2) Milligrams/liter, based on 6250 liters effluent per kkg of steel degassed (1500 gal/ton).
(3) Available technology listed is not necessarily all inclusive nor does it reflect all possible combinations or permutations of treatment methods.
(4) Costs may vary some depending on such factors as location, availability of land and chemicals, flow to be treated, treatment technology selected where competing alternatives exist, and extent of preliminary modifications required to accept the indicated control and treatment devices. Estimated total costs shown are only incremental costs required above those facilities which are normally existing within a plant.


125 GPM
GAS FROM FURNACE
250 GPM
SCRUBBER
GAS TO STACK
SEPARATOR
16.7 GPM
LIME
POLY
SUSPENDED SOLIDS 4000-6000
OIL AND GREASE 40 - 80
FLUORIDE 15-165
LEAD 10-1000
MANGANESE 10-800
SULFIDE 10-80
ZINC 10-3500
Ph 5-9
FLOW 12500l/KKg (3000 GAL/TON)
125 GPM
SETTLING TANK
225 GPM
25 GPM
250 GPM
233.3 GPM
SLAG FROM FURNACE
16.7
250 GPM
DRAG TANK
SOLIDS
OIL
SUMP
125 GPM
DRAG TANK
SUMP
BASE LEVEL SYSTEM AND BPCTCA MODEL
BATEA
SUSPENDED SOLIDS 40 mg/l
OIL & GREASE 15 mg/l
FLUORIDE 20 mg/l
LEAD 1.6 mg/l
MANGANESE 5 mg/l
ZINC 5 mg/l
FLOW 6250 l/KKg (1500 GAL/TON)
ENVIRONMENTAL PROTECTION AGENCY
FOUNDRY INDUSTRY STUDY
MELTING OPERATION
SUBCATEGORY
BPCTCA MODEL
6-25-75
FIGURE 28

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Molding and Cleaning Dust Collection Operations subcategory. As far as possible, the stated limits are based upon performance levels attained by the selected plants surveyed during this study. Where treatment levels can be improved by application of additional currently available control and treatment technology, the anticipated reduction of waste loads was included in the estimates.

The BPCTCA ELGs for the Molding and Cleaning Dust Collection Operations subcategory, and the control and treatment technology to achieve these limits, are summarized in Table 24.

Flow. Seven unit Molding and Cleaning Dust Collection Operations were surveyed in this study, with an average process water applied flow rate of 7,083 l/kkg (1,700 gal./ton) of sand passing before the ladle. Of the seven units surveyed, six were utilizing partial recycle with blowdown rates ranging between 83.4 l/kkg (20 gal./ton) and 2,779 l/kkg (667 gal./ton) of sand passing before the ladle. The remaining unit was utilizing total recycle with zero aqueous discharge.

Because of the range of effluent flows observed, the BPCTCA ELGs are conservatively based on flow rates set at about 15% of the applied rate of the eight units surveyed, or 1,250 l/kkg (300 gal./ton) of sand passing before the ladle, excluding all noncontact cooling water. This mid-range value is well within the capability of current technology to achieve, as evidenced by those plants already well below this level. At the same time, this value will provide the impetus for once-through water users to develop recycle systems while at the same time allowing them to achieve this end by 1977 in a cost effective manner. It is anticipated that as the once-through users begin to convert to recycle systems, they will find it economically advantageous to go all the way to tight recycle with minimal blowdown rather than approach this end in a stepwise manner.

Suspended Solids. Seven unit operations were surveyed in this study. Suspended solids effluent loads in treated wastewaters ranged from 0.00054 kg/kkg (0.00108 lbs/ton) of sand passing before the ladle to 0.165 kg/kkg (0.329 lbs/ton) of sand passing before the ladle, with an average of 0.0501 kg/kkg (0.100 lbs/ton) of sand passing before the ladle, for practicing polyelectrolyte addition, followed by plain sedimentation or clarification. Therefore, the BPCTCA ELG for suspended solids is conservatively set at 0.0501 kg/kkg (0.1 lb of suspended solids/ton of sand passing before the ladle equivalent to 40 mg/l in a discharge flow of 300 gal./ton of sand passing before the ladle. Unit operations

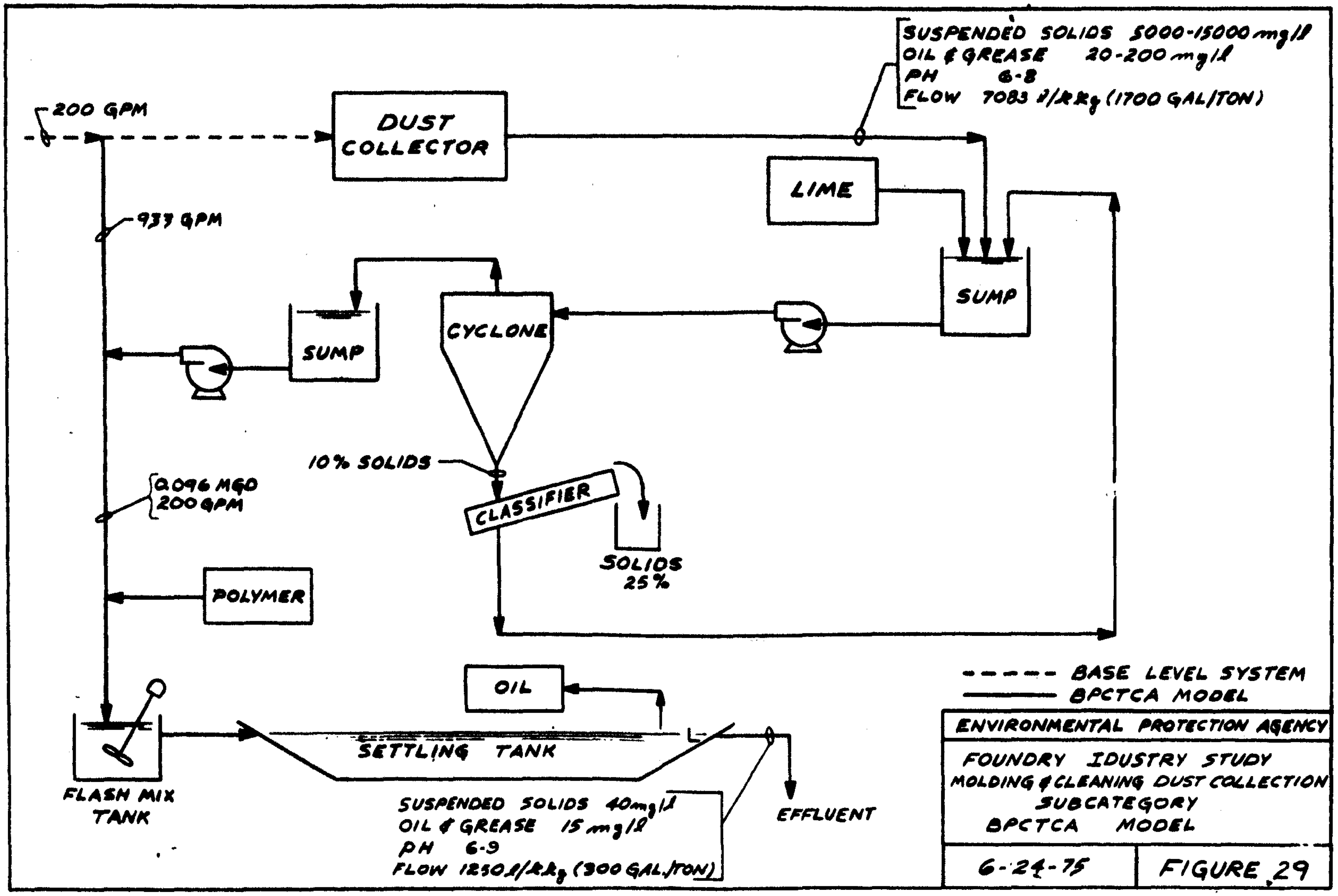
TABLE 24

BPCTCA - EFFLUENT LIMITATIONS GUIDELINES

SUBCATEGORY Molding and Cleaning Dust Collection Operations

| CRITICAL PARAMETERS | BPCTCA LIMITATIONS Kg/KKg [1] (LB/1000 LB) | BPCTCA LIMITATIONS mg/l [2] | CONTROL & TREATMENT TECHNOLOGY [3] | ESTIMATED [4] TOTAL COST $/KKg | ESTIMATED [4] TOTAL COST $/TON |
|---|---|---|---|---|---|
| Suspended Solids | 0.0500 | 40 | Solids removal via cyclone separators, classifier and dump box; lime and polymer addition; oil skimming; final settling basin | 0.925 | 0.839 |
| Oil and Grease | 0.0187 | 15 | | | |
| pH | 6.9-9.0 | | | | |
| Flow | Most probable value for moderately tight recycle system is 1250 liters of effluent per kkg of product (300 gal/ton); excluding all non-contact cooling water. | | | | |

(1) Kilograms per metric ton of sand in the system or pounds per 1000 pounds of sand passing before the ladle.
(2) Milligrams/liter, based on 1250 liters effluent per kkg of sand in the system (300 gal/ton).
(3) Available technology listed is not necessarily all inclusive nor does it reflect all possible combinations or permutations of treatment methods.
(4) Costs may vary some depending on such factors as location, availability of land and chemicals, flow to be treated, treatment technology selected where competing alternatives exist, and extent of preliminary modifications required to accept the indicated control and treatment devices. Estimated total costs shown are only incremental costs required above those facilities which are normally existing within a plant.


SUSPENDED SOLIDS 5000-15000 mg/l
OIL & GREASE 20-200 mg/l
PH 6-8
FLOW 7083 l/kkg (1700 GAL/TON)
200 GPM
DUST COLLECTOR
LIME
937 GPM
SUMP
CYCLONE
SUMP
10% SOLIDS
0.096 MGD
200 GPM
CLASSIFIER
SOLIDS 25%
POLYMER
OIL
FLASH MIX TANK
SETTLING TANK
SUSPENDED SOLIDS 40mg/l
OIL & GREASE 15 mg/l
PH 6-9
FLOW 1250 l/kkg (300 GAL./TON)
EFFLUENT
BASE LEVEL SYSTEM
BPCTCA MODEL
ENVIRONMENTAL PROTECTION AGENCY
FOUNDRY IDUSTRY STUDY
MOLDING & CLEANING DUST COLLECTION
SUBCATEGORY
BPCTCA MODEL
6-24-75
FIGURE 29

exceeding this value can readily achieve it by the addition of polyelectrolyte followed by plain sedimentation or clarification.

Oil and Grease. Unit operations surveyed show oil and grease effluent loads ranging from 0.000185 kg/kkg (0.000369 lbs/ton) of sand passing before the ladle to 0.782 kg/kkg (1.56 lbs/ton) of sand passing before the ladle, with an average value of 0.117 kg/kkg (0.233 lbs/ton). Six of the units were discharging less than 0.0188 kg/kkg (0.0375 lbs/ton) of sand passing before the ladle. The other unit would have been able to achieve this level through the use of oil skimming equipment. Therefore, the BPCTCA ELG for oil and grease is set conservatively at 0.0188 kg/kkg (0.0375 lbs of oil and grease/ton) of sand passing before the ladle, equivalent to 15 mg/l in a discharge flow of 300 gal./ton of sand passing before the ladle.

pH. All of the units surveyed fell within the pH constraint range of 6.0 to 9.0, thus providing a basis for establishing this range as BPCTCA ELG for pH. Any unit falling outside of this range can readily remedy the situation by applying appropriate neutralization procedure in the treatment process.

## Sand Washing Operations

Following is a summary of the factors used to establish the BPCTCA effluent limitation guidelines (ELGs) applying to the Sand Washing Operations subcategory. As far as possible, the stated limits are based upon performance levels attained by the selected plants surveyed during this study. Where treatment levels can be improved by application of additional currently available control and treatment technology, the anticipated reduction of waste loads was included in the estimates.

The BPCTCA ELGs for the Sand Washing Operations subcategory, and the control and treatment technology to achieve these limits, are summarized in Table 25.

Flow. Of the four sand washing unit operations surveyed in this study, two practiced once-through water usage with direct discharge; one practiced excellent water conservation by concurrent flow and sequential washing stages followed by direct discharge, while the fourth practiced recycle of wastewater with blowdown to discharge. Of these four plants, three discharged to multiple operation treatment systems, while the fourth discharged to a receiving stream.

Process water applied flow rates ranged from 417 l/kkg (100 gal./ton) of sand washing to 24,019 l/kkg (5,760 gal./ton) of sand washed, with an average water application rate of 13,191 l/kkg (3,166 gal./ton) of sand washed. Discharge flows ranged from 417 l/kkg (100 gal./ton) of sand washed to 22,725 l/kkg (5,454 gal./ton) of sand washed.

Because of the wide range of effluent flows observed, the BPCTCA ELGs are based on flow rates set at approximately 30% of the average applied rate of the four units surveyed, achieving this reduction in flow via partial recycle of wastewater. This results in recommended BPCTCA flow rates of 4,170 l/kkg (1,000 gal./ton) of sand washed. This mid-range value is well within the capability of current technology to achieve, as evidenced by the unit already achieving this level. At the same time, this value will provide the impetus for once-through water users to develop recycle systems, while at the same time allowing them to achieve this end by 1977 in a cost effective manner. It is anticipated that as the once-through users begin to convert to recycle systems, they will find it economically advantageous to go all the way to tight recycle, rather than approach it in a stepwise manner.

<u>Suspended Solids</u>. A review of unit effluent waste loads and levels of treatment technology practiced reveals that, except for recycle of wastewater, none of the units surveyed provided adequate treatment and control technology before discharge from the unit. However, waste loads from three of these units received further treatment in multiple process treatment systems.

The raw waste loads discharged from sand washing operations compare very favorably with those from the molding and cleaning dust collection operations. Therefore, a transfer of BPCTCA level treatment and control technology from the unit Molding and Cleaning Dust Collection Operation subcategory to the unit Sand Washing Operation subcategory, is justified. It is felt that all unit sand washing operations could achieve BPCTCA ELGs equivalent to those for molding and cleaning dust collection operations by the addition of polyelectrolyte, plain sedimentation or clarification. The BPCTCA ELG for suspended solids for the Molding and Cleaning Dust Collection Operations subcategory is 0.0500 kg/kkg (0.100 lbs/ton) of sand passing before the ladle. However, due to the fact that the water application rate for the unit sand washing operation is two times that of the unit molding and cleaning dust collection operation, it is felt that an additional allowance should be provided. Therefore, the

TABLE 25

BPCTCA - EFFLUENT LIMITATIONS GUIDELINES

SUBCATEGORY Sand Washing Operations

| CRITICAL PARAMETERS | BPCTCA LIMITATIONS Kg/KKg (1) (LB/1000 LB) | mg/l (2) | CONTROL & TREATMENT TECHNOLOGY (3) | ESTIMATED (4) TOTAL COST $/KKg | $/TON |
|---|---|---|---|---|---|
| Suspended solids | 0.167 | 40 | Drag tank for continuous solids removal; recycle with addition of caustic and polyelectrolyte; blowdown treated via oil skimming and settling in lagoon. | 3.00 | 2.72 |
| Oil and Grease | 0.0625 | 15 | | | |
| pH | 6.0-9.0 | | | | |
| Flow | Most probable value for moderately tight recycle system is 4170 liters of effluent per kkg of product (1000 gal/ton); excluding all non-contact cooling water. | | | | |

(1) Kilograms per metric ton of sand washed or pounds per 1000 pounds of sand washed.
(2) Milligrams/liter, based on 4170 liters effluent per kkg of sand washed (1000 gal/ton).
(3) Available technology listed is not neeessarily all inclusive nor does it reflect all possible combinations or permutations of treated methods.
(4) Costs may vary some depending on such factors as location, availability of land and chemicals, flow to be treated, treatment technology selected where competing alternatives exist, and extent of preliminary modifications required to accept the indicated control and treatment devices. Estimated total costs shown are only incremental costs required above those facilities which are normally existing within a plant.



