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Development Document for Effluent Limitations Guidelines and Standards for the Copper Forming

Final

Point Source Category

DEVELOPMENT DOCUMENT
for
EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS
for the
COPPER FORMING POINT SOURCE CATEGORY

William Ruckelshaus
Administrator

Jack E. Ravan
Assistant Administrator for Water

Steven Schatzow
Director
Office of Water Regulations and Standards

Jeffery D. Denit, Director
Effluent Guidelines Division

Ernst P. Hall, P.E., Chief
Metals and Machinery Branch

Janet K. Goodwin
Technical Project Officer

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U.S. Environmental Protection Agency
Office of Water
Office of Water Regulations and Standards
Effluent Guidelines Division
Washington, D.C. 20460

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SECTION I

SUMMARY AND CONCLUSIONS

Pursuant to Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act and the provisions of the Settlement Agreement in Natural Resources Defense Council v. Train, 8 ERC 2120 (D.D.C. 1976) modified, 12 ERC 1833 (D.D.C. 1979), EPA has collected and analyzed data for plants in the Copper Forming Point Source Category. This document and the administrative record provide the technical basis for promulgating effluent limitations based on best practicable technology (BPT) and best available technology (BAT) for existing direct dischargers, pretreatment standards for existing indirect dischargers (PSES), pretreatment standards for new indirect dischargers (PSNS), and standards of performance for new source direct dischargers (NSPS).

Summary of the Category

The copper forming category is comprised of 176 plants. Of the 176 plants, 37 discharge directly to rivers, lakes, or streams; 45 discharge to publicly owned treatment works (POTW); and 94 achieve zero discharge of process wastewater.

Copper forming is a term used to describe five basic operations used to form copper and copper alloys: hot rolling, cold rolling, extrusion, drawing, and forging. In addition to these forming operations, there are nine surface cleaning and heat treatment processes which impart desired surface and physical properties to the metal. These ancillary operations are annealing with oil, annealing with water, pickling bath and rinse, pickling fume scrubber, alkaline bath and rinse, extrusion press solution heat treatment, and solution heat treatment. In addition, copper forming facilities may perform tumbling or burnishing, surface coating, hydrotesting, surface milling, and sawing.

Raw materials used by copper forming plants originate in the casting processes of copper refineries and are commonly in the form of wire bars, cakes or slabs, and billets. In some instances they take the form of rod, wire, or strip obtained from another copper former. Copper alloys are frequently employed by the copper forming industry. For the purposes of this regulation, copper alloys include any alloy in which copper is the major constituent. Principal alloys processed by copper formers include brass, bronze, leaded brass, leaded bronze, nickel silvers, phosphor bronze, aluminum bronze, silicon bronze, beryllium copper, and cupronickel.

Pollutants found in significant amounts in copper forming waste streams include: chromium, copper, lead, nickel and zinc; toxic organics; and suspended solids, pH, and oil and grease.

EPA first studied the Copper Forming Point Source Category to determine whether differences in raw materials, final products, manufacturing processes, equipment, age and size of plants, or water usage, required the development of separate effluent limitations and standards for different segments of the category. This involved a detailed analysis of wastewater discharge and treated effluent characteristics, including (1) the sources and volume of water used, the processes employed, and the sources of pollutants and wastewaters in the plant; and (2) the constituents of wastewaters, including toxic pollutants.

EPA also identified several distinct control and treatment technologies (both in-plant and end-of-pipe) applicable to the Copper Forming Point Source Category. The Agency analyzed both historical and newly generated data on the performance of these technologies, including their nonwater quality environmental impacts and air quality, solid waste generation, and energy requirements. EPA also studied various flow reduction techniques reported in the data collection portfolios (dcp) and plant visits.

Engineering costs were prepared for each of the control and treatment options considered for the category. These costs were then used by the Agency to estimate the impact of implementing the various options on the industry. For each control and treatment option that the Agency found to be most effective and technically feasible in controlling the discharge of pollutants, the number of potential closures, number of employees affected, and impact on price were estimated. These results are reported in a separate document entitled "The Economic Impact Analysis of Effluent Limitations Guidelines and Standards for the Copper Forming Industry."

Based on consideration of the above factors, EPA identified various control and treatment technologies which formed the basis for BPT and selected control and treatment appropriate for each set of standards and limitations. The mass limitations and standards for BPT, BAT, NSPS, PSES, and PSNS are presented in Section II. The limitations and standards are discussed briefly below.

BPT

In general, the BPT level represents the average of the best existing performances of plants of various ages, sizes, processes or other common characteristics. Where existing performance is uniformly inadequate, BPT may be transferred from a different subcategory or category.

In establishing BPT model technology, EPA considers the volume and nature of existing discharges, the volume and nature of discharges expected after application of BPT, the general environmental effects of the pollutants, and cost and economic impacts of the required pollution control level.

The technology basis for the BPT limitations being promulgated is the same as for the proposed limitations and includes flow normalization, lime precipitation and sedimentation, and, where necessary, preliminary treatment consisting of chemical emulsion breaking, oil skimming, and chemical reduction of chromium.

The pollutants selected for regulation at BPT are: chromium, copper, lead, nickel, zinc, oil and grease, TSS, and pH.

Implementation of the BPT limitations will remove annually an estimated 27,000 kg of toxic pollutants and 56,000 kg of conventional and nonconventional pollutants per year beyond current discharge levels at a capital cost above equipment in place of $6.4 million and an annual cost of $6.6 million (1982 dollars).

BAT

The BAT technology level represents the best economically achievable performance of plants of various ages, sizes, processes or other shared characteristics. As with BPT, where existing performance is uniformly inadequate, BAT may be transferred from a different subcategory or category. BAT may include process changes or internal controls, even when not common industry practice.

In developing BAT, EPA has given substantial weight to the reasonableness of costs. The Agency considered the volume and nature of discharges, the volume and nature of discharges expected after application of BAT, the general environmental effects of the pollutants, and the costs and economic impacts of the required pollution control levels. Despite this consideration of costs, the primary determinant of BAT is still effluent reduction capability.

The pollutants selected for regulation at BAT are: chromium, copper, lead, nickel and zinc.

Implementation of the BAT limitations will remove annually an estimated 31,000 kg of toxic pollutants at a capital cost above equipment in place of $6.5 million and an annual cost of $6.3 million (1982 dollars). Total annual costs for BAT are estimated to be slightly lower than for BPT. BAT model technology includes flow reduction which results in the use of smaller sized treatment equipment with lower operating and maintenance costs.

BAT will remove 4,000 kg/yr of toxic pollutants incrementally above BPT; the incremental investment cost is $0.1 million and there is no additional total annual cost (1982 dollars).

NSPS

NSPS (new source performance standards) are based on the best available demonstrated technology (BDT).

EPA is establishing NSPS for the copper forming category to be equivalent to BAT technology with the addition of countercurrent cascade rinsing for pickling rinsewater and the addition of filtration prior to discharge. The Agency recognizes that new sources have the opportunity to implement this level of treatment without incurring the costs of retrofit equipment, the costs of partial or complete shutdown to install new equipment and the costs to start up and stabilize the treatment system as existing systems would have to do.

Countercurrent cascade rinsing and filtration are appropriate technologies for NSPS because they are demonstrated in this category and because new plants have the opportunity to design and implement the most efficient processes without retrofit costs and space availability limitations.

The pollutants regulated are: chromium, copper, lead, nickel, zinc, oil and grease, TSS and pH. The capital investment for new sources to meet NSPS is about 4 percent above that needed by existing sources to comply with BAT.

PSES

PSES (pretreatment standards for existing sources) are designed to prevent the discharge of pollutants which pass through, interfere with, or are otherwise incompatible with the operation of POTWs. Pretreatment standards are to be technology-based and analogous to the best available technology for removal of toxic pollutants.

EPA is promulgating PSES based on chemical precipitation and sedimentation, flow reduction, and preliminary treatment, where necessary, consisting of chromium reduction, chemical emulsion breaking, and oil skimming. This is equivalent to the technology basis of BAT.

The pollutants to be regulated by PSES are chromium, copper, lead, nickel, zinc, and 12 toxic organic compounds defined as total toxic organics (TTO). (A further discussion of TTO is presented in Section XII).

Implementation of the PSES standards will remove annually an estimated 18,700 kg of toxic pollutants at a capital cost above equipment in place of $9.2 million and an annual cost of $7.7 million (1982 dollars).

The Agency has set the PSES compliance date at three years after promulgation of this regulation: August 15, 1986.

PSNS

Like PSES, PSNS (pretreatment standards for new sources) are to prevent the discharge of pollutants which pass through, interfere with, or are otherwise incompatible with the operation of the POTW. New indirect dischargers, like new direct dischargers, have the opportunity to incorporate the best available demonstrated technologies including process changes, in-plant controls, and end-of-pipe treatment technologies, and to use plant site selection to ensure adequate treatment system installation.

This regulation establishes mass-based PSNS for the copper forming category identical to the treatment technology set forth as the basis for the NSPS.

Pollutants regulated at PSNS are chromium, copper, lead, nickel, zinc, and TTO.

Non-Water Quality Environmental Impacts

Eliminating or reducing one form of pollution may cause other environmental problems. Sections 304(b) and 306 of the Act require EPA to consider the non-water quality environmental impacts (including energy requirements) of certain regulations. In compliance with these provisions, we considered the effect of this regulation on air pollution, solid waste generation, water scarcity, and energy consumption.

This regulation was reviewed by EPA personnel responsible for non-water quality programs. While it is difficult to balance pollution problems against each other and against energy use, we believe that this regulation will best serve often competing national goals.

Wastewater treatment sludges from this category are expected to be non-hazardous under RCRA when generated using the model technology. Costs for disposal of non-hazardous wastes are included in the annual costs.

To achieve the BPT and BAT effluent limitation, a typical existing direct discharger will increase total energy consumption by less than one percent of the energy consumed for production purposes. A typical existing indirect discharger will increase energy consumption by less than two percent of the energy consumed for production purposes. **PSNS and NSPS will not significantly add to total energy consumption.**

SECTION II

RECOMMENDATIONS

This section presents the effluent limitations and standards for the Copper Forming Point Source Category.

BPT

(a) Subpart A - Hot Rolling Spent Lubricant BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy hot rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy hot rolled		
Chromium	0.045	0.018
Copper	0.195	0.103
Lead	0.015	0.013
Nickel	0.197	0.130
Zinc	0.150	0.062
Oil and Grease	2.060	1.236
TSS	4.223	2.008
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(b) Subpart A - Cold Rolling Spent Lubricant BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy cold rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy cold rolled		
Chromium	0.166	0.068
Copper	0.720	0.379
Lead	0.056	0.049
Nickel	0.727	0.481
Zinc	0.553	0.231
Oil and Grease	7.580	4.548
TSS	15.539	7.390
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(c) Subpart A - Drawing Spent Lubricant BPT Effluent Limitations. 1

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy drawn English Units - lb/1,000,000 off-lbs of copper or copper alloy drawn		
Chromium	0.037	0.015
Copper	0.161	0.085
Lead	0.012	0.011
Nickel	0.163	0.107
Zinc	0.124	0.051
Oil and Grease	1.700	1.020
TSS	3.485	1.657
pH	(2)	(2)

1 Applicable only to drawers who treat spent drawing lubricants and discharge the treated effluent.

2 Within the range of 7.5 to 10.0 at all times.

(d) Subpart A - Solution Heat Treatment BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated		
Chromium	1.118	0.457
Copper	4.827	2.541
Lead	0.381	0.330
Nickel	4.878	3.227
Zinc	3.709	1.550
Oil and Grease	50.820	30.492
TSS	104.181	49.549
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(e) Subpart A - Extrusion Heat Treatment BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated on an extrusion press English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated on an extrusion press		
Chromium	0.00088	0.00036
Copper	0.003	0.002
Lead	0.0003	0.00026
Nickel	0.003	0.002
Zinc	0.002	0.001
Oil and Grease	0.040	0.024
TSS	0.082	0.039
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(f) Subpart A - Annealing with Water BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with water English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with water		
Chromium	2.493	1.020
Copper	10.767	5.667
Lead	0.850	0.736
Nickel	10.880	7.197
Zinc	8.273	3.456
Oil and Grease	113.340	68.004
TSS	232.347	110.506
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(g) Subpart A - Annealing With Oil BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with oil English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with oil		
Chromium	0	0
Copper	0	0
Lead	0	0
Nickel	0	0
Zinc	0	0
Oil and Grease	0	0
TSS	0	0
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(h) Subpart A - Alkaline Cleaning Rinse BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	1.854	0.758
Copper	8.006	4.214
Lead	0.632	0.547
Nickel	8.090	5.351
Zinc	6.152	2.570
Oil and Grease	84.280	50.568
TSS	172.774	82.173
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(i) Subpart A - Alkaline Cleaning Rinse for Forged Parts BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts cleaned		
Chromium	5.562	2.275
Copper	24.019	12.642
Lead	1.896	1.643
Nickel	24.272	16.055
Zinc	18.457	7.711
Oil and Grease	252.840	151.704
TSS	518.322	246.519
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(j) Subpart A - Alkaline Cleaning Bath BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	0.020	0.0084
Copper	0.089	0.046
Lead	0.0070	0.0060
Nickel	0.089	0.059
Zinc	0.068	0.028
Oil and Grease	0.93	0.56
TSS	1.91	0.91
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(k) Subpart A - Pickling Rinse BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	1.593	0.651
Copper	6.881	3.622
Lead	0.543	0.470
Nickel	6.954	4.599
Zinc	5.288	2.209
Oil and Grease	72.440	43.464
TSS	148.502	70.629
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(l) Subpart A - Pickling Rinse for Forged Parts BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts pickled		
Chromium	1.723	0.705
Copper	7.444	3.918
Lead	0.587	0.509
Nickel	7.522	4.975
Zinc	5.720	2.389
Oil and Grease	78.360	47.016
TSS	160.638	76.401
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(m) Subpart A - Pickling Bath BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.051	0.020
Copper	0.220	0.116
Lead	0.017	0.015
Nickel	0.222	0.147
Zinc	0.169	0.070
Oil and Grease	2.320	1.392
TSS	4.756	2.262
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(n) Subpart A - Pickling Fume Scrubber BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.275	0.112
Copper	1.189	0.626
Lead	0.093	0.081
Nickel	1.201	0.795
Zinc	0.913	0.381
Oil and Grease	12.520	7.512
TSS	25.666	12.207
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(o) Subpart A - Tumbling or Burnishing BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy tumbled or burnished English Units - lb/1,000,000 off-lbs of copper or copper alloy tumbled or burnished		
Chromium	0.256	0.104
Copper	1.107	0.583
Lead	0.087	0.075
Nickel	1.119	0.740
Zinc	0.851	0.355
Oil and Grease	11.660	6.996
TSS	23.903	11.368
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(p) Subpart A - Surface Coating BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy surface coated English Units - lb/1,000,000 off-lbs of copper or copper alloy surface coated		
Chromium	0.326	0.133
Copper	1.411	0.743
Lead	0.111	0.096
Nickel	1.426	0.943
Zinc	1.084	0.453
Oil and Grease	14.680	8.916
TSS	30.463	14.488
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(q) Subpart A - Miscellaneous Waste Streams BPT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy formed English Units - lb/1,000,000 off-lbs of copper or copper alloy formed		
Chromium	0.009	0.003
Copper	0.041	0.021
Lead	0.003	0.002
Nickel	0.041	0.027
Zinc	0.031	0.013
Oil and Grease	0.436	0.261
TSS	0.893	0.425
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

BAT

(a) Subpart A - Hot Rolling Spent Lubricant BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy hot rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy hot rolled		
Chromium	0.045	0.018
Copper	0.195	0.103
Lead	0.015	0.013
Nickel	0.197	0.130
Zinc	0.150	0.062

(b) Subpart A - Cold Rolling Spent Lubricant BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy cold rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy cold rolled		
Chromium	0.166	0.068
Copper	0.720	0.379
Lead	0.056	0.049
Nickel	0.727	0.481
Zinc	0.553	0.231

(c) Subpart A - Drawing Spent Lubricant BAT Effluent Limitations. [1]

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy drawn English Units - lb/1,000,000 off-lbs of copper or copper alloy drawn		
Chromium	0.037	0.015
Copper	0.161	0.085
Lead	0.012	0.011
Nickel	0.163	0.107
Zinc	0.124	0.051

[1] Applicable only to drawers who treat spent drawing lubricants and discharge the treated effluent.

(d) Subpart A - Solution Heat Treatment BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated		
Chromium	0.284	0.116
Copper	1.227	0.646
Lead	0.096	0.083
Nickel	1.240	0.820
Zinc	0.943	0.394

(e) Subpart A - Extrusion Heat Treatment BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated on an extrusion press English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated on an extrusion press		
Chromium	0.00088	0.00036
Copper	0.003	0.0020
Lead	0.0003	0.00026
Nickel	0.003	0.002
Zinc	0.002	0.001

(f) Subpart A - Annealing with Water BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with water English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with water		
Chromium	0.545	0.223
Copper	2.356	1.240
Lead	0.186	0.161
Nickel	2.380	1.574
Zinc	1.810	0.756

(g) Subpart A - Annealing With Oil BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with oil English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with oil		
Chromium	0	0
Copper	0	0
Lead	0	0
Nickel	0	0
Zinc	0	0

(h) Subpart A - Alkaline Cleaning Rinse BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	1.854	0.758
Copper	8.006	4.214
Lead	0.632	0.547
Nickel	8.090	5.351
Zinc	6.152	2.570

(i) Subpart A - Alkaline Cleaning Rinse for Forged Parts BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts cleaned		
Chromium	5.562	2.275
Copper	24.019	12.642
Lead	1.896	1.643
Nickel	24.272	16.055
Zinc	18.457	7.711

(j) Subpart A - Alkaline Cleaning Bath BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	0.020	0.0084
Copper	0.088	0.046
Lead	0.0070	0.0060
Nickel	0.089	0.059
Zinc	0.068	0.028

(k) Subpart A - Pickling Rinse BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.574	0.235
Copper	2.481	1.306
Lead	0.195	0.169
Nickel	2.507	1.658
Zinc	1.906	0.796

(l) Subpart A - Pickling Rinse for Forged Parts BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts pickled		
Chromium	1.723	0.705
Copper	7.444	3.918
Lead	0.587	0.509
Nickel	7.522	4.975
Zinc	5.720	2.389

(m) Subpart A - Pickling Bath BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.051	0.020
Copper	0.220	0.116
Lead	0.017	0.015
Nickel	0.222	0.147
Zinc	0.169	0.070

(n) Subpart A - Pickling Fume Scrubber BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.275	0.112
Copper	1.189	0.626
Lead	0.093	0.081
Nickel	1.201	0.795
Zinc	0.913	0.381

(o) Subpart A - Tumbling or Burnishing BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy tumbled or burnished English Units - lb/1,000,000 off-lbs of copper or copper alloy tumbled or burnished		
Chromium	0.256	0.104
Copper	1.107	0.583
Lead	0.087	0.075
Nickel	1.119	0.740
Zinc	0.851	0.355

(p) Subpart A - Surface Coating BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy surface coated English Units - lb/1,000,000 off-lbs of copper or copper alloy surface coated		
Chromium	0.326	0.133
Copper	1.411	0.743
Lead	0.111	0.096
Nickel	1.426	0.943
Zinc	1.084	0.453

(q) Subpart A - Miscellaneous Waste Streams BAT Effluent Limitations.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy formed English Units - lb/1,000,000 off-lbs of copper or copper alloy formed		
Chromium	0.009	0.003
Copper	0.041	0.021
Lead	0.003	0.002
Nickel	0.041	0.027
Zinc	0.031	0.013

NSPS

(a) Subpart A - Hot Rolling Spent Lubricant NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy hot rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy hot rolled		
Chromium	0.038	0.015
Copper	0.131	0.062
Lead	0.010	0.0092
Nickel	0.056	0.038
Zinc	0.105	0.043
Oil and Grease	1.030	1.030
TSS	1.545	1.236
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(b) Subpart A - Cold Rolling Spent Lubricant NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy cold rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy cold rolled		
Chromium	0.140	0.056
Copper	0.485	0.231
Lead	0.037	0.034
Nickel	0.208	0.140
Zinc	0.386	0.159
Oil and Grease	3.790	3.790
TSS	5.685	4.548
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(c) Subpart A - Drawing Spent Lubricant NSPS. 1

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy drawn English Units - lb/1,000,000 off-lbs of copper or copper alloy drawn		
Chromium	0.031	0.012
Copper	0.108	0.051
Lead	0.0085	0.0076
Nickel	0.046	0.031
Zinc	0.086	0.035
Oil and Grease	0.85	0.85
TSS	1.275	1.020
pH	(2)	(2)

1 Applicable only to drawers who treat spent drawing lubricants and discharge the treated effluent.

2 Within the range of 7.5 to 10.0 at all times.

(d) Subpart A - Solution Heat Treatment NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated		
Chromium	0.239	0.096
Copper	0.826	0.394
Lead	0.064	0.058
Nickel	0.355	0.239
Zinc	0.658	0.271
Oil and Grease	6.460	6.460
TSS	9.690	7.752
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(e) Subpart A - Extrusion Heat Treatment NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated on an extrusion press English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated on an extrusion press		
Chromium	0.00074	0.00030
Copper	0.0020	0.0010
Lead	0.00020	0.00018
Nickel	0.0010	0.00074
Zinc	0.0020	0.00084
Oil and Grease	0.020	0.020
TSS	0.030	0.024
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

(f) Subpart A - Annealing with Water NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with water English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with water		
Chromium	0.458	0.186
Copper	1.587	0.756
Lead	0.124	0.111
Nickel	0.682	0.458
Zinc	1.264	0.520
Oil and Grease	12.400	12.400
TSS	18.600	14.880
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

(g) Subpart A - Annealing With Oil NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed		
Chromium	0	0
Copper	0	0
Lead	0	0
Nickel	0	0
Zinc	0	0
Oil and Grease	0	0
TSS	0	0
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(h) Subpart A - Alkaline Cleaning Rinse NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	1.559	0.632
Copper	5.393	2.570
Lead	0.421	0.379
Nickel	2.317	1.559
Zinc	4.298	1.769
Oil and Grease	42.140	42.140
TSS	63.210	50.568
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(i) Subpart A - Alkaline Cleaning Rinse for Forged Parts NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts cleaned		
Chromium	4.677	1.896
Copper	16.181	7.711
Lead	1.264	1.137
Nickel	6.953	4.677
Zinc	12.894	5.309
Oil and Grease	126.420	126.420
TSS	189.630	151.704
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(j) Subpart A - Alkaline Cleaning Bath NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	0.017	0.0070
Copper	0.059	0.028
Lead	0.0046	0.0042
Nickel	0.025	0.017
Zinc	0.047	0.019
Oil and Grease	0.46	0.46
TSS	0.70	0.56
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(k) Subpart A - Pickling Rinse NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.216	0.087
Copper	0.748	0.356
Lead	0.058	0.052
Nickel	0.321	0.216
Zinc	0.596	0.245
Oil and Grease	5.850	5.850
TSS	8.775	7.020
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(l) Subpart A - Pickling Rinse for Forged Parts NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts pickled		
Chromium	0.649	0.263
Copper	2.246	1.070
Lead	0.175	0.157
Nickel	0.965	0.649
Zinc	1.790	0.737
Oil and Grease	17.550	17.550
TSS	26.325	21.060
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(m) Subpart A - Pickling Bath NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.042	0.017
Copper	0.148	0.070
Lead	0.011	0.010
Nickel	0.063	0.042
Zinc	0.118	0.048
Oil and Grease	1.160	1.160
TSS	1.740	1.392
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(n) Subpart A - Pickling Fume Scrubber NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.231	0.093
Copper	0.801	0.381
Lead	0.062	0.056
Nickel	0.344	0.231
Zinc	0.638	0.262
Oil and Grease	6.260	6.260
TSS	9.390	7.512
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(o) Subpart A - Tumbling or Burnishing NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy tumbled or burnished English Units - lb/1,000,000 off-lbs of copper or copper alloy tumbled or burnished		
Chromium	0.215	0.087
Copper	0.746	0.355
Lead	0.058	0.052
Nickel	0.320	0.215
Zinc	0.594	0.244
Oil and Grease	5.830	5.830
TSS	8.745	6.996
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(p) Subpart A - Surface Coating NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy surface coated English Units - lb/1,000,000 off-lbs of copper or copper alloy surface coated		
Chromium	0.274	0.111
Copper	0.951	0.453
Lead	0.074	0.066
Nickel	0.408	0.274
Zinc	0.757	0.312
Oil and Grease	7.430	7.430
TSS	11.145	8.916
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

(q) Subpart A - Miscellaneous Waste Streams NSPS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy formed English Units - lb/1,000,000 off-lbs of copper or copper alloy formed		
Chromium	0.008	0.003
Copper	0.027	0.013
Lead	0.0021	0.0019
Nickel	0.011	0.008
Zinc	0.022	0.009
Oil and Grease	0.218	0.218
TSS	0.327	0.261
pH	(1)	(1)

1 Within the range of 7.5 to 10.0 at all times.

PSES

(a) Subpart A - Hot Rolling Spent Lubricant PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy hot rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy hot rolled		
Chromium	0.045	0.018
Copper	0.195	0.103
Lead	0.015	0.013
Nickel	0.197	0.130
Zinc	0.150	0.062
TTO	0.066	0.035
Oil and Grease (for alternate monitoring)	2.060	1.236

(b) Subpart A - Cold Rolling Spent Lubricant PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy cold rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy cold rolled		
Chromium	0.166	0.068
Copper	0.720	0.379
Lead	0.056	0.049
Nickel	0.727	0.481
Zinc	0.553	0.231
TTO	0.246	0.128
Oil and Grease (for alternate monitoring)	7.580	4.548

(c) Subpart A - Drawing Spent Lubricant PSES. 1

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy drawn English Units - lb/1,000,000 off-lbs of copper or copper alloy drawn		
Chromium	0.037	0.015
Copper	0.161	0.085
Lead	0.012	0.011
Nickel	0.163	0.107
Zinc	0.124	0.051
TTO	0.055	0.028
Oil and Grease (for alternate monitoring)	1.700	1.020

1 Applicable only to drawers who treat spent drawing lubricants and discharge the treated effluent.

(d) Subpart A - Solution Heat Treatment PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated		
Chromium	0.284	0.116
Copper	1.227	0.646
Lead	0.096	0.083
Nickel	1.240	0.820
Zinc	0.943	0.394
TTO	0.419	0.219
Oil and Grease (for alternate monitoring)	12.920	7.752

(e) Subpart A - Extrusion Heat Treatment PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated on an extrusion press English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated on an extrusion press		
Chromium	0.00088	0.00036
Copper	0.0030	0.0020
Lead	0.00030	0.00026
Nickel	0.0030	0.0020
Zinc	0.0020	0.0010
TTO	0.0010	0.00068
Oil and Grease (for alternate monitoring)	0.040	0.024

(f) Subpart A - Annealing with Water PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with water English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with water		
Chromium	0.545	0.223
Copper	2.356	1.240
Lead	0.186	0.161
Nickel	2.380	1.574
Zinc	1.810	0.756
TTO	0.806	0.421
Oil and Grease (for alternate monitoring)	24.800	14.880

(g) Subpart A - Annealing With Oil PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with oil English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with oil		
Chromium	0	0
Copper	0	0
Lead	0	0
Nickel	0	0
Zinc	0	0
TTO	0	0
Oil and Grease (for alternate monitoring)	0	0

(h) Subpart A - Alkaline Cleaning Rinse PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	1.854	0.758
Copper	8.006	4.214
Lead	0.632	0.547
Nickel	8.090	5.351
Zinc	6.152	2.570
TTO	2.739	1.432
Oil and Grease (for alternate monitoring)	84.280	50.568

(i) Subpart A - Alkaline Cleaning Rinse for Forged Parts PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts cleaned		
Chromium	5.562	2.275
Copper	24.019	12.642
Lead	1.896	1.643
Nickel	24.272	16.055
Zinc	18.457	7.711
TTO	8.217	4.298
Oil and Grease (for alternate monitoring)	252.840	151.704

(j) Subpart A - Alkaline Cleaning Bath PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	0.020	0.0084
Copper	0.088	0.046
Lead	0.0070	0.0060
Nickel	0.089	0.059
Zinc	0.068	0.028
TTO	0.030	0.015
Oil and Grease (for alternate monitoring)	0.93	0.56

(k) Subpart A - Pickling Rinse PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.574	0.235
Copper	2.481	1.306
Lead	0.195	0.169
Nickel	2.507	1.658
Zinc	1.906	0.796
TTO	0.848	0.444
Oil and Grease (for alternate monitoring)	26.120	15.672

(l) Subpart A - Pickling Rinse for Forged Parts PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts pickled		
Chromium	1.723	0.705
Copper	7.444	3.918
Lead	0.587	0.509
Nickel	7.522	4.975
Zinc	5.720	2.389
TTO	2.546	1.332
Oil and Grease (for alternate monitoring)	78.360	47.016

(m) Subpart A-Pickling Bath PESE.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.051	0.020
Copper	0.220	0.116
Lead	0.017	0.015
Nickel	0.222	0.147
Zinc	0.169	0.070
TTO	0.075	0.039
Oil and Grease (for alternate monitoring)	2.320	1.392

(n) Subpart A - Pickling Fume Scrubber PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.275	0.112
Copper	0.189	0.626
Lead	0.093	0.081
Nickel	1.201	0.795
Zinc	0.913	0.381
TTO	0.406	0.212
Oil and Grease (for alternate monitoring)	12.520	7.512

(o) Subpart A - Tumbling or Burnishing PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy tumbled or burnished English Units - lb/1,000,000 off-lbs of copper or copper alloy tumbled or burnished		
Chromium	0.256	0.104
Copper	1.107	0.583
Lead	0.087	0.075
Nickel	1.119	0.740
Zinc	0.851	0.355
TTO	0.378	0.198
Oil and Grease (for alternate monitoring)	11.660	6.996

(p) Subpart A - Surface Coating PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy surface coated English Units - lb/1,000,000 off-lbs of copper or copper alloy surface coated		
Chromium	0.326	0.133
Copper	1.411	0.743
Lead	0.111	0.096
Nickel	1.426	0.943
Zinc	1.084	0.453
TTO	0.482	0.252
Oil and Grease (for alternate monitoring)	14.860	8.916

(q) Subpart A - Miscellaneous Waste Streams PSES.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy formed English Units - lb/1,000,000 off-lbs of copper or copper alloy formed		
Chromium	0.009	0.003
Copper	0.041	0.021
Lead	0.003	0.002
Nickel	0.041	0.027
Zinc	0.031	0.013
TTO	0.014	0.007
Oil and Grease (for alternate monitoring)	0.436	0.261

PSNS

(a) Subpart A - Hot Rolling Spent Lubricant PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy hot rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy hot rolled		
Chromium	0.038	0.015
Copper	0.131	0.062
Lead	0.010	0.0092
Nickel	0.056	0.038
Zinc	0.105	0.043
TTO	0.035	0.035
Oil and Grease (for alternate monitoring)	1.030	1.030

(b) Subpart A - Cold Rolling Spent Lubricant PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy cold rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy cold rolled		
Chromium	0.140	0.056
Copper	0.485	0.231
Lead	0.037	0.034
Nickel	0.208	0.140
Zinc	0.386	0.159
TTO	0.128	0.128
Oil and Grease (for alternate monitoring)	3.790	3.790

(c) Subpart A - Drawing Spent Lubricant PSNS. 1

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy drawn English Units - lb/1,000,000 off-lbs of copper or copper alloy drawn		
Chromium	0.031	0.012
Copper	0.108	0.051
Lead	0.0085	0.0076
Nickel	0.046	0.031
Zinc	0.086	0.035
TTO	0.028	0.028
Oil and Grease (for alternate monitoring)	0.850	0.850

1 Applicable only to drawers who treat spent drawing lubricant and discharge the treated effluent.

(d) Subpart A - Solution Heat Treatment PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated		
Chromium	0.239	0.096
Copper	0.826	0.394
Lead	0.064	0.058
Nickel	0.355	0.239
Zinc	0.658	0.271
TTO	0.219	0.219
Oil and Grease (for alternate monitoring)	6.460	6.460

(e) Subpart A - Extrusion Heat Treatment PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated on an extrusion press English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated on an extrusion press		
Chromium	0.00074	0.00030
Copper	0.0020	0.0010
Lead	0.00020	0.00018
Nickel	0.0010	0.00074
Zinc	0.0020	0.0084
TTO	0.00068	0.00068
Oil and Grease (for alternate monitoring)	0.020	0.020

(f) Subpart A - Annealing with Water PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with water English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with water		
Chromium	0.458	0.186
Copper	1.587	0.756
Lead	0.124	0.111
Nickel	0.682	0.458
Zinc	1.264	0.520
TTO	0.421	0.421
Oil and Grease (for alternate monitoring)	12.400	12.400

(g) Subpart A - Annealing With Oil PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with oil English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with oil		
Chromium	0	0
Copper	0	0
Lead	0	0
Nickel	0	0
Zinc	0	0
TTO	0	0
Oil and Grease (for alternate monitoring)	0	0

(h) Subpart A - Alkaline Cleaning Rinse PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	1.559	0.632
Copper	5.393	2.570
Lead	0.421	0.379
Nickel	2.317	1.559
Zinc	4.298	1.769
TTO	1.432	1.432
Oil and Grease (for alternate monitoring)	42.140	42.140

(i) Subpart A - Alkaline Cleaning Rinse for Forged Parts PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts cleaned		
Chromium	4.677	1.896
Copper	16.181	7.711
Lead	1.264	1.137
Nickel	6.953	4.677
Zinc	12.894	5.309
TTO	4.298	4.298
Oil and Grease (for alternate monitoring)	126.420	126.420

(j) Subpart A - Alkaline Cleaning Bath PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	0.017	0.0070
Copper	0.059	0.028
Lead	0.0046	0.0042
Nickel	0.025	0.017
Zinc	0.047	0.019
TTO	0.015	0.015
Oil and Grease (for alternate monitoring)	0.46	0.46

(k) Subpart A - Pickling Rinse PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.216	0.087
Copper	0.748	0.356
Lead	0.058	0.052
Nickel	0.321	0.216
Zinc	0.596	0.245
TTO	0.198	0.198
Oil and Grease (for alternate monitoring)	5.850	5.850

(l) Subpart A - Pickling Rinse for Forged Parts PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts pickled		
Chromium	0.649	0.263
Copper	2.246	1.070
Lead	0.175	0.157
Nickel	0.965	0.649
Zinc	1.790	0.737
TTO	0.596	0.596
Oil and Grease (for alternate monitoring)	17.550	17.550

(m) Subpart A - Pickling Bath PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.042	0.017
Copper	0.148	0.070
Lead	0.011	0.010
Nickel	0.063	0.042
Zinc	0.118	0.048
TTO	0.039	0.039
Oil and Grease (for alternate monitoring)	1.160	1.160

(n) Subpart A - Pickling Fume Scrubber PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.231	0.093
Copper	0.801	0.381
Lead	0.062	0.056
Nickel	0.344	0.231
Zinc	0.638	0.262
TTO	0.212	0.212
Oil and Grease (for alternate monitoring)	6.260	6.260

(o) Subpart A - Tumbling or Burnishing PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy tumbled or burnished English Units - lb/1,000,000 off-lbs of copper or copper alloy tumbled or burnished		
Chromium	0.215	0.087
Copper	0.746	0.355
Lead	0.058	0.052
Nickel	0.320	0.215
Zinc	0.594	0.244
TTO	0.198	0.198
Oil and Grease (for alternate monitoring)	5.830	5.830

(p) Subpart A - Surface Coating PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy surface coated English Units - lb/1,000,000 off-lbs of copper or copper alloy surface coated		
Chromium	0.274	0.111
Copper	0.951	0.453
Lead	0.074	0.066
Nickel	0.408	0.274
Zinc	0.757	0.312
TTO	0.252	0.252
Oil and Grease (for alternate monitoring)	7.430	7.430

(q) Subpart A - Miscellaneous Waste Streams PSNS.

