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DEVELOPMENT DOCUMENT FOR EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS OF PERFORMANCE

FOR THE

MACHINERY & MECHANICAL PRODUCTS MANUFACTURING

POINT SOURCE CATEGORY

VOLUME 4 SECTIONS VIII, IX, X, XI, XII, XIII & XIV

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

JUNE 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 limitation guidelines and standards of performance--is subject to change in any and all respects.

The regulations to be published by EPA under Section 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 Machinery and Mechanical Products industry, effluent limitation guidelines, and standards of performance applicable to such industry. Judgments necessary to promulgation of regulations under Section 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 and Hazardous Materials
Effluent Guidelines Division
Washington, D. C. 20460

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CONTRACT NO. 68-01-2914

JUNE 1975

DRAFT

DRAFT

CONTENTS

Table of Contents Volume 1

DRAFT

CONTENTS (Continued)

Table of Contents Volume 1, Section III (Continued)

CONTENTS (Continued)

Table of Contents Volume 1, Section III (Continued)

DRAFT

CONTENTS (Continued)

Table of Contents Volume 2, Section III (Continued)

CONTENTS (Continued)

Table of Contents Volume 2, Section III (Continued)

DRAFT

CONTENTS (Continued)

Table of Contents Volume 2, Section III (Continued)

DRAFT

CONTENTS (Continued)

Table of Contents Volume 2, Section III (Continued)

Table of Contents Volume 3

DRAFT

CONTENTS (Continued)

Table of Contents Volume 3, Section IV (Continued)

CONTENTS (Continued)

Table of Contents Volume 3, Section V (Continued)

DRAFT

CONTENTS (Continued)

Table of Contents Volume 3, Section VI (Continued)

DRAFT

CONTENTS (Continued)

Table of Contents Volume 3, Section VI (Continued)

DRAFT

CONTENTS (Continued)

Table of Contents Volume 3, Section VII (Continued)

CONTENTS (Continued)

Table of Contents Volume 3, Section VII (Continued)

CONTENTS (Continued)

Table of Contents Volume 3, Section VII (Continued)

CONTENTS (Continued)

Table of Contents Volume 3, Section VII (Continued)

DRAFT

CONTENTS (Continued)

Table of Contents Volume 3, Section VII (Continued)

CONTENTS (Continued)

Table of Contents Volume 3, Section VII (Continued)

DRAFT

CONTENTS (Continued)

Table of Contents Volume 3, Section VII (Continued)

CONTENTS (Continued)

Table of Contents Volume 3, Section VII (Continued)

Table of Contents Volume 4

CONTENTS (Continued)

Table of Contents Volume 4, Section VIII (Continued)

CONTENTS (Continued)

Table of Contents Volume 4, Section X (Continued)

DRAFT

CONTENTS (Continued)

Table of Contents Volume 4, Section XIII (Continued)

DRAFT

CONTENTS (Continued)

Table of Contents Volume 4, Section XIII (Continued)

SECTION VIII

COST, ENERGY, AND NONWATER QUALITY ASPECTS

INTRODUCTION

This section presents the cost of implementing the control and treatment technology described in Section VII for a range of typical plants. These technology costs as well as the costs of entire systems representing BPT (Best Practicable Control Technology Currently Available) and BAT (Best Available Technology Economically Achievable) were determined by developing system costing logic and utilizing an IBM 370 computer system for cost computations. In addition, the description of each control and treatment technology presented in Section VII is extended to define nonwater characteristics. These nonwater characteristics include energy requirements and an indication of the degree to which the technology impacts air pollution, noise pollution, solid waste, and radiation.

COST ESTIMATES

Cost correlations and estimates are presented for individual waste treatment technologies and for BPT and BAT wastewater treatment systems. Cost breakdown factors used in preparing these estimates are discussed, assumptions are listed, system cost computations are reviewed, and the computer techniques used are summarized.

The basic cost data came from a number of primary sources. Some of the data were obtained during the on-site surveys. Other data were obtained through discussions with waste treatment equipment manufacturers. Another block of data was derived from previous EPA projects which utilized data from engineering firms experienced in the installation of waste treatment systems.

Technology Cost Estimates

Cost correlations listed in Table 8-1 for individual wastewater treatment technologies used in the Machinery and Mechanical Products Manufacturing industries are presented in Figures 8-1 through 8-26. Specific reference to each of these figures is made under the subheading "Technology Costs and Assumptions". Each technology is represented by a pair of graphs, which plots cost vs wastewater flow rate. Two graphs are presented for each technology because the various cost elements were usually of different orders of magnitude.

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TABLE 8-1

INDEX TO TECHNOLOGY COST GRAPHS

FIGURE	WASTE TREATMENT TECHNOLOGY
8-1	Emulsion Breaking
8-2	API Oil Skimmer
8-3	Holding Tanks
8-4	Equalization - Earthen Pond
8-5	Equalization - Concrete Tank
8-6	Clarification - Settling Tank
8-7	Clarification - Metal Removal Tube Settler
8-8	Clarification - Oil Removal Tube Settler
8-9	Neutralization - Acidic Influent
8-10	Neutralization - Alkaline Influent
8-11	Gravity Thickening
8-12	Sludge Drying Beds
8-13	Contractor Removal - Total Flow
8-14	Chemical Reduction of Chromium
8-15	Chemical Oxidation of Cyanide
8-16	Filtration - without alum precoat filter
8-17	Filtration - with alum precoat filter
8-18	Reverse Osmosis
8-19	Ultrafiltration
8-20	Ion Exchange
8-21	Distillation - Simple
8-22	Distillation - Wiped Film
8-23	Flotation/Separation - Acidic Influent
8-24	Flotation/Separation - Alkaline Influent
8-25	Sludge Pumping
8-26	Copper Cementation

In general, the graphs show costs for investment, total annual cost, depreciation, cost of capital, operation and maintenance (less energy and power), and energy. Investment cost is always shown on the first (left-hand) of the pair of graphs. Total annual cost, depreciation, operation and maintenance (less energy and power) cost, energy cost, and cost of capital are shown on whichever graph they can be read more accurately. These costs are defined under the subheadings to follow. Not all of these costs pertain to all technologies. Energy is often negligible, and some techniques such as contract removal require no investment.

Investment - Investment is the capital expenditure required to bring the technology into operation. If the installation is a package contract, the investment is the purchase price for the installed equipment. Otherwise, it includes the equipment cost, engineering costs, cost of freight, insurance, and taxes, installation costs, and overhead costs.

Total Annual Cost - Total annual cost is the sum of annual costs for depreciation, cost of capital, operation and maintenance (less energy and power), and energy as a separate function.

Depreciation - Depreciation is an allowance, based on tax regulations, for the recovery of fixed capital from an investment to be considered as a non-cash annual expense. It may be regarded as the decline in value of a capital asset due to wearout and obsolescence.

Cost of Capital - The annual cost of capital is the cost to the plant of obtaining capital, expressed as an interest rate. It is equal to the capital recovery cost (see the following section on cost factors) less depreciation.

Operation and Maintenance - Operation and maintenance cost is the annual cost of running the wastewater treatment equipment. It includes labor and materials such as waste treatment chemicals. As presented on the graphs, operation and maintenance cost does not include energy (power or fuel) costs because these costs are shown separately.

Energy Cost - The annual cost of power and fuel is shown separately, although it is commonly included as part of operation and maintenance cost. Energy cost is shown separately because of the importance of energy to the nation's economy.

Technology Costs and Assumptions

Specific cost data were generalized to obtain the cost correlations by means of certain assumptions. Correlations were then verified by checking them against independent sets of cost data. The specific assumptions for each wastewater treatment process applicable to BPT and BAT are listed under the suheadings to follow.

Emulsion Breaking - Emulsion breaking costs are shown in Figure 8-1. Costing assumptions were:

a) Costs were based on two neoprene lined conical steel tanks with a 6 hour retention time.

b) Capital costs included mixer, acid feed system, and pH control.

c) The chemical requirement was set to 20 liters of 25% aqueous sulfuric acid for every 10,000 liters of wastewater.

d) The fuel requirement was based on 52 degrees C wastewater temperature rise. The heating value of fuel was taken as 10,140 calories/gram (lower heating value at API 30). A boiler heat recovery value of 85% was assumed.

Oil Skimmer - Oil skimming costs are shown in Figure 8-2. Costing assumptions were:

a) The unit was sized per the API design procedure, with a maximum flow velocity set to the smaller of 1.52 centimeters/second or 4.72 times the oil rise rate. All units sized were analyzed for minimum surface area.

b) Costs assumed concrete construction and include excavation.

c) Power costs were ignored as they were negligible in comparison to all other operation and maintenance costs.

Holding Tank - Holding tank costs are shown in Figure 8-3. Costs were based on a single concrete tank with 7 day retention.

Equalization-Earthen Pond - Earthen pond equalization costs are shown in Figure 8-4. Costing assumptions were:

a) The cost was based on an earthen pond with an impervious lining and mechanical aerators on stationary platforms.

b) An effluent pump head of 3.05 meters was used, in conjunction with an excess capacity factor of 1.25.

Equalization-Concrete Tank - Concrete tank equalization costs are shown in Figure 8-5. Costing assumptions were:

a) The unit was of concrete construction with diffused air aeration.

b) Costs included aerated tank, air supply, sludge pumping system, and flow measuring devices.

c) An effluent pump head of 3.05 meters was used, in conjunction with an excess capacity factor of 1.25.

d) A tank length to width ratio of 1.0 was assumed.

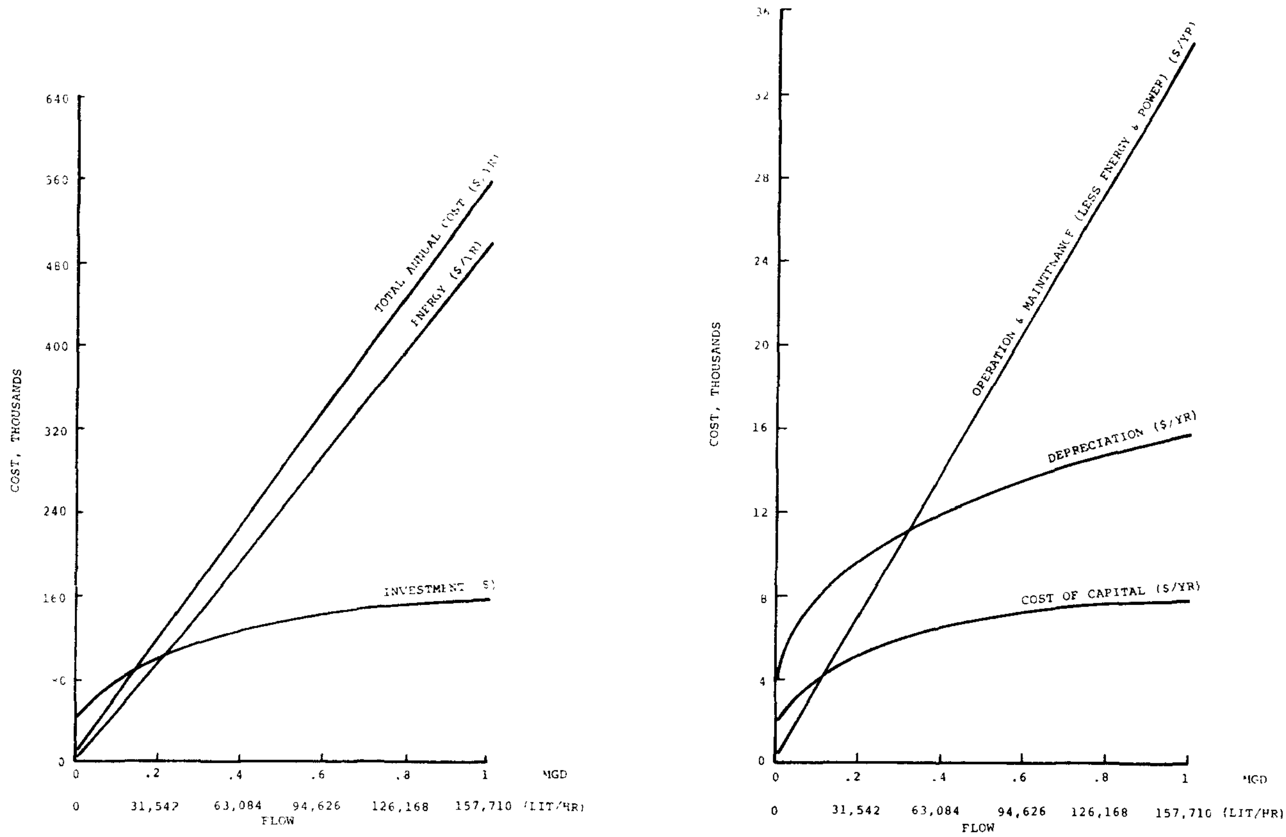

FIGURE 8-1 EMULSION BREAKING

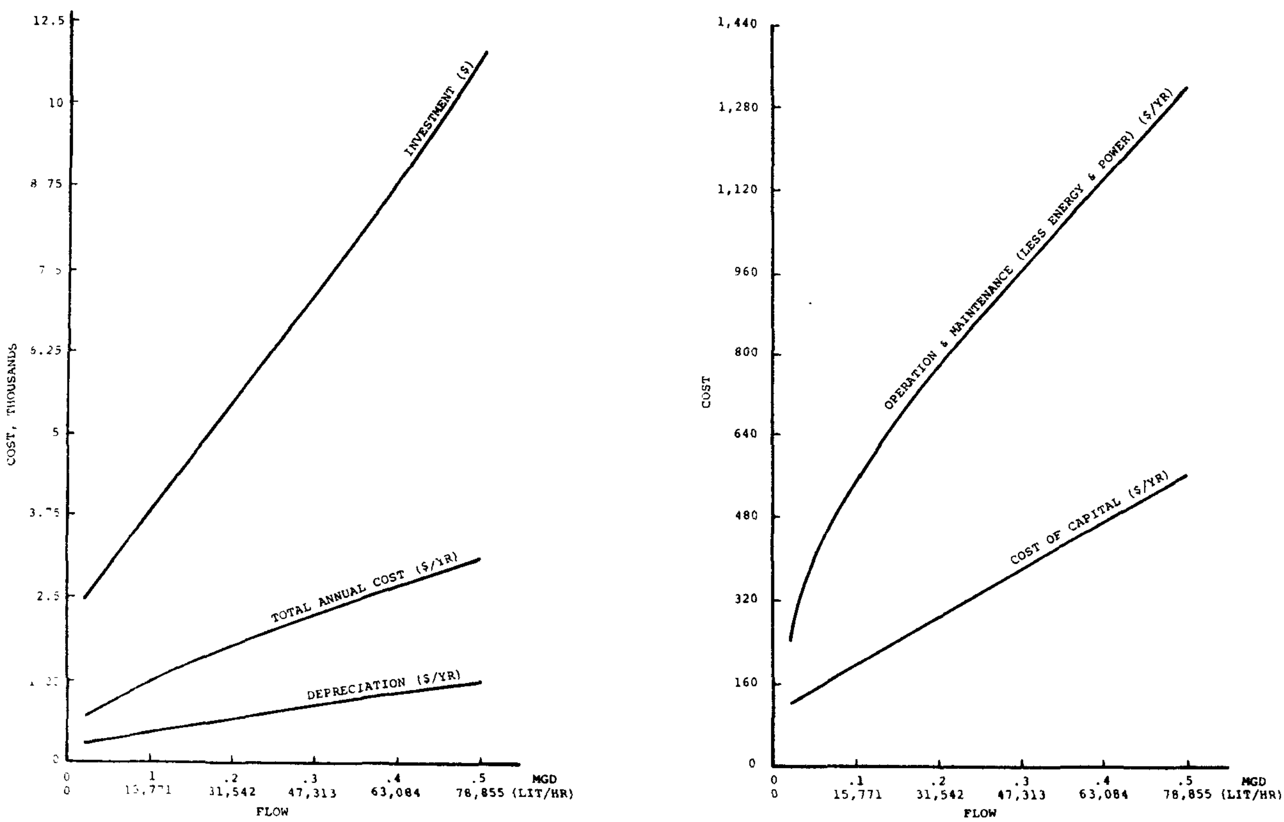

FIGURE 8-2 API OIL SKIMMER

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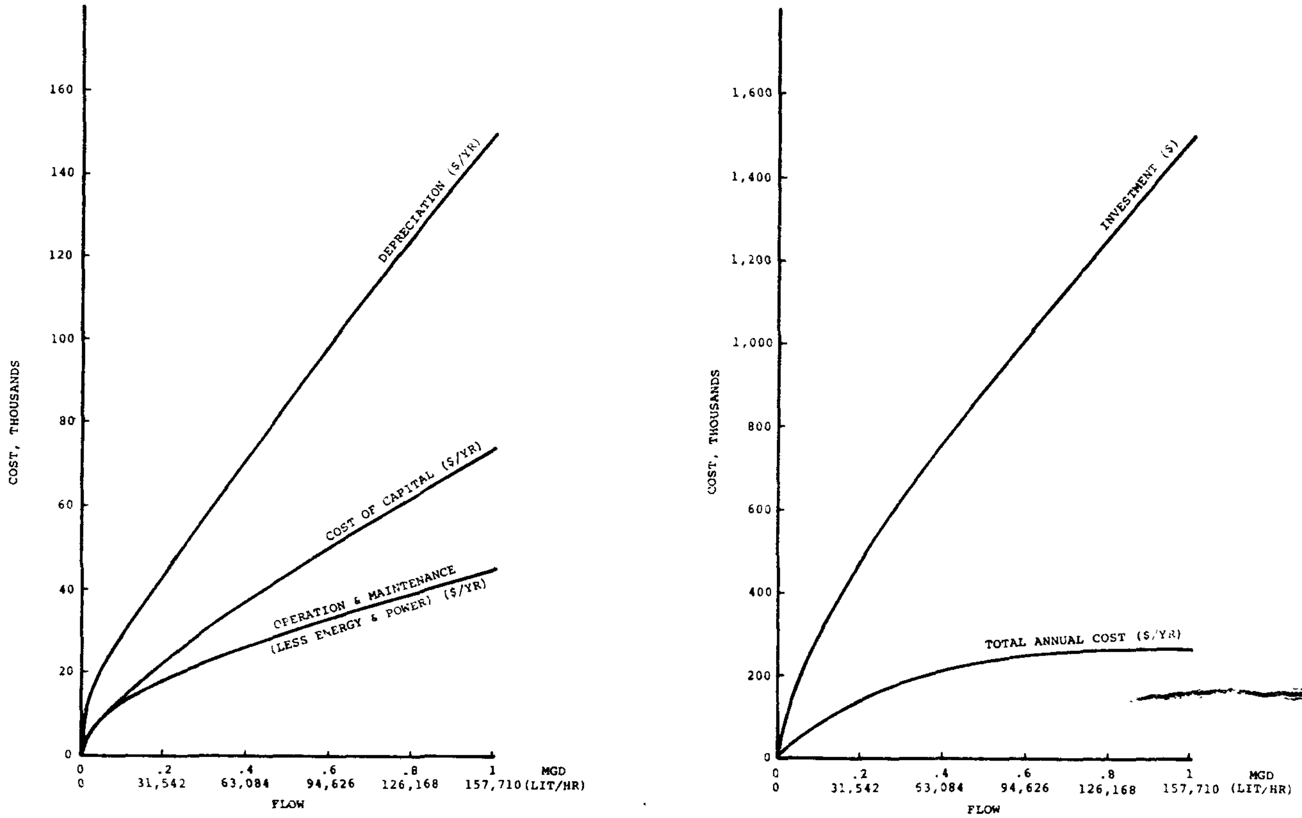

FIGURE 8—3 HOLDING TANKS

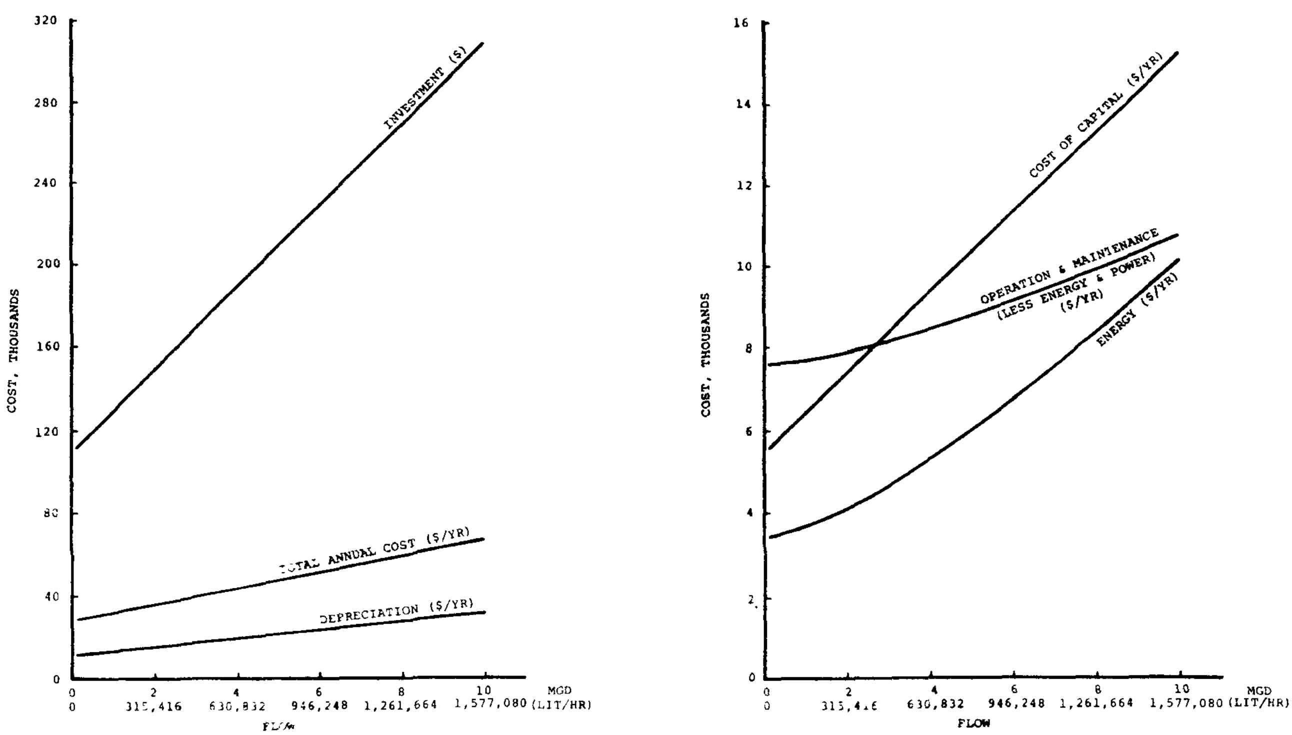

FIGURE 8—4 EQUALIZATION — EARTHEN POND

Clarification-Settling Tanks - Settling tank clarification costs are shown in Figure 8-6. Costing assumptions were:

a) Costs included concrete flocculator and its excavation, concrete settling tank with skimmer and its excavation, and sludge pumps.

b) The flocculator size was based on 45 minutes retention time, a length/width ratio of 5, a depth of 2.44 meters and a thickness of 0.305 meter, and an excess capacity factor of 1.2 was employed. A mixer was included in the flocculator.

c) The settling tank was sized by a design hydraulic loading of 32,590 liters per day per square meter, and a two hour retention time. An excess capacity factor of 1.2 was employed.

d) Sludge pump operation was assumed as 14 hours/week. An excess capacity factor of 1.2 was employed.

e) Power requirements were based on data from a major manufacturer.

Clarification-Metal and Oil Removal Tube Settlers - Tube settler clarification costs are shown in Figure 8-7 and 8-8. Costing assumptions were:

a) Cost included a concrete flocculator and its excavation, a concrete settling tank with skimmer and its excavation, sludge pumps and settling tube modules.

b) The flocculator size was based on 45 minutes retention time, a length to width ratio of 5, and depth of 2.44 meters, a thickness of 0.305 meters, and an excess capacity factor of 1.2 was employed. A mixer was included in the flocculator.

c) The settling tube area was sized by a design hydraulic loading of 146,000 liters per day per square meter, a settling tube depth of 1.22 meters, a settling tank area of 1.5 times the settling tube area and a settling tank depth of 2.44 meters.

d) Sludge pump operation was assumed as 14 hours per week and an excess capacity factor of 1.2 was employed.

e) Power requirements were based on data from a major manufacturer.

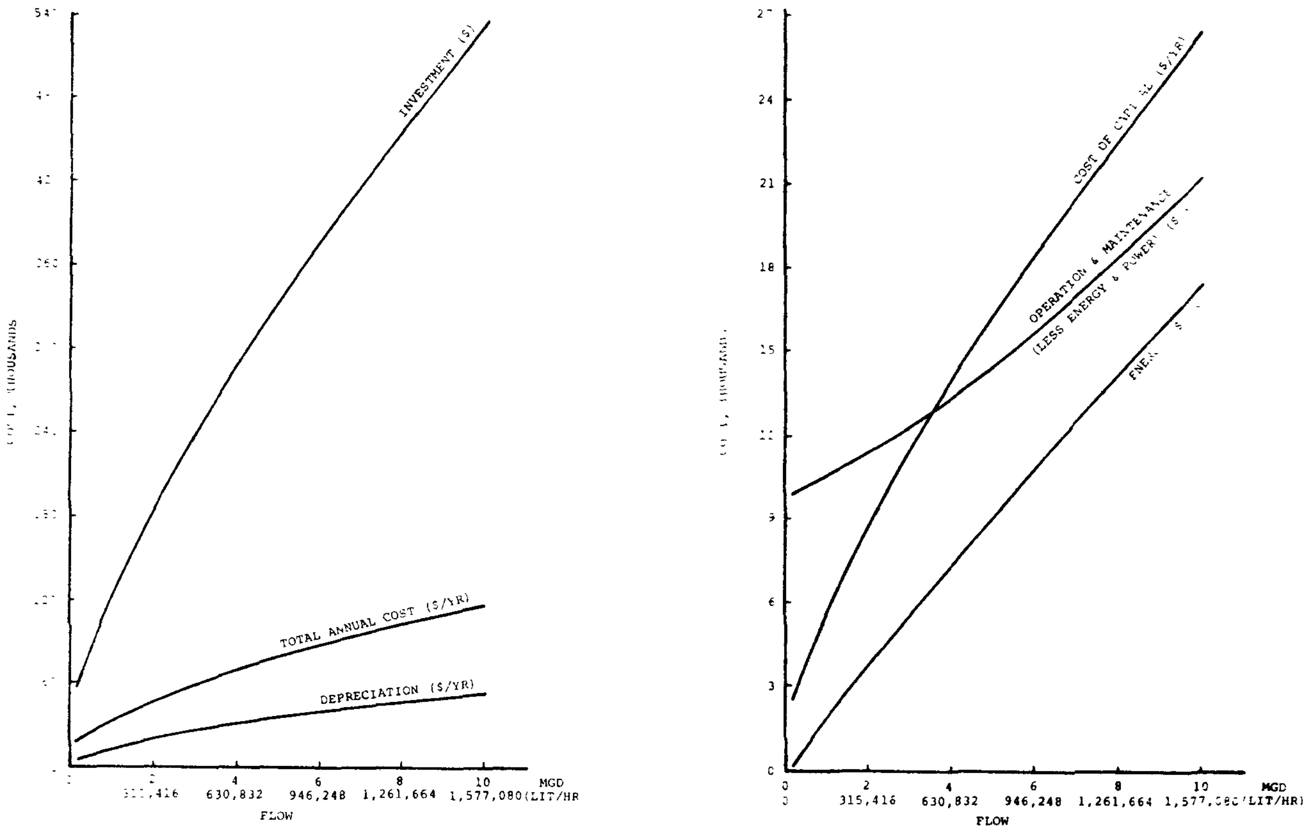

FIGURE 8–5 EQUALIZATION – CONCRETE TANK

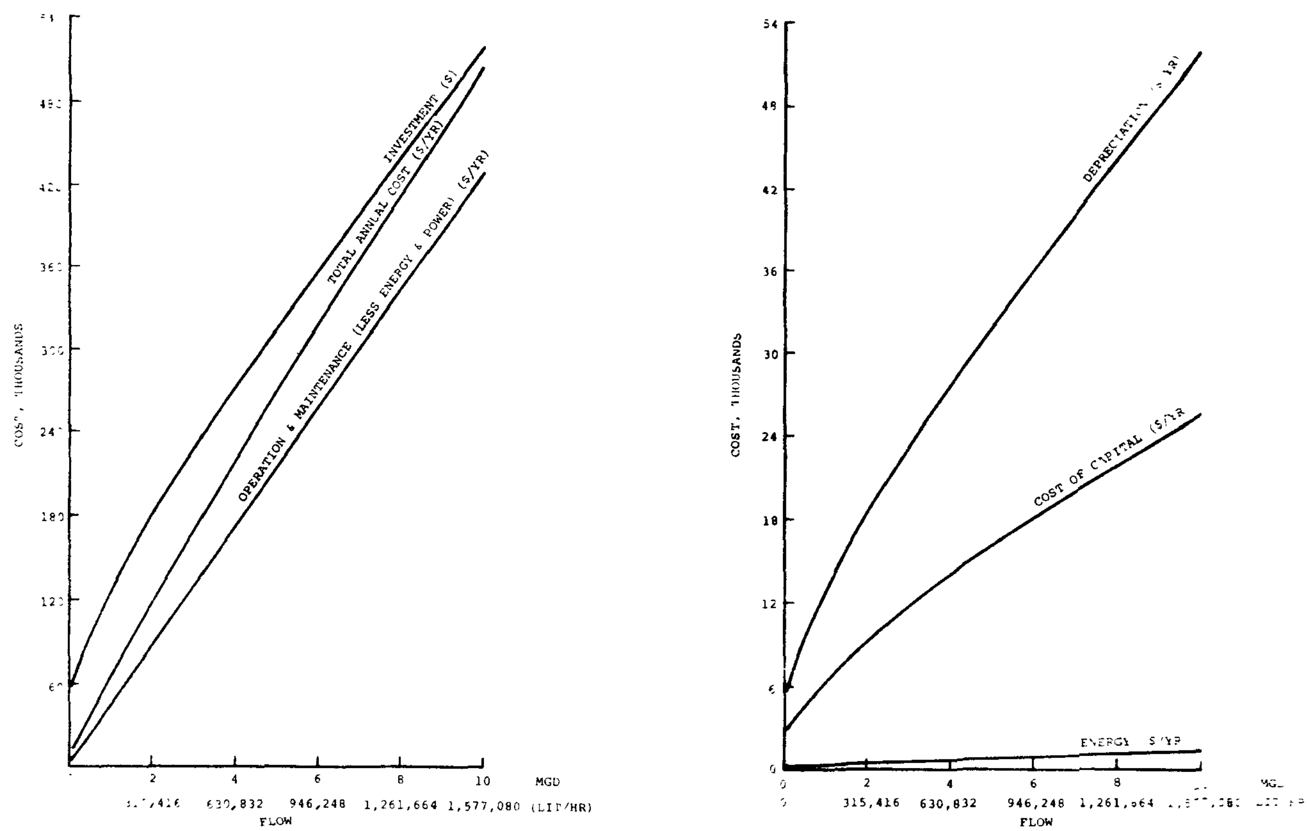

FIGURE 8–6 CLARIFICATION – SETTLING TANK

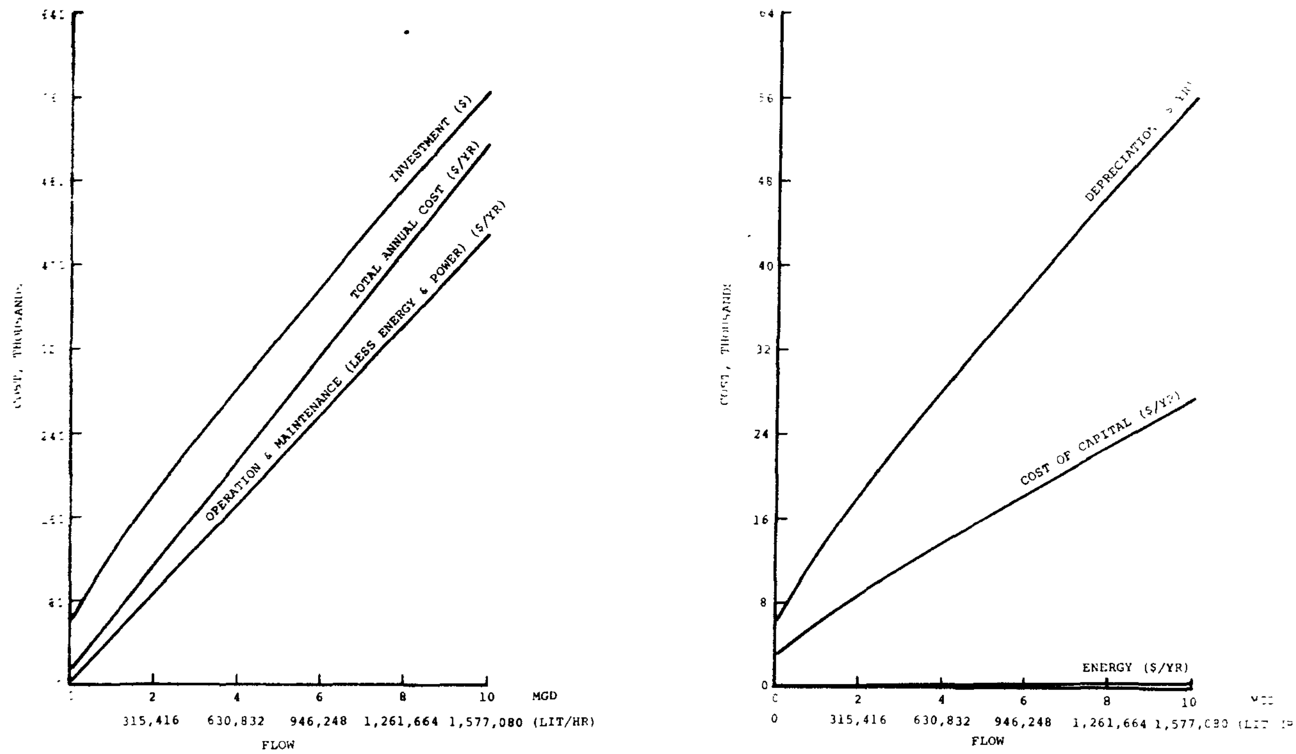

FIGURE 8–7 CLARIFICATION – METAL REMOVAL TUBE SETTLER

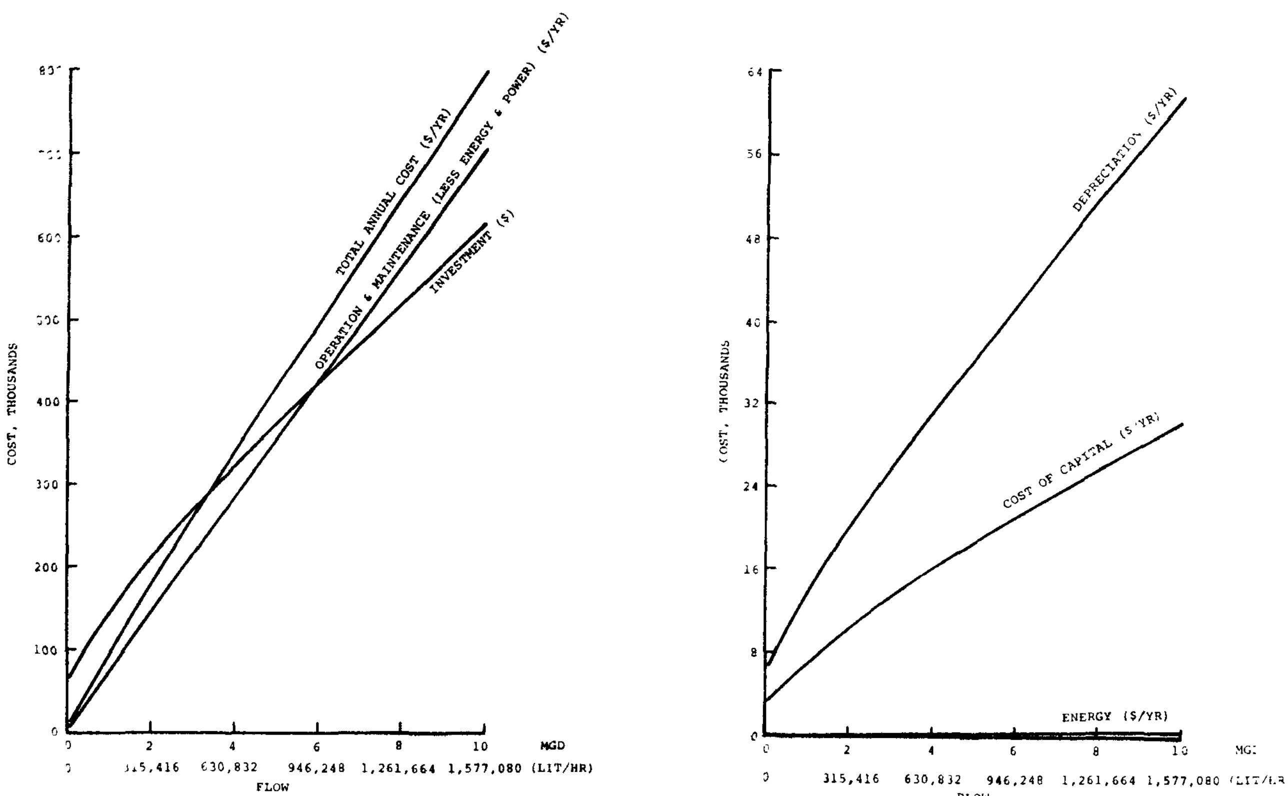

FIGURE 8–8 CLARIFICATION – OIL REMOVAL TUBE SETTLER

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<u>Neutralization-Acidic and Alkaline Influents</u> - Neutralization costs are shown in Figures 8-9 and 8-10. Costing assumptions were:

a) Costs were based on 3 baffled above ground concrete compartments, each with 5 minute retention time.

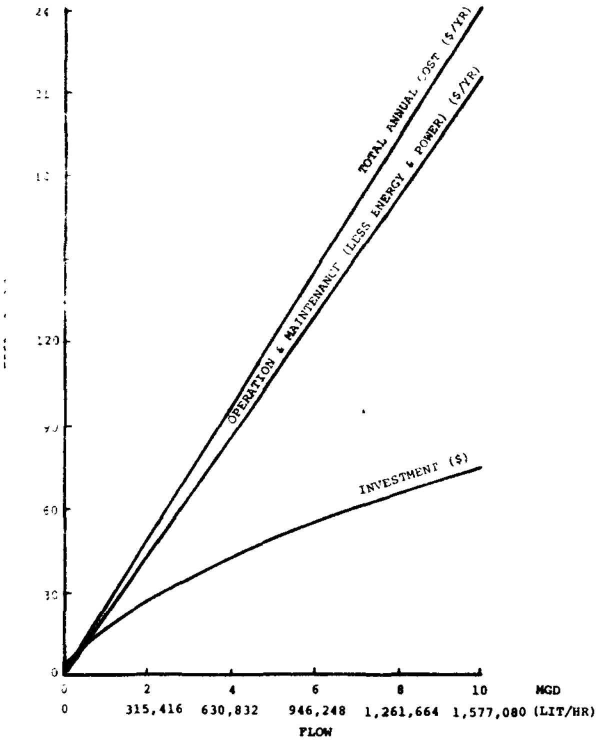
b) The overall tank volume is based on a length/width ratio of 6, a depth of 2.44 meters, and a thickness of 0.305 meters. An excess capacity factor of 1.2 was employed.

c) Power requirements were based on a representative installation with one turnover/minute.

<u>Gravity Thickening</u> - Gravity thickening costs are shown in Figure 8-11. Costing assumptions were:

a) The thickener size was based on a design overflow rate of 28,520 liters per day per square meter and a design solids loading rate of 39 kg/day/sq m.

b) The thickener was of concrete construction and includes excavation. An excess capacity factor of 1.5 was employed.



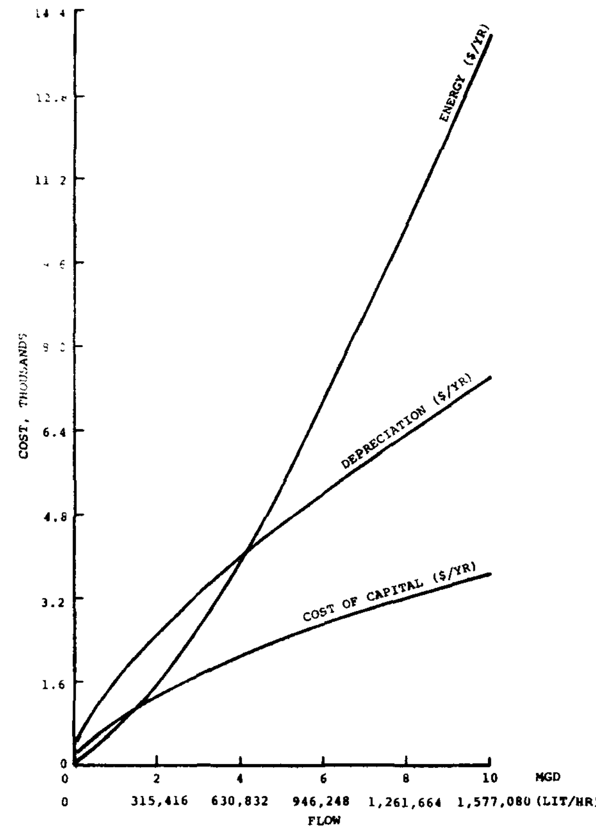
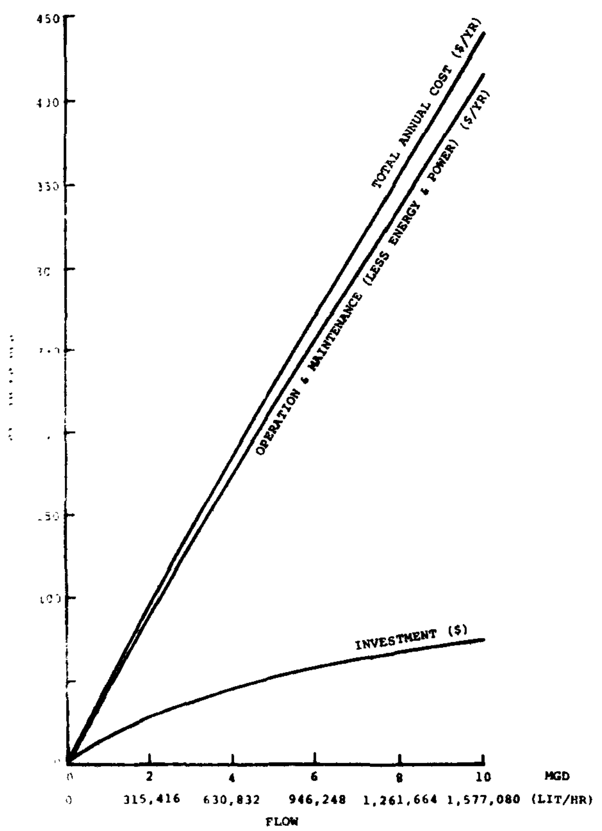


FIGURE 8—9 NEUTRALIZATION — ACIDIC INFLUENT



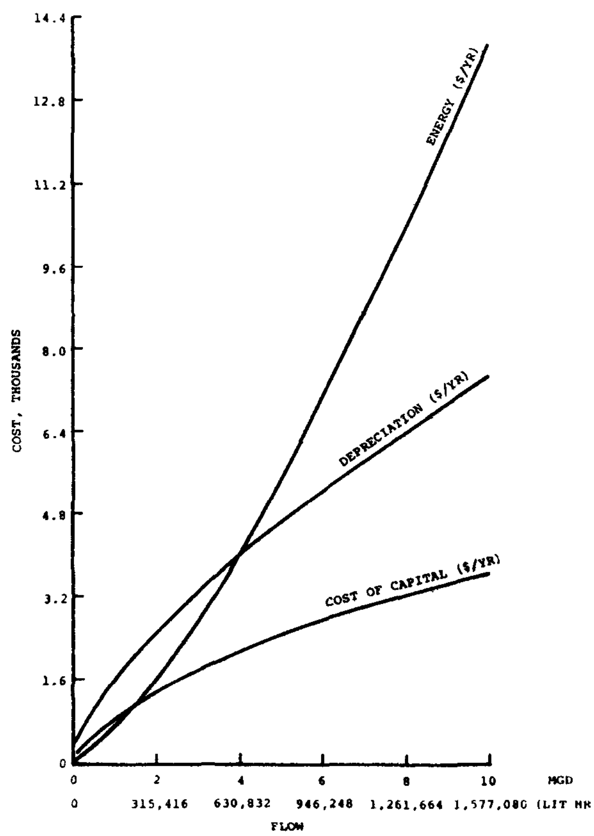


FIGURE 8—10 NEUTRALIZATION — ALKALINE INFLUENT

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Sludge Drying Beds - Sludge drying bed costs are shown in Figure 8-12. Costing assumptions were:

a) The uncovered open sand beds were sized based on a sludge bed loading of 7.6 liters per day per square meter and 35% solids in the sludge stream. An excess capacity factor of 1.5 was employed.

b) Costs included excavation, sludge and drain piping.