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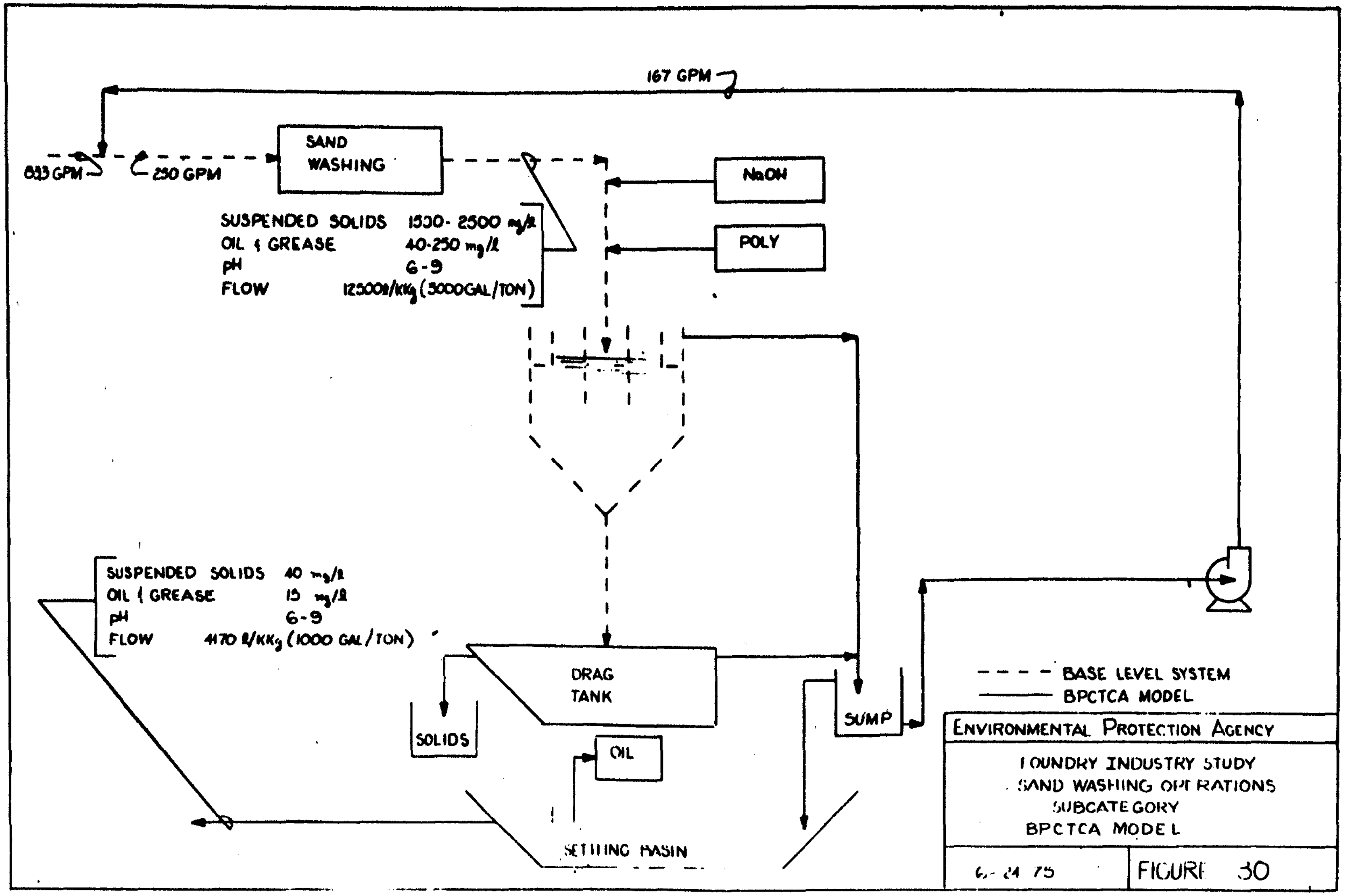
167 GPM
833 GPM
250 GPM
SAND WASHING
NaOH
POLY
SUSPENDED SOLIDS 1500-2500 mg/l
OIL & GREASE 40-250 mg/l
pH 6-9
FLOW 12500l/KKg (3000GAL/TON)
SUSPENDED SOLIDS 40 mg/l
OIL & GREASE 15 mg/l
pH 6-9
FLOW 4170 l/KKg (1000 GAL/TON)
DRAG TANK
SOLIDS
OIL
SETTLING BASIN
SUMP
BASE LEVEL SYSTEM
BPCTCA MODEL
ENVIRONMENTAL PROTECTION AGENCY
FOUNDRY INDUSTRY STUDY
SAND WASHING OPERATIONS
SUBCATEGORY
BPCTCA MODEL
6-24-75
FIGURE 30



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BPCTCA ELG for suspended solids for the unit sand washing subcategory is conservatively set at 0.167 kg/kkg (0.334 lbs of suspended solids/ton) of sand washed, equivalent to 40 mg/l in a discharge flow of 1,000 gal./ton of sand washed.

Oil and Grease. Of the four unit sand washing operations surveyed in this study, three showed oil and grease waste loads in effluent streams of less than 0.0625 kg/kkg (0.125 lbs/ton) of sand washed. The remaining unit could achieve this level by the accepted practice of oil skimming. Therefore, the BPCTCA ELG for oil and grease is set at 0.0625 kg/kkg (0.125 lbs of oil and grease/ton) of sand washed, equivalent to 15 mg/l in a discharge of 1,000 gal./ton of sand washed.

pH. All of the units surveyed fell within the pH constraints range of 6.0 to 9.0, thus providing a basis for establishing this range as BPCTCA ELG for pH. Any unit falling outside of this range can readily remedy the situation by applying appropriate neutralization procedures in the treatment process.

Multiple Operations

Following is a summary of the factors used to establish the BPCTCA effluent limitation guidelines (ELGs) applying to the Multiple Operations subcategory. As far as possible, the stated limits are based upon performance levels attained by the selected plants surveyed during this study.

It is recognized that some of the multiple operations facilities surveyed were practicing better than BPCTCA ELG treatment and control technology. Therefore, the BPCTCA ELG for multiple operation facilities should be the sum of the BPCTCA ELG treatment and control technology previously cited for each constituent unit operation. The BPCTCA ELGs for the Multiple Operations subcategory are summarized in Table 26.

Flow. The recommended BPCTCA ELG flow for the Multiple Operations subcategory shall be the sum of the previously cited individual BPCTCA ELG flows from each constituent unit operation.

Suspended Solids. The recommended BPCTCA ELG suspended solids for the Multiple Operations subcategory shall be the sum of the individual BPCTCA ELG suspended solids load for each constituent unit operation.

1. Unit Melting Operations. 0.250 kg/kkg (0.500 lbs of suspended solids/ton) of metal poured, equivalent to 40 mg/l in a discharge flow of 1,500 gal./ton of metal poured.

2. Unit Molding and Cleaning Dust Collection Operations. 0.0501 kg/kkg (0.1 lbs of suspended solids/ton) of sand passing before the ladle, equivalent to 40 mg/l in a discharge flow of 300 gal./ton of sand passing before the ladle.

3. Unit Sand Washing Operations. 0.167 kg/kkg (0.334 lbs of suspended solids/ton of sand washed, equivalent to 40 mg/l in a discharge flow of 1,000 gal./ton of sand washed.

Oil and Grease. The recommended BPCTCA ELG for oil and grease load for Multiple Operations subcategory shall be the sum of the individual BPCTCA ELG oil and grease load for each previously cited individual constituent unit operation.

1. Unit Melting Operations. 0.0937 kg/kkg (0.187 lbs of oil and grease/ton) of metal poured, equivalent to 15 mg/l in a discharge flow of 1,500 gal./ton of metal poured.

2. Unit Molding and Cleaning Dust Collection Operations. 0.0188 kg/kkg (0.0375 lbs of oil and grease/ton) of sand passing before the ladle, equivalent to 15 mg/l in a discharge flow of 300 gal./ton of sand passing before the ladle.

3. Unit Sand Washing Operations. 0.0625 kg/kkg (0.125 lbs of oil and grease/ton) of sand washed, equivalent to 15 mg/l in a discharge flow of 1,000 gal./ton of sand washed.

Lead. The recommended BPCTCA ELG for lead from Multiple Operations subcategory shall be that recommended specifically for the BPCTCA ELG for the Unit Melting Operations subcategory.

1. Unit Melting Operations. 0.0100 kg/kkg (0.0200 lbs/ton) of metal poured, equivalent to 1.6 mg/l in a discharge flow of 1,500 gal./ton of metal poured.

Manganese. The recommended BPCTCA ELG for manganese from Multiple Operations subcategory shall be that recommended specifically for the BPCTCA ELG for the Unit Melting Operations subcategory.

1. Unit Melting Operations. 0.0316 kg/kkg (0.0630 lbs of manganese/ton) of metal poured, equivalent to 5 mg/l in a discharge flow of 1,500 gal./ton of metal poured.

Zinc. The recommended BPCTCA ELG for zinc from the Multiple Operations subcategory shall be that recommended specifically for BPCTCA ELG for the Unit Melting Operations subcategory.

TABLE 26

BPCTCA - EFFLUENT LIMITATIONS GUIDELINES

SUBCATEGORY Multiple Operations

| CRITICAL PARAMETERS | BPCTCA LIMITATIONS Kg/KKg[1] (LB/1000 LB) | mg/l[2] | CONTROL & TREATMENT TECHNOLOGY[3] | ESTIMATED[4] TOTAL COST $/KKg | $/TON |
|---|---|---|---|---|---|
| Suspended Solids<br>Oil and Grease | The sum of the pounds per 1000 pounds for each subcategory for suspended solids and oil and grease. | | Joint treatment of raw wastewater or blowdowns from partially treated wastewaters from any combination of multiple operations utilizing recycle systems; lime or caustic and polymer additions; clarification; and oil skimming. | 7.53 to 14.93 | 6.83 to 13.54 |
| Fluoride | 0.125 | | | | |
| Manganese | 0.0313 | | | | |
| Lead | 0.0100 | | | | |
| Zinc | 0.0313 | | | | |
| pH | | 6.0-9.0 | | | |
| Flow | Most probable value for moderately tight recycle system will range from 10,420 to 20,420 liters/kkg (2,500 to 4,900 gal/ton) of hot metal poured, depending on the combination of multiple operations used. | | | | |

(1) Kilograms per metric ton of metal poured or pounds per 1000 pounds of metal poured.
(2) Milligrams per liter will depend on the combined discharge flow rate.
(3) Available technology listed is not necessarily all inclusive nor does it reflect all possible combinations or permutations of treatment methods.
(4) Costs may vary some depending on such factors as location, availability of land and chemicals, flow to be treated, treatment technology selected where competing alternatives exist, and extent of preliminary modifications required to accept the indicated control and treatment devices. Estimated total costs shown are only incremental costs required above those facilities which are normally existing within a plant and/or have been installed as a result of complying with BPCTCA standards.

1. Unit Melting Operations. 0.0316 kg/kkg (0.063 lbs of zinc/ton) of metal poured, equivalent to 5 mg/l in a discharge flow of 1,500 gal./ton of metal poured.

Fluoride. The recommended BPCTCA ELG for fluoride for the Multiple Operations subcategory shall be that recommended specifically for BPCTCA ELG for the Unit Melting Operations subcategory.

1. Unit Melting Operations. 0.125 kg/kkg (0.250 lbs of fluoride/ton) of metal poured, equivalent to 20 mg/l in a discharge flow of 1,500 gal./ton of metal poured.

pH. All of the unit operations for each subcategory as fell within the pH constraints range of 6.0 to 9.0, thus providing a basis for establishing this range as BPCTCA ELG for pH. Any unit operation or multiple operation facility falling outside of this range can readily remedy the situation by applying appropriate neutralizing procedures in the treatment process.

## TREATMENT MODELS

Treatment models of systems to achieve the effluent quality for each subcategory have been developed. Sketches of the BPCTCA models are presented in Figures 28 through 30. The development included not only a determination that a treatment facility of the type developed for each subcategory could achieve the effluent quality proposed but it included a determination of the capital investment and the total annual operating costs for the average size facility. In all subcategories these models are based on the combination of unit (waste treatment) operations in an "add-on" fashion as required to control the significant waste parameters. The unit operations were each selected as the least expensive means to accomplish their particular function and thus their combination into a treatment model presents the least expensive method of control for a given subcategory.

## COST EFFECTIVENESS DIAGRAMS

Figures 31B through 34E presented in Section X show the pollutant reduction achieved by each step of the treatment models discussed in Tables 16 through 22 and the cumulative cost, including base level, to achieve that reduction. The curves are discussed in more detail in Section X.

# SECTION X

## EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

### EFFLUENT LIMITATIONS GUIDELINES

### INTRODUCTION

The effluent limitations which must be achieved by July 1, 1983 are to specify the degree of effluent reduction attainable through the application of the best available technology economically achievable. Best available technology is not based upon an average of the best performance within an industrial category, but is to be determined by identifying the very best control and treatment technology employed by a specific point source within the industrial category or subcategory, or where it is readily transferable from one industry to another, such technology may be identified as BATEA technology. A specific finding must be made as to the availability of control measures and practices to eliminate the discharge of pollutants, taking into account the cost of such elimination.

Consideration must also be given to:

1. The size and age of equipment and facilities involved.

2. The processes employed.

3. Non-water quality environmental impact (including energy requirements).

4. The engineering aspects of the application of various types of control techniques.

5. Process changes.

6. The cost of achieving the effluent reduction resulting from application of BATEA technology.

Best available technology assesses the availability in all cases of in-process changes or controls which can be applied to reduce waste loads as well as additional treatment techniques which can be applied at the end of a production process. Those plant processes and control technologies which at the pilot plant, semi-works, or other level, have demonstrated both technological performances and economic viability at a level sufficient to reasonably justify investing in such facilities may be considered in assessing best available technology.

Best available technology is the highest degree of control technology that has been achieved or has been demonstrated to be capable of being designed for plant scale operation up to and including "no discharge" of pollutants. Although economic factors are considered in the development, the costs for this level of control is intended to be the top-of-the-line current technology subject to limitations imposed by economic and engineering feasibility. However, this level may be characterized by some technical risk with respect to performance and with respect to certainty of costs. Therefore, the BATEA limitations may necessitate some industrially sponsored development work prior to its application.

## RATIONALE FOR THE SELECTION OF BATEA

The following paragraphs summarize the factors that were considered in selecting the categorization, water use rates, level of treatment technology, effluent concentrations attainable by the technology, and hence the establishment of the effluent limitations for BATEA.

### Size and Age of Facilities and Land Availability Considerations

As discussed in Section IV, the age and size of iron and steel foundry industry facilities has little direct bearing on the quantity or quality of wastewater generated. Thus, the ELG for a given subcategory of waste source applies equally to all plants regardless of size or age. Land availability for installation of add-on treatment facilities can influence the type of technology utilized to meet the ELGs. This is one of the considerations which can account for a range in the costs that might be incurred.

### Consideration of Processes Employed

All plants in a given subcategory use the same or similar production methods, giving similar discharges. There is no evidence that operation of any current process or subprocess will substantially affect capabilities to implement the best available control technology economically achievable. At such time that new processes appear imminent for broad application the ELGs should be amended to cover these new sources. No process changes are envisioned for implementation of this technology for plants in any subcategory. The treatment technologies to achieve BATEA assess the availability of in-process controls as well as control or additional treatment techniques employed at the end of a production process.

## Consideration of Non-Water Quality Environmental Impact

Impact of Proposed Limitations on Air Quality. The impact of BATEA limitations upon the non-water elements of the environment has been considered. The increased use of recycle systems have the potential for increasing the loss of volatiles to the atmosphere. Recycle systems are so effective in reducing wastewater volumes and hence waste loads to and from treatment systems and in reducing the size and cost of treatment systems that a trade-off must be accepted. These systems have contributed significantly to reductions of effluent loads while contributing only minimally to air pollution problems. Careful operation of such systems can avoid or minimize air pollution problems.

Impact of Proposed Limitations on Solid Waste Problems. Consideration has also been given to the solid waste aspects of water pollution controls. The processes for treating the wastewaters from this industry produce considerable volumes of sludges. Much of this material is inert sand and iron oxide which can be reused profitably. Other sludges not suitable for reuse must be disposed of to landfills since most of them are chemical precipitates which could be little reduced by incineration. Being precipitates they are by nature relatively insoluble and nonhazardous substances requiring minimal custodial care.

Impact of Proposed Limitations Due to Hazardous Materials. In order to ensure long-term protection of the environment from harmful constituents, special consideration of disposal sites should be made. All landfill sites should be selected so as to prevent horizontal and vertical migration of these contaminants to ground or surface waters. In cases where geologic conditions may not reasonably ensure this, adequate mechanical precautions (e.g., impervious liners) should be taken to ensure long-term protection to the environment. A program of routine periodic sampling and analysis of leachates is advisable. Where appropriate the location of solid hazardous materials disposal sites, if any, should be permanently recorded in the appropriate office of legal jurisdiction.

Impact of Proposed Limitations on Energy Requirements. The effects of water pollution control measures on energy requirements has also been determined. The additional energy required in the form of electric power to achieve the effluent limitations proposed for BPCTCA and BATEA amounts to approximately 1.3% of the electrical energy used by the iron and steel foundry industry in 1972.

The enhancement to water quality management provided by these proposed effluent limitations substantially outweighs the impact on air, solid waste, and energy requirements.

Consideration of the Engineering Aspects of the Application of Various Types of Control Techniques

This level of technology is considered to be the best available and economically achievable in that the concepts are proven and available for implementation and may be readily applied through adaptation or as add-ons to proposed BPCTCA treatment facilities.

Consideration of Process Changes

No process changes are envisioned for implementation of this technology for plants in any subcategory. The treatment technologies to achieve BATEA assesses the availability of in-process controls as well as control or additional treatment techniques employed at the end of a production process.

Consideration of Costs of Achieving the Effluent Reduction Resulting from the Application of BATEA Technology

The costs of implementing the BATEA limitations relative to the benefits to be derived is pertinent but is expected to be higher per unit reduction in waste load achieved as higher quality effluents are produced. The overall impact of capital and operating costs relative to the value of the products produced and revenues generated was considered in establishing the BATEA limitations.

The technology evaluation, treatment facility, costing, and calculation of overall capital and operating costs, to the industry as described in Section IX and which provided the basis for the development of the BPCTCA limitations was also used to provide the basis for determining the BATEA limitations, the costs therefore, and the acceptability of those costs.

The initial capital investment and total annual expenditures required of the industry to achieve BATEA limitations are summarized in Table 31.

After selection of the treatment technology to be designated as one means to achieve the BATEA limitations for each subcategory was made, a sketch of each treatment model was prepared.

IDENTIFICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE - BATEA

Based on the information contained in Sections III through VIII of this report, a determination has been made that the quality of effluent attainable through the application of the Best Available Technology Economically Achievable is as listed in Tables 27 through 30. These tables set forth the ELGs for the following subcategories of the iron and steel foundry industry:

I. Melting Operations
II. Molding and Cleaning Dust Collection Operations
III. Sand Washing Operations
IV. Multiple Operations

In establishing the subject guidelines, it should be noted that the resulting limitations or standards are applicable to aqueous waste discharges only, exclusive of noncontact cooling waters. In the section of this report which discusses control and treatment technology for the iron and steel foundry industry as a whole, a qualitative reference has been given regarding "the environmental impact other than water" for the subcategories investigated.

The effluent guidelines established herein taken into account only those aqueous constituents considered to be major pollutants in each of the subcategories investigated. In general, the critical parameters were selected for each subcategory on the basis of those waste constituents known to be generated in the specific manufacturing process and also known to be present in sufficient quantity to be inimical to the environment. Certain general parameters such as suspended solids naturally include the oxides of iron and silica, however, these latter specific constituents were not included as critical parameters, since adequate removal of the general parameters (suspended solids) in turn provides for adequate removal of the more specific parameters indicated. This does not hold true when certain of the parameters are in the dissolved state; however, in the case of sand and iron oxides generated in the iron and steel foundry processes, they are for the most part insoluble in the relatively neutral effluents in which they are contained. The absence of apparent less important parameters from the guidelines in no way endorses unrestricted discharge of the same.