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy formed English Units - lb/1,000,000 off-lbs of copper or copper alloy formed		
Chromium	0.008	0.003
Copper	0.027	0.013
Lead	0.0021	0.0019
Nickel	0.011	0.008
Zinc	0.022	0.009
TTO	0.007	0.007
Oil and Grease (for alternate monitoring)	0.218	0.218

SECTION III

INTRODUCTION

LEGAL AUTHORITY

The Federal Water Pollution Control Act Amendments of 1972 established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Section 101(a)). To implement the Act, EPA was to issue effluent limitations, pretreatment standards, and new source performance standards for industry dischargers.

The Act included a timetable for issuing these standards. However, EPA was unable to meet many of the deadlines and, as a result, in 1976, it was sued by several environmental groups. In settling this lawsuit, EPA and the plaintiffs executed a court-approved "Settlement Agreement." This Agreement required EPA to develop a program and adhere to a schedule in promulgating effluent limitations guidelines, new source performance standards and pretreatment standards for 65 "priority" pollutants and classes of pollutants for 21 major industries. See *Natural Resources Defense Council, Inc.* v. *Train*, 8 ERC 2120 (D.D.C. 1976), *modified*, 12 ERC 1833 (D.D.C. 1979), modified by Orders dated October 26, 1983 and August 2, 1983.

Many of the basic elements of this Settlement Agreement program were incorporated into the Clean Water Act of 1977. Like the Agreement, the Act stressed control of toxic pollutants, including the 65 "priority" pollutants. In addition to strengthening the toxic control program, Section 304(e) of the Act authorizes the Administrator to prescribe "best management practices" (BMP) to prevent the release of toxic and hazardous pollutants from plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage associated with, or ancillary to, the manufacturing or treatment process.

DATA GATHERING

Data Gathering Efforts Prior to Proposal

In 1977 to 1978, under the authority of Section 308 of the Clean Water Act, data collection portfolios (dcp) were mailed to 475 companies identified in a Dun and Bradstreet list as companies believed to be active in copper forming. Responses were received from approximately 85 percent of the 475 companies originally contacted. The responses provided information on 176 plants that perform manufacturing operations covered under the Copper Forming Point Source Category.

In addition to the above data sources, EPA sampled 12 copper forming plants. Plant visits were made to sample wastewater sources and treatment effluents and to gather additional information on manufacturing processes, wastewater flows, and wastewater treatment technologies and associated costs. Samples were collected at these 12 plants in order to characterize the wastewaters from all of the copper forming manufacturing operations and to characterize the performance of existing treatment systems. As such, the 12 plants selected for sampling are typically plants which practice multiple forming operations and associated surface and heat treatment operations. The 12 sampled plants typically practice some combination of hot rolling, cold rolling, drawing, extrusion, and forging, as well as the ancillary operations of solution heat treatment, alkaline cleaning, annealing, and pickling. The flow rates and pollutant concentrations in the wastewaters discharged from the manufacturing operations at these plants are representative of the flow rates and pollutant concentrations which would be found in wastewaters generated by similar operations at any plant in the copper forming category.

The Agency also collected information on treatment systems not currently used in the industry. To collect this information, EPA surveyed literature, contacted waste treatment equipment manufacturers, and observed applicable treatment systems used in other industries.

Data related to the performance of the various treatment technology options considered were obtained from copper forming and other categories with similar wastewater. Performance data for chemical precipitation and sedimentation is a composite of EPA sampling and analysis data from copper forming, aluminum forming, battery manufacturing, coil coating, and porcelain enameling. Data on the performance of filtration was obtained from porcelain enameling and nonferrous metals manufacturing. Section VII (p. 263) presents a detailed discussion of the data bases for lime and settle performance and lime, settle and filtration performance.

To obtain economic data, EPA mailed an economic survey questionnaire to all plants known or believed to be copper formers. This survey was mailed under the authority of Section 308 of the Clean Water Act. The Agency received 103 responses for the 176 copper formers. The survey was designed to provide accurate and current information on the economic and financial characteristics of the industry. Data collected included information on market structure, profitability, and investment in new capital and production costs. The Agency also collected information from plant visits and personal contacts within industry. These economic data are summarized and discussed in the <u>Economic Impact Analysis of</u>

Effluent Standards and Limitations for the Copper Forming Industry, which is in the public record for this rulemaking.

In addition to the foregoing data sources, supplementary data were obtained from NPDES permit files in EPA regional offices and contacts with state pollution control offices. The concentration and mass loading of pollutant parameters in wastewater effluent discharges are monitored and reported by plants as required by individual state agencies. These historical data are available from NPDES monitoring reports.

Data Gathering Efforts Since Proposal

EPA has performed several data gathering efforts since proposal in response to comments received from industry. All additional data collected since proposal are included in the administrative record supporting this rule.

EPA collected discharge monitoring reports (DMR) for 17 discharges from 16 copper forming plants. Discharge monitoring reports provide monthly average effluent concentrations of copper and some other metals. The Agency collected these data to supplement existing data regarding treatment-in-place and the long-term performance of that treatment.

EPA conducted an engineering site visit to a forging plant in order to gather information regarding water use for both baths and rinses of forged parts. In addition, two plants submitted production normalized flow data for pickling and alkaline cleaning rinsing of forged parts. The Agency relied upon these data to re-evaluate regulatory flows for these processes when performed on forged parts.

Additional data were obtained from plants as to the disposal of wastewater from drawing operations. We contacted 28 drawing plants to confirm, and, if appropriate, update the information about disposal methods that the plants provided in the Agency's 1978 data collection portfolio. The data collected pertained to the plants disposal methods, contract hauling costs, and whether the plants drawing spent lubricant is being disposed of as hazardous waste. In addition, we contacted a number of states to determine whether they require plants to dispose of drawing spent lubricants as hazardous wastes.

Data and information relating to waste streams for which flow allowances were not provided by the proposed regulation were obtained from industry. These data consist of production normalized flow data for tumbling or burnishing, surface coating, hydrostatic testing, sawing, surface milling, and maintenance.

Additional data and information on five plants were provided by two companies to support their individual comments on the nature of wastewater sludges. These data include the results of EP toxicity testing performed in accordance with federal hazardous waste regulations (40 CFR §261.24).

OVERVIEW OF THE INDUSTRY

Introduction

The copper forming category consists of plants which roll, draw, extrude, and forge copper and copper alloys. Based on information from copper plant data collection portfolios, there are approximately 176 facilities in the copper forming industry, each employing from two to 1,500 employees. There are a total of 43,000 employees involved in the forming of copper and copper alloys.

Total industry production capacity is estimated to be 3.5 x 10^6kkg per year (7.7 x 10^9 pounds per year) with individual plant production ranging from 22,700 to 227,000,000 kg (50,000 to 500,000,000 pounds) per year.

Most of the copper forming facilities are located in the northeastern portion of the United States with the remainder fairly evenly distributed throughout the country.

Figure III-1 and Table III-1 (pp. 66 and 63, respectively) show the geographical distribution of copper forming plants.

Products and Product Uses

There are seven types of products made in copper forming plants. They are plate, sheet, strip, wire, rod, tube, and forgings. Plate is a wide rigid piece of metal usually greater than 1/4 inch thick. Printing plates were often made from copper, as are plate heat exchangers and some chemical processing vessels. Sheet is a wide piece of metal having little rigidity and usually less than 1/4 inch thick. With strip, the length is many times the width and the product is commonly handled as coils of metal called coiled strip. Its uses include roof gutters, gaskets, radio parts, trim, weather strip, washers, diaphragms, etc. Wire is usually circular in cross section and is flexible. Rod is similar to wire in that it has a circular cross section but is more rigid. Rod and wire are used for screening, fasteners, jewelry, cotter pins, lock washers, springs, truss wire, wire brushes, welding rods, chains, hooks, and electrical conductors. Wire, twisted or woven into strands, used for lifting or in structural supports, is known as cable. Tubing is material in the form of long hollow cylinders. In general, tubing is used for transporting fluids and heat transfer applications. Specifically, it is used for gas lines; heater lines; oil burner tubes; plumbing pipe and tube; refrigerators; condensers; evaporators; heat-exchanger tubes; dairy tubes, and hydraulic lines.

Approximately two thirds of all formed copper and copper alloy products are in the form of bar and wire. Sheet, strip, and plate comprise approximately 20 percent of the copper formed. Tube and pipe formed for plumbing and commercial applications account for approximately 9 and 8 percent respectively of the total copper formed. Table III-2 (p. 64) summarizes the distribution of copper forming products over the last two decades.

Building construction is the largest end user of formed copper materials, representing approximately 30 percent of the total demand. Electrical and electronic products represent approximately 28 percent, followed by industrial machinery and equipment with approximately 18 percent of the demand, consumer products with 14 percent, and transportation with 10 percent. Table III-3 (p. 65) summarizes the distribution of formed copper product usage.

Raw Materials

Raw materials for copper forming originate in the casting processes in copper refineries. Common materials are wirebars, cakes or slabs, and billets. Typical dimensions are:

- Wirebar - approximately 9 to 13 cm (3.5 to 5 inches) square cross section, usually from 1 to 1.4 meters (38 to 54 inches in length; weights from 61 to 190 kg (135 to 420 pounds). Used to form rod and wire.

- Cake - rectangular in cross section; weights range from 63 to 1,800 kg (140 to 4,000 pounds) or more. Used to form plate, sheet, and strip.

- Billet - circular in cross section, usually 7.5 to 38 cm (3 to 15 inches in diameter); lenths up to 132 cm (52 inches); weights from 254 to 3,810 kg (100 to 1,500 pounds). Used to form rod and tubing.

In some instances the raw material is obtained from a copper forming process at another mill. In these instances, rod, wire or strip is obtained and its gauge further reduced to customer specifications by redrawing or rerolling.

Raw materials used by copper forming plants may or may not consist of pure copper. In determining end uses of copper, the properties of major significance are electrical conductivity, thermal conductivity, corrosion resistance, machinability, formability, and strength. When it is desirable to improve one or more of these basic properties, especially strength, and an improvement is to be gained without significantly sacrificing other important properties, alloying (the dissolution of one metal in another) is often practiced. Copper alloys include any alloy in which copper is the major constituent. Brasses (Cu-Zn alloys) and bronze (Cu-Sn alloys), are the most frequently produced copper alloys. The principal classes of copper alloys are listed below by composition:

Copper-zinc (binary brasses)
Copper-tin (binary bronzes)
Copper-zinc-tin (special brasses and bronzes)
Copper-zinc-lead and copper-tin-lead (leaded brasses and bronzes)
Copper-zinc-nickels (nickel silvers)
Copper-zinc-manganese w/wo tin, iron or aluminum (manganese bronzes)
Copper-tin-phosphorus (phosphor bronzes)
Copper aluminum w/wo iron, nickel, or manganese (aluminum bronzes)
Copper-silicon plus manganese, tin, iron, or zinc (silicon bronzes)
Copper-nickel (cupronickel)
Copper-beryllium and copper-cobalt-beryllium (beryllium copper)

A number of additional copper alloys are used as raw materials by copper forming plants. Metals used in these alloys include silver, cadmium, arsenic, gold, magnesium, sulfur, chromium, titanium, cobalt, selenium, antimony, and vanadium.

For the purposes of this document, the term "copper" is meant to include copper or copper alloys, except when the context clearly indicates otherwise.

MANUFACTURING PROCESSES

Copper forming manufacturing facilities use five techniques to form copper: hot rolling, cold rolling, extrusion, drawing, and forging. In addition to these forming operations, there are surface and heat treatment processes which impart desired surface and physical properties to the metal. These ancillary operations include annealing, pickling, alkaline cleaning, and solution heat treatment (commonly referred to as quenching). Additional operations which may take place at copper forming facilities include tumbling or burnishing, surface coating, hydrostatic testing, sawing, and surface milling. Casting is not included in the Copper Forming Point Source Category; it is regulated under the

Metal Molding and Casting Point Source Category. The manufacture of copper powders and the forming of parts from copper or copper alloy powders is not being regulated under this regulation.

Drawing is the most commonly practiced forming operation at copper forming plants. Most plants which practice drawing also practice the ancillary operation of annealing.

There are roughly equal numbers of plants which practice hot rolling, cold rolling, and extrusion (26, 30, and 23, respectively). Approximately one third of these plants practice only one forming operation. The remaining plants practice various combinations of the five major forming operations. Most plants which practice hot rolling, cold rolling or extrusion also practice solution heat treatment, alkaline cleaning, annealing, and pickling. Only a small number of plants in the copper forming industry practice forging. Most of these plants also practice pickling of the forged products.

Each of the forming and ancillary operations is briefly described in the following paragraphs with an emphasis on where water is used and how pollutants are generated.

Hot Rolling

Rolling is used to transform cast copper into one of a number of intermediate or final products. Pressure exerted by the rolls as copper is passed between them reduces the thickness of the metal. Hot rolling is rolling that occurs at an elevated temperature but most importantly, above the recrystallization temperature of the metal. The recrystallization temperature is the temperature at which the metal crystal structure becomes reoriented, and consequently the metal becomes more soft and ductile.

Lubricants are used during hot rolling to prevent excessive wear on the rolls. Since the metal is soft and ductile it requires very little lubrication. Most plants use dilute oil--water mixtures (less than 4 percent oil by volume) or water alone as a lubricant. The lubricant also serves to cool the rolls during processing. Maintenance of a uniform temperature distribution across the rolls is essential to maintaining a product with uniform thickness. The use of deionized water to replace evaporative and carryover losses and the addition of bactericides and antioxidizing agents are practiced at many plants to increase the life of the lubricants. Nevertheless, the lubricant eventually becomes degraded and must be eliminated from circulation either by continuous bleed or periodic discharge. The discharge contains toxic organics, toxic metals, oil and grease, and suspended solids. Oil and grease and toxic organics present in the discharge originate in the lubricants used. Suspended solids and toxic metals present in the discharge result from contact of the water or lubricant solution with the copper product or rolls.

Cold Rolling

Cold rolling uses equipment that is similar to that used in hot rolling; however, it occurs at temperatures below the recrystallization point of the copper. The copper is harder and less ductile, requiring more lubrication than in hot rolling. The lubricant functions as a cooling medium but to a lesser extent than in hot rolling. The lubricants used in cold rolling consist of more concentrated oil--water mixtures to reduce the frictional resistance on the surface of the copper and the rolls. Spent cold rolling lubricants are often filtered or allowed to settle in tanks to remove metal fines and other contaminants and subsequently recirculated through the rolling mills. As is the case with hot rolling lubricants, it is necessary to periodically batch discharge and replace the lubricant. The pollutants found in the spent lubricant discharge are toxic organics, toxic metals, oil and grease, and suspended solids. These pollutants are present as a result of the use of the oil--water lubricants and the direct contact of the lubricant with the metal being rolled.

Extrusion

Extrusion is a hot deformation process which is used to produce tubing, round and shaped (e.g., hexagonal, square) rod, and extruded shapes of many different cross sections using billets as the raw material. In extrusion, copper is forced through an orifice (die) and emerges in the desired shape. Extrusion speed is temperature dependent and temperatures may range from 650° to 1,100° C (1,200° to 2,000° F). As such, considerable heat is generated by the process; if the extrusion rate is high, improperly dissipated heat may result in temperatures sufficiently high to melt or induce cracking in the metal. Water-based lubricants are generally not used to control temperature, rather, the extruded copper may be heat treated on the press (refer to Solution Heat Treatment discussion which follows).

Drawing

Drawing is a process in which wire or tubing is pulled through a die to reduce the cross-sectional area. Wire is drawn (pulled) cold through a series of tungsten carbide dies, decreasing the diameter in each draw. Diamond dies are used for fine wire. Temperature rise is important because of its relation to die life and lubrication. Water-based lubricants are used to control and to lubricate the copper as it is drawn through the die. The lubricant solution eventually becomes degraded and must be periodically discharged and replaced. Pollutants present in the discharge include toxic organics, toxic metals, oil and grease, and suspended solids. Toxic organics and oil and grease present in the discharge originate in the lubricants used. Toxic metals and suspended solids appear in the spent lubricants as a result of direct contact with the metal and dies during the drawing process.

Forging

Forging is the forming of metal, usually hot, by individual and intermittent applications of pressure. Forging may be done in open or closed dies. These pieces generally have more intricate shapes than other types of formed copper products. Hollow parts and parts with cavities or holes, as well as copper parts of detailed design, are produced by forging. Products are normally turned out as discrete pieces rather than as a continuous flowing mass. Forging requires that the material be heated uniformly to the proper temperature. Maintenance of the uniform temperature distribution throughout the workpiece is easier to control in forging than in the other forming operations. Since there is no requirement for a supplemental cooling medium and the products are turned out as discrete pieces, lubricants are not required when forging copper. Consequently, there is no discharge of wastewater from forging of copper.

Annealing

Annealing involves heating the copper or copper alloy to an elevated temperature (350° to 850° C) during rolling operations to reduce stresses introduced into the metal. It is accomplished with a variety of equipment differing in heating method, annealing atmosphere, and mode of operation. Plants commonly have multiple annealing units with several types of equipment represented.

Most annealing units are heated by the combustion of natural gas with the heat transferred by direct radiation and convection from the flame to the product. In some cases a secondary transfer medium (commonly partially burned gas) may be employed. In annealing wire, some units apply heat by passing electrical current directly through the wire. These "electroneal" units achieve exceptionally high heating efficiency and temperature control.

In addition to generating heat, the combustion of natural gas may be used to indirectly heat nitrogen in order to maintain an "inert" reducing atmosphere, which reduces surface oxidation. Older furnaces without atmosphere control yield annealed products with oxidized surfaces. The control of surface oxidation in annealing not only reduces metal loss in production, but also significantly reduces pickling requirements at later points during processing.

Annealing operations may operate continuously or on a batch basis. Continuous operation is typified by electrical anneals, continuous roller hearth furnaces, and continuous strip annealing operations. In continuous strip and wire annealing operations, the product moves through the furnace as a continuous strand, while roller hearth furnaces continuously convey discrete coils or lengths of product through the furnace. In either case, the furnace characteristically contains a heating zone, an annealing zone at approximately constant temperature, a cooling zone, and, on some units, a quench. The quench may consist of a tank through which cooling water flows. The cooling water rapidly dissipates the heat at the surface of the copper or copper alloy. These water quenches are typically discharged continuously to control the temperature in the quench tank. This discharge contains toxic metals and suspended solids which result from contact of the quench water with the heated copper product. It also contains oil and grease, which comprise the lubricants that will be washed off the surface of the copper product. Toxic organics are present as additives in the lubricant formulation and will also be washed off during the quenching process.

There are also package drawing machines which include an in-line annealing furnace followed by a quench, where the quench medium is an oil--water mixture. These oil--water quenches are typically cooled indirectly and are, therefore, not continuously discharged. The oil--water quench solution must, however, be periodically discharged and replaced because of the buildup of contaminants. The spent oil--water quench solution is contaminated with toxic organics, toxic metals, oil and grease, and suspended solids. Toxic organics and oil and grease present in this discharge originate in the oil used in the quench solution. Toxic metals and suspended solids present in the discharge result from contact of the quench solution with the heated copper wire.

Batch annealing is accomplished in "bell" anneals which are generally used with coiled products. Coils of products are stacked and then covered with an air tight jacket. They are then heated to the annealing temperature, maintained there for a specified period of time and then cooled by the use of noncontact cooling water on the outside of the jacket. After cooling, the jacket is removed and the annealed coils are unstacked. Cycle times on batch annealing units are generally much longer than on continuous annealing units. There is no contact water used in batch annealing. Consequently, there is no discharge of process water from batch annealing.

Pickling

Pickling is the use of acids (usually sulfuric) to remove surface oxides which could interfere with subsequent deformation processes or make the finished product less attractive. It generally occurs in a bath (tank) and is followed by one or more rinsing operations to remove the acid from the metal surface, and often also involves the use of additional chemicals such as sodium bichromate or hydrogen peroxide to produce a brighter and more tarnish resistant finish.

Except for some bright annealed materials, copper products are: (a) pickled after each annealing treatment; (b) completely descaled (usually); and (c) in some cases, bright dipped to produce a color and luster suitable for final product or further treatment. Pickling solutions containing (by volume) 4 to 15 percent sulfuric acid are used for the removal of oxides. Bright dips consist of sulfuric acid and nitric acid with a small amount of hydrochloric acid, a dichromate dip, and a hydrogen peroxide-acid (usually sulfuric) solution. Nickel silvers and cupronickel alloys do not respond readily to the pickling solutions usually used for brasses because nickel oxide has a limited solubility in sulfuric acid. It is desirable to control the condition of the metal surface by avoiding oxidation of the metal especially in the annealing step. Tubing made of cupro-nickel may be annealed in a reducing atmosphere to produce a clean surface that does not require acid treatment. Where pure copper is pickled with a sulfuric acid solution, the copper and acid are sometimes both recovered using electrolytic deposition of copper from the spent pickling bath. Some success has been achieved using this procedure with alloys and the recent development of methods for selectively recovering the various alloy metals shows promise.

A periodic discharge from the pickling bath ensures that contaminant concentrations will not affect product quality or reduce the effectiveness of the bath. The highly acidic nature of the bath results in high levels of dissolved metals in the bath discharge. These metals originate in the copper product which is pickled. Discharges from pickling baths may also contain hexavalent chromium which originates in the dichromate added to the baths. The bath will also contain oil and grease, present in the lubricants washed from the product surface during pickling. Toxic organics are present as additives and contaminants in the lubricant formulation.

Water used for rinsing the pickled copper contains the same pollutants; however, they are found at lower concentrations than in the bath. The higher volume of water used in rinsing acts to dilute the concentrations of the toxic contaminants which are dragged out from the pickling bath on the surface of the copper product.

Alkaline Cleaning

Alkaline cleaning commonly precedes annealing and serves to limit the amount of oil introduced into the annealing furnace. It may also follow annealing and be used to remove the resulting tarnish and smut. Vapor or solvent degreasing may be used in place of alkaline cleaning. There is no water used in vapor or solvent degreasing.

A typical alkaline cleaning operation consists of a bath (tank) in which the product is dipped and a series of water rinses to remove the entrained process solutions (drag out) and the contaminants contained therein.

A typical alkaline cleaning solution may contain from 10 to 20 percent caustic, from 5 to 20 percent sodium polyphosphate, from 30 to 50 percent silicates, from 0 to 25 percent sodium (bi) carbonate, from 5 to 10 percent resin type soap, 2 to 10 percent organic emulsifier, and wetting agents and chelating agents. To properly control the concentration of impurities, a portion of the bath is continuously or periodically discharged. The discharge will contain toxic organics, toxic metals, oil and grease, and suspended solids. The toxic organics and oil and grease present in the discharge originate in the lubricants which are cleaned from the surface of the copper product, and toxic metals and suspended solids present in the discharge are also washed from the product surface and originate in the forming operation which precedes alkaline cleaning.

Alkaline cleaning rinse water contains the same pollutants as the alkaline cleaning bath (toxic metals, toxic organics, oil and grease, and suspended solids), but in much lower concentrations. The higher volume of water used in rinsing acts to dilute the concentrations of these contaminants.

Solution Heat Treatment

In the copper forming industry, solution heat treatment refers to the practice of quenching formed copper products in water or an oil--water solution in order to reduce the temperature of the workpiece when it leaves the forming operation. The purpose of this quenching is to impart desired mechanical properties to the product and to facilitate handling and further working of the product. Solution heat treatment is practiced following all of the major forming operations; however, it is most commonly used following hot rolling and extrusion because of the high temperatures at which these operations are performed. Quenching is typically achieved by immersing the workpiece in a tank through which the cooling water flows. Spray quenching is also practiced. Water is used exclusively as the quenching medium for solution heat treatment of copper products following all of the major forming operations except extrusion. In the case of extrusion, an oil--water solution is sometimes used.

Quench water from solution heat treatment is typically discharged continuously to control the temperature in the quench tank. Pollutants present in the discharge from solution heat treatment water quenches include toxic organics, toxic metals, oil and grease, and suspended solids. Toxic organics and oil and grease present in the quench water discharge originate in the lubricants used in the forming operations which precede solution heat treatment. Toxic metals and suspended solids present in quench water discharges also originate in the forming operations which precede solution heat treatment and also result from contact of the quench water with the surface of the hot copper product.

In the case of extrusion, where oil--water mixtures are used as the quenching medium, the quench solution is cooled indirectly and is, therefore, not continuously discharged. These oil--water quench solutions must be periodically dumped and replaced, because of the continuous buildup of contaminants. The pollutants and sources of pollutants found in this discharge are the same as those for continuous discharges from solution heat treatment water quenches. Additionally, toxic organics and oil and grease are contributed by the oil which is used in the oil--water quench solution.

Additional Operations

A number of additional operations may be performed at copper forming facilities. Tumbling or burnishing is a finishing process used to polish, deburr, remove sharp corners, and generally smooth the formed parts for both cosmetic and functional purposes. The parts are placed in vibrating trays or rotating drums along with an abrading media. Water or oil--water mixtures are sometimes used for lubrication and cooling. These lubricants, in addition to the water used to wash the finished parts and clean the abrading media, become wastewater streams when discarded. Pollutants discharged include toxic metals and suspended solids, which are washed from the product surface, as well as abrading media particles entrained in the water. If lubricants are used, the waste stream will contain oil and grease and may contain toxic organics used as lubricant additives.

Surface coating (hot coating) involves coating a newly formed copper sheet in a bath of molten metal. Prior to coating, the sheet is passed through a liquid flux, usually consisting of hydrochloric acid, ammonium chloride and other additives, to clean it and to promote adhesion of the metal coating. Often the surface of the metal is abraded after coating to give it a smooth finish. Emission scrubbers may be employed to improve the quality of the emissions from the coating operation. Pollutants likely to be present in the discharge include toxic metals and suspended solids which are cleaned from the surface of the copper product. Toxic organics and oil and grease may also be present if lubricants are used in the forming operations which precede surface coating.

Hydrostatic testing operations are used to check copper parts for surface defects or subsurface imperfections. Parts are submerged in a water bath and subjected to ultrasonic signals, or in the case of tubing, pressurized with air. Piping and tubing may also be filled with water and pressurized to test their integrity. Hydrostatic testing operations are sources of wastewater because the spent water bath or test media must be periodically discarded due to the transfer into the testing media of oil and grease, solids, and suspended and dissolved metals from each product tested. Toxic organics may also be present, originating in the lubricants used in preceding forming operations.

Other operations which may generate waste streams include sawing, which is performed on copper parts to remove defects or cut to size; and milling, which removes surface irregularities and oxidation from copper. Sawing and milling operations use water soluble oil lubricants to provide cooling and lubrication. Lubricants from both operations eventually become degraded and must be discharged. The discharge will contain oil and grease, toxic organics used in lubricant formulations, and suspended solids and toxic metals resulting from contact of the lubricant with the copper product.

Maintenance Operations

Maintenance operations include the preparation of production-related equipment for repair, the maintenance of clean and safe conditions in the production area, and the evacuation of equipment that is taken off-line, such as pickling tanks.

Pollutants present in the discharge from maintenance operations include oil and grease and toxic organics, originating in the lubricants used on the equipment and present in the equipment that is evacuated (e.g., pickling tanks); and toxic metals and suspended solids, which result from contact of the water with the surface of the equipment and production areas.

Table III-1

GEOGRAPHIC DISTRIBUTION OF COPPER FORMING INDUSTRY IN THE UNITED STATES BY EPA REGIONS

EPA Region	Percent of All Copper Forming Plants	*Percent of Upper 50 Percentile of Copper Forming Plants	Percent of Copper Forming Plants Adjusted For Region Population
1	30.2	27.8	47.0
2	13.2	15.3	12.0
3	7.8	9.7	8.3
4	8.5	8.3	5.2
5	22.5	22.3	10.1
6	6.2	6.9	6.8
7	3.9	2.8	4.3
8	0.0	0.0	0.0
9	7.7	6.9	6.2
10	0.0	0.0	0.0

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*Plants having more than 4,000 metric tons (8,740,000 pounds) annual production.