Contract Removal - Contract removal costs are shown in Figure 8-13. Costing assumptions were:

a) Dry sludge was hauled 16.1 kilometers by a 30 cubic meter truck at a speed of 40 kilometers per hour to a landfill sludge disposal.

b) The landfill site was 1.8 meters deep with a 20 year planning period. Landfill costs were based on $1,000/acre with operating costs of $3/ton.

Chromium Reduction - Chromium reduction costs are shown in Figure 8-14. Costing assumptions were:

a) The unit was assumed to be an above ground cylindrical concrete tank with 45 minutes retention time.

b) Costs were based on a 0.305 meter thickness and include excavation, sulfonator, acid feed system, pH control, ORP (oxidation-reduction potential) control, and mixer.

c) A constant power requirement of 2 HP was assumed to mix small flows and rapid mix chemicals for large flows. Large flows were assumed to blend without power.

Cyanide Oxidation - Cyanide oxidation costs are shown in Figure 8-15. Costing assumptions were:

a) The unit was assumed to be a cylindrical above-ground concrete tank with 8 hours retention time. Treatment was of the batch type.

b) Costs included 2 tanks of 0.305 meter thickness and 2.44 meter depth, feed system, chlorine feed system, pH control, ORP control, and mixer.

c) The mixer power was based on 2 HP for each 11,360 liters, operational 25% of the time.

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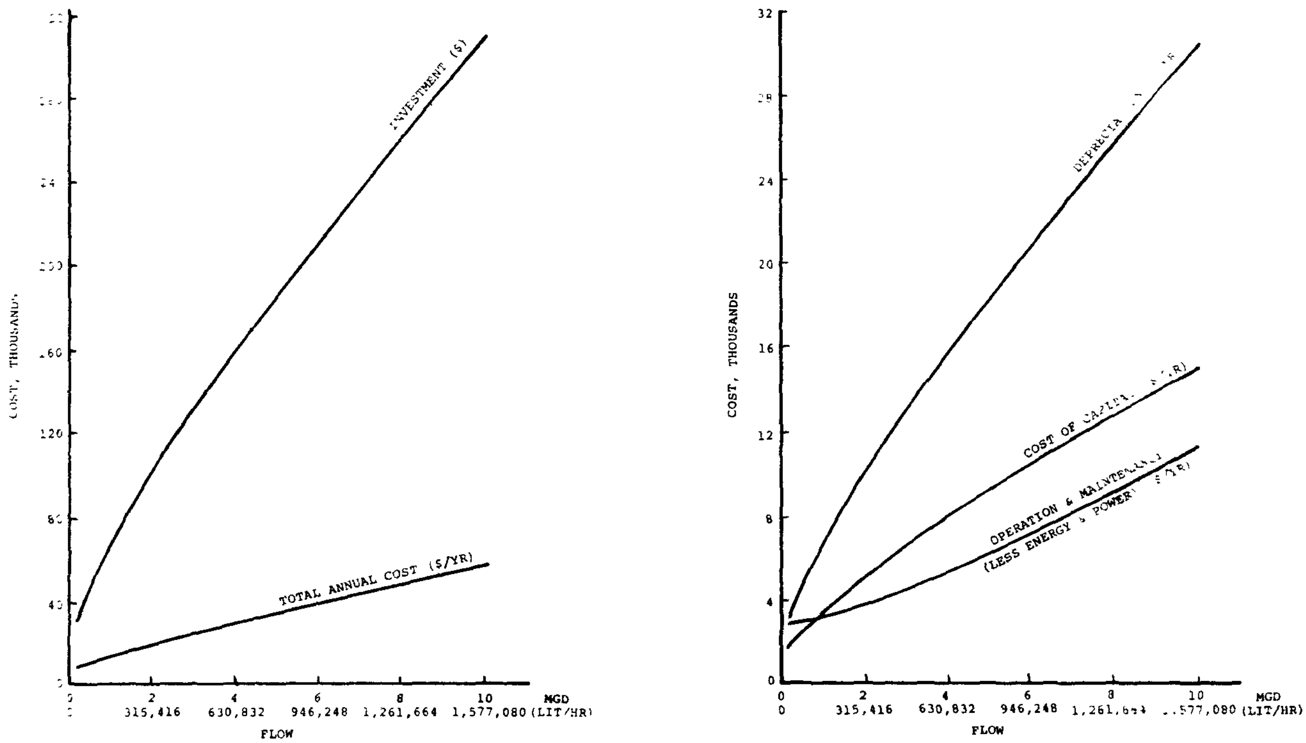

FIGURE 8—11 GRAVITY THICKENING

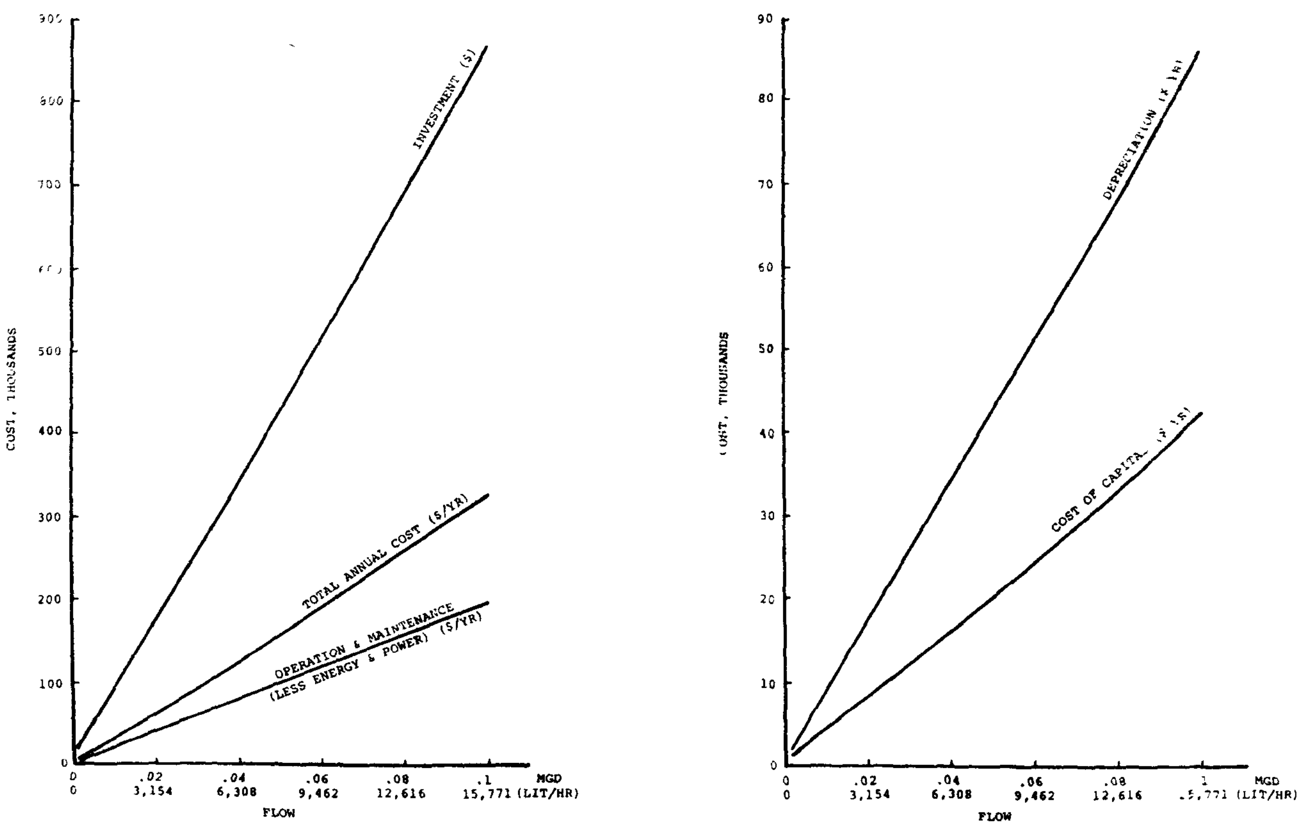

FIGURE 8—12 SLUDGE DRYING BEDS

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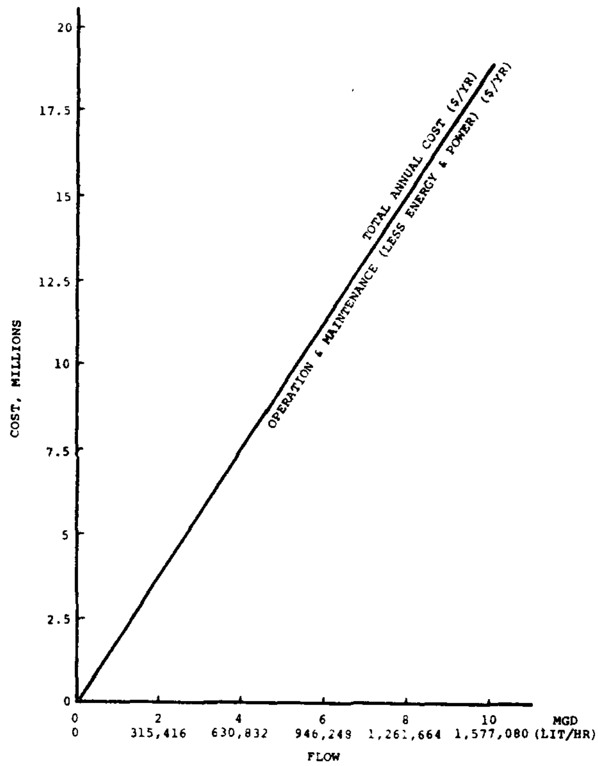
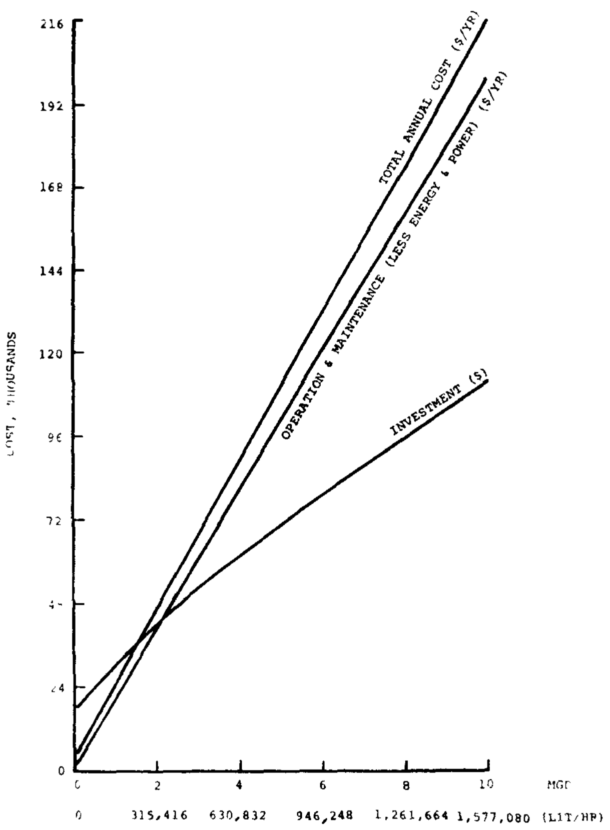


FIGURE 8—13 CONTRACTOR REMOVAL — TOTAL FLOW



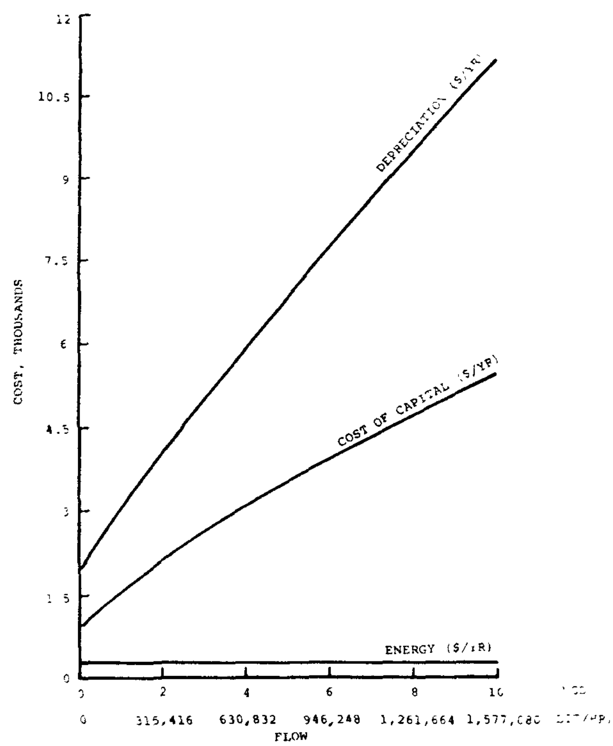


FIGURE 8—14 CHEMICAL REDUCTION OF CHROMIUM

Filtration-With and Without Alum Precoat - Filtration costs are shown in Figures 8-16 and 8-17. Costing assumptions were:

a) The unit was sized based on a hydraulic loading of 235,000 liters per day per square meter and an excess capacity factor of 1.2.

b) Operational costs included alum and sodium carbonate if an alum precoat filter was utilized.

c) The maximum allowable influent oil was set to 100 mg/l to prevent clogging of the filter.

Reverse Osmosis - Reverse osmosis costs are shown in Figure 8-18. Costing assumptions were:

a) The unit was sized based on an initial total pressure of 21 atm and a membrane water permeation coefficient of 0.010 mg/sq cm-sec-atm.

b) Permeate recovery range of 80-95% was employed.

c) Installation cost was minimal and was ignored.

Ultrafiltration - Ultrafiltration costs are shown in Figure 8-19. Costing assumptions were:

a) The unit was sized based on a hydraulic loading of 1430 liters per day per square meter and an excess capacity factor of 1.2.

b) Power was based on 30.48 meters from the equation HP = meters x 1. x (lit/min recirc)/(3532 x 0.7)
Where lit/min recirc = 35
and HP is the requirement for every 18,925 liters/day.

Ion Exchange - Ion exchange costs are shown in Figure 8-20. Costing assumptions were:

a) The unit was sized based on 3 columns to allow both cation and anion exchangers of sodium and chloride, rather than hydrogen. An average resin life of 7 years was assumed.

b) Maximum inlet concentrations of 5 mg/l were allowed as the ion exchanger was to perform a water polishing function. Regeneration costs were ignored as life under these condition is 400-1,000 days.

c) Heavy metal removal was complete.

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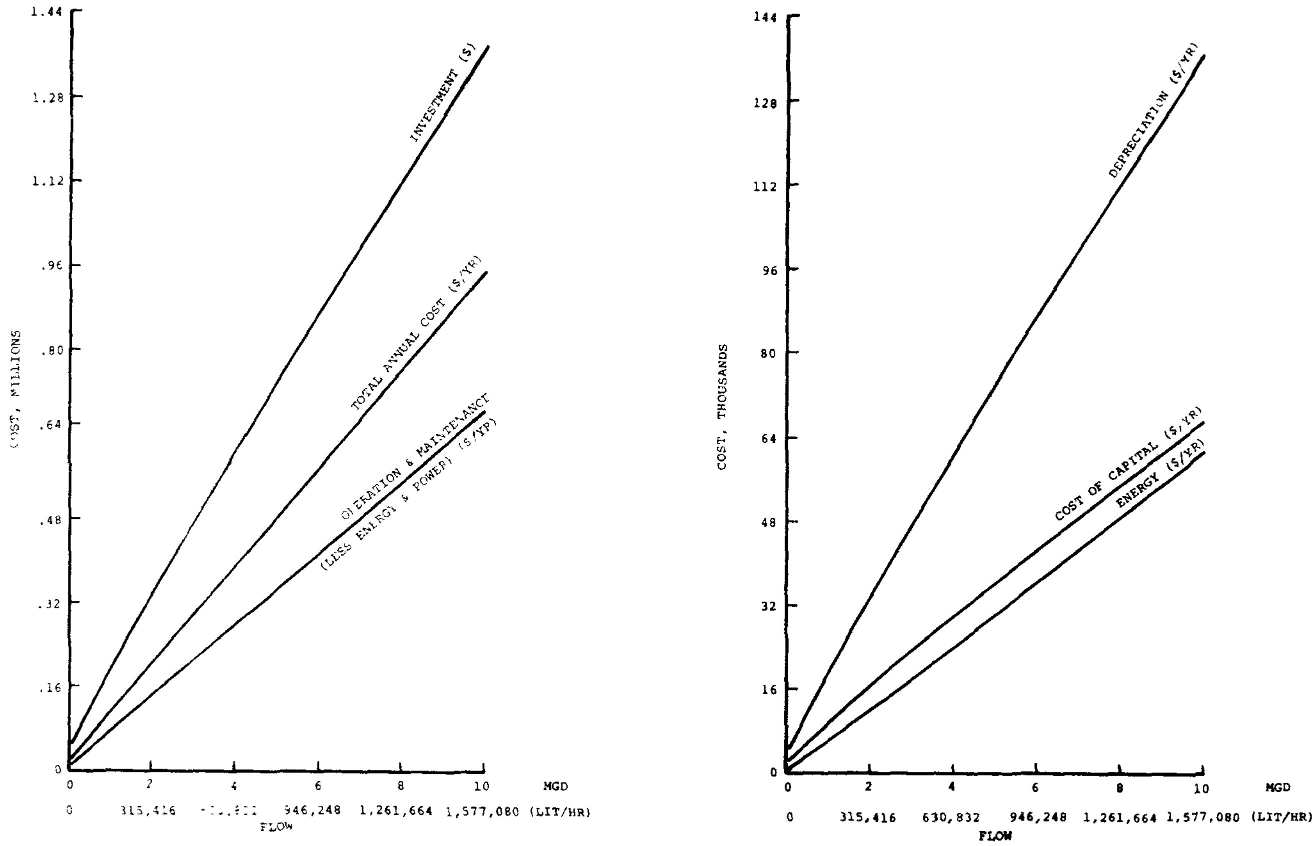

FIGURE 8–15 CHEMICAL OXIDATION OF CYANIDE

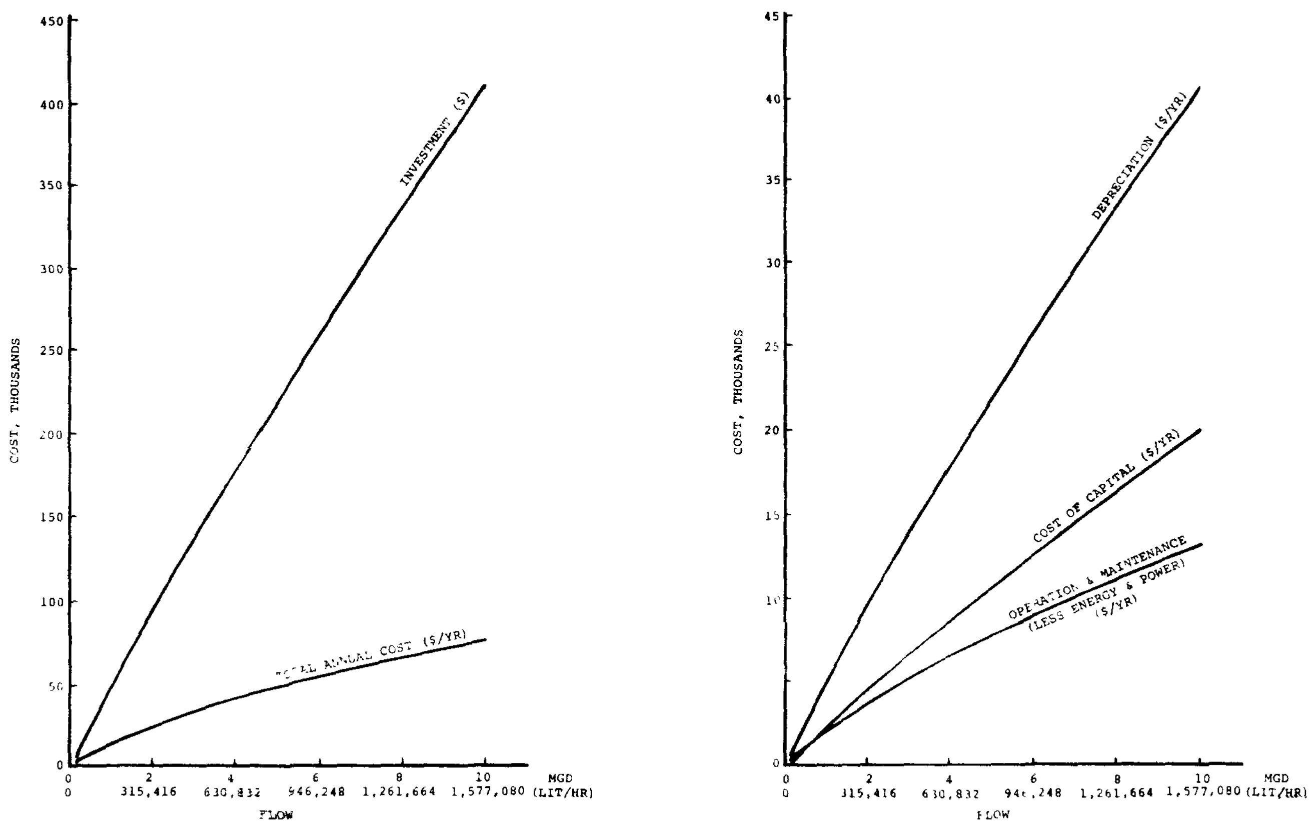

FIGURE 8–16 FILTRATION – WITHOUT ALUM PRECOAT FILTER

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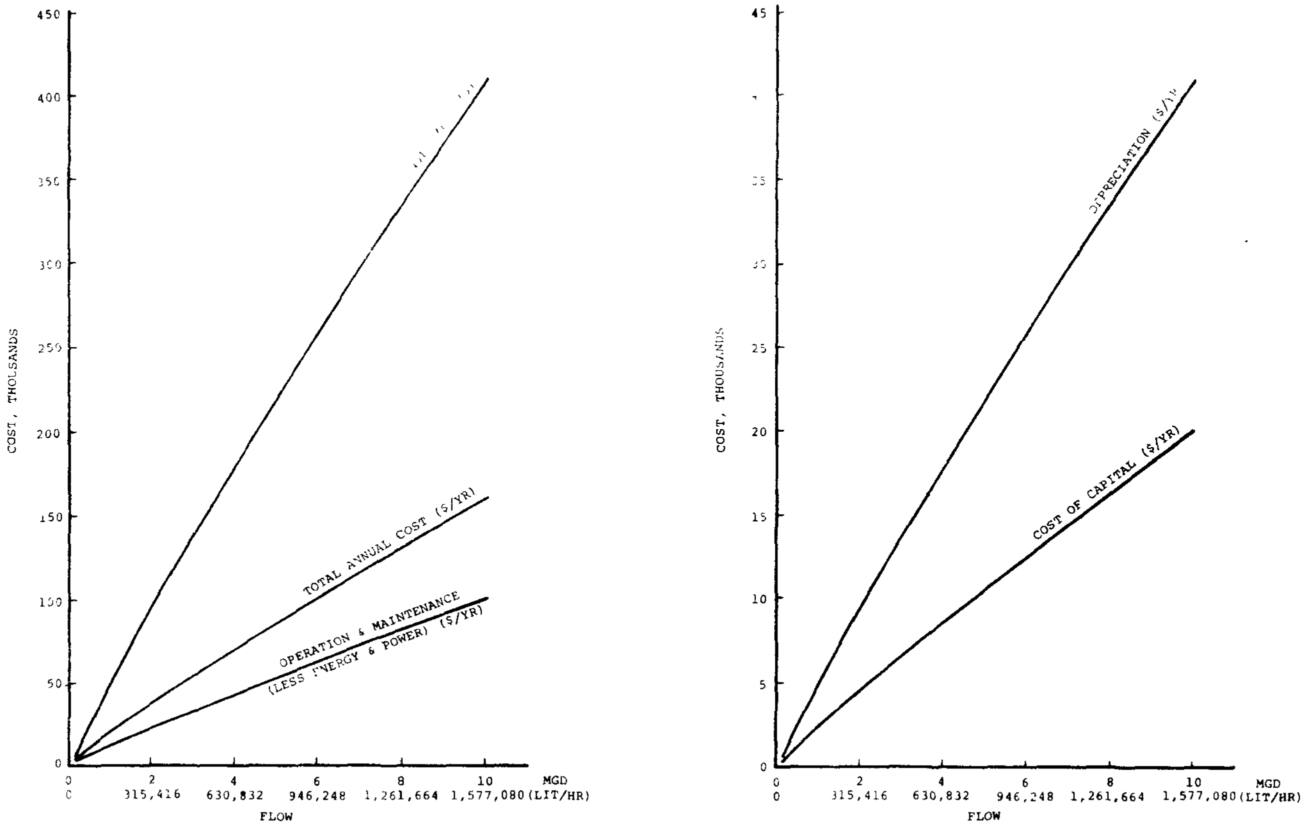


FIGURE 8–17 FILTRATION – WITH ALUM PRECOAT FILTER

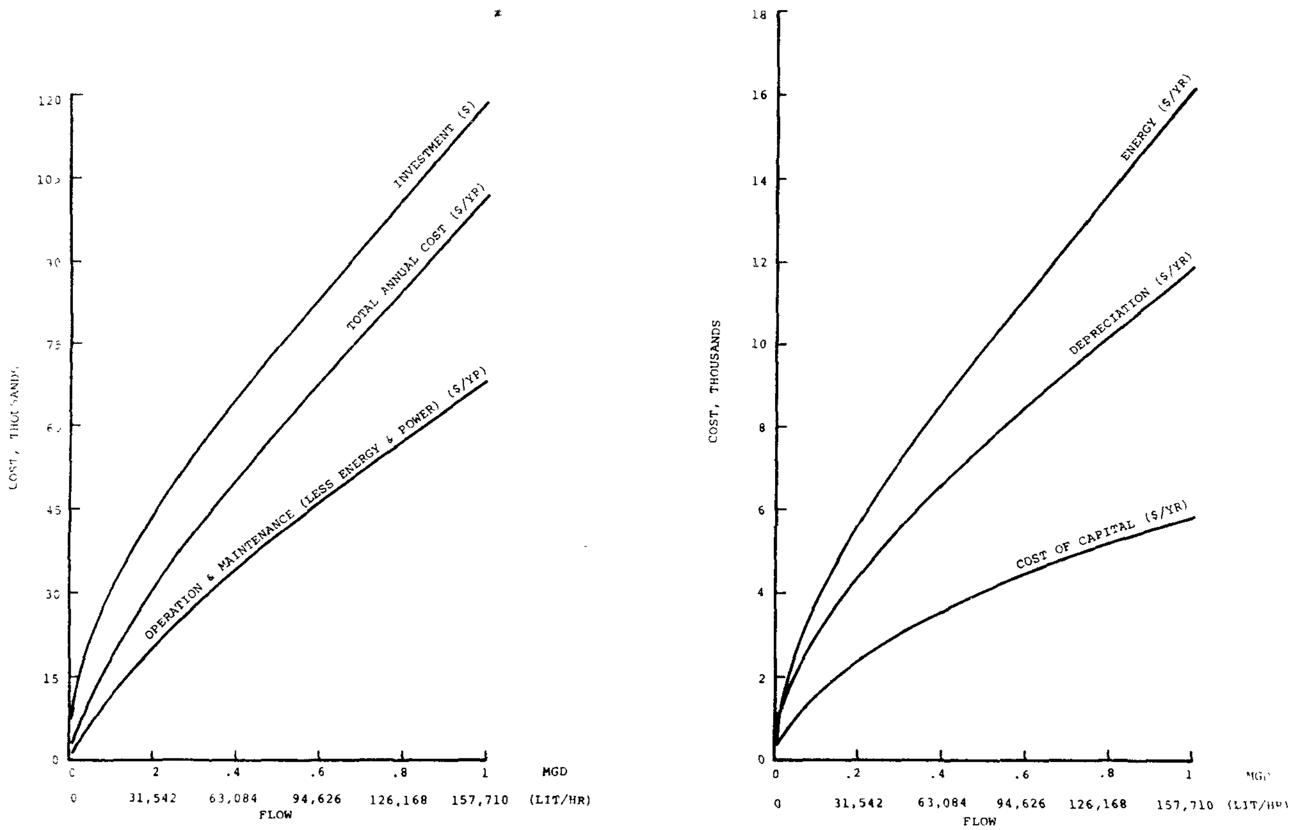
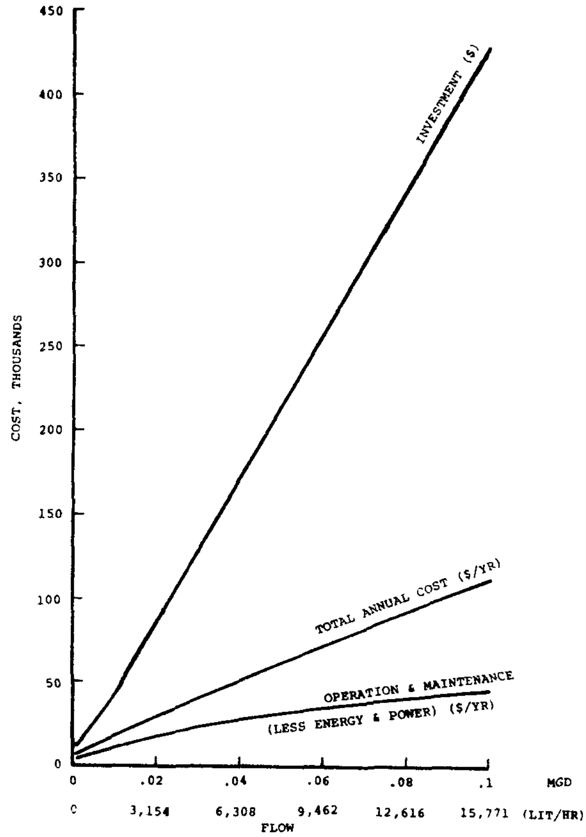


FIGURE 8–18 REVERSE OSMOSIS



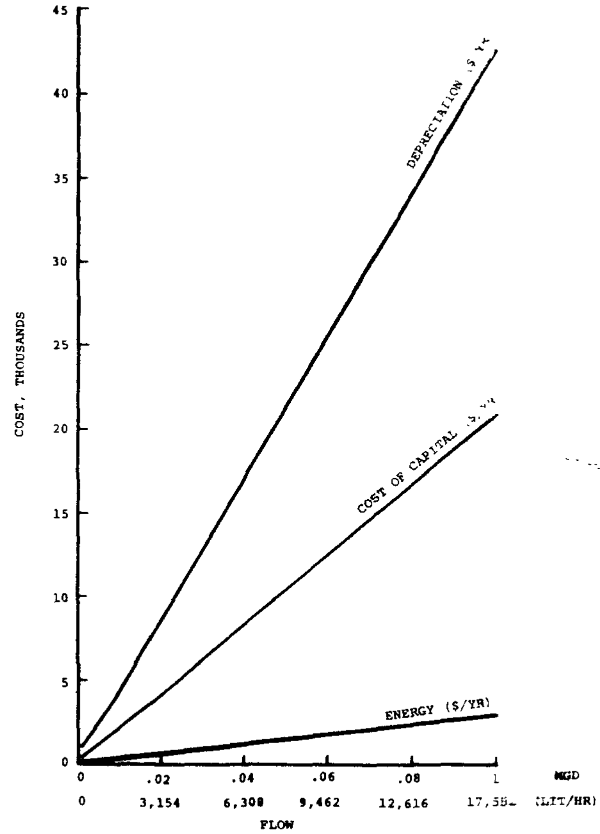
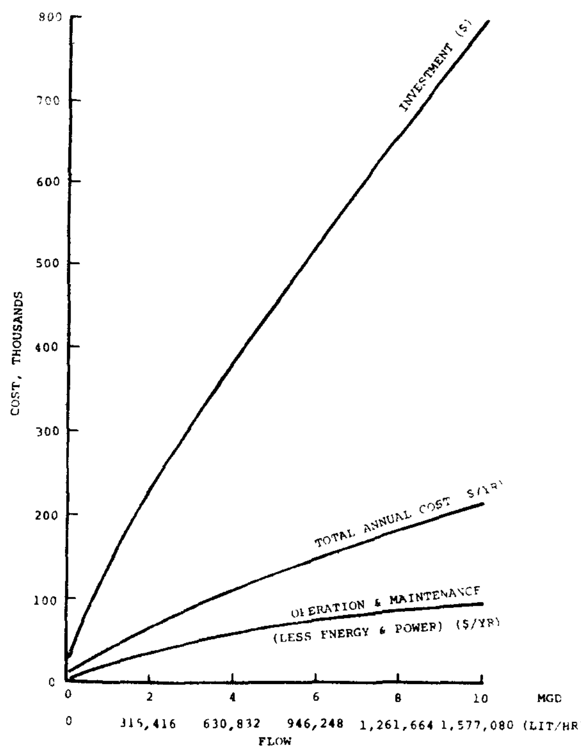


FIGURE 8–19 ULTRAFILTRATION



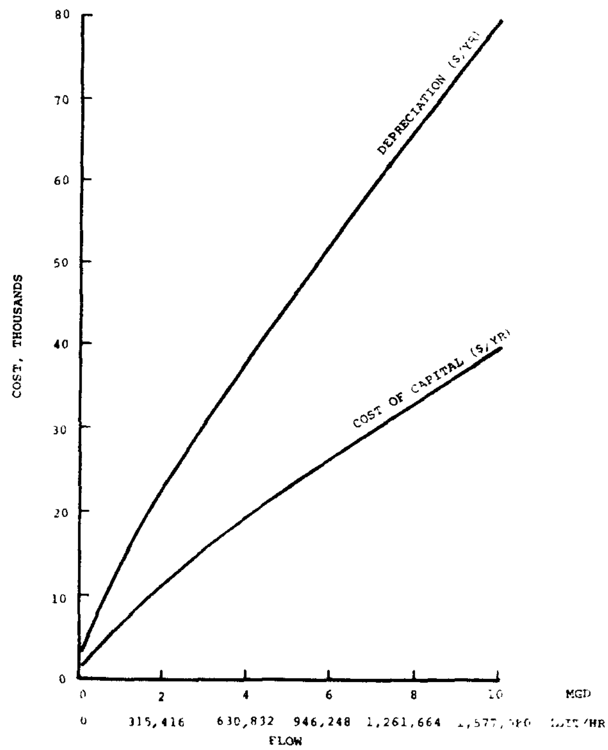


FIGURE 8–20 ION EXCHANGE

Simple Distillation - Simple distillation costs are shown in Figure 8-21. Costing assumptions were:

a) The unit was sized based on an overall heat transfer coefficient of 830 kg-cal/hr-sq m-deg C and a temperature differential of 4.4 degrees C. The evaporative heat required was calculated based on 583 cal/gram of wastewater. The heating value of fuel was taken as 10,140 cal/gram (LHV, API of 30). A boiler heat recovery value of 85% was assumed.

b) The sludge stream was set to 50% solids.

c) Unit cost was based on a standard vertical tube heat exchanger with a cast iron body and copper tubes. An excess capacity factor of 1 was employed.

Wiped Film Distillation - Wiped film distillation costs are shown in Figure 8-22. Costing assumptions were:

a) The unit was sized based on a Plant ID 526 installation for 56.8 liters per minute. Evaporative heat of 583 cal/gram of wastewater required. The heating value of fuel was taken as 10,140 cal/gram (LHV, API of 30) with a boiler heat recovery of 85%. An excess capacity factor of 2 was employed.

b) The sludge stream was set to 95% solids.

c) The electrical requirement was based on a Plant ID 526 installation.

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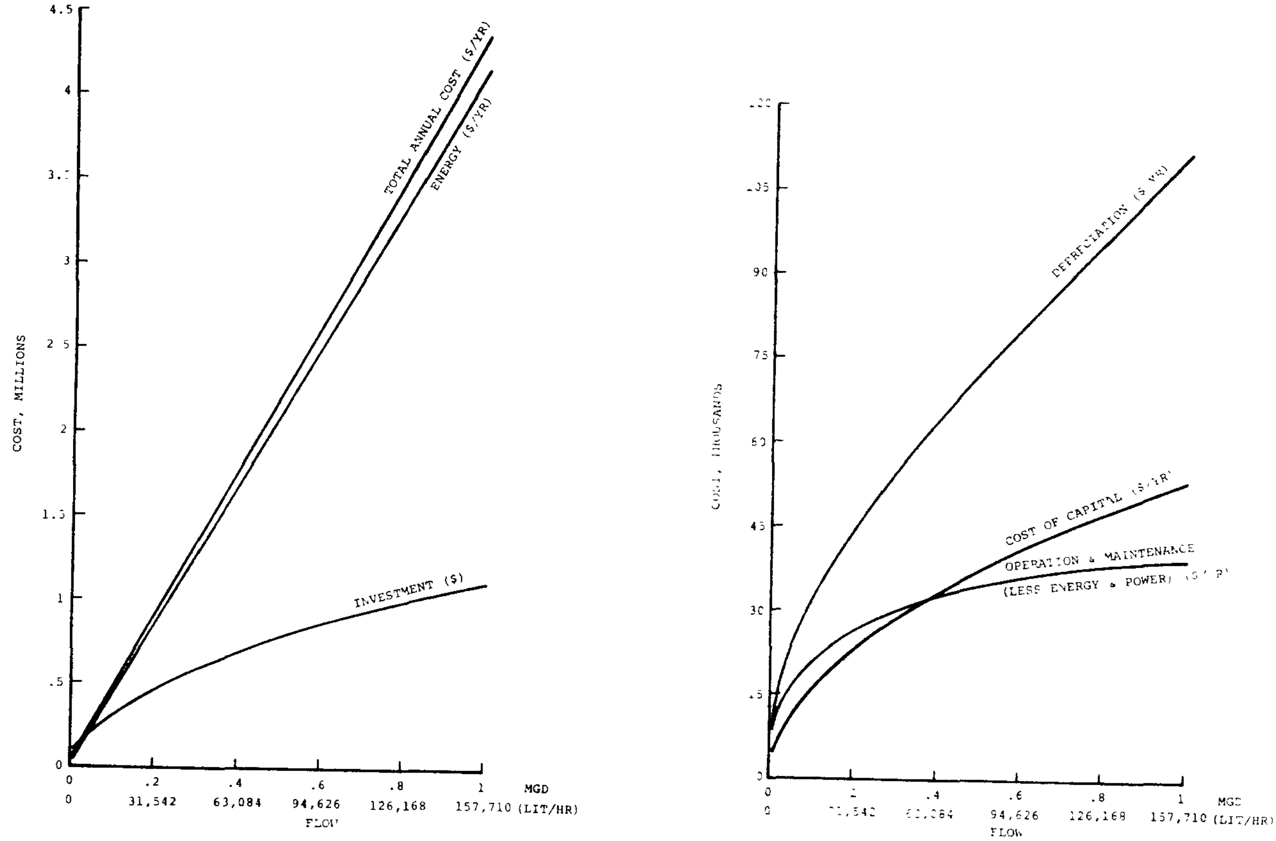

FIGURE 8–21 DISTILLATION – SIMPLE

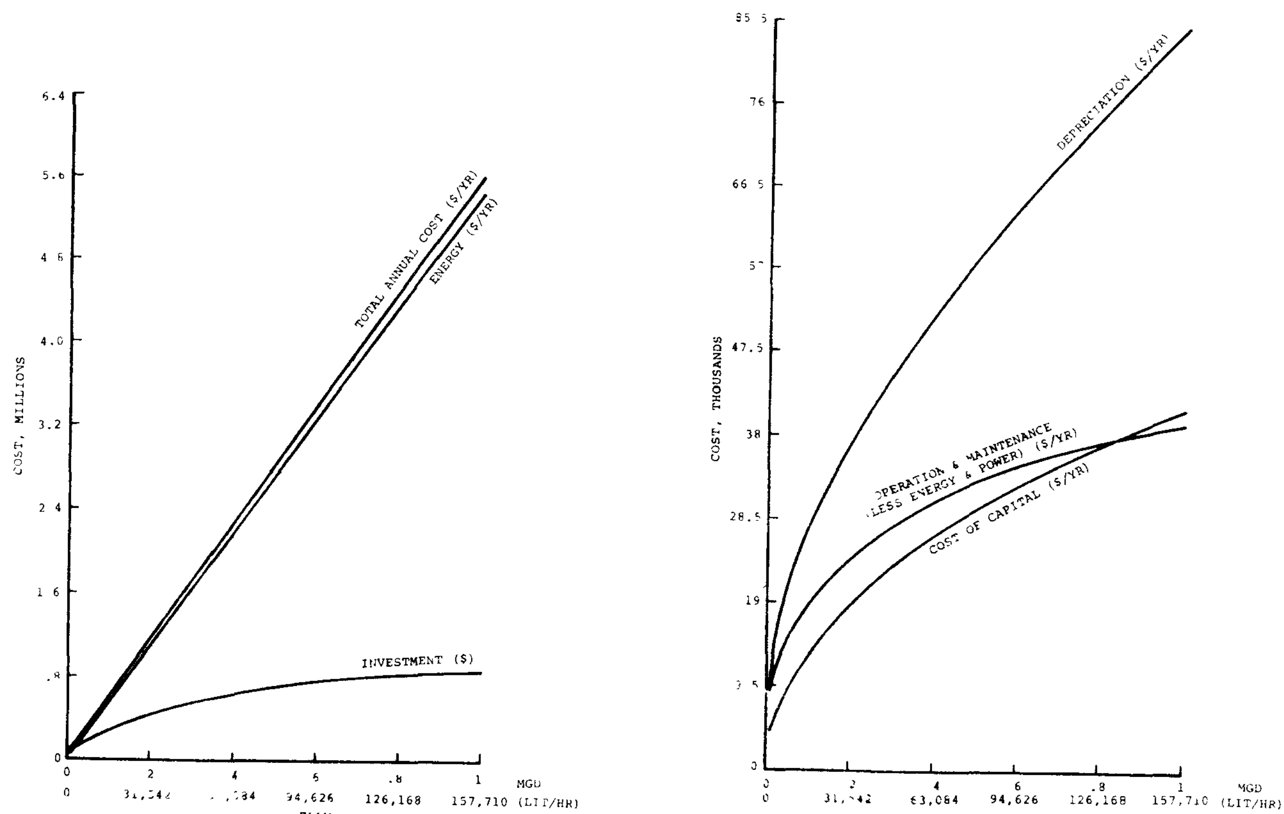

FIGURE 8–22 DISTILLATION – WIPED FILM

Flotation/Separation-Acidic and Alkaline Influents - Flotation/ Separation costs are shown in Figures 8-23 and 8-24. Costing assumptions were:

a) The unit area was sized by a design hydraulic loading of 58,500 liters per day per square meter and a minimum surface area of 1.4 square meters. An excess capacity factor of 1.2 was used.

b) The capital and power cost were based on data from major manufacturers.

Sludge Pumping - Costs for sludge pumping are shown in Figure 8-25. Costing assumptions were:

a) The capital and operating costs were based on a previous study for the EPA by another contractor.

b) All operation and maintenance costs other than labor were assumed to be energy costs only.

Copper Cementation - Costs for copper cementation are shown in Figure 8-26. Costing assumptions were:

a) Cost included 2 concrete tanks each with a retention time of 50 minutes, a length to width ratio of 3, and a wall thickness of 0.305 meters and an excess capacity factor of 1.2 was employed.

b) Sixty percent of the influent copper concentration was assumed recovered as a saleable product.