The recommended effluent limitations guidelines resulting from this study for BATEA limitations are summarized in Tables 27 to 30. These tables also list the control and treatment technology applicable or normally utilized to reach the constituent levels indicated. These effluent limitations set herein are by no means the absolute lowest values attainable (except where no discharge of process wastewater pollutants to navigable waters is recommended) by the indicated technology, but moreover they represent values which can be readily controlled around on a day-by-day basis.

It should be noted that these effluent limitations represent values not to be exceeded by any 30 continuous day average. The maximum daily effluent loads per unit of production should not exceed these values by a factor of three as discussed in Section IX.

## Cost Versus Effluent Reduction Benefits

Estimated total costs on a dollars per ton basis have been included for each subcategory as a whole. These costs have been based on the wastewaters emanating from a typical average size production facility for each of the subcategories investigated. In arriving at these effluent limitations guidelines, due consideration was given to keeping the costs of implementing the new technology to a minimum. Specifically, the effluent limitations guidelines were kept at values which would not result in excessive capital or operating costs to the industry. The capital and annual operating costs that would be required of the industry to achieve BATEA was determined by a six-step process for each of the four subcategories. It was first determined what treatment processes were already in place and currently being utilized by most of the plants. Secondly, a hypothetical treatment system was envisioned which, as an add-on to existing facilities would treat the effluent sufficiently to meet BATEA ELGs. Thirdly, the average plant size was determined by dividing the total industry production by the number of operation facilities. Fourth, a quasi-detailed engineering estimate was prepared on the cost of the components and the total capital cost of the add-on facilities for the average plant. Fifth, the annual operating, maintenance, capital recovery (basis 10 years straight line depreciation) and capital use (basis 7% interest) charges were determined. And sixth, the costs developed for the average facility were multiplied by the total number of facilities to arrive at the total capital and annual costs to the industry for each subcategory. The results are summarized in Table 31.

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BATEA EFFLUENT LIMITATIONS GUIDELINES

The BATEA limitations have been established in accordance with the policies and definitions set forth at the beginning of this section. Further refinements of some of the technologies and the ELGs discussed in the previous Section IX of this study will be required. The subject BATEA limitations are summarized in Tables 27 to 30 along with their projected costs and treatment technologies.

DISCUSSION BY SUBCATEGORIES

The rationale used for developing BATEA effluent limitations guidelines is summarized below for each of the major subcategories. All effluent limitations guidelines are presented on a "gross" basis since for the most part, removals are relatively independent of initial concentrations of contaminants. The ELGs are in kilograms of pollutant per metric ton of product or in pounds of pollutant per thousand pounds of product and in these terms only. The ELGs are not a limitation on flow, type of technology to be utilized, or concentrations to be achieved. These items are listed only to show the basis for the ELGs and may be varied as the discharger desires so long as the ELGs per unit of production are met.

Melting Operations

Following is a summary of the factors used to establish the BATEA effluent limitation guidelines (ELGs) applying to the Melting Operations subcategory. As far as possible, the stated limits are based upon performance levels attained by the selected plants surveyed during this study. Where treatment levels can be improved by application of additional currently available control and treatment technology, the anticipated reduction of waste loads was included in the estimates.

The BATEA ELGs for the Melting Operations subcategory, and the control and treatment technology to achieve these limits, are summarized in Table 27.

Flow. One of the unit melting operations surveyed recycling wastewater from the furnace emission control process utilized caustic addition for pH adjustment and corrosion control and polyelectrolyte addition followed by clarification for solids removal. All wastewater was recycled resulting in a zero aqueous discharge. Another unit melting operation simply discharged all its raw wastewater to a large holding tank for overnight settling of solids and natural equilibration of the wastewater resulting in zero aqueous discharge from the unit melting operation.

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One unit melting operation surveyed in this study employed 98% recycle of wastewater from the furnace emission control system. This was accomplished through the utilization of caustic addition for corrosion control and pH adjustment. Solids from raw waste flow were removed in a drag tank with continuous bottom drag chain. The effluent from the drag tank was discharged to a holding tank and then pumped to centrifugal degritters for further solids removal. The solids thus removed were transferred to the drag tank for exclusion from the system. The effluent from the degritters was further processed by sand filtration to remove the finer suspended solid particles. The filters were backwashed periodically with the backwash receiving flash mixing with polyelectrolyte followed by clarification with a discharge flow of 208 l/kkg (50 gal./ton) of metal poured.

This same unit melting operation also operated a recycling wet slag quench process with 96% recycle of wastewater. Solids were removed by a continuous bottom drag chain in the slag quench pit, followed by direct discharge of the blowdown at 917 l/kkg (220 gal./ton) of metal poured.

The quality of this slag quench blowdown waste stream was far superior to that which was being recycled back to the furnace emission control system. Further, it compared quite favorably with the fresh makeup water being applied to the furnace emission control stack gas quench ring. Water consumption of the stack gas quench ring was three times that of the slag quench process blowdown. Slag quench wastewater discharges are commonly used as part of the makeup water routinely consumed by furnace emission control systems. Quite often the entire raw waste load from the slag quenching process is discharged directly into and/or combined with the total raw waste load from the furnace emission control system. Alternatively, just the slag quench blowdown itself can be combined with the recycled wastewater returned to the furnace emission control system. Any of the above alternatives affects a zero aqueous discharge from the slag quench process.

It is felt that the subject unit melting operations could conveniently incorporate the blowdown from the slag quench process with other wastewater recycled back to the furnace emission control system and thus affect a zero aqueous discharge from the slag quench process. This would result in a 98% recycle of all wastewater applied to unit melting operations while still achieving the previously stated 208 l/kkg (50 gal./ton) of metal poured from the wastewater treatment system. This modification would affect an 80%

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reduction of the current 1,125 l/kkg (270 gal./ton) of metal poured while still satisfying all the water application requirements of the unit melting operations. However, this modification has yet to be executed by the unit melting operations.

Although zero discharge has been successfully achieved at several melting operations, it is not recommended at this time due to the fact that this complete practice may not be universally applicable. The BATEA ELG recommended discharge flow rate is felt to be very conservative when set at slightly above the combined total discharge flow rate from this unit melting operation. Therefore, the BATEA ELG recommended discharge flow rate is set at 1,250 l/kkg (300 gal./ton) of metal poured.

Suspended Solids. The unit melting operation operating the slag quench under flow was discharging a suspended solids waste load of 0.00266 kg/kkg (0.0053 lbs/ton) of metal poured from the furnace emission control wastewater treatment system, and 0.0812 kg/kkg (0.162 lbs/ton) of metal poured from its slag quench process. It is felt that the slag quench process discharge could be used as makeup water to the emission control system. This would result in a negligible increased suspended solids load of 1.3% on the treatment system which is currently successfully treating a suspended solids raw waste load of 62.1 kg/kkg (124 lbs/ton) of metal poured. Further, this unit was only discharging 208 l/kkg (50 gal./ton) of metal poured from the wastewater treatment system. Using the same suspended solids load factor of the treatment system discharge, but with a discharge flow rate adjusted upward to the BATEA ELG recommended discharge flow of 1,250 l/kkg (300 gal./ton) of metal poured, the suspended solids discharge load would be equivalent to 0.0159 kg/kkg (0.0318 lbs/ton) of metal poured.

In view of the above rationale, BATEA ELG is felt to be very conservative when set at twice this value. Therefore, the BATEA ELG for suspended solids is set at 0.0313 kg/kkg (0.0626 lbs of suspended solids/ton) of metal poured, equivalent to 25 mg/l suspended solids in a discharge flow of 300 gal./ton of metal poured.

Oil and Grease. This same unit melting operation discussed under BATEA flow, was discharging an oil and grease load of 0.000716 kg/kkg (0.00143 lbs/ton) of metal poured from its furnace emission control wastewater treatment system, and 0.00316 kg/kkg (0.00631 lbs/ton) of metal poured from its slag quench process. It is felt that the slag quench

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process discharge should be used as makeup water to the furnace emission control system. This would result in a negligible increased oil and grease of 1.48% on the treatment system which is currently successfully treating an oil and grease raw waste load of 0.213 kg/kkg (0.4263 lbs/ton) of metal poured. Further, this unit was only discharging 208 l/kkg (50 gal./ton) of metal poured from the treatment system. Using the same oil and grease load factor of the treatment system discharge flow but with a discharge rate adjusted upward to the BATEA ELG recommended discharge flow of 1,250 l/kkg (300 gal./ton) of metal poured, the oil and grease load would be equivalent to 0.00858 kg/kkg (0.00143 lbs/ton) of metal poured. Basing this load on the recommended BATEA ELG discharge flow of 1,250 l/kkg (300 gal./ton) of metal poured, results in concentrations too low to adequately measure by most readily available analytical techniques. Therefore, the BATEA ELG for oil and grease is conservatively set at 0.0125 kg/kkg (0.0250 lbs of oil and grease/ton) of metal poured, equivalent to 10 mg/l in a discharge flow of 300 gal./ton of metal poured.

Lead. The unit melting operation discussed under flow was discharging a lead waste load of 0.000760 kg/kkg (0.000380 lbs/ton) of metal poured from its furnace emission control wastewater treatment system and 0.000586 kg/kkg (0.00117 lbs/ton) of metal poured from its slag quench process. It is felt that the slag quench process discharge should be used as makeup water to the emission control system. This would result in a negligible increased lead load of 2.90% on the treatment system which is currently successfully treating a lead raw waste load of 2.02 kg/kkg (4.03 lbs/ton) of metal poured. Further, this unit was only discharging 208 l/kkg (50 gal./ton) of metal poured from the treatment system. Using the same lead load factor of the treatment system discharge, but with a discharge rate adjusted upward to the BATEA ELG recommended discharge flow 1,250 l/kkg (300 gal./ton) of metal poured, the lead discharge load would be equivalent to 0.00114 kg/kkg (0.00228 lbs of lead/ton) of metal poured. Therefore, the BATEA ELG for lead is set slightly above this value at 0.00125 kg/kkg (0.00250 lbs of lead/ton) of metal poured, equivalent to 1 mg/l of lead in 300 gal./ton of metal poured.

Manganese. The unit melting operation discussed under flow was discharging a manganese waste load of 0.000440 kg/kkg (0.000878 lbs/ton) of metal poured from its furnace emission control wastewater treatment system, and 0.00105 kg/kkg (0.00209 lbs/ton) of metal poured from its slag quench process. It is felt that the slag quench process discharge

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should be used as makeup water to the emission control system. This would result in a negligible increased manganese load of 1.09% on the treatment system which is currently successfully treating a manganese raw waste load of 2.62 kg/kkg (5.23 lbs/ton) of metal poured. Further, this unit was only discharging 209 l/kkg (50 gal./ton) of metal poured from the treatment system. Using the same manganese load factors of the treatment system discharge, but with a discharge rate adjusted upward to BATEA ELG recommended discharge flow of 1,250 l/kkg (300 gal./ton) of metal poured, the manganese discharge load would be equivalent to 0.00263 kg/kkg (0.00525 lbs/ton) of metal poured. Therefore, the BATEA ELG for manganese is set slightly above this value at 0.00375 kg/kkg (0.00750 lbs of manganese/ton) of metal poured, equivalent to 3 mg/l of manganese in 300 gal./ton of metal poured.

Zinc. The unit melting operation discussed in flow was discharging a zinc waste load of 0.000715 kg/kkg (0.00143 lbs/ton) of metal poured from its furnace emission control waste treatment system and 0.00180 kg/kkg (0.00360 lbs/ton) of metal poured from its slag quench process. It is felt that the slag quench process discharge could be used as makeup water to the emission control system. This would result in a negligible increased zinc load of 0.0178% on the treatment system which is currently successfully treating a raw zinc load of 10.1 kg/kkg (20.2 lbs/ton) of metal poured. Further, this unit was only discharging 208 l/kkg (50 gal./ton) of metal poured from the treatment system. Using this same zinc load factor of the treatment system discharge, but with a discharge rate adjusted upward to BATEA ELG recommended discharge flow 1,250 l/kkg (300 gal./ton) of metal poured, the zinc discharge load would be equivalent to 0.00442 kg/kkg (0.00882 lbs/ton) of metal poured. Therefore, the BATEA ELG for zinc is set slightly less than this value at 0.00375 kg/kkg (0.00750 lbs of zinc/ton) of metal poured, equivalent to 3 mg/l of zinc in 300 gal./ton of metal poured.

Sulfide. The unit melting operation discussed under flow was discharging a sulfide waste load of 0.000471 kg/kkg (0.000940 lbs/ton) of metal poured from its furnace emission control system, and 0.000451 kg/kkg (0.000901 lbs/ton) of metal poured from its slag quench process. It is felt that the slag quench process discharge could be used as makeup water to the emission control system. This would result in a negligible increased sulfide load of 2.36% on the treatment system which is currently successfully treating a sulfide raw waste load of 0.0191 kg/kkg (0.0382 lbs/ton) of metal poured. Further, this unit was only discharging 208 l/kkg

(50 gal./ton) of metal poured from the treatment system. Using the same sulfide load factor of the treatment system but with a discharge flow adjusted upward to BATEA ELG recommended discharge flow 1,250 l/kkg (300 gal./ton) of metal poured, the sulfide discharge load would be equivalent to 0.00283 kg/kkg (0.00564 lbs/ton) of metal poured. However, the decrease of the wastewater recycle rate from 98% to 90% would greatly aid the oxidation of sulfide to even lower levels than the current 0.000471 kg/kkg (0.000940 lbs/ton) of metal poured. Therefore, the BATEA ELG for sulfide is being conservatively set at 0.00157 kg/kkg (0.00313 lbs of sulfide/ton) of metal poured, equivalent to 1.25 mg/l of sulfide in 300 gal./ton of metal poured.

<u>Fluoride</u>. The unit melting operation discussed under flow was discharging a fluoride waste load of 0.00420 kg/kkg (0.00840 lbs/ton) of metal poured from its furnace emission control wastewater treatment system, and 0.000586 kg/kkg (0.00117 lbs/ton) of metal poured from its slag quench process. It is felt that the slag quench process discharge could be used as makeup water to the emission control system. This would result in a negligible increased fluoride load of 0.0413% on the treatment system which is currently successfully treating a fluoride raw waste load of 0.177 kg/kkg (0.353 lbs/ton) of metal poured. Further, this unit is only discharging 208 l/kkg (50 gal./ton) of metal poured from the treatment system. Using the same fluoride load factor of the treatment system discharge, but with a discharge rate adjusted upward to BATEA ELG recommended discharge flow 1,250 l/kkg (300 gal./ton) of metal poured, the fluoride discharge load would be equivalent to 0.00577 kg/kkg (0.0155 lbs/ton) of metal poured. However, the appearance of fluoride in waste loads is largely a function of the constituents used in the melting process. Gross fluoride loads are commonly controlled by the addition of lime for pH adjustment. Therefore, the BATEA ELG for fluoride is being conservatively set at 0.0157 kg/kkg (0.0313 lbs of fluoride/ton) of metal poured, equivalent to 12.5 mg/l of fluoride in 300 gal./ton of metal poured.

<u>pH</u>. All unit melting operations surveyed fell within the pH constraint range of 6.0 to 9.0 for final effluent, thus providing a basis for establishing this range as the BATEA ELG. Any plant falling outside this range can easily remedy the situation by applying appropriate neutralization procedures to the final effluent.

TABLE 27

BATEA - EFFLUENT LIMITATIONS GUIDELINES

SUBCATEGORY Melting Operations

| CRITICAL PARAMETERS | BATEA LIMITATIONS Kg/KKg[1] (LB/1000 LB) | BATEA LIMITATIONS mg/l[2] | CONTROL & TREATMENT TECHNOLOGY[3] | ESTIMATED[4] TOTAL COST $/KKg | ESTIMATED[4] TOTAL COST $/TON |
|---|---|---|---|---|---|
| Suspended Solids | 0.0313 | 25 | Sand filtration, with recycle of all filtrates; discharge of filtrate backwash to separator clarifier, with polymer addition and flash mixing. | 5.35 | 4.85 |
| Oil and Grease | 0.0125 | 10 | | | |
| Fluoride | 0.0157 | 12.5 | | | |
| Manganese | 0.00375 | 3 | | | |
| Lead | 0.00125 | 1 | | | |
| Zinc | 0.00375 | 3 | | | |
| Sulfide | 0.00157 | 1.25 | | | |
| pH | 6.0-9.0 | | | | |
| Flow | Most probable value for tight recycle system is 1250 liters of effluent per kkg of product (300 gal/ton); excluding all non-contact cooling water. | | | | |

(1) Kilograms per metric ton of metal poured or pounds per 1000 pounds of metal poured.
(2) Milligrams per liter based on 1250 liters effluent per kkg of steel produced (300 gal/ton).
(3) Available technology listed is not necessarily all inclusive nor does it reflect all possible combinations or permutations of treatment methods.
(4) Costs may vary some depending on such factors as location, availability of land and chemicals, flow to be treated, treatment technology selected where competing alternatives exist, and extent of preliminary modifications required to accept the indicated control and treatment devices. Estimated total costs shown are only incremental costs required above those facilities which are normally existing within a plant and/or have been installed as a result of complying with BPCTCA standards.