Table III-2

DISTRIBUTION OF COPPER FORMING INDUSTRY PRODUCTS

Year	Percent Sheet, Strip, and Plate	Percent Rod, Bar, and Wire	Percent Plumbing Tube and Pipe	Percent Commercial Tube and Pipe	Total Millions of Metric Tons
1960	19.3	63.5	8.7	8.5	1.54
1962	19.6	59.9	11.8	8.7	1.81
1964	19.3	60.1	12.2	8.4	2.17
1966	22.6	60.7	8.1	8.6	2.64
1968	20.8	62.6	8.0	8.6	2.25
1970	18.2	64.7	7.8	9.3	2.20
1972	18.9	65.1	8.2	7.8	2.57
1974	19.4	66.5	6.4	7.7	2.48
1976	19.8	66.3	7.5	6.4	2.22
1978	17.4	68.6	8.0	6.0	2.60

Table III-3

FORMED COPPER PRODUCT USAGE DISTRIBUTION

Year	Percent Building Construction	Percent Transportation	Percent Consumer and General Products	Percent Industrial Machinery and Equipment	Percent Electrical and Electronic Products	Products to Domestic Markets (Millions of Metric Tons)
1960	29.6	12.1	14.4	20.8	23.0	1.97
1962	31.0	11.9	14.7	20.2	22.2	2.23
1964	31.2	11.9	14.9	19.6	22.5	2.65
1966	28.9	11.4	16.8	19.1	23.7	3.18
1968	28.5	10.7	18.2	18.6	24.0	2.71
1971	28.4	11.5	18.0	18.3	23.8	3.03
1972	29.4	11.8	16.8	17.6	24.4	3.04
1974	27.6	12.1	17.5	17.9	25.0	2.85
1976	27.1	13.3	12.7	23.9	23.0	2.65
1978	30.7	12.9	13.6	17.8	25.0	3.10
1980	30.4	10.1	13.9	17.9	27.7	2.68

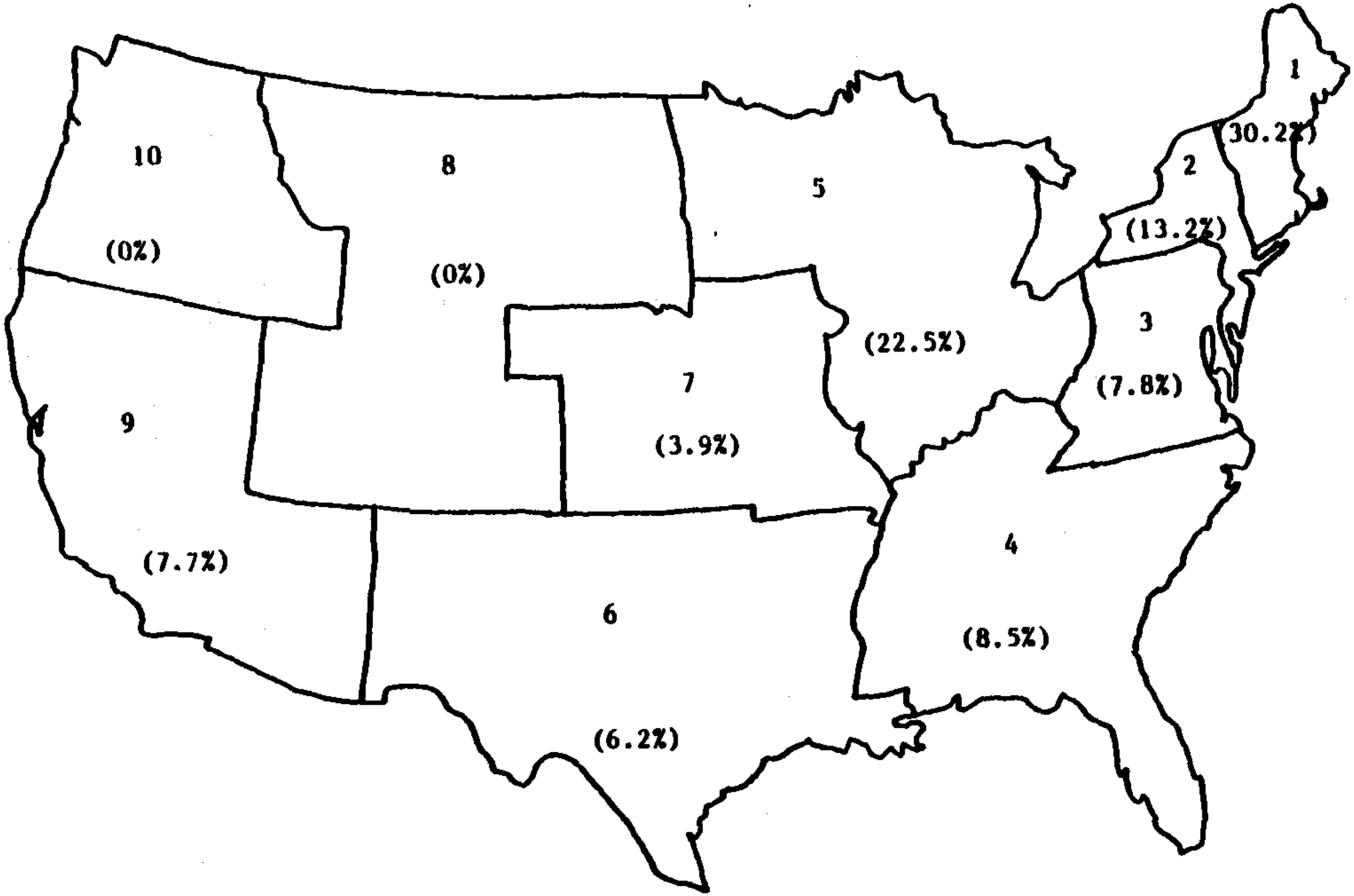


Figure III-1

DISTRIBUTION OF THE COPPER FORMING INDUSTRY BY EPA REGION

SECTION IV

INDUSTRY SUBCATEGORIZATION

SUBCATEGORIZATION

In developing regulations for the copper forming industry, the Agency considered whether different effluent limitations and standards are appropriate for different segments of the industry. The Act requires EPA to consider a number of factors to determine if subcategorization is needed. These factors include raw materials, final products, plant size, plant age, manufacturing processes, geographical location, and nonwater quality environmental impacts including energy costs and solid waste generation.

The factors which were considered as a basis for subcategorization of the copper forming category are discussed below. After consideration of all these factors, the Agency has determined that the copper forming category is most appropriately regulated as a single category.

Raw Materials

The raw materials used in the copper forming category can be classified as follows:

- Copper and copper alloys,
- Lubricants, and
- Surface treatment and degreasing chemicals.

While raw materials affect wastewater characteristics, the type and amounts of pollutants generated by the forming of various copper and copper alloys are not sufficiently different as to require different limitations or treatment. For example, plants processing brass (copper-zinc alloy) will generally have higher levels of zinc in the wastewater than plants processing pure copper; however, the streams at both plants are amenable to the same type of treatment, chemical precipitation and sedimentation, and upon application of this treatment will achieve the same effluent concentration of zinc. Refer to Section VII for further discussion of treatment system performance.

Final Products

The parameter is not suitable as a basis for subcategorization because many product types can be formed using various combinations of the basic forming and ancillary operations, and the process employed is much more important in determining wastewater characteristics than the final product. For example, sheet can be made using hot rolling alone, with or without water or lubricants, or by using hot rolling followed by cold rolling, annealing, and pickling. The wastewater discharged from these two forming processes would be quite different, although the final product is the same. The particular process used will depend upon the copper alloy used and the customer specifications, both of which vary frequently.

Plant Size

The number of employees and amount of production can be used to measure relative sizes of copper forming plants. However, neither factor provides an adequate basis for subcategorization.

Wastewaters are largely independent of the number of plant employees. Variations in staff occur for many reasons, including shift differences, clerical and administrative support, maintenance workers, efficiency of plant operations, and market fluctuations. Due to these and other factors, the number of employees is constantly fluctuating, making it difficult to develop a correlation between the number of employees and wastewater generation.

While plant production can be used to approximate the mass of pollutant generated, the Agency has determined that it should not be used to establish different effluent limitations for any copper forming segment for the following reasons:

(1) As previously discussed under final products, total production will not account for the various forming and ancillary operations used and the associated wastewater characteristics and flows.

(2) while the amount of production significantly affects the total mass of pollutants, it has little effect on the types and range of concentrations of pollutants found in the wastewater. Therefore there is little, if any, difference between the treatment technology required at small and large plants.

Plant Age

The forming operations used by copper forming plants have not changed basically over the past 80 years, to the extent that there are significant variations in the manner in which water is used and discharged, or the way in which pollutants are generated. Consequently, EPA found that plant age did not provide an adequate basis for subcategorization.

Geographical Location

Location is not a significant factor on which to base subcategorization of the copper forming category. Most copper forming plants are located in urban areas; thus, there is no vast disparity in land availability. In addition, few plants use land application or evaporation to treat copper forming wastewaters. Location is therefore not an appropriate basis for subcategorization of the copper forming category.

Manufacturing Processes

The principal copper forming manufacturing processes are hot rolling, cold rolling, extrusion, drawing, and forging. The Agency considered subcategorizing the copper forming category based on these five forming operations. This method of subcategorizing would be consistent with the fact that plants generally recognize the above forming operations as unique plant segments and that a signficant number of plants perform a single forming operation. After considering a number of factors, the Agency decided to regulate the category as a single unified subcategory. This is appropriate because most plants except those drawing copper use more than one forming operation and would be covered under more than one subcategory.

Non-Water Quality Factors

The non-water quality factors of energy usage, air emissions, and solid waste generation do not provide a basis for subcategorizing the copper forming category. After a review of all available information, the Agency was unable to identify any plant or type of plant which have an unusual non-water quality associated impact. Similarly, energy requirements in terms of amounts and availability did not distinguish any particular segment of the copper forming category.

Conclusion

The Agency considered all of the above factors and none of them served to identify discrete segments within the category so different as to warrant subcategorization. Conversely, the Agency found that different processes generated similar waste streams, treatable by the same technologies to the same level. Therefore, subcategorization is unnecessary and the category is being considered as a single (unified) subcategory.

PRODUCTION NORMALIZING PARAMETER

Effluent limitations and standards for the copper forming category are mass-based and are a function of production. Four different measures of production, each referred to as a production normalizing parameter (PNP), were evaluated for the copper forming category. These are:

1. Mass of copper processed,
2. Number of finished products manufactured,
3. Surface area of copper processed, and
4. Mass of process chemicals used.

In selecting the PNP for copper forming, the principal consideration was the correlation of the PNP with the mass of pollutants discharged. Other important considerations included the availability of data on a particular PNP and the ease of regulation from both a plant and permitting perspective. In consideration of these factors, the PNP established for copper forming is mass of copper processed through a given forming or ancillary operation. Specifically, the PNP is "off-kilograms" (off-pounds) and is defined as the mass of copper or copper alloy removed from a forming or ancillary operation at the end of a process cycle for transfer to a different machine or process. For example, in the rolling process copper wirebar enters the mill to be processed. Following one process cycle which reduces the wirebar's thickness and which may include multiple mill passes, the copper is removed from the rolling mill. It may then be processed through another operation, such as annealing, sizing, cleaning, or it may be stored before being brought back to the rolling mill for another process cycle, further reducing the thickness. The mass of copper removed from the rolling mill after each process cycle multiplied by the number of process cycles is the PNP for that process.

The evaluation of these alternatives is presented in the discussion that follows.

Alternatives Considered

Number of End Products Processed. The number of products processed by a given plant would not account for the variations in mass typical of formed products. Extrusions, for instance, are produced in a wide range of sizes. It would be unreasonable to expect the quenching of a large extrusion to use the same amount of water required for a small extrusion.

Surface Area of Copper Processed. Surface area may be an appropriate production normalizing parameter for copper which has been rinsed (i.e., the water use and discharge may correlate with surface area). Where surface area phenomena are involved, such as cleaning or pickling rinse, the use of surface area as a PNP may be the appropriate parameter. However, other phenomena, such as cooling, are wholely unrelated to surface area. Hence, surface area might be adequate for some processes but would be wholely inappropriate for others. In addition, the area of copper processed is not generally kept or known by industry. In some cases, such as forging of miscellaneous shapes, surface area data would be very difficult to determine. In any case, surface area data would be difficult to collect. For these reasons, surface area is an inappropriate PNP for the copper forming industry.

Mass of Process Chemicals Used. The mass of process chemicals used (e.g., lubricants, solvents, and acids) is more dependent on the processes which the copper undergoes than on the amount of copper used in the process. Some operations, such as annealing with water, use large amounts of process water but do not use any process chemicals. In addition, the use of this parameter as the production normalizing parameter would tend to discourage regeneration and reuse of process chemicals.

SECTION V

WATER USE AND WASTEWATER CHARACTERISTICS

A description of the sampling and analytical program is presented below, followed by a description of the process wastewater sources in the Copper Forming Point Source Category. The source of wastewater is discussed in the context of the process which produces the water. The amount of water used and wastewater generated on a production basis is then presented for each of the sources. Finally, data from the sampling and analytical program is presented in tabular form.

SAMPLING AND ANALYTICAL PROGRAM

EPA sampled 12 copper forming plants. Prior to each sampling visit, all available data, such as layout and diagrams of the selected plant's production processes and wastewater treatment facilities, were reviewed. Often an engineering visit to the plant to be sampled was made prior to the actual sampling visit to finalize the sampling approach. Representative sample points were then selected to provide coverage of discrete raw wastewater sources, total raw wastewater entering a wastewater treatment system, and final effluents. Finally, before conducting a visit, a detailed sampling plan showing the selected sample points and all pertinent sample data to be obtained was generated and reviewed.

The wastewater sampling program conducted at each plant usually consisted of screening and verification. Samples were collected over a three day period. Screening and verification was undertaken at three plants. Verification alone was performed at the remaining plants. Screening analysis was performed on the first day's samples while verification was performed on samples from days two and three. The objective of screening was to determine which pollutants were present in the plant wastewater and to quantify the levels of pollutants present. Particular emphasis was placed upon collection and analysis of samples for the 129 toxic pollutants. Once the screening data were obtained, parameters were chosen for verification analysis based on three considerations: (1) whether or not the pollutant was detected during screening; (2) information reported on the dcp concerning the presence or absence of the 129 toxic pollutants; and (3) technical judgment concerning the probable presence or absence of each pollutant. Samples collected for verification analysis were shipped within 24 hours to the analytical laboratory, preserved, and extracted. The preserved extracts were then held until the screen samples were analyzed. A more detailed discussion of sample preservation and analysis is presented below.

Site Selection

Twelve copper forming plants were visited for an on-site study of their manufacturing processes, water use, and wastewater treatment. In addition, wastewater samples were collected at the 12 plants visited in order to quantify the level of pollutants in the waste streams. The reason that the Agency selected these 12 plants was to adequately represent the full range of manufacturing operations found in this industry as well as the performance of existing wastewater treatment systems. As such, the plants selected for sampling were typically plants with multiple forming operations and associated surface and heat treatment operations. The flow rates and pollutant concentrations in the wastewaters discharged from the manufacturing operations at these plants are representative of the flow rates and pollutant concentrations which would be found in wastewaters generated by similar operations at any plant in the copper forming industry. Also, the 12 plants selected for sampling have a variety of treatment systems in place. Included in the 12 plants were plants with no treatment as well as plants using the technologies considered as the basis for regulation.

Pollutants Analyzed

The chemical pollutants sought in analytical procedures fall into three groups: conventional, nonconventional, and toxics. The latter group comprises the 129 pollutants found in the priority pollutant list shown in Table V-1 (p. 85).

Conventional pollutants are those generally considered treatable by secondary municipal wastewater treatment. The conventional pollutants examined for this study are:

pH,
Oil and Grease (O&G) and
Total Suspended Solids (TSS).

Nonconventional pollutants are those which are neither conventional nor on the list of toxic pollutants. The following nonconventional pollutants were examined in the copper forming category. Fluoride, manganese, iron and phosphorus were analyzed because it was anticipated that they might be present as a result of the alloys processed. Total organic carbon and total phenols were analyzed because they were viewed as possible indicators of the presence or absence of toxic organic pollutants.

Total Organic Carbon,
Total Phenols (4AAP),
Fluoride,
Iron,

Manganese, and
Phosphorus.

Some additional nonconventional pollutants were occasionally examined at one or more plants where the processes or alloys used would indicate the presence of these pollutants:

Aluminum,
Ammonia,
Boron,
Cobalt,
Gold, and
Titanium.

Sampling Methodology

During the initial visit to a facility, a selection was made of sampling points so as to best characterize process wastes and evaluate the efficiency of wastewater treatment. Representative sample points were then selected to provide coverage of discrete raw wastewater sources, total raw wastewater entering a wastewater treatment system, and final effluents. The nature of the wastewater flow at each selected sampling point then determined the method of sampling, i.e., automatic composite, grab composite, or one-time grab sample. The sample points were individual raw waste streams, combined influent to treatment, or treated effluent.

Each sample was collected by an automatic time series compositor over a 24-hour sampling period whenever possible. When automatic compositing was not possible, grab samples were taken at intervals over the same period, and were composited manually. When a sample was taken for analysis of toxic organics, a blank was also taken to determine the level of contamination inherent to the sampling and transportation procedures.

All metals, oil and grease, and organics samples were iced immediately and kept at 4° C. They were then shipped within 24 hours to the analytical laboratory, where the metals samples were preserved immediately and the organic samples were extracted and preserved. On some occasions, cyanide and TSS samples were not shipped out, but were analyzed by a local laboratory.

Analytical Methods

The analytical techniques for the identification and quantification of toxic pollutants were those described in Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants, revised in April, 1977.

In the laboratory, samples for organic pollutant analysis were separated by specific extraction procedures into acid (A), base-neutral (B-N), and pesticide (P) fractions. Volatile organic samples (V) were taken separately as a series of grab samples at 4-hour intervals and composited in the laboratory. The analysis of these fractions included the application of strict quality control techniques including the use of standards, blanks, and spikes. Gas chromatography and gas chromatography-mass spectrometry were the analytical procedures used for the organic pollutants. Two other analytical methods were used for the measurement of toxic metals: flameless atomic absorption and inductively coupled argon plasma spectrometric analysis (ICAP). The metals determined by each method were:

Flameless AA

Antimony
Arsenic
Beryllium
Mercury
Selenium
Silver
Thallium

ICAP

Cadmium
Chromium
Copper
Lead
Nickel
Zinc

For the analysis of conventional and nonconventional pollutants, procedures described by EPA were followed. The following conventions were used in quantifying the levels determined by analysis:

- For organic pollutants other than pesticides, the symbol * is used to indicate detection at levels less than or equal to 0.01 mg/l, the quantifiable limit of detection. For pesticides (pollutants 89-105), the symbol ** indicates detection at levels less than or equal to the quantifiable limit of 0.005 mg/l. For metals, the use of < indicates that the pollutant was not detected by analysis with the detection limit shown.
- Blank samples of organic-free distilled water were placed adjacent to sampling points to detect airborne contamination of water samples

WASTEWATER SOURCES

This section presents a discussion of the sources of process wastewater from plants in the copper forming category. The major sources of wastewater in the copper forming category are lubrication and cooling, alkaline cleaning, annealing, heat treatment, and pickling.

Water is used for lubrication and cooling in all of the major forming operations in the copper forming industry. Two types of waste streams result from lubrication and cooling: spent lubricants and solution heat treatment wastewater. Spent lubricants result from water, emulsified oils, or soluble oils that are applied directly to the product or the forming machine during the forming operation. The three specific spent lubricant waste streams generated in the copper forming industry are hot rolling spent lubricants, cold rolling spent lubricants, and drawing spent lubricants.

Process water is used in alkaline cleaning to remove soil and lubricants from the product. Alkaline cleaning is usually practiced before annealing to prevent the formation of undesirable films on the metal. Removal of the soils and films after annealing is also sometimes practiced. Pollutants introduced result from cleaning agents and lubricants, and from residues cleaned from the metal. Cleaning operations may be either continuous (typically for strip) or batch operations (for rod or tube). Cleaning is followed by one or more rinses which produce most of the discharge associated with this process.

Process water use in annealing is primarily for the purpose of rapidly cooling annealed products in order to limit surface oxidation and facilitate subsequent handling. Quenches may be either aqueous baths in which the product is submerged or sprays through which the product passes. The quench solution may contain only water, or may consist of a soluble oil solution in water. Spray quenches generally use water only, while quench baths are likely to contain soluble oils. Bell annealing units do not involve a quench and are most often employed without the use of contact water.

Pickling removes contaminants from the surface of a formed product by submerging the product in an acidic solution that dissolves the contaminants. The acidic solution remaining on the product surface is then rinsed off. In some cases, wet scrubbers are used to control air pollution resulting from pickling bath fumes. Water is used in the initial bath to form the acid solution, in the subsequent rinsing, and in the wet scrubber. All three of these uses may result in a pickling wastewater discharge.

The specific wastewater sources associated with the copper forming category are listed below:

--Spent Hot Rolling Lubricants,
--Spent Cold Rolling Lubricants,
--Spent Drawing Lubricants,
--Solution Heat Treatment,
--Extrusion Press Solution Heat Treatment,
--Alkaline Cleaning Bath,
--Alkaline Cleaning Rinse,

- --Annealing With Water,
- --Annealing With Oil,
- --Pickling Bath,
- --Pickling Rinse,
- --Pickling Fume Scrubber,
- --Tumbling or Burnishing,
- --Surface Coating, and
- --Miscellaneous Waste Streams, which include Hydrostatic Testing, Sawing, Surface Milling, and Maintenance.

A brief discussion of each stream follows:

Hot Rolling Spent Lubricant

In hot rolling, lubricants are used to reduce frictional forces in the metal deformation process. In most cases, lubricants are sprayed on the metal before it enters the rollers, but on occasion lubricants are swabbed on the metal. Lubricants consist of water, soluble oils, or oil--water mixtures.

Cold Rolling Spent Lubricant

A variety of lubrication techniques are used in processing the metal on the various types of cold rolling machines. Emulsified water soluble oils, insoluble oil-water mixtures, and mineral oil alone are the main types of lubricants used. Soluble oil emulsions and pure oil lubricants are generally recycled and dumped periodically. Insoluble oil--water mixtures and contaminated cooling water are generally discharged continuously after contact with the product or mill. In most cases, lubricants are sprayed onto the metal just before it enters the rollers, although lubricant is occasionally swabbed onto the metal. In cases where insoluble oil and water are both applied to the metal, they are usually sprayed on simultaneously.

Drawing Spent Lubricant

For drawing, soluble or emulsified lubricants are used most frequently although some lubricants contain no water. The effects of lubrication are to prolong die life, provide a better surface finish on the drawn material, remove residues, and increase drawing speed. In drawing, the lubricant may be sprayed onto the rod or wire as it enters the die or the die may be immersed in lubricant. Lubricant is commonly recirculated through a lubrication cooling system from a holding tank.

Solution Heat Treatment

Solution heat treatment wastewaters result from cooling of the formed copper product after it leaves the forming machine. Water is used for quenching copper products from hot rolling, cold rolling, extrusion, and drawing. The data indicate that the flow rates and raw waste characteristics of solution heat treatment wastewater are similar regardless of the forming operation which precedes the water quench. Solution heat treatment wastewater from water quenching of formed copper products is therefore considered to be a single waste stream.

Extrusion Press Solution Heat Treatment

Some extrusion quenches, particularly those used for submerged extrusion, contain emulsified or soluble oils. These quenches are characteristically recycled and reused. As a result, their discharges are considerably less than discharges from water quenches. The waste stream which results from quenching of extruded copper products in emulsified or soluble oils is known as extrusion press solution heat treatment wastewater.

Alkaline Cleaning Bath

Alkaline cleaning bath wastewaters result from the periodic dumping of batch alkaline cleaning baths, or a bleed stream from a continuous recirculating alkaline cleaning operation.

Alkaline Cleaning Rinse

Alkaline cleaning rinse wastewaters result from the rinsing of copper products after alkaline cleaning. The rinsing operation may be either spray rinsing or stagnant rinsing.

Annealing With Water

Wastewater discharge from spray quenches results either as the quench medium runs directly out of the quench chamber or as a blowdown or overflow from a quench water recirculation system. The quench medium is either water or an oil--water mixture, with water as the major constituent. Annealing quench water is sometimes mixed with noncontact cooling water and other process water in recirculation systems. Discharge from quench baths may occur as a continuous overflow or as a periodic dump of the bath.

Strip is often processed in continuous lines which combine alkaline cleaning, annealing, and pickling. The annealing units in these lines commonly incorporate a water tank through which the strip passes after annealing. Other products, including coiled strip, are generally quenched by water sprays included as an integral part of roller hearth annealing units.

Annealing With Oil

At many facilities, wire or other copper products are quenched in baths which contain oil as the major constituent. These quenches usually follow continuous annealing. Annealing with oil is generally associated with drawing operations.

Pickling Bath

Pickling baths are used to remove oxidized metal and other undesirable contaminants from the surface of copper and copper alloy products at various points during and after forming operations. After repeated use, the acid content of the bath (generally H_2SO_4) becomes depleted and the bath becomes enriched in metals and other impurities. While acid depletion may be overcome by the addition of makeup acid, the accumulation of impurities in the bath ultimately renders it unfit for continued use. At that point the bath is commonly discharged and replaced with a fresh acid solution. The pickling bath thus constitutes an intermittent, low volume, but very concentrated source of process wastewater.

Pickling Rinse

Rinses remove dragout from the pickling bath adhering to cleaned product surfaces and thus become contaminated with the materials present in the bath. The wastewater which results from pickling rinses is higher in volume and lower in concentration than pickling bath discharges.

Pickling Fume Scrubber

Wet scrubbers are used to control air emissions which result from the volatile components of pickling baths and produce relatively dilute waste streams similar to those from pickling rinses.

Tumbling or Burnishing

Tumbling or burnishing is a finishing process used to polish, deburr, remove sharp corners, and generally smooth formed parts, for both cosmetic and functional purposes. The parts are placed in vibrating trays or rotating drums along with an abrading media. Water or oil--water mixtures are sometimes used for lubrication and to dissipate the frictional heat generated in the abrasion process. Wastewater results from tumbling or burnishing when the finished parts and abrading media are cleaned to rid them of lubricants and dirt.

Surface Coating

The term surface coating or hot coating refers to the coating of a copper sheet by immersing it in a bath of molten metal. Prior to immersion, the sheet is passed through a liquid flux, usually consisting of hydrochloric acid, ammonium chloride, and other additives, to clean it and to promote adhesion of the metal coating. Often the surface of the coated metal is abraded to give it a smooth finish. Occasionally a wet scrubber is used to control air emissions from the fluxing operation.

Miscellaneous Waste Streams

Miscellaneous waste streams include hydrotesting, sawing, surface milling, and maintenance.

Hydrostatic testing, or hydrotesting, is used to check formed copper parts for surface defects or subsurface imperfections. Parts are submerged in a water bath and subjected to ultrasonic signals, or in the case of tubing, pressurized with air. Piping and tubing may also be filled with water and pressurized to test their integrity. Oil and grease, solids, and metals are transferred into the testing media from each part that is tested. Eventually this fluid must be discarded when the accumulation of these substances renders it unfit for continued use.

Sawing is simply the cutting of copper parts to remove defects or adjust the size; surface milling removes irregularities and oxidation from the surface of a copper part. Water soluble oil lubricants may be used in these operations to provide cooling and lubrication. These lubricants become degraded and must eventually be discarded.

Maintenance operations include the preparation of production-related equipment for repair, the maintenance of clean and safe conditions in the production area, and the evacuation of equipment that is taken off-line, such as pickling tanks.

PRODUCTION NORMALIZED FLOWS

Wastewater flow rates are related to the amount of production at a given plant. In order to take production into account, wastewater flow rates are discussed in terms of production normalized flows. The production normalized flow is defined as the flow rate of a given waste stream divided by the production of the manufacturing operation associated with the waste stream. The unit of production specified is known as the production normalizing parameter (see p. 69). Production normalized flows are expressed in units of liters of wastewater per thousand kilograms of product (l/kkg).

The production normalized flows as reported in the dcp are presented in Tables V-2 through V-14 for 13 of the 17 copper forming wastewater streams. For production normalized flow data for the other waste streams, see Sections IX and X. In addition, these tables present information on reported production and recycle rates.

POLLUTANTS FOUND AND SOURCES OF THESE POLLUTANTS

Tables V-15 through V-26 summarize the analytical data from each of the copper forming plants sampled and identifies the specific waste streams represented by each sample.

The pollutants found in significant concentrations in copper forming wastewaters are presented in this section along with a discussion of the sources of these pollutants in copper forming operations. A few waste streams were not sampled; these are tumbling or burnishing, surface coating, and miscellaneous streams comprised of hydrotesting, sawing, surface milling, and maintenance. Based on industry descriptions of these streams, it is reasonable to expect that the discussion of pollutants and sources of pollutants provided below for the sampled wastewater streams also applies to the non-sampled wastewater streams.

Toxic Metals

Toxic metals in copper forming wastewaters result from process wastewater contact with the metal surface, and, in the case of chromium, from pickling baths containing sodium dichromate as a brightening agent. In addition to chromium, the predominant toxic metals are copper, lead, nickel, and zinc. Metals found at sampled plants to a lesser extent and in smaller concentrations are antimony, arsenic, beryllium, cadmium, selenium, and silver.

Other toxic metals can be employed as alloying additives and therefore, when used, can be present in copper forming wastewaters. However, based on sampling data representative of many alloys, wastewaters from forming of these other copper alloys would not be expected to differ significantly from copper forming wastewaters sampled.

Toxic Organics

The toxic organic pollutants found in significant concentrations in copper forming wastewaters are benzene; 1,1,1-trichloroethane; chloroform; 2,6-dinitrotoluene; ethylbenzene; methylene chloride; naphthalene; N-nitrosodiphenylamine; anthracene; phenanthrene; toluene; and trichloroethylene.

Organic priority pollutants found in copper forming wastewaters originate primarily in the lubricants used in the forming processes. Published information and information obtained during plant visits confirm the presence of these organics in lubricants used in manufacturing copper and copper alloy products. Most of these toxic organics are present either as additives or as contaminants. For example, nonaromatic chlorinated hydrocarbons are used in stabilized chlorinated oils, which are used for lubrication under severe conditions. Specific compounds in this class, such as 1,1,1-trichloroethane and trichloroethylene, are commonly used as solvents for oils and fats, as are benzene and toluene.

Other toxic organics may be found in copper forming wastewaters even though they were not found in the sampled waste streams. This is because toxic organic compounds originate in lubricants and these compounds can vary depending upon the formulation of the lubricant. Many polyaromatic hydrocarbons and organic solvents can be substituted for one another to perform the same function.

Conventional Pollutants

The conventional pollutants found in significant concentrations in copper forming wastewaters are oil and grease, total suspended solids (TSS), and pH.

Oil and grease found in raw waste streams at copper forming plants is primarily attributed to the lubricants used in the forming processes. The lubricants enter wastewater streams as a result of deliberate mixing in soluble or emulsified oil systems, mixing of fluid lubricants with cooling water on rolling mills, solution or entrainment of greases used on roll necks or other machinery parts in cooling water, contamination of quench baths with lubricants from product surfaces, and removal of lubricants from product surfaces in alkaline cleaning.

TSS results from the abrasion or particles from the surface of the copper product or the surface of the rolls or dies used in the major forming operations. Miscellaneous dirt and particles as well as soot from annealing furnaces and oxides which form on the product surface end up in annealing quenches, alkaline cleaning, and pickling wastewaters. Also, suspended solids can form as a result of chemical precipitation of dissolved solids as streams of different pH are mixed deliberately or through dragout on the product surface.