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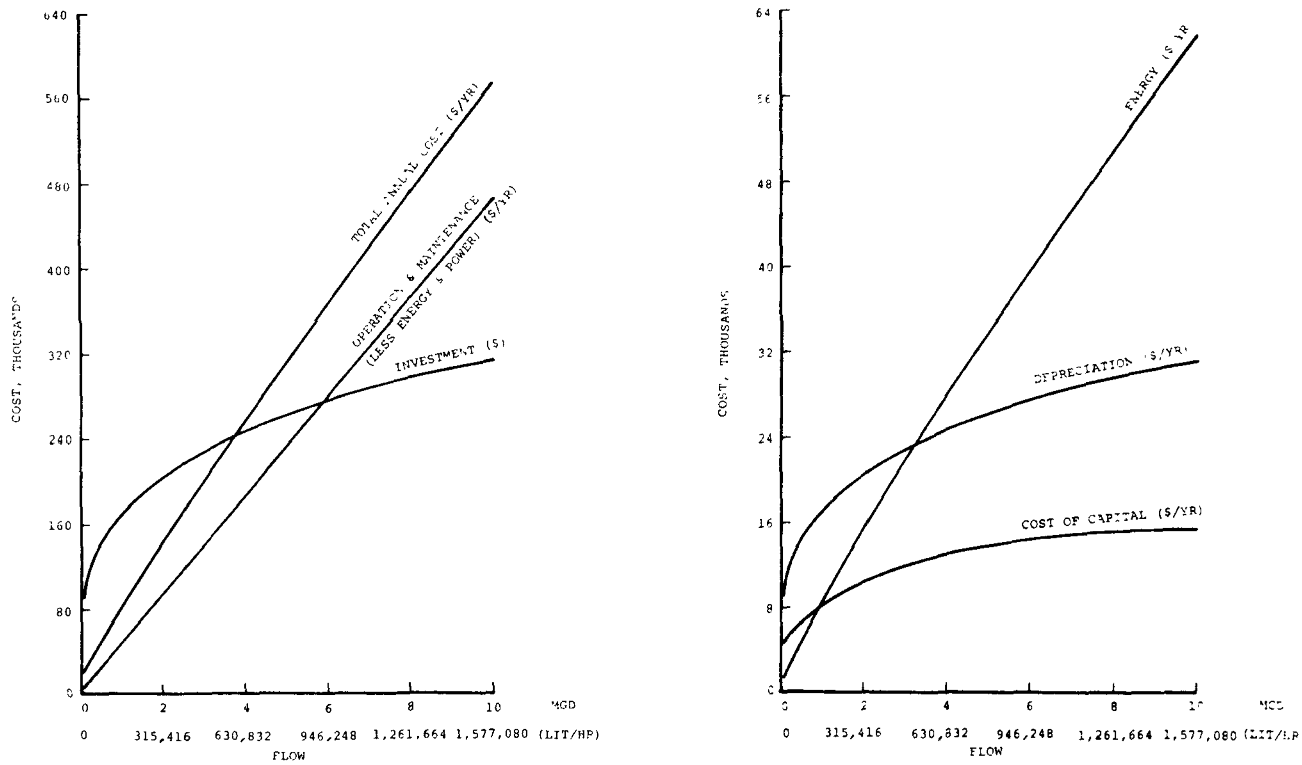

FIGURE 8-23 FLOTATION/SEPARATION – ACIDIC INFLUENT

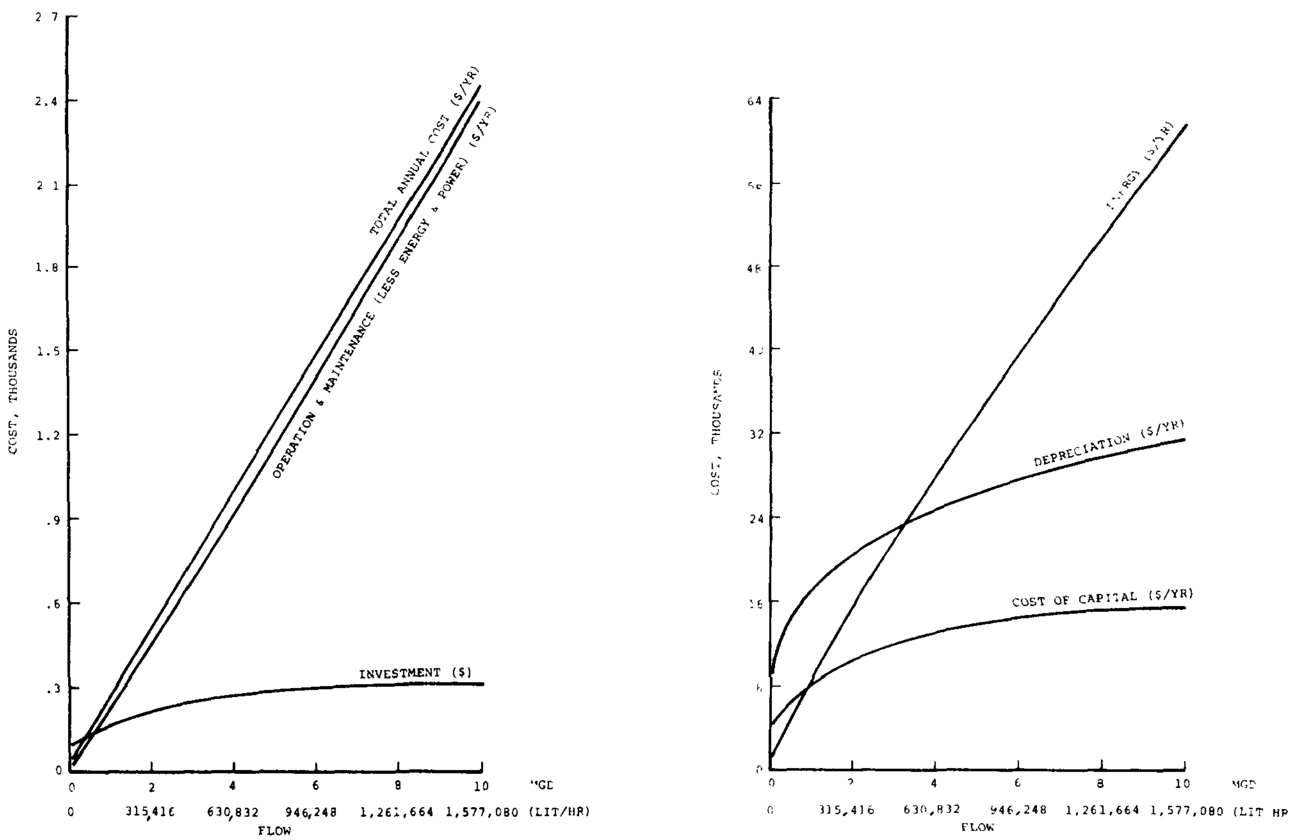

FIGURE 8–24 FLOTATION/SEPARATION – ALKALINE INFLUENT

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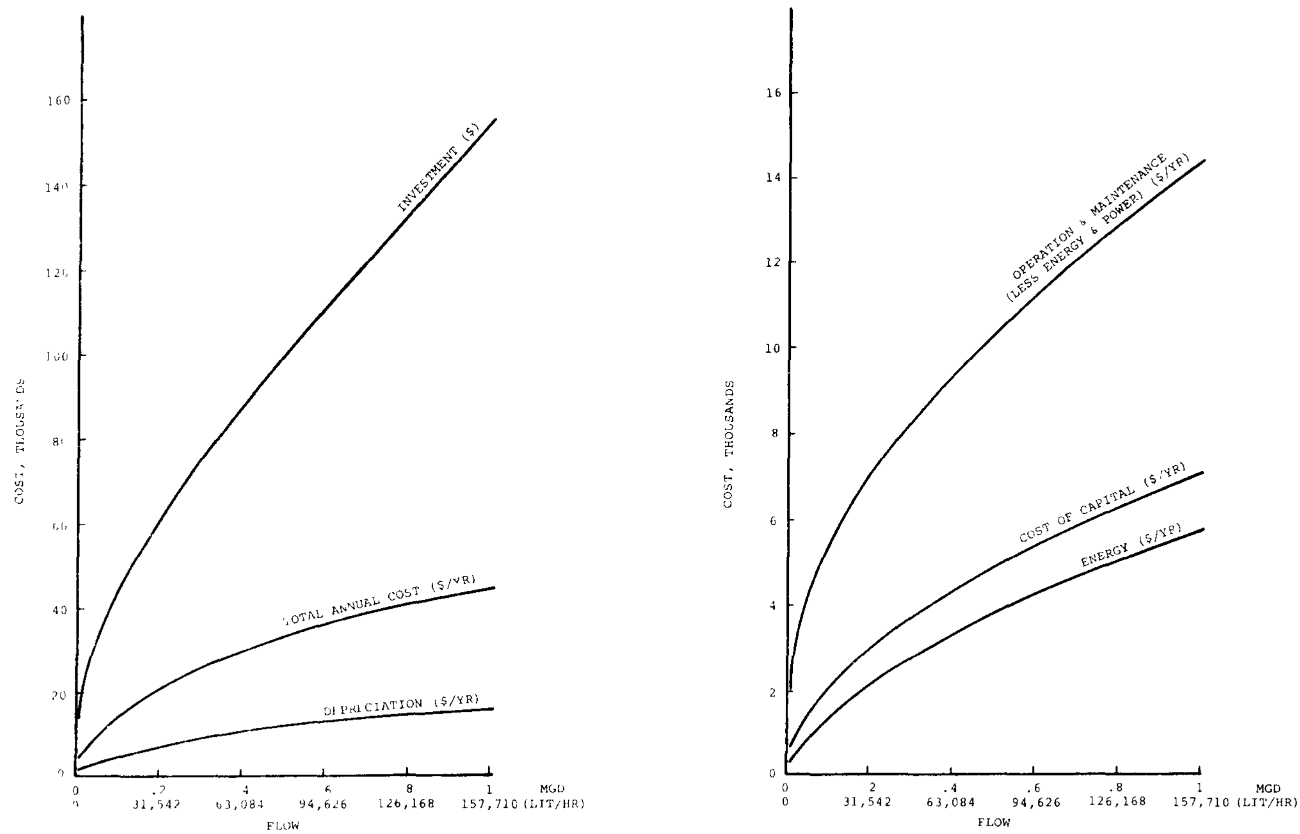

FIGURE 8–25 SLUDGE PUMPING

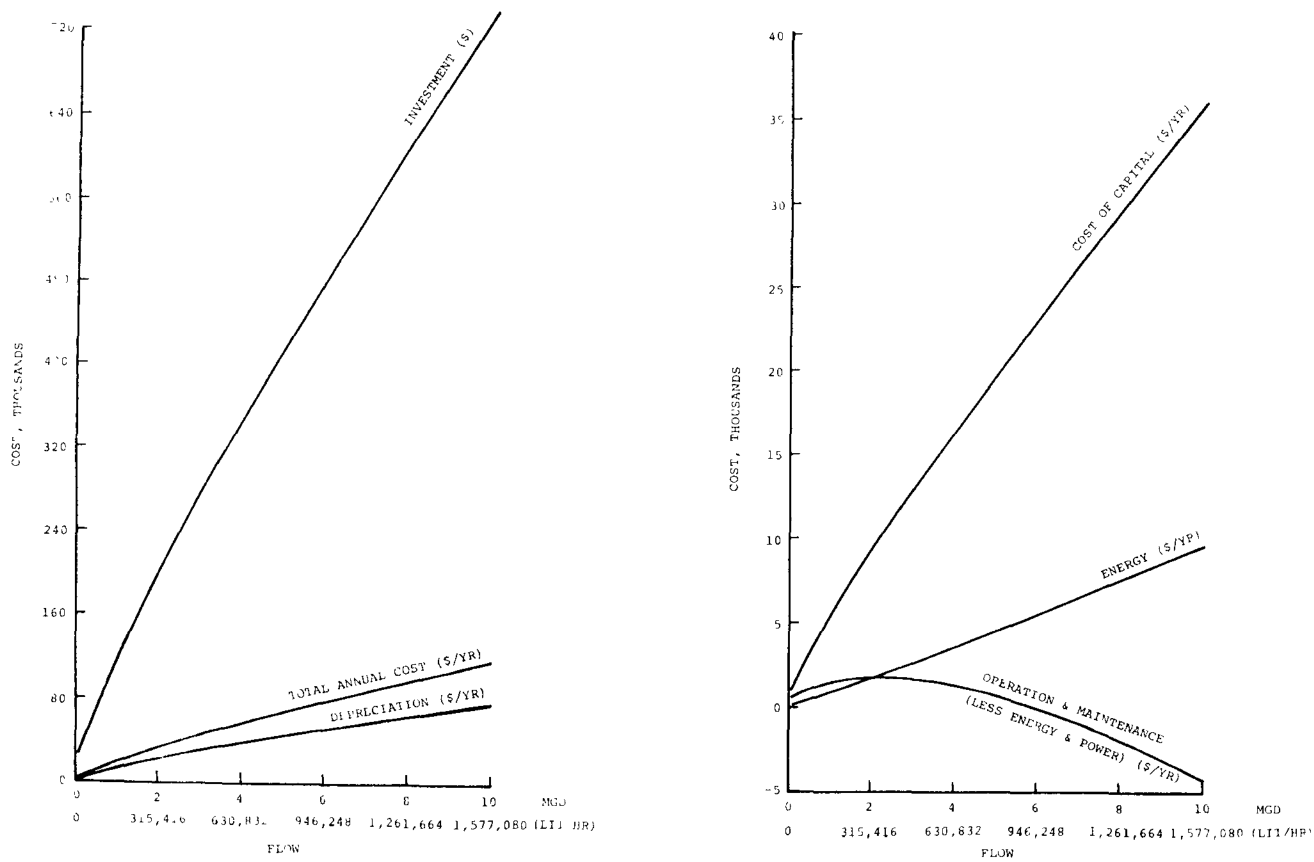

FIGURE 8–26 COPPER CEMENTATION

For copper cementation, the operation and maintenance cost curve is unusual because at higher flow rates the curve has a negative slope and costs are negative. These characteristics represent a credit due to increasingly efficient recovery of copper for reuse as plant size increases.

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System Cost Estimates

Cost estimates for BPT and BAT systems for the Machinery and Mechanical Products Manufacturing industries subcategories are based on the specific treatment systems discussed in Section VII of this document. For each series (BPT and BAT) of systems, the subcategory costs are presented in a series of tables, and each series is preceded by the the appropriate baseline schematic that served as the basis for the tabulated costs.

On each table, costs are listed for treatment of four representative wastewater processing rates, which cover a broad range of flow rates. The range of flow rates for BAT is lower than the range for BPT because in-plant control measures, discussed in Section VII, are expected to reduce water use substantially. However, the flow rates for BPT and BAT were selected so that three of the four rates are identical, permitting a direct comparison between BPT costs and BAT costs for any subcategory. The basic cost elements used in preparing these costs are the same as those presented for the individual technologies: investment, annual capital cost, annual depreciation, annual operation and maintenance cost (less energy and power costs), energy and power cost, and total annual cost. These elements were discussed in detail earlier in this section.

Performance is indicated in terms of typical or representative raw wastewater pollutant concentrations and typical effluent (treated wastewater) pollutant concentrations. BAT raw wastewater concentrations were defined as twice the value of BPT raw wastewater concentrations. This factor of two indicates that higher concentrations of contaminants in treated wastewater are expected due to reduced water use. However, the BAT treatment enables water effluent quality to be completely adequate for reuse.

The costs from the cost tables may be applied directly to plants using water in more than one subcategory. To estimate the cost for a multiple subcategory plant, the subcategory with the most complex system is selected, and the cost is then determined from the corresponding cost table, using the total plant process wastewater treatment rate.

Flow rates on the sytem cost tables are shown in metric units. The following conversion chart is presented for convenience in using the tables:

Liters/hr	3,943	7,885	15,771	39,427	157,708
Gal/day	25,000	50,000	100,000	250,000	1,000,000

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BPT System Costs - Figure 8-27 shows the baseline BPT system. The system shown applies directly to Subcategories 1, 2, 3, 5, 8, and 12. Subcategory 4 and 10 require cyanide oxidation in addition to the baseline technologies. Subcategories 6 and 7 require chromium reduction in addition to the baseline technologies. There is no system for Subcategory 9, because when process water is used it is normally recycled for reuse, and there is no end-of-pipe treatment. There is no system for Subcategory 11 because end-of-pipe treatment is not applicable. It must be emphasized that these systems are representative techniques for achieving BPT. There are alternative methods which are equally effective. The costs assume no prior waste treatment facility.

The cost tables based on these BPT systems are as follows:

Subcategory 1 - Casting and Molding-Metals	Table 8-2
Subcategory 2 - Mechanical Material Removal	Table 8-3
Subcategory 3 - Material Forming-All Materials Except Plastics	Table 8-4
Subcategory 4 - Physical Property Modification	Table 8-5
Subcategory 5 - Assembly Operations	Table 8-6
Subcategory 6 - Chemical-Electrochemical Operations	Table 8-7
Subcategory 7 - Material Coating	Table 8-8
Subcategory 8 - Smelting and Refining of Nonferrous Metals	Table 8-9
Subcategory 10 - Film Sensitizing	Table 8-10
Subcategory 12 - Lead Acid Battery Manufacture	Table 8-11

The actual costs of installing and operating a BPT system at a particular plant may be substantially below the tabulated values. Reductions in investment and operating cost are possible in several potential areas. Design and installation costs may be reduced by using plant engineering and maintenance personnel instead of contracting the work. Equipment costs may be reduced by using or modifying existing equipment instead of purchasing all new equipment. Application of an excess capacity factor, which increased the size of most equipment to compensate for shutdowns, may be unnecessary. Excavation and foundation costs could be reduced if an existing concrete pad or floor can be utilized.

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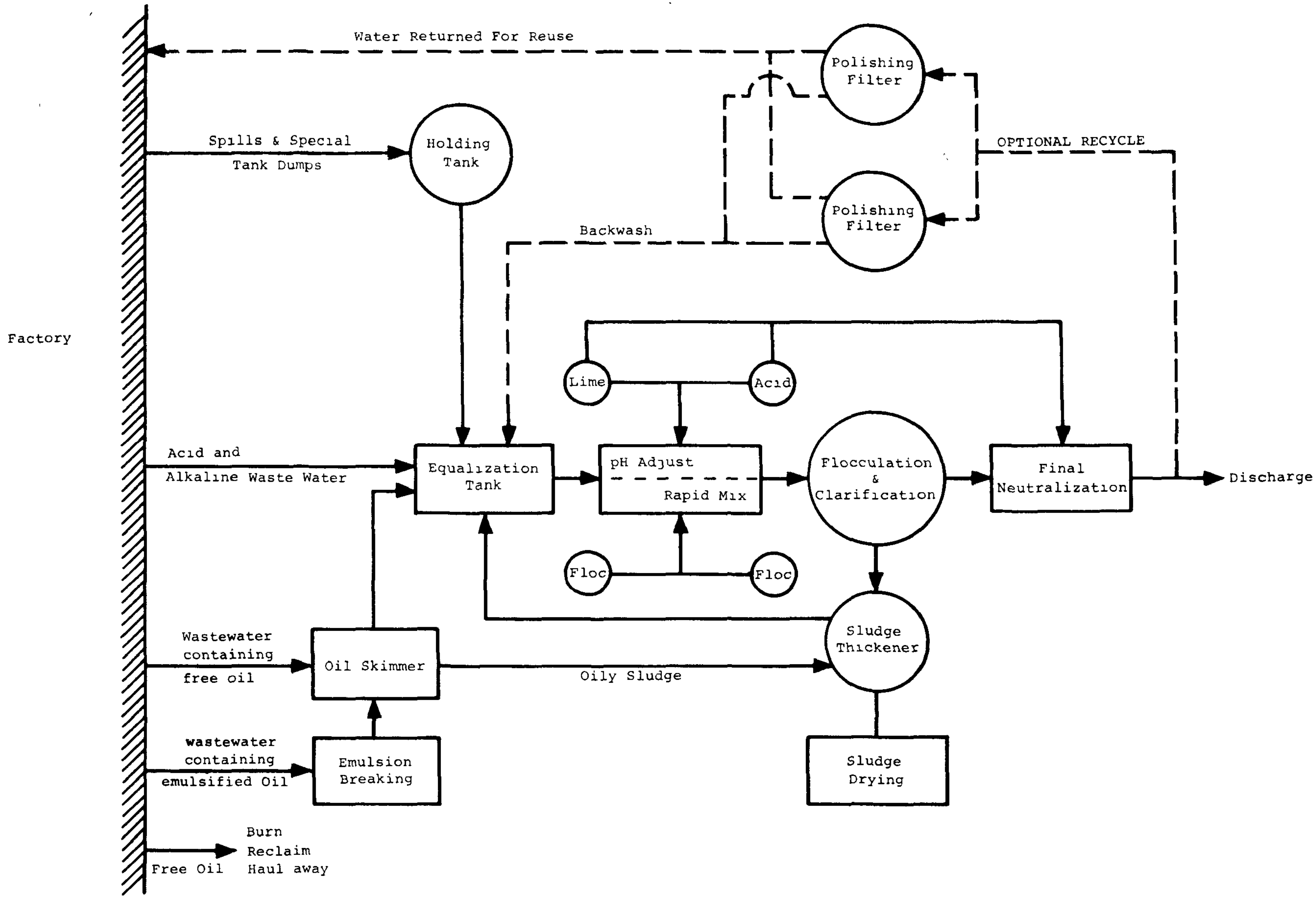

BPT BASELINE WASTEWATER TREATMENT SYSTEM SCHEMATIC

FIGURE 8-27

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TABLE 8-2

WATER EFFLUENT TREATMENT COSTS-BPT

SUBCATEGORY 1: CASTING AND MOLDING - METALS

COST

Flow Rate (Liters/Hr)	7,885	15,771	39,427	157,708
Investment	$349,959	$407,602	$545,984	$1,132,728
Annual Costs:				
Capital Costs	17,158	19,984	26,769	55,537
Depreciation	34,996	40,760	54,598	113,273
Operation & Maintenance Costs (Excluding Energy & Power Costs)	34,645	34,284	52,011	113,052
Energy & Power Costs	10,064	20,138	50,382	201,527
Total Annual Cost	$ 96,863	$120,166	$183,761	$ 483,389

PERFORMANCE

Effluent Pollutant Parameters	Typical Waste Load	Typical Effluent Discharge Level
pH	8.2	8.5
Total Suspended Solids	1490 mg/l	17.9 mg/l
Cadmium	0.04 mg/l	0.02 mg/l
Copper	9.7 mg/l	0.2 mg/l
Iron	13.8 mg/l	0.5 mg/l
Lead	0.6 mg/l	0.1 mg/l
Nickel	4.6 mg/l	0.2 mg/l
Oil & Grease	1050 mg/l	8.1 mg/l
Chemical Oxygen Demand	2430 mg/l	72.9 mg/l
Silver	0.02 mg/l	0.02 mg/l
Zinc	10.8 mg/l	0.5 mg/l

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TABLE 8-3

WATER EFFLUENT TREATMENT COSTS-BPT

SUBCATEGORY 2: MECHANICAL MATERIAL REMOVAL

COST				
Flow Rate (Liters/Hr)	7,885	15,771	39,427	157,7
Investment	$344,936	$398,924	$527,008	$1,063,1
Annual Costs:				
Capital Costs	16,912	19,559	25,839	52,1
Depreciation	34,494	39,892	52,701	106,3
Operation & Maintenance Costs (Excluding Energy & Power Costs)	34,207	38,451	49,965	103,6
Energy & Power Costs	10,064	20,139	50,383	201,5
Total Annual Cost	$ 95,676	$118,041	$178,887	$ 463,6

PERFORMANCE

Effluent Pollutant Parameters	Typical Waste Load	Typical Effluent Discharge Level
pH	9.2	8.5
Total Suspended Solids	1220 mg/l	15.0 mg/l
Cadmium	2.4 mg/l	0.12 mg/l
Chromium, Total	18.9 mg/l	0.4 mg/l
Copper	4.5 mg/l	0.2 mg/l
Fluoride	8.5 mg/l	2.0 mg/l
Iron	9.0 mg/l	0.5 mg/l
Lead	2.0 mg/l	0.1 mg/l
Nickel	3.4 mg/l	0.2 mg/l
Oil & Grease	668 mg/l	5.8 mg/l
Chemical Oxygen Demand	3087 mg/l	92.6 mg/l
Phosphates	10.0 mg/l	2.6 mg/l
Zinc	7.1 mg/l	0.5 mg/l

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TABLE 8-4

WATER EFFLUENT TREATMENT COSTS-BPT

SUBCATEGORY 3: MATERIAL FORMING - ALL MATERIALS EXCEPT PLASTICS

COST				
Flow Rate (Liters/Hr)	7,885	15,771	39,427	157,708
Investment	$340,738	$391,880	$512,176	$1,011,174
Annual Costs:				
Capital Costs	16,706	19,214	25,112	49,577
Depreciation	34,074	39,188	51,218	101,117
Operation & Maintenance Costs (Excluding Energy & Power Costs)	33,912	37,897	48,624	97,653
Energy & Power Costs	10,064	20,139	50,384	201,535
Total Annual Cost	$ 94,755	$116,437	$175,337	$ 449,882

PERFORMANCE

Effluent Pollutant Parameters	Typical Waste Load	Typical Effluent Discharge Level
pH	8.8	8.5
Total Suspended Solids	1030 mg/l	15.0 mg/l
Copper	8.5 mg/l	0.2 mg/l
Iron	29.3 mg/l	0.6 mg/l
Lead	2.8 mg/l	0.1 mg/l
Nickel	5.8 mg/l	0.2 mg/l
Oil & Grease	600 mg/l	5.4 mg/l
Chemical Oxygen Demand	2830 mg/l	84.9 mg/l
Phosphates	6.5 mg/l	1.7 mg/l
Silver	0.01 mg/l	0.01 mg/l
Zinc	10.8 mg/l	0.5 mg/l

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TABLE 8-5

WATER EFFLUENT TREATMENT COSTS-BPT

SUBCATEGORY 4: PHYSICAL PROPERTY MODIFICATION

COST				
Flow Rate (Liters/Hr)	7,885	15,771	39,427	157,708
Investment	$ 362,404	$ 410,126	$ 520,973	$ 971,811
Annual Costs:				
Capital Costs	17,768	20,108	25,543	47,647
Depreciation	36,240	41,013	52,097	97,181
Operation & Maintenance Costs (Excluding Energy & Power Costs)	44,162	47,369	57,486	102,628
Energy & Power Costs	8,099	16,208	40,558	162,233
Total Annual Cost	$ 106,270	$ 124,699	$ 175,685	$ 409,689

PERFORMANCE

Effluent Pollutant Parameter	Typical Waste Load	Typical Effluent Discharge Level
pH	9.0	8.5
Total Suspended Solids	716 mg/l	15.0 mg/l
Cyanide	67.2 mg/l	0.05 mg/l
Iron	14.5 mg/l	0.5 mg/l
Lead	2.8 mg/l	0.1 mg/l
Nickel	1.3 mg/l	0.2 mg/l
Oil & Grease	681 mg/l	5.5 mg/l
Chemical Oxygen Demand	2360 mg/l	70.8 mg/l

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TABLE 8-6

WATER EFFLUENT TREATMENT COSTS-BPT

SUBCATEGORY 5: ASSEMBLY OPERATIONS

COST

Flow Rate (Liters/Hr)	7,885	15,771	39,427	157,708
Investment	$341,325	$392,894	$514,384	$1,019,225
Annual Costs:				
Capital Costs	16,735	19,263	25,220	49,972
Depreciation	34,132	37,289	51,438	101,923
Operation & Maintenance Costs (Excluding Energy & Power Costs)	33,808	37,683	48,080	95,572
Energy & Power Costs	10,064	20,139	50,383	201,534
Total Annual Cost	$ 94,739	$116,374	$175,122	$ 449,000

PERFORMANCE

Effluent Pollutant Parameters	Typical Waste Load	Typical Effluent Discharge Level
pH	8.7	8.5
Total Suspended Solids	1060 mg/l	15.0 mg/l
Cadmium	1.3 mg/l	0.07 mg/l
Copper	3.6 mg/l	0.2 mg/l
Fluoride	14.8 mg/l	3.0 mg/l
Iron	9.6 mg/l	0.5 mg/l
Lead	3.3 mg/l	0.1 mg/l
Mercury	0.01 mg/l	0.01 mg/l
Nickel	2.3 mg/l	0.2 mg/l
Oil & Grease	720 mg/l	6.1 mg/l
Chemical Oxygen Demand	2440 mg/l	73.2 mg/l
Phosphates	8.0 mg/l	2.1 mg/l
Silver	0.01 mg/l	0.01 mg/l
Zinc	2.9 mg/l	0.5 mg/l

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TABLE 8-7

WATER EFFLUENT TREATMENT COSTS-BPT

SUBCATEGORY 6: CHEMICAL-ELECTROCHEMICAL PROCESSING

COST

Flow Rate (Liters/Hr)	7,885	15,771	39,427	157,708
Investment	$355,713	$403,486	$515,197	$974,699
Annual Costs:				
Capital Costs	17,440	19,783	25,260	47,789
Depreciation	35,571	40,349	51,520	97,470
Operation & Maintenance Costs (Excluding Energy & Power Costs)	41,552	52,370	84,760	241,277
Energy & Power Costs	8,298	16,384	40,664	161,990
Total Annual Cost	$102,862	$128,886	$202,203	$548,525

PERFORMANCE

Effluent Pollutant Parameters	Typical Waste Load	Typical Effluent Discharge Level
pH	3.7	8.5
Total Suspended Solids	837 mg/l	15.0 mg/l
Chromium, Total	11.5 mg/l	0.2 mg/l
Chromium, Hexavalent	3.8 mg/l	0.05 mg/l
Copper	22.9 mg/l	0.5 mg/l
Fluoride	1.6 mg/l	1.6 mg/l
Iron	30.4 mg/l	0.6 mg/l
Oil & Grease	97.0 mg/l	2.0 mg/l
Chemical Oxygen Demand	419 mg/l	12.6 mg/l

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TABLE 8-8

WATER EFFLUENT TREATMENT COSTS-BPT

SUBCATEGORY 7: MATERIAL COATING

COST				
Flow Rate (Liters/Hr)	7,885	15,771	39,427	157,708
Investment	$357,495	$406,472	$521,439	$996,384
Annual Costs:				
Capital Costs	17,528	19,929	25,566	48,852
Depreciation	35,750	40,647	52,144	99,638
Operation & Maintenance Costs (Excluding Energy & Power Costs)	34,301	38,070	48,978	98,638
Energy & Power Costs	8,298	16,384	40,663	161,988
Total Annual Cost	$ 95,876	$115,030	$167,352	$408,810

PERFORMANCE

Effluent Pollutant Parameters	Typical Waste Load	Typical Effluent Discharge Level
pH	8.9	8.5
Total Suspended Solids	918 mg/l	15.0 mg/l
Cadmium	2.0 mg/l	0.1 mg/l
Chromium, Total	20.0 mg/l	0.4 mg/l
Chromium, Hexavalent	1.5 mg/l	0.02 mg/l
Copper	21.1 mg/l	0.4 mg/l
Fluoride	6.9 mg/l	2.0 mg/l
Iron	21.6 mg/l	0.5 mg/l
Lead	1.7 mg/l	0.1 mg/l
Mercury	.01 mg/l	0.01 mg/l
Oil & Grease	545 mg/l	4.7 mg/l
Chemical Oxygen Demand	1840 mg/l	55.2 mg/l
Phosphates	9.6 mg/l	2.5 mg/l
Silver	0.01 mg/l	0.01 mg/l
Zinc	4.7 mg/l	0.5 mg/l

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TABLE 8-9

WATER EFFLUENT TREATMENT COSTS-BPT

SUBCATEGORY 8: SMELTING AND REFINING OF NONFERROUS METALS

COST

Flow Rate (Liters/Hr)	7,885	15,771	39,427	157,708
Investment	$ 361,062	$ 427,152	$ 588,566	$ 1,290,007
Annual Costs:				
Capital Costs	17,703	20,943	28,857	63,249
Depreciation	36,106	42,689	58,857	129,001
Operation & Maintenance Costs (Excluding Energy & Power Costs)	39,544 (-2,100) (-2,100)	49,006 (-4,000) (-4,000)	76,345 (-10,000 (-10,000)	214,028 (-42,000) (-42,000)
Energy & Power Costs	10,063	20,137	50,380	201,519
Total Annual Cost	$ 103,416 (-2,400) (-2,400)	$ 132,762 (-4,000) (-4,000)	$ 214,438 (-10,500) (-10,500)	$ 607,796 (-42,000) (-42,000)

PERFORMANCE

Effluent Pollutant Parameters	Typical Waste Load	Typical Effluent Discharge Level
pH	2.7	8.5
Total Suspended Solids	2090 mg/l	25.0 mg/l
Cadmium	0.8 mg/l	0.04 mg/l
Copper	7.1 mg/l	0.2 mg/l
Iron	96.4 mg/l	1.9 mg/l
Lead	4.6 mg/l	0.2 mg/l
Mercury	0.03 mg/l	0.01 mg/l
Nickel	16.5 mg/l	0.5 mg/l
Oil & Grease	166 mg/l	2.8 mg/l
Chemical Oxygen Demand	1650 mg/l	49.5 mg/l
Silver	0.05 mg/l	0.05 mg/l
Zinc	23.5 mg/l	.71 mg/l

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TABLE 8-10

WATER EFFLUENT TREATMENT COSTS-BPT

SUECATEGORY 10: FILM SENSITIZING

COST				
Flow Rate (Liters/Hr)	7,885	15,771	39,427	157,708
Investment	$ 347,981	$ 386,029	$ 472,992	$ 818,790
Annual Costs:				
Capital Costs	17,061	18,927	23,190	40,145
Depreciation	34,798	38,603	47,299	81,879
Operation & Maintenance Costs (Excluding Energy & Power Costs)	43,264	45,206	50,076	71,903
Energy & Power Costs	8,099	16,210	40,560	162,242
Total Annual Cost	$ 103,223	$ 118,945	$ 161,126	$ 356,169

PERFORMANCE

Effluent Pollutant Parameters	Typical Waste Load	Typical Effluent Discharge Level
pH	5.8	8.5
Total Suspended Solids	183 mg/l	15.0 mg/l
Cadmium	1.5 mg/l	.07 mg/l
Cyanide	1.2 mg/l	.01 mg/l
Iron	2.9 mg/l	0.5 mg/l
Mercury	0.01 mg/l	0.01 mg/l
Oil & Grease	386 mg/l	3.8 mg/l
Chemical Oxygen Demand	1230 mg/l	36.9 mg/l
Phosphates	3.4 mg/l	1.0 mg/l
Silver	0.05 mg/l	0.05 mg/l
Zinc	1.4 mg/l	0.5 mg/l

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TABLE 8-11

WATER EFFLUENT TREATMENT COSTS-BPT

SUBCATEGORY 12: LEAD ACID BATTERY MANUFACTURE

COST

Flow Rate (Liters/Hr)	7,885	15,771	39,427	157,708
Investment	$314,587	$347,832	$422,101	$718,409
Annual Costs:				
Capital Costs	15,424	17,054	20,695	35,223
Depreciation	31,459	34,783	42,210	71,841
Operation & Maintenance Costs (Excluding Energy & Power Costs)	40,155	48,958	74,392	196,241
Energy & Power Costs	10,065	20,140	50,388	201,551
Total Annual Cost	$ 97,102	$120,936	$187,685	$504,855

PERFORMANCE

Effluent Pollutant Parameters	Typical Waste Load	Typical Effluent Discharge Level
pH	2.0	8.5
Total Suspended Solids	22.8 mg/l	15.0 mg/l
Cadmium	0.02 mg/l	0.02 mg/l
Chromium, Total	0.2 mg/l	0.2 mg/l
Chromium, Hexavalent	0.01 mg/l	0.01 mg/l
Iron	32.3 mg/l	0.6 mg/l
Lead	2.2 mg/l	0.1 mg/l
Nickel	0.09 mg/l	0.09 mg/l
Oil & Grease	15.4 mg/l	1.0 mg/l
Chemical Oxygen Demand	92.5 mg/l	2.8 mg/l
Phosphates	1.3 mg/l	1.0 mg/l
Zinc	0.6 mg/l	0.5 mg/l

Equipment size requirements may be reduced by the ease of treatment (for example, shorter retention time) of particular waste streams. Substantial reductions in both investment and operating cost would pertain if a plant reduced its water use rate by various in-plant techniques. Then, to estimate its costs from the tables, the plant would use the projected flow rate rather than the current flow rate. If a plant has lower raw waste concentrations than those indicated on the tables, investment and, in particular, operating costs will be lower. The tabulated costs are based on around-the-clock operation 365 days per year. Thus, if a plant operates one or two shifts per day, five or six days per week, or has an annual shutdown period, operating costs would be significantly lower. In some parts of the country, operating costs would be lower because of wage rates lower than the value used in the computations. Reductions in labor cost by using operating and maintenance personnel on a shared (part time) basis may be practical. Substantial reductions in energy cost may be practical at a particular plant. For example, increased residence time for emulsion breaking can obviate the need for heating the emulsion, without reducing effectiveness.

BAT System Costs - Figure 8-28 shows the baseline BAT system. The system shown applies to all subcategories except 9 and 11. There is no system for Subcategory 9, because when process water is used it is normally recycled for reuse, and there is no end-of-pipe treatment. There is no system for Subcategory 11 because end-of-pipe treatment is not applicable. It must be emphasized that the system is a representative method for achieving BAT pollutant control. A plant can use either the method shown or an alternative technique. In particular, the centralized system shown can be simplified by substitution of localized in-plant techniques for centralized treatment functions.

The cost tables based on this BAT system are as follows:

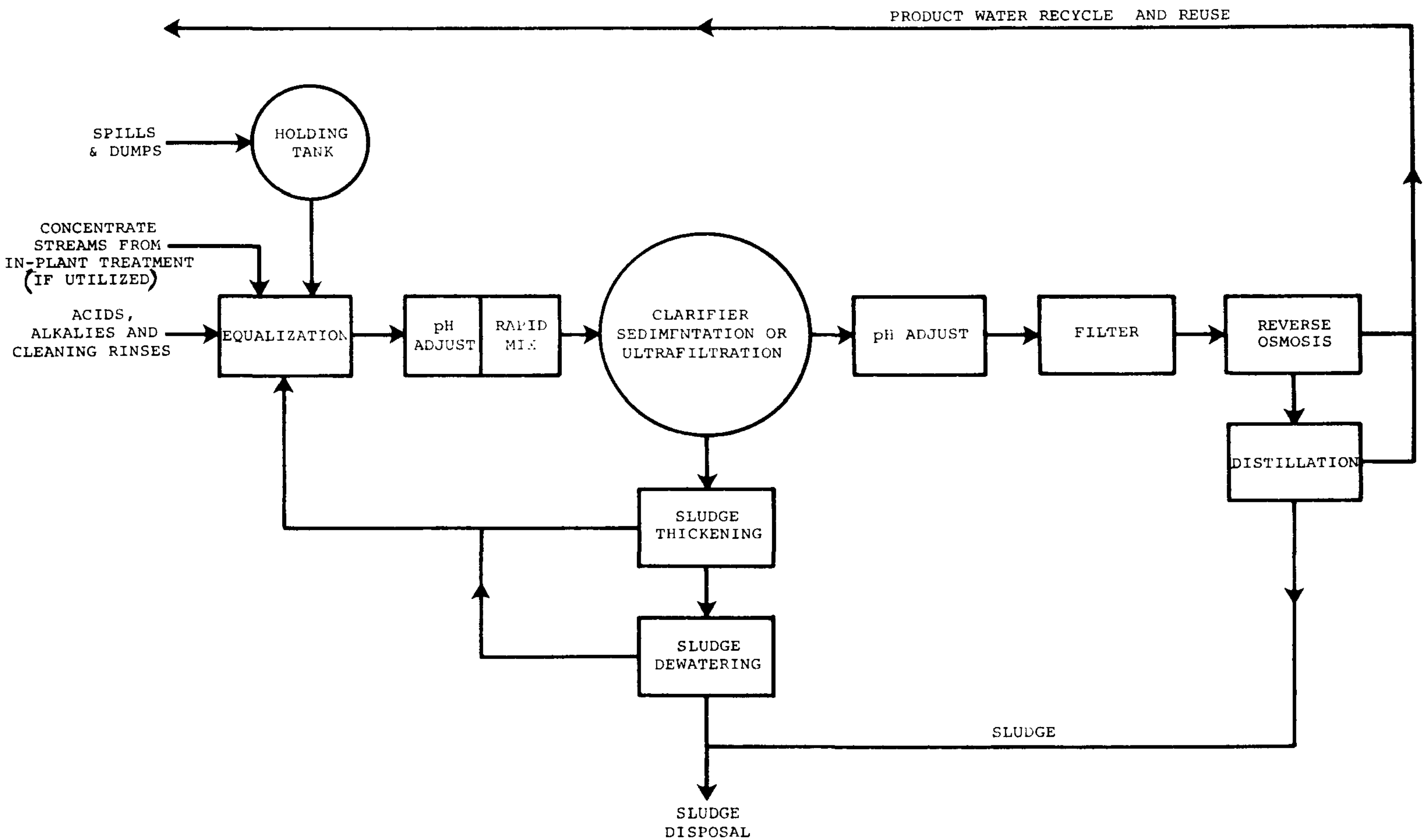
Subcategory 1 - Casting and Molding-Metals	Table 8-12
Subcategory 2 - Mechanical Material Removal	Table 8-13
Subcategory 3 - Material Forming-All Materials Except Plastics	Table 8-14
Subcategory 4 - Physical Property Modification	Table 8-15
Subcategory 5 - Assembly Operations	Table 8-16
Subcategory 6 - Chemical-Electrochemical Operations	Table 8-17

Subcategory 7 - Material Coating	Table 8-18
Subcategory 8 - Smelting and Refining of Nonferrous Metals	Table 8-19
Subcategory 10 - Film Sensitizing	Table 8-20
Subcategory 12 - Lead Acid Battery Manufacture	Table 8-21

The actual costs of installing and operating a BAT system at a particular plant may be substantially below the tabulated values, for the sam reasons discussed under BPT System Costs. In particular, existing plants should already have a BPT system at the time a BAT stystem is required. For those plants, therefore, the BPT system could be upgraded to BAT in an add-on fashion. Moreover, use of localized in-plan treatment would simplify the centralized treatment system, reducing its cost. The actual cost reduction would be dependent on the particular plant BPT system, the reduction in flow accomplished (if any), and the raw waste concentrations.

System Cost Computation - A computer program was developed to calculate the system costs listed in the BPT and BAT cost tables. A mathematical model or set of correlations was developed for each individual wastewater treatment technology. In general, these correlations related equipment size to influent flow rate and pollutant concentrations and, in turn, related cost to equipment size. The computer was programmed to combine specified individual treatment technologies in a specified arrangement, forming a system. Using this arrangement, the computer then determined flow rates and concentrations at all points in the spec fied system, determined equipment sizes, determined equipment costs, and added these costs to arrive at a total system cost.

The correlations used for computing equipment size and cost were derived from cost data obtained from several sources listed under the "Cost Estimates" heading. These data for wastewater flow rate, corresponding equipment size, and corresponding cost, were related to form the correlations by means of a separate computer program. This program was developed to correlate the data by regression analysis, utilizing first order arithmetic equations, first order logarithmic equations, and multiple order equations, as appropriate.