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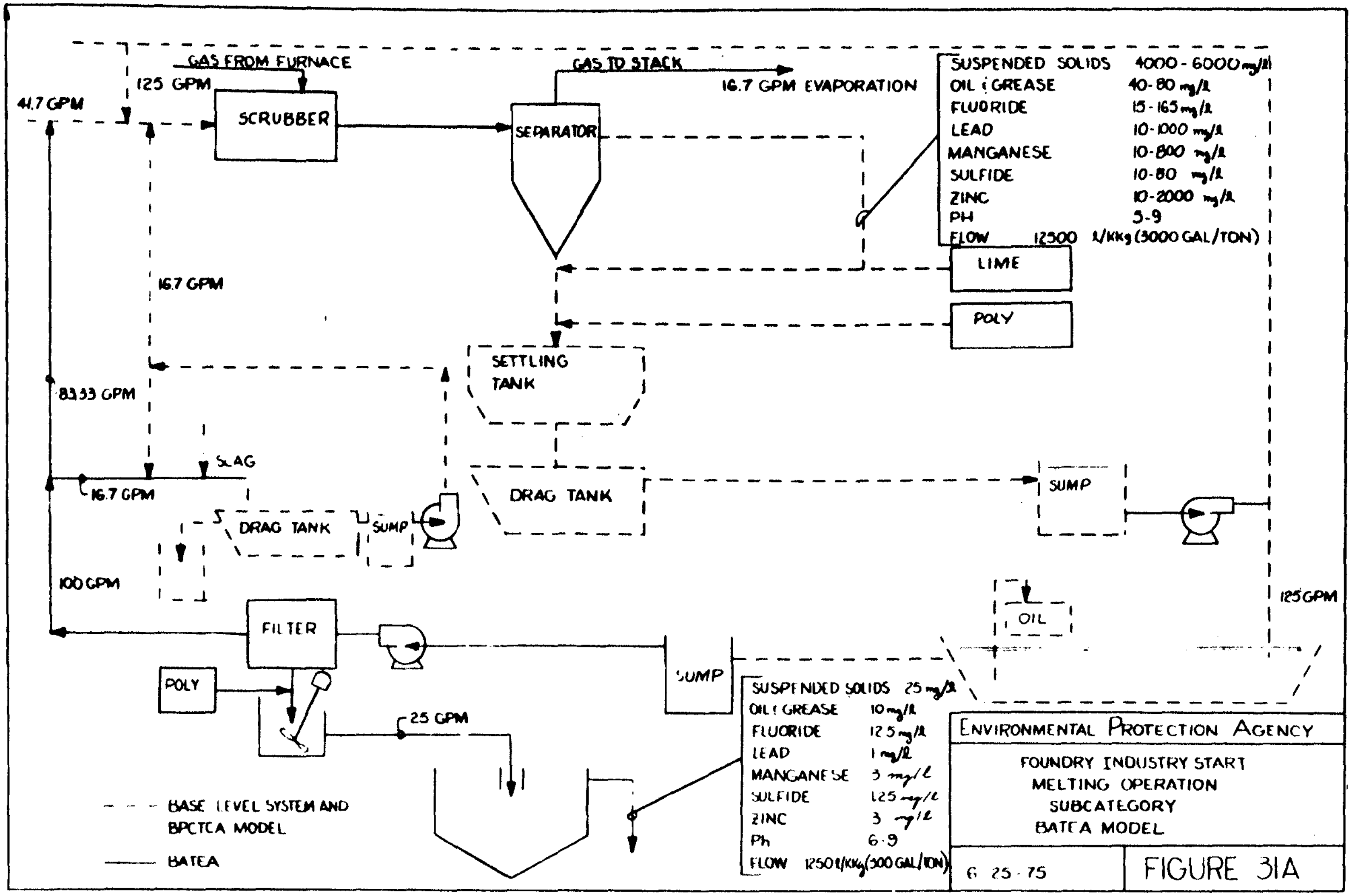
GAS FROM FURNACE
125 GPM
41.7 GPM
SCRUBBER
GAS TO STACK
16.7 GPM EVAPORATION
SEPARATOR
SUSPENDED SOLIDS 4000 - 6000 mg/l
OIL & GREASE 40-80 mg/l
FLUORIDE 15-165 mg/l
LEAD 10-1000 mg/l
MANGANESE 10-800 mg/l
SULFIDE 10-80 mg/l
ZINC 10-2000 mg/l
PH 5-9
FLOW 12500 l/kkg (3000 GAL/TON)
LIME
POLY
16.7 GPM
SETTLING TANK
83.33 GPM
SLAG
16.7 GPM
DRAG TANK
SUMP
DRAG TANK
SUMP
100 GPM
125 GPM
OIL
FILTER
SUMP
POLY
25 GPM
SUSPENDED SOLIDS 25 mg/l
OIL & GREASE 10 mg/l
FLUORIDE 12.5 mg/l
LEAD 1 mg/l
MANGANESE 3 mg/l
SULFIDE 1.25 mg/l
ZINC 3 mg/l
Ph 6-9
FLOW 1250 l/kkg (300 GAL/TON)
BASE LEVEL SYSTEM AND BPCTCA MODEL
BATEA
ENVIRONMENTAL PROTECTION AGENCY
FOUNDRY INDUSTRY START
MELTING OPERATION
SUBCATEGORY
BATEA MODEL
6-25-75
FIGURE 31A

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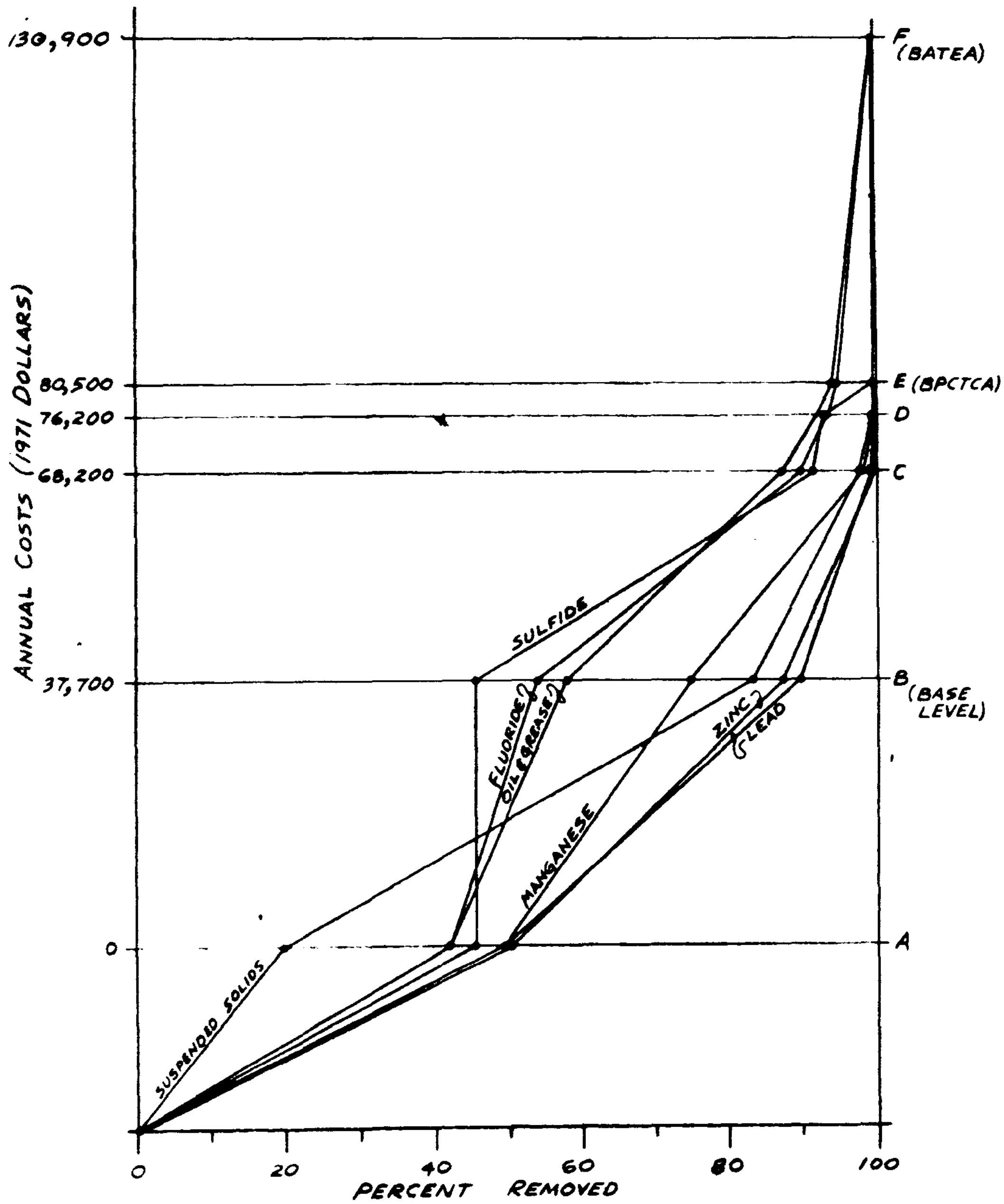
FIGURE 31B
MODEL COST EFFECTIVENESS DIAGRAM
MELTING SUBCATEGORY

ANNUAL COSTS = BASED ON TEN YEAR CAPITAL RECOVERY
+ INTEREST RATE 7%
+ OPERATING COSTS INCLUDE LABOR, CHEMICALS & UTILITIES
+ MAINTENANCE COSTS BASED ON 3.5% OF CAPITAL COSTS
COSTS BASED ON 36.3 KKG/DAY (40 TONS/DAY) PRODUCTION
THIS GRAPH CANNOT BE USED FOR INTERMEDIATE VALUES



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## Molding and Cleaning Dust Collection Operations

Following is a summary of the factors used to establish the BATEA effluent limitation guidelines (ELGs) applying to the Molding and Cleaning Dust Collection Operations subcategory. As far as possible, the stated limits are based upon performance levels attained by the selected plants surveyed during this study. Where treatment levels can be improved by application of additional currently available control and treatment technology, the anticipated reduction of waste loads was included in the estimates.

The BATEA ELGs for the Molding and Cleaning Dust Collection Operations subcategory, and the control and treatment technology to achieve these limits, are summarized in Table 28.

Flow. One unit molding and cleaning dust collection operation surveyed in this study was discharging the raw waste load from the operation to a lagoon for solids removal. All wastewater was recycled resulting in a zero aqueous discharge. It is felt that the practice employed by this unit operation may not be universally applied to all unit molding and cleaning dust collection operations. Therefore, zero aqueous discharge is not being recommended as the BATEA ELG treatment and control method technology.

Two of the unit molding and cleaning dust collection operations surveyed in this study were practicing recycle of wastewater from the operation. One utilized lime addition for pH adjustment of the recycled wastewater while the other provided no pH adjustment. In both cases, wastewaters were collected in a reservoir holding tank from which they were pumped to a wet cyclone separator for removal of solids. The wastewaters were then delivered to a second reservoir for continuous recycle back to the unit molding and cleaning dust collection operations. Solids from the cyclone separator were dewatered by a classifier operation. A portion of the wastewater effluent from the wet cyclone separator was taken as the system's blowdown.

In both cases, this blowdown received flash mixing with polyelectrolyte, or polyelectrolyte and alum. Waste loads were further reduced by delivering the flow to a clarifier, thickener. The overflow from the unit was delivered to discharge while the underflow solids were dewatered by a vacuum filter. The effluent flow from one unit molding and cleaning dust collection operation's waste treatment system was 129 l/kkg (31 gal./ton) of sand passing before the ladle, while the other was discharging 667 l/kkg (160 gal./ton)

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of sand passing before the ladle. The average discharge of the two units was 398 l/kkg (95.5 gal./ton) of sand passing before the ladle. Therefore, the recommended flow from unit molding and dust collection operations for BATEA ELG treatment and technology is set slight above this average at 417 l/kkg (100 gal./ton) of sand passing before the ladle. The unit operation exceeding this value could achieve it by closer control of its recycle rate.

Suspended Solids. The two unit molding and cleaning dust collection operations were discharging suspended solids ranging from 0.00542 kg/kkg (0.0108 lbs/ton) of sand passing before the ladle to 0.0334 kg/kkg (0.0667 lbs/ton) of sand passing before the ladle, with an average of 0.0194 kg/kkg (0.0388 lbs/ton) of sand passing before the ladle. However, the unit operation discharging the greater load far exceeded the BATEA ELG recommended flow, while the unit discharging the smaller load was under the BATEA ELG recommended flow. Therefore, the BATEA ELG for suspended solids is conservatively set at approximately twice this lower value, or 0.0104 kg/kkg (0.0208 lbs/ton) of sand passing before the ladle, equivalent to 25 mg/l of suspended solids in a discharge flow of 100 gal./ton of sand passing before the ladle.

The unit exceeding this value can readily achieve this limit by closer control of its recycle rate, and thus discharge less suspended solids load, or by closer control of the waste treatment system.

Oil and Grease. The two unit molding and cleaning dust collection operations were discharging oil and grease loads ranging from 0.000348 kg/kkg (0.000696 lbs/ton) of sand passing before the ladle, to 0.00401 kg/kkg (0.00800 lbs/ton) of sand passing before the ladle, with an average of 0.00218 kg/kkg (0.00435 lbs/ton) of sand passing before the ladle. However, selecting this average for the BATEA ELG would result in concentrations too low to adequately measure by the most readily available analytical techniques. Therefore, the BATEA ELG for oil and grease is conservatively set at 0.00417 kg/kkg (0.00833 lbs/ton) of sand passing before the ladle, equivalent to 10 mg/l in a discharge flow of 100 gal./ton of sand passing before the ladle.

pH. All molding and cleaning dust collection operations surveyed fell within the pH constraint range of 6.0 to 9.0, both for filter feeds and for final effluents, thus providing a basis for establishing this range as the BATEA ELG. Any plant falling outside this range can easily remedy the situation by applying appropriate neutralization procedures to the final effluent.

## TABLE 28

### BATEA - EFFLUENT LIMITATIONS GUIDELINES

### SUBCATEGORY Molding and Cleaning Dust Collection Operations

| CRITICAL PARAMETERS | BATEA LIMITATIONS Kg/KKg (1) (LB/1000 LB) | mg/l (2) | CONTROL & TREATMENT TECHNOLOGY (3) | ESTIMATED (4) TOTAL COST $/KKg | $/TON |
|---|---|---|---|---|---|
| Suspended Solids | 0.0104 | 25 | Tighter recycle system; side stream clarification via thickener, with vacuum filtration of underflows. | 0.797 | 0.723 |
| Oil and Grease | 0.00417 | 10 | | | |
| pH | 6.0-9.0 | | | | |
| Flow | Most probable value for tight recycle system is 417 liters of effluent per kkg of product (100 gal/ton); excluding all non-contact cooling water. | | | | |

(1) Kilograms per metric ton of sand in the system or pounds per 1000 pounds of sand passing before the ladle.
(2) Milligrams per liter based on 417 liters effluent per kkg of sand in the system (100 gal/ton).
(3) Available technology listed is not necessarily all inclusive nor does it reflect all possible combinations or permutations of treatment methods.
(4) Costs may vary some depending on such factors as location, availability of land and chemicals, flow to be treated, treatment technology selected where competing alternatives exist, and extent of preliminary modifications requried to accept the indicated control and treatment devices. Estimated total costs shown are only incremental costs required above those facilities which are normally existing within a plant and/or have been installed as a result of complying with BPCTCA standards.

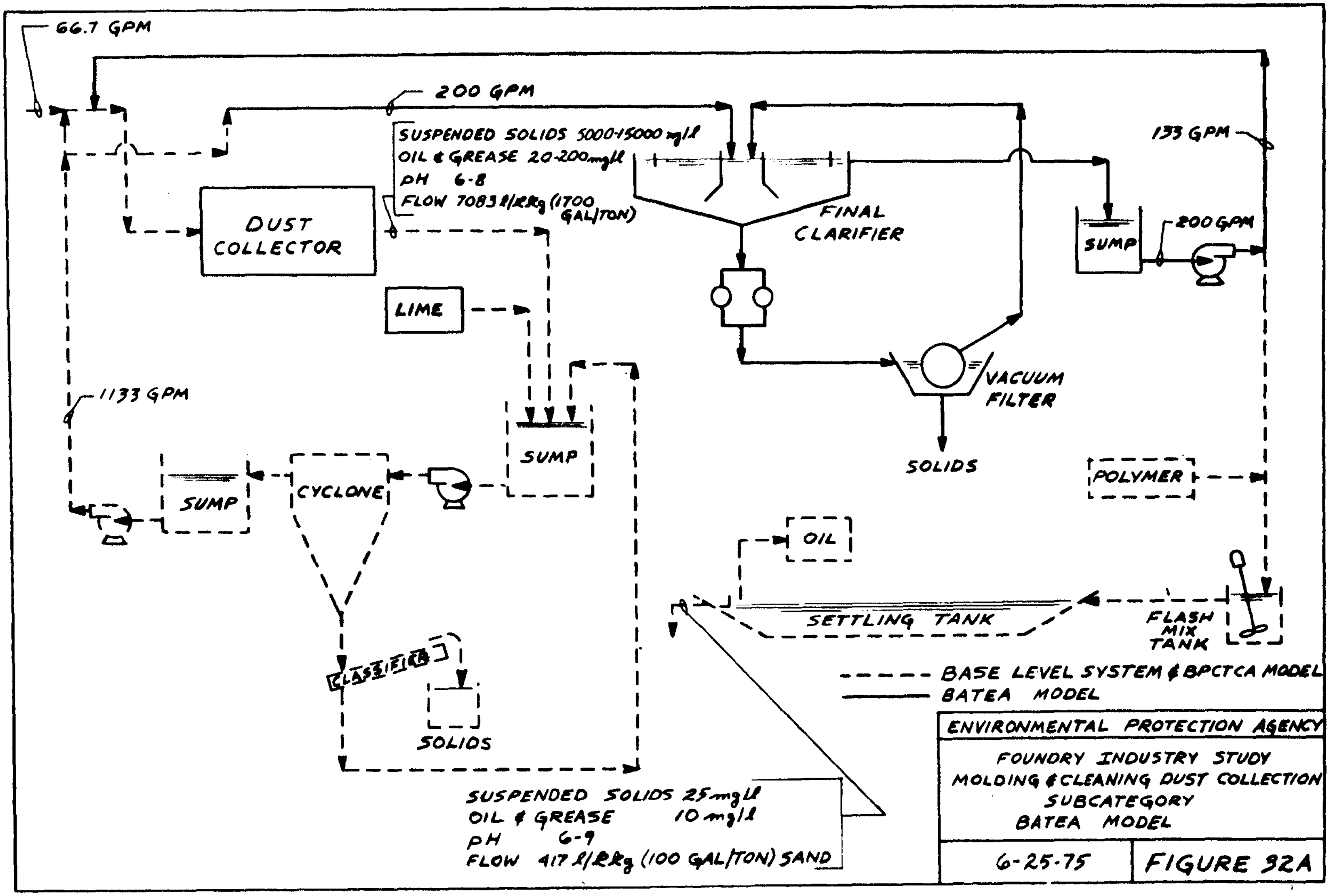
66.7 GPM
200 GPM
SUSPENDED SOLIDS 5000-15000 mg/l
OIL & GREASE 20-200 mg/l
pH 6-8
FLOW 7083 l/kkg (1700 GAL/TON)
133 GPM
DUST COLLECTOR
FINAL CLARIFIER
SUMP
200 GPM
LIME
VACUUM FILTER
1133 GPM
SUMP
CYCLONE
SUMP
SOLIDS
POLYMER
OIL
SETTLING TANK
FLASH MIX TANK
CLASSIFIER
SOLIDS
BASE LEVEL SYSTEM & BPCTCA MODEL
BATEA MODEL
SUSPENDED SOLIDS 25 mg/l
OIL & GREASE 10 mg/l
pH 6-9
FLOW 417 l/kkg (100 GAL/TON) SAND
ENVIRONMENTAL PROTECTION AGENCY
FOUNDRY INDUSTRY STUDY
MOLDING & CLEANING DUST COLLECTION
SUBCATEGORY
BATEA MODEL
6-25-75
FIGURE 32A