Wastewater with an abnormally high or low pH can result when acid or alkaline cleaning waters are discharged.

Nonconventional Pollutants

No nonconventional pollutants were regularly found in significant concentrations in copper forming wastewater. However, several nonconventional pollutants are sometimes used as alloying materials. These include tin, iron, aluminum, phosphorus, manganese, silicon, and cobalt. These pollutants could be found in significant concentrations when they are used as a constituent of a copper alloy.

Table V-1

LIST OF 129 TOXIC POLLUTANTS

Compound Name

1. acenaphthene
2. acrolein
3. acrylonitrile
4. benzene
5. benzidene
6. carbon tetrachloride (tetrachloromethane)

Chlorinated benzenes (other than dichlorobenzenes)

7. chlorobenzene
8. 1,2,4-trichlorobenzene
9. hexachlorobenzene

Chlorinated ethanes

10. 1,2-dichloroethane
11. 1,1,1-trichlorethane
12. hexachlorethane
13. 1,1-dichloroethane
14. 1,1,2-trichloroethane
15. 1,1,2,2-tetrachloroethane
16. chloroethane

Chloroalkyl ethers

17. deleted
18. bis (2-chloroethyl) ether
19. 2-chloroethyl vinyl ether (mixed)

Chlorinated naphthalene

20. 2-chloronaphthalene

Chlorinated phenols (other than those listed elsewhere)

21. 2,4,6-trichlorophenol
22. parachlorometa cresol
23. chloroform (trichloromethane)
24. 2-chlorophenol

Table V-1 (Continued)

LIST OF 129 TOXIC POLLUTANTS

Dichlorobenzenes

25. 1,2-dichlorobenzene
26. 1,3-dichlorobenzene
27. 1,4-dichlorobenzene

Dichlorobenzidine

28. 3,3'-dichlorobenzidine

Dichloroethylenes

29. 1,1-dichloroethylene
30. 1,2-trans-dichloroethylene
31. 2,4-dichlorophenol

Dichloropropane and dichloropropene

32. 1,2-dichloropropane
33. 1,2-dichloropropylene (1,3-dichloropropene)
34. 2,4-dimethylphenol

Dinitrotoluene

35. 2,4-dinitrotoluene
36. 2,6-dinitrotoluene
37. 1,2-diphenylhydrazine
38. ethylbenzene
39. fluoranthene

Haloethers (other than those listed elsewhere)

40. 4-chlorophenyl phenyl ether
41. 4-bromophenyl phenyl ether
42. bis(2-chloroisopropyl) ether
43. bis(2-choroethoxy) methane

Halomethanes (other than those listed elsewhere)

44. methylene chloride (dichloromethane)
45. methyl chloride (chloromethane)
46. methyl bromide (bromomethane)
47. bromoform (tribromomethane)
48. dichlorobromomethane

Table V-1 (Continued)

LIST OF 129 TOXIC POLLUTANTS

49. deleted
50. deleted
51. chlorodibromomethane
52. hexachlorobutadiene
53. hexachlorocyclopentadiene
54. isophorone
55. naphthalene
56. nitrobenzene

Nitrophenols

57. 2-nitrophenol
58. 4-nitrophenol
59. 2,4-dinitrophenol
60. 4,6-dinitro-o-cresol

Nitrosamines

61. N-nitrosodimethylamine
62. N-nitrosodiphenylamine
63. N-nitrosodi-n-propylamine
64. pentachlorophenol
65. phenol

Phthalate esters

66. bis(2-ethylhexyl) phthalate
67. butyl benzyl phthalate
68. di-n-butyl phthalate
69. di-n-octyl phthalate
70. diethyl phthalate
71. dimethyl phthalate

Polynuclear aromatic hydrocarbons

72. benzo (a)anthracene (1,2-benzanthracene)
73. benzo (a)pyrene (3,4-benzopyrene)
74. 3,4-benzofluoranthene
75. benzo(k)fluoranthane (11,12-benzofluoranthene)
76. chrysene
77. acenaphthylene
78. anthracene
79. benzo(ghi)perylene (1,11-benzoperylene)
80. fluorene
81. phenanthrene

Table V-1 (Continued)

LIST OF 129 TOXIC POLLUTANTS

82. dibenzo (a,h)anthracene (1,2,5,6-dibenzanthracene)
83. indeno (1,2,3-cd)pyrene (w,e,-o-phenylenepyrene)
84. pyrene
85. tetrachloroethylene
86. toluene
87. trichloroethylene
88. vinyl chloride (chloroethylene)

<u>Pesticides and metabolites</u>

89. aldrin
90. dieldrin
91. chlordane (technical mixture and metabolites)

<u>DDT and metabolites</u>

92. 4,4'-DDT
93. 4,4'-DDE(p,p'DDX)
94. 4,4'-DDD(p,p'TDE)

<u>Endosulfan and metabolites</u>

95. a-endosulfan-Alpha
96. b-endosulfan-Beta
97. endosulfan sulfate

<u>Endrin and metabolites</u>

98. endrin
99. endrin aldehyde

<u>Heptachlor and metabolites</u>

100. heptachlor
101. heptachlor epoxide

<u>Hexachlorocyclohexane (all isomers)</u>

102. a-BHC-Alpha
103. b-BHC-Beta
104. r-BHC (lindane)-Gamma
105. g-BHC-Delta

Table V-1 (Continued)

LIST OF 129 TOXIC POLLUTANTS

Polychlorinated biphenyls (PCB's)

106. PCB-1242 (Arochlor 1242)
107. PCB-1254 (Arochlor 1254)
108. PCB-1221 (Arochlor 1221)
109. PCB-1232 (Arochlor 1232)
110. PCB-1248 (Arochlor 1248)
111. PCB-1260 (Arochlor 1260)
112. PCB-1016 (Arochlor 1016)

Metals and Cyanide, and Asbestos

114. antimony
115. arsenic
116. asbestos (Fibrous)
117. beryllium
118. cadmium
119. chromium (Total)
120. copper
121. cyanide (Total)
122. lead
123. mercury
124. nickel
125. selenium
126. silver
127. thallium
128. zinc

Other

113. toxaphene
129. 2,3,7,8-tetra chlorodibenzo-p-dioxin (TCDD)

Table V-2

HOT ROLLING LUBRICANT

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
28033	6,952	0	99+	67,000,000	Z
36032	NR	0	99+	9,044,429	Z
37038	NR	0	99+	25,080,000	Z
36542	NR	0	NR	NR	Z
30174	NR	0.32	99	182,000,000	I
33043	NR	0.43	NR	25,241,000	I
28048	NR	0.48	NR	14,000,000	I
11086	18,611	0.85	99.9	226,186,000	I
41058	NR	2.21	99	18,879,755	I
23041	38,642	2.33	99.9	358,550,709	I
30070	NR	2.91	NR	68,892,965	I
02031	NR	10.85	NR	15,409,000	I
41075	108	14.02	87	250,152,000	I
12036	19,112	54.50	99.7	329,737,200	I
30059	20,781	65.01	99.7	77,000,000	D
44030	74,195	202.81	99.7	83,000,000	I
30065	23,285	582.55	97.5	353,667,315	I
12110	1,110	1,110.00	0	179,305,000	I
19019	6,702	6,701.00	0	19,658,880	D
20093	6,810	6,810.00	0	21,807,988	I
47432	7,853	7,678.00	2.2	83,398,575	I
28044	162,745	NR	NR	35,482,630	I
11910	12,018	NR	NR	483,166,000	D
36070	NR	NR	NR	NR	D
30174	NR	NR	NR	NR	I
33042	NR	NR	NR	25,241,000	D
36070	NR	NR	NR	625,000	D
38030	NR	NR	NR	480,000,000	I

Note: NR means not reported.

Table V-3

COLD ROLLING LUBRICANT

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
28048	NR	0	NR	9,200,000	Z
36542	NR	0	99+	81,000,000	Z
06106	NR	0	NR	47,814,891	Z
06060	NR	0	NR	77,402,206	Z
37067	NR	0	99+	133,444	Z
36034	NR	0	NR	1,206,400	Z
06082	NR	0	NR	38,700,000	Z
11144	NR	0	NR	35,160,000	Z
19040	NR	0	NR	80,000	Z
44030	NR	0	NR	979,000	Z
20048	NR	0	NR	131,000	Z
44030	225,340	0	99.9	12,000,000	Z
12110	647	0	99+	278,830,148	Z
19044	NR	0	99+	10,000,000	Z
28041	NR	0	99+	11,801,703	Z
06013	NR	0	NR	18,583,200	Z
36032	NR	0	100	9,044,429	Z
30174	NR	0	NR	NR	Z
33091	NR	0.491	99+	3,400,000	I
33065	NR	0.555	NR	646,895,449	I
36081	NR	2.23	NR	9,000,000	I
23033	NR	8.76	99+	2,384,000	I
20068	NR	18.60	NR	33,616,000	I
06461	NR	25.40	NR	13,408,000	D
06058	NR	614	NR	122,278,275	I
19019	2,629	2,630	0	24,151,680	D
47432	NR	2,650	99+	209,713,193	I
06070	4,682	4,680	0	8,112,100	I
19058	NR	NR	NR	20,000	D
33042	NR	NR	NR	NR	D
36070	NR	NR	NR	6,250,000	D

Note: NR means not reported.

Table V-4

DRAWING LUBRICANT

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent* Recycle	Production (off lb/yr)	Discharge Status
37040	NR	0	99+	15,000,000	Z
37039	NR	0	99+	4,000,000	Z
37032	NR	0	99+	5,621,958	Z
37031	NR	0	99+	24,765,522	Z
36032	NR	0	99+	9,044,429	Z
36031	9,765	0	99+	1,539,000	Z
30036	9,105	0	99+	3,300,000	Z
30032	NR	0	99+	10,000,000	Z
28053	NR	0	99+	9,500,000	Z
28042	982,300	0	99+	1,353,640	Z
01852	NR	0	99+	10,000,000	Z
23038	NR	0	99+	5,302,612	Z
19047	NR	0	99+	6,538,317	Z
04129	NR	0	99+	5,000,000	Z
04095	NR	0	99+	3,562,696	Z
03034	NR	0	99+	4,320,000	Z
15034	39,290	0	99+	6,500,000	Z
14052	NR	0	99+	2,000,000	Z
12046	NR	0	99+	420,000	Z
06099	3.446	0	99+	12,350,560	Z
41075	0.3968	0	99+	109,000,000	Z
19076	NR	0	99+	906,000,000	Z
04070	NR	0	NR	150,000	Z
41058	NR	0	99+	16,069,121	Z
28041	136,700	0	99+	59,215,971	Z
06106	NR	0	NR	99,963,945	Z
36045	NR	0	NR	33,000,000	Z
04083	NR	0	NR	17,000,000	Z
14051	0.0004966	0	99+	24,200,000	Z
30059	NR	0	NR	45,000,000	Z

Table V-4 (Continued)

DRAWING LUBRICANT

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent* Recycle	Production (off lb/yr)	Discharge Status
41063	NR	0	99+	29,508,000	Z
12031	11,320	0	99+	23,900,000	Z
37038	NR	0	99+	18,200,000	Z
20071	NR	0	99+	26,000,000	Z
11075	NR	0	99.97	2,600,000	Z
11074	17.13	0	75.2	9,100,000	Z
06061	NR	0	NR	54,000,000	Z
12108	NR	0	NR	8,877,932	Z
19048	NR	0	99+	695,000	Z
12860	NR	0	NR	30,788,000	Z
37030	NR	0	99	35,288,567	Z
19075	NR	0	99+	8,130,170	Z
19038	NR	0	98	11,500,000	Z
11046	24,570	0	99.97	9,340,000	Z
30031	NR	0	NR	57,500,000	Z
40030	NR	0	95	2,142,790	Z
12030	176,200	0	99	6,824,311	Z
25001	NR	0	99+	166,361,620	Z
33079	36,890	0	99+	19,004,314	Z
19046	NR	0	99+	556,000	Z
30033	95,480	0	99+	9,100,000	Z
20114	NR	0	NR	17,200,000	Z
22023	NR	0	NR	10,263,000	Z
12109	46,590	0	99+	16,444,593	Z
11047	482,200	0	99+	4,500,000	Z
08054	NR	0	NR	21,670,141	Z
33043	NR	0	NR	56,382,000	Z
30040	NR	0	99+	2,361,600	Z
04430	NR	0	NR	1,127,000	Z
06109	NR	0	NR	21,824,000	Z
30037	NR	0	99+	9,575,000	Z

Table V-4 (Continued)

DRAWING LUBRICANT

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent* Recycle	Production (off lb/yr)	Discharge Status
28009	NR	0	NR	9,500,000	Z
15030	NR	0	NR	6,000,000	Z
12036	NR	0.722	NR	462,400,000	I
23033	NR	1.207	NR	65,700,000	I
28033	69,610	1.890	99+	53,000,000	I
02031	NR	2.708	NR	15,409,000	I
02030	NR	2.980	NR	140,000,000	I
06068	160,700	3.455	99+	21,500,000	I
06071	NR	5.239	NR	15,930,574	I
30092	NR	5.901	99+	16,970,000	I
19043	2,209,000	6.137	99+	13,600,000	I
19045	NR	7.113	99	35,197,000	I
04086	195,100	9.756	99+	7,700,000	I
37067	NR	13.94	99+	104,772	I
06108	NR	16.69	NR	1,000,000	I
06120	NR	47.15	NR	708,115	I
28044	227.8	49.99	78	8,654,300	I
12032	345,600	51.78	99+	18,858,000	I
36033	NR	53.34	99+	5,132,000	I
16030	NR	55.89	NR	5,375,387	I
06059	NR	68.40	NR	1,851,000	I
06461	NR	303.0	NR	21,897	D
20044	309.6	309.6	0	4,853,218	D
37068	NR	847.7	NR	21,700	I

* - 99+ indicates that more than 99 percent of the drawing lubricant is recycled; less than 1 percent of the drawing lubricant is contract hauled or evaporated.

Note: NR means not reported.

Table V-5

SOLUTION HEAT TREATMENT

Sequence Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production off lb/yr	Discharge Status	Forming Operation That Precedes Solution Heat Treatment
19019	64,200	0	100	1,497,600	Z	E
06099	1,310	0	100	12,350,560	Z	D
28042	8,930	0	100	1,363,640	Z	D
37032	NR	4.58	NR	4,850,187	D	E
18534	36.30	36.19	0	78,570,000	I	D
11910	60.20	59.99	0	13,863,432	D	CR
06059	NR	68.31	NR	1,851,000	I	D
12036	4,910	108.9	98	329,737,200	I	HR
19019	119.0	118.9	0	8,050,560	D	HR
23033	214.0	213.8	0	65,700,000	I	D
11229	349.0	347.8	0	1,034,719,764	D	CR
33043	82,700	411.8	99.5	25,241,000	I	HR
28041	12,400	424.3	97	358,550,709	I	HR
06461	1,240	1,231.0	0	25,000,000	D	E
04094	16,600	1,514.0	91	33,586,861	I	E
12110	163.0	1,622.0	0	101,108,000	I	HR
06373	1,950	1,947.0	0	9,579,454	D	E
06060	2,630	2,621.0	0	78,342,851	D	E
28033	17,800	2,712.0	85	53,000,000	I	D
12110	3,620	3,611.0	0	179,305,000	I	HR
47432	5,890	4,135.0	NR	81,715,299	I	E
28044	5,690	4,376.0	NR	35,482,630	I	HR
06106	22,500	11,730.0	NR	69,534,007	D	E
11084	16,100	16,060.0	0	43,800,284	D	E

Note: NR means not reported; CR means Cold Rolling; E means Extrusion; D means Drawing; HR means Hot Rolling.

Table V-6

EXTRUSION PRESS SOLUTION HEAT TREATMENT

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
28041	1,890,000	0	100	1,605,506	Z
30174	NR	0	100	8,381,250	Z
03031	28,300	0	100	116,652,544	Z
06058	NR	0	100	86,200,000	Z
28048	NR	1.11	NR	6,000,000	I
20068	NR	2.04	NR	16,316,000	I
44033	NR	2.82	NR	17,687,855	D
11111	44,900	NR	NR	144,000,000	I
26030	NR	NR	NR	NR	I
36181	NR	NR	NR	49,011,000	I

Note: NR means not reported.

Table V-7

ALKALINE CLEANING BATH

Plant Code	Water Application (1/kkg)	Water Discharge (1/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
04097	NR	46.7	NR	445,000	I
37068	NR	2,790	NR	21,700	I
37032	NR	NR	NR	5,621,958	D
06069	NR	NR	NR	64,681,500	I
09176	NR	NR	NR	NR	I

Note: NR means not reported.

Table V-8

ALKALINE CLEANING RINSE

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
12110	2,100	2,100	0	30,304,000	I
06461	2,350	2,350	0	23,998,200	D
06058	3,890	3,890	0	14,400,000	D
47432	9,820	4,330	44	16,207,938	D
04097	8,400	8,400	0	445,000	I
06069	4,630	NR	NR	64,681,500	I
09176	NR	NR	NR	NR	I
25001	NR	NR	NR	NR	I

Note: NR means not reported.

Table V-9

ANNEALING WATER

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
23038	NR	0	100	5,302,612	Z
41058	NR	0	100	16,069,121	Z
36032	NR	0	100	7,044,429	Z
33079	2,630	0	100	38,008,628	Z
19044	NR	0	100	8,000,000	Z
19039	NR	0	100	100,000	Z
14052	NR	0	100	2,000,000	Z
12032	34,100	0	100	18,858,000	Z
12031	13,800	0	100	23,900,000	Z
06082	134	0	100	60,450,000	Z
06058	NR	0	100	238,000,000	Z
30047	9.40	4.69	50	5,000,000	D
22023	NR	19.6	NR	10,263,000	I
15035	8,260	137	98	14,558,390	D
18534	258	258	0	77,200,000	I
02030	372	372	0	140,000,000	I
23031	1,032	1,032	0	964,598	I
47432	2,510	1,260	50	234,506,266	D
04094	12,200	1,750	86	10,450,560	I
28033	1,810	1,810	0	53,000,000	I
28077	4,370	1,870	57	20,000,000	D
06106	6,210	2,420	61	79,967,179	D
06064	NR	2,500	NR	15,225,000	D
06461	NR	2,650	NR	126,000,000	D
12110	3,610	3,610	0	354,747,936	I
11144	3,670	3,670	0	43,130,620	I
19019	5,730	5,730	0	16,101,120	D
20093	7,500	7,500	0	12,083,407	I
06373	8,230	8,230	0	27,505,710	D
11084	10,150	10,150	0	39,252,637	D

TABLE V-9 (Continued)

ANNEALING WATER

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
36542	NR	12,810	NR	35,000,000	D
37067	21,000	21,000	0	476,332	I
25001	35,900	35,900	0	82,797,620	I
06375	NR	NR	NR		
19058	NR	NR	NR		
23033	NR	NR	NR	16,430,000	I
28044	NR	NR	NR	6,923,440	I
33042	NR	NR	NR		D
33043	NR	NR	NR		D
36181	NR	NR	NR	12,500,000	D
40030	NR	NR	NR	1,624,182	D
30065	NR	NR	NR		I
20004	NR	NR	NR		I
27048	NR	NR	NR		D
01056	NR	NR	NR		I
01053	NR	NR	NR		I
06060	NR	NR	NR		D
28103	NR	NR	NR		I

Note: NR means not reported.

Table V-10

ANNEALING OIL

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
30059	NR	0	NR	45,000,000	Z
11074	3.20	0	93	8,750,000	Z
04070	NR	0	NR	150,000	Z
11086	11.65	0	87	67,183,912	Z
04083	NR	0	NR	17,000,000	Z
14051	49,504	0	99+	24,200,000	Z
19075	NR	0	99+	4,000,000	Z
02031	NR	0	NR	15,409,000	Z
20071	NR	0	99+	26,000,000	Z
12108	NR	0	NR	8,877,932	Z
12860	NR	0	NR	30,788,000	Z
23011	NR	0	99+	8,781,365	Z
30040	NR	0	99+	1,180,800	Z
06109	NR	0	NR	21,824,000	Z
19048	NR	0	NR	100,000	Z
12030	8,820	0	77	6,824,311	Z
37031	NR	0	100	24,765,552	Z
30032	NR	0	100	10,000,000	Z
28041	3,870	0	100	85,514,723	Z
15034	39,200	0	100	6,500,000	Z
11047	NR	0	100	NR	Z
08054	NR	0	100	21,670,141	Z
04129	NR	0	100	5,000,000	Z
15030	NR	NR	NR	6,000,000	D
12036	NR	0.720	NR	462,400,000	I
19045	NR	1.190	99	10,500,000	I
06068	50,170	2.44	99+	21,500,000	I
19043	2,200,000	6.12	99+	13,600,000	I
04086	NR	6.75	NR	11,100,000	I
11075	NR	7.92	NR	2,100,000	I
06120	NR	857.0	NR	77,658	I

Note: NR means not reported.

Table V-11

PICKLING BATH

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
06082	558.7	0		51,470,000	Z
20068	9,984	0		30,000,000	Z
28048	-	0		14,000,000	Z
30059	1,945	0		77,000,000	Z
30174	12,120	0		172,950,000	Z
28044	2,439	0		35,482,630	Z
28041	94.52	0		437,700,000	Z
06061	-	3.150		47,540,000	D
06069	24,560	17.38		60,978,967	I
19044	-	31.20		20,000,000	D
04097	-	33.65		445,000	I
11144	17,310	39.54		34,334,000	I
11110	2,464	55.79		969,377	D
11084	75.80	75.80		43,800,284	D
23033	184.4	129.0		57,750,000	I
28103	7,488	208.0		100,000	D
36032	-	309.1		9,044.429	I
30065	373.7	373.7		400,765,887	I
06013	1,264	NR		11,614,500	D
06064	-	NR		15,750,000	D
37032	-	NR		5,621,952	D
36542	-	NR		29,000,000	D
06070	NR	NR		3,881,656	D
11043	NR	NR		2,300,000	D
20004	NR	NR		700,000	D
20071	NR	NR		50,000,000	D
33042	NR	NR		-	D
33044	NR	NR		-	I

Note: NR means not reported.

Table V-12

PICKLING RINSE

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
30174	41,250	0	100	172,950,000	Z
28048	NR	0	100	14,000,000	Z
12036	NR	65.58	NR	329,869,566	I
41075	216.2	120.1	44.4	250,152,000	I
11084	152.1	152.1	0.0	43,800,284	D
11044	NR	203.0	NR	74,000,000	I
30059	1,041	260.1	75	77,000,000	D
23033	277.5	277.5	0.0	57,750,000	I
30065	585.2	585.2	0.0	400,765,887	I
28041	1,517	695.5	54.2	437,700,000	I
37038	NR	958.1	NR	25,080,000	I
28053	1,082	1,082	0.0	12,500,000	D
04094	1,193	1,193	0.0	30,235,503	I
28033	1,196	1,196	0.0	67,000,000	I
20068	18,630	1,502	91.9	30,000,000	D
20044	1,919	1,919	0.0	1,252,614	D
02031	NR	1,950	NR	15,409,000	D
06106	2,369	2,369	0.0	157,009,814	D
06082	2,490	2,490	0.0	51,470,000	D
06070	3,321	3,321	0.0	3,881,656	D
06461	6,204	3,494	43.7	96,143,250	D
06058	3,750	3,750	0.0	319,000,000	D
06373	4,006	4,006	0.0	37,500,000	D
04130	4,206	4,206	0.0	89,768,096	I
11229	4,335	4,335	0.0	442,164,147	D
28044	4,490	4,490	0.0	35,482,630	I
06060	NR	4,579	NR	433,000,000	D
19019	5,316	4,709	11.4	28,381,036	D

Table V-12 (Continued)

PICKLING RINSE

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
06064	NR	48.63	NR	15,750,000	D
12110	5,525	5,525	0.0	448,669,000	I
11144	6,744	6,744	0.0	34,334,000	I
04097	8,438	8,438	0.0	445,000	I
06061	10,120	10,120	0.0	47,540,000	D
06140	10,790	10,790	0.0	2,228,000	I
47432	12,780	12,780	0.0	47,976,003	D
20093	15,860	15,860	0.0	11,132,422	I
20043	20,610	20,610	0.0	3,600,464	I
20114	21,460	21,460	0.0	7,000,000	I
06069	24,140	24,140	0.0	60,978,967	D
37067	NR	105,200	NR	238,166	I
41068	257,000	257,000	0.0	28,708	I
11043	NR	NR	NR	2,300,000	I
33170	NR	NR	NR	NR	
30460	NR	NR	NR	NR	
20054	NR	NR	NR	NR	
04128	NR	NR	NR	NR	
01053	NR	NR	NR	NR	

Note: NR means not reported.

Table V-13

PICKLING FUME SCRUBBER

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off lb/yr)	Discharge Status
11229	271	271	0	442,164,147	D
06069	982	982	0	60,978,964	I
06070	4,320	3,090	0	3,881,656	I

Note: NR means not reported.

Table V-14

PICKLING RINSE FOR FORGED PARTS

Plant Code	Water Application (l/kkg)	Water Discharge (l/kkg)	Percent Recycle	Production (off-lbs/yr)	Discharge Status
06375	NR	11,440	NR	3,500,000	D
36070	NR	50,330	NR	12,000,000	D
11043	NR	NR	NR	2,300,000	I
30460	NR	NR	NR	NR	D
20054	NR	NR	NR	NR	I
11110	NR	NR	NR	969,377	Z
*	NR	4,346	25	NR	D
*	NR	3,473	40	NR	NR

Note: NR means not reported.

*No plant code - data submitted during comment period.

Table V-15

SUMMARY OF SAMPLING DATA FROM PLANT 47432
(All Concentrations in mg/l)

SAMPLE POINT	266	223	250	412	212	203	199
	Annealing Water	Alkaline Cleaning Rinse	Pickling Rinse	Treated Oily Waste	Cold Rolling Spent Lubricant	Pickling Rinse	Volatile Organics Trip Blank
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	6.2	6.2	2.3	6.8	6.8	2.7	
Maximum pH	7.7	8.0	2.3	7.4	7.4	6.7	
Temperature °C	24.0	29.0	69.0	14.0	13.0	8.0	
Cyanide, Total	*				*		
Cyanide Amn. to Chlor	*				*		
Oil & Grease	8.0	13.0	19.0	19.0	23.0	2.0	
Fluorides	0.12	0.15	0.0	0.14		0.14	
Phosphorus	0.0	0.0	1.8	0.46		0.0	
Tot Organic Carbon	24.0	<2.0	95.0	668.0	158.0	13.0	
Totl Suspended Solids	5.0	8.0	490.0	63.0	431.0	14.0	
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	
Arsenic	0.0	0.0	0.74	0.0	0.0	0.0	
Cadmium	0.0	0.0	0.21	0.017	0.002	0.006	
Chromium, Total	0.0	0.0	30.4	0.0	0.008	0.005	
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0	
Copper	0.052	0.072	492.0	0.72	0.34	13.8	
Iron	0.09	0.086	7.97	0.95	0.135	0.13	
Lead	0.0	0.0	167.0	0.14	0.65	0.0	
Manganese	0.0	0.0	3.03	0.016	0.0	0.18	
Nickel	0.0	0.02	5.0	0.0	0.0	1.0	
Zinc	0.28	1.95	870.0	0.8	1.55	53.0	
Silver	0.0	0.0	0.03	0.0	0.0	0.0	
Phenols, Total	*	*	0.0	*	*	0.0	
Benzene		*	0.0	0.0	*	0.0	*
Chlorobenzene		0.0	0.0	0.0	0.0	0.0	0.0
111-Trichloroethane		*	*	*	*	0.0	*
Hexachloroethane				0.0	0.0		0.0
Chloroform	0.0	0.0		0.0	0.0		0.0
26-Dinitrotoluene			0.0	5.1	0.13	0.0	
Ethylbenzene				0.0	0.0		0.0
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naphthalene		*	0.0	0.74	0.016	0.0	
N-Nitrosodiphenlamin				0.025	0.3		
B2-Ethyhexlphthalate		*	0.0	0.13	0.029	0.0	
Butylbenzylphthalate				0.18	0.026		
Di-N-Octyl Phthalate				0.012	0.0		
Diethyl Phthalate		0.0	0.0			0.0	
Dimethyl Phthalate				0.0	*		
Anthracene		*	0.0	1.2	0.19	0.0	
Phenanthrene		*	0.0	1.2	0.19	0.0	
Tetrachloroethylene		0.0	0.0	0.0	0.0	0.0	*
Toluene		0.0	0.0	0.0	*	0.0	*
Trichloroethylene		0.0	0.0	0.0	0.0	0.0	0.0

Table V-15 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 47432
(All Concentrations in mg/l)

SAMPLE POINT	227 Annealing Water	218 Solution Heat Treatment	207 Pickling Rinse	411 Treated Oily Waste	211 Spent Hot Rolling Lubricant	252 Pickling Bath
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	4.8	4.9	1.6	5.0	4.8	0.8
Maximum pH	6.0	6.7	2.0	6.0	6.0	0.8
Temperature °C	10.0	10.0	40.0	2.0	5.0	40.0
Cyanide, Total	0.022					0.0
Cyanide Amn. to Chlor	0.022					0.0
Oil & Grease	5.0	4.0	4.0	20.0	30.0	0.0
Fluorides	0.14	1.10	1.0	0.12	0.14	
Phosphorus	0.045	0.0	0.0	0.150	0.0	
Tot Organic Carbon	8.0	27.0	51.0	39.0	5.0	0.0
Totl Suspended Solids	5.0	5.0	5.0	23.0	18.0	12.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.011	0.0	0.011	0.0	0.0	2.83
Chromium, Total	0.0	0.0	0.06	0.0	0.0	9.5
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	
Copper	0.12	0.44	172.0	0.9	1.68	9400.0
Iron	0.19	0.038	1.5	0.24	0.12	241.0
Lead	0.0	0.0	0.52	0.0	0.0	4.94
Manganese	0.0	0.0	0.045	0.0	0.0	148.0
Nickel	0.0	0.0	0.67	0.0	0.029	385.0
Zinc	8.0	0.19	59.0	1.08	0.095	45000.0
Silver	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	*	*	0.0			0.0
Benzene		0.0	0.0	*	0.0	0.0
Chlorobenzene		0.0	0.0	0.0	0.0	0.0
111-Trichloroethane		*	0.0	*	*	0.0
Chloroform	0.0	0.0		*	0.0	
26-Dinitrotoluene			0.0			0.0
Ethylbenzene				0.0	0.0	
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0
Naphthalene		*	0.0	*	*	0.0
B2-Ethyhexlphthalate		*	0.0	*		0.0
Di-N-Butyl Phthalate				*	0.0	
Diethyl Phthalate		0.0	0.0	*	0.0	0.0
Anthracene		0.0	0.0	*	*	0.0
Phenanthrene		0.0	0.0	*	*	0.0
Tetrachloroethylene		*	0.0	0.0	0.0	0.0
Toluene		0.0	0.0	*	0.0	0.0
Trichloroethylene		0.0	0.0	*	0.0	0.0

Table V-15 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 47432
(All Concentrations in mg/l)