BAT BASELINE WASTEWATER TREATMENT SYSTEM SCHEMATIC

FIGURE 8-28

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TABLE 8-12

WATER EFFLUENT TREATMENT COSTS-BAT

SUBCATEGORY 1: CASTING AND MOLDING - METALS

COST				
Flow Rate (Liters/Hr)	3,943	7,885	15,771	39,427
Investment	$326,345	$389,768	$489,550	$733,270
Annual Costs:				
Capital Costs	16,001	19,110	24,002	35,952
Depreciation	32,635	38,977	48,955	73,327
Operation & Maintenance Costs (Excluding Energy & Power Costs)	40,257	47,170	54,307	92,118
Energy & Power Costs	7,655	15,160	24,723	69,780
Total Annual Cost	$96,547	$120,417	$161,987	$271,177

PERFORMANCE

Effluent Pollutant Parameters	Representative Waste Load	Typical Effluent Available for Reuse
pH	8.2	8.4
Total Suspended Solids	2980 mg/l	0.0 mg/l
Cadmium	0.08 mg/l	0.01 mg/l
Copper	19.5 mg/l	0.023 mg/l
Iron	27.6 mg/l	0.032 mg/l
Lead	1.2 mg/l	0.006 mg/l
Nickel	9.1 mg/l	0.016 mg/l
Oil & Grease	2100 mg/l	0.0 mg/l
Chemical Oxygen Demand	4860 mg/l	56.5 mg/l
Silver	0.04 mg/l	0.001 mg/l
Zinc	21.9 mg/l	0.038 mg/l

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TABLE 8-13

WATER EFFLUENT TREATMENT COSTS-BAT

SUBCATEGORY 2: MECHANICAL MATERIAL REMOVAL

COST				
Flow Rate (Liters/Hr)	3,943	7,885	15,771	39,427
Investment	$322,139	$382,498	$476,467	$703,059
Annual Costs:				
Capital Costs	15,794	18,754	23,361	34,471
Depreciation	32,214	38,250	47,647	70,306
Operation & Maintenance Costs (Excluding Energy & Power Costs)	40,019	46,722	58,418	89,650
Energy & Power Costs	7,646	15,139	29,668	69,539
Total Annual Cost	$ 95,673	$118,865	$159,093	$263,966

PERFORMANCE

Effluent Pollutant Parameters	Representative Waste Load	Typical Effluent Available for Reuse
pH	9.2	8.4
Total Suspended Solids	2440 mg/l	0.0 mg/l
Cadmium	4.9 mg/l	0.014 mg/l
Chromium, Total	37.8 mg/l	0.044 mg/l
Copper	8.9 mg/l	0.012 mg/l
Fluoride	17.0 mg/l	0.20 mg/l
Iron	18.0 mg/l	0.029 mg/l
Lead	4.1 mg/l	0.010 mg/l
Nickel	6.7 mg/l	0.012 mg/l
Oil & Grease	1340 mg/l	0.0 mg/l
Chemical Oxygen Demand	6180 mg/l	72.0 mg/l
Phosphates	20.4 mg/l	0.31 mg/l
Zinc	14.2 mg/l	0.029 mg/l

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TABLE 8-14

WATER EFFLUENT TREATMENT COSTS-BAT

SUBCATEGORY 3: MATERIAL FORMING - ALL MATERIALS EXCEPT PLASTICS

COST

Flow Rate (Liters/Hr)	3,943	7,885	15,771	39,427
Investment	$317,878	$375,164	$463,349	$673,060
Annual Costs:				
Capital Costs	15,585	18,394	22,718	33,000
Depreciation	31,788	37,516	46,335	67,306
Operation & Maintenance Costs (Excluding Energy & Power Costs)	39,629	45,962	56,909	85,746
Energy & Power Costs	7,817	15,477	30,329	71,097
Total Annual Cost	$ 94,819	$117,349	$156,291	$257,148

PERFORMANCE

Effluent Pollutant Parameters	Representative Waste Load	Typical Effluent Available for Reuse
pH	8.8	8.4
Total Suspended Solids	2060 mg/l	0.0 mg/l
Copper	17.0 mg/l	0.020 mg/l
Iron	58.6 mg/l	0.068 mg/l
Lead	5.5 mg/l	0.013 mg/l
Nickel	11.6 mg/l	0.020 mg/l
Oil & Grease	1200 mg/l	0.0 mg/l
Chemical Oxygen Demand	5660 mg/l	65.8 mg/l
Phosphates	12.9 mg/l	0.20 mg/l
Silver	0.02 mg/l	0.003 mg/l
Zinc	20.8 mg/l	0.036 mg/l

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TABLE 8-15

WATER EFFLUENT TREATMENT COSTS-BAT

SUBCATEGORY 4: PHYSICAL PROPERTY MODIFICATION

COST

Flow Rate (Liters/Hr)	3,943	7,885	15,771	39,427
Investment	$312,595	$366,551	$448,757	$641,668
Annual Costs:				
Capital Costs	15,326	17,972	22,002	31,461
Depreciation	31,259	36,655	44,876	64,167
Operation & Maintenance Costs (Excluding Energy & Power Costs)	39,839	45,334	55,703	82,630
Energy & Power Costs	7,676	15,191	24,738	69,474
Total Annual Cost	$ 94,100	$115,152	$152,319	$247,731

PERFORMANCE

Effluent Pollutant Parameters	Representative Waste Load	Typical Effluent Available for Reuse
pH	9.0	8.4
Total Suspended Solids	1432 mg/l	0.0 mg/l
Cyanide*	0.1 mg/l	0.006 mg/l
Iron	29.0 mg/l	0.034 mg/l
Lead	5.5 mg/l	0.013 mg/l
Nickel	2.5 mg/l	0.012 mg/l
Oil & Grease	1362 mg/l	0.0 mg/l
Chemical Oxygen Demand	4720 mg/l	55.0 mg/l

*Prior Oxidation of Cyanide is Assumed

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TABLE 8-16

WATER EFFLUENT TREATMENT COSTS-BAT

SUBCATEGORY 5: ASSEMBLY OPERATIONS

COST

Flow Rate (Liters/Hr)	3,943	7,885	15,771	39,42
Investment	$318,383	$376,040	$464,929	$676,70
Annual Costs:				
Capital Costs	15,610	18,437	22,795	33,17
Depreciation	31,838	37,604	46,493	67,67
Operation & Maintenance Costs (Excluding Energy & Power Costs)	39,506	45,711	56,403	84,49
Energy & Power Costs	7,812	15,467	30,312	71,06
Total Annual Cost	$ 94,766	$117,220	$156,003	$256,40

PERFORMANCE

Effluent Pollutant Parameters	Representative Waste Load	Typical Effluent Available for Reuse
pH	8.7	8.4
Total Suspended Solids	2120 mg/l	0.0 mg/l
Cadmium	2.7 mg/l	0.008 mg/l
Copper	7.1 mg/l	0.012 mg/l
Fluoride	29.6 mg/l	0.34 mg/l
Iron	19.2 mg/l	0.029 mg/l
Lead	6.7 mg/l	0.015 mg/l
Mercury	0.02 mg/l	0.001 mg/l
Nickel	4.6 mg/l	0.012 mg/l
Oil & Grease	1440 mg/l	0.0 mg/l
Chemical Oxygen Demand	4880 mg/l	56.8 mg/l
Phosphates	16.0 mg/l	0.24 mg/l
Silver	0.02 mg/l	0.001 mg/l
Zinc	5.8 mg/l	0.029 mg/l

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TABLE 8-17

WATER EFFLUENT TREATMENT COSTS-BAT

SUBCATEGORY 6: CHEMICAL-ELECTROCHEMICAL PROCESSING

COST

Flow Rate (Liters/Hr)	3,943	7,885	15,771	39,427
Investment	$316,131	$372,419	$458,864	$663,763
Annual Costs:				
Capital Costs	15,500	18,259	22,498	32,544
Depreciation	31,613	37,242	45,886	66,376
Operation & Maintenance Costs (Excluding Energy & Power Costs)	47,136	60,247	85,512	157,192
Energy & Power Costs	7,531	14,903	29,174	68,149
Total Annual Cost	$101,780	$130,652	$183,071	$324,261

PERFORMANCE

Effluent Pollutant Parameters	Representative Waste Load	Typical Effluent Available for Reuse
pH	3.7	8.4
Total Suspended Solids	1674 mg/l	0.0 mg/l
Chromium, Total	23.0 mg/l	0.027 mg/l
Chromium, Hexavalent	7.6 mg/l	0.006 mg/l
Copper	45.8 mg/l	0.053 mg/l
Fluoride	3.1 mg/l	0.12 mg/l
Iron	60.8 mg/l	0.071 mg/l
Oil & Grease	194 mg/l	0.0 mg/l
Chemical Oxygen Demand	838 mg/l	9.8 mg/l

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TABLE 8-18

WATER EFFLUENT TREATMENT COSTS-BAT

SUBCATEGORY 7: MATERIAL COATING

COST				
Flow Rate (Liters/Hr)	3,943	7,885	15,771	39,42
Investment	$316,387	$372,532	$458,550	$661,83
Annual Costs:				
Capital Costs	15,512	18,265	22,482	32,44
Depreciation	31,639	37,253	45,855	66,18
Operation & Maintenance Costs (Excluding Energy & Power Costs)	39,842	45,866	57,737	85,27
Energy & Power Costs	7,788	15,419	30,211	70,77
Total Annual Cost	$ 94,781	$116,803	$155,285	$254,68

PERFORMANCE

Effluent Pollutant Parameters	Representative Waste Load	Typical Effluent Available for Reuse
pH	8.9	8.4
Total Suspended Solids	1836 mg/l	0.0 mg/l
Cadmium	4.1 mg/l	0.012 mg/l
Chromium, Total	40.0 mg/l	0.047 mg/l
Chromium, Hexavalent	3.0 mg/l	0.002 mg/l
Copper	42.2 mg/l	0.049 mg/l
Fluoride	13.8 mg/l	0.16 mg/l
Iron	43.2 mg/l	0.05 mg/l
Lead	3.4 mg/l	0.008 mg/l
Mercury	0.02 mg/l	0.001 mg/l
Oil & Grease	1090 mg/l	0.0 mg/l
Chemical Oxygen Demand	3680 mg/l	42.8 mg/l
Phosphates	19.1 mg/l	0.29 mg/l
Silver	0.02 mg/l	0.001 mg/l
Zinc	9.3 mg/l	0.029 mg/l

TABLE 8-19

WATER EFFLUENT TREATMENT COSTS-BAT

SUBCATEGORY 8: SMELTING AND REFINING OF NONFERROUS METALS

COST

Flow Rate (Liters/Hr)	3,943	7,885	15,771	39,427
Investment	$342,505	$419,420	$545,782	$869,807
Annual Costs:				
Capital Costs	16,793	20,564	26,759	42,646
Depreciation	34,250	41,942	54,578	86,981
Operation & Maintenance Costs (Excluding Energy & Power Costs)	47,043	60,712	86,446	160,796
Energy & Power Costs	6,153	12,165	23,768	55,152
Total Annual Cost	$104,240	$135,383	$191,551	$345,574

PERFORMANCE

Effluent Pollutant Parameters	Representative Waste Load	Typical Effluent Available for Reuse
pH	2.7	8.4
Total Suspended Solids	4180 mg/l	0.0 mg/l
Cadmium	1.6 mg/l	0.005 mg/l
Copper	14.2 mg/l	0.017 mg/l
Iron	193 mg/l	0.23 mg/l
Lead	9.2 mg/l	0.022 mg/l
Mercury	0.06 mg/l	0.001 mg/l
Nickel	33.0 mg/l	0.058 mg/l
Oil & Grease	332 mg/l	0.0 mg/l
Chemical Oxygen Demand	3300 mg/l	38.9 mg/l
Silver	0.10 mg/l	0.003 mg/l
Zinc	47.0 mg/l	0.083 mg/l

TABLE 8-20

WATER EFFLUENT TREATMENT COSTS-BAT

SUBCATEGORY 10: FILM SENSITIZING

COST

Flow Rate (Liters/Hr)	3,943	7,885	15,771	39,427
Investment	$298,280	$342,604	$408,149	$555,457
Annual Costs:				
Capital Costs	14,625	16,798	20,011	27,234
Depreciation	29,828	34,260	40,815	55,546
Operation & Maintenance Costs (Excluding Energy & Power Costs)	42,625	50,472	64,575	103,782
Energy & Power Costs	7,987	15,804	30,933	72,219
Total Annual Cost	$ 95,064	$117,334	$156,335	$258,781

PERFORMANCE

Effluent Pollutant Parameters	Representative Waste Load	Typical Effluent Available for Reuse
pH	5.9	8.4
Total Suspended Solids	366 mg/l	0.0 mg/l
Cadmium	2.9 mg/l	0.009 mg/l
Cyanide*	0.004 mg/l	0.0 mg/l
Iron	5.8 mg/l	0.029 mg/l
Mercury	0.02 mg/l	0.001 mg/l
Oil & Grease	772 mg/l	0.0 mg/l
Chemical Oxygen Demand	2460 mg/l	28.7 mg/l
Phosphates	6.8 mg/l	0.10 mg/l
Silver	0.10 mg/l	0.003 mg/l
Zinc	2.9 mg/l	0.029 mg/l

*Prior Oxidation of Cyanide is Assumed

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TABLE 8-21

WATER EFFLUENT TREATMENT COSTS-BAT

SUBCATEGORY 12: LEAD ACID BATTERY MANUFACTURE

COST				
Flow Rate (Liters/Hr)	3,943	7,885	15,771	39,427
Investment	$299,776	$348,276	$422,286	$596,286
Annual Costs:				
Capital Costs	14,698	17,076	20,705	29,236
Depreciation	29,978	34,828	42,229	54,629
Operation & Maintenance Costs (Excluding Energy & Power Costs)	48,547	62,305	88,228	161,986
Energy & Power Costs	6,466	12,762	24,839	56,924
Total Annual Cost	$ 99,889	$126,970	$176,001	$307,774

PERFORMANCE

Effluent Pollutant Parameters	Representative Waste Load	Typical Effluent Available for Reuse
pH	2.0	8.4
Total Suspended Solids	45.6 mg/l	0.0 mg/l
Cadmium	0.04 mg/l	0.001 mg/l
Chromium, Total	0.4 mg/l	0.012 mg/l
Chromium, Hexavalent	0.02 mg/l	0.001 mg/l
Iron	64.6 mg/l	0.076 mg/l
Lead	4.4 mg/l	0.010 mg/l
Nickel	0.2 mg/l	0.011 mg/l
Oil & Grease	30.8 mg/l	0.0 mg/l
Chemical Oxygen Demand	185 mg/l	2.19 mg/l
Phosphates	2.6 mg/l	0.061 mg/l
Zinc	1.1 mg/l	0.030 mg/l

Each computer run involved several items of input and output. Specifically, to compute system costs, the computer required as input (1) identification of system components (oil skimmer, clarifier, etc.), (2 definition of how these components were schematically arranged, (3) raw wastewater flow rate, and (4) raw waste pollutant concentrations. The computer output consisted of a cost breakdown and an effluent characteristics summary. Capital cost was listed, and total annual cost was broken down to yield operation and maintenance cost, energy cost, depreciation, and cost of capital. The effluent concentrations and other characteristics pertained to whatever characteristics were included in the input.

The program was developed to accept any of the components (up to 25 in a particular system) listed in Table 8-1. In addition, "mixers" and "splitters" were added to represent merging or separation of streams. The schematic arrangements of these components that could be input to the computer were entirely flexible, permitting simulation and costing of many variations. The computer handled a wide range of wastewater flow rates. Care was taken to assure reasonable results for extremely large as well as extremely small plants. The program was designed to handle the wastewater parameters listed in Table 8-22. The program used standard values for certain cost factors such as depreciation rate but different values could be input if desired.

Computer Techniques - The cost estimating computer program consists of a main routine which accepts the system input cards and accesses all other routines, a series of subroutines which compute the performance and cost of each of the unit processes, a cost routine, and a routine for printing the results. The main routine performs a system iteratior until a mass balance has been established. The mass balance is established when the pollutant parameter concentrations in all the process streams differ from the values in the process streams in the previous iteration by less than one part in one hundred thousand or by 0.1 mg/l, whichever is larger.

The program was based on earlier work done by the EPA to compute costs of municipal treatment plants. This earlier program was analyzed, revised, and expanded to obtain the present program. Many of the earlier subroutines were not applicable because they modelled biological sy tems; those that were useful were expanded to accommodate the longer list of industrial pollutants and modified to be compatible with the

TABLE 8-22

COST PROGRAM POLLUTANT PARAMETER

Parameter, Units	Parameter, Units
Flow, MGD	Oil, Grease, mg/l
pH, pH units	Hardness, mg/l $CaCO_3$
Turbidity, Jackson units	Chemical Oxygen Demand, mg/l
Temperature, ^{o}C	Algicides, mg/l
Dissolved Oxygen, mg/l	Total Phosphates, mg/l
Residual Chlorine, mg/l	Polychlorobiphenyls, mg/l
Acidity, mg/l $CaCO_3$	Potassium, mg/l
Alkalinity, mg/l $CaCO_3$	Silica, mg/l
Ammonia, mg/l	Sodium, mg/l
Biochemical Oxygen Demand, mg/l	Sulfate, mg/l
Color, Chloroplatinate units	Sulfite, mg/l
Sulfide, mg/l	Titanium, mg/l
Cyanides, mg/l	Zinc, mg/l
Kjeldahl Nitrogen, mg/l	Arsenic, mg/l
Phenols, mg/l	Boron, mg/l
Conductance, micromhos/cm	Iron, Dissolved, mg/l
Total Solids, mg/l	Mercury, mg/l
Total Suspended Solids, mg/l	Nickel, mg/l
Settleable Solids, mg/l	Nitrate, mg/l
Aluminum, mg/l	Selenium, mg/l
Barium, mg/l	Silver, mg/l
Cadmium, mg/l	Strontium, mg/l
Calcium, mg/l	Beryllium, mg/l
Chloride, mg/l	Chlorinated Hydrocarbons, mg/l
Chromium, Hexavalent, mg/l	Total Volatile Solids, mg/l
Chromium, Total, mg/l	Surfactants, mg/l
Copper, mg/l	Plasticizers, mg/l
Fluoride, mg/l	Antimony, mg/l
Iron, Total, mg/l	Bromide, mg/l
Lead, mg/l	Cobalt, mg/l
Magnesium, mg/l	Thallium, mg/l
Molybdenum, mg/l	Tin, mg/l

rest of the industrial program. Many new treatment process subroutines were added to the modified subroutines from the earlier work. The industrial wastewater treatment cost estimating program was written in FORTRAN IV for an IBM-370-158 computer system.

Cost Breakdown Factors

The factors used to compute the values of the cost elements for the individual technologies and entire systems are defined and discussed under the following subheadings. They are Dollar Base, Investment Cost Adjustment, Supply Cost Adjustment, Cost of Labor, Cost of Energy and Power, Capital Recovery Costs, Debt-Equity Ratio, and Subsidiary Costs.

Dollar Base - A dollar base of August 1972 was used for all costs.

Investment Cost Adjustment - Investment costs were adjusted to the aforementioned dollar base by use of the Sewage Treatment Plant Construction Cost Index. This cost index is published monthly by the EPA Division of Facilities Construction and Operation. The national average of the Construction Cost Index for August 1972 was 173.11. Within each process, the investment cost was usually defined as some function of the unit size or capacity. Where applicable, an excess capacity factor was used when obtaining the cost-determining size or capacity. This excess capacity factor is a multiplier on the size of the process to account for shutdown for cleaning and maintenance.

Supply Cost Adjustment - Supply costs such as chemicals were related to the dollar base by the Wholesale Price Index. This figure was obtained from the U. S. Department of Labor, Bureau of Labor Statistics, "Monthly Labor Review". For August 1972 the "Industrial Commodities" Wholesale Price Index was 118.5. Process supply and replacement costs were included in the estimate of the total process operating and maintenance cost.

Cost of Labor - To relate the operating and maintenance labor costs, the hourly wage rate for production of non-supervisory workers in water, steam, and sanitary systems was used from the U. S. Department of Labor, Bureau of Labor Statistics monthly publication, Employment and Earnings". For August 1972, this wage rate was $3.97 per hour. This wage rate was then applied to estimates of operational and maintenance man-hours within each process to obtain process direct labor charges. To account for indirect labor charges, 15 percent of the direct labor of the direct labor costs was added to the direct labor charge to yield estimated total labor costs. The 15 percent value was listed in three references as the correct value for estimation of indirect labor charges. Such items as Social Security, employer contributions to pension or retirement funds, and employer-paid premiums to various forms of insurance programs were considered indirect labor costs.

Cost of Energy and Power - Energy and power requirements were calculated directly within each process. Estimated costs were then determined by applying either typical fuel costs or, in the case of electrical requirements, a rate of approximately 1.6 cents per kilowatt hour. This charge was based on 1.5 cents per kilowatt hour for January 1971 which was then adjusted by the Wholesale Price Index for the correct dollar base.

The electrical charge for August 1972, based on the above procedure, was corroborated through consultation by the Energy Consulting Services Department of the Connecticut Light and Power Company. This electrical charge was determined by assuming that any electrical needs of a waste treatment facility would be satisfied by an existing electrical distribution system; i.e., no new meter would be required. This eliminated the formation of any new demand load base for the electrical charge, thus minimizing the electrical rates applied. Base charges and an August 1972 fuel adjustment rate were used. Typical long-hours use industrial customers were studied and the actual rates charged were consistent with the assumption.

Capital Recovery Costs - Capital recovery costs were divided into straight line ten-year depreciation and cost of capital at an eight percent annual interest rate for a period of ten years. The ten year depreciation period was consistent with the faster write-off (financial life) allowed for these facilities even though the equipment life is in the range of 20 to 25 years.

The capital recovery factor (CFR) is normally used in industry to help allocate the initial investment and the interest to the total operating cost of the facility. The CFR is equal to the interest rate plus the interest rate divided by A-1, where A is equal to the quantity 1 plus the interest rate raised to the Nth Power, where N is the number of years the interest is applied. The annual capital recovery (ANR) was obtained by multiplying the initial investment by the CFR. The annual depreciation (D) of the capital investment was calculated by dividing the initial investment by the depreciation period N, which had been assumed to be ten years. The annual cost of capital was then equal to the annual capital recovery (ANR) minus the depreciation (D).

Debt-Equity Ratio - Limitations on new borrowings assume that debt may not exceed a set percentage of the shareholders equity. This defines the breakdown of the capital investment between debt and equity charges. However, due to the large number of plants in this study and a lack of information about their financial status, it was not feasible to estimate typical shareholders equity to obtain debt financing limitations. For these reasons, no attempt was made to break down the capital cost into debt and equity charges. Rather, the annual cost of capital is calculated via the procedure outlined in the Capital Recovery Costs section, above.

Subsidiary Costs - The costs presented in Tables 8-2 through 8-21 for BPT and BAT wastewater control and treatment systems include all subsidiary costs associated with system construction and operation. These subsidiary costs include estimates of garage and shop facilities; administrative and laboratory facilities; yardwork; laboratory operation; administration and general costs; yardwork operation; cost of land required for plant construction (based on $1000 per acre for August 1972); legal, fiscal, and administrative services during plant construction; engineering costs during plant construction; and the cost of interest during plant construction.

ENERGY AND NONWATER QUALITY ASPECTS

Energy and nonwater quality aspects of the wastewater treatment technologies described in Section VII are summarized in Tables 8-23 and 8-24. Energy requirements are listed, the impact on environmental air and noise pollution is noted, and solid waste generation characteristics are summarized. The treatment processes are divided into two groups, wastewater treatment processes on Table 8-23 and sludge and solids handling processes on Table 8-24.

Energy Aspects

Energy aspects of the wastewater treatment processes are important because of the impact of energy use on our natural resources and on the economy. Electrical power and fuel requirements (coal, oil, or gas) are listed in units of kilowatt hours per ton of dry solids for sludge and solids handling. Specific energy uses are noted in the "Remarks" column.

Energy requirements are generally low, although distillation and heat drying are exceptions. Thus, if these operations are used to achieve no discharge of pollutants, the influent water rate should be minimized by all means possible. For example, an upstream reverse osmosis or ultrafiltration unit can drastically reduce the flow rate of wastewater to a distillation operation.

Nonwater Quality Aspects

It is important to consider the impact of each treatment process on air, noise, and radiation pollution of the environment to assure that a process which reduces water pollution does not result in a more significant adverse environmental impact.

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TABLE 8-23

NONWATER QUALITY ASPECTS OF WASTEWATER TREATMENT

PROCESS	ENERGY: Power kw/1000	ENERGY: Fuel liter-min	Energy Use	NONWATER QUALITY IMPACT: Air Pollution Impact	Noise Pollution Impact	Solid Waste	Solid Waste Concentration % Dry Solids	Solid Waste Disposal Technique
Neutralization	6-8.7	----	Mixing	None	None	None	----	N/A
Chemical Reduction	4.4-9.0	----	Mixing	None	None	None	----	N/A
Skimming	0.01-.3	----	Skimmer Drive	None	None	Concentrated	5-50 (Oil)	Incinerate or Landfill
Clarification	0.1-3.2	----	Sludge Collector Drive	None	None	Concentrated	1-10	Thicken, Dry & Landfill or Incinerate
Flotation	36	----	Recirculation Pump, Compressor, Skim	None	None	Concentrated	3-5	Skim, Dry, Landfill or Incinerate
Chemical Oxidation	4.4-96	----	Mixing	None	None	None	----	N/A
Oxidation w/Ozone	4.4-9.0	----	Mixing	None	None	None	----	N/A
Chemical Precipitation	1.02	----	Flocculation Paddles	None	None	Concentrated	3-10	Dewater, Landfill
Flocculation Coagulation	1.02	----	Flocculation Paddles	None	None	Concentrated	3-5	Dewater & Landfill or Incinerate
Sedimentation	0.1-3.2	----	Sludge Collector Drive	None	None	Concentrated	1-3	Dewater & Landfill or Incinerate
Microstraining	2.5	----	Rotation, Backwash Pump	None	None	Concentrated	Variable	Dewater & Landfill or Incinerate
Deep Bed Filtration	0.02	----	Head, Backwash Pumps	None	None	Concentrated	Variable	Backwash to Settling
Screening	0.01	----	Rake Drive	None	None	Dewatered	50	Landfill or Incinerate
Ion Exchange	30	----	Pumps	None	Not Objectionable	None	N/A	N/A
Adsorption	30	15	Pumps, Evaporate During Regeneration	None	None	None/Waste Carbon	40	Regenerate or Landfill
Distillation	----	2,500,000	Evaporate Water	None	None	Concentrated/ Dewatered	50-100	Landfill or Incinerate
Reverse Osmosis	130-390	----	High Pressure Pump	None	Not Objectionable	Dilute Concentrate	1-40	Distill & Incinerate, Landfill
Ultrafiltration	2.5-26	----	High Pressure Pump	None	Not Objectionable	Dilute Concentrate	1-40	Distill & Incinerate, Landfill
Electrodialysis	79.5	----	Ion Transport	None	None	Dilute Concentrate	1-5	Distill, Landfill
Liquid/Liquid Extraction	6-8.7	----	Mixing	None	None	None	----	N/A
Gas Phase Separation	68	----	Mixing	None	None	None	----	N/A
Freezing Crystallization	1080	----	Freezing	None	Not Objectionable	None	----	N/A
Disinfection	0.1-0.4	----	Chlorine Pumps	Minor	None	None	----	N/A
Emulsion Breaking	17.7-36	4,240	Mixer Heat Liquid	None	None	Concentrated	50(oil)	Incinerate

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TABLE 8-24

NONWATER QUALITY ASPECTS OF SLUDGE AND SOLIDS HANDLING

PROCESS	ENERGY: Power	ENERGY: Fuel	Energy Use	NONWATER QUALITY IMPACT: Air Pollution Impact	Noise Pollution Impact	Solid Waste	Solid Waste Concentration % Dry Solids	Solid Waste Disposal Technique
	kwh/ton dry solids							
Anaerobic Digestion	132-269	----	Mixing	None	None	Concentrated	4-12	Dewater, Landfill
Aerobic Digestion	635-1090	----	Mixing, Aeration	Minor (Odor)	None	Concentrated	2-5	Thicken, Dewater, Landfill
Sludge Thickening	29-930	----	Skimmer, Sludge Rake Drive	None	None	Concentrated	4-27	Dewater & Landfill or Incinerate
Pressure Filtration	21	----	High Pressure Pumps	None	None	Dewatered	25-50	Landfill or Incinerate
Heat Treatment	----	2,700	Heat	None	None	Concentrated	5-10	Dewater & Landfill or Incinerate
Heat Drying	----	8,300-26,200	Evaporate Water	Significant (Dust)	None	Dewatered	90	Landfill
Sand Bed Drying	----	35	Removal Equipment	None	None	Dewatered	15-40	Landfill
Vacuum Filter	16.7-66.8	----	Vacuum Pump, Rotation	None	Not Objectionable	Dewatered	20-40	Landfill or Incinerate
Centrifuge	0.2-98.5	----	Rotation	None	Not Objectionable	Dewatered	15-50	Landfill or Incinerate
Landfill	----	20-980	Haul, Landfill 1-10 Mile Trip	None	None	Dewatered	N/A	N/A
Lagoon	----	36	Removal Equipment	None	None	Dewatered	3-5	Dewater & Landfill
Incinerator	38	----	Rakes, Cooling Fan (Feed Combustible)	Significant (Dust)	Not Objectionable	Dewatered/ Scrubber Water	100 & Scrubber Water	Landfill Ash/ Return Scrubber Water
Wet Air Oxidation	47	383	High Pressure Pumps, Pre-Heat Feed	Minor (Odor)	None	Concentrated	1-5	Dewater & Landfill or Incinerate
Pyrolysis	----	27-127	Air Supply, Gas Handling, Feed	Minor (Dust, Odor, Flammable)	None	Dewatered	100	Landfill or Byproduct Recovery

None of the liquid handling processes causes air pollution with the possible minor exception of disinfection. Incineration and heat drying of sludges or solids can, however, cause significant air pollution. In fact, efforts to reduce this air pollution by scrubbing can result in water pollution. Noise pollution sometimes disturbs equipment operators or even the surrounding community. However, none of the wastewater treatment processes causes objectionable noise in either respect. None of the treatment processes has any potential for radioactive radiation hazards.

The solid waste impact of each wastewater treatment process is indicated in three columns on the table. The first column shows whether effluent solids are to be expected and, if so, the solids content in qualitative terms. The second column lists typical values of percent solids of the sludge or residue. The third column indicates the usual method of solids disposal associated with the process.

The processes for treating the wastewaters from this category produce considerable volumes of sludges. Much of this material is inert metal oxides which can be reused profitably. Other sludges not suitable for reuse must be disposed of to landfills since most of the sludge is 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 used to ensure long-term protection of 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.

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SECTION IX

BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

EFFLUENT LIMITATIONS

INTRODUCTION

The effluent limitations which must be achieved by July 1, 1977, (Level I) attainable through the application of the best practicable control technology currently available (BPT) are established in this section. BPT is based upon the average of the best existing performance by plants of various sizes, ages and manufacturing processes within the industrial category and its subcategories as discussed in Sections III through VIII of this report.

In particular, consideration was given to:

(a) the size and age of facilities
(b) the processes employed
(c) nonwater quality environmental impact
(d) the engineering impact on waste treatment facilities
(e) process changes
(f) the total cost of meeting the effluent limitations

The best practicable control technology currently available emphasizes treatment facilities at the end of pipe, but includes the control technologies within the plant or process itself when these are considered to be normal practice within an industry.

A further consideration is that the economic and engineering reliabilities of the waste treatment facilities required to meet these limitations are already known since they are currently in operation by the majority of the plants treating their wastewaters.

APPLICABILITY

The point source category covered is Machinery and Mechanical Products Manufacturing. The complexity, variety, and volume of products within these industries required subcategorization by a method which was independent of the actual product produced. After review of the more traditional factors for subcategorization which included standard industrial classification, plant size, geographical location, and products produced, categorization by major groupings of manufacturing processes common to all industries was selected.

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.

These subcategories are:

1. Casting and Molding - Metals
2. Mechanical Material Removal
3. Material Forming - All materials except plastics
4. Physical Property Modification
5. Assembly Operations
6. Chemical-Electrochemical Operations
7. Material Coating
8. Smelting and Refining of Nonferrous Metals
9. Molding and Forming - Plastics

The identification of best practicable control technology currently available and recommended effluent limitations presented in this section cover all the Machinery and Mechanical Products Manufacturing industries and apply to all existing plants, except for those subcategories specifically covered by other sets of effluent limitations as discussed in Section IV of this report. In general, the effluent limitations in this report cover all industries in subcategories 2, 3, 4, 5, 7 and 9, and most of subcategory 1. Limited portions of subcategory 6 and 8 are covered as defined in Section IV of this report.

In addition to the above subcategories, separate subcategories were established for Film Sensitizing, Subcategory 10; Dockside Shipbuilding Activities, Subcategory 11; and Lead Acid Battery Manufacture, Subcategory 12 due to the specialized processes involved.

Plant data were used to derive limitations which, when applied in a building block fashion in conjunction with other pertinent effluent limitations to a particular plant, result in specific limitations for that plant. A set of effluent limitations was determined for each industry subcategory. The effluent limitations generally limit pollutant rate rather than water quality. That is, they are expressed in terms of milligrams of pollutant per hour per square meter of production floor area rather than concentration.

The wastewater treatment and control technology associated with the BPT limitations was discussed in Section VII, and typical costs for this technology were listed in Section VIII. This section defines the effluent limitations, reviews the technology and estimates the overall economic impact of effluent limitations implementation.

BPT EFFLUENT LIMITATIONS

Based on the information contained in Sections III through VIII of this report, it was established that the effluent limitations attainable through the application of the best practicable control technology currently available are as listed in Table 9-1. This table sets forth the 30 day average effluent limitations for Subcategories 1 through 8, 10 and 12 of the Machinery and Mechanical Products Manu-

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TABLE 9-1

BPT EFFLUENT LIMITATIONS (30-DAY AVERAGE) $mg/hr\text{-}m^2$

Pollutant Parameter	Subcategories									
	1	2	3	4	5	6	7	8	10	12
Cadmium	0.071	0.010	---	---	0.003	---	0.048	0.043	0.047	0.071
C. O. D.	327	33	53	148	16	1060	165	66	152	90
Chrome, Total	---	0.076	---	---	---	4.7	1.3	---	---	0.057
Chrome, Hex	---	---	---	---	---	0.41	0.10	---	---	0.012
Copper	0.37	0.060	0.18	---	0.014	4.4	0.66	0.13	---	---
Cyanide	---	---	---	0.080	---	---	---	---	0.13	---
Fluoride	---	0.89	---	---	0.42	53	10	---	---	---
Iron	1.5	0.96	0.32	3.9	0.25	12	3.2	1.4	0.79	0.97
Lead	0.24	0.032	0.032	0.55	0.010	---	0.12	0.26	---	0.19
Mercury	---	---	---	----	0.003	---	0.012	.007	0.006	---
Nickel	0.14	0.11	0.12	0.20	0.057	---	---	0.36	---	0.073
Oil, Grease	41	4.3	7.1	20	3.0	154	17	6.1	17	12
Phosphates	---	0.60	0.79	---	0.15	---	9.1	---	0.23	1.3
Silver	0.007	---	0.002	---	0.001	---	0.013	0.015	0.008	---
TS Solids	72	4.8	9.2	28	2.7	221	59	17	45	65
Zinc	1.1	0.31	1.6	---	0.14	---	1.3	0.88	0.57	0.49
pH	6 to 9 for all subcategories									

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

facturing industries. Table 9-2 defines the single-day maximum effluent limitations for the same subcategories. The units of these limitations are milligrams of pollutant discharged per hour of production per square meter of active production floor area. The only exception is pH which for all subcategories is 6-9. Application of these limitations to particular plants is detailed later in this section.

The effluent limitation for Molding and Forming - Plastics, Subcategory 9, is no discharge of pollutants. This is because no process water is required for molding of plastics. Some plants use water for extruding and foaming; however, exemplary plants contacted had no effluent discharge because they recycle the contact coolant water.

The effluent limitation for Dockside Shipbuilding Activities, Subcategory 11, is that the entire work area must be broom cleaned to remove loose shot, paint, scale, oil spills and other debris before flooding or submerging of the work area.

No effluent limitations were established for the toxic constituents (polychlorinated biphenyls (PCB's), phenols and chlorinated hydrocarbons) since no BPT is available to control them. As a result, their use should be reduced or eliminated. These constituents may be regulated as toxic pollutants under Section 307A of the Act.

Two definitions are important in implementing these effluent limitations; active production floor area and hours of production. Active production floor area is defined as that general floor area within a plant assigned to a specific subcategory (based on the manufacturing processes performed) which is actively in production. The floor area does not necessarily have to be contiguous. The area includes aisles, columns, in-process active storage areas immediately adjacent to the operation (i.e., storage area necessary to maintain a smooth flow of work) and any other adjacent floor area actively associated with operation of the processes in the subcategory. When two or more processes in different subcategories are so intimately associated (integrated or shared) that determination of separate subcategory floor areas is impossible, the integrated floor area should be assigned to the more restrictive subcategory involved. If a manufacturing process in one subcategory exists as an "island" within the floor area associated with another subcategory and if the floor area of the island is no more than five percent of the total of the other subcategory floor area, the process area may be included as part of the dominant subcategory floor area. Inactive plant areas, storage areas other than described above, general office areas, power generating facilities and similar areas are not included or considered part of the active production floor area.

Hours of production means the actual time that a manufacturing, assembly, or other type of production operation in a subcategory is performed.

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TABLE 9-2

BPT EFFLUENT LIMITATIONS (SINGLE-DAY MAX)

Pollutant Parameter	Subcategories									
	1	2	3	4	5	6	7	8	10	12
Cadmium	0.11	0.015	---	---	0.005	---	0.072	[illegible]	0.071	0.11
C. O. D.	654	66	106	296	32	2110	330	232	304	180
Chrome, Total	---	0.11	---	---	---	7.1	[illegible]	---	---	0.086
Chrome, Hex	---	---	---	---	---	0.62	0.15	---	---	0.018
Copper	0.56	0.090	0.27	---	0.021	6.6	0.99	[illegible]	---	---
Cyanide	---	---	---	0.12	---	---	---	---	0.20	---
Fluoride	---	1.3	---	---	0.63	80	15	---	---	---
Iron	2.9	1.9	0.64	5.9	0.50	18	6.4	2.7	1.6	1.5
Lead	0.36	0.048	0.048	0.83	0.015	---	0.18	0.39	---	0.29
Mercury	---	---	---	---	0.005	---	0.018	[illegible]	0.009	---
Nickel	0.21	0.17	0.18	0.30	0.086	---	---	0.54	---	0.11
Oil, Grease	82	8.6	14	40	6.0	308	94	12	34	24
Phosphates	---	1.2	1.6	---	0.30	---	18	---	1.9	[illegible]
Silver	0.011	---	0.003	---	0.002	---	0.020	0.023	0.012	---
TS Solids	144	9.6	18	56	5.4	442	118	34	90	130
Zinc	1.7	0.47	2.3	---	0.21	---	1.9	1.3	0.90	0.74
pH	6 to 9 for all subcategories									

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

IDENTIFICATION OF BPT

Best practicable control technology currently available for all the applicable Machinery and Mechanical Products Manufacturing industries is the use of physical and chemical methods of wastewater treatment at the end of the process combined with the best practical in-process control technology normally practiced to conserve rinse water and reduce the amount of treated wastewater discharged.

The primary water pollutants generated in most facilities in this industry category are characterized generally as:

- Free and emulsified oils and greases
- Suspended and dissolved solids
- Dilute acids and alkaline chemicals

Free oils are normally directly removed by use of an oil skimmer where the oil is swept into a receiving channel and pumped to a holding tank for ultimate disposal.

Soluble or emulsified oils and greases are removed by adding sulfuric acid and heat to the emulsion. After initial emulsion breaking and decanting, the remaining emulsified oil, usually 100 to 150 ppm, is treated by adding a chemical coagulant, and the resultant floc removed by either settling or air flotation. Suspended solids are also removed at this time.

Dissolved solids, dilute acids and alkaline chemicals are usually treated together with any remaining free or emulsified oils using chemical treatment. Chemical treatment methods are exemplified, as applicable, by destruction of cyanide by oxidation, reduction of hexavalent chromium to the trivalent form, neutralization, and coprecipitation of metals as hydroxides or hydrated oxides (with settling and clarification to remove suspended solids prior to discharge). The above technology has been widely practiced by many plants for over 25 years.

RATIONALE FOR SELECTION OF BPT

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

Age and Size of Facilities

As discussed in Section IV, the age of industry manufacturing facilities has little direct bearing on the quantity or quality of wastewater generated. Thus, the effluent limitation for a given subcategory applies equally to all plants regardless of age. Land availability for installation of add-on treatment facilities can influence the type of technology utilized to meet the effluent limitations. This is one of the considerations which can account for a range in the costs that might be incurred. The size of a facility by subcategory is considered directly during implementation of the effluent limitations.

Processes Employed

All plants in a given subcategory use the same or similar manufacturing processes, 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. No changes in process employed are envisioned as necessary for implementation of this technology for plants in any subcategory. The treatment technologies to achieve BPT are end-of-process methods which can be added onto the existing treatment facilities.

Nonwater Quality Environmental Impact

The enhancement of water quality provided by these proposed effluent limitations substantially outweighs the impact on air, solid waste and energy requirements, as discussed below.

Impact of Proposed Limitations on Air Pollution - Use of Level I end-of-pipe treatment methods has no effect on air quality. However, use of recycle systems to help achieve Level I limitations has the potential for increasing the loss of volatile substances to the atmosphere. Use of cooling towers, permitting process water reuse, has contributed significantly to reductions of effluent loads while contributing only minimally to air pollution problems. Careful operation of these 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 category produce considerable volumes of sludge. Much of this material is inert metal oxides which can be reused profitably. Other sludge not suitable for reuse must be disposed of to landfills since chemical precipitates form most of the sludge and these cannot be appreciably 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 potentially 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 any 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 used to ensure long-term protection of the environment. A program of routine periodic sampling and analysis of leachates is advisable. Where appropriate, the location of solid hazardous material disposal sites, if any, should be permanently recorded in the appropriate office of legal jurisdiction.

Impact of Proposed Limitations on Energy Requirements - The effect 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 BPT and BAT amounts to less than one percent of the electrical energy used by this industry in 1974.

Engineering Impact on Treatment Facilities

The level of technology selected as the basis for BPT limitations is considered to be practicable since the concepts are proven and are currently available for implementation and may be readily applied as "add-ons" to existing treatment facilities. In addition, in many plants, improved housekeeping and automation of existing treatment facilities is adequate to meet the effluent limitations.

Process Changes

No in-process changes are required to achieve the BPT limitations although improved housekeeping and recycle water quality changes may occur as a result of efforts to reduce effluent discharge rates. Many plants are employing recycle, cascade uses, or treatment and recycle as a means to minimize water use and the volume of effluents discharged. The limitations are pollutant rate limitations (unit weight of pollutant discharged per unit floor area per hour worked) 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.

Cost of Meeting the Effluent Limitations

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. Table 9-3 defines by subcategory the number of plants that will be governed by these limitations, i.e. plants that have a point source discharge. Eighty percent of these plants currently have waste treatment facilities which already meet or approach the limitation levels required. It should be noted that the total number of plants affected by these limitations is much less than that listed by subcategory since most of the plants have manufacturing processes in several subcategories. These are referred to as multiple subcategory plants.

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TABLE 9-3

PLANT EFFLUENT DISCHARGE BY SUBCATEGORY

Subcategory	Number of Plants that Discharge to Navigable Waters *
1. Casting and Molding - Metals	921
2. Mechanical Material Removal	1,494
3. Material Forming - All Materials Except Plastics	666
4. Physical Property Modification	370
5. Assembly Operations	385
6. Chemical-Electrochemical Operations	8,430
7. Material Coating	1,786
8. Smelting and Refining of Nonferrous Metals	264
9. Molding and Forming - Plastics	369
10. Film Sensitizing	112
11. Dockside Shipbuilding Activities	Not Applicable
12. Lead Acid Battery Manufacture	61

*Data based on random telephone poll of the industries and Department of Commerce Industry data base.

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The economic impact was then determined by considering both single subcategory and multiple subcategory plants. Of the estimated 113,032 plants, 85 percent had no point source discharge. Of the balance, 4,527 discharged to navigable waters. Of these, 80 percent already perform some type of waste treatment. There are thus an estimated 724 plants which discharge to navigable waters without treatment, and 3,803 plants which treat their waste before discharge. Approximately 25 percent of these plants have a manufacturing process that includes the Electroplating and Metal Finishing Point Source Category. These plant totals, adjusted to reflect the metal finishing activities, were then used to determine the economic impact on the point source category.

Two types of plant situations were then defined. One type required a new treatment system and the other required add-ons to existing facilities to 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 obtaining an average plant size based on data compiled. The capital costs were developed from an engineering estimate based on actual plant cost data for components in each of the systems.

The results of this analysis showed the estimated cost for plants without treatment facilities. For plants with treatment, the cost to modify the existing facility to meet the effluent limitations was determined by estimating a cost to update a typical plant assuming the plant had an average waste treatment facility. This cost was then applied to all the estimated plants which have treatment. This total cost was then added to the total cost for new waste treatment facilities to determine the estimated total cost to the Machinery and Mechanical Products Manufacturing industries which was one billion dollars.

PROCEDURE FOR DEVELOPMENT OF BPT EFFLUENT LIMITATIONS

The BPT effluent limitations were derived from analysis of the treated effluent collected from a cross section of exemplary plants within the Machinery and Mechanical Products Manufacturing industries.

Screening Rationale

Because the effluent limitations were to be based on the performance of exemplary plants, a number of techniques were used to obtain a final data base. First, the following five sources were asked to supply names of such plants:

- U. S. Environmental Protection Agency Regional Offices
- Industry Trade Associations
- State environmental protection offices
- Individual manufacturing companies
- Consultants

In addition, three other sources were investigated to obtain more plant names:

NPDES permit listings
Periodical literature
Technical papers and reports

All of the aforementioned information sources are quantitatively summarized in the Supplement B to this document, and a list of industry trade associations contacted is presented in Section III. Additionally, to augment the list of potentially exemplary plants, a list of about 6,000 plants was screened by inspection.

Based on the information and listings from all of the previously mentioned sources a total of 1,422 plants were evaluated in detail by telephone using standardized evaluation forms, and 339 plants were selected for on-site evaluation. Plants selected for on-site evaluation were still regarded as only potentially exemplary. Indeed, subsequent data analysis showed that pollutant rates from some were excessive. That is the reason why the analytical screening based on effluent sample analysis, described below, formed a valid final data base.

The plant data collected from these plants were found by the following methods to be typical of long-term plant effluent data.

1. A comparison of the test data collected with the plant effluent data supplied by the plant was made. Forty percent of the plants supplied some effluent data, thus permitting a good check on the parameters tested. Where large discrepancies existed for a particular parameter the sample analysis was recalculated or redone. If a discrepancy was discovered, it was corrected. If no discrepancy was found, the plant supplied data was reviewed and if it represented verified data (i.e., reported to a state agency) it was substituted for the test parameter. Less than one percent of all the data collected was revised in this manner.

2. All test analysis results were sent to the plants for examination and comments. Over 40 percent of the plants acknowledged receipt of data and commented on the analysis. If plant representatives questioned a particular parameter(s) they were asked if historical or verified data existed to support their position. If support existed and subsequent reevaluation of the data point showed this data was correct, it was included in the data base. In general, almost all

the revisions decreased the pollutant parameter concentration. The total number of values changed in this manner are included in the less than one percent factor noted previously.

3. All the plant data collected were analyzed employing a computer program. The data collected were first examined in terms of effluent concentration for each subcategory (1 through 9). This analysis provided the minimum, average and maximum effluent concentrations for all the plant data collected. Any concentration data or pollution discharge rate that was much larger than the mean was flagged, the plant identified, and the data reviewed. This provided an opportunity to check parameters which appeared excessively out of line when compared with other plants. Thus, the data point highlighted was checked and corrected if possible. If still high, the plant became a possible candidate to be defined as nonexemplary.

Thus the plant sample data collected was verified in three ways, by comparison with previous plant data, by evaluation by plant representatives and by comparison with data from other plants performing similar activities.

Determination of 30-Day Average Effluent Limitations

The actual effluent limitation was determined as follows. For plants with a single subcategory, the concentration (mg/l) of each pollutant was determined and then was multiplied by the plant's average effluent discharge rate (l/hr) and divided by the production subcategory floor area (sq m) to obtain the normalized average pollutant discharge rate (mg/hr-sq m). For plants with more than one subcategory, the concentration of each pollutant was first multiplied by the plant's average effluent discharge rate to obtain the average pollutant discharge rate (mg/hr). These pollutant discharge rates were then apportioned according to subcategory flow rate among the subcategories where the pollutant occurred, and the resulting subcategory pollutant discharge rates were divided by the subcategory production floor areas to obtain normalized subcategory pollutant discharge rates (mg/hr-sq m).