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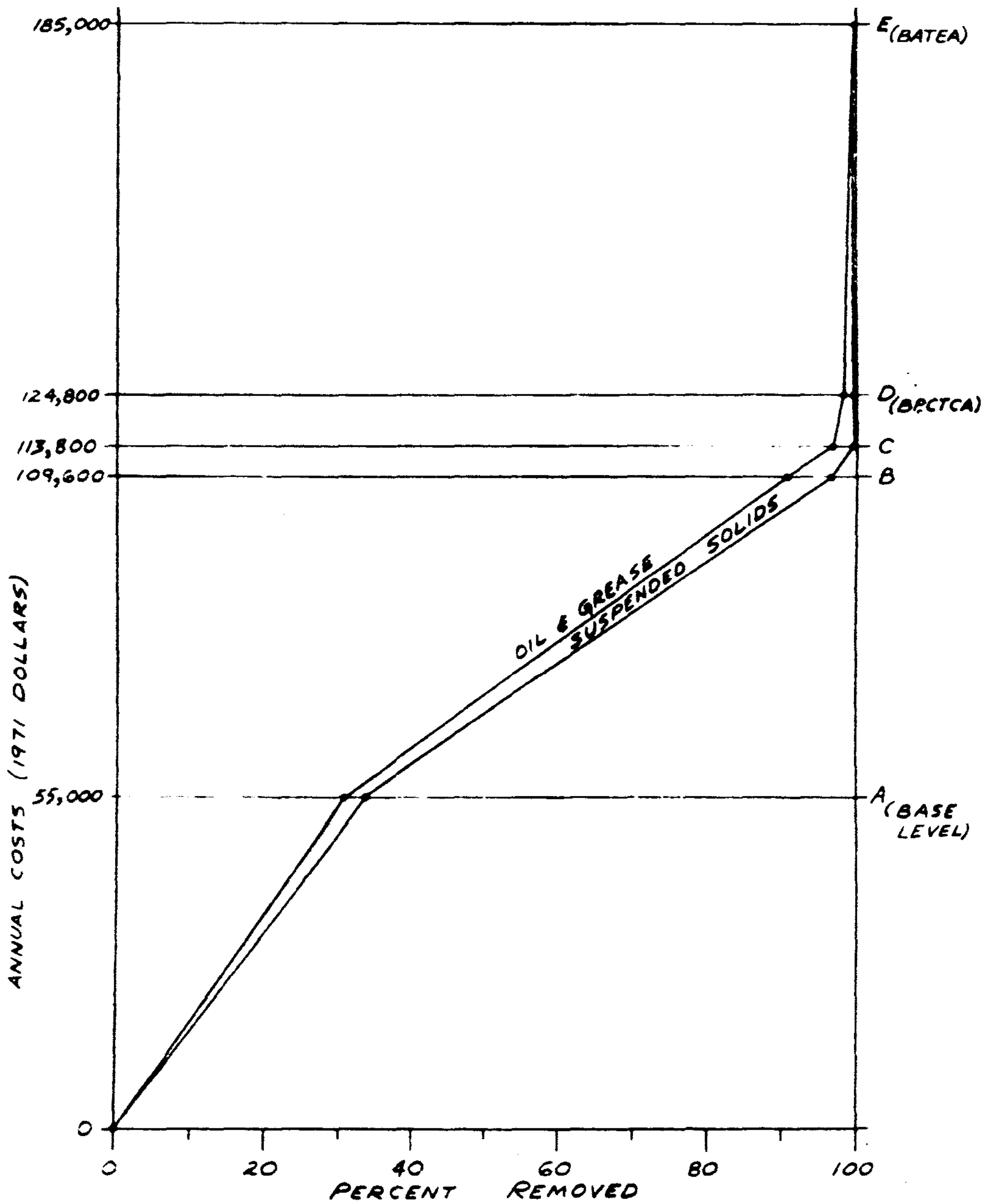
FIGURE 32 B
MODEL COST EFFECTIVENESS DIAGRAM
MOLDING & CLEANING DUST COLLECTION
SUBCATEGORY

ANNUAL COSTS = BASED ON TEN YEAR CAPITAL RECOVERY
+ INTEREST RATE 7%
+ OPERATING COSTS INCLUDE LABOR, CHEMICALS & UTILITIES
+ MAINTENANCE COSTS BASED ON 3.5% OF CAPITAL COSTS
COSTS BASED ON 36.3 KKG/DAY (40 TONS/DAY) PRODUCTION
THIS GRAPH <u>CANNOT</u> BE USED FOR INTERMEDIATE VALUES



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## Sand Washing Operations

Following is a summary of the factors used to establish the effluent limitation guidelines (ELGs) applying to the Sand Washing Operations subcategory. As far as possible, the stated limits are based upon performance levels attained by the selected plants surveyed during this study. Where treatment levels can be improved by application of additional currently available control and treatment technology, the anticipated reduction of waste loads was included in the estimates.

The BATEA ELGs for the Sand Washing Operations subcategory, and the control and treatment technology to achieve these limits, are summarized in Table 29.

Flow. Of the four sand washing unit operations surveyed in this study, two practiced once-through water usage with direct discharge; one practiced excellent water conservation by concurrent flow and sequential washing stages followed by direct discharge; while the fourth practiced recycle of wastewater with blowdown to discharge. Of these four plants, three discharged to multi-unit operation treatment system, while the fourth discharged to a receiving stream.

Process water applied flow rates ranged from 24,000 l/kkg (5,760 gal./ton) of sand washed downward to 417 l/kkg (100 gal.ton) of sand washed, with an average water application rate of 13,202 l/kkg (3,166 gal./ton) of sand washed. Discharge flows ranged from 22,743 l/kkg (5,454 gal./ton) of sand washed downward to 417 l/kkg (100 gal./ton) of sand washed.

Because of the wide range of effluent flows observed, the BATEA ELGs are based on flow rates set at approximately 10% of the average applied rate of the four units surveyed, achieving this reduction in flow via partial recycle of wastewater. This results in recommended BATEA flow rates of 1,250 l/kkg (300 gal./ton) of sand washed. This value is well within the capability of current technology to achieve, as evidenced by the unit already achieving this level. At the same time, this value will provide the impetus for once-through water users to develop recycle systems, while at the same time allowing them to achieve this end by 1983 in a cost effective manner. It is anticipated that as the once-through users begin to convert to recycle systems, they will find it economically advantageous to go all the way to tight recycle, rather than approach it in a stepwise manner.

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Suspended Solids. A review of unit effluent waste loads and levels of treatment technology practiced reveals that, except for recycle of wastewater, none of the units surveyed provided adequate treatment and control technology before discharge from the unit. However, waste loads from three of these units received further treatment in multi-unit process treatment systems.

The raw waste loads discharged from sand washing operations compare very favorably with those from the molding and cleaning dust collection operations. Therefore, a transfer of BATEA level treatment and control technology from the unit Molding and Cleaning Dust Collection Operations subcategory to the unit Sand Washing Operations subcategory is justified. It is felt that all unit sand washing operations could achieve BATEA ELGs equivalent to those for molding and cleaning dust collection operations by the addition of polyelectrolyte, plain sedimentation or clarification. The BATEA ELG for suspended solids for the Molding and Cleaning Dust Collection Operations subcategory is 0.0104 kg/kkg (0.0208 lbs/ton) of sand passing before the ladle. However, due to the fact that the water application rate for the unit sand washing operations is two to three times that of the unit molding and cleaning dust collection operations, it is felt that an additional allowance should be provided. Therefore, the BATEA ELG for suspended solids for the unit Sand Washing Operations subcategory is conservatively set at 0.0313 kg/kkg (0.0625 lbs of suspended solids/ton) of sand washed, equivalent to 25 mg/l in a discharge flow of 300 gal./ton of sand washed.

Oil and Grease. Of the four unit sand washing operations surveyed in this study, one showed oil and grease waste loads in effluent stream of less than 0.0125 kg/kkg (0.0250 lbs/ton) of sand washed. The remaining unit could achieve this level by the accepted practice of oil skimming. Therefore, the BATEA ELG for oil and grease is set at 0.0125 kg/kkg (0.0250 lbs of oil and grease/ton) of sand washed, equivalent to 10 mg/l in 300 gal./ton of sand washed.

pH. All of the units surveyed fell within the pH constraints range of 6.0 to 9.0, thus providing a basis for establishing this range as BATEA ELG for pH. Any unit falling outside of this range can readily remedy the situation by applying appropriate neutralization procedures in the treatment process.

TABLE 29

BATEA - EFFLUENT LIMITATIONS GUIDELINES

SUBCATEGORY Sand Washing Operations

| CRITICAL PARAMETERS | BATEA LIMITATIONS Kg/KKg[1] (LB/1000 LB) | BATEA LIMITATIONS mg/l[2] | CONTROL & TREATMENT TECHNOLOGY[3] | ESTIMATED[4] TOTAL COST $/KKg | ESTIMATED[4] TOTAL COST $/TON |
|---|---|---|---|---|---|
| Suspended Solids | 0.0313 | 25 | Tighter recycle system; side stream clarification via thickener, with vacuum filtration of underflows. | 5.60 | 5.08 |
| Oil and Grease | 0.0125 | 10 | | | |
| pH | 6.0-9.0 | | | | |
| Flow | Most probable value for tight recycle system is 1250 liters of effluent per kkg of product (300 gal/ton); excluding all non-contact cooling water. | | | | |

(1) Kilograms per metric ton of sand washed or pounds per 1000 pounds of sand washed.
(2) Milligrams per liter based on 1250 liters effluent per kkg of sand washed (300 gal/ton).
(3) Available technology listed is not necessarily all inclusive nor does it reflect all possible combinations or permutations of treatment methods.
(4) Costs may vary some depending on such factors as location, availability of land and chemicals, flow to be treated, treatment technology selected where competing alternatives exist, and extent of preliminary modifications required to accept the indicated control and treatment devices. Estimated total costs shown are only incremental costs required above those facilities which are normally existing within a plant and/or have been installed as a result of complying with BPCTCA standards.

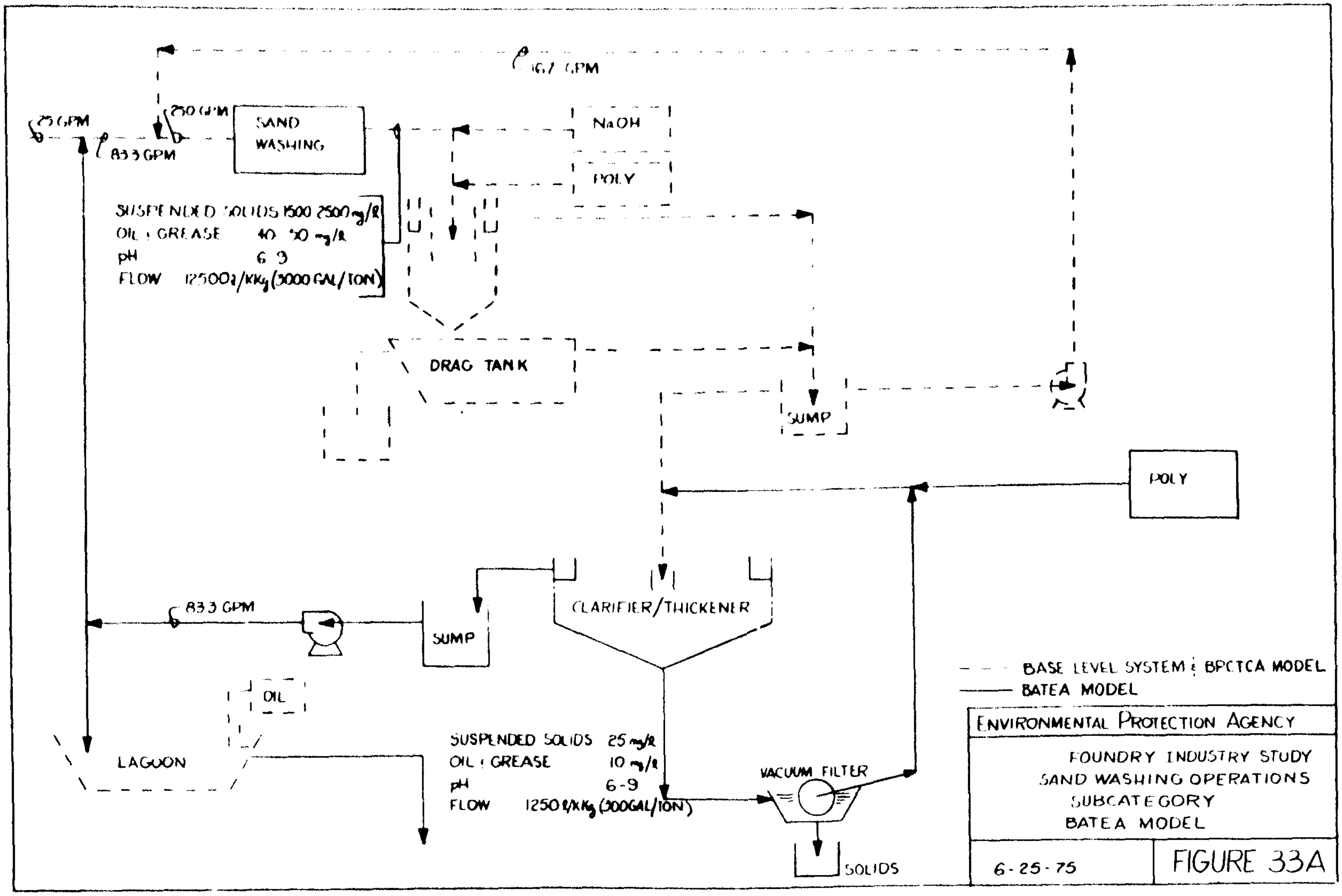
167 GPM
25 GPM
250 GPM
83.3 GPM
SAND WASHING
NaOH
POLY
SUSPENDED SOLIDS 1500-2500 mg/l
OIL + GREASE 40-50 mg/l
pH 6-9
FLOW 12500 l/kkg (3000 GAL/TON)
DRAG TANK
SUMP
POLY
CLARIFIER/THICKENER
83.3 GPM
SUMP
OIL
LAGOON
SUSPENDED SOLIDS 25 mg/l
OIL + GREASE 10 mg/l
pH 6-9
FLOW 1250 l/kkg (300 GAL/TON)
VACUUM FILTER
SOLIDS
BASE LEVEL SYSTEM & BPCTCA MODEL
BATEA MODEL
ENVIRONMENTAL PROTECTION AGENCY
FOUNDRY INDUSTRY STUDY
SAND WASHING OPERATIONS
SUBCATEGORY
BATEA MODEL
6-25-75
FIGURE 33A

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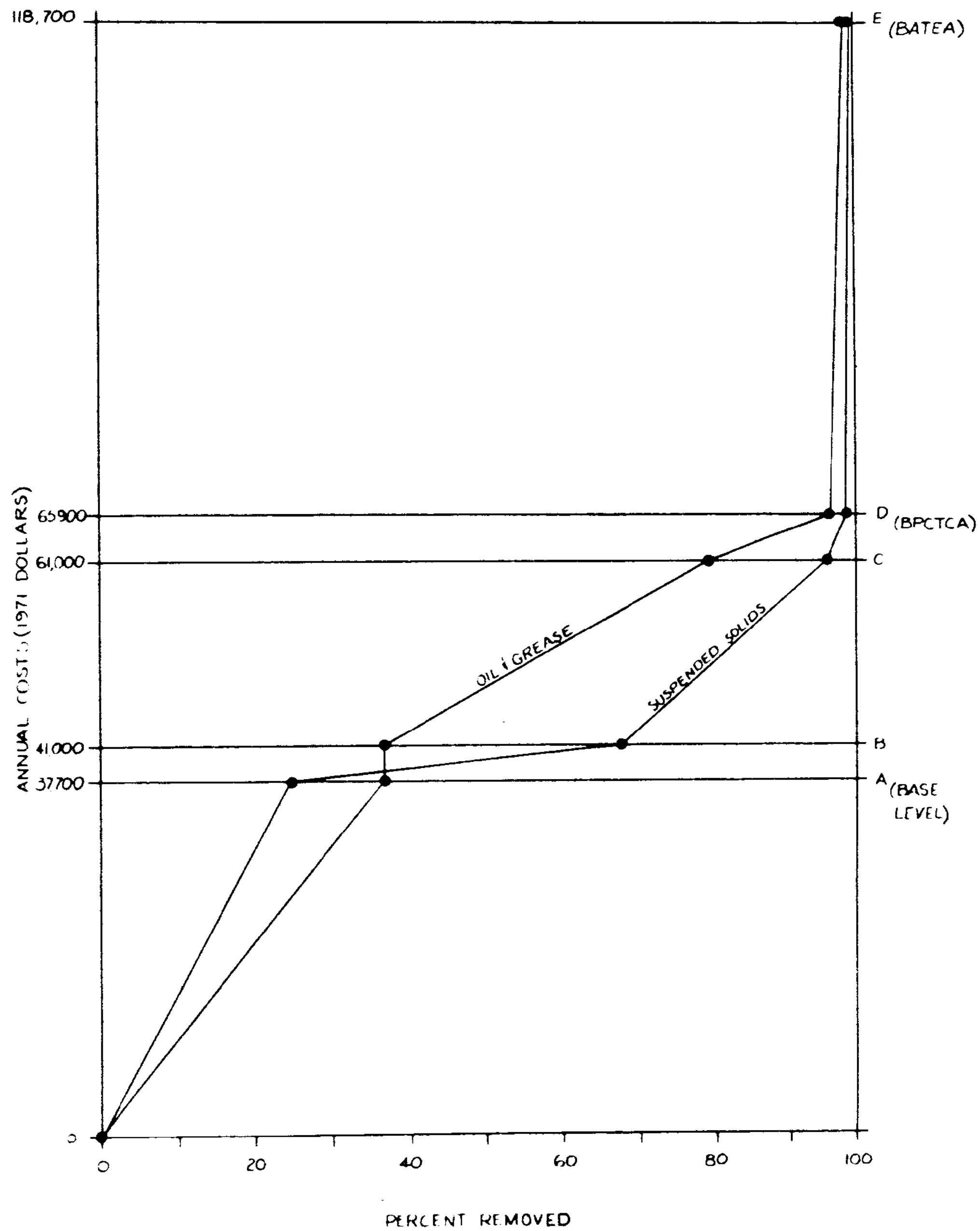
FIGURE 33B

MODEL COST EFFECTIVENESS DIAGRAM
SAND WASHING - SUBCATEGORY

ANNUAL COSTS • BASED ON TEN YEAR CAPITAL RECOVERY
+ INTREST RATE 7%
+ OPERATING COSTS INCLUDE LABOR, CHEMICALS & UTILITIES
+ MAINTENANCE COSTS BASED ON 3.5% OF CAPITAL COSTS
COSTS BASED ON 36.3 KKG/DAY (40 TONS/DAY) PRODUCTION
THIS GRAPH CANNOT BE USED FOR INTERMEDIATE VALUES



Multiple Operations

Following is a summary of the factors used to establish the BATEA effluent limitation guidelines (ELGs) applying to the Multiple Operations subcategory. As far as possible, the stated limits are based upon performance levels attained by the selected plants surveyed during this study. Where treatment levels can be improved by application of additional currently available control and treatment technology, the anticipated reduction of waste loads was included in the estimates.