SAMPLE POINT	200 Combined Pickling Waste to Treatment	130 Municipal Source Water	400 Combined Treated Effluent	120 Lake Source Water	215 Solution Heat Treatment	251 Pickling Bath
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	2.4	7.4	8.7	6.8	6.5	
Maximum pH	3.4	8.7	8.7	10.7	12.5	
Temperature °C	21.0	21.0	14.0	3.0	17.0	
Cyanide, Total	*	*		*		0.0
Cyanide Amn. to Chlor	*	*		*		0.0
Oil & Grease	13.0	3.0	8.0	<1.0	4.0	0.0
Fluorides	0.42	1.11	0.41	0.12	0.14	0.0
Phosphorus	4.11	0.0	0.23	0.7	0.0	
Tot Organic Carbon	45.0	5.0	3.0	3.0	3.0	380.0
Totl Suspended Solids	39.0	<5.0	8.0	<5.0	5.0	34550.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.25
Cadmium	0.024	0.0	0.0	0.0	0.0	1.57
Chromium, Total	2.12	0.0	0.009	0.0	0.0	1.8
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0
Copper	312.0	0.105	0.22	0.072	0.065	24000.0
Iron	1.0	0.05	0.014	0.1	0.11	60.0
Lead	1.74	0.0	0.0	0.0	0.0	110.0
Manganese	0.086	0.0	0.0	0.0	0.0	1.49
Nickel	0.86	0.0	0.0	0.0	0.0	63.6
Selenium	0.0				0.0	
Thallium	0.0				0.0	
Zinc	250.0	0.1	0.31	1.21	0.36	2300.0
Silver	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	*	*	0.072	*	*	0.0
Benzene	*	*	*	*	*	0.0
Chlorobezene	0.0	0.0	0.0	0.0	0.0	0.0
111-Trichloroethane	0.015	0.0	0.0	*	*	0.0
Hexachloroethane		0.0		0.0		
Chloroform	0.0	0.0	0.0	0.0	0.0	
26-Dinitrotoluene		0.0		0.0		0.0
Ethylbenzene		0.0		0.0		
Methylene Chloride	*	0.0	0.0	0.0	0.0	0.0
Naphthalene	*	0.0	0.0	0.0	0.0	0.0
N-Nitrosodiphenlamin		0.0		0.0		
B2-Ethyhexlphthalate	*	*	*	*	*	0.0
Butylbenzylphthalate		*	*	*		
Di-N-Butyl Phthalate		*		0.0		
Di-N-Octyl Phthalate		0.0		0.0		
Diethyl Phthalate	0.0	0.0	*	0.0	0.0	0.0
Dimethyl Phthalate		0.0		0.0		
Anthracene	*	0.0	*	0.0	0.0	0.0
Phenanthrene	*	0.0	*	0.0	0.0	0.0
Tetrachloroethylene	0.0	*	0.0	0.0	0.0	0.0
Toluene	*	*	0.0	*	0.0	0.0
Trichloroethylene	0.0	0.0	0.0	0.0	0.0	0.0

Table V-15 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 47432
(All Concentrations in mg/l)

SAMPLE POINT	226 Annealing Water Day 2	223 Alkaline Cleaning Rinse Day 2	202 Combined Alkaline Cleaning and Pickling Rinse Day 2	225 Annealing Water Day 2	412 Treated Oily Waste Day 2	212 Cold Rolling Spent Lubricant Day 2	199 Volatile Organics Trip Blank Day 2	252 Pickling Bath Day 2
Minimum pH	7.1	7.0	7.9	6.2	6.7	6.8		0.8
Maximum pH	7.9	8.1	10.4	7.1	6.9	6.9		0.8
Temperature °C	36.0	29.0	25.0	50.0	16.0	32.0		40.0
Cyanide, Total	*			0.058	0.021	*		0.0
Cyanide Amn. to Chlor	*			0.058	0.021	*		0.0
Oil & Grease	<1.0	2.0	10.0	8.0	15.0	7070.0		0.0
Fluorides	0.14	0.13	0.14	0.14	0.14			
Phosphorus	0.14	0.0	0.0	0.12	0.61			
Tot Organic Carbon	8.0	13.0	88.0	13.0	506.0	7721.0		0.0
Totl Suspended Solids	9.0	19.0	110.0	19.0	20.0	1179.0		12.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Cadmium	0.0	0.0	0.0	0.0	0.008	0.006		2.83
Chromium, Total	0.0	0.0	0.0	0.0	0.0	0.022		9.5
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0		
Copper	0.065	0.072	13.2	0.22	0.2	9.2		9400.0
Iron	0.15	0.13	0.3	0.13	0.81	0.77		241.0
Lead	0.0	0.0	0.47	0.04	0.085	0.54		4.94
Manganese	0.0	0.0	0.009	0.0	0.007	0.011		148.0
Nickel	0.0	0.0	0.0	0.0	0.0	0.034		385.0
Zinc	0.25	2.1	8.37	2.25	0.51	2.63		45000.0
Silver	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Phenols, Total	*	*	0.0	0.064	0.022	0.028		0.0
Benzene		*	0.0		0.015	0.0	*	0.0
Chlorobenzene		0.0	0.0		0.0	0.0	0.0	0.0
111-Trichloroethane		*	0.0		*	*	*	0.0
Hexachloroethane					0.0	0.0	0.0	
Chloroform	0.0	0.0		0.0	0.0	0.0	0.0	
26-Dinitrotoluene			0.0		0.0	0.26		0.0
Ethylbenzene					0.0	0.0	0.0	
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naphthalene		0.0	0.0		*	0.48		0.0
N-Nitrosodiphenlamin					*	3.8		
B2-Ethyhexlphthalate		*	0.0		*	0.35		0.0
Butylbenzylphthalate					*	0.22		
Di-N-Octyl Phthalate					*	0.15		
Diethyl Phthalate		0.0	0.0				0.0	
Dimethyl Phthalate					0.0	0.12		
Anthracene		0.0	0.0		*	2.5		0.0
Phenanthrene		0.0	0.0		*	2.5		0.0
Tetrachloroethylene		0.0	0.0		0.0	0.0	*	0.0
Toluene		0.0	0.0		0.017	0.0	*	0.0
Trichloroethylene		0.0	0.0		0.0	0.0	0.0	0.0

Table V-15 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 47432 .
(All Concentrations in mg/l)

SAMPLE POINT	227	206	205	218	411	211
	Annealing Water	Pickling Rinse	Pickling Rinse	Solution Heat Treatment	Treated Oily Waste	Spent Hot Rolling Lubricant
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH	6.0	3.8	2.1	5.3	6.3	7.0
Maximum pH	10.2	5.4	2.2	5.3	6.5	7.3
Temperature °C	9.0	47.0	58.0	13.0	4.0	2.0
Cyanide, Total	*					
Cyanide Amn. to Chlor	*					
Oil & Grease	<1.0	1.0	<1.0	4.0	4.0	<1.0
Fluorides	0.14	0.13	0.8	0.92	0.14	0.14
Phosphorus	0.135	0.45	0.0	0.0	0.15	0.0
Tot Organic Carbon	3.0	5.0	<1.0	<1.0	24.0	16.0
Totl Suspended Solids	8.0	6.0	<5.0	10.0	22.0	11.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.006	0.011	0.012	0.0	0.0	0.0
Chromium, Total	0.0	0.036	0.024	0.0	0.0	0.0
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0
Copper	0.081	133.0	150.0	0.48	0.54	0.72
Iron	0.18	0.45	0.63	0.035	0.12	0.14
Lead	0.0	0.79	0.0	0.0	0.0	0.0
Manganese	0.0	0.044	0.009	0.0	0.0	0.0
Nickel	0.0	0.51	0.04	0.0	0.0	0.0
Zinc	2.1	59.0	8.75	1.99	0.075	0.098
Silver	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	*	0.0	0.0	*	*	*
Benzene		0.0	0.0	*	0.0	*
Chlorobenzene		0.0	0.0	0.0	0.0	0.0
111-Trichloroethane		0.0	0.0	*	*	*
Chloroform	0.0			0.0	*	*
26-Dinitrotoluene		0.0	0.0			
Ethylbenzene					0.0	0.0
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0
Naphthalene		0.0	0.0	*	*	*
B2-Ethyhexlphthalate		0.0	0.0	*	*	*
Di-N-Butyl Phthalate					*	*
Diethyl Phthalate		0.0	0.0	*	*	*
Dimethyl Phthalate						
Anthracene		0.0	0.0	*	*	*
Phenanthrene		0.0	0.0	*	*	*
Tetrachloroethylene		0.0	0.0	0.0	0.0	0.0
Toluene		0.0	0.0	*	0.0	*
Trichloroethylene		0.0	0.0	0.0	*	*

Table V-15 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 47432
(All Concentrations in mg/l)

SAMPLE POINT	120 Lake Source Water	208 Pickling Rinse	200 Combined Pickling Waste Treatment	400 Combined Treated Effluent
	Day 2	Day 2	Day 2	Day 2
Minimum pH	5.0		1.0	5.0
Maximum pH	6.0		3.0	6.0
Temperature °C	3.0		19.0	15.0
Cyanide, Total	*		*	
Cyanide Amn. to Chlor	*		*	
Oil & Grease	130.0	4.0	7.0	<1.0
Fluorides	0.12	0.15	0.41	0.47
Phosphorus	0.09	0.27	0.53	0.2
Tot Organic Carbon	5.0	3.0	30.0	24.0
Totl Suspended Solids	6.0	25.0	16.0	19.0
Antimony	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0
Cadmium	0.0	0.0	0.003	0.0
Chromium, Total	0.0	0.037	1.17	0.0
Chromium, Hexavalent	0.0	0.0	0.0	0.0
Copper	0.029	9.58	120.0	5.12
Iron	0.16	0.32	0.86	0.01
Lead	0.0	1.26	0.85	0.0
Manganese	0.0	0.007	0.12	0.028
Nickel	0.0	0.011	0.36	0.2
Selenium			0.0	
Thallium			0.0	
Zinc	1.49	2.75	32.5	25.0
Silver	0.0	0.0	0.0	0.0
Phenols, Total	*	0.0	*	0.064
Benzene	*	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.003
111-Trichloroethane	*	0.0	0.0	0.0
Hexachloroethane	0.0			
Chloroform	0.0		0.0	0.0
26-Dinitrotoluene	0.0	0.0		
Ethylbenzene	0.0			
Methylene Chloride	0.0	0.0	0.0	0.0
Naphthalene	0.0	0.0	0.0	*
N-Nitrosodiphenlamin	0.0			
B2-Ethyhexlphthalate	*	0.0	*	*
Butylbenzylphthalate	*			
Di-N-Butyl Phthalate	0.0			
Di-N-OPctyl Phthalate	0.0			
Diethyl Phthalate	0.0	0.0	*	*
Dimethyl Phthalate	0.0			
Anthracene	0.0	0.0	*	*
Phenanthrene	0.0	0.0	*	*
Tetrachloroethylene	0.0	0.0	*	0.0
Toulene	*	0.0	0.0	0.0
Trichloroethylene	0.0	0.0	0.0	0.0

Table V-15 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 47432
(All Concentrations in mg/l)

SAMPLE POINT	223 Alkaline Cleaning Rinse	226 Annealing Water	210 Hot Rolling Spent Lubricant	410 Treated Oily Waste	212 Cold Rolling Spent Lubricant	412 Treated Oily Waste	225 Annealing Water	253 Cold Rolling Spent Lubricant
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	6.9	7.0	7.1	7.1	6.2	6.2		
Maximum pH	7.4	7.4	7.6	7.9	6.8	6.8		
Temperature °C	31.0	32.0	2.0		22.0	20.0		
Cyanide, Total		*			*	*	0.021	*
Cyanide Amn. to Chlor		*			*	*	0.021	*
Oil & Grease	<1.0	2.0	1.0	3.0	1004.0	5.0	<1.0	11220.0
Fluorides	0.14	0.15	0.17	0.13	0.17	0.15	0.13	
Phosphorus	0.0	0.19	0.0	0.19	0.12	0.62	0.15	
Tot Organic Carbon	11.0	-1.0	11.0	8.0	3277.0	386.0	5.0	61294.0
Totl Suspended Solids	11.0	7.0	47.0	26.0	1386.0	27.0	5.0	3720.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.54
Cadmium	0.0	0.0	0.063		0.0	0.021	0.0	0.33
Chromium, Total	0.0	0.0	0.005	0.0	0.018	0.005	0.0	0.85
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Copper	0.07	0.029	19.1	0.9	17.1	0.22	0.083	54.2
Iron	0.17	0.19	0.48	0.88	1.94	2.6	0.145	29.7
Lead	0.0	0.0	0.0	0.0	1.3	0.08	0.0	1.17
Manganese	0.0	0.0	0.036	0.0	0.084	0.029	0.005	0.65
Nickel	0.0	0.014	1.7	0.086	1.14	0.088	0.0	15.7
Zinc	1.36	3.13	2.25	1.45	14.6	1.55	3.03	163.0
Silver	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	*	*	*	*	0.023	0.017	0.013	0.106
Benzene	*		*	*	*	*		*
Chlorobenzene	0.0		0.0	0.0	0.0	0.0		0.0
111-Trichloroethane	*		0.0	0.0	*	*		*
Hexachloroethane					0.0	0.0		0.0
Chloroform	0.0	0.0	*	0.0	0.0	0.0	0.0	0.0
26-Dinitrotoluene					0.028	0.0		14.0
Ethylbenzene			*	*	0.0	0.0		0.0
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naphthalene	0.0		*	*	*	*		0.0
N-Nitrosodiphenlamin					0.023	*		13.0
B2-Ethyhexlphthalate	*		*	*	0.0	*		1.6
Butylbenzylphthalate					0.0	0.0		0.54
Di-N-Butyl Phthalate			*	*				
Di-N-Octyl Phthalate					0.0	0.0		0.21
Diethyl Phthalate	0.0		0.0	*				
Dimethyl Phthalate						0.0		0.89
Anthracene	*		*	*	0.02	*		1.6
Phenanthrene	*		*	*	0.02	*		1.6
Tetrachloroethylene	0.0		0.0	0.0	0.0	*		0.0
Toluene	0.0		0.018	*	*	*		*
Trichloroethylene	0.0		0.0	0.0	0.0	*		0.0

Table V-15 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 47432
(All Concentrations in mg/l)

SAMPLE POINT	252	211	411	204	214	205	209	218
	Pickling Bath	Hot Rolling Spent Lubricant	Treated Oily Waste	Pickling Rinse	Solution Heat Treatment	Pickling Rinse	Pickling Rinse	Solution Heat Treatment
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	0.8	7.0	6.6	3.1	7.9	2.1	2.3	
Maximum pH	0.8	7.0	6.8	3.6	8.0	2.2	3.4	
Temperature °C	40.0	4.0	4.0	30.0	14.0	56.0	60.0	
Cyanide, Total	0.0							
Cyanide Amn. to Chlor	0.0							
Oil & Grease	0.0	<1.0	15.0	2.0	2.0	7.0	<1.0	1.0
Fluorides		0.14	0.14	0.12	0.14	0.69	0.9	1.05
Phosphorus		0.1	0.19	0.12	0.0	0.0	0.13	0.0
Tot Organic Carbon	<0.0	21.0	42.0	24.0	57.0	30.0	39.0	2.0
Totl Suspended Solids	12.0	20.0	18.0	98.0	9.0	-5.0	5.0	<5.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	2.83	0.0	0.006	0.047	0.0	0.018	0.0	0.0
Chromium, Total	9.5	0.0	0.0	0.024	0.0	0.018	0.027	0.026
Chromium, Hexavalent		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copper	9400.0	1.53	0.6	470.0	0.71	130.0	102.0	0.56
Iron	241.0	0.19	0.19	5.04	0.22	0.56	2.0	0.025
Lead	4.94	0.0	0.0	0.11	0.0	0.0	0.04	0.0
Manganese	148.0	0.0	0.0	0.041	0.0	0.005	0.019	0.0
Nickel	385.0	0.0	0.0	0.071	0.0	0.011	0.051	0.0
Zinc	45000.0	1.68	1.23	0.43	0.93	2.23	7.76	0.78
Silver	0.0	0.0	0.0	0.13	0.003	0.0	0.0	0.0
Phenols, Total	0.0	*	*	0.0	*	0.0	0.0	*
Benzene	0.0	*	0.0	0.0	*	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
111-Trichloroethane	0.0	*	0.0	0.0	0.0	0.0	0.0	*
Chloroform		*	*		0.0			*
26-Dinitrotoluene	0.0			0.0		0.0	0.0	
Ethylbenzene		0.0	0.0		0.0			
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naphthalene	0.0	*		0.0	*	0.0	0.0	*
B2-Ethyhexlphthalate	0.0	*		0.0	*	0.0	0.0	*
Di-N-Butyl Phthalate		*			*			
Diethyl Phthalate	0.0	*		0.0	*	0.0	0.0	0.0
Anthracene	0.0	*		0.0	*	0.0	0.0	0.0
Phenanthrene	0.0	*		0.0	*	0.0	0.0	0.0
Tetrachloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toluene	0.0	*	0.0	0.0	*	0.0	0.0	*
Trichloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table V-15 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 47432
(All Concentrations in mg/l)

SAMPLE POINT	320 Spent Drawing Lubricant Day 3	227 Annealing Water Day 3	215 Solution Heat Treatment Day 3	120 Source Lake Water Day 3	200 Combined Pickling Waste to Treatment Day 3	400 Combined Treated Effluent Day 3	199 Volatile Organics Trip Blank Day 3
Minimum pH		5.1	5.0	5.0	2.0	6.6	
Maximum pH		8.1	6.8	6.4	5.0	8.1	
Temperature °C		9.0			20.0		
Cyanide, Total		0.045		*	*		
Cyanide Amn. to Chlor		0.045		*	*		
Oil & Grease	24870.0	<1.0	<1.0	<1.0	7.0	<1.0	
Fluorides		0.13	0.13	0.13	0.41	0.45	
Phosphorus		0.135	0.0	0.05	0.64	0.45	
Tot Organic Carbon	55965.0	5.0	33.0	<1.0	35.0	33.0	
Totl Suspended Solids	8425.0	6.0	5.0	<5.0	16.0	7.0	
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	
Cadmium	0.0	0.003	0.0	0.0	0.004	0.0	
Chromium, Total	0.305	0.0	0.0	0.0	2.98	0.009	
Chromium, Hexavalent		0.0	0.0	0.0	0.0	0.0	
Copper	372.0	0.13	0.13	0.052	107.0	0.66	
Iron	9.58	0.18	0.21	0.18	0.79	0.03	
Lead	1.72	0.0	0.0	0.0	0.92	0.0	
Manganese	0.65	0.0	0.0	0.0	0.11	0.009	
Nickel	3.28	0.0	0.0	0.0	0.35	0.0	
Selenium			0.0		0.0		
Thallium			0.0		0.0		
Zinc	79.0	3.25	0.16	1.49	43.8	0.66	2300.0
Silver	0.0	0.0	0.0	0.0	0.0	0.0	
Phenols, Total	0.164	0.013	*	*	*	0.026	
Benzene	0.0		0.0	*	0.0	*	*
Chlorobenzene	0.002		0.0	0.0	0.0	0.0	0.0
111-Trichloroethane	*		*	*	0.0	*	*
Hexachloroethane				0.0			0.0
Chloroform	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26-Dinitrotoluene				0.0			
Ethylbenzene				0.0			0.0
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naphthalene	0.63		0.0	0.0	0.0	0.0	
N-Nitrosodiphenlamin				0.0			
B2-Ethyhexlphthalate	0.48		*	*	*	*	
Butylbenzylphthalate				*			
Di-N-Butyl Phthalate				0.0			
Di-N-Octyl Phthalate				0.0			
Diethyl Phthalate	0.2		0.0	0.0	*	*	
Dimethyl Phthalate				0.0			
Anthracene	7.5		0.0	0.0	*	*	
Phenanthrene	7.5		0.0	0.0	*	*	
Tetrachloroethlene	*		0.0	0.0	0.0	0.0	*
Toluene	0.0		0.0	*	0.0	0.0	*
Trichloroethylene	*		0.0	0.0	0.0	0.0	0.0

Table V-16

SUMMARY OF SAMPLING DATA FROM PLANT 28044
(All Concentrations in mg/l)

SAMPLE POINT	201 Hot Rolling Spent Lubricant	300 Hot Rolling Spent Lubricant	400 Hot Rolling Spent Lubricant	199 Volatile Organics Trip Blank
	Day 1	Day 1	Day 1	Day 1
Minimum pH	5.4	4.9	5.3	
Maximum pH	6.0	5.8	5.9	
Temperature °C	12.0	17.0	18.0	
Oil & Grease	135.0	65.0	90.0	
Fluorides	0.0	0.0	0.0	
Phosphorus	0.0	0.0	0.0	
Tot Organic Carbon	85.0	60.0	70.0	
Totl Suspended Solids	65.0	50.0	100.0	
Antimony	0.0	0.0	0.0	
Arsenic	0.0	0.0	0.0	
Cadmium	0.054	0.003	0.003	
Chromium, Total	0.0	0.01	0.005	
Chromium, Hexavalent	0.0	0.0	0.0	
Copper	98.0	31.5	93.0	
Iron	0.52	0.23	0.6	
Lead	0.097	0.0	0.058	
Manganese	0.082	0.072	0.075	
Nickel	0.029	0.0	0.0	
Zinc	0.93	1.27	0.25	
Silver	0.0	0.0	0.0	
Phenols, Total	0.02	*	0.02	
Benzene	0.0	0.0	*	*
Chlorobenzene	0.0	0.0	0.0	0.0
111-Trichloroethane	*	*	*	*
Chloroform	0.0	0.0	0.0	0.0
Methylene Chloride	*	0.0	0.0	0.0
Naphthalene	0.0	0.0	0.0	
B2-Ethyhexlphthalate	*	*	*	
Di-N-Octyl Phthalate	*	*	*	
Diethyl Phthalate	*	*	*	
Anthracene	0.0	0.0	*	
Phenanthrene	0.0	0.0	*	
Tetrachloroethylene	0.0	0.0	0.0	0.0
Toluene	0.0	0.0	*	*
Trichloroethylene	0.0	0.0	0.0	0.0

Table V-16 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 28044
(All Concentrations in mg/l)

SAMPLE POINT	201 Hot Rolling Spent Lubricant	300 Hot Rolling Spent Lubricant	400 Hot Rolling Spent Lubricant	130 Municipal Source Water
	Day 2	Day 2	Day 2	Day 2
Minimum pH	5.8	5.8	5.9	
Maximum pH	7.0	6.3	6.7	
Temperature °C	18.5	22.0	22.0	
Cyanide, Total				*
Cyanide Amn,to Chlor				*
Oil & Grease	70.0	40.0	95.0	
Fluorides	0.0	0.0	0.0	0.0
Phosphorus	0.0	0.0	0.0	0.0
Tot Organic Carbon	70.0	60.0	60.0	90.0
Totl Suspended Solids	25.0	75.0	90.0	25.0
Antimony	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0
Cadmium	0.005	0.006	0.006	0.0
Chromium, Total	0.0	0.0	0.0	0.0
Chromium, Hexavalent	0.0	0.0	0.0	0.0
Copper	76.0	1.39	58.0	0.033
Iron	0.48	0.09	0.26	0.14
Lead	0.085	0.0	0.069	0.0
Manganese	0.073	0.063	0.065	0.10
Nickel	0.1	0.0	0.0	0.0
Zinc	2.0	3.9	0.25	0.13
Silver	0.0	0.0	0.0	0.0
Phenols, Total	0.0	0.04	*	*
Benzene	*	0.0	*	*
Chlorobenzene	0.0	0.0	0.0	0.0
111-Trichlorothane	*	*	*	*
Hexachlorothane				0.0
Chloroform	0.0	0.0	0.0	0.0
26-Dinitrotoluene				0.0
Ethylbenzene				0.0
Methylene Chloride	0.0	0.0	0.0	0.0
Naphthalene	0.0	0.0	0.0	0.0
N-Nitrosodiphenlamin				0.0
B2-Ethyhexlphthalate	*	*	*	*
Butylbenzylphthalate				0.0
Di-N-Octyl Phthalate				0.0
Di-N-Butyl Phthalate	*	*	*	0.0
Diethyl Phthalate	0.0	*	*	0.0
Dimethyl Phthalate				0.0
Anthracene	0.0	0.0	0.0	
Phenanthrene	0.0	0.0	0.0	0.0
Tetrachloroethylene	0.0	0.0	0.0	0.0
Toluene	*	0.0	*	*
Trichloroethylene	0.0	0.0	0.0	0.0

Table V-16

SUMMARY OF SAMPLING DATA FROM PLANT 28044
(All Concentrations in mg/l)

SAMPLE POINT	201 Hot Rolling Spent Lubricant	300 Hot Rolling Spent Lubricant	400 Hot Rolling Spent Lubricant	251 Annealing Oil	252 Drawing Spent Lubricant	255 Annealing Water
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	5.4	5.7	5.9			
Maximum pH	6.1	6.3	6.3			
Temperature °C	22.0	22.0	22.0			
Cyanide, Total				0.1		0.03
Cyanide Amn,to Chlor				0.09		0.03
Oil & Grease	9.0	4.0	7.0	17.0	580.0	13.0
Fluorides	0.0	0.0	0.0	0.0	0.69	0.12
Phosphorus	0.0	0.0	0.0			0.0
Tot Organic Carbon	4.0	10.0	30.0	12100.0	7800.0	180.0
Totl Suspended Solids	60.0	50.0	100.0	320.0	920.0	20.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.7	0.8	0.0
Cadmium	0.006	0.004	0.046	0.02	0.1	0.0
Chromium, Total	0.0	0.0	0.0	0.0	0.051	0.004
Chromium, Hexavalent	0.0	0.0	0.0			0.0
Copper	63.0	1.86	62.0	24.9	336.0	0.25
Iron	0.39	0.05	0.49	0.91	8.85	2.66
Lead	0.12	0.0	0.15	0.0	2.82	0.0
Manganese	0.081	0.073	0.083	0.130	0.25	0.13
Nickel	0.014	0.0	0.0	0.0	1.05	0.029
Zinc	2.0	0.53	6.16	31.7	11.5	0.53
Silver	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	*	*	0.03	20.0	5.0	*
Benzene	*	0.0	0.0	*	0.013	
Chlorobenzene	0.0	0.0	0.0	*	0.0	
111-Trichlorothane	*	*	*	*	0.0	
Chloroform	0.0	0.0	0.0	0.0	0.0	0.0
Methylene Chloride	0.0	0.0	0.0	0.0	*	0.0
Naphthalene	0.0	0.0	0.0	0.24	0.0	0.0
B2-Ethyhexlphthalate	*	*	*	0.0	0.48	*
Di-N-Butyl Phthalate	*	0.0	*			
Diethyl Phthalate	0.0	0.0	*	0.0	0.4	0.0
Anthracene	*	0.0	*	1.5	0.016	0.0
Phenanthrene	*	0.0	*	1.5	0.016	0.0
Tetrachloroethylene	0.0	0.0	0.0	0.0	0.0	
Toluene	*	*	0.0	*	*	
Trichloroethylene	0.0	0.0	0.0	0.0	0.0	

Table V-17

SUMMARY OF SAMPLING DATA FROM PLANT 37032
(All Concentrations in mg/l)

SAMPLE POINT	201 Pickling Rinse	400 Combined Treated Effluent	250 Waste to Contract Hauling
	Day 1	Day 1	Day 1
Minimum pH	2.7	8.5	4.5
Maximum pH	4.2	8.6	5.0
Temperature °C	27.3	24.0	44.0
Cyanide, Total	*	0.01	
Cyanide Amn. to Chlor.	*	*	
Oil & Grease	<1.0	<1.0	3.4
Fluorides	1.0	1.0	0.74
Phosphorus	0.39	0.93	
Total Suspended Solids	<5.0	<5.0	60440.0
Antimony	0.0	0.0	0.0
Arsenic	0.0	0.0	2.27
Cadmium	0.002	0.0	1.96
Chromium, Total	0.0	1.63	4.73
Chromium, Hexavalent	0.0	1.65	
Copper	33.6	1.1	17500.0
Iron	0.33	0.15	294.0
Lead	0.15	0.0	110.0
Manganese	0.0	0.0	0.75
Nickel	0.0	0.0	4.62
Selenium	0.0	0.0	
Thallium	0.0	0.0	
Zinc	12.3	0.45	7500.0
Silver	0.0	0.0	0.52
Phenols, Total	*	*	
Naphthalene	*	*	
B2-Ethyhexylphthalate	0.22	0.041	
Diethyl Phthalate	*	*	
Anthracene	0.0	0.0	
Phenanthrene	0.0	0.0	

Table V-17 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 37032
(All Concentrations in mg/l)

SAMPLE POINT	251 Solution Heat Treatment Day 1	199 Volatile Organics Trip Blank Day 1
Minimum pH	7.7	
Maximum pH	7.7	
Temperature °C	34.0	
Cyanide, Total	*	
Cyanide Amn. to Chlor.	*	
Oil & Grease	5.2	
Fluorides	3.7	
Total Suspended Solids	650.0	
Antimony	0.1789	
Arsenic	0.561	
Beryllium	0.0118	
Cadmium	0.034	
Chromium, Total	0.05	
Chromium, Hexavalent	0.0	
Copper	4.08	
Iron	62.667	
Lead	0.5	
Manganese	1.19	
Mercury	0.0024	
Nickel	0.06	
Selenium	1.7241	
Thallium	0.2462	
Zinc	15.9	
Gold	0.0	
Silver	0.0235	
Phenols, Total	0.72	
Cobalt	0.018	
Acenaphthene	0.0	
Acrolein	0.0	0.0
Acrylonitrile	0.0	0.0
Benzene	0.0	0.0
Benzidine	0.0	
Carbon Tetrachloride	0.0	0.0
Chlorobenzene	0.0	0.0
124-Trichlorobenzene	0.0	
Hexachlorobenzene	0.0	
11-Dichloroethane	0.0	0.0
112-Trichloroethane	0.0	0.0
1122-Tetrachloroethane	0.0	0.0
Chloroethane	0.0	0.0
Bischloromethylether	0.0	0.0
Bis2chloroethylether	0.0	
2Chloroethylvinylether	0.0	
2Chloronaphthalene	0.0	

Table V-17 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 37032
(All Concentrations in mg/l)

SAMPLE POINT	251 Solution Heat Treatment Day 1	199 Volatile Organics Trip Blank Day 1
246-Trichlorophenol	0.0	
Parachlorometacresol	0.0	
Chloroform	0.0	0.0
2-Chlorophenol	0.0	
12-Dichlorobenzene	0.0	
13-Dichlorobenzene	0.0	
14-Dichlorobenzene	0.0	
33-Dichlorobenzidine	0.0	
11-Dichloroethylene	0.0	0.0
12T-Dichloroethylene	0.0	0.0
24-Dichlorophenol	0.0	
12-Dichloropropane	0.0	
12-Dichloropropylene	0.0	0.0
24-Dimethylphenol	0.0	
24-Dinitrotoluene	0.0	
26-Dinitrotoluene	0.0	
12-Diphenylhydrazine	0.0	
Ethylbenzene	0.0	0.0
Fluoranthene	0.0	
4ClPhenylphenylether	0.0	
4BrPhenylphenylether	0.0	
B2Chloroisoproplethr	0.0	
B2Chlorethoxymethan	0.0	
Methylene Chloride	0.053	0.013
Methyl Chloride	0.0	0.0
Methyl Bromide	0.0	0.0
Bromoform	0.0	0.0
Dichlorobromomethane	0.0	0.0
Triclorofloromethane	0.0	0.0
Diclorodifloromethan	0.0	0.0
Chlorodibromomethane	0.0	0.0
Hexachlorobutadiene	0.0	
CL6 Cyclopentadiene	0.0	
Isophorone	0.0	
Naphthalene	0.0	
Nitrobenzene	0.0	
2-Nitrophenol	0.0	
4-Nitrophenol	0.0	
24-Dinitrophenol	0.0	
46-Dinitro-o-cresol	0.0	
N-nitrosodimethlamin	0.0	
N-nitrosodiphenlamin	0.0	
N-nitrosodinproplamin	0.0	
Pentachlorophenol	0.0	

Table V-17 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 37032
(All Concentrations in mg/l)