Next, the pollutant discharge rates were screened to eliminate plants that were not exemplary. This step was necessary because the limitations "shall not be based upon a broad range of plants within an industrial category or subcategory, but shall be based upon performance levels achieved by exemplary plants". While the plants to be visited had been previously screened to give a high probability of being exemplary, reassessment by means of actual data proved essential. The first step in the screening process was to establish a reasonable water discharge rate for each subcategory. This was accomplished by using plots of water discharge rate vs production floor area (presented and discussed in Section IV of this report) to establish normalized water discharge rates (l/hr-sq m). Next, pollutant concentrations that were generally achieved by exemplary plants were established by inspection of plant data and consideration of state standards. These concentrations were then multiplied by the normalized water discharge rates to determine the tentative pollutant rate limits (mg/hr-sq m) for exemplary plants. Actual plant pollutant rates were then compared with these limits to identify plants with rates exceeding the limit. These plants were then investigated. This investigation often included reanalysis of the samples and determination of whether the sample had been taken during upset conditions. Finally, plants with a large number of excessive pollutant discharge rates were judged not exemplary and were eliminated from the data base used to develop the effluent limitations. As a result, 30 percent of the plants were screened out by this procedure.

The final step in the effluent limitations derivation was to average for all exemplary plants the pollutant discharge rates (mg/hr-sq m) for each pollutant parameter within each subcategory. The average pollutant discharge rate for each parameter was then reviewed by determining the resultant concentrations and comparing them with the other subcategories for consistency. One exception to the above discussion is that for TSS in Subcategory 12, Lead Acid Battery Manufacture, the average TSS concentration was unacceptably high and did not reflect BPT technology. For this TSS parameter, a value of 33 mg/l was selected based on the effluent data from two battery plants. Since this figure represented the best treatment currently available and was reasonably close to that obtained by using BPT, the effluent limitation was established using this concentration and the average plant water discharge to average floor area ratio defined in Section IV.

Table 9-4 summarizes for each applicable subcategory the significant pollutant concentrations. The table shows the concentrations normally attainable with BPT (CP). Also shown for each subcategory is the average pollutant concentration attained by the plants used to establish the limitations (CL). The third parameter (CF) in Table 9-4 is the average concentration determined by using the limitations and the average plant discharge to average floor area ratio.

In general there is reasonably good correlation between the three concentration figures and from subcategory to subcategory. They do not agree completely because the CL concentration is the actual average concentration for each pollutant parameter. The average flow associated for each CL pollutant varies because not every plant within a subcategory discharged every pollutant. However, the average concentration (CF) was determined by using a single average flow for the whole subcategory as will be the case for a particular plant. Both concentration figures (CL and CF) reflect integrated concentrations

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TABLE 9-4 POLLUTANT CONCENTRATION COMPARISON - mg/l

Pollutant Parameter	ALL	1		2		3		4		5		6		7		8		10		14	
	CP	CT	CP	CT	CP	CT	CP	CT	CP	CT	CP	C	CP	CT	CP	CT	CP	CL	CP	T	CP
Cadmium	0.2	0.022	0.028	0.055	0.013		---		---	0.010	0.014			0.017	0.02[illegible]	[illegible]	[illegible]	0.077	0.030	0.018	0.016
C.O.D.	11[illegible]	117	130	173	10[illegible]	222	90	136	98	153	73	9	89	11[illegible]	[illegible]	106	49	141	96	[illegible]	46
Chrome, Total	[illegible]	---	--	46	0.24		---	--	---	---	---	15	40	58	[illegible]			-	---	0.025	0.028
Chrome, Hex	0.[illegible]		-		--		--	---	---	--	---	0.025	0.035	0.049	0.036	-	--	--	--	0.007	0.005
Copper	0.[illegible]	0.11	0.15	0.16	0.18	0.18	0.30	---	---	0.093	0.064	0.18	0.40	0.29	0.37	0.1	0.10	---	--	-	--
Cyanide	0.[illegible]	--	---	--	---	--	---	0.051	0.053	--	---	---	---	--	---	--	---	0.22	0.082	---	---
Fluoride	10.0	-	-	3.4	2.7	---	---	---	--	2.2	1.9	[illegible]6	4.5	4.5	5.5	--	--	---	---	--	--
Iron	2.[illegible]	1.3	0.[illegible]9	1.6	1.5	[illegible]	0.54	2.9	2.6	1.1	1.[illegible]	0.58	0.99	1.2	1.8	1.2	1.0	0.67	0.50	2.6	0.53
Lead	0.2	0.07[illegible]	0.0[illegible]	0.19	0.19	[illegible]51	0.054	0.18	0.36	0.033	0.053	--	--	0.041	0.067	0.11	0.19	---		0.14	0.[illegible]
Mercury	0.01	-	-	--	-	--	-	--	--	0.010	0.014	-	--	0.008	0.00[illegible]	[illegible]	0.005	0.009	0.004	--	---
Nickel	0.5	0.13	0.0[illegible]	0.38	[illegible]	0.63	0.20	0.13	0.13	0.11	0.27	-		-	--	0.19	0.27	---	--	0.0[illegible]	0.03[illegible]
Oil Grease	15.[illegible]	16.[illegible]	16.3	26.0	1[illegible]	3.6	1[illegible].0	17.6	13.[illegible]	9.3	13.6	10.0	1[illegible].0	18.[illegible]	9.4	8.0	4.5	5.0	10.[illegible]	14.9	6.[illegible]
Phosphates	2.5	---	--	2.6	[illegible]	2.9	1.3	--	---	0.9	0.7		--	[illegible]	[illegible]1	-	--	1.5	0.6	[illegible]4	[illegible]
Silver	0.05	0.01[illegible]	0.003	---	-	0.003	0.003	---	--	0.004	0.004	---	--	0.005	0.007	0.014	0.011	0.009	0.005	--	---
TS Solids	25.0	24.5	28.6	2[illegible].1	14.5	2[illegible].3	15.6	18.6	18.4	12.1	12.1	23.2	18.6	[illegible]	32.8	120	12.9	64.5	28.2	33.0	33.0
Zinc	1.0	0.44	0.44	0.78	0.94	1.0	2.6	---	---	0.50	0.66	--	-	0.76	0.71	0.74	0.65	0.91	0.36	0.26	0.25
pH	6 to [illegible] for all subcategories																				

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 in that they are the concentrations achieved at the end of pipe treatment and include both single and multi-subcategory plants.

In some limited cases the average CL parameter is much higner than the average CF parameter because some plants with an acceptable pollutant rate had a very high concentration level for a particular pollutant with a very low effluent flow. Also, in some cases, particularly for cadmium and silver, the values shown for CL and CF are significantly less than what would be expected using BPT. This difference reflects the fact that many plants are already treating for these parameters inside the plant and/or that these pollutant effluent streams normally contribute only a very small percentage of the plant total effluent.

It should be noted that the concentration values presented are for reference use only. The actual concentrations for a particular plant can be higher or lower depending on the quantity of the effluent discharged and the effectiveness of the treatment methods because the effluent limitations are expressed in terms of mass of pollutant per hour per unit floor area.

Single-Day Maximum Effluent Limitations

To determine the single-day maximum effluent limitations, data for a selected group of plants were examined. For each of these plants, individual measurements were compared with the average of all such measurements over a 30-day period. Specifically, the difference between the maximum measurement and the 30-day average measurement was determined, and this difference was evaluated as to its overall pollutant impact. This resulted in conversion factors which were multiplied by each 30-day average effluent limitation to determine the single-day maximum effluent limitations shown in Table 9-2.

APPLYING THE EFFLUENT LIMITATIONS

This subsection deals with the procedure for applying the effluent limitations to actual manufacturing plants. The general principles of application are discussed and some plant examples are presented.

General Principles of Application

The procedure for applying the effluent limitations to individual plants consists of identifying the manufacturing processes by subcategory along with the floor area and number of hours worked per day in eacn subcategory. If some of the operations within a plant are covered by other effluent limitations as defined in Section IV of this report they should also be noted.

Maximum allowable discharges for a plant in grams per day (g/day) for each pertinent pollutant parameter for each subcategory are then determined by multiplying the effluent limitation by the production floor area and the number of hours worked per day. This calculation procedure is repeated for each existing plant subcategory with an effluent discharge.

The maximum allowable discharges for each pollutant from each subcategory are then added together to establish the plant maximum allowable pollutant discharge. If part of the plant manufacturing operation is covered by another point source category, the allowable pollutant discharge from that category should be determined and added to the maximum allowable pollutant discharge to determine the total plant maximum allowable pollutant discharge. If any of the subcategories in a plant have zero end-of-pipe effluent discharge, the maximum allowable pollutant discharge for that subcategory is zero.

The actual plant pollutant discharge should be equal to or less than the above-determined plant maximum allowable pollutant discharge for each of the pollutant parameters. If any value is exceeded, the quantity of effluent flow must be reduced or the effectiveness of the waste treatment facility must be improved.

Examples

The examples presented in the following pages cover the most common variations in the characteristics of individual plants. An understanding of the examples will enable the reader to determine the proper approach to other variations. The five examples presented are:

1. Plant with a single subcategory covered by Machinery and Mechanical Products Manufacturing effluent limitations.

2. Plant with two subcategories, one covered by other effluent limitations and the second a zero discharge operation covered by the Machinery and Mechanical Products Manufacturing effluent limitations.

3. Plant with multiple subcategories covered by Machinery and Mechanical Products Manufacturing effluent limitations.

4. Plant with multiple subcategories with zero effluent discharge in some subcategories.

5. Plant with multiple subcategories partially covered by other effluent limitations.

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Example 1: Plant with a Single Subcategory, Covered by Machinery and Mechanical Products Manufacturing Effluent Limitations - The plant considered in this example consists of a single manufacturing subcategory. The example is carried out in four tables. Table 9-5 presents pertinent plant data including number of hours worked per day, production floor area, the quantity of wastewater discharged each day, and actual effluent concentrations for pollutants covered by Subcategory 3 effluent limitations. Table 9-6 shows how actual pollutant discharges (g/day) are calculated by multiplying the pollutant concentrations by the quantity of wastewater discharged each day. Table 9-7 shows how the plant maximum allowable discharges are calculated by multiplying the effluent limitations by the floor area and by the number of hours worked each day. Table 9-8 shows the resulting comparison between the actual pollutant discharges (from Table 9-6) and the maximum allowable pollutant discharges (from Table 9-7). All of the actual discharges are less than the maximum allowable discharges, and the plant is, therefore, in compliance with the effluent limitations.

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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TABLE 9-5

EXAMPLE 1 PLANT DATA

Manufacturing Description:	Production of Stampings
Plant Average Effluent Discharge:	60,000 liters per day
Subcategory:	3
Manufacturing Process:	Material Forming - All Materials Except Plastics
Production Floor Area (sq m):	20,000
Hours Worked Per Day:	8

Plant Effluent Pollutant Paramater Concentrations (30 Day Average)

Parameter	Concentration
pH	7.9
Total Suspended Solids	22.1 mg/l
Copper	0.30 mg/l
Iron	0.68 mg/l
Lead	0.07 mg/l
Nickel	0.25 mg/l
Oil and Grease	15.0 mg/l
Chemical Oxygen Demand	64.0 mg/l
Phosphate	2.0 mg/l
Silver	0.005 mg/l
Zinc	0.92 mg/l

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TABLE 9-6

EXAMPLE 1 POLLUTANT DISCHARGE CALCULATIONS

$$\text{Plant Actual Pollutant Discharge (g/day)} = \text{Concentration (mg/l)*} \times \frac{\text{Plant Average Effluent Discharge (l/day)}}{1{,}000\ \text{(mg/g)}}$$

Parameter	Plant Actual Pollutant Discharge (g/day)
Total Suspended Solids	22.1 x 60,000/1,000 = 1,326
Copper	0.30 x 60,000/1,000 = 18.0
Iron	0.68 x 60,000/1,000 = 40.8
Lead	0.07 x 60,000/1,000 = 4.2
Nickel	0.25 x 60,000/1,000 = 15.0
Oil & Grease	15.0 x 60,000/1,000 = 900
Chemical Oxygen Demand	64.0 x 60,000/1,000 = 3,840
Phosphate	2.0 x 60,000/1,000 = 120
Silver	0.005 x 60,000/1,000 = 0.30
Zinc	0.92 x 60,000/1,000 = 55.2

*From Table 9-5

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

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TABLE 9-7

EXAMPLE 1 PLANT MAXIMUM ALLOWABLE DISCHARGE CALCULATIONS

$$\text{Plant Maximum Allowable Pollutant Discharge (g/day)} = \text{Effluent Limitation (mg/hr-sq m)*} \times \frac{\text{Production Floor Area (sq m)**}}{1{,}000\ \text{(mg/g)}} \times \text{Production Time (hr/day)**}$$

Parameter	Effluent Limitations mg/hr - sq m	Maximum Allowable Discharge (g/day)
Total Suspended Solids	9.2	9.2 x 20,000/1,000 x 8 = 1,472
Copper	0.18	0.18 x 20,000/1,000 x 8 = 28.8
Iron	0.32	0.32 x 20,000/1,000 x 8 = 51.2
Lead	0.032	0.032 x 20,000/1,000 x 8 = 5.12
Nickel	0.12	0.12 x 20,000/1,000 x 8 = 19.2
Oil & Grease	7.1	7.1 x 20,000/1,000 x 8 = 1,136
Chemical Oxygen Demand	53.0	53.0 x 20,000/1,000 x 8 = 8,480
Phosphate	0.79	0.79 x 20,000/1,000 x 8 = 126.4
Silver	0.002	0.002 x 20,000/1,000 x 8 = 0.32
Zinc	1.6	1.6 x 20,000/1,000 x 8 = 256.0

* From Table 9-1
**From Table 9-5

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TABLE 9-8

EXAMPLE 1 COMPLIANCE COMPARISON

Parameter	Plant Actual Pollutant Discharge*	Plant Maximum Allowable Pollutant Discharge**
pH	7.9	6 to 9
Total Suspended Solids	1,326 g/day	1,472 g/day
Copper	18.0 g/day	28.8 g/day
Iron	40.8 g/day	51.2 g/day
Lead	4.2 g/day	5.12 g/day
Nickel	15.0 g/day	19.2 g/day
Oil & Grease	900 g/day	1,136 g/day
Chemical Oxygen Demand	3,840 g/day	8,480 g/day
Phosphate	120 g/day	126.4 g/day
Silver	0.30 g/day	0.32 g/day
Zinc	55.2 g/day	256.0 g/day

*From Table 9-6
**From Table 9-7

Example 2: Plant with a Subcategory Covered by Other Effluent Limitations and a Zero Discharge Subcategory Covered by Machinery and Mechanical Products Manufacturing Effluent Limitations - The plant considered in this example manufactures a product covered by the Machinery and Mechanical Products Manufacturing Point Source Category. Their one operation having an effluent discharge is chrome plating. Their second operation, a machining operation, does not have an end-of-pipe discharge because its pollutants are removed by a contractor. Effluent limitations promulgated for the Electroplating and Metal Finishing Point Source Category apply to this plant. Table 9-9 presents pertinent plant data including number of hours worked per day for each subcategory, production floor area for each subcategory, and the total quantity of wastewater discharged each day. Other plant data (such as area plated per hour and number of associated operations) needed to determine the Subcategory 6 limitations are defined in the Electroplating and Metal Finishing Development Document and are not shown here because it is not within the scope of this document. The Subcategory 2 maximum allowable discharge is zero because the plant has no end-of-pipe discharge from Subcategory 2. The plant is, therefore, in compliance with the Machinery and Mechanical Products Manufacturing effluent limitations.

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TABLE 9-9

EXAMPLE 2 PLANT DATA

Manufacturing Description:	Production of machined and plated components	
Plant Average Effluent Discharge:	50,000 liters per day from Subcategory 6	

Subcategory:	2	6
Manufacturing Process:	Mechanical Material Removal	Electroplating*
Production Floor Area (sq m):	4,000	5,000
Hours Worked Per Day:	8	8

Plant Effluent Pollutant Parameter Concentrations

Not shown because there is no end-of-pipe discharge from Subcategory 2.

*Electroplating is not covered by the Machinery and Mechanical Products Manufacturing industries effluent limitations (refer to Section IV of this report). Effluent limitations should be determined using the procedures defined for the Electroplating and Metal Finishing industries.

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Example 3: Multiple Subcategory Plant, Covered by Machinery and Mechanical Products Manufacturing Effluent Limitations - In this example, the plant under consideration has three manufacturing subcategories. The example is carried out in seven steps. Table 9-10 presents pertinent plant data including number of hours worked per day for each subcategory, production floor area for each subcategory, the total quantity of wastewater discharged each day, and actual effluent concentrations for pollutants with Subcategory 3, 5, or 7 effluent limitations. Table 9-11 shows how actual pollutant discharges are calculated by multiplying the pollutant concentrations by the quantity of wastewater discharged each day. Table 9-12 shows how the subcategory 3 maximum allowable discharges are calculated by multiplying the subcategory 3 effluent limitations by the subcategory 3 floor area and by the number of hours worked each day in subcategory 3. Table 9-13 shows how the subcategory 5 maximum allowable discharges are calculated by multiplying the subcategory 5 effluent limitations by the subcategory 5 floor area and by the number of hours worked each day in subcategory 5. Table 9-14 shows how the subcategory 7 maximum allowable discharges are calculated by multiplying the subcategory 7 effluent limitations by the subcategory 7 floor area and by the number of hours worked each day in subcategory 7. Table 9-15 shows how the plant maximum allowable discharges are calculated by adding the subcategory maximum allowable discharges (from Tables 9-12, 9-13, and 9-14). Table 9-16 shows the resulting comparison between the actual pollutant discharges (from Table 9-11) and the maximum allowable pollutant discharges (from Table 9-15). All of the actual discharges are less than the maximum allowable discharges, and the plant is, therefore, in compliance with the effluent limitations.

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TABLE 9-10

EXAMPLE 3 PLANT DATA

Manufacturing Description: Production and assembly of painted stampings

Plant Average Effluent Discharge: 320,000 liters per day for Subcategories 3, 5, and 7

Subcategory:	3	5	7
Manufacturing Process:	Material Forming	Assembly Operations	Material Coating
Production Floor Area (sq m):	20,000	21,000	5,000
Hours Worked Per Day:	16	8	16

Plant Effluent Pollutant Parameter Concentrations (30 Day Average)

Parameter	Concentration
pH	6.7
Total Suspended Solids	23.0 mg/l
Cadmium	0.013 mg/l
Chromium, Hexavalent	0.02 mg/l
Chromium, Total	0.07 mg/l
Copper	0.34 mg/l
Fluoride	1.1 mg/l
Iron	1.2 mg/l
Lead	0.06 mg/l
Mercury	0.004 mg/l
Nickel	0.09 mg/l
Oil and Grease	12.5 mg/l
Chemical Oxygen Demand	56.0 mg/l
Phosphate	2.2 mg/l
Silver	0.005 mg/l
Zinc	0.9 mg/l

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TABLE 9-11

EXAMPLE 3 POLLUTANT DISCHARGE CALCULATIONS

$$\text{Plant Actual Pollutant Discharge (g/day)} = \text{Concentration (mg/l)*} \times \frac{\text{Plant Average Effluent Discharge (l/day)}}{\text{1,000 (mg/g)}}$$

Parameter	Actual Plant Pollutant Discharge (g/day)
Suspended Solids	23 x 320,000/1,000 = 7,360
Cadmium	0.013 x 320,000/1,000 = 4.16
Chromium, Hexavalent	0.02 x 320,000/1,000 = 6.40
Chromium, Total	0.07 x 320,000/1,000 = 22.4
Copper	0.34 x 320,000/1,000 = 108.8
Fluoride	1.1 x 320,000/1,000 = 352
Iron	1.2 x 320,000/1,000 = 384
Lead	0.06 x 320,000/1,000 = 19.2
Mercury	0.004 x 320,000/1,000 = 1.28
Nickel	0.09 x 320,000/1,000 = 28.8
Oil & Grease	12.5 x 320,000/1,000 = 4,000
Chemical Oxygen Demand	56 x 320,000/1,000 = 17,920
Phosphate	2.2 x 320,000/1,000 = 704
Silver	0.005 x 320,000/1,000 = 1.6
Zinc	0.9 x 320,000/1,000 = 288

*From Table 9-10

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

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TABLE 9-12

EXAMPLE 3 SUBCATEGORY 3 MAXIMUM ALLOWABLE DISCHARGE CALCULATIONS

$$\text{Plant Maximum Allowable Pollutant Discharge (g/day)} = \text{Effluent Limitation (mg/hr-sq m)}^{*} \times \frac{\text{Production Floor Area (sq m)}^{**}}{\text{1,000 (mg/g)}} \times \text{Production Time (hr/day)}^{**}$$

Parameter	Effluent Limitations mg/hr-sq m	Subcategory 3 Maximum Allowable Discharge (g/day)
Suspended Solids	9.2	9.2 x 20,000/1,000 x 16 = 2,944
Copper	0.18	0.18 x 20,000/1,000 x 16 = 57.6
Iron	0.32	0.32 x 20,000/1,000 x 16 = 102.4
Lead	0.032	0.032 x 20,000/1,000 x 16 = 10.24
Nickel	0.12	0.12 x 20,000/1,000 x 16 = 38.4
Oil & Grease	7.1	7.1 x 20,000/1,000 x 16 = 2,272
Chemical Oxygen Demand	53.0	53.0 x 20,000/1,000 x 16 = 16,960
Phosphate	0.79	0.79 x 20,000/1,000 x 16 = 2,528
Silver	0.002	0.002 x 20,000/1,000 x 16 = 0.64
Zinc	1.6	1.6 x 20,000/1,000 x 16 = 512.0

* From Table 9-1
**From Table 9-10

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

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TABLE 9-13

EXAMPLE 3 SUBCATEGORY 5 MAXIMUM ALLOWABLE DISCHARGE CALCULATIONS

$$\text{Plant Maximum Allowable Pollutant Discharge (g/day)} = \text{Effluent Limitation (mg/hr-sq m)*} \times \frac{\text{Production Floor Area (sq m)**}}{\text{1,000 (mg/g)}} \times \text{Production Time (hr/day)**}$$

Parameter	Effluent Limitations mg/hr-sq m	Subcategory 5 Maximum Allowable Discharge (g/day)
Suspended Solids	2.7	2.7 x 21,000/1,000 x 8 = 453.6
Cadmium	0.003	0.003 x 21,000/1,000 x 8 = 0.5
Copper	0.014	0.014 x 21,000/1,000 x 8 = 2.35
Fluoride	0.42	0.42 x 21,000/1,000 x 8 = 70.6
Iron	0.25	0.25 x 21,000/1,000 x 8 = 42.0
Lead	0.01	0.01 x 21,000/1,000 x 8 = 1.68
Mercury	0.003	0.003 x 21,000/1,000 x 8 = 0.5
Nickel	0.057	0.057 x 21,000/1,000 x 8 = 9.58
Oil & Grease	3.0	3.0 x 21,000/1,000 x 8 = 504.0
Chemical Oxygen Demd	16.0	16.0 x 21,000/1,000 x 8 = 2,688
Phosphate	0.15	0.15 x 21,000/1,000 x 8 = 25.2
Silver	0.001	0.001 x 21,000/1,000 x 8 = 0.17
Zinc	0.14	0.14 x 21,000/1,000 x 8 = 23.52

* From Table 9-1
**From Table 9-10

NOTICE These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

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TABLE 9-14

EXAMPLE [illegible] SUBCATEGORY 7 MAXIMUM ALLOWABLE DISCHARGE CALCULATIONS

Plant Maximum Allowable Pollutant Discharge (g/day) = Effluent Limitation (mg/hr-sq m)* x $\frac{\text{Production Floor Area (sq m)**}}{\text{1,000 (mg/g)}}$ x Production Time (hr/day)**

Parameter	Effluent Limitations mg/hr-sq m	Subcategory 7 Maximum Allowable Discharge (g/day)
Suspended Solids	59	59 x 5,000/1,000 x 16 = 4,720
Cadmium	0.048	0.048 x 5,000/1,000 x 16 = 3.84
Chromium, Hexavalent	0.10	0.10 x 5,000/1,000 x 16 = 8.0
Chromium, Total	1.3	1.3 x 5,000/1,000 x 16 = 104.0
Copper	0.66	0.66 x 5,000/1,000 x 16 = 52.8
Fluoride	10	10 x 5,000/1,000 x 16 = 800.0
Iron	3.2	3.2 x 5,000/1,000 x 16 = 256.0
Lead	0.12	0.12 x 5,000/1,000 x 16 = 9.6
Mercury	0.012	0.012 x 5,000/1,000 x 16 = 0.96
Oil & Grease	17	17 x 5,000/1,000 x 16= 1,360
Chemical Oxygen Demand	165	165 x 5,000/1,000 x 16 = 13,200
Phosphate	9.1	9.1 x 5,000/1,000 x 16 = 728.0
Silver	0.013	0.013 x 5,000/1,000 x 16 = 1.04
Zinc	1.3	1.3 x 5,000/1,000 x 16 = 104.0

* From Table 9-[illegible]
** From Table [illegible]

NOTICE: These are tentative recommendations based upon [illegible] report and are subject to change based upon comments received [illegible] review by EPA.

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TABLE 9-15

EXAMPLE 3 PLANT MAXIMUM ALLOWABLE DISCHARGE CALCULATIONS

Maximum Allowable Discharge (g/day) = Subcategory 3 Maximum Allowable Pollutant Discharge (g/day)* + Subcategory 5 Maximum Allowable Pollutant Discharge (g/day)** + Subcategory 7 Maximum Allowable Pollutant Discharge (g/day)***

Parameter	Plant Maximum Allowable Discharge (g/day)						
Suspended Solids	2,944	+	453.6	+	4,720	=	8,118
Cadmium			0.5	+	3.84	=	4.34
Chromium, Hexavalent					8.0	=	8.0
Chromium, Total					104.0	=	104.0
Copper	57.6	+	2.35	+	52.8	=	112.8
Fluoride			70.6	+	800.0	=	870.6
Iron	102.4	+	42.0	+	256.0	=	400.4
Lead	10.24	+	1.68	+	9.6	=	21.52
Mercury			.05	+	0.96	=	1.46
Nickel	38.4	+	9.58			=	47.98
Oil & Grease	2,272	+	504.0	+	1,360	=	4,136
Chemical Oxygen Demand	16,960	+	2,688	+	13,200	=	32,848
Phosphate	252.8	+	25.2	+	728	=	1,006
Silver	0.64	+	0.17	+	1.04	=	1.85
Zinc	512.0	+	23.52	+	104.0	=	639.5

* From Table 9-12
** From Table 9-13
***From Table 9-14

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

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TABLE 9-16

EXAMPLE 3 COMPLIANCE COMPARISON

Parameter	Plant Actual Pollutant Discharge*	Plant Maximum Allowable Pollutan Discharge**
pH	6.7	6 to 9
Total Suspended Solids	7,360 g/day	8,118 g/day
Cadmium	4.16 g/day	4.34 g/day
Chromium, Hexavalent	6.40 g/day	8.0 g/day
Chromium, Total	22.4 g/day	104.0 g/day
Copper	108.8 g/day	112.8 g/day
Fluoride	352 g/day	870.6 g/day
Iron	384 g/day	400.4 g/day
Lead	19.2 g/day	21.52 g/day
Mercury	1.28 g/day	1.46 g/day
Nickel	28.8 g/day	47.98 g/day
Oil & Grease	4,000 g/day	4,136 g/day
Chemical Oxygen Demand	17,920 g/day	32,848 g/day
Phosphate	704 g/day	1,006 g/day
Silver	1.6 g/day	1.85 g/day
Zinc	288 g/day	639.5 g/day

*From Table 9-11
**From Table 9-15

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

Example 4: Multiple Subcategory Plant, with Zero Effluent Discharge in Some Subcategories - In this example, the plant under consideration has four manufacturing subcategories, but only three of these subcategories have an end-of-pipe discharge. Subcategory 1 has no effluent discharge due to contract removal of concentrated waste. This zero discharge subcategory is allowed no pollutant discharge and is, therefore, treated as if it did not exist. Therefore, all of the pollutants are attributed to the three discharging subcategories, and these three subcategories are treated exactly as they were in Example 3.

Table 9-17 presents pertinent plant data including number of hours worked per day for each subcategory, production floor area for each subcategory, the total quantity of wastewater discharged each day, and actual effluent concentrations for pollutants with Subcategory 3, 5, or 7 effluent limitations. The calculation results are identical with those performed in Example 3, and the plant is, therefore, in compliance with the effluent limitations.

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TABLE 9-17

EXAMPLE 4 PLANT DATA

Manufacturing Description: Production and assembly of castings and painted stampings

Plant Average Effluent Discharge: 320,000 liters per day from Subcategories 3, 5, and 7

Subcategory:	1	3	5	7
Manufacturing Process:	Casting and Molding - Metals	Material Forming	Assembly Operations	Material Coating
Production Floor Area (sq m):	40,000	20,000	21,000	5,000
Hours Worked Per Day:	16	16	8	16

Plant Effluent Pollutant Parameter Concentrations (30 Day Average)

Parameter	Concentration
pH	6.7
Total Suspended Solids	23.0 mg/l
Cadmium	0.013 mg/l
Chromium, Hexavalent	0.02 mg/l
Chromium, Total	0.07 mg/l
Copper	0.34 mg/l
Fluoride	1.1 mg/l
Iron	1.2 mg/l
Lead	0.06 mg/l
Mercury	0.004 mg/l
Nickel	0.09 mg/l
Oil and Grease	12.5 mg/l
Chemical Oxygen Demand	56.0 mg/l
Phosphate	2.2 mg/l
Silver	0.005 mg/l

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Example 5: Plant with Multiple Subcategories Partially Covered by Other Effluent Limitations - The plant in this example consists of two manufacturing subcategories. The effluent limitations promulgated for the Electroplating and Metal Finishing Point Source Category apply to Subcategory 6 of this plant. The example is carried out in six steps. Table 9-18 presents pertinent plant data including number of hours worked per day for each subcategory, production floor area for each subcategory, the total quantity of wastewater discharged each day, and effluent concentrations for pollutants covered by Subcategory 3 effluent limitations. Table 9-19 shows how actual pollutant discharges are calculated by multiplying the pollutant concentrations by the quantity of wastewater discharged each day. Table 9-20 shows how the Subcategory 3 maximum allowable discharges are calculated by multiplying the Subcategory 3 effluent limitations by the Subcategory 3 floor area and by the number of hours worked each day in Subcategory 3. The Subcategory 6 maximum allowable pollutant discharges are calculated based on the instructions in the Development Document for the Electroplating and Metal Finishing Point Source Category (the method of calculation is described in that document and is not shown here). Table 9-21 shows how the plant maximum allowable discharges are calculated by adding the maximum allowable discharges (from Table 9-18 and 9-20). Table 9-22 shows the resulting comparison between the actual pollutant discharges (from Table 9-19) and the maximum allowable discharges (from Table 9-21). All of the actual discharges are less than the maximum allowable pollutant discharges, and the plant is, therefore, in compliance with the effluent limitations.

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TABLE 9-18

EXAMPLE 5 PLANT DATA

Manufacturing Description:	Production of plated stampings	
Plant Average Effluent Discharge:	100,000 liters per day from Subcategories 3 and 6	
Subcategory:	3	6
Manufacturing Process:	Material Forming	Electroplating*
Production Floor Area (sq m):	20,000	10,000
Hours Worked Per Day:	8	8

Plant Effluent Pollutant Parameter Concentrations (30 Day Average)

Parameter	Concentration
pH	7.9
Total Suspended Solids	13.3 mg/l
Copper	0.5 mg/l
Iron	0.5 mg/l
Lead	0.05 mg/l
Nickel	0.18 mg/l
Oil and Grease	9.0 mg/l
Chemical Oxygen Demand	38.0 mg/l
Phosphate	1.2 mg/l
Silver	0.003 mg/l
Zinc	0.92 mg/l

*Electroplating is not covered by the Machinery and Mechanical Products Manufacturing industries effluent limitations (refer to Section IV of this report). Effluent limitations should be determined using the procedures for the Electroplating and Metal Finishing industries.

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TABLE 9-19

EXAMPLE 5 POLLUTANT DISCHARGE CALCULATIONS - SUBCATEGORY 3

$$\text{Plant Actual Pollutant Discharge (g/day)} = \text{Concentration (mg/l)*} \times \frac{\text{Plant Average Effluent Discharge (l/day)}}{\text{1,000 (mg/g)}}$$

Parameter	Actual Plant Pollutant Discharge (g/day)
Total Suspended Solids	13.3 x 100,000/1,000 = 1,330
Copper	0.5 x 100,000/1,000 = 50.0
Iron	0.5 x 100,000/1,000 = 50.0
Lead	0.5 X 100,000/1,000 = 5.0
Nickel	0.18 x 100,000/1,000 = 18.0
Oil & Grease	9.0 x 100,000/1,000 = 900
Chemical Oxygen Demand	38.0 x 100,000/1,000 = 3,800
Phosphate	1.2 x 100,000/1,000 = 120
Silver	0.003 x 100,000/1,000 = 0.3
Zinc	0.92 x 100,000/1,000 = 92

*From Table 9-18

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

TABLE 9-20

EXAMPLE 5 SUBCATEGORY 3 MAXIMUM ALLOWABLE DISCHARGE CALCULATIONS

$$\text{Plant Maximum Allowable Pollutant Discharge (g/day)} = \text{Effluent Limitation (mg/hr-sq m)*} \times \frac{\text{Production Floor Area (sq m)**}}{1{,}000 \text{ (mg/g)}} \times \text{Production Time (hr/day)**}$$

Parameter	Effluent Limitations mg/hr-sq m	Subcategory 3 Maximum Allowable Discharge (g/day)
Total Suspended Solids	9.2	9.2 x 20,000/1,000 x 8 = 1,472
Copper	0.18	0.18 x 20,000/1,000 x 8 = 28.8
Iron	0.32	0.32 x 20,000/1,000 x 8 = 51.2
Lead	0.032	0.032 x 20,000/1,000 x 8 = 5.12
Nickel	0.12	0.12 x 20,000/1,000 x 8 = 19.2
Oil & Grease	7.1	7.1 x 20,000/1,000 x 8 = 1,136
Chemical Oxygen Demand	53.0	53.0 x 20,000/1,000 x 8 = 8,480
Phosphate	0.79	0.79 x 20,000/1,000 x 8 = 126.4
Silver	0.002	0.002 x 20,000/1,000 x 8 = 0.32
Zinc	1.6	1.6 x 20,000/1,000 x 8 = 256.0

* From Table 9-1
**From Table 9-18

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Subcategory 6 Maximum Allowable Discharge***

Parameter	Maximum Allowable Discharge (g/day)
Total Suspended Solids	960
Copper	320
Nickel	320
Zinc	320

***Calculation method not shown as determined from Electroplating Point Source Category effluent limitations.

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TABLE 9-21

EXAMPLE 5 PLANT MAXIMUM ALLOWABLE DISCHARGE CALCULATIONS

Plant Maximum Allowable Pollutant Discharge (g/day) = Subcategory 3 Maximum Allowable Pollutant Discharge (g/day)* + Subcategory 6 Maximum Allowable Pollutant Discharge (g/day)*

Parameter	Plant Maximum Allowable Discharge (g/day)				
Total Suspended Solids	1,472	+	960	=	2,432
Copper	28.8	+	320	=	348.8
Iron	51.2	+	0	=	51.2
Lead	5.12	+	0	=	5.12
Nickel	19.2	+	320	=	339.2
Oil & Grease	1,136	+	0	=	1,136
Chemical Oxygen Demand	8,480	+	0	=	8,480
Phosphate	126.4	+	0	=	126.4
Silver	0.32	+	0	=	0.32
Zinc	256.0	+	320	+	576

*From Table 9-20

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TABLE 9-22

EXAMPLE 5 COMPLIANCE COMPARISON

Parameter	Plant Actual Pollutant Discharge*	Plant Maximum Allowable Pollutant Discharge**
pH	7.9	6 to 9
Total Suspended Solids	1,330 g/day	2,432 g/day
Copper	50.0 g/day	348.8 g/day
Iron	50.0 g/day	51.2 g/day
Lead	5.0 g/day	5.12 g/day
Nickel	18.0 g/day	339.2 g/day
Oil & Grease	900 g/day	1,136 g/day
Chemical Oxygen Demand	3,800 g/day	8,480 g/day
Phosphate	120 g/day	126.4 g/day
Silver	0.30 g/day	0.32 g/day
Zinc	92 g/day	576 g/day

*From Table 9-19
**From Table 9-21

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SECTION X

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

EFFLUENT LIMITATIONS

INTRODUCTION

Level II effluent limitations are based on performance using the best available technology economically achievable (BAT). That is, they are based on performance of the very best plant or other practical demonstration of the technology. The BAT limitations are to be implemented by 1983.

This section of the report lists and provides the rationale for the effluent limitations, reviews BAT, discusses application of the limitations to individual plants, and estimates the overall economic impact of the limitations.

APPLICABILITY

The BAT effluent limitations are applicable to all of the Machinery and Mechanical Product Manufacturing subcategories as defined in Section IV of this document. The limitations apply to direct contact process water discharging into navigable waters. The control and treatment technology capable of achieving the BAT limitations is described in Section VII. The cost to individual plants for achieving the limitations for each subcategory is covered in Section VIII.

BAT EFFLUENT LIMITATIONS

With one exception, the Level II effluent limitations are uniform for all subcategories of the Machinery and Mechanical Products Manufacturing Point Source Category. The limitation is no discharge of pollutants for both the thirty-day average and the single-day maximum limitation. For Dockside Shipbuilding Activities, the recommended Level II regulation is that the entire work area must be cleaned by vacuum cleaning to remove loose shot, paint, scale, oil spills and other debris before flooding a graving dock or submerging a floating drydock.

RATIONALE FOR SELECTION OF BAT

By definition, BAT effluent limitations are "...not based upon an average of the best performance within an industrial category, but are to be determined by indentifying the very best control and treatment technology employed by a specific point source within the industrial category or subcategory". However, a large number of plants satisfy the no-discharge limitations at the present time. This is achieved either by use of manufacturing processes that do not require water, by recycle of wastewaters, or by contract removal of concentrated waterborne wastes. Some plants achieve no discharge through the use of advanced

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technology. Table 10-1 summarizes by subcategory the percentage and number of plants that have no point source discharge as estimated from the project data base. Table 10-2 lists specific plants contacted which have no pollutant discharge in Subcategories 1 through 7 and 9. The general reasons for no pollutant discharge are also noted. The list of plants illustrates that, with proper consideration, many plants are able to achieve BAT today.

At the present time in Subcategory 8, Smelting and Refining of Nonferrous Metals, there is only one plant in our survey which had no pollutant discharge; however, several plants were recycling a large portion of the process water. With the application of the BAT techniques noted in Section VII, all plants will be able to achieve BAT limitations as required.

Because the BPT effluent limitation for Subcategory 9, Molding and Forming - Plastics, is no discharge of pollutants, BAT requirements for this subcategory remain the same as BPT.

The effluent limitation for Subcategory 10, Film Sensitizing, and Subcategory 12, Lead Acid Battery Manufacture, is also no discharge of pollutants on the basis that the technology used to obtain no discharge of pollutants for Subcategories 1 through 9 is directly applicable and has been adequately demonstrated. It should also be noted that one plant in Subcategory 12 is now implementing waste treatment plant changes that will be completed in July 1975 which will result in no effluent discharge.

The recommended BAT regulation for Subcategory 11, Dockside Shipbuilding Activities, is that the entire work area must be cleaned by vacuum cleaning to remove loose shot, paint, scale, oil spills, and other debris before flooding or submerging the work area. The means for implementing this regulation are well within the technology currently available.

APPLICATION OF BAT

Introduction

BAT may be represented by any of several techniques that tend to eliminate end-of-pipe pollutant discharge. When these techniques are effectively combined into a system, the result is practical achievement of no pollutant discharge. Systems that approach or achieve no pollutant discharge use one or more of the following techniques:

- Pollutant Reduction or Elimination
- Water Use Reduction or Elimination
- In-Plant Water Reuse
- Wastewater Reclamation and Reuse
- Contract Removal

Figure 10-1 represents an overview of a water reclamation system to achieve no discharge of pollutants. The box at the left-hand side of Figure 10-1 represents the plant and its manufacturing subcategories and the in-plant techniques for achieving no pollutant discharge. The balance of the figure is a generalized representation of wastewater

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TABLE 10-1

NO POINT SOURCE PLANT SUBCATEGORY DISCHARGE LIST

Subcategory	Percent of Plants With No Point Source Discharge*	Number of Plants With No Point Source Discharge*
1 - Casting and Molding - Metals	89.7	10,753
2 - Mechanical Material Removal	82.5	65,742
3 - Material Forming - All Materials Except Plastics	97.3	61,632
4 - Physical Property Modification	93.2	30,557
5 - Assembly Operations	95.2	84,076
6 - Chemical-Electrochemical Operations	22.5	6,943
7 - Material Coating	83.2	45,453
8 - Smelting and Refining of Nonferrous Metals	66.7	527
9 - Molding and Forming - Plastics	92.2	13,020
10 - Film Sensitizing	0	0
11 - Dockside Shipbuilding Activities	Not Applicable	
12 - Lead Acid Battery Manufacture	0	1**

*Data based on a random telephone survey using Department of Commerce plant data base. Data includes multi-subcategory plants.

**To be implemented by July 1975.

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TABLE 10-2

PLANT PROCESS WATER EVALUATION

SUBCATEGORY: 1-CASTING AND MOLDING-METALS

Reasons for no discharge:
- Process does not require contact process water
- Coolant water is recycled
- Air scrubbing water is recycled

Plants With No Point Source Discharge			
17	368	511	715
45	369	520	717
53	371	532	741
100	372	537	799
120	376	542	803
132	380	543	835
140	392	558	942
194	398	612	975
235	427	647	1497
357	447	687	
359	464	689	
363	482	694	

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TABLE 10-2 (cont.)

PLANT PROCESS WATER EVALUATION

SUBCATEGORY: 2-MECHANICAL MATERIAL REMOVAL

Reasons for no discharge:

- Process does not require contact process water
- Coolant fluid is recycled
- Expended fluid is disposed of by contractor, incineration or reclaimed
- Process fluid is recycled by use of an advanced technology (R.O.-Ion exchange)

Plants With No Point Source Discharge									
5	69	143	276	366	464	532	624	739	955
8	74	149	282	368	475	535	625	749	958
12	78	153	287	370	476	537	656	756	961
15	88	158	300	372	514	543	664	786	970
25	100	171	304	376	515	549	665	787	975
26	108	177	321	380	518	552	678	803	981
30	109	180	339	382	519	569	687	826	983
46	111	182	342	387	520	590	694	923	1017
53	116	221	345	392	521	598	700	928	1495
54	118	223	356	394	525	602	715	929	
59	125	225	357	404	526	606	717	948	
61	132	242	359	410	529	617	727	949	
64	140	246	365	429	531	618	732	954	

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TABLE 10-2 (cont.)

PLANT PROCESS WATER EVALUATION

SUBCATEGORY: 3-MATERIAL FORMING
ALL MATERIALS EXCEPT PLASTICS

Reasons for no discharge:

- Process does not require contact process water
- Coolant fluid is recycled
- Expended fluid is disposed of by contractor, incineration or reclaimed
- Process fluid is recycled by use of an advanced technology (R.O.-Ion exchange)

Plants With No Point Source Discharge											
5	58	132	214	278	339	378	475	539	623	713	932
7	64	140	217	282	343	388	476	543	624	715	940
11	70	141	221	283	345	392	511	549	625	721	942
12	74	143	222	286	356	399	514	552	656	739	948
15	88	144	223	287	359	404	515	558	665	741	949
17	100	149	224	298	360	410	520	561	677	749	954
25	110	153	225	300	361	413	521	569	678	755	958
26	111	177	229	301	365	425	529	579	679	756	961
29	118	182	234	310	366	429	531	590	687	786	967
34	120	193	235	311	368	431	532	602	689	826	968
45	121	194	242	324	374	447	537	612	707	835	969
53	131	195	246	336	376	464	538	618	712	829	975
										983	1496

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TABLE 10-2 (cont.)

PLANT PROCESS WATER EVALUATION

SUBCATEGORY: 4-PHYSICAL PROPERTY MODIFICATION

Reasons for no discharge:
- Process does not require contact process water
- Coolant fluid is recycled
- Air scrubbing water is recycled
- Expended fluid is disposed of by contractor, incineration or reclaimed

Plants With No Point Source Discharge									
6	59	144	278	357	388	511	624	741	976
7	61	149	282	359	391	514	625	749	1110
8	70	153	296	360	392	515	654	756	
12	74	171	298	361	410	521	665	803	
15	88	182	300	365	413	533	678	826	
17	100	193	301	366	416	537	679	835	
25	108	214	310	371	425	539	687	929	
29	118	217	324	372	431	542	700	932	
34	125	221	336	374	446	543	713	942	
41	136	225	339	382	475	552	721	949	
50	140	235	342	383	476	569	727	954	
54	141	248	345	387	482	612	732	970	

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TABLE 10-2 (cont.)