The BATEA ELGs for the Multiple Operations subcategory, and the control and treatment technology to achieve these limits, are summarized in Table 30.

Flow. One multiple operation facility was discharging raw waste loads from two unit melting operations (including the blowdown of a recirculating slag quench process) as well as the raw waste load from a large unit molding and dust collection operation to a lagoon for settling of suspended solids and the natural equilibration of the wastewater. All wastewater was then recycled indiscriminately back to the two unit melting operations and the unit molding and cleaning dust collection operation. Cooling tower blowdown was supplied as makeup water to the slag quench process. This affected a zero aqueous discharge from the multiple operation facility.

It is felt that the practices employed by this multiple operation facility may not be universally applicable to all multiple operation facilities. Therefore, zero aqueous discharge is not being recommended as the BATEA ELG treatment and control method technology.

Three multiple operation facilities combining discharges from unit sand washing operations and unit molding and cleaning dust collection operations were surveyed in this study. One facility was discharging 96% of the BATEA ELG recommended flow for the unit molding and cleaning dust collection operation and a flow grossly in excess of the BATEA ELG the unit sand washing operation. The combined flows created an effluent flow from the multiple operation which was in excess of the sum of the flows recommended under the BATEA ELG for the two multiple operations.

A second facility was operating a unit molding and cleaning dust collection operation with a discharge of 2% of the BATEA ELG recommended flow, while the discharge from the unit sand washing operation was grossly in excess of the

BATEA ELG recommended flow. The combined flow created an effluent flow from these two unit operations that was in excess of the sum of the flows recommended by the BATEA ELG for the two unit operations.

A third multiple operation facility was discharging 8.5% of the recommended BATEA ELG flow from a unit molding and cleaning dust collection operation, and 71% of the recommended BATEA ELG flow from a unit sand washing operation. The combined flows created an effluent that was only 29% of the sum of the BATEA ELG flow recommended for the two unit operations.

Another multiple operation facility was discharging the untreated blowdown from a recycled unit molding and cleaning dust collection operation into a drag tank used for solids removal for a recycled unit melting operation which also operated a recycled slag quench process. Cooling tower blowdown was used as a source of makeup water to the unit melting operation. The blowdown from the recycled unit melting operation was delivered to a settling tank for clarification and discharged. The effluent from this multiple operation was considerably less than 25% of the sum of the recommended BATEA ELG flows for the two unit operations.

From the above discussion, it is clear that the waste loads from the three separate unit operation subcategories can be combined in any of several different ways, and thus achieve a reduced flow that may be considerably less than the sum of the BATEA ELG recommended flows for each constituent unit operation and thereby enjoy the benefits of common treatment of wastewaters from multiple operations. Therefore, the recommended BATEA ELG flow from multiple operation facilities is set at the sum of 75% of the BATEA ELG flow previously established for each of the three separate constituent unit operation subcategories. Multiple operation facilities can achieve this flow reduction through the recycle of good quality wastewater back to the constituent unit operations.

The recommended BATEA ELG flow for the unit melting operations portion of a multiple operation facility is conservatively set at 113 l/kkg (225 gal./ton) of metal poured.

The recommended BATEA ELG flow for the unit molding and cleaning dust collection operation portion of a multiple operation facility is conservatively set at 37.6 l/kkg (75 gal./ton) of sand passing before the ladle.

The recommended BATEA ELG flow for the unit sand washing operation portion of a multiple operation facility is conservatively set at 113 l/kkg (225 gal./ton) of sand washed.

<u>Suspended Solids</u>. One multiple operation facility treating wastewater from a unit molding and cleaning dust collection operation and a unit melting operation was discharging a suspended solids load of about 3% of the sum of the suspended solids load of the BATEA ELG for the two constituent unit operations. This was accomplished by discharging the waste load from a recycled unit molding and cleaning dust collection operation into a drag tank used for solids removal from a recycled unit melting operation which also operated a recycled slag quench process. Cooling tower blowdown was used as a source of makeup water to the unit melting operation. The blowdown from the recycled unit melting operation was delivered to a settling tank for clarification and discharged.

Another multiple operation facility surveyed was combining wastewaters from a unit molding and cleaning dust collection operation and a unit sand washing operation for common treatment with polyelectrolyte and solids removal in a drag tank followed by further solids removal by a lagoon before discharging. This multiple operation is currently discharging 85% of the sum of the suspended solids load of the BATEA ELG for the constituent unit operations. However, this discharged load could be reduced substantially by the exclusion of a noncontact cooling water flow which accounts for 60% of the discharge flow. Therefore, the recommended BATEA ELG suspended solids load from multiple operation facilities is conservatively set at 75% of the sum of the BATEA ELG suspended solids loads previously established for each of the separate constituent unit operation subcategories. Thus, the recommended BATEA ELG for suspended solids load from the unit melting operation portion of a multiple operation facility is conservatively set at 0.0235 kg/kkg (0.0469 lbs of suspended solids/ton) of metal poured, equivalent to 25 mg/l in a discharge flow of 225 gal./ton of metal poured.

The recommended BATEA ELG for suspended solids load from the unit molding and cleaning dust collection operation portion of a multiple operation facility is conservatively set at 0.00782 kg/kkg (0.0156 lbs of suspended solids/ton) of sand passing before the ladle, equivalent to 25 mg/l in 75 gal./ton of sand passing before the ladle.

The recommended BATEA ELG for suspended solids load from the unit sand washing operation portion of a multiple operation facility is conservatively set at 0.0235 kg/kkg (0.0469 lbs of suspended solids/ton) of sand washed, equivalent to 25 mg/l in a discharge flow of 225 gal./ton of sand washed.

Oil and Grease. Three multiple operations were surveyed combining wastewater flows from unit molding and cleaning dust collection operations and unit sand washing operations for common solids removal in a lagoon followed by discharge.

One of the multiple operation facilities was discharging oil and grease loads approximately 2.5 times that of the sum of the recommended BATEA ELG for the two constituent unit operations. A second multiple unit operation was discharging oil and grease loads approximately 4.4 times the recommended BATEA ELG for the two constituent unit operations. However, these multiple operations provided no oil skimming equipment for oil and grease removal. A third multiple operation combined wastewater for common treatment by polyelectrolyte addition followed by solids removal in a drag tank followed by a lagoon for further solids removal and discharge. This multiple facility was discharging an oil and grease load of about 29% of the sum of the recommended BATEA ELG for the constituent unit operations.

Another multiple operation surveyed was discharging the waste load from a recycle unit molding and cleaning dust collection operation into a drag tank used for solids removal from a recycled unit melting operation which also operated a recycled slag quench process. Cooling tower blowdown was used as a source of makeup water to the unit melting operation. The blowdown was delivered to a settling tank for clarification and discharge. This multiple facility was discharging oil and grease loads of less than one percent of the sum of the recommended BATEA ELG from each constituent unit operation. However, selecting this low value for the BATEA ELG would result in concentrations too low to adequately measure by most readily available analytical techniques. Therefore, the BATEA ELG for oil and grease from multiple operation facilities is conservatively set at the sum of 75% of the BATEA ELG oil and grease loads previously established for each of the three separate constituent unit operation subcategories. Thus, the recommended BATEA ELG for oil and grease loads from the unit melting operations portion of a multiple operation facility is conservatively set at 0.00939 kg/kkg (0.0188 lbs of oil and grease/ton) of metal poured, equivalent to 10 mg/l in a discharge flow of 225 gal./ton of metal poured.

The recommended BATEA ELG for oil and grease loads from the unit molding and cleaning dust collection operations portion of multiple operation facilities is conservatively set at 0.00313 kg/kkg (0.00625 lbs of oil and grease/ton) of sand passing before the ladle, equivalent to 10 mg/l in a discharge flow of 75 gal./ton of sand passing before the ladle. The recommended BATEA ELG for oil and grease loads from the unit sand washing operations portion of multiple operation facilities is conservatively set at 0.00939 kg/kkg (0.0188 lbs of oil and grease/ton) of sand washed, equivalent to 10 mg/l in a discharge flow of 225 gal./ton of sand washed.

Lead. The data indicate that lead is a critical parameter for unit melting operations only. In general, lead appears in particulate form and its concentration is proportional to the suspended solids concentration. Good hard data for lead loads discharged from multiple operation facilities with unit melting operations does not exist. However, the evidence is persuasive that extremely low lead discharge levels can be demonstrated by the unit melting operation discussed under BATEA ELG lead. The unit is currently discharging 0.000190 kg/kkg (0.000380 lbs/ton) of metal poured. It is felt that through the benefits of combined treatment with wastewater from other unit operations, and the benefits of a tighter recycle flow, that a reduction of the lead load from multiple operation facilities proportional to the suspended solids reductions achieved is justified.

One multiple operation facility treating wastewater from a unit molding and cleaning dust collection operation and a unit melting operation was discharging a suspended solids load of about 3% of the sum of the suspended solids load of the BATEA ELG for the two constituent unit operations. This was accomplished by discharging the waste load from a recycle unit molding and cleaning dust collection operation into a drag tank used for solids removal from a recycled unit melting operation which also operated a recycled slag quench process. Cooling tower blowdown was used as a source of makeup water to the unit melting operation. The blowdown from the recycled unit melting operation was delivered to a settling tank for clarification and discharged.

Another multiple operation facility surveyed was combining wastewater from a unit molding and cleaning dust collection operation and a unit sand washing operation for common treatment with polyelectrolyte and solids removal in a drag tank followed by further solids removal by a lagoon before discharging. This multiple operation is currently discharging 85% of the sum of the suspended solids load of the BATEA ELG for the constituent unit operations. However, this discharged load could be reduced substantially by the exclusion of a noncontact cooling water flow which accounts for 60% of the discharge flow.

Since lead is a critical parameter only for unit melting operations, the recommended BATEA ELG for lead is 75% of the BATEA limit for melting operations alone. Therefore, the BATEA ELG for lead from the unit melting operation of a multiple operation facility is conservatively set at 0.000938 kg/kkg (0.00188 lbs of lead/ton) of metal poured, equivalent to 1 mg/l of lead in a discharge flow of 225 gal./ton of metal poured. Any affected multiple operation facility can achieve this value through proper pH adjustment, polyelectrolyte addition and clarification as well as maintaining a high rate of recycle. No additional load is provided for the other portions of multiple operation facilities.

Manganese. The data indicate that manganese is a critical parameter for unit melting operations only. In general, manganese appears in particulate form and its concentration is proportional to the suspended solids concentration. The first multiple operation facility was discharging a manganese load approximately 1% of that which would have been allowed under the BATEA ELG for the unit melting operation only. The evidence is very persuasive that extremely low manganese levels can be readily achieved. This is demonstrated by the referenced unit melting operation currently discharging 0.000419 kg/kkg (0.000836 lbs/ton) of metal poured. It is felt that through the benefits of combined treatment with wastewater from other unit operations, and the benefits of a tighter recycle flow, that a reduction of the manganese load from multiple operation facilities proportional to the suspended solids reductions achieved is justified.

One multiple operation facility treating wastewater from a unit molding and cleaning dust collection operation and a unit melting operation was discharging a suspended solids load of about 3% of the sum of the suspended solids load of the BATEA ELG for the two constituent unit operations. This was accomplished by discharging the waste load from a recycled unit molding and cleaning dust collection operation into a drag tank used for solids removal from a recycled unit melting operation which also operated a recycled slag quench process. Cooling tower blowdown was used as a source of makeup water to the unit melting operation. The blowdown from the recycled unit melting operation was delivered to a settling tank for clarification and discharged.

Another multiple operation facility surveyed was combining wastewater from a unit molding and cleaning dust collection operation and a unit sand washing operation for common treatment with polyelectrolyte and solids removal in a drag tank followed by further solids removal by a lagoon before discharging. This multiple operation is currently discharging 85% of the sum of the suspended solids load of the BATEA ELG for the constituent unit operations. However, this discharged load could be even reduced substantially more by the exclusion of a noncontact cooling water flow which accounts for 60% of the discharge flow.

The BATEA ELG for manganese being recommended is 75% of the BATEA ELG for unit melting operations. Therefore, the BATEA ELG for manganese from unit melting operations of a multiple operation facility is conservatively set at 0.00281 kg/kkg (0.00563 lbs of manganese/ton) of metal poured, equivalent to 3 mg/l in a discharge flow of 225 gal./ton of metal poured. Any affected multiple operation facility can achieve this value through proper pH adjustment, polyelectrolyte addition and clarification as well as maintaining a high rate of recycle. No additional manganese load is provided for the other portions of multiple operation facilities.

Zinc. The data indicate that zinc is a critical parameter for unit melting operations only. In general, zinc appears in particulate form and its concentration is proportional to the suspended solids concentration. Good hard data for zinc loads discharged from multiple operation facilities with unit melting operations does not exist. However, the evidence is persuasive that extremely low zinc loads proportional to the suspended solids reductions achieved are justified.

One multiple operation facility treating wastewater from a unit molding and cleaning dust collection operation and a unit melting operation was discharging a suspended solids load of about 3% of the sum of the suspended solids load of the BATEA ELG for the two constituent unit operations. This was accomplished by discharging the waste load from a recycled unit molding and cleaning dust collection operation into a drag tank used for solids removal from a recycled unit melting operation which also operated a recycled slag quench process. Cooling tower blowdown was used as a source of makeup water to the unit melting operation. The blowdown from the recycled unit melting operation was delivered to a settling tank for clarification and discharged.

Another multiple operation facility surveyed was combining wastewater from a unit molding and cleaning dust collection operation and a unit sand washing operation for common treatment with polyelectrolyte and solids removal in a drag tank followed by further solids removal by a lagoon before discharging. This multiple operation is currently discharging 85% of the sum of the suspended solids load of the BATEA ELG for the constituent unit operations. However, this discharged load could be reduced substantially by the exclusion of a noncontact cooling water flow which accounts for 60% of the discharge flow.

The BATEA ELG for zinc being recommended is 75% of the BATEA ELG for unit melting operations. Therefore, the BATEA ELG for zinc from unit melting operations of multiple operation facilities is conservatively set at 0.00281 kg/kkg (0.00563 lbs of zinc/ton) of metal poured, equivalent to 3 mg/l of zinc in a discharge flow of 225 gal./ton of metal poured.

It is felt that through the benefits of combined treatment with other unit operations, any multiple unit operation facility can achieve this value through proper pH adjustment, polyelectrolyte addition and clarification as well as maintaining a high rate of recycle. No additional zinc load is provided for the other portions of multiple operation facilities.

Sulfide. One multiple operation facility treating wastewater from a unit molding and cleaning dust collection operation and a unit melting operation was discharging a sulfide load of about 50% of that which would have been recommended by the BATEA ELG for unit melting operations alone. This was accomplished by discharging the waste load from a recycled unit molding and cleaning dust collection operation into a drag tank used for solids removal from a recycled unit melting operation which also operated a recycled slag quench process. Cooling tower blowdown was used as a source of makeup water to the unit melting operation. The blowdown from the recycled unit melting operation was delivered to a settling tank for clarification and discharged.

The data indicate that sulfide is a critical parameter for unit melting operations only. In general, sulfide may be aerated and oxidized by recycling the wastewater back to the furnace emission control system. The referenced multiple operation was achieving a sulfide discharge load of 0.000769 kg/kkg (0.00154 lbs/ton) of metal poured even while practicing an extremely tight wastewater recycle of 99%. Reducing this recycle rate would aid in reducing the discharged sulfide load to even lower values. The evidence is persuasive that extremely low sulfide load discharge levels can be achieved. It is felt that through the benefits of combined treatment of wastewater from other unit operations, and the benefits of appropriate recycle flows, that a reduction of the sulfide discharge load from multiple operation facilities is justified. The BATEA ELG for sulfide being recommended is 75% of the BATEA ELG for unit melting operations. Therefore, the BATEA ELG for sulfide from the unit melting operations of a multiple operation facility is set at 0.00117 kg/kkg (0.00235 lbs/ton) of metal poured, equivalent to 1.25 mg/l of sulfide in a discharge flow of 225 gal./ton of metal poured. Any affected multiple operation facility can achieve this value through the proper control of the wastewater recycle rate for the unit melting operations. No additional sulfide load is provided for the other portions of multiple operation facilities.