SAMPLE POINT	251 Solution Heat Treatment	199 Volatile Organics Trip Blank
	Day 1	Day 1
Phenol	0.13	
B2-Ethyhexlphthalate	0.0	
Butylbenzylphthalate	0.0	
Di-n-butyl Phthalate	0.0	
Di-n-octyl Phthalate	0.0	
Diethyl Phthalate	0.048	
Dimethyl Phthalate	0.0	
12-Benzanthracene	0.0	
Benzo(a)pyrene	0.0	
34-Benzofluoranthene	0.0	
Benzo(k)fluoranthene	0.0	
Chrysene	0.0	
Acenaphthylene	0.0	
Anthracene	0.04	
112-Benzoperylene	0.0	
Fluorene	0.0	
Phenanthrene	0.04	
1256Dibenzanthracene	0.0	
Ideno(123-cd)pyrene	0.0	
Pyrene	0.0	
Tetrachloroethylene	*	0.0
Toluene	*	0.0
Trichloroethylene	0.0	0.0
Vinyl Chloride	0.0	0.0
Aldrin	0.0	
Dieldrin	0.0	
Chlordane	0.0	
4,4-DDT	0.0	
4,4-DDE(P,P-DDX)	0.0	
4,4-DDD(P,P-TDE)	0.0	
Alpha-Endosulfan	0.0	
Beta-Endosulfan	0.0	
Endosulfan Sulfate	0.0	
Endrin	0.0	
Endrin Aldehyde	0.0	
Heptachlor	0.0	
Heptachlor Epoxide	0.0	
Alpha-BHC	0.0	
Beta-BHC	0.0	
Gamma-BHC (Lindane)	0.0	
Delta-BHC	0.0	
PCB-1242	0.0	
PCB-1254	0.0	
PCB-1221	0.0	

Table V-17 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 37032
(All Concentrations in mg/l)

SAMPLE POINT	251 Solution Heat Treatment Day 1	199 Volatile Organics Trip Blank Day 1
PCB-1232	0.0	
PCB-1248	0.0	
PCB-1260	0.0	
PCB-1016	0.0	
Toxaphene	0.0	
TCDD	0.0	

Table V-17 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 37032
(All Concentrations in mg/l)

SAMPLE POINT	201	400	130	302	199	201	400
	Pickling Rinse	Combined Treated Effluent	Municipal Source Water	Boiler Cooling Water	Volatile Organics Trip Blank	Automatic Sampler Blank	Automatic Sampler Blank
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH	2.5	8.4	9.0	9.0			
Maximum pH	9.4	8.9	9.1	9.1			
Temperature °C	28.3	26.4	24.0	28.5			
Cyanide, Total	0.01	*	*	*			
Cyanide Amn to Chlor	*	*	*	*			
Oil & Grease	<1.0	<1.0	<1.0	<1.0			
Fluorides	1.0	0.98	1.15	1.05			
Phosphorus	0.38	0.14	0.045	1.24			
Totl Suspended Solids	<5.0	<5.0	<5.0	0.0			
Antimony	<0.0013	0.0567	0.0079	0.0074			
Arsenic	0.0183	0.0683	0.0134	0.0183			
Beryllium	0.0006	0.0111	0.0011	0.0007			
Cadmium	0.012	0.004	0.069	0.0046			
Chromium, Total	0.0009	0.43	0.0004	0.0064			
Chromium, Hexavalent	0.0	0.52	0.0	0.0			
Copper	7.717	1.29	0.011	0.032			
Iron	0.0103	0.108	0.043	0.023			
Lead	0.27	0.015	0.0024	0.0029			
Manganese	0.0018	0.002	0.002	0.0025			
Mercury	<0.0011	0.011	<0.001	0.0001			
Nickel	0.002	0.018	0.008	0.005			
Selenium	0.7328	0.2845	0.069	0.5172			
Thallium	0.0009	0.041	0.0032	0.004			
Zinc	2.05	0.332	0.01	0.0002			
Gold	0.0	0.0	0.0	0.0			
Silver	0.0056	0.0224	0.0026	0.0068			
Phenols, Total	*	*	*	*			
Cobalt	0.0013	0.0088	0.0035	0.0031			
Acenaphthene	0.0	0.0	0.0	0.0		0.0	0.0
Acrolein	0.0	0.0	0.0	0.0	0.0		
Acrylonitrile	0.0	0.0	0.0	0.0	0.0		
Benzene	0.0	0.0	0.0	0.0	0.0		
Benzidine	0.0	0.0	0.0	0.0		0.0	0.0
Carbon Tetrachloride	0.0	0.0	0.0	0.0	0.0		
Chlorobenzene	0.0	0.0	0.0	0.0	0.0		
124-Trichlorobenzene	0.0	0.0	0.0	0.0		0.0	0.0
Hexachlorobenzene	0.0	0.0	0.0	0.0		0.0	0.0
12-Dichloroethane	0.0	0.0	0.0	0.0	0.0		
111-Trichloroethane	0.0	0.0	0.0	0.0	0.0		
Hexachloroethane	0.0	0.0	0.0	0.0		0.0	0.0
11-Dichloroethane	0.0	0.0	0.0	0.0	0.0		
112-Trichloroethane	0.0	0.0	0.0	0.0	0.0		
1122Tetrachloroethan	0.0	0.0	0.0	0.0	0.0		
Chloroethane	0.0	0.0	0.0	0.0	0.0		
Bischloromethylether	0.0	0.0	0.0	0.0	0.0		
Bis2chloroethylether	0.0	0.0	0.0	0.0		0.0	0.0
2Chloroethlvinylethr	0.0	0.0	0.0	0.0	0.0		

Table V-17 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 37032
(All Concentrations in mg/l)

SAMPLE POINT	201 Pickling Rinse Day 2	400 Combined Treated Effluent Day 2	130 Municipal Source Water Day 2	304 Boiler Cooling Water Day 2	199 Volatile Organics Trip Blank Day 2	201 Automatic Sampler Blank Day 2	400 Automatic Sampler Blank Day 2
2-Chloronaphthalene	0.0	0.0	0.0	0.0		0.0	0.0
246-Trichlorophenol	0.0	0.0	0.0	0.0		0.0	0.0
Parachlorometacresol	0.0	0.0	0.0	0.0		0.0	0.0
Chloroform	*	*	*	*	0.0		
2-Chlorophenol	0.0	0.0	0.0	0.0		0.0	0.0
12-Dichlorobenzene	0.0	0.0	0.0	0.0		0.0	0.0
13-Dichlorobenzene	0.0	0.0	0.0	0.0		0.0	0.0
14-Dichlorobenzene	0.0	0.0	0.0	0.0		0.0	0.0
33-Dichlorobenzidine	0.0	0.0	0.0	0.0		0.0	0.0
11-Dichloroethylene	0.0	0.0	0.0	0.0	0.0		
12T-Dichloroethylene	0.0	0.0	0.0	0.0	0.0		
24-Dichlorophenol	0.001	0.0	0.0	0.0		0.0	0.0
12-Dichloropropane	0.0	0.0	0.0	0.0			
12-Dichloropropylene	0.0	0.0	0.0	0.0	0.0		
24-Dimethylphenol	0.0	0.0	0.0	0.0		0.0	0.0
24-Dinitrotoluene	0.0	0.0	0.0	0.0		0.0	0.0
26-Dinitrotoluene	0.0	0.0	0.0	0.0		0.0	0.0
12-Diphenylhydrazine	0.0	0.0	0.0	0.0		0.0	0.0
Ethylbenzene	0.0	0.0	0.0	0.0	0.0		
Fluoranthene	0.0	0.0	0.0	0.0		0.0	0.0
4ClPhenylphenylether	0.0	0.0	0.0	0.0		0.0	0.0
4BrPhenylphenylether	0.0	0.0	0.0	0.0		0.0	0.0
B2Chloroisoproplethr	0.0	0.0	0.0	0.0		0.0	0.0
B2Chloroethoxymethan	0.0	0.0	0.0	0.0		0.0	0.0
Methylene Chloride	0.013	0.031	*	0.041	0.013		
Methyl Chloride	0.0	0.0	0.0	0.0	0.0		
Methyl Bromide	0.0	0.0	0.0	0.0	0.0		
Bromoform	0.0	0.0	0.0	0.0	0.0		
Dichlorobromomethane	0.0	0.0	0.0	0.0	0.0		
Tricloroflorometbane	0.0	0.0	0.0	0.0	0.0		
Diclorodiflorometban	0.0	0.0	0.0	0.0	0.0		
Chlorodibromomethane	0.0	0.0	0.0	0.0	0.0		
Hexachlorobutadiene	0.0	0.0	0.0	0.0		0.0	0.0
Cl6 Cyclopentadiene	0.0	0.0	0.0	0.0		0.0	0.0
Isophorone	0.0	0.0	0.0	0.0		0.0	0.0
Naphthalene	0.0	0.0	0.0	0.0		0.0	0.0
Nitrobenzene	0.0	0.0	0.0	0.0		0.0	0.0
2-Nitrophenol	0.0	0.0	0.0	0.0		0.0	0.0
4-Nitrophenol	0.0	0.0	0.0	0.0		0.0	0.0
24-Dinitrophenol	0.0	0.0	0.0	0.0		0.0	0.0
46-Dinitro-o-cresol	0.0	0.0	0.0	0.0		0.0	0.0
N-nitrosidimethlamin	0.0	0.0	0.0	0.0		0.0	0.0
N-nitrosodiphenlamin	0.0	0.0	0.0	0.0		0.0	0.0
N-nitrosodinproplamin	0.0	0.0	0.0	0.0		0.0	0.0
Pentachlorophenol	0.0	0.0	0.0	0.0		0.0	0.0
Phenol	*	0.0	0.0	0.0		*	*
B2-Ethyhexlphthalate	0.0	*	*	0.0		*	*

Table V-17 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 37032
(All Concentrations in mg/l)

SAMPLE POINT	201	400	130	304	199	201	400
	Pickling Rinse	Combined Treated Effluent	Municipal Source Water	Boiler Cooling Water	Volatile Organics Trip Blank	Automatic Sampler Blank	Automatic Sampler Blank
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Butylbenzylphthalate	0.0	0.0	0.0	0.0		0.0	0.0
Di-n-butyl Phthalate	*	*	0.0	*		*	*
Di-n-octyl Phthalate	0.0	0.0	0.0	0.0		0.0	0.0
Diethyl Phthalate	0.0	0.001	0.0	0.0		0.015	0.01
Dimethyl Phthalate	0.0	0.0	0.0	0.0		0.0	0.0
12-Benzanthracene	0.0	0.0	0.0	0.0		0.0	0.0
Benzo(a)pyrene	0.0	0.0	0.0	0.0		0.0	0.0
34-Benzofluoranthene	0.0	0.0	0.0	0.0		0.0	0.0
Benzo(k)fluoranthene	0.0	0.0	0.0	0.0		0.0	0.0
Chrysene	0.0	0.0	0.0	0.0		0.0	0.0
Acenaphthylene	0.0	0.0	0.0	0.0		0.0	0.0
Anthracene	0.0	0.0	0.0	0.0		0.0	0.0
112-Benzoperylene	0.0	0.0	0.0	0.0		0.0	0.0
Fluorene	0.0	0.0	0.0	0.0		0.0	0.0
Phenanthrene	0.0	0.0	0.0	0.0		0.0	0.0
1256Dibenzanthracene	0.0	0.0	0.0	0.0		0.0	0.0
Ideno(123-cd)pyrene	0.0	0.0	0.0	0.0		0.0	0.0
Pyrene	0.0	0.0	0.0	0.0		0.0	0.0
Tetrachloroethylene	*	0.017	*	*	0.0		
Toluene	*	*	*	0.0	0.0		
Trichloroethylene	0.0	*	0.0	0.0	0.0		
Vinyl Chloride	0.0	0.0	0.0	0.0	0.0		
Aldrin	0.0	0.0	0.0	0.0			
Dieldrin	0.0	0.0	0.0	0.0			
Chlordane	0.0	0.0	0.0	0.0			
4,4-DDT	0.0	0.0	0.0	0.0			
4,4-DDE (P,P-DDX)	0.0	0.0	0.0	0.0			
4,4-DDD (P,P-TDE)	0.0	0.0	0.0	0.0			
Alpha-Endosulfan	0.0	0.0	0.0	0.0			
Beta-Endosulfan	0.0	0.0	0.0	0.0			
Endosulfan Sulfate	0.0	0.0	0.0	0.0			
Endrin	0.0	0.0	0.0	0.0			
Endrin Aldehyde	0.0	0.0	0.0	0.0			
Heptachlor	0.0	0.0	0.0	0.0			
Heptachlor Epoxide	0.0	0.0	0.0	0.0			
Alpha-BHC	0.0	0.0	0.0	0.0			
Beta-BHC	0.0	0.0	0.0	0.0			
Gamma-BHC (Lindane)	0.0	0.0	0.0	0.0			
Delta-BHC	0.0	0.0	0.0	0.0			
PCB-1242	0.0	0.0	0.0	0.0			
PCB-1254	0.0	0.0	0.0	0.0			
PCB-1221	0.0	0.0	0.0	0.0			
PCB-1232	0.0	0.0	0.0	0.0			
PCB-1248	0.0	0.0	0.0	0.0			
PCB-1260	0.0	0.0	0.0	0.0			
PCB-1016	0.0	0.0	0.0	0.0			
Toxaphene	0.0	0.0	0.0	0.0			
TCDD	0.0	0.0	0.0	0.0			

Table V-17 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 37032
(All Concentrations in mg/l)

SAMPLE POINT	201 Pickling Rinse	400 Combined Treated Effluent
	Day 3	Day 3
Minimum pH	2.1	8.3
Maximum pH	6.6	9.1
Temperature °C	28.4	27.0
Cyanide, Total	*	*
Cyanide Amn. to Chlor.	*	*
Oil & Grease	<1.0	<1.0
Fluorides	1.05	1.0
Phosphorus	1.05	0.15
Total Suspended Solids	<5.0	<5.0
Antimony	0.0	0.0
Arsenic	0.0	0.0
Cadmium	0.003	0.0
Chromium, Total	0.0	0.35
Chromium, Hexavalent	0.0	0.29
Copper	29.7	0.29
Iron	0.15	0.16
Lead	0.15	0.0
Manganese	0.0	0.0
Nickel	0.0	0.0
Selenium	0.0	
Thallium	0.0	
Zinc	22.9	0.2
Silver	0.0	0.0
Phenols, Total	*	*
Benzene	*	*
Carbon Tetrachloride	0.0	0.0
111-Trichloroethane	0.0	*
Methylene Chloride	0.0	0.0
Naphthalene	*	*
B2-Ethyhexylphthalate	0.039	*
Diethyl Phthalate	*	*
Anthracene	0.0	0.0
Phenanthrene	0.0	0.0
Tetrachloroethylene	0.0	*
Toluene	0.0	0.0
Trichloroethylene	0.0	0.0

Table V-18

SUMMARY OF SAMPLING DATA FROM PLANT 36096
(All Concentrations in mg/l)

SAMPLE POINT	201 Alkaline Cleaning Rinse	202 Alkaline Cleaning Rinse	251 Alkaline Cleaning Bath	252 Alkaline Cleaning Bath
	Day 1	Day 1	Day 1	Day 1
Minimum pH	8.4	7.3	10.5	6.3
Maximum pH	9.1	8.3	10.5	6.3
Temperature °C	19.1	55.6	51.0	70.0
Oil & Grease	37.4	1.2	1367.0	1441.0
Fluorides	1.75	1.3	6.0	9.2
Phosphorus	12.8	1.05		
Ammonia	5.75	1.4	8.75	750.0
Tot Organic Carbon	86.7	4.6	15296.0	10596.0
Totl Suspended Solids	38.8	2.0	630.0	44.0
Antimony	0.0	0.0	0.0	0.0
Arsenic		0.0	0.0	0.0
Cadmium	0.0	0.0	0.0	0.25
Chromium, Total	0.0	0.0	0.52	0.25
Chromium, Hexavalent	0.0	0.0	0.0	0.0
Copper	5.08	0.39	330.0	550.0
Iron	0.14	0.14	1.69	
Lead	0.0	0.0	1.18	1.22
Manganese	0.0	0.0	0.085	0.34
Nickel	0.0	0.0	0.047	0.073
Selenium	0.0	0.0	0.0	0.0
Thallium	0.0	0.0	0.0	0.0
Zinc	0.35	0.25	5.69	7.51
Silver	0.0	0.0	0.0	0.0
Phenols, Total	*	0.013	0.045	0.031
Benzene	0.0	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	*
111-Trichloroethane	*	*	*	*
Methylene Chloride	0.0	0.0	0.0	0.0
Naphthalene	0.0	*	0.0	0.0
B2-Ethyhexlphthalate	0.0	*	0.0	0.056
Diethyl Phthalate	0.0	0.0	0.0	0.0
Anthracene	*	*	0.023	*
Phenanthrene	*	*	0.023	*
Tetrachloroethylene	0.0	0.0	0.0	0.0
Toluene	0.0	0.0	0.0	0.0
Trichloroethylene	0.0	0.0	0.0	0.0

Table V-18 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 36096
(All Concentrations in mg/l)

SAMPLE POINT	201 Alkaline Cleaning Rinse	202 Alkaline Cleaning Rinse	130 Municipal Source Water
	Day 2	Day 2	Day 2
Minimum pH	8.1	7.1	7.4
Maximum pH	8.8	7.7	7.8
Temperature °C	17.8	59.1	19.3
Oil & Grease	10.0	3.6	2.1
Fluorides	1.30	1.25	1.4
Phosphorus	7.95	1.2	0.0
Ammonia	2.45	1.08	0.82
Tot Organic Carbon	39.4	6.0	2.1
Totl Suspended Solids	11.4	0.4	1.2
Antimony	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0
Cadmium	0.0	0.0	0.0
Chromium, Total	0.009	0.011	0.0
Chromium, Hexavalent	0.0	0.0	0.0
Copper	2.17	0.29	0.009
Iron	0.21	0.095	0.086
Lead	0.0	0.0	0.0
Manganese	0.0	0.0	0.0
Nickel	0.0	0.0	0.0
Selenium	0.0	0.0	0.0
Thallium	0.0	0.0	0.0
Zinc	0.095	0.017	0.15
Silver	0.0	0.0	0.0
Phenols, Total	*	*	*
Benzene	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0
111-Trichloroethane	*	*	*
Methylene Chloride	0.0	0.0	0.0
Naphthalene	*	0.0	0.0
B2-Ethyhexlphthalate	*	0.0	*
Diethyl Phthalate	0.0	0.0	0.0
Anthracene	0.0	0.0	0.0
Phenanthrene	0.0	0.0	0.0
Tetrachloroethylene	0.0	0.0	0.0
Toluene	0.0	0.0	0.0
Trichloroethylene	0.0	0.0	0.0

Table V-18 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 36096
(All Concentrations in mg/l)

SAMPLE POINT	201 Alkaline Cleaning Rinse	202 Alkaline Cleaning Rinse	199 Organics Trip Blank
	Day 3	Day 3	Day 3
Minimum pH	8.2	6.9	
Maximum pH	8.5	7.1	
Temperature °C	19.4	53.7	
Oil & Grease	9.6	1.2	
Fluorides		1.20	
Phosphorus		4.4	
Ammonia		1.38	
Toc Organic Carbon		1.9	
Totl Suspended Solids		1.2	
Antimony		0.0	
Arsenic		0.0	
Cadmium		0.0	
Chromium, Total		0.0	
Chromium, Hexavalent		0.0	
Copper		0.3	
Iron		0.086	
Lead		0.0	
Manganese		0.0	
Nickel		0.0	
Selenium		0.0	
Thallium	0.0		
Zinc		0.018	
Silver		0.0	
Phenols, Total	*	*	
Benzene	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0
111-Trichloroethane	0.0	*	*
Methylene Chloride	0.0	0.0	0.0
Naphthalene			
B2-Ethyhexlphthalate			
Diethyl Phthalate			
Anthracene			
Phenanthrene			
Tetrachloroethylene	0.0	0.0	0.0
Toluene	0.0	0.0	0.0
Trichloroethylene	0.0	0.0	0.0

Table V-19

SUMMARY OF SAMPLING DATA FROM PLANT 1053
(All Concentrations in mg/l)

SAMPLE POINT	201	202	203	204	205	206	207	208
	Pickling Rinse	Alkaline Cleaning Rinse	Combined Pickling and Alkaline Rinse	Finning Waste	Solution Heat Treatment	Solution Heat Treatment	Annealing Water	Annealing Water
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	2.3	6.4	5.0	4.8	5.3	5.8	4.4	5.2
Maximum pH	6.8	7.5	6.5	7.0	6.4	6.1	6.7	7.0
Temperature °C	25.0	33.0	22.0	32.0	20.0	20.0	26.0	27.0
Oil & Grease	1.0	12.0	4.0	2620.0	34.0	466.0	0.0	6.0
Fluorides	0.66	0.74	0.68	0.68	0.88	0.90	0.74	1.0
Phosphorus	0.69	0.54	0.8	0.94		0.4	0.0	0.94
Tot Organic Carbon	11.7	45.0	23.9	654.9	69.1	297.0	167.9	38.8
Totl Suspended Solids	3.0	20.0	16.0	233.0	30.0	126.0	0.0	0.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.006	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromium, Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copper	3.16	0.88	1.46	0.62	0.07	1.55	0.018	0.084
Iron	0.51	0.33	0.15	0.095	0.16	0.3	0.033	0.96
Lead	0.0	0.0	0.0	0.0	0.15	0.24	0.0	0.0
Manganese	0.29	0.01	0.16	0.027	0.012	0.013	0.0	0.021
Nickel	0.12	0.03	0.096	0.017	0.0	0.0	0.0	0.0
Selenium			0.0		0.0	0.0		
Thallium			0.0		0.0	0.0		
Zinc	22.9	0.84	12.9	0.3	0.58	1.72	0.23	0.53
Silver	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0
Phenols, Total	0.014	0.012	*	*	0.018	*	*	0.012
Benzene	0.0	0.0	*	*	*	0.0		
Chlorobenzene	0.0	0.0	0.0	0.0	*	0.0		
111-Trichloroethane	0.0	0.0	0.0	*	*	0.0		
Hexachloroethane				0.0				
Chloroform	0.0	0.014	*	0.0	*	*	*	0.0
Ethylbenzene				*				
Methylene Chloride	0.0	*	*	0.0	*	*	*	*
Naphthalene	0.0	0.0	0.0	*	*	*		
B2-Ethyhexlphthalate	0.0	*	*	*	<0.029	*		
Diethyl Phthalate	0.0	0.0		0.0	0.0	0.0		
Anthracene	0.0	0.0	0.0	*	*	*		
Phenanthrene	0.0	0.0	0.0	*	*	*		
Tetrachloroethylene	0.0	*	*	*	*	*		
Toluene	0.0	0.0	*	0.012	0.0	0.0		
Trichloroethylene	0.0	*	*	*	*	*		

Table V-19 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 1053
(All Concentrations in mg/l)

SAMPLE POINT	209 Combined Oily Waste	310 Oil Skimming Effluent	400 Settling Basin Effluent	401 Biological Lagoon Effluent	199 Volatile Organics Trip Blank
	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	5.3	5.3	5.0	4.8	
Maximum pH	6.4	6.4	7.2	6.1	
Temperature °C	21.0	18.0	10.0	12.0	
Oil & Grease	307.0	717.0	10.0	54.0	
Fluorides	0.76	76.0	0.68	0.76	
Phosphorus			0.0	0.15	
Tot Organic Carbon	324.7	472.3	11.6	141.8	
Totl Suspended Solids	96.0	63.0	12.0	111.0	
Antimony	0.0	0.0	0.0	0.0	
Arsenic	0.0	0.0	0.0	0.0	
Cadmium	0.0	0.0	0.0	0.0	
Chromium, Total	0.0	0.0	0.0	0.0	
Chromium, Hexavalent	0.0	0.0	0.0	0.0	
Copper	0.37	0.21	0.4	0.23	
Iron	0.16	0.18	0.14	0.12	
Lead	0.1	0.08	0.0	0.0	
Manganese	0.023	0.025	0.07	0.1	
Nickel	0.0	0.0	0.056	0.0	
Zinc	0.35	0.34	2.06	0.36	
Silver	0.0	0.0	0.0	0.0	
Phenols, Total	0.018	0.028	*	*	
Benzene	*	*	*	*	*
Chlorobenzene	0.0	0.0	0.0	0.0	<0.001
111-Trichloroethane	*	0.018	0.0	*	0.0
Hexachloroethane	0.0	0.0		0.0	
Chloroform	*	*	*	*	*
Ethylbenzene	0.0	*		0.0	
Methylene Chloride	*	*	*	*	0.0
Naphthalene	*	*	0.0	0.0	
B2-Ethyhexlphthalate	*	*	*	*	
Diethyl Phthalate	*	*	0.0	0.0	
Anthracene	*	<0.013	0.0	0.0	
Phenanthrene	*	<0.013	0.0	0.0	
Tetrachloroethylene	*	*	*	0.0	0.0
Toluene	*	*	*	*	*
Trichloroethylene	*	*	*	*	0.0

Table V-19 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 1053
(All Concentrations in mg/l)

SAMPLE POINT	201 Pickling Rinse	202 Alkaline Cleaning Rinse	203 Combined Pickling and Alkaline Rinse	204 Finning Waste	205 Solution Heat Treatment	206 Solution Heat Treatment	207 Annealing Water	208 Annealing Water
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH	2.8	6.8	4.0	5.0	6.0	6.5	5.0	5.0
Maximum pH	6.8	9.0	6.5	7.0	7.1	7.1	6.8	7.0
Temperature °C	23.0	34.0	26.0	26.0	26.0	22.0	25.0	22.0
Oil & Grease	6.0	8.0	4.0	1280.0	33.0	166.0	0.0	2.0
Fluorides	0.6	0.72	0.9	0.66	0.9	1.0	0.82	1.05
Phosphorus	0.41	0.98	0.38	0.9	0.49	0.68	0.25	1.07
Tot Organic Carbon	4.9	156.0	18.3	1229.6	37.9	383.0	9.6	15.3
Totl Suspendd Solids	0.0	27.0	5.0	411.0	26.0	12.0	<5.0	0.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromium, Total	0.0	0.0	0.007	0.0	0.0	0.0	0.0	0.0
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copper	2.43	1.5	3.24	0.46	0.091	0.4	0.023	0.074
Iron	0.48	0.11	0.72	0.15	0.088	0.23	0.051	0.37
Lead	0.0	0.0	0.0	0.0	0.083	0.17	0.0	0.0
Magnesium								0.0
Manganese	0.16	0.01	0.15	0.048	0.009	0.009	0.0	0.01
Nickel	0.1	0.04	0.12	0.043	0.0	0.0	0.0	0.0
Selenium			0.0		0.0	0.0		
Thallium			0.0		0.0	0.0		
Zinc	12.8	1.49	14.0	0.45	0.35	0.16	0.065	0.59
Silver	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	0.012	0.014	*	0.012	*	*	*	0.02
Benzene	0.0	*	0.0	*	*	*		
Chlorobenzene	0.0	0.0.	*	0.0	*	0.0		
111-Trichloroethane	0.0	*	*	0.0	*	*		
Hexachloroethane				*				
Chloroform	0.0	*	*	*	*	0.014	0.0	0.0
Ethylbenzene				*				
Methylene Chloride	0.0	*	*	*	*	*	*	*
Naphthalene	0.0	0.0	0.0	*	*	*		
B2-Ethyhexlphthalate	0.0	*	*	*	*	0.0		
Diethyl Phthalate	0.0	0.0	0.0	*	*	*		
Anthracene	0.0	0.0	0.0	<0.029	*	0.019		
Phenanthrene	0.0	0.0	0.0	<0.029	*	0.019		
Tetrachloroethylene	0.0	*	*	*	*	*		
Toluene	0.0	*	0.0	0.012	*	*		
Trichloroethylene	0.0	*	*	*	*	*		

Table V-19 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 1053
(All Concentrations in mg/l)

SAMPLE POINT	209	310	400	401	130	199
	Combined Oily Waste	Oil Skimming Effluent	Settling Basin Effluent	Biological Lagoon Effluent	Municipal Source Water	Volatile Organics Trip Blank
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH	5.0	5.0	5.0	5.0	5.0	
Maximum pH	6.0	6.0	6.0	5.5	5.5	
Temperature °C	26.0	21.0	13.0	17.0	22.0	
Oil & Grease	299.0	56.0	4.0	272.0		
Fluorides	0.9	0.92	0.66	0.78	0.72	
Phosphorus	0.62	0.62	0.38	10.3	0.29	
Tot Organic Carbon	314.2	378.1	16.7	177.3	9.5	
Totl Suspendd Solids	123.0	83.0	148.0	12.0	0.0	
Antimony	0.0	0.0	0.0	0.0	0.0	
Arsenic	0.0	0.0	0.0	0.0	0.0	
Cadmium	0.0	0.0	0.0	0.0	0.0	
Chromium, Total	0.0	0.0	0.0	0.0	0.0	
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	
Copper	0.7	0.58	0.5	0.8	0.005	
Iron	0.28	0.24	0.077	0.72	2.41	
Lead	0.17	0.12	0.0	0.083	0.0	
Manganese	0.021	0.029	0.08	0.1	0.018	
Nickel	0.0	0.0	0.053	0.017	0.0	
Zinc	0.35	0.35	3.78	0.35	0.19	
Silver	0.0	0.0	0.0	0.0	0.0	
Phenols, Total	0.014	0.02	*	*	*	
Benzene	*	*	*	*		*
Chlorobenzene	0.0	0.0	0.0	0.0		*
111-Trichloroethane	0.0	0.0	0.0	*		0.0
Hexachloroethane	0.0	*		*		0.0
Chloroform	0.005	*	*	*		*
26-Dinitrotoluene					0.0	
Ethylbenzene	0.0	0.0		0.0		0.0
Methylene Chloride	*	*	*	*		*
Naphthalene	*	*	0.0	0.0	0.0	
B2-Ethyhexlphthalate	*	*	*	*	*	
Butylbenzylphthalate					0.0	
Di-N-butyl Phthalate					0.0	
Di-N-octyl Phthalate					*	
Diethyl Phthalate	*	0.0	0.0	*	0.0	
Dimethyl Phthalate					0.0	
Anthracene	*	*	0.0	*	0.0	
Phenanthrene	*	*	0.0	*	0.0	
Tetrachloroethylene	0.0	*	*	*		0.0
Toluene	*	*	*	*		*
Trichloroethylene	*	*	*	0.0		0.0

Table V-19 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 1053
(All Concentrations in mg/l)

SAMPLE POINT	201	202	203	204	205	206	207	208
	Pickling Rinse	Alkaline Cleaning Rinse	Combined Pickling and Alkaline Rinse	Finning Waste	Solution Heat Treatment	Solution Heat Treatment	Annealing Water	Annealing Water
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	5.0	7.0	3.0	4.5	6.0	6.0	5.0	6.0
Maximum pH	6.0	9.0	5.0	7.0	7.0	6.0	6.0	7.0
Temperature °C	26.0	36.0	29.0	30.0	31.0	31.0	27.0	52.0
Oil & Grease	0.0	27.0	3.0	153.0	49.0	80.0	0.0	7.0
Fluorides	0.66	0.74	0.68	0.72	0.84		0.70	1.0
Phosphorus	0.32	0.44	0.8	1.13	0.41		0.13	1.13
Tot Organic Carbon	7.0	86.0	22.5	475.7	7.3	252.7	12.2	17.1
Totl Suspendd Solids	0.0	28.0	29.0	182.0	14.0	112.0	0.0	0.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.0	0.0	0.0	0.0	0.0	0.0	0.004	0.0
Chromium, Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copper	1.92	1.54	1.56	0.28	0.1	0.6	0.011	0.086
Iron	0.35	0.051	0.33	0.13	0.15	0.13	0.06	0.11
Lead	0.0	0.0	0.0	0.0	0.1	0.15	0.0	0.0
Manganese	0.11	0.0	0.078	0.03	0.008	0.006	0.0	0.01
Nickel	0.066	0.026	0.11	0.023	0.0	0.0	0.0	0.0
Selenium			0.0		0.0	0.0		
Thallium			0.0		0.0	0.0		
Zinc	10.1	0.72	7.5	0.067	0.035	0.27	0.53	0.67
Silver	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	0.012	*	0.02	*	*	*	*	0.03
Benzene	0.0	*		0.0	*	*		
Chlorobenzene	0.0	0.0		0.0	0.0	0.0		
111-Trichloroethane	0.0	*		*	0.011	*		
Hexachloroethane				0.0				
Chloroform	0.0	0.0		*	*	*	0.0	0.0
Ethylbenzene				0.0				
Methylene Chloride	0.0	0.0		*	*	*	*	0.0
Naphthalene	0.0	0.0	0.0	*	*	*		
B2-Ethyhexlphthalate	0.0	*	*	*	0.018	*		
Diethyl Phthalate	0.0	0.0	0.0	0.0	*	0.0		
Anthracene	0.0	0.0	0.0	*	*	*		
Phenanthrene	0.0	0.0	0.0	*	*	*		
Tetrachloroethylene	0.0	*		*	*	*		
Toluene	0.0	0.0		*	0.0	*		
Trichloroethylene	0.0	*		0.016	*	*		