PLANT PROCESS WATER EVALUATION

SUBCATEGORY: 5-ASSEMBLY OPERATIONS

Reasons for no discharge:

- Process does not require contact process water
- Coolant fluid is recycled
- Expended fluid is disposed of by contractor, incineration or reclaimed
- Process fluid is recycled by use of an advanced technology (R.O.-Ion exchange)

Plants With No Point Source Discharge												
5	50	144	225	339	379	416	533	590	678	786	951	149[illegible]
6	53	149	234	345	382	427	535	598	679	799	954	
7	61	153	241	347	383	437	537	602	682	835	955	
11	64	158	246	356	384	465	538	609	687	923	958	
12	88	177	278	357	387	511	539	612	698	928	961	
15	100	180	282	359	388	514	543	618	707	929	967	
17	108	193	286	360	390	515	548	621	715	931	969	
25	110	194	300	365	392	518	550	624	717	932	974	
26	111	195	301	366	398	519	552	625	737	934	975	
29	116	214	304	368	399	525	558	647	739	940	981	
30	118	217	310	369	404	526	561	654	741	941	983	
34	121	221	321	370	409	529	569	656	749	942	1017	
41	140	222	324	371	410	531	572	665	755	943	1110	
45	143	223	336	372	413	532	579	677	756	949	1495	

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TABLE 10-2 (cont.)

PLANT PROCESS WATER EVALUATION

SUBCATEGORY: 6-CHEMICAL-ELECTROCHEMICAL OPERATIONS

Reasons for no discharge:
- Expended fluid is disposed of by contractor, incineration or reclaimed
- Process fluid is recycled by use of an advanced technology (R.O.-Ion exchange)
- Air scrubbing water is recycled

Plants With No Point Source Discharge			
8	431	526	732
371	477	712	803
410	518	721	983

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TABLE 10-2 (cont.)

PLANT PROCESS WATER EVALUATION

SUBCATEGORY: 7-MATERIAL COATING

Reasons for no discharge:

- Process does not require contact process water
- Process fluid is recycled
- Expended fluid is disposed of by contractor, incineration or reclaimed
- Process fluid is recycled by use of an advanced technology (R.O.-Ion exchange-ultrafiltration)

Plants With No Point Source Discharge						
1	100	241	370	533	704	836
5	111	278	382	548	715	923
7	116	301	383	561	721	934
8	118	304	390	564	737	949
15	136	310	427	602	739	951
25	140	324	431	612	741	954
30	144	336	514	618	749	955
45	149	342	515	624	756	958
58	153	356	520	625	786	966
64	182	360	525	654	799	968
74	214	365	526	664	826	975
78	221	366	531	687	833	981
88	222	369	532	698	835	983

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TABLE 10-2 (cont.)

PLANT PROCESS WATER EVALUATION

SUBCATEGORY: 9-MOLDING AND FORMING-PLASTICS

Reasons for no discharge:
- Process does not require contact process water
- Process fluid is recycled

Plants With No Point Source Discharge		
1	224	535
12	254	538
30	282	567
64	283	632
67	356	646
79	366	707
131	368	712
136	388	755
144	397	924
153	404	940
180	515	975
193	519	978
214	520	1495

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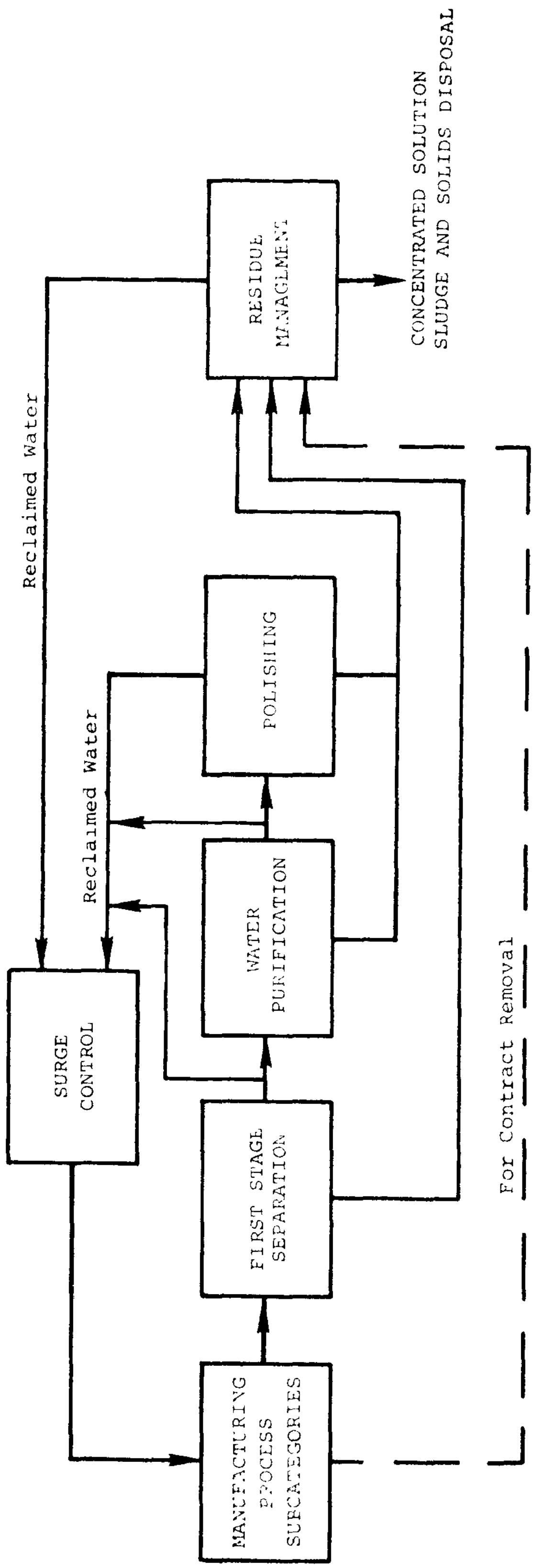

WATER RECLAMATION OVERVIEW

FIGURE 10-1

These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

reclamation systems. The first stage separation step represents separation of water from pollutants by means of BPT. Water recycled directly from this step should be of a quality adequate for about 60 percent of the water consuming operations at a typical plant. Plant No. 924 is an example of a plant which satisfies 60 percent of its water needs by recycling effluent water. The step labeled Water Purification in Figure 10-1 represents advanced techniques which, together with the polishing operation, generate water adequate for reuse anywhere in a plant. Residues or concentrates from these processes have additional water removed in the residue management step. The resulting dry or semidry residue is removed by a licensed contractor or used for landfill. Surge control is provided by adequate retention time in a holding tank or lagoon. This permits continued operation even if the manufacturing processes or waste treatment facility is temporarily inoperative or upset.

Figure 10-2, Water Reclamation Alternatives, is a more detailed version of the overview showing specific alternative techniques for achieving each step in the reclamation process. Although cost is a factor, selection of techniques should be based mainly on which ones are technically most appropriate for the characteristics of the manufacturing process and of the waste stream.

The left-hand block in Figure 10-2 represents both the manufacturing process subcategories within the plant and the six techniques that may be used either singly or in combination, as appropriate, to achieve no discharge of pollutants. Techniques that may extend outside the immediate manufacturing area are shown in expanded form on the balance of the diagram.

The first stage separation step represents use of conventional equipment to separate water from the pollutants it contains. The terms "filtration", "flocculation/clarification", and "oil separation" represent both the main processing step and any auxiliary operations. For example, if the wastewater contains an emulsified oil, "oil separation" may include both addition of heat and chemicals to break the emulsion and removal of the resulting oil layer by decantation. Each technology includes many variations in chemicals and/or equipment, and these technologies may be used either singly or in combination, as appropriate.

The water purification technologies are the key to water reuse for two reasons. First, they produce a permeate stream of adequate quality (with appropriate polishing) for any potential reuse application. Second, they reduce the quantity of polluted wastewater requiring further treatment by a factor of ten or more. Reverse osmosis separates dissolved salts from the reclaimed water, and ultrafiltration separates emulsions such as oils and paints.

The reclaimed water stream from the water purification step is often "polished" to remove minor impurities. The most common techniques are adsorption on charcoal and ion exchange. Adsorption is used mainly to remove organic impurities such as emulsifying agents from the reclaimed water. Ion exchange may be used specifically to remove traces of heavy

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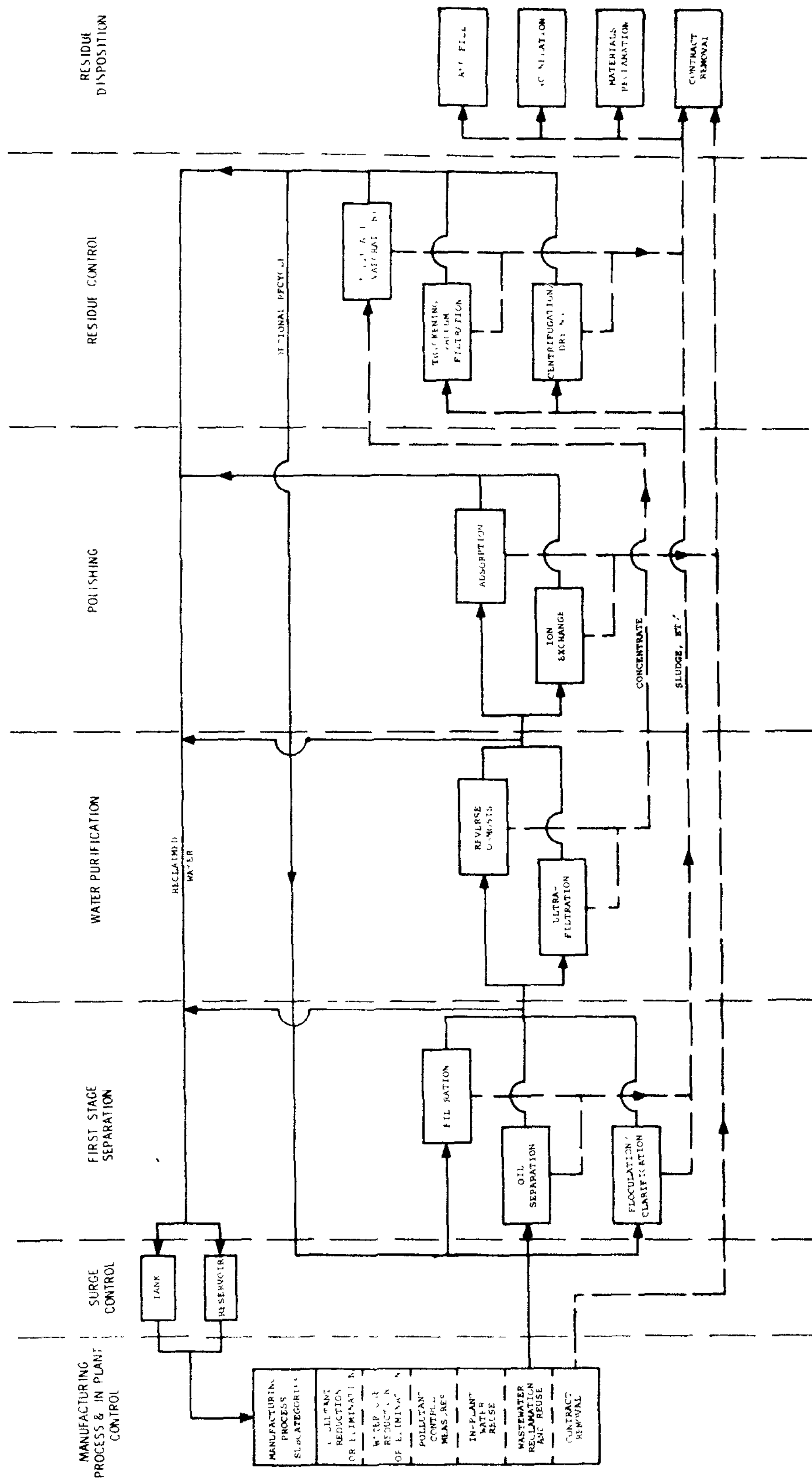

FIGURE 10-2
WATER RECLAMATION ALTERNATIVES

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metals, but its more general application is generation of deionized water for final rinses in the manufacturing process.

Sludge from the first stage separation step or concentrate from the water purification step is dewatered in the residue control step. Thickening followed by vacuum filtration is the most common of the techniques shown. The separated water is often recycled to the clarifier. Use of centrifugation is much less common, but it is increasing. Distillation to evaporate nearly all of the water from the residue is accomplished in a few plants within the Machinery and Mechanical Products Manufacturing Category. It requires a wiped-film evaporator, more usually found in other industries.

Residues, concentrates, or even raw wastewater may be treated for recovery of useful constituents or it may be disposed of by landfill, incineration, or contract removal, as appropriate. Landfill is used for nearly dry insoluble residues such as metal hydroxides. Incineration is used for organic concentrates such as oils. Materials reclamation may recover either metals or processing chemicals. Contract removal is used for everything from raw wastewater to dry residue.

Many variations on the illustrated schematic arrangement are possible. For example, ultrafiltration and reverse osmosis may be used together in series instead of one or the other alone.

The paragraphs to follow give specific examples of how some of these techniques are used to achieve no discharge of pollutants in existing plants today.

Pollutant Reduction or Elimination

The first step in achieving no discharge of pollutants is pollutant reduction or elimination, because it may simplify the overall wastewater treatment process. For example, the following chemical agents or processes may be used in place of existing ones:

Nonphosphate cleaners
Nonchromium dips and pickles
Noncyanide plating and stripping solutions
Nonoily forming lubricants

Each of these techniques is in actual full-production use at this time. For example, nonphosphate acidic cleaners are used at Plant Number 924. Although the acid is a potential pollutant, it is easily neutralized, and the resulting salt is separated and landfilled. This plant also substitutes a hydrogen peroxide pickling solution for chromic acid and uses a noncyanide (alkaline or acid chloride) plating solution. This plant also uses a "dry coat" forming lubricant (a soap-borax solution) instead of an emulsified oil. Since the manufacturing operations at this plant are very typical of those at thousands of other plants, the pollutant elimination techniques are broadly applicable.

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Water Use Reduction or Elimination

Pollution rate generally depends on the quantity of wastewater treated because effluent concentrations from exemplary plants tend to be relatively uniform. This uniformity results both from the dependency of the wastewater treatment process driving force on concentration and from regulations requiring control of effluent wastewater to recognized maximum limits. Thus, if the quantity of water used is minimized, the quantity of wastewater treated is reduced as is the quantity of pollutant discharged. Water use reduction also decreases treatment costs.

Water usage reduction in rinsing can be achieved by means of (1) minimum effective rinse flow rates, (2) automatic control of water addition, (3) counterflow, multiple tank rinsing, (4) spray rinsing, (5) chemical rinsing, and (6) rinse water agitation. Minimum effective flow rates are determined by reducing rinse water rates until a further reduction would cause manufacturing problems. Sometimes required rinse water flow rates are variable and can be automatically controlled to a variable minimum through continuous measurement of rinse water purity. Counterflow multiple tank rinsing, practiced in many plants, can easily decrease water usage by a factor of more than 100. Spray rinsing is often much more efficient than immersion rinsing, minimizing water requirements. Chemical rinsing (use of rinse water containing a treatment chemical such as sodium bisulfite) sometimes makes rinsing more efficient by breaking down the diffusion layer at the workpiece surface. Rinse tank agitation (by impellers, air jets, water jet mixers, or ultrasonic means) produces the same result.

Water usage reduction or elimination is also achieved by a fundamental modification of the manufacturing processes. Examples are reduction of coolant (especially emulsified oils) use by decreasing machining speed; reduction of coolant use by material changes in the cutting tool or workpiece; elimination of machining coolants by use of die casting, molding, or powder metallurgy in place of machining; use of materials that do not require painting or coating; elimination of overspray waterwalls by substitution of electrostatic spray painting; and use of air cooling in place of direct water quenching.

Finally, a simple method of water conservation is turning off the water when it is not needed. Many plants have let water run continuously, even when the manufacturing process or rinse tank is not in operation, because there is little incentive to turn it off. Reducing such waste may require operator retraining or use of automatic shutoff controls.

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Pollutant Control Measures

Dragout minimization and good housekeeping tend to keep process liquids (potential pollutants) where they are used. Dragout is the quantity of active chemical solution carried out of a process tank by an emerging piece of work. It results in the chemical process solution reaching a spent condition sooner (requiring disposal) and increased contamination of rinse water. Dragout is minimized in many plants by: (1) use of low viscosity chemical agents, (2) use of effective wetting agents, (3) low withdrawal velocity, (4) workpiece orientation for maximum drainage, and (5) racking to provide free drainage paths.

Good housekeeping measures also control potential pollutants. These measures include: (1) an inspection and maintenance system that minimizes leakage of process liquids (such as hydraulic oils and machinery lubricants) that become pollutants, (2) minimization of careless waste such as unnecessary paint overspray into a waterwall, (3) steps to minimize spillage, and (4) provision to contain and treat spillage. Examples of the latter item are Plant Number 53, which has floor trenches that carry spills to neutralization and filtration equipment, and Plant Number 926, which uses epoxy-lined underfloor trenches both to carry spills to the waste treatment equipment and to house water transfer lines. In general, provision should be made to contain spills by means of dikes, floor trenches, or wastewater surge ponds.

In-Plant Water Reuse

Treatment and reuse of water-based solutions at the point of use is becoming widespread. Machining coolants are used over and over by means of continuous filtration. Grinding solutions are screened, filtered, and reused. Plant Number 380 is a good example. It has four grinding operations, each with its own grinding fluid recycle system. Used fluid flows by gravity through a magnetic separator into a centrifuge and then to a reservoir. It is pumped from the reservoir through a 0.5 micron filter back to the grinding machine. Based on eight years of operating experience, fluid changes because of contamination are never necessary.

A number of more advanced techniques may be applied in either of two ways. These techniques process contaminated rinse water to generate a pure water stream and a concentrate stream. Depending on the particular application, the concentrate stream may be either reused in the manufacturing process or disposed of in some manner. When the concentrate is reused, the treatment equipment is generally closely coupled with the manufacturing process. Such applications are discussed in the following paragraphs. Applications that generate a nonuseful concentrate are discussed under the next subheading, Wastewater Reclamation and Reuse.

Distillation is applied to reuse of rinse water associated with chemical treatments such as plating and pickling. Contaminated rinse water is evaporated, often under vacuum, in a single or double effect evaporator. The condensate is reused in the rinse tank, while the concentrate returns to the plating or pickling tank to replace drag-out. Equipment of this type from one manufacturer alone is installed at 57 plants, including Plant Numbers 9, 214, 371, 520, 561, 679, 717 and 932 used in the data base for this report.

Wastewater Reclamation and Reuse

Advanced waste treatment concepts have been used independently or as a supplement to existing systems to achieve zero discharge of waste-water. The major techniques are reverse osmosis, ultrafiltration, centrifugation, and distillation. Adsorption and ion exchange are often used in association with these techniques.

Reverse osmosis is used in Plant Numbers 230, 526 and 984. As shown in Figure 10-3, Plant Number 230 uses reverse osmosis in two ways. In the first application, the reverse osmosis unit separates chromic acid from a wastewater stream. The acid stream is polished by an ion exchange unit before reuse in the manufacturing process, and the remaining wastewater is neutralized together with wastewater from other operations. The neutralized wastewater then goes to the second reverse osmosis unit for further purification before reuse in the manufacturing process. The concentrate goes to an evaporator which is described in a later paragraph.

Reverse osmosis is used in a somewhat similar way in Plant Number 526 which is planned to be on line in July 1975. The plant design was based on successful pilot type operations. As shown in Figure 10-4, used rinse water is filtered (in a two-stage cartridge filter) and then enters the reverse osmosis unit. The permeate is polished by adsorption on charcoal before reuse in the manufacturing process. The concentrate goes to an evaporation step, described in a later paragraph.

Figure 10-5 shows reverse osmosis is used for the same purpose as above at Plant Number 984. The only difference is that the concentrate is processed through more conventional equipment. Thus, it is clarified in a decanter, neutralized, and sent to the sewer. With further treatment this water could be recycled, but there was no reason to do so at the time the plant was surveyed. Even so, Plant Number 984 very closely approaches no discharge of pollutants.

Ultrafiltration is used to achieve no discharge of pollutants for two applications in Plant Number 983, as shown in Figure 10-6. One application processes rinse water containing 30 to 40 mg/l emulsified oil from a phosphate washing operation. Ninety-nine percent of the wastewater emerges from the ultrafiltration unit as permeate. Low

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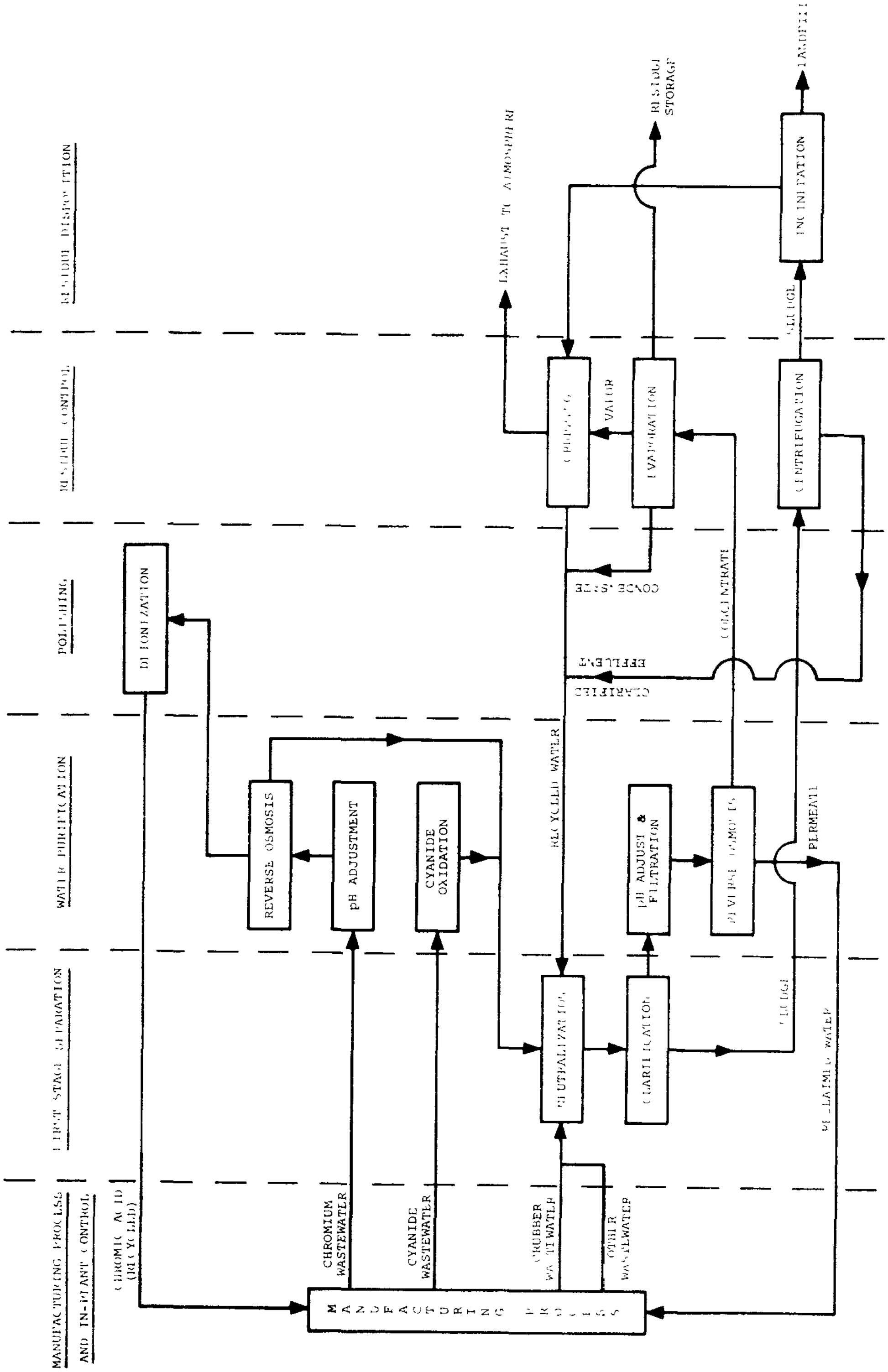

FIGURE 10-3

WATER REUSE AT PLANT NO. 230

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

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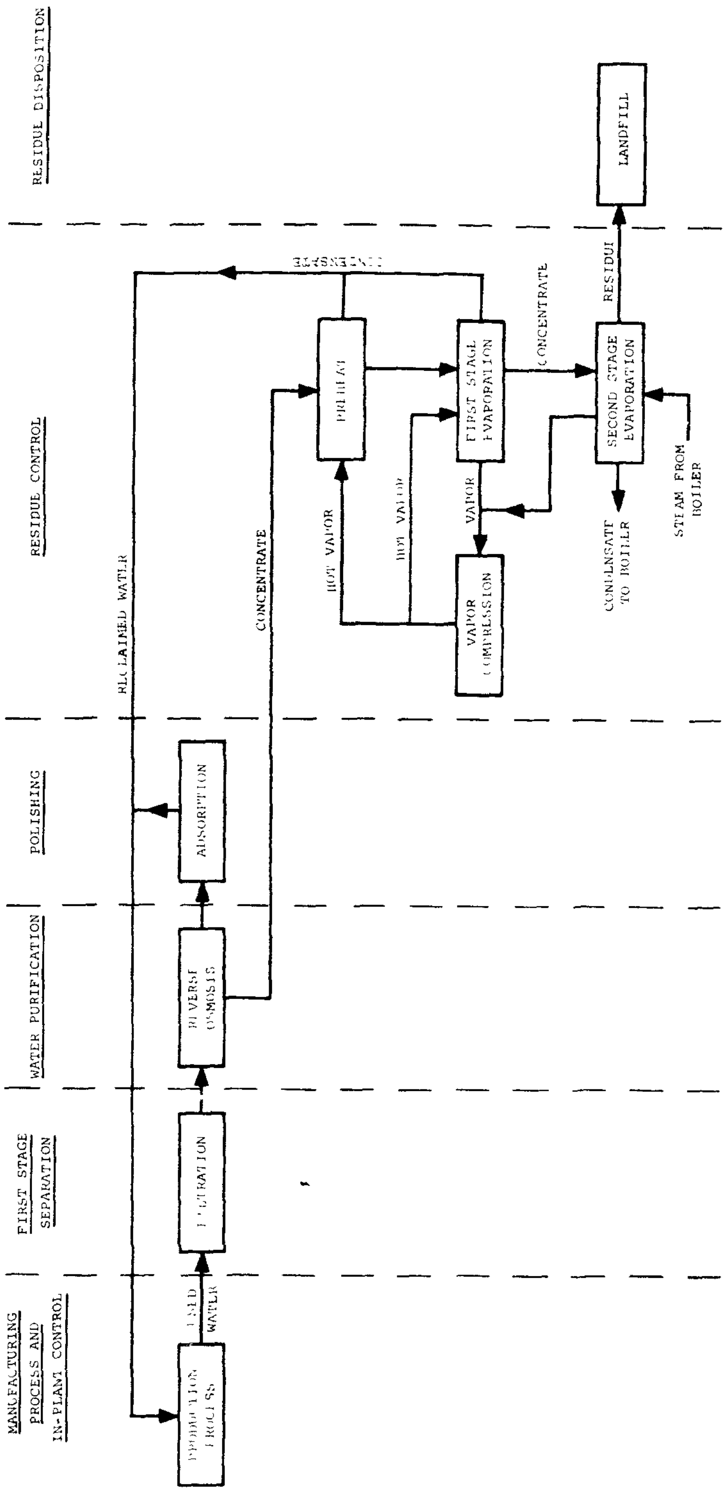

FIGURE 10-4

WATER REUSE AT PLANT NO. 526

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

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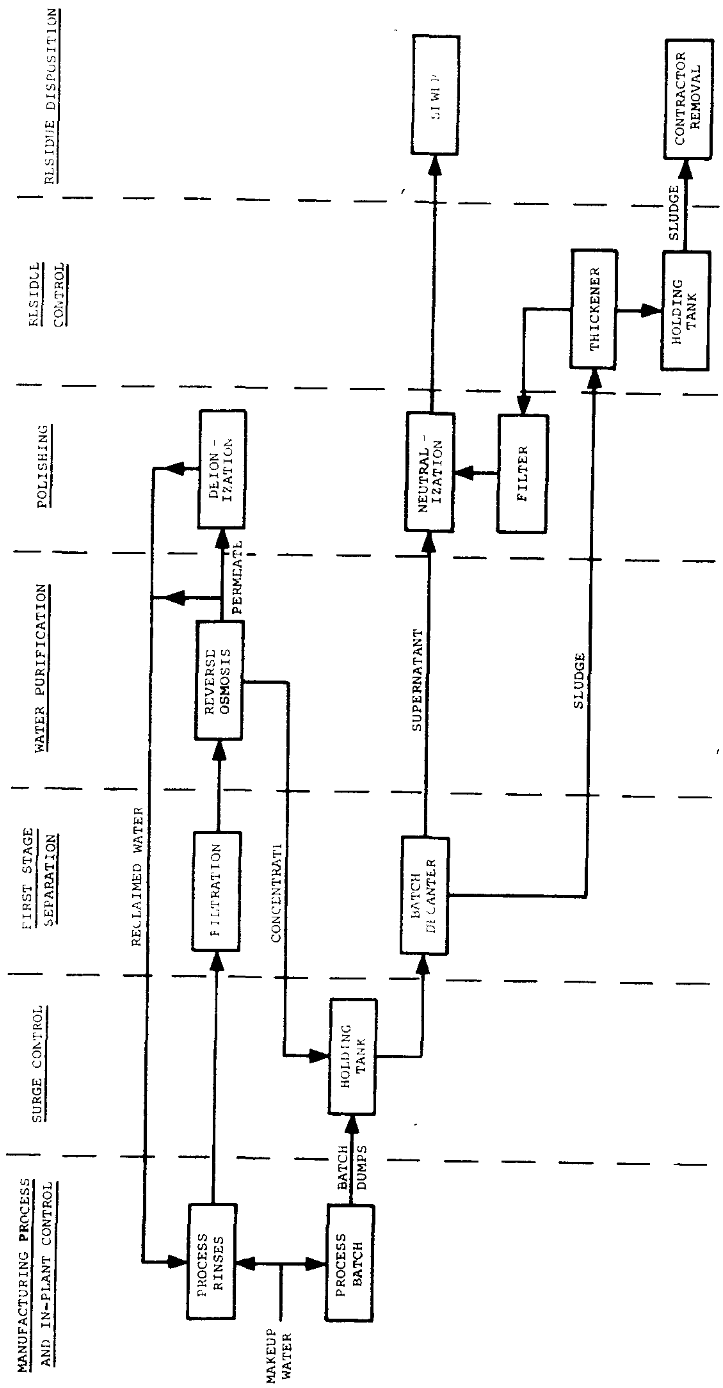

FIGURE 10-5
WATER REUSE AT PLANT NO. 984

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

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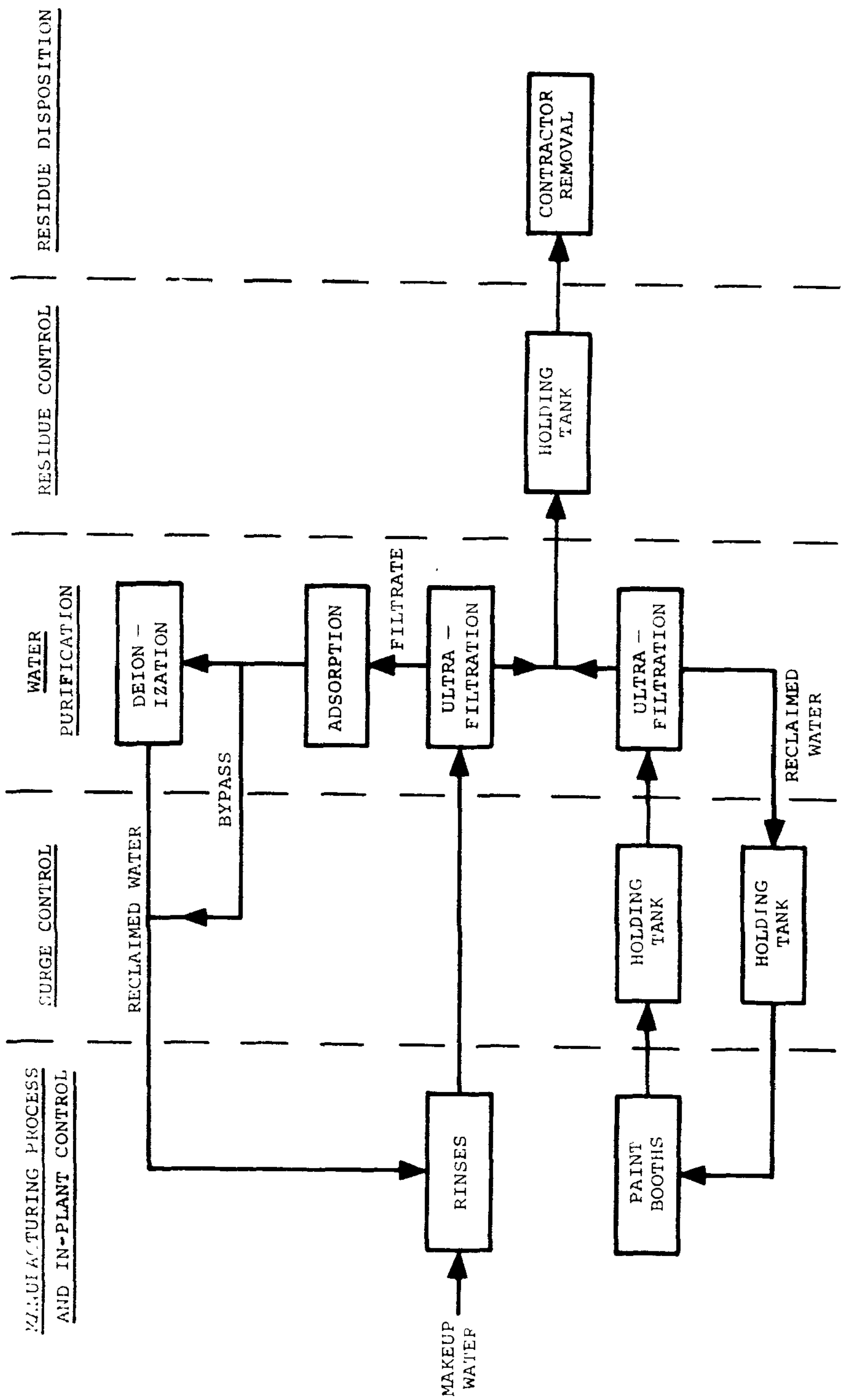

FIGURE 10-6

WATER REUSE AT PLANT NO. 983

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

molecular weight organic contaminants are removed from this permeate by adsorption and dissolved salts are removed by ion exchange before the water is reused. The volume of concentrate lost from the rinse system is made up with city water. The other ultrafiltration application in Plant Number 983 processes water from several water wall paint booths. The processing is carried out batchwise, as required. Ninety-five percent of the feed water is recovered as paint-free permeate. The concentrate from both applications is removed by a contractor, and the plant discharges no process wastewater whatever.

Centrifugation is used in Plant Number 230 (shown earlier in Figure 10-3) to reclaim water from the clarifier sludge. The resultant water from the centrifuge is not clean enough for reuse and is, therefore, recycled back through the neutralization and clarification operations before undergoing filtration and reverse osmosis prior to reuse. The centrifuge removes sufficient water from the clarifier effluent that high temperature drying, described in the next paragraph, of the resulting sludge is considered practical.

Distillation (evaporation) is used in Plant Number 230 (Figure 10-3) to achieve no discharge of pollutants. In this plant, evaporation takes place both in a wiped film evaporator and in a multiple hearth furnace dryer. The evaporator processes concentrate from the reverse osmosis unit described earlier. The resulting salt residue is stored as a nearly-dry powder prior to disposal. Vapor from the evaporator is condensed and returned for recycle though the neutralization and clarification steps, which were also described earlier. Residue from the furnace dryer, which processes centrifuge sludge, consists of dry metal oxides that are ready for landfill. Water vapor from the operation is scrubbed and exhausted.

At Plant Number 526 (shown earlier in Figure 10-4), reverse osmosis concentrate is also fed to a distillation unit (wiped film evaporator). However, the evaporator is preceded by a first stage pre-evaporator which removes about 50 percent of the water. The pre-evaporator uses a vapor compression cycle (the heat of condensation is utilized to provide the energy for evaporation) to reduce energy demand substantially. The condensate is recycled to the manufacturing process for reuse along with the reverse osmosis permeate discussed earlier. The residual salts are removed by a contractor for disposal at an approved site. No discharge of process water occurs with this system.

Contract Removal

From the manufacturer's standpoint, contract removal of concentrates and sludges is not a treatment but rather an alternative way of achieving zero water discharge. Contract removal is not restricted to small plants, and the plant does not always pay for this service, due to the value of materials in the concentrates or sludges. Plant Number 15, which has a production floor area of over 500,000 sq m, reduced its cyanide treatment cost by 83 percent by having all cyanide-bearing wastewater hauled away, although a modern treatment facility is available. A contractor pays Plant 983 for its reverse osmosis concentrate because of its heavy metal values.

APPLYING THE EFFLUENT LIMITATIONS

The only way to provide absolute assurance of no discharge of pollutants for all subcategories except for subcategory 11, Dockside Shipbuilding Activities, is to have no discharge of process wastewater. Application of these effluent limitations is, therefore, straightforward.

ECONOMIC IMPACT

The economic impact of implementing the BAT effluent limitations was determined by computing the average cost to add BAT equipment to update BPT equipment assuming BPT limitations were already being met. This average cost was then multiplied by the total number of plants assumed to meet BPT limitations, producing a total economic impact on the Machinery and Mechanical Products Manufacturing Point Source Category of approximately two billion dollars.

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SECTION XI

NEW SOURCE PERFORMANCE STANDARDS

AND PRETREATMENT STANDARDS

INTRODUCTION

New source performance standards (NSPS) contained herein apply immediat ly to all new sources which discharge effluent to navigable waters. The Federal Water Pollution Control Act Ammendment of 1972 defines the term "new source" as "any source, the construction of which is commence after the publication of proposed regulations prescribing a standard of performance". NSPS are to be based on best available technology economically achievable (BAT) and, in addition, on further pollution reduction through major changes in the manufacturing processes.

Pretreatment standards contained herein apply to plants which discharge to sanitary sewers, with particular emphasis on those pollutant parameters which are not removed by municipal treatment plants. Municipal treatment plants are defined as well designed and operated publicly owned activated sludge or trickling filter wastewater treatment systems. Pretreatment standards are established for both existing and new sources.

NEW SOURCE PERFORMANCE STANDARDS

Applicability, standards, rationale, technology, and economic impact of NSPS are discussed under the subheadings to follow.

Applicability

New source performance standards are applicable to all of the Machinery and Mechanical Products Manufacturing subcategories as defined in Secti IV of this document.

New Source Performance Standards

New source performance standards are identical with BAT effluent limitations as described in Section X of this document.

Rationale for New Source Performance Standards

New source performance standards are identical with those for BAT limitations, which are based mostly on relatively new plants. Thus they reflect what the best new plants are now doing. This clearly provides a sound basis for the selected new source performance standards. Compliance with NSPS requires that adequate attention be given to control and treatment of all process water during design of new plants.

Best Available Demonstrated Control Technology

New source performance standards are based on the best available demonstrated control technology, which encompasses the entire range of BAT as described in Section X of this document. However, it is recommended that maximum emphasis be placed on manufacturing process changes. These changes should result in pollutant reduction or elimination, more positive pollutant control, water use reduction or elimination and in-plant water recycling.

Accomplishment of the above changes was discussed in Section X of this document and will be reviewed at this time. Often, pollutants can be eliminated at the source by using chemical formulations that do not contain pollutants. This generally requires using material substitutes and sometimes necessitates adjustments in the manufacturing process. Use of nonphosphate cleaners is an example. A potential pollutant can also be eliminated by removing the manufacturing process that causes it. Examples are use of vacuum-metalized plastics or hot stamping foils instead of plated metals, use of powder metal gears in place of machined metal gears, and use of carbonitriding or induction hardening in place of cyaniding.

The term "more positive pollutant control", used above in the first paragraph really means good design and maintenance to prevent pollution. Plant Number 926 is a good example. The waste treatment equipment is designed right into the production floor plan. This places the more critical equipment under the factory roof, minimizing waste transfer distance, and allowing servicing even under the worst weather conditions. Pipes and tanks are made of corrosion-resistant materials, and the possibility of leakage is minimized. If spills should occur, the only place they can go is into epoxy-lined trenches in the production floor. These trenches lead to a sump which is pumped into the waste treatment system. In case the waste treatment system malfunctions or if there is a power failure, the wastewater holding tanks overflow to a large "panic pond", rubber lined to prevent infiltration into the aquifer. Constant attention to waste treatment is a must at this plant--there are no connections to either sewers or streams.

Water use reduction or elimination goes hand-in-hand with pollutant reduction or elimination. That is, manufacturing process changes can reduce or eliminate both pollutants and water use. Water use reduction or elimination reduces or prevents wastewater contamination by the particular manufacturing process. It also makes recycling of essential process water more economically attractive because there is

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no extra water "going along for the ride."

In-plant water recycling should be maximized because it drastically reduces wastewater. It is most efficient because water treatment at the machine or process tank can be designed specifically for that process. Furthermore, in-plant recycling often pays dividends in the form of cost savings from recovered chemicals. Screening, filtering, centrifuging, oil separation, and distillation are in fairly common use. As discussed in Section X of this document, reverse osmosis and ultrafiltration are finding increasing application as a means to permit recycling of wastewater. Use of more specialized processes such as electrolytic copper recovery is also increasing.

Economic Impact

As described in Section VIII of this document, the economic impact of NSPS on a particular plant is much the same as the impact of BAT limitations. Since the new sources do not exist at this time, adequate information is not available to predict the impact of NSPS on the Machinery and Mechanical Products Manufacturing Point Source Category.

PRETREATMENT STANDARDS

Pretreatment standards are nearly as important as effluent limitations because 75 percent of all plants with a wastewater effluent in the Machinery and Mechanical Products Manufacturing Point Source Category discharge their wastewater to sewers. The municipal treatment plant adequately removes some pollutants. For others, it acts simply as a pipeline to a stream or other navigable body of water. Still other pollutants interfere with the municipal treatment process. Applicability, standards, rationale, and technology for pretreatment are considered under the following subheadings.

Applicability

The pretreatment standards are applicable to all of the Machinery and Mechanical Products Manufacturing subcategories defined in Section IV of this document where process water is discharged to a sanitary sewer.

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Pretreatment Standards

Pretreatment standards for existing sources are defined as the pretreatment standards effective on the same date (July 1, 1977) as BPT effluent limitations. Pretreatment standards for new sources are defined as the pretreatment standards applying to any new source as defined earlier in this section. For Subcategory 9, Molding and Forming - Plastics, the pretreatment standards are the same as the BPT effluent limitation, which is no discharge of pollutants. For Subcategory 11, Dockside Shipbuilding Activities, pretreatment standards are not applicable. The pretreatment standards for each of the subcategories listed are as follows:

Pretreatment Standards for Existing Sources - Thirty-day average standards, defined in the same manner as thirty-day average effluent limitations, are listed in Table 11-1. Single-day maximum pretreatment standards are listed in Table 11-2.

Pretreatment Standards for New Sources - Thirty-day average pretreatment standards are listed in Table 11-3, and single-day maximum pretreatment standards are listed in Table 11-4.

Pretreatment Standards Rationale

In municipal treatment plants, various pollutants are either controlled by the treatment process, compatible with the treatment process, or incompatible with the treatment process. The parameters that are controlled are pH, suspended solids, and BOD. Therefore, standards are not defined for these parameters.

Fluorides, iron, and phosphates are pollutant parameters compatible with municipal treatment processes. However, they are not generally controlled by municipal treatment plants and they are therefore eventually discharged to a stream. Hence, pretreatment standards are required. COD and oil and grease require pretreatment standards because they are only partially controlled by the municipal treatment process although they are generally compatible with it. Because these above pretreatment standards should be identical with the effluent limitations.

Incompatible pollutants such as zinc, mercury and lead interfere with the municipal treatment process and must therefore be controlled to minimum practical levels as defined by the effluent limitations.

Thus, pretreatment standards for existing sources are essentially identical with BPT effluent limitations, except for pollutants normally controlled by municipal treatment plants.