Fluoride. One multiple operation facility treating wastewater from a unit molding and cleaning dust collection operation and a unit melting operation was discharging a fluoride load of about 3% of that which would have been recommended by the BATEA ELG for unit melting operations. This was accomplished by discharging the waste load from a recycled unit molding and cleaning dust collection operation into a drag tank used for solids removal from a recycled unit melting operation which also operated a recycled slag quench process. Cooling tower blowdown was used as a source of makeup water to the unit melting operation. The blowdown from the recycled unit melting operation was delivered to a settling tank for clarification and discharged.

The data indicate that fluoride is a critical parameter for the unit melting operations only. The appearance of fluoride in waste loads is largely a function of the constituents used in the melting process. The referenced multiple operation was achieving a fluoride discharge load of 0.000528 kg/kkg (0.00105 lbs/ton) of metal poured. The low discharge load was accomplished by the action of the calcium contributed from the slag quench process with the fluoride. It is felt that through this means, and through the benefits of combined treatment with wastewater from other unit operations, and the benefits of recycling wastewater, that a reduction of the fluoride discharge load from multiple operation facilities is justified. The BATEA ELG for fluoride being recommended is 75% of the BATEA ELG for unit melting operation. Therefore, the BATEA ELG for fluoride from the unit melting operations of a multiple operation facility is set at 0.0117 kg/kkg

TABLE 30

BATEA - EFFLUENT LIMITATIONS GUIDELINES

SUBCATEGORY Multiple Operations

| CRITICAL PARAMETERS | BATEA LIMITATIONS Kg/KKg [1] (LB/1000 LB) | mg/l [2] | CONTROL & TREATMENT TECHNOLOGY [3] | ESTIMATED [4] TOTAL COST $/KKg | $/TON |
|---|---|---|---|---|---|
| Suspended Solids<br>Oil and Grease | Seventy-five percent of the sum of the pounds per ton for each subcategory for suspended solids and oil and grease. | | Additional treatment or combined wastes from BPCTCA treatment via tightened recycle systems; sidestream treatment; additional polyelectrolyte addition; filtration; flash mixing and clarification of filter backwashes. | 4.47 to 9.00 | 4.06 to 8.16 |
| Fluoride | 0.0117 | | | | |
| Manganese | 0.00281 | | | | |
| Lead | 0.000938 | | | | |
| Sulfide | 0.00117 | | | | |
| Zinc | 0.00281 | | | | |
| pH | | 6.0-9.0 | | | |
| Flow | Most probable value for tight recycle system will range from 1,875 to 4,375 l/kkg (450 to 1,050 gal/ton), of hot metal poured, depending on the combination of multiple operations used. | | | | |

(1) Kilograms per metric ton of metal poured or pounds per 1000 pounds of metal poured.
(2) Milligrams/liter will depend on the combined discharge flow rate.
(3) Available technology listed is not necessarily all inclusive nor does it reflect all possible combinations or permutations of treatment methods.
(4) Costs may vary some depending on such factors as location, availability of land and chemicals, flow to be treated, treatment technology selected where competing alternatives exist, and extent of preliminary modifications required to accept the indicated control and treatment devices. Estimated total costs shown are only incremental costs required above those facilities which are normally existing within a plant.



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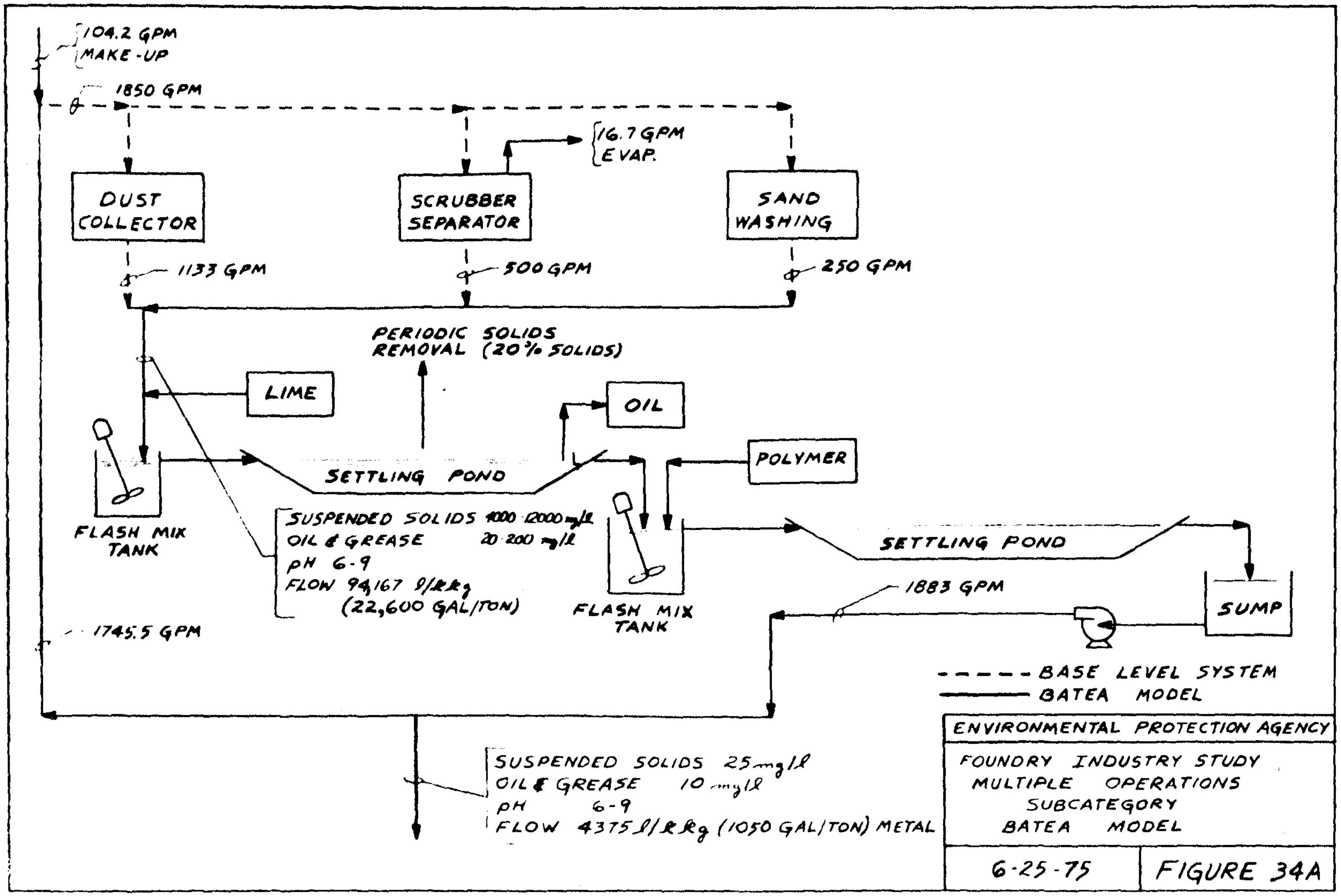
104.2 GPM
MAKE-UP
1850 GPM
16.7 GPM
EVAP.
DUST COLLECTOR
SCRUBBER SEPARATOR
SAND WASHING
1133 GPM
500 GPM
250 GPM
PERIODIC SOLIDS REMOVAL (20% SOLIDS)
LIME
OIL
POLYMER
SETTLING POND
FLASH MIX TANK
SUSPENDED SOLIDS 4000-12000 mg/l
OIL & GREASE 20-200 mg/l
pH 6-9
FLOW 94,167 l/kkg
(22,600 GAL/TON)
FLASH MIX TANK
SETTLING POND
1883 GPM
SUMP
1745.5 GPM
BASE LEVEL SYSTEM
BATEA MODEL
SUSPENDED SOLIDS 25 mg/l
OIL & GREASE 10 mg/l
pH 6-9
FLOW 4375 l/kkg (1050 GAL/TON) METAL
ENVIRONMENTAL PROTECTION AGENCY
FOUNDRY INDUSTRY STUDY
MULTIPLE OPERATIONS
SUBCATEGORY
BATEA MODEL
6-25-75
FIGURE 34A



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FIGURE 34 B

MODEL COST EFFECTIVENESS DIAGRAM
MULTIPLE OPERATIONS - MELTING & MOLDING & CLEANING DUST COLLECTION OPERATIONS SUBCATEGORY

ANNUAL COSTS = BASED ON TEN YEAR CAPITAL RECOVERY
+ INTREST RATE 7%
+ OPERATING COSTS INCLUDE LABOR, CHEMICALS & UTILITIES
+ MAINTENANCE COSTS BASED ON 3.5% OF CAPITAL COSTS
COSTS BASED ON 36.3 KKG/DAY (40 TONS/DAY) PRODUCTION
THIS GRAPH CANNOT BE USED FOR INTERMEDIATE VALUES

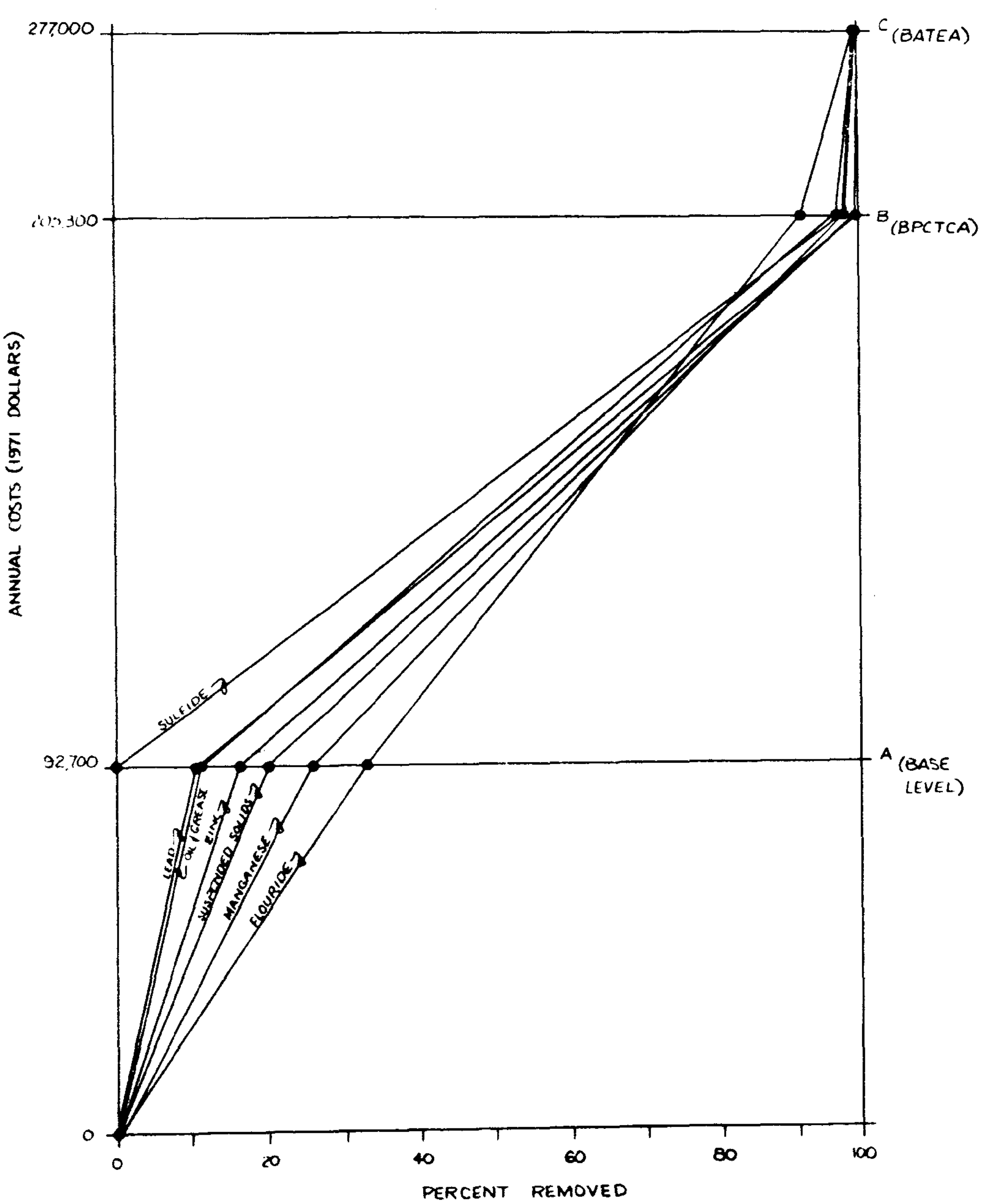

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FIGURE 34C
MODEL COST EFFECTIVENESS DIAGRAM
MULTIPLE OPERATIONS MELTING & SAND WASHING
OPERATIONS SUBCATEGORY

ANNUAL COSTS = BASED ON THE YEAR CAPITAL RECOVERY
+ INTEREST RATE 7%
+ OPERATING COSTS INCLUDE LABOR, CHEMICALS & UTILITIES
+ MAINTENANCE COSTS BASED ON 3.5% OF CAPITAL COSTS
COSTS BASED ON 36.3 KKG/DAY (40 TONS/DAY) PRODUCTION
THIS GRAPH CANNOT BE USED FOR INTERMEDIATE VALUES

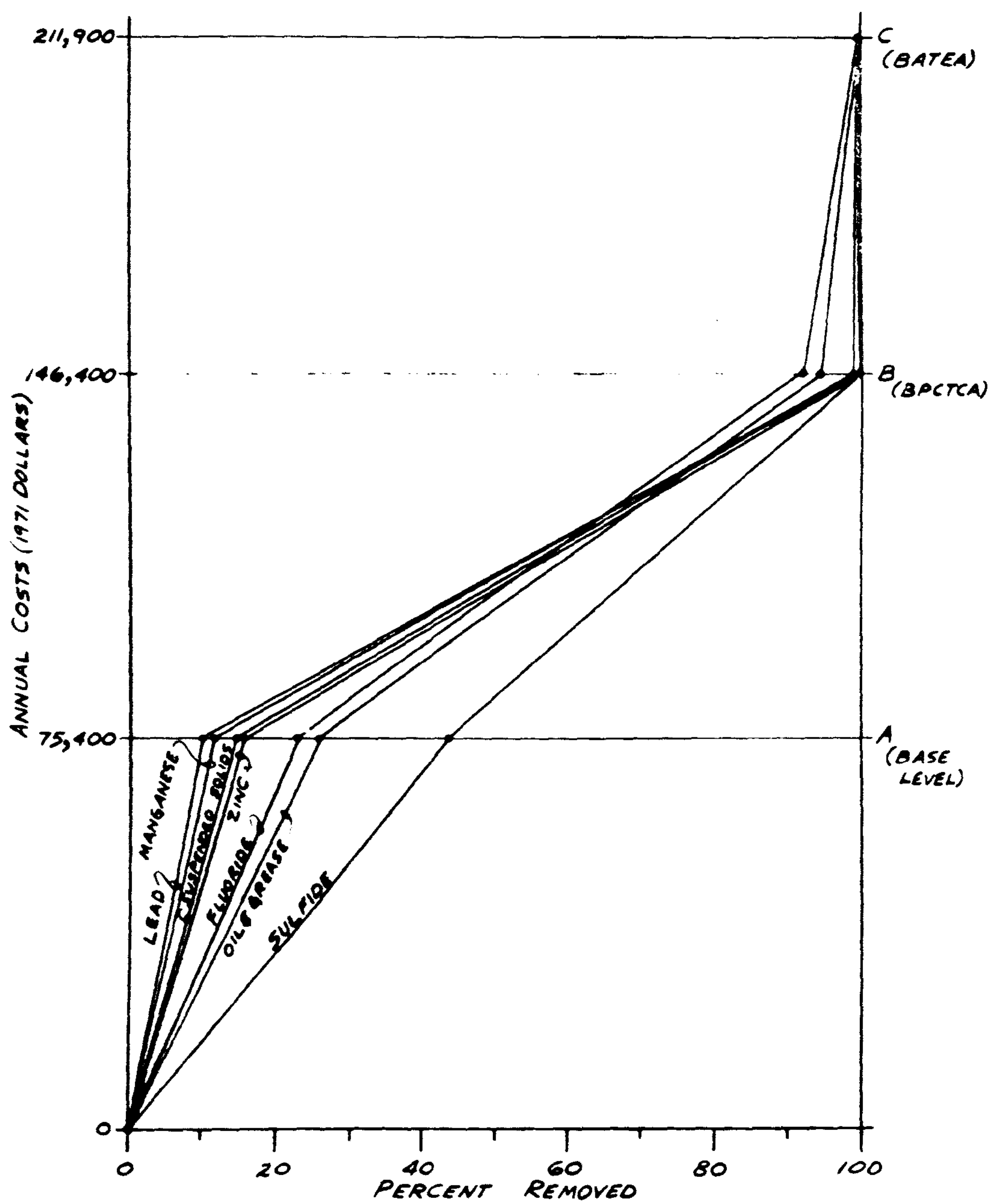

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FIGURE 34 D

MODEL COST EFFECTIVENESS DIAGRAM
MULTIPLE OPERATIONS MOLDING & CLEANING DUST
COLLECTION AND SAND WASHING OPERATIONS SUBCATEGORY

ANNUAL COSTS - BASED ON TEN YEAR CAPITAL RECOVERY
+ INTEREST RATE 7%
+ OPERATING COSTS INCLUDE LABOR, CHEMICALS & UTILITIES
+ MAINTENANCE COSTS BASED ON 3.5% OF CAPITAL COSTS
COSTS BASED ON 36.3 KKG/DAY (40 TONS/DAY) PRODUCTION
THIS GRAPH CANNOT BE USED FOR INTERMEDIATE VALUES