Table V-19 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 1053
(All Concentrations in mg/l)

SAMPLE POINT	209 Combined Oily Waste	310 Oil Skimming Effluent	400 Settling Basin Effluent	401 Biological Lagoon Effluent	199 Volatile Organics Trip Blank
	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	5.0	4.5	6.0	5.0	
Maximum pH	6.0	5.5	7.3	5.5	
Temperature °C	30.0	28.0	17.0	17.0	
Oil & Grease	422.0	160.0	0.0	58.0	
Fluorides	0.76	0.8	0.7	0.8	0.7
Phosphorus		0.9	0.0	9.49	12.0
Tot Organic Carbon	354.9	376.7	17.0	255.0	
Totl Suspended Solids	20.0	76.0	7.0	122.0	
Antimony	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0
Cadmium	0.0	0.006	0.024	0.0	
Chromium, Total	0.0	0.0	0.0	0.0	0.0
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0
Copper	0.5	0.46	1.03	0.098	0.58
Iron	0.16	0.31	0.34	0.07	0.15
Lead	0.09	0.11	0.0	0.0	0.0
Manganese	0.021	0.027	0.1	0.094	0.092
Nickel	0.013	0.0	0.066	0.0	0.086
Zinc	0.47	1.86	7.11	0.3	0.51
Silver	0.0	0.0	0.0	0.0	0.0
Phenols, Total	0.024	0.026	0.014	*	
Benzene	*	*			*
Chlorobenzene	0.0	0.0			0.0
111-Trichloroethane	*	0.0			*
Hexachloroethane	*	0.0			0.0
Chloroform	*	*			*
Ethylbenzene	0.0	0.0			*
Methylene Chloride	*	*			*
Naphthalene	*	*	0.0	0.0	
B2-Ethyhexlphthalate	*	*	*	*	
Diethyl Phthalate	0.0	*	0.0	0.0	
Anthracene	0.011	*	0.0	*	
Phenanthrene	0.011	*	0.0	*	
Tetrachloroethylene	*	0.0			0.0
Toluene	0.0	*			*
Trichloroethylene	*	*			0.0

Table V-20

SUMMARY OF SAMPLING DATA FROM PLANT 19019
(All Concentrations in mg/l)

SAMPLE POINT	120 Source Pond Water	400 Treated Oily Waste	199 Volatile Organics Trip Blank	204 Leveler Cooling Water	300 Vacuum Filter Effluent	451 Treated Pickling Waste
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	6.3	5.3		6.1	9.7	7.6
Maximum pH	6.7	6.6		8.4	9.8	8.6
Temperature °C	20.0	6.0		20.0	10.0	20.0
Cyanide, Total	*	*		0.0		
Cyanide Amn. to Chlor	*	*		0.0		
Oil & Grease	0.0	28.1		11.1	0.0	15.0
Fluorides	0.18	0.27		0.30	0.41	0.41
Phosphorus	0.045	0.41		0.0	0.0	0.0
Tot Organic Carbon	5.0					
Totl Suspended Solids	20.0			12.0	334.0	1.0
Antimony	0.0	0.0		0.0	0.0	0.0
Arsenic	0.0	0.0		0.0	0.0	0.0
Cadmium	0.0	0.0		0.0	0.0	0.0
Chromium, Total	0.0	0.009		0.0	0.036	0.008
Chromium, Hexavalent	0.0	0.0		0.0	0.0	0.0
Copper	0.061	1.17		0.32	36.5	0.18
Iron	0.15	1.32		0.15	2.86	0.18
Lead	0.0	0.14		0.0	0.07	0.0
Manganese	0.0	0.078		0.006	0.2	0.009
Nickel	0.0	0.13		0.0	5.7	0.28
Zinc	0.42	1.49		1.68	4.61	0.088
Silver	0.0	0.0		0.0	0.005	0.0
Phenols, Total	*	*		0.0		
Benzene	*	0.018	*	0.0		
Chlorobenzene	0.0	0.0	0.0	0.0		
111-Trichloroethane	0.014	*	*	0.0		
Hexachloroethane	0.0	*	0.0	0.0		
Chloroform	0.0	*	0.0	0.0		
26-Dinitrotoluene	0.0	0.0		0.0		
Ethylbenzene	0.0	*	0.0	0.0		
Methylene Chloride	0.0	0.0	0.0	0.0		
Naphthalene	0.0	0.0		0.0		
N-Nitrosodiphenlamin	0.0	*		0.0		
B2-Ethyhexlphthalate	*	*		0.0		
Butylbenzylphthalate	0.0	*		0.0		
Di-n-butyl Phthalate	0.0			0.0		
Di-n-octyl Phthalate	0.0	*		0.0		
Diethyl Phthalate	0.0			0.0		
Dimethyl Phthalate	0.0	*		0.0		
Anthracene	0.0	*		0.0		
Phenanthrene	0.0	*	0.0	0.0		
Tetrachloroethylene	*	*	0.0	0.0		
Toluene	0.0	*	*	0.0		
Trichloroethylene	0.0	*	0.0	0.0		

Table V-20 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 19019
(All Concentrations in mg/l)

SAMPLE POINT	200 Combined Hot Rolling Waste	201 Noncontact Cooling Water	203 Noncontact Cooling Water	205 Noncontact Cooling Water	206 Cold Rolling Spent Lubricant	207 Cold Rolling Spent Lubricant	209 Combined Oily Waste	208 Combined Pickling Waste
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	6.0	6.0	5.3	6.6	5.0	6.3		2.3
Maximum pH	7.8	7.4	7.1	7.1	5.0	6.7		3.2
Temperature °C	10.0	11.0	6.0	15.0	16.0	8.0	12.0	24.0
Cyanide, Total			<0.005	<0.005	<0.005	<0.005	<0.005	
Cyanide Amn. to Chlor			<0.005	<0.005	<0.005	<0.005	<0.005	
Oil & Grease	59.1	17.4	21.7	32.7	1014.3	58.7	40.3	10.6
Fluorides	0.22	0.21	0.15			0.29		0.48
Phosphorus		0.4	0.0			0.14		0.24
Tot Organic Carbon	13.0	7.0	6.0	6.0	30.0	28.0	13.0	
Totl Suspended Solids	62.0	22.0	1.0	257.0	664.0	65.0	6848.0	170.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.0	0.0	0.0	0.0	0.0	0.0	0.004	0.0
Chromium, Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.04
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Copper	2.62	0.2	0.023	0.024	1.91	0.15	1.1	89.0
Iron	1.76	2.0	0.8	0.056	0.091	0.14	0.79	2.42
Lead	0.12	0.0	0.0	0.0	0.0	0.0	0.07	0.1
Manganese	0.069	0.038	0.009	0.0	0.011	0.016	0.067	0.39
Nickel	0.13	0.23	0.0	0.0	0.0	0.026	0.052	9.76
Selenium								0.0
Thallium								0.0
Zinc	1.08	0.2	0.028	0.083	1.2	0.13	1.14	5.12
Silver	0.0	0.0	0.0	0.0	0.004	0.0	0.0	0.0050
Phenols, Total	0.011	*	*	0.012	*	*	0.0	
Benzene	0.0	0.012	*	0.0	0.012	*	0.0	
Chlorobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
111-Trichloroethane	0.012	0.019	*	*	0.0	0.0	0.0	
Hexachloroethane	*	0.0	*	*	*	*	*	
Chloroform	*	0.0	0.0	0.0	*	0.014	0.0	
26-Dinitrotoluene	0.0	0.0	0.0	0.44	0.0	0.0	0.088	
Ethylbenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Naphthalene	*	0.033	0.0	0.15	1.5	*	0.18	
N-Nitrosodiphenlamin	0.0	0.0	0.0	0.076	3.1	0.0	0.66	
B2-Ethyhexlphthalate	*	*	*	*	0.0	*	0.11	
Butylbenzylphthalate	0.0	0.0	0.0	*	0.17	0.0	0.079	
Di-N-butyl Phthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Di-N-octyl Phthalate	0.0	0.0	0.0	*	0.0	*	0.0	
Diethyl Phthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Dimethyl Phthalate	0.0	0.0	0.0	*	*	0.0	0.036	
Anthracene	*	0.0	*	0.18	1.6	*	0.29	
Phenanthrene	*	0.0	*	0.18	1.6	*	0.29	
Tetrachloroethylene	*	*	*	*	*	0.0	0.0	
Toluene	0.0	*	0.0	0.0	0.014	*	0.0	
Trichloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	*	

Table V-20 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 19019
(All Concentrations in mg/l)

SAMPLE POINT	120	400	199	204	300	451
	Source Pond Water	Treated Oily Waste	Volatile Organics Trip Blank	Leveler Cooling Water	Vacuum Filter Effluent	Treated Pickling Waste
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH	6.9	5.1		6.6	5.9	6.1
Maximum pH	7.5	6.4		7.5	8.8	6.1
Temperature °C	1.0	8.0		1.0	12.0	16.0
Cyanide, Total	*	*		0.0		
Cyanide Amn. to Chlor	<0.006	*		0.0		
Oil & Grease	0.0	23.2		0.0	0.0	0.0
Fluorides	0.18	0.22		0.16	0.36	0.36
Phosphorus	0.02	0.2		0.03	0.17	0.0
Tot Organic Carbon	5.5	10.0		0.0		
Totl Suspended Solids	4.0	25.0		10.0	766.0	1.0
Antimony	0.0	0.0		0.0	0.0	0.0
Arsenic	0.0	0.0		0.0	0.0	0.0
Cadmium	0.0	0.0			0.0	0.0
Chromium, Total	0.0	0.0		0.0	0.06	0.0
Chromium, Hexavalent	0.0	0.0		0.0	0.0	0.0
Copper	0.018	0.96		0.91	80.0	0.27
Iron	0.21	0.92		0.14	4.4	0.2
Lead	0.0	0.07		0.68	0.62	0.0
Manganese	0.0	0.072		0.18	0.51	0.054
Nickel	0.0	0.052		0.12	9.98	1.08
Zinc	0.022	0.91		6.94	9.44	0.55
Silver	0.0	0.0		0.0	0.0	0.0
Phenols, Total	0.012	0.009		0.0		
Benzene	0.0	*	*	0.0		
Chlorobenzene	0.0	0.0	0.0	0.0		
111-Trichloroethane	*	*	*	0.0		
Hexachloroethane	0.0	*	0.0	0.0		
Chloroform	0.0	*	0.0	0.0		
26-Dinitrotoluene	0.0	0.0		0.0		
Ethylbenzene	0.0	0.0	0.0	0.0		
Methylene Chloride	0.0	0.0	0.0	0.0		
Naphthalene	0.0	*		0.0		
N-Nitrosodiphenlamin	*	*		0.0		
B2-Ethyhexlphthalate	*	*		0.0		
Butylbenzylphthalate	0.0	*		0.0		
Di-n-butyl Phthalate	0.0			0.0		
Di-n-octyl Phthalate	0.0	*		0.0		
Diethyl Phthalate	0.0			0.0		
Dimethyl Phthalate	0.0	*		0.0		
Anthracene	0.0	*		0.0		
Phenanthrene	0.0	*		0.0		
Tetrachloroethylene	0.0	0.0	0.0	0.0		
Toluene	*	*	*	0.0		
Trichloroethylene	0.0	*	0.0	0.0		

Table V-20 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 19019
(All Concentrations in mg/l)

SAMPLE POINT	200	201	203	205	206	209	208
	Combined Hot Rolling Waste	Noncontact Cooling Water	Noncontact Cooling Water	Noncontact Cooling Water	Cold Rolling Spent Lubricant	Cold Rolling Spent Lubricant	Combined Oily Waste
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH	6.7	6.4	0.4	4.8	5.0		2.2
Maximum pH	7.3	7.0	8.0	7.0	5.0		4.5
Temperature °C	11.0	8.0	10.0	14.0		10.0	
Cyanide, Total			*	*	*	*	
Cyanide Amn. to Chlor			*	*	*	*	
Oil & Grease	43.1	<5.0	0.0	0.0	503.6	63.9	0.0
Fluorides	0.16	0.17	0.15	0.18			0.32
Phosphorus	0.53	0.18	0.0				
Tot Organic Carbon	9.5	6.5	6.5	6.0	179.0	13.0	
Totl Suspended Solids	50.0	14.0	2.0	138.0	1149.0	429.0	50.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.084	0.0	0.0
Cadmium	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromium, Total	0.012	0.0	0.0	0.0	0.0	0.009	0.022
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0		0.0
Copper	3.41	0.095	0.018	0.026	5.92	1.76	72.0
Iron	1.72	0.39	0.72	0.51	0.26	1.39	2.42
Lead	0.14	0.0	0.0	0.0	0.56	0.097	1.29
Manganese	0.17	0.017	0.008	0.009	0.0365	0.072	0.62
Nickel	0.18	0.0	0.0	0.0	0.026	0.1	16.2
Selenium							0.0
Thallium							0.0
Zinc	1.82	0.29	0.028	0.064	0.066	1.2	11.7
Silver	0.0	0.0	0.0	0.008	0.004	0.0	0.015
Phenols, Total	0.012	0.018	*	0.034	0.016	0.017	
Benzene	0.0	0.0	0.0	0.0	0.012	0.0	
Chlorobenzene	0.0	0.0	0.0	0.0	0.0	0.0	
111-Trichloroethane	*	*	*	0.013	0.0	0.0	
Hexachloroethane	*	0.0	*	0.0	*	*	
Chloroform	0.0	0.0	*	*	*	*	
26-Dinitrotoluene	0.0	0.0	0.0	0.046	1.2	0.0	
Ethylbenzene	0.0	0.0	0.0	0.0	0.0	0.0	
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0	
Naphthalene	*	*	*	0.082	2.5	0.12	
N-Nitrosodiphenlamin	0.0	0.0	0.0	0.28	1.3	0.54	
B2-Ethyhexlphthalate	*	*	*	0.0	0.095	0.0	
Butylbenzylphthalate	0.0	0.0	0.0	*	0.48	0.014	
Di-N-butyl Phthalate	0.0	*	0.0	0.0	0.0	0.0	
Di-N-octyl Phthalate	0.0	0.0	0.0	0.0	0.06	0.0	
Diethyl Phthalate	0.0	0.0	0.0	0.0	0.0	0.0	
Dimethyl Phthalate	0.0	0.0	0.0	0.0	0.0	0.0	
Anthracene	*	*	*	0.16	14.0	0.27	
Phenanthrene	*	*	*	0.16	14.0	0.27	
Tetrachloroethylene	0.0	0.0	0.0	*	*	0.0	
Toluene	0.0	0.0	*	0.0	0.014	0.0	
Trichloroethylene	0.0	0.0	0.0	*	0.0	0.0	

Table V-20 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 19019
(All Concentrations in mg/l)

SAMPLE POINT	120	400	199	204	300	451	258	259
	Source Pond Water	Treated Oily Waste	Volatile Organics Trip Blank	Leveler Cooling Water	Vacuum Filter Effluent	Treated Pickling Waste	Pickling Bath	Pickling Bath
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	6.3	5.4		6.3	6.6	6.5		
Maximum pH	7.6	5.5		9.4	6.9	6.5		
Temperature °C	1.0	12.0		1.0	13.0	22.0		
Cyanide, Total	*	*						
Cyanide Amn. to Chlor	*	*						
Oil & Grease	0.0	27.4		0.0	6.5	16.1		
Fluorides	0.18	0.22		0.16	0.29	0.28		
Phosphorus	0.02	0.22		0.0	0.14	0.0		
Tot Organic Carbon	7.0	16.0						
Totl Suspended Solids	2.0	56.0		5.0	521.0	5.0		
Antimony	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0		0.0	0.0	0.0	0.116	0.076
Cadmium	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Chromium, Total	0.0	0.01		0.0	0.03	0.0	1.33	0.23
Chromium, Hexavalent	0.0	0.0		0.0	0.0	0.0		
Copper	0.025	2.12		0.31	48.0	0.18	23000.0	20000.0
Iron	0.11	1.34		0.14	3.52	0.098	144.0	95.0
Lead	0.0	0.07		0.16	0.21	0.0	0.5	0.42
Manganese	0.0	0.077		0.037	0.5	0.023	64.0	47.1
Nickel	0.0	0.086		0.026	21.0	1.38	1100.0	1400.0
Zinc	0.022	0.96		4.61	6.67	0.87	75.0	150.0
Silver	0.0	0.0		0.004	0.025	0.0	0.062	0.094
Phenols, Total	*	0.014						
Benzene	*	0.0	*	0.0				
Chlorobenzene	0.0	*	0.0	0.0				
111-Trichloroethane	*	*	*	0.0				
Hexachloroethane	*	*	0.0	0.0				
Chloroform	0.0	0.0	0.0	0.0				
26-Dinitrotoluene	0.0	0.0		0.0				
Ethylbenzene	0.0	0.0	0.0	0.0				
Methylene Chloride	0.0	0.0	0.0	0.0				
Naphthalene	0.0	*		0.0				
N-Nitrosodiphenlamin	0.0	0.015		0.0				
B2-Ethyhexlphthalate	*	*		0.0				
Butylbenzylphthalate	0.0	*		0.0				
Di-N-butyl Phthalate	0.0			0.0				
Di-N-octyl Phthalate	0.0	0.0		0.0				
Diethyl Phthalate	0.0			0.0				
Dimethyl Phthalate	0.0	0.0		0.0				
Anthracene	0.0	*		0.0				
Phenanthrene	0.0	*		0.0				
Tetrachloroethylene	0.0	0.0	0.0	0.0				
Toluene	0.0	0.0	*	0.0				
Trichloroethylene	0.0	0.0	0.0	0.0				

Table V-20 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 19019
(All Concentrations in mg/l)

SAMPLE POINT	200 Combined Hot Rolling Waste	201 Noncontact Cooling Water	203 Noncontact Cooling Water	205 Noncontact Cooling Water	206 Cold Rolling Spent Lubricant	207 Cold Rolling Spent Lubricant	209 Combined Oily Waste	208 Combined Pickling Waste
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	5.5	5.2	6.2	6.4	5.0	5.6		2.5
Maximum pH	7.1	6.6	6.8	6.5	6.9	5.9		3.4
Temperature °C	15.0	8.0	7.0	10.0	20.0	14.0	15.0	28.0
Cyanide, Total			*	*	*	*	*	
Cyanide Amn. to Chlor			*	*	*	*	*	
Oil & Grease	8.7	<5.0	0.0	0.0	97.0	6.3	37.9	5.0
Fluorides	0.15	0.13	0.15	0.19		0.31	0.22	0.32
Phosphorus	0.45	0.13	0.0			0.09		0.0
Tot Organic Carbon	11.0	7.0	7.0	16.5	558.0	19.0	18.0	
Totl Suspended Solids	22.0	2.0	2.0	394.0	445.0	81.0	75.0	
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.0	0.011	0.0	0.0	0.0	0.0	0.0	0.0
Chromium, Total	0.013	0.0	0.0	0.0	0.0	0.0	0.011	0.072
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Copper	4.67	0.088	0.018	0.018	0.86	0.36	3.11	60.0
Iron	2.2	0.51	0.57	0.78	0.014	0.13	0.98	1.76
Lead	0.0	0.0	0.0	0.0	1.23	0.0	0.07	0.31
Manganese	0.1	0.014	0.007	0.009	0.0	0.0	0.056	0.52
Nickel	0.17	0.0	0.0	0.0	0.052	0.01	0.1	9.66
Selenium								0.0
Thallium								0.0
Zinc	0.72	0.2	0.018	0.044	1.39	0.13	0.7	12.6
Silver	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.007
Phenols, Total	*	*	0.013	0.014	*	0.013	0.011	
Benzene	0.0	0.013	0.0	0.0	*		*	
Chlorobenzene	0.0	0.0	0.0	0.0	0.0		0.0	
111-Trichloroethane	*	0.013	*	*	0.0		*	
Hexachloroethane	*	0.0	0.0	0.0	*		*	
Chloroform	0.0	0.0	0.0	*	*		*	
26-Dinitrotoluene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Ethylbenzene	0.0	0.0	0.0	0.0	0.0		0.0	
Methylene Chloride	0.0	0.0	0.0	0.0	0.0		0.0	
Naphthalene	*	*	0.0	*	0.91	*	*	
N-Nitrosodiphenlamin	0.0	0.0	0.0	0.089	1.3	0.017	0.062	
B2-Ethyhexlphthalate	*	*	*	*	0.0	0.0	0.0	
Butylbenzylphthalate	0.0	0.0	0.0	*	0.056	0.0	*	
Di-N-butyl Phthalate	*	0.0	0.0	0.0	0.0	0.0	0.0	
Di-N-octyl Phthalate	0.0	0.0	0.0	*	0.012	0.0	0.0	
Diethyl Phthalate	0.0	*	0.0	0.0	0.0	0.0	0.0	
Dimethyl Phthalate	0.0	0.0	0.0	0.0	*	0.0	0.0	
Anthracene	*	*	*	0.091	0.23	0.022	0.041	
Phenanthrene	*	*	*	0.091	0.23	0.022	0.041	
Tetrachloroethylene	*	*	*	0.0	0.0	0.0	*	
Toluene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Trichloroethylene	*	0.0	*	*	0.0	0.0	*	

Table V-21

SUMMARY OF SAMPLING DATA FROM PLANT 12036
(All Concentrations in mg/l)

SAMPLE POINT	130 Source Municipal Water	201 Hot Rolling Spent Lubricant	302 Non-Contact Cooling Water	203 Alkaline Cleaning Rinse	204 Pickling Rinse	400 Treated Oily Waste	199 Volatile Organics Trip Blank	308 Treated Oily Waste
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	8.6	7.0	8.1	9.7	2.0	7.1		
Maximum pH	9.8	8.1	9.4	10.0	6.7	9.1		
Temperature °C	6.6	25.5	20.0	35.5	22.7	21.5		
Cyanide, Total	0.0							
Oil & Grease	0.3	159.0	0.4	1.8	3.4	176.0		
Fluorides	1.5	2.5	1.4	1.2	1.2	2.1		1.95
Phosphorus	0.03	0.6	0.02	0.06	0.34	0.14		0.49
Tot Organic Carbon	14.5	260.0	12.5	36.3	10.0	248.3		
Totl Suspended Solids	<5.0	110.0	<5.0	16.0	<5.0	86.0		
Antimony	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Cadmium	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Chromium, Total	0.0	0.009	0.0	0.008	0.013	0.023		0.036
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Copper	0.018	48.6	0.06	3.28	156.0	34.3		42.9
Iron	0.098	0.48	0.063	0.095	0.6	0.46		0.4
Lead	0.0	0.0	0.0	0.0	0.0	0.04		0.0
Manganese	0.0	0.036	0.0	0.0	0.0	0.033		0.03
Nickel	0.0	0.01	0.0	0.0	0.026	0.026		0.018
Selenium				0.0	0.0			
Thallium				0.0	0.0			
Zinc	0.0	0.13	0.0	0.0	0.011	0.066		0.092
Silver	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Phenols, Total	0.0	0.03	0.0			0.08		
Benzene	*	*	0.012			*	0.012	
Chlorobenzene	0.0	0.0	0.0			0.0	0.0	
111-Trichloroethane	*	0.012	0.012			0.012	*	
Hexachloroethane	0.0	0.0	0.0			0.0	0.0	
Chloroform	0.0	0.0	0.0			0.0	0.0	
Ethylbenzene	0.0	0.0	0.0			0.0	0.0	
Methylene Chloride	0.0	*	0.0			0.0	0.0	
Tetrachloroethylene	*	0.0	*			*	0.0	
Toluene	0.014	0.0	*			0.0	*	
Trichloroethane	*	*	0.0			*	0.0	

Table V-21 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 12036
(All Concentrations in mg/l)

SAMPLE POINT	205 Alkaline Cleaning Bath	305 Alkaline Cleaning Bath (Settled)	206 Pickling Bath	306 Pickling Bath After Recovery
	Day 1	Day 1	Day 1	Day 1
Minimum pH	11.2	11.2	2.0	2.0
Maximum pH	13.0	12.4	2.0	2.0
Temperature °C	41.6	40.5	33.3	31.1
Oil & Grease	13.8	14.4	1.6	1.2
Fluorides	0.94	1.0	0.43	0.4
Phosphorus	0.75	0.68	0.96	0.14
Tot Organic Carbon	165.0	155.0	57.5	60.5
Totl Suspended Solids	1024.0	134.0	292.0	138.0
Antimony	0.0	0.81	2.26	1.96
Arsenic	0.0	0.0	0.0	0.0
Chromium, Total	0.035	0.026	0.93	0.93
Chromium, Hexavalent	0.0	0.0	0.0	0.0
Copper	445.0	6.95	7350.0	8500.0
Iron	0.39	0.0	32.5	29.8
Lead	0.0	0.13	0.38	0.38
Manganese	0.0	0.0	0.15	0.22
Nickel	0.0	0.0	0.85	0.14
Selenium	0.0			
Thallium	0.0			
Zinc	0.066	0.066	1.17	0.16
Silver	0.0	0.0	0.057	0.0

Table V-21 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 12036
(All Concentrations in mg/l)

SAMPLE POINT	201 Hot Rolling Spent Lubricant	203 Alkaline Cleaning Rinse	204 Pickling Rinse	400 Treated Oily Waste
	Day 2	Day 2	Day 2	Day 2
Minimum pH	6.9	9.7	2.3	7.1
Maximum pH	8.8	10.8	2.8	8.3
Temperature °C	28.3	27.3	20.5	25.0
Oil & Grease	138.0	4.7	2.3	138.0
Fluorides	2.5	1.2	1.2	2.0
Phosphorus	0.56	0.02	0.32	0.45
Tot Organic Carbon	246.3	37.0	9.5	243.8
Totl Suspendd Solids	180.0	14.0	<5.0	96.0
Antimony	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0
Cadmium	0.0	0.0	0.0	0.0
Chromium, Total	0.018	0.008	0.013	0.036
Chromium, Hexavalent	0.0	0.0	0.0	0.0
Copper	90.0	4.98	146.0	35.5
Iron	0.52	0.11	0.67	0.47
Lead	0.0	0.0	0.0	0.04
Manganese	0.038	0.0	0.0	0.035
Nickel	0.023	0.0	0.026	0.026
Selenium		0.0	0.0	
Thallium		0.0	0.0	
Zinc	0.12	0.018	0.0	0.12
Silver	0.0	0.0	0.0	0.0
Phenols, Total	0.120			0.1
Benzene	0.0			0.015
Chlorobenzene	*			0.0
111-Trichloroethane	*			0.0
Hexachloroethane	0.0			0.0
Chloroform	0.0			0.0
Ethylbenzene	0.0			0.0
Methylene Chloride	0.0			0.0
Tetrachloroethylene	*			*
Toluene	0.0			*
Trichloroethylene	0.0			0.0

Table V-21 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 12036
(All Concentrations in mg/l)

SAMPLE POINT	201 Hot Rolling Spent Lubricant	203 Alkaline Cleaning Rinse	204 Pickling Rinse	207 Spent Drawing Lubricant	307 Spent Drawing Lubricant (Treated)	400 Treated Oily Waste	199 Volatile Organics Trip Blank
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	6.4	8.8	2.1	6.5	7.7	6.8	
Maximum pH	8.4	9.5	2.8	8.4	8.4	7.6	
Temperature °C	30.0	29.4	25.0	48.3	42.7	26.1	
Oil & Grease	175.0	3.1	2.8	2600.0	2780.0	290.0	
Fluorides	2.4	1.25	1.2			2.0	
Phosphorus	0.62	0.07	0.135			0.54	
Tot Organic Carbon	247.5	38.8	12.0	33000.0	40500.0	257.5	
Totl Suspendd Solids	232.0	46.0	<5.0	4500.0	6200.0	112.0	
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	
Cadmium	0.0	0.0	0.0	0.0	0.0	0.0	
Chromium, Total	0.009	0.008	0.018	0.27	0.28	0.015	
Chromium, Hexavalent	0.0	0.0	0.0			0.0	
Copper	82.0	27.3	105.0	760.0	790.0	30.5	
Iron	0.54	0.085	0.49	12.9	14.3	0.52	
Lead	0.0	0.0	0.0	0.0	0.0	0.0	
Manganese	0.037	0.0	0.0	0.12	0.18	0.031	
Nickel	0.013	0.0	0.0	0.1	0.51	0.039	
Selenium		0.0	0.07				
Thallium		0.0	0.0				
Zinc	0.13	0.009	0.0	1.74	5.04	0.1	
Silver	0.0	0.0	0.0	0.0	0.061	0.0	
Phenols, Total	0.08			0.06	0.03	0.06	
Benzene	*			*	0.0	0.0	0.012
Chlorobenzene	*			0.0	0.0	*	0.0
111-Trichloroethane	0.0			*	*	*	*
Hexachloroethane	0.0			0.0	0.0	0.0	0.0
Chloroform	0.0			0.0	0.0	0.0	0.0
Ethylbenzene	0.0			0.0	0.0	0.0	0.0
Methylene Chloride	0.0			0.0	0.0	0.0	0.0
Tetrachloroethylene	*			*	0.0	*	0.0
Toluene	*			*	0.0	0.0	0.0
Trichloroethylene	*			0.0	0.0	*	0.0

Table V-22

SUMMARY OF SAMPLING DATA FROM PLANT 4086
(All Concentrations in mg/l)

SAMPLE POINT	130 Source Municipal Water	321 Spent Drawing Lubricant	322 Recir-culating Drawing Lubricant	200 Thermal Emulsion Breaking Influent	400 Thermal Emulsion Breaking Effluent	199 Volatile Organics Trip Blank	253 Annealing Oil
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	5.0	7.0	7.0	4.0	3.2		7.0
Maximum pH	5.0	7.0	7.0	4.0	3.9		7.0
Temperature °C	9.0	37.5	37.2	10.3	22.0		40.0
Cyanide, Total	0.0			0.02	0.0		0.02
Cyanide Amn. to Chlor	0.0			*	0.0		*
Oil & Grease	<1.0	81.5	82.4	2016.1	28.7		6.3
Fluorides		26.0	21.0		0.0		0.7
Phosphorus	0.0				0.3		
Tot Organic Carbon	10.0	25500.0	25300.0	4180.0	530.0		1080.0
Totl Suspendd Solids	2.4	16610.0	5460.0	46350.0	8.9		269.0
Antimony	0.0	0.0	0.0	0.0	0.0		0.0
Arsenic	0.0	0.0	0.0	0.0	0.0		0.0
Cadmium		0.0	0.0	0.041	0.0		0.0
Chromium, Total		0.0	0.0	1.08	0.0		0.0
Chromium, Hexavalent					0.0		0.0
Copper		290.0	115.0	3700.0	0.4		13.7
Iron	0.23	5.54	9.86	218.0	0.065		2.0
Lead	0.0	0.0	0.0	16.7	0.0		0.0
Manganese	0.0	0.4	0.27	1.79	0.0		0.028
Nickel	0.0	0.0	0.0	0.5	0.0		0.0
Zinc	0.54	3.22	1.73	1400.0	0.3		0.26
Silver	0.0	0.0	0.0	0.017	0.0		0.0
Phenols, Total	*.009	0.16	0.14	0.43	0.37		0.09
Benzene		*	0.0			0.0	0.0
Chlorobenzene		0.0	0.0			0.0	0.0
111-Trichloroethane		0.0	0.0			0.0	0.0
Chloroform	*	0.0	*	*	*	0.0	0.0
Methylene Chloride	*	0.0	0.0	0.0	*	0.0	0.0
Naphthalene	0.0	0.0	0.0	4.6	*		0.0
B2-Ethyhexlphthalate	*	0.43	0.71	3.2	0.043		0.02
Diethyl Phthalate	*	0.52	0.4	0.052	0.015		*
Anthracene	0.0	0.45	0.75	0.13	*		0.0
Phenanthrene	0.0	0.45	0.75	0.13	*		0.0
Tetrachloroethylene		0.0	0.0			0.0	
Toluene		0.0	0.0			0.0	
Trichloroethylene		0.0	0.0			0.0	