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TABLE 11-1

EXISTING SOURCE PRETREATMENT STANDARDS (30-DAY AVERAGE) mg/hr-m²

Pollutant Parameter	Subcategories									
	1	2	3	4	5	6	7	8	10	12
Cadmium	0.071	0.010	---	---	0.003	---	0.048	0.043	0.047	0.071
C. O. D.	327	33	53	148	16	1060	165	66	152	90
Chrome, Total	---	0.076	---	---	---	4.7	1.3	---	---	0.057
Chrome, Hex	---	---	---	---	---	0.41	0.10	---	---	0.012
Copper	0.37	0.060	0.18	---	0.014	4.4	0.66	0.13	---	---
Cyanide	---	---	---	0.080	---	---	---	---	0.13	---
Fluoride	---	0.89	---	---	0.42	53	10	---	---	---
Iron	1.5	0.96	0.32	3.9	0.25	12	3.2	1.4	0.79	0.97
Lead	0.24	0.032	0.032	0.55	0.010	---	0.12	0.26	---	0.19
Mercury	---	---	---	----	0.003	---	0.012	0.007	0.006	---
Nickel	0.14	0.11	0.12	0.20	0.057	---	---	0.36	---	0.073
Oil, Grease	41	4.3	7.1	20	3.0	154	17	6.1	17	12
Phosphates	---	0.60	0.79	---	0.15	---	9.1	---	0.93	1.3
Silver	0.007	---	0.002	---	0.001	---	0.013	0.015	0.008	---
TS Solids	---	---	---	---	---	---	---	---	---	---
Zinc	1.1	0.31	1.6	---	0.14	---	1.3	0.88	0.57	0.49

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

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TABLE 11-2

EXISTING SOURCE PRETREATMENT STANDARDS (SINGLE-DAY MAXIMUM) mg/hr-m^2

Pollutant Parameter	Subcategories 1	2	3	4	5	6	7	8	10	12
Cadmium	0.11	0.015	---	---	0.005	---	0.072	0.065	0.071	0.11
C. O. D.	654	66	106	296	32	2110	330	132	304	180
Chrome, Total	---	0.11	---	---	---	7.1	2.0	---	---	0.086
Chrome, Hex	---	---	---	---	---	0.62	0.15	---	---	0.018
Copper	0.56	0.090	0.27	---	0.021	6.6	0.99	0.20	---	---
Cyanide	---	---	---	0.12	---	---	---	---	0.20	---
Fluoride	---	1.3	---	---	0.63	80	15	---	---	---
Iron	2.9	1.9	0.64	5.9	0.50	18	6.4	2.7	1.6	1.5
Lead	0.36	0.048	0.048	0.83	0.015	---	0.18	0.39	---	0.29
Mercury	---	---	---	---	0.005	---	0.018	0.011	0.009	---
Nickel	0.21	0.17	0.18	0.30	0.086	---	---	0.54	---	0.11
Oil, Grease	82	8.6	14	40	6.0	308	94	12	34	24
Phosphates	---	1.2	1.6	---	0.30	---	18	---	1.9	2.6
Silver	0.011	---	0.003	---	0.002	---	0.020	0.023	0.012	---
TS Solids	---	---	---	---	---	---	---	---	---	---
Zinc	1.7	0.47	2.3	---	0.21	---	1.9	1.3	0.90	0.74

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

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TABLE 11-3

NEW SOURCE PRETREATMENT STANDARDS (30-DAY AVERAGE) $mg/hr-m^2$

Pollutant Parameter	Subcategories 1	2	3	4	5	6	7	8	10	12
Cadmium	0.036	0.005	---	---	0.002	---	0.024	0.022	0.024	0.036
C. O. D.	164	17	27	74	8.0	530	83	33	71	45
Chrome, Total	---	0.038	---	---	---	2.4	0.65	---	---	0.029
Chrome, Hex	---	---	---	---	---	0.21	0.05	---	---	0.006
Copper	0.19	0.030	0.090	---	0.007	2.2	0.33	0.065	---	---
Cyanide	---	---	---	0.040	---	---	---	---	0.065	---
Fluoride	---	0.45	---	---	0.21	27	5.0	---	---	---
Iron	0.75	0.48	0.16	2.0	0.13	6.0	1.6	0.70	0.40	0.49
Lead	0.12	0.016	0.016	0.28	0.005	---	0.060	0.13	---	0.10
Mercury	---	---	---	---	0.002	---	0.006	0.004	0.003	---
Nickel	0.07	0.055	0.060	0.10	0.029	---	---	0.18	---	0.037
Oil, Grease	21	2.2	3.6	10	1.5	77	8.5	3.1	8.5	6.0
Phosphates	---	0.30	0.40	---	0.075	---	4.6	---	0.47	0.65
Silver	0.004	---	0.001	---	0.001	---	0.007	0.008	0.004	---
TS Solids	---	---	---	---	---	---	---	---	---	---
Zinc	0.55	0.16	0.80	---	0.070	---	0.65	0.44	0.29	0.25

NOTICE: These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

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TABLE 11-4

NEW SOURCE PRETREATMENT STANDARDS (SINGLE-DAY MAXIMUM) mg/hr-m^2

Pollutant Parameter	Subcategories 1	2	3	4	5	6	7	8	10	12
Cadmium	0.055	0.008	---	---	0.003	---	0.036	0.033	0.036	0.055
C. O. D.	327	33	53	148	16	1060	165	66	152	90
Chrome, Total	---	0.055	---	---	---	3.6	1.0	---	---	0.043
Chrome, Hex	---	---	---	---	---	0.31	0.075	---	---	0.009
Copper	0.28	0.045	0.14	---	0.011	3.3	0.50	0.10	---	---
Cyanide	---	---	---	0.060	---	---	---	---	0.10	---
Fluoride	---	0.65	---	---	0.32	40	7.5	---	---	---
Iron	1.5	1.0	0.32	3.0	0.25	9.0	3.2	1.4	0.80	0.75
Lead	0.18	0.024	0.024	0.42	0.008	---	0.090	0.20	---	0.15
Mercury	---	---	---	---	0.003	---	0.009	0.006	0.005	---
Nickel	0.11	0.085	0.090	0.15	0.043	---	---	0.27	---	0.055
Oil, Grease	41	4.3	7.0	20	3.0	154	47	6.0	17	12
Phosphates	---	0.60	0.80	---	0.15	---	9.0	---	1.0	1.3
Silver	0.006	---	0.002	---	0.001	---	0.010	0.010	0.006	---
TS Solids	---	---	---	---	---	---	---	---	---	---
Zinc	0.85	0.24	1.2	---	0.11	---	1.0	0.65	0.45	0.37

NOTICE. These are tentative recommendations based upon information in this report and are subject to change based upon comments received and further review by EPA.

Pretreatment standards for new sources are equal to one half of the BPT effluent limitations. This reduction is based on achieving a fifty percent decrease in effluent concentrations by using advanced waste treatment technology such as BAT while maintaining the same wastewater discharge rates. This will result in a corresponding reduction in pollutant discharge by municipal treatment plants as these parameters are not normally treated. These pretreatment standards are less stringent than the BAT effluent limitations in order to encourage combined municipal and industrial waste treatment as required by the Federal Water Pollution Control Act Amendment of 1972.

Technology

The technology needed to comply with the pretreatment standards is, in general, the same as that required to meet the BPT and BAT limitations discussed in Sections IX and X of this document, and originally described in Section VII. In specific instances, however, certain wastewater treatment steps can be eliminated or designed for reduced residence time. This difference in technology results from differences between the effluent limitations and the pretreatment standards.

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SECTION XII

ACKNOWLEDGEMENTS

This document was prepared by the Hamilton Standard Division of United Technologies Corporation. The program was under the overall direction of Mr. Daniel Lizdas, Project Manager. Mr. Gilbert Kleiner directed the engineering activities, and field operations were under the direction of Mr. Albert Krivickas. Significant contributions to this report were made by Messrs. Walter Drake, Robert Blaser, Eric Auerbach, Robert Lewis, Jeffrey Robert, and Miner C. Friend.

Project members who assisted in the collection, analysis and presentation of data for this report were:

Mr. Clark Anderson
Mr. Arthur Birch
Miss Nancy Broderick
Mr. John Carmody
Mr. Vincent Celino
Mr. Benjamin Delson
Mr. Michael Emery
Mr. William Fawcett
Mr. William Fisher
Mr. Thomas Gagliardo
Mr. Everett Galligan
Mr. Richard Kearns
Mr. Rene LaPointe
Miss Susan Pelkey
Mr. Thomas Pietrycha
Mr. Clark Rees
Mrs. Patricia Rohrbach
Mrs. Lorraine Rosser
Mr. Allen Ryan
Mr. Robert Scagni
Mr. James Scanlon
Mrs. A. J. Scogna
Mr. James Taylor
Mr. Robert Waleryszak
Mr. Jeffrey Wehner
Mr. Edwin Young

The following consultants provided assistance in the designated areas:

Dr. Theo Z. Kattamis University of Connecticut	Primary Metal Products & Fabricated Metal Products
Dr. John E. Williams University of Connecticut	Nonelectrical Machinery & Miscellaneous Products
Daniel F. Hefler Arthur D. Little, Inc.	Electrical Machinery & Electronic Instruments
Dr. James P. Bell University of Connecticut	Plastic Products
Dr. T. Helfgott University of Connecticut	Wastewater Treatment Technology

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The technical direction and guidance of the Project Officer, Mr. Ernst P. Hall, Assistant Director, Effluent Guidelines Division, throughout the conduct of the study are greatly appreciated, as are the assistance and support of Mr. Harold B. Coughlin, Chief, Effluent Guidelines Implementation Branch, Mr. John Newbrough and Dr. Mike Shamaiengar.

The cooperation of the hundreds of individual plants and the many trade associations within the Machinery and Mechanical Products manufacturing industries who offered their plants for on-site verification and who contributed pertinent data is acknowledged and is greatly appreciated.

Acknowledgement is also made of the assistance of personnel in all the EPA Regional offices and in many state agencies that were contacted to obtain assistance in identifying those plants in the Machinery and Mechanical Products Manufacturing industries that are achieving effective waste treatment.

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SECTION XIII

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SECTION XIV

GLOSSARY

Abrasive Belt Grinding

Roughing and/or finishing a workpiece by means of a power-driven belt coated with a substance, usually in powdered form, which removes material by scratching the surface.

Abrasive Belt Polishing

Finishing a workpiece with a power-driven abrasive-coated belt in order to develop a very good finish.

Abrasive Blasting

(Surface treatment and cleaning) Using dry or wet abrasive particles under air pressure for short durations of time to clean a metal surface.

Abrasive Cutoff

Severing a workpiece by means of a thin abrasive wheel.

Abrasive Jet Machining

Removal of material from a workpiece by a high-speed stream of abrasive particles carried by gas from a nozzle. The process is used chiefly to cut materials that are sensitive to heat damage and thin sections of hard materials that chip easily, and to cut intricate holes that would be more difficult to produce by other methods.

Abrasive Machining

Used to accomplish heavy stock removal at high rates by use of a free-cutting grinding wheel.

Acceptance Testing

A test, or series of tests, and inspections that confirms product functioning in accordance with specified requirements.

Acid Cleaning

Using any acid for the purpose of cleaning any material. Some methods of acid cleaning are pickling and oxodizing.

Acid Dip

An acidic solution for activating the workpiece surface prior to electroplating in an acidic solution, especially after the workpiece has been processed in an alkaline solution.

Acidity

The quantitative capacity of aqueous solutions to react with hydroxyl ions. It is measured by titration with a standard solution of a base to a specified end point. Usually expressed as milligrams per liter of calcium carbonate.

Act

The Federal Water Pollution Control Act Amendments of 1972.

Adhesive Bonding

Joining two or more pieces with a substance such as glue or cement.

Administrator

Means the Administrator of the United States Environmental Protection Agency.

Adsorption

A physical or chemical bond process in which molecules of gas, of dissolved substances, or of liquids adhere in an extremely thin layer to the surface of solid bodies with which they are in contact.

Aerobic Digestion

(Sludge Processing) The biochemical decomposition of organic matter, by organisms living or active only in the presence of oxygen, which results in the formation of mineral and simpler organic compounds.

Aging

The change in properties (eg. increase in tensile strength and hardness) that occurs in certain metals at atmospheric temperature after heat treatment.

Air Flotation

Separation of low density contaminants from water using minute air bubbles attached to individual particles to provide or increase the buoyancy of the particle.

Air Pollution

The presence in the outdoor (ambient) atmosphere of one or more air pollutants or any combination thereof in such quantities and of such characteristics and duration as to be, or be likely to be, injurious to public welfare, to the health of human, plant or animal life, or to property, or as unreasonably to interfere with the enjoyment of life and property.

Air Scrubbing

A method of removing air impurities by contact with water or an aqueou chemical solution.

Air Pollution Control Equipment

Devices necessary to prevent air pollution by reducing the escape of undesirable materials in stack gases.

Algicides

Chemicals for preventing the growth of algae.

Alkaline Cleaning

A process for cleaning steel where mineral and animal fats and oils must be removed from the surface. Solutions at high temperatures containing caustic soda, soda ash, alkaline silicates and alkaline phosphates are commonly used.

Alkalinity

1. The extent to which an aqueous solution contains more hydroxyl ions than hydrogen ions.

2. The capacity of water to neutralize acids, a property imparted by the water's content of carbonates, bicarbonates, hydroxides, and occasionally borates, silicates and phosphates.

Alloy Process

(Semiconductor Mfg.) A fabrication technique in which a small part of the semiconductor material is melted together with the desired metal and allowed to recrystallize. The alloy developed is usually intended to form a pn junction or an ohmic contact.

Alloy Steels

Steels with carbon content between 0.1% to 1.1% and containing elements such as nickel, chromium, molybdenum and vanadium. (The total of all such alloying elements in these type steels is usually less than 5%.)

Aluminizing

Forming an aluminum or aluminum alloy coating on a metal by hot dipping, hot spraying or diffusion.

Anaerobic Waste Treatment

(Sludge Processing) Waste stabilization brought about through the action of microorganisms in the absence of air or elemental oxygen.

Anions

The negatively charged ions in solution, e.g., hydroxyl.

Annealing

A process for preventing brittleness in a metal part. The process consists of raising the temperature of the metal to a pre-established level and slowly cooling the steel at a prescribed rate.

Anode

The positively charged electrode in an electrochemical process or battery.

Anodizing

The production of protective oxide film on aluminum or other light metals by passing a high voltage electric current through a bath in which the metal is suspended.

Aquifer

Water bearing stratum of permeable rock.

Ash

The solid residue left after complete combustion.

Assembly

The fitting together of manufactured parts into a complete machine, structure, or unit of a machine.

Atomic Absorption

An instrumental method of analysis for determining the concentration of certain wastewater pollutants.

Automated Phenolate Method

A standard method of measuring Kjeldahl nitrogen concentration in a solution.

Austempering

Heat treating process to obtain greater toughness and ducticity in certain high-carbon steels. The process is characterized by interrupted quenching and results in the formation of bainite grain structure.

Austenitizing

Heating a steel to a temperature at which the structure transforms to a solution of one or more elements in face-centered cubic iron. Usually performed as the essential preliminary of heat treatment, in order to get the various alloying elements into solid solution.

Bag Molding

(Vacuum, Pressure, Autoclave) A method of applying pressure during bonding or molding, in which a flexible cover usually in connection with a rigid die or mold, exerts pressure on the material being molded through application of air pressure or drawing of a vacuum.

Barrel Finishing

Improving the surface finish of metal objects or parts by processing them in rotating equipment along with abrasive particles which may be suspended in a liquid.

Batch Treatment

A waste treatment method where wastewater is collected over a period of time and then treated prior to discharge.

Bending

Turning or forcing by a brake press or other device from a straight or even to a curved or angular condition.

Best Available Technology Economically Achievable (BAT)

Level of technology applicable to effluent limitations to be achieved by July 1, 1983, for industrial discharges to surface waters, as defined by Section 301(b) (2) (A) of the Act.

Best Practicable Control Technology Currently Available (BPT)

Level of technology applicable to effluent limitations to be achieved by July 1, 1977, for industrial discharges to surface waters, as defined by Section 301(b) (1) (A) of the Act.

Biochemical Oxygen Demand (BOD)

The amount of oxygen in milligrams per liter used by microorganisms to consume biodegradable organics in wastewater under aerobic conditions.

Blanking

Cutting desired shapes out of sheet metal by means of dies.

Blowdown

The minimum discharge of recirculating water for the purpose of discharging materials contained in the water, the further buildup of which would cause concentration in amounts exceeding limits established by best engineering practice.

Blow Molding

A method of producing hollow objects (e.g. bottles) by injecting a hot melt into a hollow mold, then injecting air to force the melt against the cool mold surface, where it solidifies into shape.

BOD5

The five-day Biochemical Oxygen Demand (BOD5) is the quantity of oxygen used by bacteria in consuming organic matter in a sample of wastewater over a five-day period. BOD from the standard five-day test equals about two-thirds of the total BOD. See Biochemical Oxygen Demand.

Bonding

The process of uniting using an adhesive or fusible ingredient.

Boring

Enlarging a hole by removing metal with a single or occasionally a multiple point cutting tool moving parallel to the axis of rotation of the work or tool.

1. Single-Point Boring - Cutting with a single-point tool

2. Precision Boring - Cutting to tolerances held within narrow limits

3. Gun Boring - Cutting of deep holes

4. Jig Boring - Cutting of high-precision and accurate location holes

5. Groove Boring - Cutting accurate recesses in hole walls

Brazing

Joining metals by flowing a thin layer, capillary thickness, of non-ferrous filler metal into the space between them. Bonding results from the intimate contact produced by the dissolution of a small amount of base metal in the molten filler metal, without fusion of the base metal. Sometimes the filler metal is put in place as a thin solid sheet or as a clad layer and the composite is heated in furnace brazing. The term brazing is used where the temperature exceeds some arbitrary value, such as 800 Degrees F; the term soldering is used for temperatures lower than the arbitrary value.

Bright Dipping

Using acidic solutions to produce a bright surface on a metal.

Brine

An aqueous salt solution.

Broaching

Cutting with a tool which consists of a bar having a single edge or a series of cutting edges (i.e., teeth) on its surface. The cutting edges of multiple-tooth, or successive single-tooth, broaches increase in size and/or change in shape. The broach cuts in a straight line or axial direction when relative motion is produced in relation to the workpiece, which may also be rotating. The entire cut is made in single or multiple passes over the workpiece to shape the required surface contour.

1. Pull Broaching - Tool pulled through or over workpiece

2. Push Broaching - Tool pushed over or through workpiece

3. Chain Broaching - A continuous high production surface broach

4. Tunnel Broaching - Work travels through an enclosed area containing broach inserts

Brucine Method

Standard method of measuring concentration of nitrate in water solutions.

Buffing

An operation to provide a high luster to a surface. The operation, which is not intended to remove much material, usually follows polishing.

Burnishing

Finish sizing and smooth finishing of surfaces (previously machined or ground) by displacement, rather than removal, of minute surface irregularities with smooth point or line-contact, fixed or rotating tools.

Calcination

The roasting or burning of any substance to bring about physical or chemical changes; e.g., the conversion of limestone to quicklime.

Calendering

Process of forming a continuous sheet by squeezing the material between two or more parallel rolls to impart the desired finish or to insure uniform thickness.

Calibration

The determination, checking, or rectifying of the graduation of any instrument giving quantitative measurements.

Calibration Equipment

Equipment used for calibration of instruments.

Canned Powder Forging

A process where powder is placed in a sealed mold, vibrated and heated to a forging temperature. The mold is then forged and cooled at room temperature. The mold is removed from the powder formed part by either machining or pickling.

Capital Recovery Costs

Allocates the initial investment and the interest to the total operating cost. The capital recovery cost is equal to the initial investment multiplied by the capital recovery factor.

Capital Recovery Factor

Capital Recovery Factor is defined as:

i + i/(a - 1)
where i = interest rate
a = (1 + i) to the power n
n = interest period in years

Captive Operation

A manufacturing operation carried out in a facility to support subsequent manufacturing, fabrication or assembly operations.

Carbides

Usually refers to the general class of pressed and sintered tungsten carbide cutting tools which contain tungsten carbide plus smaller amounts of titanium and tantalum carbides along with cobalt which acts as a binder. (It is also used to describe hard compounds in steels and cast irons.)

Carbon Bed Catalytic Destruction

A non-electrolytic process for the catalytic oxidation of cyanide wastes using trickling filters filled with low-temperature coke.

Carbon Steels

Steel which owes its properties chiefly to various percentage of carbon without substantial amounts of other alloying elements.

Carbonate

A compound containing the acid radical of carbonic acid (CO_3 group).

Carbonitriding

Process for case or core hardening of metals. The heated metals absorb carbon in a gaseous atmosphere.

Carburizing

(Physical Property Modification) Increasing the carbon content of a metal by heating with a carburizing medium (which may be solid, liquid or gas) usually for the purpose of producing a hardened surface by subsequent quenching.

Case Hardening

A heat treating method by which the surface layer of alloys is made substantially harder than the interior. (Carburizing and nitriding are common ways of case hardening steels.)

Cast

A state of the substance after solidification of the molten substance.

Cast (plastics)

1. To form a "plastic" object by pouring a fluid monomer-polymer solution into an open mold where it finishes polymerizing

2. Forming plastic film and sheet by pouring the liquid resin onto a moving belt or by precipitation in a chemical bath

Types - slush molding, rotational molding, centrifugal molding, dip molding

Casthouse

The facility which melts metal, holds it in furnaces for degassing (fluxing) and alloying and then casts the metal into pigs, ingots, billets, rod, etc.

Casting

The operation of pouring molten metal into a mold.

Casting Shrinkage

1. "Liquid shrinkage" - the reduction in volume of liquid metal as it cools to the liquidus.

2. "Solidification shrinkage" - the reduction in volume of metal from the beginning to ending of solidification.

3. "Solid shrinkage" - the reduction in volume of metal from the solidus to room temperature.

4. "Total shrinkage" - the sum of the shrinkage in parts 1., 2. and 3.

Category

Also point source category. A segment of industry for which a set of effluent limitations has been established.

Cathode

The negatively charged electrode in an electrochemical process or battery.

Cations

The positively charged ions in a solution.

Caustic

Capable of destroying or eating away by chemical action. Applied to strong bases and characterized by the presence of hydroxyl ions in solution.

Caustic Soda

Sodium hydroxide, NaOH, whose solution in water is strongly alkaline.

Cementation

Cementation is the electrochemical reduction of metal ions by contact with a metal of higher oxidation potential. It is usually used for the simultaneous recovery of copper and reduction of hexavalent chromium with the aid of scrap iron.

Centerless Grinding

Grinding the outside or inside of a work piece mounted on rollers rather than on centers. The work piece may be in the form of a cylinder or the frustrum of a cone.

Centrifugal Molding

A casting made by pouring liquified plastic into a rotating mold.

Centrifugation

(Sludge Dewatering) The removal of water in sludge by introducing the water sludge slurry into a centrifuge. The sludge is driven outward with the water remaining near the center. The water is withdrawn and the dewatered sludge is usually landfilled.

Centrifuge

A device having a rotating container in which centrifugal force separates substances of differing densities.

Ceramic Mold Casting

Ceramic mold casting employs permanent patterns and zircon and alumina slurries to form a ceramic mold. The mold is expendible and produces very precise castings as an investment casting. It differs from investment casting because the mold is not monolithic but has a copy and drop or drag section alone.

Ceramic Coating

High temperature coatings based on carbides, silicides, borides, nitrides, cermets and other inorganic materials.

Chelate Compound

A compound in which the metal is contained as an integral part of a ring structure and is not readily ionized.

Chelating Agent

A compound capable of forming a chelate compound with a metal ion.

Chemical Brightening

Process utilizing an addition agent that leads to the formation of a bright plate, or that improves the brightness of the deposit.

Chemical Deposition

Process used to deposit a metal oxide on a substrate. The film is formed by hydrolysis of a mixture of chlorides at the hot surface of the substrate. Careful control of the water mixture insures that the oxide is formed on the substrate surface.

Chemical Etching

To dissolve a part of the surface of a metal or all of the metal laminated to a base.

Chemical Machining

Production of derived shapes and dimensions through selective or overall removal of metal by controlled chemical attack or etching.

Chemical Metal Coloring

The production of desired colors on metal surfaces by appropriate chemical or electrochemical action.

Chemical Milling

Removing large amounts of stock by etching selected areas of complex work pieces. This process entails cleaning, masking, etching and demasking.

Chemical Oxidation

(including cyanide) The addition of chemical agents to wastewater for the purpose of oxidizing pollutional material.

Chemical Oxygen Demand (COD)

The amount of oxygen in milligrams per liter to oxidize both organic and oxidizable inorganic compounds.

Chemical Polishing

A chemical solution is used to put a smooth finish on a metallic surface.

Chemical Precipitation

1. A deposit separated from a solution induced by the addition of chemicals

2. The process of softening water by the addition of lime or lime and soda ash as the precipitants

Chemical Recovery Systems

Chemical treatment to remove metals or other materials from wastewater for later reuse.

Chemical Reduction

(including chromium conversion) The addition of chemical agents to wastewater for the purpose of reducing pollutional material; e.g. conversion of hexavalent chromium to trivalent chromium.

Chemical Treatment

Treating contaminated water by chemical means.

Chip Dragout

Cutting fluid or oil adhering to metal chips from a machining operation

Chlorinated Hydrocarbons

Organic compounds containing chlorine such as many insecticides.

Chlorination

The application of chlorine to water generally for purposes of disinfection, but frequently for accomplishing other biological or chemical results.

Chloroplatinate Units

Units of color measured by a colorimetric or spectrophotometric method.

Chromate Conversion Coating

Formed by immersing metal in an aqueous acidified chromate solution consisting substantially of chromic acid or coater soluble salts of chromic acid together with various catalysts or activators.

Chromatizing

To treat or impregnate with a chromate (salt of ester of chromic acid) or dichromate, especially with potassium dichromate.

Chrome-Pickle Process

Forming a corrosion-resistant oxide film on the surface of magnesium-base metals by immersion in a bath of an alkali bichromate.

Clarification

Any process or combination of processes, the primary purpose of which is to reduce the concentration of suspended matter in a liquid.

Clarifier

A unit which provides for settling and removal of solids from wastewater.

Cleaning

See Vapor Degreasing
Solvent Cleaning
Contaminant Factor
Acid Cleaning
Emulsion Cleaning
Alkaline Cleaning
Salt Bath Descaling
Pickling
Passivate
Abrasive Blast Cleaning
Sonic and Ultrasonic Cleaning

Closed-Loop Evaporation System

A system used for the recovery of chemicals and water from a chemical finishing process. An evaporator concentrates flow from the rinse water holding tank. The concentrated rinse solution is returned to the bath, and distilled water is returned to the final rinse tank. The system is designed for recovering 100 percent of the chemicals, normally lost in dragout, for reuse in the process.

Coagulation

The clumping of particles to settle out impurities; often induced by chemicals such as lime or alum.

Coating

See Aluminum Coating, Hot Dip
Ceramic Coatings, Metal Spraying
Phosphate Coating, Vacuum
Chrome Conversion Coating, Gas Plating
Painting, Siliconizing of Steel
Rust-Preventive Compounds
Porcelain Enamels, Mechanical Plating

COD

See Chemical Oxygen Demand.

Coining

1. A closed-die squeezing operation, usually performed cold, in which all surfaces of the work are confined or restrained, resulting in a well-defined imprint of the die upon the work.

2. A restriking operation used to sharpen or change an existing radius or profile.

3. Pow. met. The final pressing of a sintered compact to obtain a definite surface configuration (not to be confused with re-pressing or sizing).

Cold Compression Molding

(plastics) A technique of thermoset molding in which the molding compound is shaped at room temperature and cured by subsequent baking.

Cold Drawing

A process of forcing material through dies or other mandrels to produce wire, rod, tubular and some bars.

Cold Heading

A method of forcing metal to flow cold into enlarged sections by endwise squeezing. Typical coldheaded parts are standard screws, bolts under 1 in. diameter and a large variety of machine parts such as small gears with stems.

Cold Rolling

A process of forcing material through rollers to produce bars and sheet stock.

Colorimetric

A procedure for establishing the concentration of impurities in water by comparing its color to a set of known color impurity standards.

Compatible Pollutants

Those pollutants which can be adequately treated in publicly-owned treatment works without upsetting the treatment process.

Composite Mold Casting

Casting using molds assembled from several components among which at least one component varies from the others in the process by which it was made and in the molding material. Thus the advantages of several mold materials or techniques can be incorporated in the operation.

Compounding

(Plastic Process) "Compounding a polymer" refers to those chemical and, especially, physical methods used to modify the polymer's properties in accordance with specific performance appearance or economic requirements.

Conductance

See Electrical Conductivity.

Composite Wastewater Sample

A combination of individual samples of water or wastewater taken at selected intervals, generally hourly for some specified period, to minimize the effect of the variability of the individual sample. Individual samples may have equal volume or may be proportioned to the flow at time of sampling.

Compression Molding

The forming of thermosetting plastics in an open mold by heat and pressure.

Conductivity Meter

An instrument which displays a quantitative indication of conductance.

Contact Molding

(Plastics) A process in which a thermosetting resin is blended with a reinforcing material and applied to an open mold where, accelerated by heating, it is allowed to cure.

Contact Water

See Process Wastewater.

Contaminate

Intrusion of undesirable elements.

Continuous Casting

A casting technique in which in ingot, billet, tube or other shape is continuously solidified while it is being poured, so that its length is not determined by mold dimensions.

Continuous Treatment

Treatment of waste streams operating uninterruptedly as opposed to batch treatment; sometimes referred to as flow-through treatment.

Contractor Removal

Disposal of oils, spent solutions, or sludge by a scavenger service.

Conversion Coating

A coating produced by chemical or electrochemical treatment of a metallic surface that gives a superficial layer containing a compound of the metal, for example, chromate coatings on zinc and cadmium, oxide coatings on steel.

Cooling Water

Water which is used to absorb and transport heat generated in a process or machinery.

Corrosion Resistant Steels

A term often used to describe the stainless steels with high nickel and chromium alloy content.

Cost of Capital

The annual cost of capital is assumed to be equal to the annual capital recovery costs minus the annual depreciation.

Counterboring

Removal of material to enlarge a hole for part of its depth with a rotary, pilot guided, end cutting tool having two or more cutting lips and usually having straight or helical flutes for the passage of chips and the admission of a cutting fluid.

Counterflow Rinsing

Rinsing of parts in such a manner that the rinse water is moved from tank to tank counter to the flow of parts being rinsed.

Countersinking

Beveling or tapering the work material around the periphery of a hole creating a concentric surface at an angle less than 90 degrees with the centerline of the hole for the purpose of chamfering holes or recessing screw and rivet heads.

Crystal Growing Processes

The crystal growing process provides a means for converting polycrystalline material into a single crystal. See Czochralski Crystallization Solution or Evaporation Float Zone Technique.

Crystallization

1. Process used to manufacture semiconductors in the electronics industry.

2. A means of concentrating pollutants in wastewaters by cyrstallizing out pure water.

Curcumine or Carmine Method

A standard method of measuring the concentration of boron (B) within a solution.

Cyaniding

A process of case hardening an iron-base alloy by the simultaneous absorption of carbon and nitrogen by heating in a cyanide salt. Cyaniding is usually followed by quenching to produce a hard case.

Cyclone Separator

A device which removes entrained solids from gas streams.

Czochralski Crystallization

(Crystal Growing Process) This method is used to produce single crystals. This is done by dipping a seed crystal into a molten mass of material contained in a crucible and then slowly withdrawing it. The molten material freezes onto the seed as a single crystal in the same crystallographic orientation as the seed.

Deburring

Removal of burrs or sharp edges from parts by filing, grinding or rolling the work in a barrel with abrasives suspended in a suitable medium.

Decorative Overlaying

(Plastics) A finishing process of embedding into suitable clear, light-stabilized resin a decorative web which becomes a permanent part of the finished laminate.

Degassing

(Fluxing) The removal of hydrogen and other impurities from molten primary aluminum in a casthouse holding furnace by injecting chlorine gas (often with nitrogen and carbon).

Demineralization

The removal from water of mineral contaminants usually present in ionized form. The methods used include ion-exchange techniques, flash distillation or electrolysis.

Deoxidizing

The removal of an oxide film from a material.

Depreciation

Decline in value of a capital asset, caused either by use or by obsolescence.

Descaling

The removal of scale and metallic oxides from the surface of a metal by mechanical or chemical means. The former includes the use of steam, scale-breakers and chipping tools, the latter method includes pickling in acid solutions.

Desmutting

The removal of smut (matter that soils or blackens) generally by chemical action.

Dewatering

(Sludge Processing) Removing water from sludge.

Diaminobenzidene

A standard method of measuring the concentrations of selenium in a solution.

Diazotization

A standard method of measuring the concentration of nitrite in a solution.

Dichromate Reflux

A standard method of measuring the chemical oxygen demand of a solution

Die Casting

(hot chamber, vacuum, pressure) Castings are produced by forcing molten metal under pressure into metal molds called dies. In hot chamber machines, the pressure cylinder is submerged in the molten metal resulting in a minimum of time and metal cooling during casting. Vacuum feed machines use a vacuum to draw a measured amount of melt from the molten bath into the feed chamber. Pressure feed systems use a hydraulic or pneumatic cylinder to feed molten metal to the die.

Diffusion Process

(Semi-Conductor Mfg.) The method of producing junctions by disseminating acceptors or donors into a semiconductor at a high temperature.

Digestion

A standard method of measuring organic nitrogen.

Dip Molding

A male mold, usually aluminum, is heated and dipped in a tank of vinyl plastisol. When the required buildup is achieved, the coated mold is moved to an oven for curing. The resulting plastic part is then cooled and separated from the mold.

Dipping

Material coating by briefly immersing parts in a molten bath, solution or suspension.

Dispersed-air Flotation

Separation of low density contaminants from water using minute air bubbles attached to individual particles to provide or increase the buoyancy of the particle. The bubbles are generated by introducing air through a revolving impeller or porous media.

Dissolved-air Flotation

Separation of low density contaminants from water using minute air bubbles attached to individual particles to provide or increase the buoyancy of the particle. The air is put into solution under elevated pressure and later released under atmospheric pressure or put into solution by aeration at atmospheric pressure and then released under a vacuum.

Direct Labor Costs

Salaries, wages and other direct compensations earned by the employee.

Discharge of Pollutant(s)

1. The addition of any pollutant to navigable waters from any point source.

2. Any addition of any pollutant to the waters of the contiguous zone or the ocean from any point source, other than from a vessel or other floating craft. The term "discharge" includes either the discharge of a single pollutant or the discharge of multiple pollutants.

Dissolved Oxygen (DO)

The oxygen dissolved in sewage, water, or other liquid, usually expressed in milligrams per liter or percent of saturation. It is the test used in BOD determination.

Distillation

Vaporization of a liquid followed by condensation of the vapor.

Distillation-AgNO3 Titration

A standard method of measuring the concentration of cyanides in a solution.

Distillation-Nesslerization

A standard method of measuring ammonia concentration in a solution.

Distillation Refining

A metal with an impurity having a higher vapor pressure than the base metal can be refined by heating the metal to the point where the impurity vaporizes.

Distillation-SPADNS

A standard method of measuring the concentration of fluoride in a solution.

DO Probe

An instrument for measuring dissolved oxygen concentration in wastewater.

Dollar Base

A period in time to which all costs are related. Investment costs are related by the Sewage Treatment Plant Construction Cost Index. Supply costs are related by the "Industrial Commodities" Wholesale Price Index.

Drag-in

Water or solution carried into another solution by the work and the associated handling equipment.

Dragout

The solution that adheres to the objects removed from a bath, more precisely defined as that solution which is carried past the edge of the tank.

Dragout Reduction

Minimization of dragout through use of improved rinsing methods.

Drawing

Reduction of cross section area and increasing the length by pulling metal through conical tapered dies.

Drilling

Hole making with a rotary, end-cutting tool having one or more cutting lips and one or more helical or straight flutes or tubes for the ejection of chips and the passage of a cutting fluid.

1. Center Drilling - Drilling a conical hole in the end of a work piece

2. Core Drilling - Enlarging a hole with a chamer-edged, multiple-flute drill

3. Spade Drilling - Drilling with a flat blade drill tip

4. Step Drilling - Using a multiple diameter drill

5. Gun Drilling - Using special straight flute drills with a single lip and cutting fluid at high pressures for deep hole drilling

6. Oil Hole or Pressurized Coolant Drilling - Using a drill with one or more continuous holes through its body and shank to permit the passage of a high pressure cutting fluid which emerges at the drill point and ejects chips

Dross

Metallic oxides which float to or form on the surface of molten metal.

Drying Beds

Areas for dewatering of sludge by evaporation and seepage.

EDTA Titration

EDTA - ethylenediamine tetracetic acid (or its salts). A standard method of measuring the hardness of a solution.

Effluent

The quantities, rates and concentrations of chemical, physical, biological and other constituents which are discharged from point sources.

Effluent Limitation

Any restriction (including schedules of compliance) established by a State or EPA on quantities, rates, and concentrations of chemical, physical, biological and other constituents which are discharged from point sources into navigable waters, the waters of the contiguous zone, or the ocean.

Electrical Conductivity

The property of a solution which allows an electric current to flow when a potential difference is applied. It is the reciprocal of the resistance in ohms measured between opposite faces of a centimeter cube of an aqueous solution at a specified temperature. It is expressed as microohms per centimeter at temperature degrees Celsius.

Electrical Discharge Machining

Metal removed by a rapid spark discharge between different polarity electrodes, one the work piece and the other the tool separated by a gap distance of 0.0005 in. to 0.035 in. The gap is filled with dielectric fluid and metal particles which are melted, in part vaporized and expelled from the gap.

Electrobrightening

A process of reversed electro-deposition which results in anodic metal taking a high polish.

Electrochemical Machining (ECM)

A machining process whereby the part to be machined is made the anode and a shaped cathode is maintained in close proximity to the work. Electrolyte is pumped between the electrodes and a potential applied with the result that metal is rapidly dissolved from the work in a selective manner and the shape produced on the work complements that of the cathode.

Electrode

Conducting material for passing electric current out of a solution by taking up electrons or passing electric current into it by giving up electrons from or to ions in the solution.

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Electrodialysis

A treatment process that uses electrical current and an arrangement of permeable membranes to separate soluble minerals from water. Ofte used to desalinate salt or brackish water.

Electroless Plating

Deposition of a metallic coating by a controlled chemical reduction that is catalyzed by the metal or alloy being deposited.

Electrolysis

The chemical decomposition by an electric current of a substance in a dissolved or molten state.

Electrolyte

1. An ionic conductor

2. A liquid, most often a solution, that will conduct an electric current

Electrolytic Cell

A unit apparatus in which electrochemical reactions are produced by applying electrical energy, or which supplies electrical energy as a result of chemical reactions and which includes two or more electrode and one or more electrolytes contained in a suitable vessel.

Electrolytic Decomposition

An electrochemical treatment used for the oxidation of cyanides. The method is practical and economical when applied to concentrated solutions such as contaminated baths, cyanide dips, stripping solutions, and concentrated rinses. Electrolysis is carried out at a current density of 35 amp/sq ft at the anode and 70 amp/sq ft at the cathode. Metal is deposited at the cathode and can be reclaimed.

Electrolytic Oxidation

A reaction by an electrolyte in which there is an increase in valence resulting from a loss of electrons.

Electrolytic Reduction

A reaction in which there is a decrease in valence resulting from a gain in electrons.

Electrolytic Refining

The method of producing pure metals by making the impure metal the anode in an electrolytic cell and depositing a pure cathode. The impurities either remain undissolved at the anode or pass into solutions in the electrolyte.

Electrometallurgical Process

The application of electric current to a metallurgical process either for electrolytic deposition or as a source of heat.

Electrometric Titration

A standard method of measuring the alkalinity of a solution.

Electron Beam Machining

Material removal accomplished by a high velocity focused stream of electrons which melt and vaporize a work piece at the point of impingement.

Electropainting

A coating process in which the coating is formed on the work piece by making it anodic or cathodic in a bath that is generally an aqueous emulsion of the coating material.

Electroplating

The production of a thin coating of one metal on another by electrodeposition.

Electropolishing

A process for obtaining a smooth surface by passing an electric current through the part and a chemical electrolyte. The process is a method of etching away the high points of a rough surface more rapidly than the lower portion.

Electrostatic Painting

Spray painting with electrically charged paint particles to eliminate overspray.

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Electrostatic Precipitator

A unit for removing particulate solids from a gas stream by collecting the particles on electrically charged plates or wires. The system may operate dry or the plates may be continuously cleaned by a falling film of water.

Embossing

Raising a design in relief against a surface.

Emulsified Oil and Grease

Consists of an oil or grease dispersed in an immiscible liquid usually in droplets of larger than colloidal size. In general suspension of oil or grease within another liquid.

Emulsifying Agent

A material that increases the stability of a dispersion of one liquid in another.

Emulsion Breaking

Decreasing the stability of dispersion of one liquid in another.

Emulsion Cleaning

Organic solvents dispersed in an aqueous medium with the aid of an emulsifying agent.

Enamel

A paintlike coating usually sprayed and then air dryed or baked available in unlimited colors and textures. Enameling is used for decorative and protective purposes.

Encapsulation

A process where a coating or molding is put around the hybrid film substate. The coatings range from wax to epoxy.

Environmental Protection Agency

The United States Environmental Protection Agency.

EPA

See Environmental Protection Agency.

Equalization

(continuous flow) Holding tank is used to give a continuous flow for a system that has widely varying inflow rates.

Evaporation (Crystal Growing Process)

"Hydrothermal Method" - A saturated aqueous solution containing quartz nutrient that has been raised to an elevated temperature and pressurized inside an autoclave to insure solubility. A temperature gradient between the bottom and top of the autoclave permits density gradients within the saturated solution and insures the proper flow of nutrients to the seeds.

Evaporation Ponds

Liquid waste disposal areas that allow the liquid to vaporize to cool discharge water temperatures or to thicken sludge.

Etching

A process where material is removed by chemical action.

Excess Capacity Factor

A multiplier on process size to account for shutdown for cleaning and maintenance.

Extrusion

A material that is forced through a die to form lengths of rod, tube or special sections.

Ferrite

A solid solution in which alpha iron is present.

Ferrous

Relating to or containing iron.

Filtrate

Liquid after passing through a filter.

Filtration

Removal of solid particles from liquid or particles from air or gas stream through a permeable membrane.

Types: Gravity
Pressure
Microstraining
Ultrafiltration
Reverse Osmosis (hyperfiltration)

Flame Hardened

Surface hardened by controlled torch heating followed by quenching with water or air.

Flame Photometry

A standard method of measuring the concentration of strontium in a solution.

Flame Spraying

Method of applying a plastic coating in which finely powdered fragments of the plastic, together with suitable fluxes, are projected through a cone of flame onto a surface.

Flameless Atomic Absorption

A method of measuring the concentration of a solution.

Float Zone Crystal

A crystal grown by passing a molten zone through a cylinder of material. No other material with the possible exception of a gas, contacts the molten zone. When the crystal is grown in a vacuum, the term "vacuum float-zone crystal" is frequently used.

Float Zone Technique

(Crystal Growth) This is accomplished by placing a crystal seed in contact with the end of a polycrystalline rod and lowering that end of the rod into a furnace chamber. A molten zone is established in the rod and the seed is welded to the poly-rod. The rod is slowly removed and the material at the lower end will have the same crystal structure as the seed.

Flocculation

The process of separating suspended solids from wastewater by chemical creation of clumps or flocs.

Flotation

The rising of suspended matter to the surface of the liquid in a tank as scum by aeration, the evolution of gas, chemicals, electrolysis, heat, or bacterial decomposition and the subsequent removal of the scum by skimming.

See: Centrifugal
Air Flotation
Gravity

Flow Turning

A method of metal forming.

* Fluid Sand Molding

Fluid sand molding employs sand, sodium silicate, wetting agents, chemical hardeners and water to produce a brightly flowable mixture. After pouring the mold air will harden requiring heating only to force dry a surface wash.

Fluxing

(Degassing) The removal of oxides and other impurities from molten primary aluminum in a casthouse holding furnace by injecting chlorine gas (often with nitrogen and carbon monoxide).

Foaming

A process which consists of expanding a fluid polymer phase to create small discontinuities or cells and causing these cells to grow to a desired volume then stabilizing this cellular structure by physical or chemical processes.

Forging

A cold or hot mechanical working process performed by presses or hammers to shape metals.

Types: Hammer
Press
Hot Upset
High Energy Rate
Ring Rolling
Canned Powder

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Forming

(Plastic Process) Process of heating pieces until soft and then shaping them through the use of a mold and low pressure to the desired configuration.

4-AAP Colorimetric

A standard method of measurement for phenols in aqueous solutions.

Free Cyanide

1. True - the actual concentration of cyanide radical, or equivalent alkali cyanide, not combined in complex ions with metals in solutions.

2. Calculated - the concentration of cyanide, or alkali cyanide, present in solution in excess of that calculated as necessary to form a specified complex ion with a metal or metals present in solution.

3. Analytical - the free cyanide content of a solution as determined by a specified analytical method.

Freezing/Crystallization

A unit treatment process in which water is crystallized and the crystals removed from the concentrated waste stream. Ice crystals normally form relatively free of impurities.

Galvanizing

The deposition of zinc on the surface of steel for corrosion protection.

Gangue

The worthless rock or other material in which valuable metals or minerals occur.

Gas Carburizing

The introduction of carbon into the surface layers of mill steel by heating in a current of gas high in carbon.

Gas Chromotography

A complex instrumental method of determining the concentrations of certain wastewater contaminants.

Gas Nitriding

Case hardening metal by heating and diffusing nitrogen gas into the surface.

Gas Plating

See Vapor Plating.

Gear Forming

Process for making small gears by rolling the gear material as it is pressed between hardened gear shaped dies.

Glass Fiber Filtration

A standard method of measuring total suspendable solids.

Good Housekeeping

(In-Plant Technology) Good and proper maintenance minimizing spills and upsets.