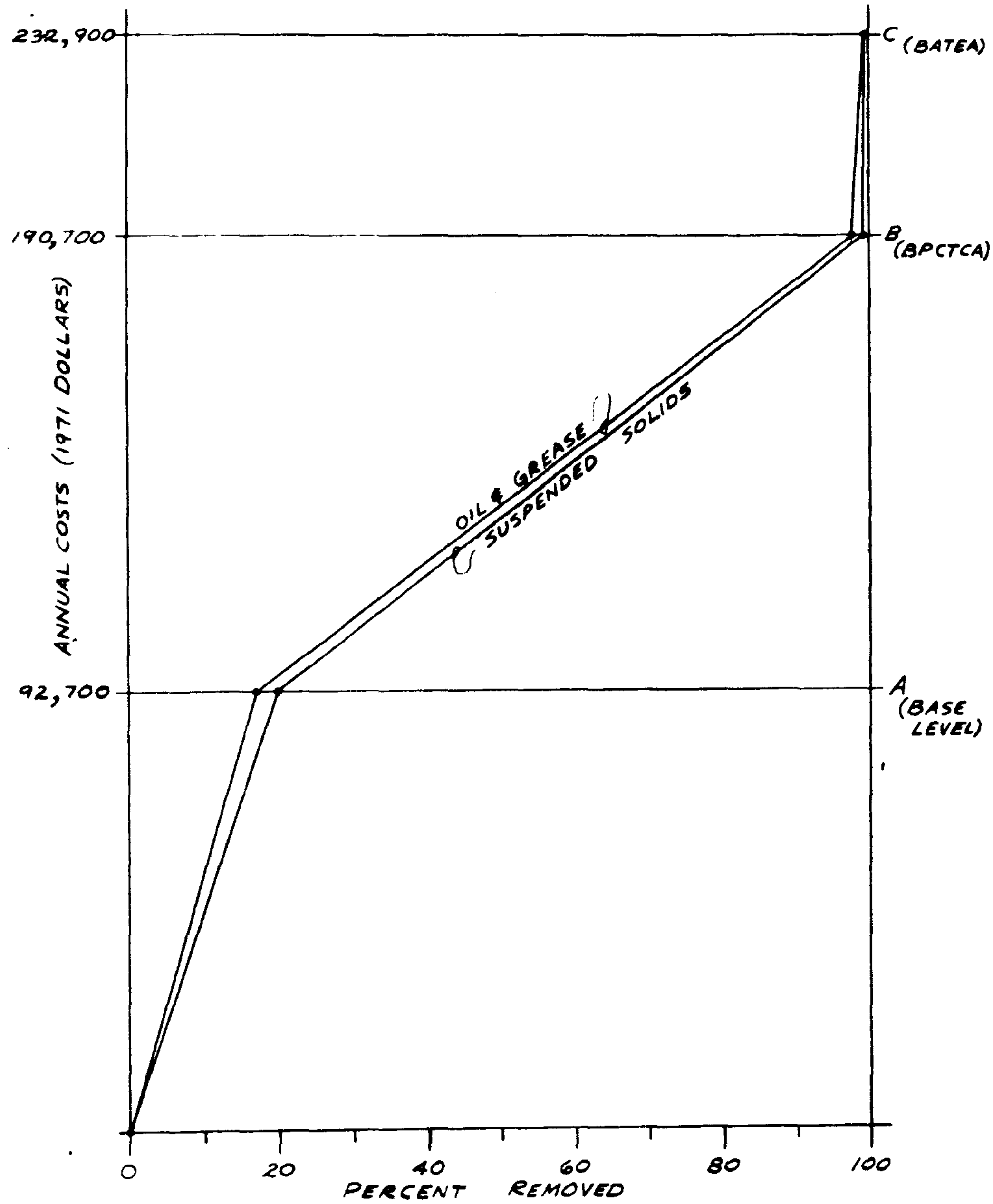
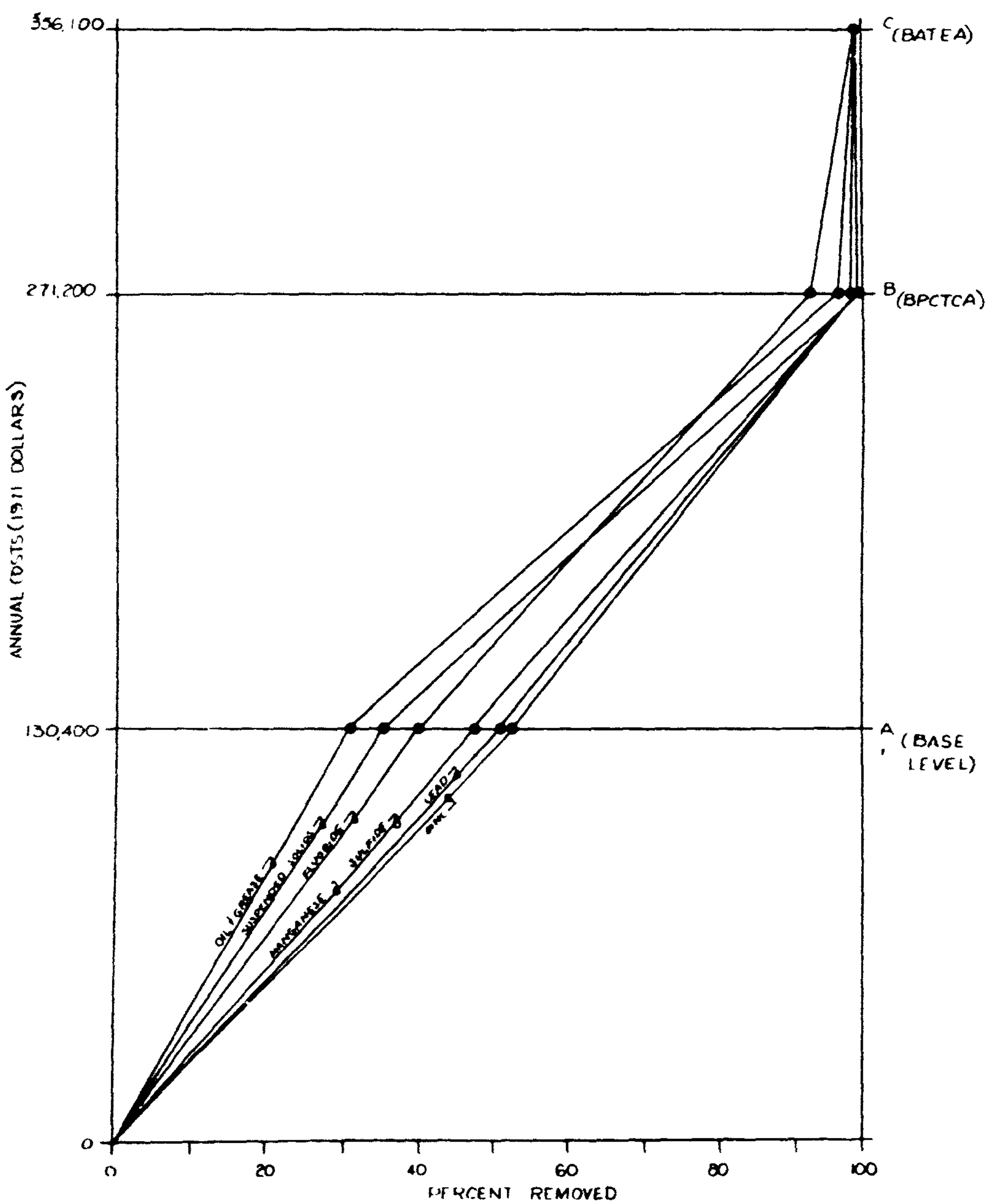


FIGURE 34E

MODEL COST EFFECTIVENESS DIAGRAM
MULTIPLE OPERATIONS SUBCATEGORY
ALL SUBCATEGORIES

ANNUAL COSTS = BASED ON TEN YEAR CAPITAL RECOVERY
+ INTREST RATE 7%
+ OPERATING COSTS INCLUDE LABOR, CHEMICALS & UTILITIES
+ MAINTENANCE COSTS BASED ON 3.5% OF CAPITAL COSTS

COSTS BASED ON 36.3 KKG/DAY (40 TONS/DAY) PRODUCTION
THIS GRAPH CANNOT BE USED FOR INTERMEDIATE VALUES



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(0.0235 lbs/ton) of metal poured, equivalent to 12.5 mg/l in a discharge flow of 225 gal./ton of metal poured. Any affected multiple operation facility can easily achieve this value through the incorporation of slag quench process wastewater with furnace emission control recycled wastewater. Alternatively, lime addition for pH control may be used to achieve the same effect. No additional fluoride load is provided for the other portions of multiple operation facilities.

pH. All multiple operation plants surveyed fell within the pH constraint range of 6.0 to 9.0, both for filter feeds and for final effluents, thus providing a basis for establishing this range as the BATEA ELG. Any plant falling outside this range can easily remedy the situation by applying appropriate neutralization procedures to the final effluent.

## COST TO THE FOUNDRY INDUSTRY

Table 31 presents a summary of projected capital and annual operating costs to the foundry industry as a whole to achieve the effluent quality proposed herein for BPCTCA and BATEA guidelines.

As presented in the table, an initial capital investment of approximately $210 million, with annual capital and operating costs of $50 million would be required by the industry to achieve BPCTCA guidelines. An additional capital investment of approximately $187 million and total annual capital amortization and operating costs of $94 million would be needed to achieve BATEA guidelines. Costs may vary depending upon such factors as location, availability of land and chemicals, flows to be treated, treatment technology selected where competing alternatives exist, and the extent of preliminary modifications required to accept the necessary control and treatment devices.

## ECONOMIC IMPACT

The economic impact of these proposed BPCTCA and BATEA limitations will be discussed in an economic analysis report prepared by another contractor.

TABLE 31

FOUNDRY OPERATIONS
PROJECTED TOTAL COSTS FOR RELATED SUBCATEGORIES

| | Subcategory | 1972 Annual Production Millions of Tons(2) | Number of Plants | Costs to Industry(1) BPCTCA Annual Capital and Operating Costs | BPCTCA Initial Capital Investment | BATEA Annual Capital(3) and Operating Costs | BATEA Initial Capital Investment |
|---|---|---|---|---|---|---|---|
| I. | Melting | 3.87 | 401 | 17,162,800 | 67,769,000 | 37,373,200 | 79,398,000 |
| II. | Molding & Cleaning Dust Collection | 1.99 | 206 | 14,378,000 | 63,386,200 | 26,780,000 | 56,629,400 |
| III. | Sand Washing | 0.12 | 12 | 338,400 | 1,467,600 | 972,000 | 2,367,600 |
| IV. | Multiple Process | | | | | | |
| | I & II | 0.93 | 96 | 10,809,600 | 45,763,200 | 17,693,800 | 31,392,000 |
| | I & III | 0.12 | 12 | 852,000 | 3,495,600 | 1,638,000 | 3,607,200 |
| | II & III | 0.46 | 49 | 4,802,000 | 21,070,000 | 6,868,000 | 9,408,000 |
| | I, II, III | 0.12 | 12 | 1,688,600 | 7,188,000 | 2,708,400 | 4,626,000 |
| | TOTAL | 7.61 | 788 | 50,031,400 | 210,139,600 | 94,033,400 | 187,428,200 |

(1) Costs determined by following relationships:
(a) Annual capital + operating = number of plants x annual cost/facility
(b) Initial capital investment = number of plants x first cost/facility

(2) Production does not include plants with completely dry pollution control systems and no aqueous discharges.

(3) Includes BPCTCA costs.

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# SECTION XI

## EFFLUENT QUALITY ATTAINABLE THROUGH THE APPLICATION OF NEW SOURCE PERFORMANCE STANDARDS

### INTRODUCTION

The Best Available Demonstrated Control Technology (BADCT) is to be achieved by "New Sources." "New Sources" has been defined as any source the construction of which is commenced after the publication of the proposed regulations. The BADCT technology is that level which can be achieved by adding to the BATEA technology improved production processes and/or treatment techniques. For purposes of developing the BPCTCA and BATEA technologies and limitations, the industry was divided into the following subcategories:

I. Melting Operations
II. Molding and Cleaning Dust Collection
III. Sand Washing Operations
IV. Multiple Operations

With the expection of sand washing, there are plants in all other categories who are presently achieving the proposed BATEA effluent limitation guidelines. However, the treating technology proposed for sand washing is identical to other operations. This in itself justifies the fact that technology is available and demonstrates that the limitations can be achieved on a day by day basis. Therefore, it is recommended that in all categories new source installations meet the BATEA guidelines.

NSPS Discharge Standard. Refer to rationale for all subcategories as discussed in Section X, BATEA.

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# SECTION XII

## ACKNOWLEDGEMENTS

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SECTION XIII

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# SECTION XIV

## GLOSSARY

Agglomerate. The collecting of small particles together into a larger mass.

Baghouse. An independent structure or building that contains fabric bags to collect dusts. Usually contains fans and dust conveying equipment also.

Binder. Any material used to help sand grains to stick together.

Bulk Bed Washer. A wet type dust collector consisting of a bed of lightweight spheres through which the dust laden air must pass while being sprayed by water or liquor.

Charge. A minimum combination of the various materials required to produce a hot metal of proper specifications.

Classifier. A device that separates particles from a fluid stream by size. The larger sized units drop out when the stream velocity can no longer carry them. Stream velocity is gradually reduced.

Cope. The top half of a two piece mold.

Core. An extra firm shape of sand used to obtain a hollow section in a casting by placing it in a mold cavity to give interior shape to a casting.

Crucible. A highly refractory vessel used to melt metals.

Cupola. A vertical shaft furnace consisting of a cylindrical steel shell lined with refractories and equipped with air inlets at the base and an opening for charging with fuel and melting stock near the top. Molten metal runs to the bottom.

Drag. The lower half of a two piece mold.

Electrode. Long cylindrical rods made of carbon or graphite and used to conduct electricity into a charge of metal.

Flask. A rectangular frame open at top and bottom used to retain molding sand around a pattern.

Flux. A substance used to promote the melting or purification of a metal in a furnace.

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Gate. An entry passage for molted metal into a mold.

Head. A large reservoir of molten metal incorporated in a mold that can supply hot metal to a shrinking portion of a casting during its cooling stage.

Heat Treat. To adjust or alter a metal property through heat.

Hydraulic Cyclone. A fluid classifying device that separates heavier particles from a slurry.

Impingement. The striking of air or gasborne particles on a wall or baffle.

Induction Furnace. A crucible surrounded by coils carrying alternating electric current. The current induces magnetic forces into the metal charged into the crucible. These forces cause the metal to heat.

Ladle. A vessel used to hold or pour molten metal.

Mold. A form, made of sand, metal, or refractory material, which contains the cavity into which molten metal is poured to produce a casting.

Pattern. A form of wood, metal, or other material around which molding material is placed to make a mold for casting metals.

Quenching. A process of inducing rapid cooling from an elevated temperature.

Recuperator. A steel or refractory chamber used to reclaim heat from waste gases.

Scrap. Usually refers to miscellaneous metal used in a charge to make new metal.

Shot Blast. A casting cleaning process employing a metal abrasive (grit or shot) propelled by centrifugal or air force.

Shakeout. The operation of removing castings from the mold. A mechanical unit for separating the mold material from the solidified casting.

Slag. A product resulting from the action of a flux on the oxidized non-metallic constituents of molten metals.

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Slag Quench. A process of rapidly cooling molten slag to a solid material. Usually performed in a water trough or sump.

Snorkel. A pipe through the furnace roof, or an opening in a furnace roof, used to withdraw the furnace atmosphere.

Spray Chamber. A large volume chamber in a flowing stream where water or liquor sprays are inserted to set the flowing gas.

Sprue. A vertical channel from the top of the mold used to conduct the molten metal to the mold cavity.

Tapping. The process of removing molten metal from a furnace.

Tuyere. An opening in a cupola for introduction of air for combustion.

Venturi Scrubber. A wet type of dust collector that uses the turbulence developed in a narrowed section of the conduit to promote intermixing of the dust laden gas with water sprayed into the conduit.

Washing Cooler. A large vessel where a flowing gas stream is subjected to sprays of water or liquor to remove gasborne dusts and to cool the stream by evaporation.

Wet Cap. A mechanical device placed on the top of a stack that forms a curtain from a water stream through which the stack gases must pass.

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TABLE 32

METRIC UNITS
CONVERSION TABLE

MULTIPLY (ENGLISH UNITS) TO OBTAIN (METRIC UNITS)

| ENGLISH UNIT | ABBREVIATION | CONVERSION | ABBREVIATION | METRIC UNIT |
|---|---|---|---|---|
| acre | ac | 0.405 | ha | hectares |
| acre-feet | ac ft | 1233.5 | cu m | cubic meters |
| British Thermal Unit | BTU | 0.252 | kg cal | kilogram - calories |
| British Thermal Unit/ cubic foot | BTU/cu | 9.00 | kg cal/ cu in | kilogram calorie/ cubic meter |
| British Thermal Unit/pound | BTU/lb | 0.555 | kg cal/kg | kilogram calories/kilogram |
| cubic feet/minute | cfm | 0.028 | cu m/min | cubic meters/minute |
| cubic feet/second | cfs | 1.7 | cu m/min | cubic meters/minute |
| cubic feet | cu ft | 0.028 | cu m | cubic meters |
| cubic feet | cu ft | 28.32 | l | liters |
| cubic inches | cu in | 16.39 | cu cm | cubic centimeters |
| degree Fahrenheit | °F | 0.555(°F-32)* | °C | degree Centigrade |
| feet | ft | 0.3048 | m | meters |
| gallon | gal | 3.785 | l | liters |
| gallon/minute | gpm | 0.0631 | l/sec | liters/second |
| gallon/ton | gal/t | 4.17 | l/kkg | liter/metric ton |
| horsepower | hp | 0.7457 | kw | kilowatts |
| inches | in | 2.54 | cm | centimeters |
| inches of mercury | in Hg | 0.03342 | atm | atmospheres |
| million gallons/day | mgd | 3,785 | cu m/day | cubic meters/day |
| mile | mi | 1.609 | km | kilometer |
| pounds | lb | 0.454 | kg | kilograms |
| pound/square inch(gauge) | psig | (0.06085 psig+1)* | atm | atmospheres(absolute) |
| pounds/ton | lb/t | 0.501 | kg/kkg | kilograms/metric ton |
| square feet | sq ft | 0.0929 | sq m | square meters |
| square inches | sq in | 6.452 | sq cm | square centimeters |
| tons(short) | t | 0.907 | kkg | metric tons(1000 kilograms) |
| yard | y | 0.9144 | m | meters |

*Actual conversion, not a multiplier