GPD

Gallons per day.

Grab Sample

A single sample of wastewater taken at neither set time nor flow.

Gravimetric 103-105C

A standard method of measuring total solids in aqueous solutions.

Gravimetric 550C

A standard method of measuring total volatile solids in aqueous solutions.

Gravity Filtration

Settling of heavier and rising of lighter constituents within a solution.

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Gravity Flotation

The separation of water and low density contaminants as oil or grease by reduction of the wastewater flow velocity and turbulence for a sufficient time to permit separation due to difference in specific gravity time. The floated material is removed by some skimming technique.

Gray Cast Irons

Alloys primarily of iron, carbon and silicon along with other alloying elements in which the grapl..'e is in flake form. (These irons are characterized by low ductil..y but have many other properties such as good castability and good damping capacity.)

Grease

In wastewater, a group of substances including fats, waxes, free fatty acids, calcium and magnesium soaps, mineral oils, and certain other nonfatty materials. The type of solvent and method used for extraction should be stated for quantification.

Grease Skimmer

A device for removing floating grease or scum from the surface of wastewater in a tank.

Grinding

Material removal by use of abrasive grains held by a binder.

1. Surface Grinding - Producing a flat surface with a rotating grinding wheel as the work piece passes under the wheel.

2. Cylindrical Grinding - Grinding the outside diameters of cylindrical work pieces held between centers.

3. Internal Grinding - Grinding the inside of a rotating work piece by use of a wheel spindle which rotates and reciprocates through the length of depth of the hole being ground.

Hammer Forging

Heating and pounding metal to shape it into the desired form.

Hardened

Designates condition produced by various heat treatments such as quench hardening, age hardening and precipitation hardening.

Hardness

A characteristic of water, imparted by salts of calcium, magnesium and iron such as bicarbonates, carbonates, sulfates, chlorides and nitrates, that cause curdling of soap, deposition of scale in boilers, damage in some industrial processes and sometimes objectionable taste. It may be determined by a standard laboratory procedure or computed from the amounts of calcium and magnesium as well as iron, aluminum, manganese, barium, strontium and zinc and is expressed as equivalent calcium carbonate.

Heading

(Material Forming) Upsetting wire, rod or bar stock in dies to form parts having some of the cross-sectional area larger than the original. Examples are bolts, rivets and screws.

Heat Resistant Steels

Steel with high resistance to oxidation and moderate strength at high temperatures above 500 Degrees C.

Heat Treatment

Heating and cooling a solid metal or alloy in such a way as to obtain desired conditions or properties. Heating for the sole purpose of hot working is excluded from the meaning of this definition.

Heavy Metals

Metals which can be precipitated by hydrogen sulfide in acid solution, e.g., lead, silver, gold, mercury, bismuth, copper, nickel, iron, chromium, zinc, cadmium and tin.

Hermetic Sealing

Air and fluid tight closure that must be broken to be opened.

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High Energy Forming

Processes where parts are formed at a rapid rate by using extremely high pressures.

Examples: Explosive forming
Electrohydraulic forming

High Energy Rate Forging (HERF)

A closed die process where hot or cold deforming is accomplished by a high velocity ram.

Hobbing

Gear cutting by use of a tool resembling a worm gear in appearance, having helically-spaced cutting teeth. In a single-thread hob, the rows of teeth advance exactly one pitch as the hob makes one revolution. With only one hob, it is possible to cut interchangeable gears of a given pitch of any number of teeth within the range of the hobbing machine.

Honing

A finishing operation using fine grit abrasive stones to produce accurate dimensions and excellent finish.

Hot Compression Molding

(Plastic Processing) A technique of thermoset molding in which preheated molding compound is placed in the open mold cavity, mold is closed and heat and pressure (in the form of a downward moving ram) are applied until the material has cured.

Hot Dip Coating

A method of coating one metal with another by immersing in a molten bath to provide a protective film.

Hot Rolled

A term used to describe alloys which are rolled at temperatures above the recrystallization temperature. (Many alloys are hot rolled, and machinability of such alloys may vary because of differences in cooling conditions from lot to lot.)

Hot Stamping

Engraving operation for marking plastics in which roll leaf is stamped with heated metal dies onto the face of the plastics. Ink compounds can also be used.

Hot Upset Forging

The diameter is locally increased i.e. to upset the head of a bolt, the end of the barstock is heated and then deformed by an axial blow often into a suitably shaped die.

Hydrometallurgical Process

The treatment of ores by wet processes such as leaching.

Immersion Plate

(cementation) A metallic deposit produced by a displacement reaction in which one metal displaces another from solution, for example:

$$Fe + Cu(+2) = Cu + Fe\ (+2)$$

Incineration

(Sludge Disposal) The combustion (by burning) or organic matter in wastewater sludge solids after water evaporation from the solids.

Incineration/Combustion

(Oil Disposal) Burning oil and other wastes in an incinerator at high temperatures.

Incompatible Pollutants

Those pollutants which would cause harm to, adversely affect the performance of, or be inadequately treated in publicly-owned treatment works.

Indirect Labor Costs

Labor-related costs paid by the employer other than salaries, wages and other direct compensation such as social security and insurance.

Induction Hardened

Surface or through hardened using induction heating followed by quenching with water or air.

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Industrial User

Any industry that introduces pollutants into public sewer systems and whose wastes are treated by a publicly-owned treatment facility.

Industrial Wastes

The liquid wastes from industrial processes, as distinct from domestic or sanitary wastes.

Injection Molding

A molding procedure whereby a heat-softened plastic material is forced from a cylinder into a relatively cool cavity which gives the article the desired shape.

In-mold Decoration

(Plastics) Process where a piece of printed melamine-impregnated paper called a foil is introduced into the mold after a part is partially cured.

Inspection

A checking or testing of something against standards or specification.

Intake Water

Gross water minus reused water.

Integrated Chemical Treatment

A waste treatment method in which a chemical rinse tank is inserted in the pickling line between the process tank and the water rinse tank. The chemical rinse solution is continuously circulated through the tank and removes the dragout while reacting chemicals with it.

Integrated Circuit (IC)

1. A combination of interconnected circuit elements inseparably associated on or within a continuous substrate.

2. Any electronic device in which both active and passive elements are contained in a single package. Methods of making an integrated circuit are by masking process, screening and chemical deposition.

Intraforming

A method of forming by means of squeezing.

Investment Casting

1. Casting metal into a mold produced by surrounding (investing) an expendable pattern with a refractory slurry that sets at room temperature after which the wax, plastic or frozen mercury pattern is removed through the use of heat. Also called precision casting, or lost-wax process.

2. A casting made by the process.

Investment Costs

The capital expenditures required to bring the treatment or control technology into operation.

Ion Exchange

A reversible chemical reaction between a solid and a fluid by means of which ions may be interchanged from one substance to another. The customary procedure is to pass the fluid through a bed of the solid, which is granular and porous and has a limited capacity for exchange. The process is essentially a batch type in which the ion exchanger, upon nearing depletion, is regenerated by inexpensive sales or acid.

Ion-Flotation Technique

Treatment for electroplating rinse waters (containing chromium and cyanide) in which ions are separated from solutions by flotation.

Iridite Dip Process

Dipping process for zinc or zinc-coated objects that deposits an adherent protective film that is a chrome gel, chrome oxide or hydrated chrome oxide compound.

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Isolation

Segregation of a waste for separate treatment and/or disposal.

Jackson Units

The standard unit for measuring turbidity.

Joining

To put or bring together so as to form a unit.

See: Welding
Brazing
Soldering
Laminating
Riveting
Adhesive Bonding

Kiln

(Rotary) A large cylindrical mechanized type of furnace.

Kjeldahl Nitrogen

A method of determining the ammonia and organically bound nitrogen in the -3 valance state but does not determine nitrite, azides, nitro, nitroso, oximes or nitrate nitrogen.

Knurling

Impressing a design into a metallic surface, usually by means of small, hard rollers that carry the corresponding design on their surfaces.

Lagoon

A man-made pond or lake for holding wastewater for the removal of suspended solids. Lagoons are also used as retention ponds, after chemical clarification to polish the effluent and to safeguard against upsets in the clarifier; for stabilization of organic matter by biological oxidation; for storage of sludge; and for cooling of water.

Laminate

1. A composite metal, usually in form of sheet, or bar, composed of two or more metal layers so bonded that the composite metal forms a structural member.

2. To form a metallic product of two or more bonded layers.

Laminating

Forming of plastic or wood parts by adhesive bonding of layers.

Land Fill

Disposal of inert, insoluble waste solids by dumping at an approved site and covering with earth.

Lapping

An abrading process to improve surface quality by reducing roughness, waviness and defects to produce accurate as well as smooth surfaces.

Laser Beam Machining

Use of a highly focused mono-frequency collimated beam of light to melt or sublime material at the point of impingement on a work piece.

Leach Field

An area of ground to which wastewater is discharged. Not considered an acceptable treatment method for industrial wastes.

Leaching

Dissolving out by the action of a percolating liquid, such as water, seeping through a sanitary landfill.

Level I

BPT technology or effluent limitations.

Level II

BAT technology or effluent limitations

Level III

New Source Performance Standards

Liquid Carburizing

A method used for case hardening steel or iron. It is accomplished by immersing the work piece in cyanide bath.

Liquid-Liquid Extraction with Trichlorotrifluroethane

A method of extracting oil or grease by distillation with Dupont Freon precision cleaning agent or equivalent.

Liquid Nitriding

Process of case hardening a metal in a molten cyanide bath.

Liquid Phase Pefining

A metal with an impurity possessing a lower melting point is refined by heating the metal to the point of melting of the low temperature metal. It is separated by sweating out.

Low Pressure Molding

A method of molding reinforced plastics.

Maintenance

The upkeep of property of equipment.

Malleablizing

Process of annealing brittle white cast iron in such a way that the combined carbon is wholly or partly transformed to graphitic or temper carbon nodules in a ferritic or pearlitic microstructure, thus providing a ductile and machinable material.

Maraged

Describes a series of heat treatments used to treat high strength steels of complex composition (maraging steels) by aging of martensite.

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Martensite

An acicular or needlelike microstructure that is formed in quenched steels. (It is very hard and brittle in the as quenched form and, therefore, is usually tempered before being placed into service. The harder forms of tempered martensite have poorer machinability.)

Martempering

Quenching an austentized ferrous alloy is a medium at a temperature in the upper part of the martensite range, or slightly above that range, and holding it in the medium until the temperature throughout the alloy is substantially uniform. The alloy is then allowed to cool in air through the martensite range.

Material Modification

(In-Plant Technology) Altering the substance from which a part is made.

Mechanical Finish

Final operations on a product performed by a machine or tool.

See: Polishing, Buffing
Barrel Finishing
Shot Peening
Power Brush Finishing

Mechanical Plating

Providing a coating wherein fine metal powders are peened onto the part by tumbling or other means.

Melting

When a material is changed from a solid to a liquid by the application of heat.

Membrane

A thin sheet of synthetic polymer, through the apertures of which small molecules can pass, while larger ones are retained.

Mercuric Nitrate Titration

A standard method of measuring chloride.

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Metal Masks

They are used to protect the metal that is not plated or otherwise surface treated.

Metal Oxidation Refining

A refining technique that removes impurities from the base metal because the impurity oxidizes more readily than the base. The metal is heated and oxygen supplied. The impurity upon oxidizing separates by gravity or volatilizes.

Metal Paste Production

Manufacture of metal pastes for use as pigments by mixing metal powders with mineral spirits, fatty acids and solvents. Grinding and filtration are steps in the process.

Metal Powder Production

Production of metal particles for such uses as pigments either by milling and grinding of scrap or by atomization of molten metal.

Metal Spraying

Coating metal objects by spraying molten metal upon the surface with gas pressure.

Methylene Blue Method

A standard method of measuring surfactants in aqueous solutions.

Microstraining

A tertiary effluent treatment consisting of a revolving drum which has micropore stainless steel panels attached to it.

Milling

Using a rotary tool with one or more teeth which engage the work piece and remove material as the work piece moves past the rotating cutter.

1. Face Milling - Milling a surface perpendicular to the axis of the cutter. Peripheral cutting edges remove the bulk of the material while the face cutting edges provide the finish of the surface being generated.

2. End Milling - Milling accomplished with a tool having cutting edges on its cylindrical surfaces as well as on its end. In end milling - peripheral, the peripheral cutting edges on the cylindrical surface are used; while in end milling-slotting, both end and peripheral cutting edges remove metal.

3. Side and Slot Milling - Milling of the side or slot of a work piece using a peripheral cutter.

4. Slab Milling - Milling of a surface parallel to the axis of a helical, multiple-toothed cutter mounted on an arbor.

5. Straddle Milling - Peripheral milling a work piece on both sides at once using two cutters spaced as required.

Modified Winkler or D.O. Probe

A standard method of measuring dissolved oxygen in aqueous solution.

Mold

1. A form made of sand, metal or other material which contains the cavity into which molten metal is poured to produce a casting of definite shape and outline.

2. Powder metallurgy - same as die.

Monitoring

The measurement, sometimes continuous, of water quality.

Mother Liquor

The solution from which crystals are formed.

Multiple Operation Machinery

Two or more tools are used to perform simultaneous or consecutive operations.

Multi-Effect Evaporator

In chemical processing installations, requiring a series of evaporations and condensations, the individual units are set up in series and the latent heat of vaporization from one unit is used to supply energy for the next. Such units are called "effects" in engineering parlance as, e.g., a triple effect evaporator.

Multiple Subcategory Plant

A plant discharging process wastewater from more than one manufacturing process subcategory.

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National Pollutant Discharge Elimination System (NPDES)

The federal mechanism for regulating point source discharge by means of permits.

Navigable Waters

All navigable waters of the United States; tributaries of navigable waters of the United States; interstate waters; intrastate lakes, rivers and streams which are utilized by interstate travelers for recreational or other purposes; intrastate lakes, rivers, and streams from which fish or shellfish are taken and sold in interstate commerce; and intrastate lakes, rivers and streams which are utilized for industrial purposes by industries in interstate commerce.

Neutralization

Reaction of acid or alkali with the opposite reagent until the concentrations of hydrogen and hydroxyl ions in the solution are approximately equal.

New Source

Any building, structure, facility or installation from which there is or may be the discharge of pollutants, the construction of which is commenced after the publication of proposed regulations prescribing a standard of performance under section 306 of the Act which will be applicable to such source if such standard is thereafter promulgated in accordance with section 306 of the Act.

New Source Performance Standards (NSPS)

Performance standards for the industry and applicable new sources as defined by Section 306 of the Act.

Nitriding

A heat treating method in which nitrogen is diffused into the surface of iron-base alloys. (This is done by heating the metal at a temperature of about 950 degrees F in contact with ammonia gas or other suitable nitrogenous materials. The surface, because of formation of nitrides becomes much harder than the interior. Depth of the nitrided surface is a function of the length of time of exposure and can vary from .0005" to .032" thick. Hardness is generally in the 65 to 70 R_c range, and, therefore, these structures are almost always ground.)

Nitriding Steels

Steels which are selected because they form good case hardened structures in the nitriding process. (In these steels, elements such as aluminum and chromium are important for producing a good case.)

Non-contact Cooling Water

Means water used for cooling which does not come into direct contact with any raw material, intermediate product, waste product or finished product.

Non-contact Cooling Water Pollutants

Pollutants present in non-contact cooling waters.

Non-emulsified Oil and Grease

An oil or grease that is uniform throughout. (Does not have one liquid suspended in another liquid.)

Non-ferrous

No iron content.

Normalized

Heat treatment of iron-base alloys above the critical temperature, followed by cooling in still air. (This is often done to refine or homogenize the grain structure of castings, forgings and wrought steel products.)

Notching

Cutting out various shapes from the edge or side of a sheet, strip, blank or part.

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NPDES

See National Pollutant Discharge Elimination System.

Ocean Disposal

The dumping of pollutants in the ocean.

Operation and Maintenance Costs

The annual cost of running the wastewater treatment equipment. This includes labor costs, material and supply costs, and energy and power costs.

ORP Recorders

Oxidation-reduction potential recorders.

Overlaying

A form of laminating in which a highly resinous surface sheet is pressed over a pattern. This overlay sheet reproduces the press plate texture and protects the pattern on the adjacent print sheet.

Oxidizable Cyanide

Cyanide amenable to oxidation by chlorine according to standard analytical methods.

Oxidizing

Combining the material concerned with oxygen.

Pack Carburizing

Case hardening by completely surrounding the work piece with a carbonaceous material in a closed container. The CO gas for carburizing is obtained by heating the packing material. Economical for small lots and for large pieces, particularly because it can be done in almost any furnace.

Painting, Lacquering, etc.

Generic terms for the application of coatings to the surface of a material for decorative and protective purposes.

Types: Solvent
Water Base
Electrostatic

Parameter

A characteristic element or constant factor.

Parameter (Lattice)

In a crystal, the length, usually in Angstrom units, or the unit cell along one of its aces or edges, also called "lattice constant".

Passivation

The changing of the chemically active surface of a metal to a much less reactive state by means of an acid dip.

Pearlite

A microstituent found in iron-base alloys consisting of a lamellar (Platelike) composite of ferrite and iron carbide. (This structure results from the decomposition of austenite and is very common in cast irons and annealed steels.)

Peening

Mechanical working of metal by hammer blows or shot impingement.

Permanent Mold

A metal mold (other than an ingot mold) of two or more parts that is used repeatedly for the production of many castings of the same form. Liquid metal is poured in by gravity.

pH

A unit for measuring acidity or alkalinity of water, based on hydrogen ion concentrations. a pH of 7 indicates a "neutral" water or solution. At pH lower than 7, a solution is acidic. At pH higher than 7, a solution is alkaline.

Phenols

A group of aromatic compounds having the hydroxyl group directly attached to the benzene nucleous. Phenols can be a contaminant in a waste stream from a manufacturing process.

Phosphate Coating

Process of forming rust-resistant layers on iron or steel by immersing in a hot solution of acid manganese, iron or zinc phosphate.

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Phosphates

Salts or esters of phosphoric acid. Often used in phosphatizing metal part prior to painting or porcelainizing.

Phosphatizing

Process of forming rust-resistant coating on iron or steel by im in a hot solution of acid manganese, iron or zinc phosphates.

Photolithography

The process of printing from a photographic plate on which the i to be printed is ink-receptive and the blank area ink repellent.

Photosensitive Coating

A chemical layer that is receptive to the action of radiant ener

Pickle

An acid solution used to remove oxides or other compounds relate the basis metal from its surface of a metal by chemical or elect chemical action.

Pickling

The process of removing scale, oxide or foreign matter from the of metal by immersing it in a bath containing a suitable chemica agent which will attack the oxide or scale, but will not appreci act upon the metal during the period of pickling. Frequently it necessary to immerse the metals in a detergent solution or to de in a vapor degreaser before pickling.

Planing

Producing flat surfaces by linear reciprocal motion of the work the table to which it is attached relative to a stationary singl point cutting tool.

Plant Effluent or Discharge After Treatment

The wastewater discharged from the industrial plant. In this de tion, any waste treatment device (pond, trickling filter, etc.) sidered part of the industrial plant.

Plasma Arc Machining

Material removed or formed with a high velocity jet of high temperature ionized gas.

Plaster Molding

Molding wherein a gypsum-bonded aggregate flour in the form of a water slurry is poured over a pattern, permitted to harden, and, after removal of the pattern, thoroughly dried. The technique is used to make smooth nonferrous castings of accurate size.

Plastic Coating

(Metals) Provide corrosion resistant, attractive surfaces, mask surface scratches, dampening to reduce noise. The coatings include P. V. C. (polyvinyl chloride, nylon, PTFE, polythene, polypropylene, epoxy resins, chlorinated polyethers and c.a.b. (cellulose acetate butyrate).

Plastic Compounding

The process of blending, with a raw polymer, additive ingredient(s) in order to alter its physical or chemical properties.

Plastic Drying

The process of reducing the volatiles contained in unprocessed plastics material in order to reduce or eliminate gaseous inclusions in the molded product.

Plastic Molding

1. To shape plastic parts or finished articles by heat and pressure.

2. The cavity or matrix into which the plastic composition is placed and from which it takes form.

3. The assembly of all the parts that function collectively in the molding process.

4. Sometimes used to demote finished piece.

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Plastics Preheating

The process of heating a plastic material immediately prior to molding in order to improve its flow characteristics and, therefore, its ultimate strength and appearance.

Plasticizers

High-boiling liquids used as ingredients in synthetic materials. They do not evaporate but preserve the flexibility and adhesive power of the synthetic material.

Plating

(Surface Treatment and Cleaning) Forming an adherent layer of metal upon an object.

Point Source

Any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Point Source Category

See Category.

Polishing

Removal of metal by the action of abrasive grains carried to the work by a flexible support, generally either a wheel or a coated abrasive belt.

Pollutant

Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal and agricultural waste discharged into water. It does not mean (1) sewage from vessels or (2) water, gas or other material which is injected into a well to facilitate production of oil or gas, or water derived in association with oil or gas production and disposed of in a well, if the well, used either to facilitate production or for disposal purposes, is approved by authority of the State in which the well is located, and if such State determines that such injection or disposal will not result in degradation of ground or surface water resources.

Pollutant Parameters

Those constituents of wastewater determined to be detrimental and, therefore, requiring control.

Pollution

The man-made or man-induced alteration of the chemical, physical, biological and radiological integrity of water.

Polychlorinated Biphenyl (PCB)

A family of chlorinated biphenyls with unique thermal properties and chemical inertness which have a wide variety of uses as plasticizers, flame retardants and insulating fluids. They represent a persistent contaminant in waste streams and receiving waters.

Porcelain Enameling

Glass coatings applied primarily to products made of sheet steel, cast iron or aluminum or improve appearance and protect the metal surface.

Porcelainizing

To fire a vitreous coating on material such as steel.

Post Curing

Treatment after changing the physical properties of a material by chemical reaction.

Pouring

(Casting and Molding) Transferring molten metal from a furnace or a ladle to a mold.

Powder Molding

Sintering.

Power Brush Finishing

This is accomplished (wet or dry) using a wire or nonmetallic-fiber-filled brush used for deburring, edge blending and surface finishing of metals.

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Precipitation

The discrete particles of material rejected from a solid or liquid solution.

Precipitation Hardening Metals

Certain metal compositions which respond to precipitation hardening hardening or aging treatment.

Press Forging

Heating and hydraulically or mechanically squeezing a piece of metal into a desired shape.

Pressure Filtration

(Sludge Dewatering) Any separation (by filtering) of impurities from a fluid where pressure is used.

Pretreatment

Any process used to reduce the pollutant load before the waste is introduced into a sewer system sanitary drain or delivered to a treatment plant.

Primary Aluminum

Aluminum metal prepared from an ore, as distinguished from processed scrap metal.

Primary Settling

The first settling for the removal of settleable solids through which wastewater is passed in a treatment works.

Primary Treatment

The first stage in wastewater treatment in which floating or settleable solids are mechanically removed by screening and sedimentation.

Printed Circuit Boards

A circuit in which the interconnecting wires have been replaced by conductive strips printed, etched, etc. onto an insulating board. Methods of making include etched circuit, electroplating and stamping.

Printing

A process whereby a design or pattern in ink or types of pigments are impressed onto the surface of a part.

Process Modification

(In-Plant Technology) Reduction of water pollution by basic changes in a manufacturing process.

Process Wastewater

Any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material intermediate product, finished product, byproduct or waste product.

Punching

A method of cold extruding, cold heading, hot forging or stamping in a machine whereby the mating die sections control the shape or contour of the part.

Pyrolysis

(Sludge Removal) Decomposition of materials by the application of heat in an oxygen-deficient atmosphere.

Pyrometallurgical Process

(Smelting) Metallurgy involved in winning and refirming metals where heat is used, as in roasting and smelting.

Purzolone-Colorimetric

A standard method of measuring cyanides in aqueous solutions.

Quantity GPD

Gallons per day.

Quenched

Rapid cooling of alloys by immersion in liquids or gases after heating.

Radiation Processing

Process of using gamma radiation sources or electron accelerator sources for initiating free radical chemical reactors within the plastic materials without the use of heat or catalyst.

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Radiography

A nondestructive method of internal examination in which metal or other objects are exposed to a beam of x-ray or gamma radiation. Differences in thickness, density or absorption, caused by internal discontinuities, are apparent in the shadow image either on a fluorescent screen or on photographic film placed behind the object.

Reaming

An operation in which a previously formed hole is sized and contoured accurately by using a rotary cutting tool (reamer) with one or more cutting elements (teeth). The principal support for the reamer during the cutting action is obtained from the work piece.

1. Form Reaming - Reaming to a contour shape.

2. Taper Reaming - Using a special reamer for taper pins.

3. Hand Reaming - Using a long lead reamer which permits reaming by hand.

4. Pressure Coolant Reaming (or Gun Reaming) - Using a multiple-lip, end cutting tool through which coolant is forced at high pressure to flush chips ahead of the tool or back through the flutes for finishing of deep holes.

Receiving Waters

Rivers, lakes, oceans or other water courses that receive treated or untreated wastewaters.

Recycle Lagoon

A pond that collects treated wastewater, most of which is recycled as process water.

Reduction

1. In cupping and deep drawing, a measure of the percentage decrease from blank diameter to cup diameter, or of diameter reduction in redraws.

2. In forging, rolling and drawing, either the ratio of the original to final cross-sectional area.

3. A reaction in which there is a decrease in valance resulting from a gain in electrons. Contrast with oxidation.

Refining

Purifying crude or impure metals.

See: Liquid Phase Refining
Distillation Refining
Electrolytic Refining
Melt Oxidation Refining

Residual Chlorine

The amount of chlorine left in the treated water is available to oxidize contaminants.

Reverse Osmosis

(Hyperfiltration) A recovery process in which the more concentrated solution is put under a pressure greater than the osmotic pressure to drive water across the membrane to the dilute stream while leaving behind the dissolved salts.

Ring Rolling

A metals process in which a doughnut shaped piece of stock is flattened to the desired ring shape by rolling between variably spaced rollers. This process produces a seamless ring.

Rinse

Water for removal of dragout by dipping, spraying, fogging, etc.

Riveting

Joining of two or more members of a structure by means of metal rivets, the unheaded end being upset after the rivet is in place.

Roasting

Heating an ore to effect some chemical change that will facilitate smelting.

Rod Mill

(or Shop) A facility at some primary aluminum plants for casting aluminum and forming rod usually about one-half inch in diameter.

Rolling

Reducing the cross-sectional area of metal stock, or otherwise shaping metal products, through the use of rotating rolls.

Rotational Molding

A process where the mold is rotated about two perpendicular axes simultaneously. This process is intended primarily for the manufacture of hollow objects from thermoplastics and, to a limited extent, it is also used to process thermosetting materials.

Routing

Cutting out and contouring edges of various shapes in a relatively thin material using a small diameter rotating cutter which is operated at fairly high speeds.

Running Rinse

A rinse tank in which water continually flows in and out.

Rust Prevention Compounds

These are coatings used to protect iron and steel surfaces against corrosive environments during fabrication, storage or use.

Salt Bath Descaling

Removing the layer of oxides formed on some metals at elevated temperatures in a salt solution.

See: Reducing
Oxidizing
Electrolytic

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Sand Casting

1. The principal ingredient used to form molds.

2. A physical part made from this process.

Sand Filtration

A process of filtering wastewater through sand. The wastewater is trickled over the bed of sand when air and bacteria decompose the wastes. The clean water flows out through drains in the bottom of the bed. The sludge accumulating at the surface must be removed from the bed periodically.

Sand Molding

Sand forms the cavity (or cavities) of the shape to be cast.

Sanitary Water

The supply of water used for sewage transport and the continuation of such effluents to disposal.

Sanitary Sewer

Pipes and conveyances that principally carry wastewater to a treatment plant.

Sawing

Using a toothed blade or disc to sever parts or cut contours.

1. Circular Sawing - Using a circular saw fed into the work by motion of either the work piece or the blade.

2. Power Band Sawing - Using a long, multiple-tooth continuous band resulting in a uniform cutting action as the work piece is fed into the saw.

3. Power Hack Sawing - Sawing in which a reciprocating saw blade is fed into the workpiece.

Screening

1. A process of using a device with openings, generally of uniform size, to retain or remove suspended or floating solids in flowing water or wastewater and to prevent them from entering an intake or passing a given point in a conduit. The screening element may consist of parallel bars, rods wires, grating, wire mesh or perforated plate, and the openings may be of any shape, although they are usually circular or rectangular.

2. A device used to segregate granular material such as sand, crushed rock and soil into various sizes.

Scrubber Liquor

The liquid in which dust and fumes are captured in a wet scrubber.

Seaming

Joining sheet metal parts by interlocking bends.

Secondary Settling

Effluent from some prior treatment process flows for the purpose of removing settleable solids.

Secondary Treatment

The treatment of wastewater by biological methods after primary treatment by sedimentation.

Sedimentation

The process of subsidence and deposition of suspended matter carried by water, wastewater or other liquids, by gravity. It is usually accomplished by reducing the velocity of the liquid below the point at which it can transport the suspended material. Also called settling.

Semi-Conductor Manufacturing Processes

See: Alloy Process
Diffusion Process
Sintering

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Settleable Solids

That matter in wastewater which will not stay in suspension during a preselected settling period, such as one hour, but either settles to the bottom or floats to the top.

Settling Ponds

A large shallow body of water into which industrial wastewaters are discharged. Suspended solids settle from the wastewaters due to the large retention time of water in the pond.

Shaping

Using single point tools fixed to a ram reciprocated in a linear motion past the work.

1. Form Shaping - Shaping with a tool ground to provide a specified shape.

2. Contour Shaping - Shaping of an irregular surface, usually with the aid of a tracing mechanism.

3. Internal Shaping - Shaping of internal forms such as keyways and guides.

Shaving

1. As a finishing operation, the accurate removal of a thin layer by drawing a cutter in straight line motion across the work surfaces.

2. Trimming parts like stampings, forgings and tubes to remove uneven sheared edges or to improve accuracy.

Shearing

Process of placing metal between adjacent sharp edges and stressing to make it shear at the point where the blades meet in the center of the metal.

Shell Molding

Forming a mold from thermosetting resin-bonded sand mixtures brought in contact with preheated (300 to 500 degrees F) metal patterns, resulting in a firm shell with a cavity corresponding to the outline of the pattern. Also called "Croning process".

Shipping

Transporting.

Shot Peening

Dry abrasive cleaning of metal surfaces by impacting the surfaces with high velocity steel shot.

Shotting

The production of small spherical particles of metal by pouring molten metal in finely divided streams. Solidified spherical particles are formed during the descent and are cooled in a tank of water.

Shredding

(Cutting or Stock Removal) Material cut, torn or broken up into small parts.

SIC - Standard Industrial Classification

Defines industries in accordance with the composition and structure of the economy and covers the entire field of economic activity.

Silica

(SiO_2) Dioxide of silicon which occurs in crystalline form as quartz, cristobalite, tridymite. Used in its pure form for high-grade refractories and high temperature insulators and in impure form (i.e. sand) in silica bricks.

Siliconizing

Diffusing silicon into solid metal, usually steel, at an elevated temperature for the purposes of case hardening thereby providing a corrosion and wear-resistant surface.

Sintered

(Metallurgical) The sintered condition results from a heating of pressed powdered materials for specified times at elevated temperature. Improved strength and other benefits result, but generally machinability is decreased.

Sintering

(Semi-conductor Manufacturing Process) A process where powdered metal is pulverized, molded and heated to a point before melting to form a consistent nonvaporous vacuum-tight piece. Photo conductive cells are made by this process.

Sizing

1. Secondary forming or squeezing operations, required to square up, set down, flatten or otherwise correct surfaces, to produce specified dimensions and tolerances. See restriking.

2. Some burnishing, broaching, drawing and shaving operations are also called sizing.

3. A finishing operation for correcting ovality in tubing.

4. Powd met. Final pressing of a sintered compact.

Skimming

Removal of floating matter.

Slag

The material formed by fusion of constituents of a charge or by the reactions between refractory materials and fluxes during metallurgical processes. This material contains many of the non-metallic constituents of the ore and will usually float on the molten metal.

Slaking

The process of reacting lime with water to yield a hydrated product.

Sludge

Residue produced in a waste treatment process.

Slurry

A watery suspension of solid materials.

Slush Molding

Similar to rotational molding of plastics, except the shells are not fitted with closures.

Smelting

Thermal processing wherein chemical reactions take place to produce liquid metal from a beneficiated ore.

Snagging

Heavy stock removal of superfluous material from a work piece by using a portable or swing grinder mounted with a coarse grain abrasive wheel.

Soldering

Similar to brazing with the filler metal having a melting temperature range below an arbitrary value, generally 800 degrees F. Soft solders are usually lead-tin alloys.

Solids

(Plant Waste) Residue material that has been completely dewatered.

Solute

A dissolved substance.

Solution

Homogeneous mixture of two or more components such as a liquid or a solid in a liquid.

Solution

(Crystal Growing Process) The solution technique is accomplished by introducing a seed into a saturated solution and by slowly lowering the temperature to allow the nutrients to grow onto a seed of the same solution.

Solution Treated

(Metallurgical) A process by which it is possible to dissolve micro-constituents by taking certain alloys to an elevated temperature and then keeping them in solution after quenching. (Often a solution treatment is followed by a precipitation or aging treatment to improve the mechanical properties. Most high temperature alloys which are solution treated and aged machine better in the solution treated state just before they are aged.)

Solvent

A liquid used to dissolve materials. In dilute solutions the component present in large excess is called the solvent and the dissolved substance is called the solute.

Solvent Cleaning

Removal of oxides, soils, oils, fats, waxes, greases, etc. by solvents.

Specific Conductance

The property of a solution which allows an electric current to flow when a potential difference is applied. See electrical conductivity.

Spectrophotometry

A method of analyzing a wastewater sample by means of the spectra emitted by its constituents under exposure to light.

Spinning

Shaping of seamless hollow cylindrical sheet metal parts by the combined forces of rotation and pressure.

Spotfacing

Using a rotary, hole piloted end facing tool to produce a flat surface normal to the axis of rotation of the tool on or slightly below the work piece surface.

Sputtering

A method of obtaining thin films of metal on metallic and non-metallic surfaces. The surface to be coated is bombarded with positive ions in a gas discharge tube, which is evacuated to a low pressure.

Squeezing

The process of reducing the size of a piece of heated material so that it is smaller but more compressed than it was before.

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Stainless Steels

Steels which have good or excellent corrosion resistance. (One of the common grades contains 18% chromium and 8% nickel. There are three broad classes of stainless steels - ferritic, austenitic, and martensitic. These various classes are produced through the use of various alloying elements in differing quantities.

Staking

Fastening two parts together permanently by recessing one part within the other and then causing plastic flow at the joint.

Stamping

A general term covering almost all press operations. It includes blanking, shearing, hot or cold forming, drawing, bending and coining.

Standard of Performance

The term means any restriction established by the Administrator pursuant to section 306 of the Act on quantities, rates and concentrations of chemical, physical, biological and other constituents which are or may be discharged from new sources into navigable waters, the waters of the contiguous zone or the ocean.

Storm Water Lake

Reservoir for storage of storm water runoff collected from plant site; also, auxiliary source of process water.

Stress Relieved

The heat treatment used to relieve the internal stresses induced by forming or heat treating operations. (It consists of heating a part uniformly, followed by cooling slow enough so as not to reintroduce stresses. To obtain low stress levels in steels and cast irons, temperatures as high as 1250 degrees F may be required.)

Strike

1. noun - a thin coating of metal (usually less than 0.0001 inch in thickness) to be followed by other coatings.

2. noun - a solution used to deposit a strike.

3. verb - a plate for a short time, usually at a high initial current density.

Stripping

The term used to describe the removal of an ingot from the mold. It also refers to the removal of coatings from metal.

Structural Steels

Steels covering a wide range of strengths and used for structural purposes. These steels are sometimes called high strength steels or constructional steels.

Subcategory

A segment of a point source category for which specific effluent limitations have been established.

Substrates

Thin coatings (as of hardened gelatin) on the support of a photographic film or plate to facilitate the adhesion of the sensitive emulsion.

Surface Waters

Any visible stream or body of water.

Surfactants

Surface active chemicals which tend to lower the surface tension between liquids, such as between acid and water.

Surge

A sudden rise to an excessive value, such as flow, pressure, temperature.

Swaging

Forming a taper or a reduction on metal products such as rod and tubing by forging, squeezing or hammering.

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Tank

A receptacle for holding transporting or storing liquids.

Tapping

Producing internal threads with a cylindrical cutting tool having two or more peripheral cutting elements shaped to cut threads of the desired size and form. By a combination of rotary and axial motion, the leading end of the tap cuts the thread while the tap is supported mainly by the thread it produces.

Tempering

Reheating a quench-hardened or normalized ferrous alloy to a temperature below the transformation range and then cooling at any rate desired.

Testing

An examination observation or evaluation to determine that article under inspection is in accordance with required specifications.

Thermoforming

(Vacuum, Pressure, Drape, Plug Assist, Matched Mold) Thermoforming is a technique in which thermoplastic sheet is heated until it is soft and then formed or shaped into a mold by means of low pressure processes.

Thermoplastic

A classification of plastics that become soft and pliable when heated.

Thermosetting

A classification of plastics that become permanently hard and rigid when heated or cured.

Thickener

A device or system wherein the solid contents of slurries or suspensions are increased by gravity settling and mechanical separation of the phases, or by flotation and mechanical separation of the phases.

Thickening

(Sludge Dewatering) Thickening or concentration is the process of removing water from sludge after its initial separation from wastewater. The basic objective of thickening is to reduce the volume of liquid sludge to be handled in subsequent sludge disposal processes.

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Threading

Producing external threads on a cylindrical surface.

1. Die Threading - A process for cutting external threads on cylindrical or tapered surfaces by the use of solid or self-opening dies.

2. Single-Point Threading - Turning threads on a lathe.

3. Thread Grinding - See definition under grinding.

4. Thread Milling - A method of cutting screw threads with a milling cutter.

Titration

1. A method of measuring acidity or alkalinity.

2. The determination of a constituent in a known volume of solution by the measured addition of a solution of known strength to completion of the reaction as signaled by observation of an end point.

Titrimetric; Iodine-Iodate

A method of measuring sulfide by measuring the amount of iodine that will react with sulfide under acidic conditions.

Total Organic Carbon (TOC)

TOC is a measure of the amount of carbon in a sample originating from organic matter only. The test is run by burning the sample and measuring the CO_2 produced.

Tool Steels

Steels used to make cutting tools and dies. (Many of these steels have considerable quantities of alloying elements such as chromium, carbon, tungsten, molybdenum and other elements. These form hard carbides which provide good wearing qualities but at the same time decrease machinability. Tool steels in the trade are classified for the most part by their applications, such as hot work die, cold work die, high speed, shock resisting, mold and special purpose steels.)

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Total Chromium

Total chromium (CrT) is the sum of chromium in all valences.

Total Cyanide

The total content of cyanide expressed as the radical CN-, or alkali cyanide whether present as simple or complex ions. The sum of both the combined and free cyanide content of a plating solution. In analytical terminology, total cyanide is the sum of cyanide amenable to oxidation by chlorine and that which is not according to standard analytical methods.

Total Dissolved Solids (TDS)

The total amount of dissolved solid materials present in an aqueous solution.

Total Metal

Sum of the metal content in both soluble and insoluble form.

Total Solids

The sum of dissolved and undissolved constituents in water or wastewater, usually stated in milligrams per liter.

Total Suspended Solids (TSS)

Solids found in wastewater or in the stream, which in most cases can be removed by filtration. The origin of suspended matter may be man-made or of natural sources, such as silt from erosion.

Total Volatile Solids

Volatile residue present in wastewater.

Toxic Pollutants

A pollutant or combination of pollutants including disease causing agents, which after discharge and upon exposure, ingestion, inhalation or assimilation into any organism either directly or indirectly cause death, disease, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction), and physical deformations in such organisms and their offspring.

Transfer Molding

A method of molding thermosetting materials, in which the plastic is first softened by heat and pressure in a transfer chamber, then forced through high pressure through suitable sprues, runners and gates into closed mold for final curing.

Trepanning

Cutting with a boring tool so designed as to leave an unmachined core when the operation is completed.

Trickling Filters

A filter consisting of an artificial bed of coarse material, such as broken stone, clinkers, slate, slats, or brush, over which an effluent is distributed and applied in drops, films, or spray, from troughs, drippers, moving distributors, or fixed nozzles, and through which it trickles to the underdrains giving opportunity for the formation of zoogleal slimes which clarify and oxidize the effluent.

Tumbling

An operation where the work, usually castings or forgings, is rotated in a barrel with metal slugs or abrasives to remove sand, scale or fins. It may be done dry or with aqueous solution.

Turbidimeter

An instrument for measurement of turbidity in which a standard suspension is usually used for reference.

Turbidity

1. A condition in water or wastewater caused by the presence of suspended matter, resulting in the scattering and absorption of light rays.

2. A measure of fine suspended matter in liquids.

3. An analytical quantity usually reported in arbitrary turbidity units determined by measurements of light diffraction.

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Turning

Generating cylindrical forms by removing metal with a single-point cutting tool moving parallel to the axis of rotation of the work.

1. Single-Point Turning - Using a tool with one cutting edge.

2. Face Turning - Turning a surface perpendicular to the axis of the workpiece.

3. Form Turning - Using a tool with a special shape.

4. Turning Cutoff - Severing the work piece with a special lathe tool.

5. Box Tool Turning - Turning the end of work piece with one or more cutters mounted in a boxlike frame, primarily for finish cuts.

Ultrafiltration

Filtration of colloids by a semipermeable membrane.

Ultrasonic Cleaning

Immersion cleaning aided by ultrasonic waves which cause microagitatio

Ultrasonic Machining

Material removal by means of an ultrasonic-vibrating tool usually working in an abrasive slurry in close contact with a work piece or having diamond or carbide cutting particles on its end.

Unit Operation

A single, discrete process as part of an overall sequence, e.g., precipitation, settling and filtration.

Vacuum Deposition

Condensation of thin metal coatings on the cool surface of work in a vacuum.

Vacuum Evaporization

A method of coating articles by melting and vaporizing the coating material on an electrically heated conductor in a chamber from which air has been exhausted. The process is only used to produce a decorative effect. Gold, silver, copper and aluminum have been used.

Vacuum Filtration

(Sludge Dewatering) Sludge passes over drum with filter medium and vacuum is applied to the inside of the drum compartments. As the drum rotates sludge accumulates on the filter surface and the vacuum removes water.

Vacuum Metalizing

This is a vapor-deposited coating. Metal vapor is flash heated in a high-vacuum chamber containing the parts to be coated and the vapor condenses on all exposed surfaces.

Vapor Degreasing

Degreasing work in vapor over a boiling liquid solvent, the vapor being considerably heavier than air. At least one constituent of the soil must be soluble in the solvent.

Vapor Plating

Deposition of a metal or compound upon a heated surface by reduction or decomposition of a volatile compound at a temperature below the melting points of the deposit and the basis material. The reduction is usually accomplished by a gaseous reducing agent such as hydrogen. The decomposition process may involve thermal dissociation or reaction with the basis material. Occasionally used to designate deposition on cold surfaces by vacuum evaporation -- see vacuum deposition.

Volume Method

A standard method of measuring settleable solids in an aqueous solution.

Waste Discharged

The amount (usually expressed as weight) of some residual substance which is suspended or dissolved in the plant effluent.

Wastewater Constituents

Those materials which are carried by or dissolved in a water stream for disposal.

Wastewater

Any water that has been released from the purpose for which it was intended to be used.

Water Recirculation or Recycling

The volume of water already used for some purpose in the plant which is returned with or without treatment to be used again in the same or another process.

Water Use

The total volume of water applied to various uses in the plant. It is the sum of water recirculation and water withdrawal.

Water Withdrawal or Intake

The volume of fresh water removed from a surface or underground water source by plant facilities or obtained from some source external to the plant.

Web Impregnation

(Plaster Process) Process of penetrating gaps or holes in a piece with coating compounds. This is done by impregnation of fibrous webs with film forming material. This can be done to things like woven fabrics, glass and paper.

Welding

1. Joining two or more pieces of material by applying heat, pressure or both, with or without filler material, to produce a localized union through fusion or recrystallization across the interface. The thickness of the filler material is much greater than the capillary dimensions encountered in brazing.

2. May also be extended to include brazing.

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Wet Air Oxidation

(Sludge Disposal) This process oxidizes the sludge in the liquid phase without mechanical dewatering. High-pressure high-temperature air is brought into contact with the waste material in a pressurized reactor. Oxidation occurs at 300 to 500 degrees F and from several hundred to 3,000 psig.

Wet Scrubbing

A unit in which dust and fumes are removed from a gas stream to a liquid. Gas-liquid contact is promoted by jets, sprays, bubble chambers, etc.

Wheatstone Bridge

(Resistance Bridge) A method of measuring resistance. A null-type resistance-measuring circuit in which resistance is measured by direct comparison with a standard resistance.

Work Piece

The item to be processed.

Wrought

Condition of a material which has been worked mechanically as in forging, rolling, drawing, etc.

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METRIC UNITS

CONVERSION TABLE

MULTIPLY (ENGLISH UNITS) TO OBTAIN (METRIC UNI

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 ft	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 kilo
yard	y	0.9144	m	meters

*Actual conversion, not a multiplier

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