Table V-22 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 4086
(All Concentrations in mg/l)

SAMPLE POINT	160 Inlet Deionized Water	321 Spent Drawing Lubricant	322 Recir-culating Drawing Lubricant	200 Thermal Emulsion Breaking Influent	400 Thermal Emulsion Breaking Effluent
	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH	5.0	7.0	7.0	5.0	3.6
Maximum pH	6.0	7.0	7.0	5.0	4.5
Temperature °C	18.0	39.5	37.4	14.2	23.7
Cyanide, Total	0.0			0.03	0.04
Cyanide Amn. to Chlor	0.0			*	0.04
Oil & Grease	<1.0	378.5	1078.4	4025.2	<1.1
Fluorides	0.0	22.0	23.0		0.0
Phosphorus	0.53				0.47
Tot Organic Carbon	5.0	24300.0	23030.0	7100.0	580.0
Totl Suspendd Solids	<0.1	15054.0	20340.0	16500.0	6.8
Antimony	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0
Cadmium	0.0	0.0	0.0	0.0	0.0
Chromium, Total	0.0	0.0	0.025	0.17	0.002
Chromium, Hexavalent	0.0				0.0
Copper	0.0	190.0	280.0	990.0	0.55
Iron	0.018	12.4	8.52	85.0	0.12
Lead	0.0	0.16	0.14	3.31	0.0
Manganese	0.0	0.4	0.4	0.69	0.0
Nickel	0.0	0.0	0.0	0.051	0.0
Zinc	0.012	3943.0	3.45	88.0	0.34
Silver	0.0	0.0	0.0	0.0	0.0
Phenols, Total	*	0.16	0.19	0.45	0.5
Benzene		0.0	0.0	0.0	0.0
Chlorobenzene		0.0	0.0	0.0	0.0
111-Trichloroethane		0.0	0.0	0.0	*
Chloroform	0.0	0.0	*	0.0	*
Methylene Chloride	0.0	0.0	0.0	0.0	*
Naphthalene	*	0.0	0.0	0.37	0.0
B2-Ethyhexlphthalate	0.032	2.4	0.85	0.83	*
Diethyl Phthalate	*	0.43	0.19	0.0	0.0
Anthracene	*	0.68	0.28	0.032	0.0
Phenanthrene	*	0.68	0.28	0.32	0.0
Tetrachloroethylene		0.0	0.0	0.0	0.0
Toluene		0.0	0.0	*	*
Trichloroethylene		0.0	0.0	0.0	*

Table V-22 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 4086
(All Concentrations in mg/l)

SAMPLE POINT	200 Thermal Emulsion Breaking Influent	400 Thermal Emulsion Breaking Effluent
	Day 3	Day 3
Minimum pH	5.0	5.0
Maximum pH	5.0	5.0
Temperature °C	0.09	0.02
Cyanide, Total	0.07	0.02
Cyanide Amn. to Chlor	1720.4	1.3
Oil & Grease	4200.0	0.0
Fluorides	12520.0	0.47
Phosphorus	0.0	79.0
Tot Organic Carbon	0.0	0.0
Totl Suspendd Solids	0.048	0.0
Antimony	0.19	0.0
Arsenic	770.0	0.0
Cadmium	74.0	0.002
Chromium, Total	2.28	0.0
Chromium, Hexavalent	0.62	0.35
Copper	0.0	0.17
Iron	57.0	0.0
Lead	0.0	0.005
Manganese	0.42	0.0
Nickel		0.81
Zinc		0.0
Silver		0.39
Phenols, Total		
Benzene		
Chlorobenzene		
111-Trichloroethane		
Chloroform	*	*
Methylene Chloride	0.0	*
Naphthalene	0.52	*
B2-Ethyhexlphthalate	0.63	0.011
Diethyl Phthalate	0.0	*
Anthracene	0.27	*
Phenanthrene	0.27	*

Table V-23

SUMMARY OF SAMPLING DATA FROM PLANT 36070
(All Concentrations in mg/l)

SAMPLE POINT	254 Spent Drawing Lubricant	130 Source Municipal Water	199 Volatile Organics Trip Blank
	Day 1	Day 1	Day 1
Minimum pH	6.6	7.6	
Maximum pH	7.0	7.7	
Temperature °C	22.0	24.1	
Cyanide, Total	*	*	
Cyanide Amn. to Chlor	*	*	
Oil & Grease	40.0	0.0	
Fluorides		1.2	
Phosphorus		0.0	
Totl Suspendd Solids	49780.0	2.0	
Antimony	0.1259	0.0007	
Arsenic	0.195	0.0004	
Beryllium	0.0001	<0.001	
Cadmium	0.0311	0.0017	
Chromium, Total	1.78		
Chromium, Hexavalent		0.01	
Copper	2850.0	0.025	
Iron	62.5	17.2	
Lead	8.25	0.0015	
Manganese	8.12	4.58	
Mercury	<0.001	<0.001	
Nickel	0.7	<0.001	
Selenium	<0.001	<0.001	
Thallium	<0.001	<0.001	
Zinc	13.75	0.0305	
Gold	0.0	0.0	
Silver	0.39	0.0004	
Phenols, Total	0.73	*	
Cobalt	0.056	0.009	
Acenaphthene	0.0	0.0	
Acrolein	0.0	0.0	0.0
Acrylonitrile	0.0	0.0	0.0
Benzene	*	0.0	0.0
Benzidine	0.0	0.0	
Carbon Tetrachloride	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0
124-Trichlorobenzene	0.0	0.0	
Hexachlorobenzene	0.0	0.0	
12-Dichloroethane	0.0	0.0	0.0
111-Trichloroethane	0.087	0.0	0.0
Hexachloroethane	0.0	0.0	
11-Dichloroethane	0.0	0.0	0.0
112-Trichloroethane	0.0	0.0	0.0
1122-Tetrachloroethane	0.0	0.0	0.0
Chloroethane	0.0	0.0	0.0
Bischloromethylether	0.0	0.0	0.0
Bis2chloroethylether	0.0	0.0	
2Chloroethlvinylethr	0.0	0.0	0.0

Table V-23 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 36070
(All Concentrations in mg/l)

SAMPLE POINT	254 Spent Drawing Lubricant	130 Source Municipal Water	199 Volatile Organics Trip Blank
	Day 1	Day 1	Day 1
2-Chloronaphthalene	0.0	0.0	
246-Trichlorophenol	0.0	0.0	
Parachlorometacresol	0.0	0.0	
Chloroform	0.0	0.0	0.0
2-Chlorophenol	0.0	0.0	
12-Dichlorobenzene	0.0	0.0	
13-Dichlorobenzene	0.0	0.0	
14-Dichlorobenzene	0.0	0.0	
33-Dichlorobenzidine	0.0	0.0	
11-Dichloroethylene	0.0	0.0	0.0
12T-Dichloroethylene	0.0	0.0	0.0
24-Dichlorophenol	0.0	0.0	
12-Dichloropropane	0.0	0.0	
12-Dichloropropylene	0.0	0.0	
24-Dimethylphenol	0.0	0.0	
24-Dinitrotoluene	0.0	0.0	
26-Dinitrotoluene	0.0	0.0	
12-Diphenylhydrazine	0.0	0.0	
Ethylbenzene	0.0	0.0	
Fluoranthene	0.0	0.0	
4Clphenylphenylether	0.0	0.0	
4Brphenylphenylether	0.0	0.0	
B2chloroisoproplethr	0.0	0.0	
B2chloroethoxymethan	0.0	0.0	
Methylene Chloride	0.0	*	*
Methyl Chloride	0.0	0.0	0.0
Methyl Bromide	0.0	0.0	0.0
Bromoform	0.0	0.0	0.0
Dichlorobromomethane	0.0	0.0	0.0
Tricloroflorome thane	0.0	0.0	0.0
Diclorodifloromethan	0.0	0.0	0.0
Chlorodibromomethane	0.0	0.0	0.0
Hexachlorobutadiene	0.0	0.0	
C16 Cyclopentadiene	0.0	0.0	
Isophorone	0.0	0.0	
Naphthalene	1.7	0.0	
Nitrobenzene	0.0	0.0	
2-Nitrophenol	0.0	0.0	
4-Nitrophenol	0.0	0.0	
24-Dinitrophenol	0.0	0.0	
46-Dinitro-o-cresol	0.0	0.0	
N-nitrosodimethlamin	0.0	0.0	
N-nitrosidiphenlamin	0.0	0.0	
Nnitrosodinproplamin	0.0	0.0	
Pentachlorophenol	0.0	*	
Phenol	0.0	0.0	
B2-Ethyhexlphthalate	0.0	0.0	
Butylbenzylphthalate	0.0	0.0	

Table V-23 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 36070
(All Concentrations in mg/l)

SAMPLE POINT	254 Spent Drawing Lubricant	130 Source Municipal Water	199 Volatile Organics Trip Blank
	Day 1	Day 1	Day 1
Di-N-Butyl Phthalate	0.0	0.0	
Di-N-Octyl Phthalate	0.0	0.0	
Diethyl Phthalate	0.0	0.0	
Dimethyl Phthalate	0.0	0.0	
12-Benzanthracene	0.0	0.0	
Benzo(a)pyrene	0.0	0.0	
34-Benzofluoranthene	0.0	0.0	
Benzo(k)fluoranthene	0.0	0.0	
Chrysene	0.0	0.0	
Acenaphthylene	0.0	0.0	
Anthracene	0.0	0.0	
112-Benzoperylene	0.0	0.0	
Fluorene	0.0	0.0	
Phenanthrene	0.0	0.0	
1256Dibenzanthracene	0.0	0.0	
Ideno(123-cd)pyrene	0.0	0.0	
Pyrene	0.0	0.0	
Tetrachloroethylene	0.018	0.0	0.0
Toluene	0.057	*	0.0
Trichloroethylene	0.0	0.0	0.0
Vinyl Chloride	0.0	0.0	
Aldrin	0.0	0.0	
Dieldrin	0.0	0.0	
Chlordane	0.0	0.0	
4,4-DDT	0.0	0.0	
4,4-DDE (P,P-DDX)	0.0	0.0	
4,4-DDD (P,P-TDE)	0.0	0.0	
Alpha-Endosulfan	0.0	0.0	
Beta-Endosulfan	0.0	0.0	
Endosulfan Sulfate	0.0	0.0	
Endrin	0.0	0.0	
Endrin Aldehyde	0.0	0.0	
Heptachlor	0.0	0.0	
Heptachlor Epoxide	0.0	0.0	
Alpha-BHC	0.0	0.0	
Beta-BHC	0.0	0.0	
Gamma-BHC (Lindane)	0.0	0.0	
Delta-BHC	0.0	0.0	
PCB-1242	0.0	0.0	
PCB-1254	0.0	0.0	
PCB-1221	0.0	0.0	
PCB-1232	0.0	0.0	
PCB-1248	0.0	0.0	
PCB-1260	0.0	0.0	
PCB-1016	0.0	0.0	
Toxaphene	0.0	0.0	
TCDD	0.0	0.0	

Table V-23 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 36070
(All Concentrations in mg/l)

SAMPLE POINT	201 Annealing Water	202 Combined Raw Waste	203 Non-Contact Cooling Water	300 Combined Treated Waste	200 Combined Influent to Treatment	199 Volatile Organics Trip Blank
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	6.8	2.5	7.6	8.0	5.4	
Maximum pH	6.8	8.3	8.1	8.3	7.6	
Temperature °C	26.0	26.6	23.7	22.7	22.0	
Cyanide, Total	*	*	*	*	*	
Cyanide Amn. to Chlor	*	*	*	*	*	
Oil & Grease	5.0	1.0	0.0	3.0	1.0	
Fluorides	1.45	1.35	1.2	1.3	0.8	
Phosphorus	0.09	0.2	0.47	0.05	0.3	
Totl Suspendd Solids	25.0	35.0	55.0	22.0	55.0	
Aluminum						
Antimony	0.0	0.0	0.0	0.0	0.0	
Arsenic	0.0	0.0	0.0	0.0	0.0	
Boron						
Cadmium	0.0	0.0		0.0	0.0	
Chromium, Total	0.0	0.0	0.8	0.0	0.0	
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	
Copper	1.8	40.3	56.0	1.32	1.13	
Iron	0.39	0.092	11.0	0.27	0.2	
Lead	0.0	0.0	0.0	0.0	0.0	
Manganese	0.017	0.054	0.15	0.01	0.03	
Nickel	0.0	0.0	0.11	0.0	0.0	
Selenium		0.0	0.0			
Thallium		0.0	0.0			
Zinc	0.043	0.086	0.086	0.14	0.059	
Silver	0.0	0.31		0.004	0.0	
Phenols, Total	*	0.013	0.0	*	0.018	
Benzene	0.0	0.0		*	*	*
Chlorobenzene	0.0	0.0		0.0	*	*
111-Trichloroethane	0.0	0.0		0.0	*	0.0
Chloroform	0.0	0.0		*	*	*
Methylene Chloride	0.0	0.0		*	*	*
Naphthalene	0.0	0.0		*	*	
B2-Ethyhexlphthalate	0.0	0.0		0.36	0.049	
Di-N-Butyl Phthalate	0.0	0.0		*	0.0	
Diethyl Phthalate	0.0	0.0		0.0	0.0	
Anthracene	0.0	0.0		0.011	0.013	
Phenanthrene	0.0	0.0		0.011	0.013	
Tetrachloroethylene	0.0	0.0		*	*	0.0
Toluene	0.0	0.0		*	0.014	*
Trichloroethylene	0.0	0.0		0.0	0.0	0.0

Table V-23 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 36070
(All Concentrations in mg/l)

SAMPLE POINT	203 Non-Contact Cooling Water	199 Volatile Organics Trip Blank
	Day 2	Day 2
Minimum pH	6.2	
Maximum pH	7.3	
Temperature °C	21.0	
Cyanide, Total	*	
Cyanide Amn. to Chlor	*	
Oil & Grease	15.0	
Fluorides	1.25	
Phosphorus	0.85	
Totl Suspendd Solids	215.0	
Antimony	0.0007	
Arsenic	0.0003	
Beryllium	0.0	
Cadmium	0.0081	
Chromium, Total	0.0875	
Copper	42.75	
Iron	0.08	
Lead	0.002	
Manganese	0.75	
Mercury	0.0	
Nickel	0.1875	
Selenium	0.0	
Thallium	0.0	
Zinc	0.0938	
Gold	0.0	
Silver	0.0003	
Phenols, Total	0.022	
Cobalt	0.007	
Acenaphthene	0.0	
Acrolein	0.0	0.0
Acrylonitrile	0.0	0.0
Benzene	0.0	*
Benzidine	0.0	
Carbon Tetrachloride	0.0	0.0
Chlorobenzene	0.0	0.0
124-Trichlorobenzene	0.0	
Hexachlorobenzene	0.0	
12-Dichloroethane	0.0	0.0
111-Trichloroethane	0.0	0.0
Hexachloroethane	0.0	
11-Dichloroethane	0.0	0.0
112-Trichloroethane	0.0	0.0
1122-Tetrachloroethane	0.0	0.0
Chloroethane	0.0	0.0
Bischloromethylether	0.0	
Bis2chloroethylether	0.0	
2Chloroethlvinylethr	0.0	0.0

Table V-23 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 36070
(All Concentrations in mg/l)

SAMPLE POINT	203 Non-Contact Cooling Water	199 Volatile Organics Trip Blank
	Day 2	Day 2
2-Chloronaphthalene	0.0	
246-Trichlorophenol	0.0	
Parachlorometacresol	0.0	
Chloroform	0.0	*
2-Chlorophenol	0.0	
12-Dichlorobenzene	0.0	
13-Dichlorobenzene	0.0	
14-Dichlorobenzene	0.0	
33-Dichlorobenzidine	0.0	
11-Dichloroethylene	0.0	0.0
12T-Dichloroethylene	0.0	0.0
24-Dichlorophenol	0.0	
12-Dichloropropane	0.0	0.0
12-Dichloropropylene	0.0	0.0
24-Dimethylphenol	0.0	
24-Dinitrotoluene	0.0	
26-Dinitrotoluene	0.0	
12-Diphenylhydrazine	0.0	
Ethylbenzene	*	0.0
Fluoranthene	*	
4Clphenylphenylether	0.0	
4Brphenylphenylether	0.0	
B2chloroisoproplethr	0.0	
B2chloroethoxymethan	0.0	
Methylene Chloride	*	*
Methyl Chloride	0.0	0.0
Methyl Bromide	0.0	0.0
Bromoform	0.0	0.0
Dichlorobromomethane	0.0	0.0
Tricloroflorомethane	0.0	0.0
Diclorodifloromethan	0.0	0.0
Chlorodibromomethane	0.0	0.0
Hexachlorobutadiene	0.0	
C16 Cyclopentadiene	0.0	
Isophorone	*	
Naphthalene	*	
Nitrobenzene	0.0	
2-Nitrophenol	0.0	
4-Nitrophenol	0.0	
24-Dinitrophenol	0.0	
46-Dinitro-o-cresol	0.0	
N-nitrosodimethlamin	0.0	
N-nitrosidiphenlamin	*	
Nnitrosodinproplamin	0.0	
Pentachlorophenol	0.0	
Phenol	0.0	
B2-Ethyhexlphthalate	*	
Butylbenzylphthalate	0.0	

Table V-23 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 36070
(All Concentrations in mg/l)

SAMPLE POINT	203 Non-Contact Cooling Water	199 Volatile Organics Trip Blank
	Day 2	Day 2
Di-N-Butyl Phthalate	*	
Di-N-Octyl Phthalate	0.0	
Diethyl Phthalate	*	
Dimethyl Phthalate	0.0	
12-Benzanthracene	0.0	
Benzo(a)pyrene	0.0	
34-Benzofluoranthene	0.0	
Benzo(k)fluoranthene	0.0	
Chrysene	0.0	
Acenaphthylene	*	
Anthracene	*	
112-Benzoperylene	0.0	
Fluorene	*	
Phenanthrene	*	
1256Dibenzanthracene	0.0	
Ideno(123-cd)pyrene	0.0	
Pyrene	*	
Tetrachloroethylene	0.0	0.0
Toluene	*	*
Trichloroethylene	0.0	*
Vinyl Chloride	0.0	
Aldrin	0.0	
Dieldrin	0.0	
Chlordane	0.0	
4,4-DDT	0.0	
4,4-DDE (P,P-DDX)	0.0	
4,4-DDD (P,P-TDE)	0.0	
Alpha-Endosulfan	0.0	
Beta-Endosulfan	0.0	
Endosulfan Sulfate	0.0	
Endrin	0.0	
Endrin Aldehyde	0.0	
Heptachlor	0.0	
Heptachlor Epoxide	0.0	
Alpha-BHC	0.0	
Beta-BHC	0.0	
Gamma-BHC (Lindane)	0.0	
Delta-BHC	0.0	
PCB-1242	0.0	
PCB-1254	0.0	
PCB-1221	0.0	
PCB-1232	0.0	
PCB-1248	0.0	
PCB-1260	0.0	
PCB-1016	0.0	
Toxaphene	0.0	
TCDD	0.0	

Table V-23 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 36070
(All Concentrations in mg/l)

SAMPLE POINT	201	202	203	200	300	199
	Annealing Water	Combined Raw Waste	Non-Contact Cooling Water	Combined Influent to Treatment	Combined Treated Waste	Volatile Organics Trip Blank
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH	6.9	2.6	6.2	5.1	7.0	
Maximum pH	6.9	9.3	7.3	8.3	9.3	
Temperature °C	26.0	22.0	21.0	23.0	21.0	
Cyanide, Total	*	*	*	*	*	
Cyanide Amn. to Chlor	*	*	*	*	*	
Oil & Grease	9.0	5.0	15.0	6.0	15.0	
Fluorides	1.25	1.2	1.25	1.15	1.2	
Phosphorus	0.05	0.04	0.85	0.04	0.59	
Totl Suspendd Solids	15.0	208.0	215.0	5.0	31.0	
Antimony	0.0	0.0	0.0007	0.0	0.0	
Arsenic	0.0	0.0	0.0003	0.0	0.0	
Cadmium	0.0	0.0		0.0	0.0	
Chromium, Total	0.0	0.0	0.0875	0.0	0.0	
Chromium, Hexavalent	0.0	0.0	1.25	0.0	0.0	
Copper	1.3	20.0	42.75	1.69	3.48	
Iron	0.26	0.042	0.086	0.07	0.54	
Lead	0.0	0.0	0.002	0.0	0.0	
Manganese	0.008	0.023	0.075	0.018	0.019	
Nickel	0.0	0.0	0.1875	0.0	0.0	
Selenium		0.0	0.0			
Thallium		0.0	0.0			
Zinc	0.016	0.059	0.0938	0.53	0.081	
Silver	0.0	0.014	0.0003	0.0	0.011	
Phenols, Total	0.28	0.2	0.022	0.2	0.02	
Benzene	0.0	0.0		1.0	*	*
Chlorobenzene	0.0	0.0		0.0	0.0	0.0
111-Trichloroethane	0.0	0.0		*	0.0	0.0
Chloroform	0.0			0.011	*	*
Methylene Chloride	0.0			*	*	*
Naphthalene	0.0	0.0		0.0	*	
B2-Ethyhexlphthalate	0.0	0.0		*	*	
Di-N-Butyl Phthalate	0.0	0.0		*	*	
Diethyl Phthalate	0.0	0.0		0.0	*	
Anthracene	0.0	0.0		*	*	
Phenanthrene	0.0	0.0		*	*	
Tetrachloroethylene	0.0	0.0		*	0.0	0.0
Toluene	0.0	0.0		*	0.0	*
Trichloroethylene	0.0	0.0		0.0	0.0	0.0

Table V-23 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 36070
(All Concentrations in mg/l)

SAMPLE POINT	201 Annealing Water	202 Combined Raw Waste	203 Non-Contact Cooling Water	200 Combined Influent to Treatment	300 Combined Treated Waste	550 Sludge Sample	199 Volatile Organics Trip Blank
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	8.4	2.8	7.5	6.8	8.5		
Maximum pH	8.8	8.6	8.2	8.0	9.4		
Temperature °C	23.0	26.0	22.0	23.0	23.0		
Cyanide, Total	*	*	*	*	*		
Cyanide Amn. to Chlor	*	*	*	*	*		
Oil & Grease	9.0	8.0	7.0	6.0	7.0		
Fluorides	1.25	1.3	1.25	1.2	1.2		
Phosphorus	0.0	0.0	1.04	0.0	0.75		
Totl Suspendd Solids	17.0	6.0	112.0	38.0	33.0		
Antimony	0.0	0.0	0.0	0.0	0.0		
Arsenic	0.0	0.0	0.0	0.0	0.0		
Cadmium	0.0	0.0	0.0	0.0	0.0		
Chromium, Total	0.0	0.0	0.14	0.0	0.0		
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0		
Copper	1.2	1.09	51.0	3.36	1.3		
Iron	0.25	0.051	22.0	0.015	0.22		
Lead	0.0	0.0	0.0	0.0	0.0		
Manganese	0.0	0.008	0.3	0.02	0.0		
Nickel	0.0	0.0	0.17	0.0	0.0		
Selenium		0.0					
Thallium		0.0					
Zinc	0.015	0.015	0.26	0.062	0.006		
Silver	0.41	0.0	0.0	0.0	0.0		
Phenols, Total	0.028	*	*	0.018	0.022		
Benzene	0.0	0.0	*	*	*	*	
Chlorobenzene	0.0	0.0	*	0.0	0.0	*	
111-Trichloroethane	0.0	0.0	0.0	0.002	0.0	*	
Chloroform	0.0	0.0	0.0	0.0	0.012	*	
Methylene Chloride	0.0	0.0	0.001	*	*	*	
Naphthalene	0.0	0.0		*	*		
B2-Ethyhexlphthalate	0.0	0.0		*	0.23		
Di-N-Butyl Phthalate	0.0	0.0		*	0.0		
Diethyl Phthalate	0.0	0.0		0.0	0.0		
Anthracene	0.0	0.0		*	*		
Phenanthrene	0.0	0.0		*	*		
Tetrachloroethylene	0.0	0.0	*	0.0	0.0		
Toluene	0.0	0.0	0.0	0.0	0.012	*	
Trichloroethylene	0.0	0.0	*	0.0	*		

Table V-24

SUMMARY OF SAMPLING DATA FROM PLANT 6070
(All Concentrations in mg/l)

SAMPLE POINT	130	201	202	203	205	209	210	410
	Source Municipal Water	Pickling Rinse	Partially Treated Waste	Combined Waste Stream	Annealing Water	Stainless Steel Annealing Water	Combined Oily Waste	Treated Oily Waste
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	6.0	2.0	2.5	1.0	6.0	5.5	5.0	5.0
Maximum pH	6.0	3.7	3.4	2.5	7.0	8.6	6.8	6.8
Temperature °C	15.0	15.0	17.0	29.0	76.0	63.0	17.0	15.0
Cyanide, Total	0.0				0.0	0.0	0.0	0.0
Cyanide Amn. to Chlor	0.0				0.0	0.0	0.0	0.0
Oil & Grease	0.0	0.0	0.0	9.0	0.0	33.0	16000.0	109.0
Fluorides	1.0	1.05	0.8	1.0	1.15	1.15		
Phosphorus	0.28	60.0	42.0	4.2	0.8	0.95		
Tot Organic Carbon	8.0	6.0	5.0	12.0	4.0	28.0	20.0	145.0
Totl Suspendd Solids	0.0	2.0	150.0	13.0	0.0	50.0	64.0	46.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.0	0.0	0.0	0.008	0.013	0.0	0.0	0.0
Chromium, Total	0.0	11.6	8.83	0.029	0.002	0.027	0.005	0.002
Chromium, Hexavalent	0.0	8.7	0.0	0.0	0.0	0.0	0.0	0.0
Copper	0.25	5.34	5.34	1.42	0.067	0.03	0.26	0.64
Iron	0.42	0.27	380.0	30.59	0.22	0.42	0.22	0.2
Lead	0.0	0.0	0.0	0.63	0.0	0.0	0.0	0.0
Manganese	0.03	0.03	2.36	1.0	0.025	0.04	0.2	0.23
Nickel	0.0	0.0	0.031	0.38	0.045	0.22	0.044	0.05
Selenium			0.0	0.0				
Thallium			0.0	0.0				
Zinc	0.23	0.12	0.91	31.3	0.26	0.051	0.27	0.37
Silver	0.0	0.008	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	0.0	*	0.0	0.0	*	0.015		*
Benzene	0.0	0.0	0.0	0.0	0.0	0.0	*	0.0
Chlorobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
111-Trichloroethane	*	*	*	0.0	*	*	*	*
Hexachloroethane	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chloroform	*	*	*	*	*	*	*	*
26-Dinitrotoluene	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Ethylbenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naphthalene	0.0	0.0	0.0	*		*	0.018	*
N-Nitrosodiphenlamin	0.0	0.0	0.0	0.0		*	0.0	0.033
B2-Ethyhexlphthalate	*	*	*	*		*	0.0	0.022
Butylbenzylphthalate	0.0	0.0	0.0	0.0		*	0.0	0.0
Di-N-Octyl Phthalate	0.0	0.0	*	0.0		0.0	0.0	*
Dimethyl Phthalate	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Anthracene	0.0	*	*	*		*	0.055	0.021
Phenanthrene	0.0	*	*	*		*	0.055	0.021
Tetrachloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toluene	0.0	0.0	0.0	*	0.0	0.0	*	0.0
Trichloroethylene	0.0	0.0	0.0	0.0	*	0.0	*	*

Table V-24 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6070
(All Concentrations in mg/l)

SAMPLE POINT	200 Combined Influent to Treatment	400 Combined Treated Effluent	254 Combined Waste Stream
	Day 1	Day 1	Day 1
Minimum pH	1.5	5.5	
Maximum pH	2.3	8.8	
Temperature °C	15.0	15.0	
Cyanide, Total			0.0
Cyanide Amn. to Chlor			0.0
Oil & Grease	2.0	4.0	0.0
Fluorides	1.05	13.5	
Phosphorus	34.0	3.6	
Tot Organic Carbon	17.0	9.0	
Totl Suspendd Solids	12.0	24.0	0.0
Antimony	0.0	0.0	0.0
Arsenic	0.0	0.0	0.92
Cadmium	0.0	0.0	0.032
Chromium, Total	2.9	0.064	0.16
Chromium, Hexavalent	0.0	0.0	0.0
Copper	5.43	0.28	324.0
Iron	90.0	0.61	190.0
Lead	0.35	0.0	1.59
Manganese	0.91	0.45	33.6
Nickel	0.19	0.54	4.24
Zinc	15.3	1.97	765.0
Silver	0.0	0.0	0.0
Phenols, Total	0.015	0.015	0.0
Benzene	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0
111-Trichloroethane	*	*	0.0
Hexachloroethane	0.0	0.0	0.0
Chloroform	*	*	0.0
26-Dinitrotoluene	0.0	0.0	0.0
Ethylbenzene	0.0	0.0	0.0
Methylene Chloride	0.0	0.0	0.0
Naphthalene	*	*	0.0
N-Nitrosodiphenlamin	0.0	0.0	0.0
B2-Ethyhexlphthalate	*	0.0	0.0
Butylbenzylphthalate	0.0	*	0.0
Di-N-Octyl Phthalate	0.0	0.0	0.0
Dimethyl Phthalate	0.0	0.0	0.0
Anthracene	*	*	0.0
Phenanthrene	*	*	0.0
Tetrachloroethylene	0.0	0.0	0.0
Toluene	0.0	0.0	0.0
Trichloroethylene	*	*	0.0

Table V-24 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6070
(All Concentrations in mg/l)

SAMPLE POINT	203 Combined Pickling Waste	200 Combined Influent to Treatment	400 Combined Treated Effluent	205 Annealing Water	209 Stainless Steel Annealing Water	410 Treated Oily Waste	210 Combined Oily Waste
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH	1.5	1.0	5.0	7.0	5.5	5.0	5.0
Maximum pH	2.8	3.2	7.0	8.4	8.0	6.9	6.1
Temperature °C	26.0	17.0	15.0	79.0	53.0	16.0	18.0
Cyanide, Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyanide Amn. to Chlor	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil & Grease	3.0	4.0	1.0	0.0	12.0	30.0	485.0
Fluorides	1.1	0.8	10.0	1.25	1.3		1.5
Phosphorus	1.26	5.0	0.86	0.47	0.82		
Tot Organic Carbon	13.0	12.0	10.0	4.0	24.0	19.0	13.0
Totl Suspendd Solids	9.0	18.0	18.0	0.0	52.0	124.0	58.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.0	0.0	0.0	0.042	0.0	0.0	0.0
Chromium, Total	0.036	0.2	0.023	0.0	0.011	0.004	0.002
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copper	9.79	9.35	0.22	0.05	0.018	0.3	0.22
Iron	6.12	13.0	0.27	0.66	0.27	0.32	0.19
Lead	0.85	0.43	0.0	0.0	0.0	0.16	0.0
Manganese	0.77	0.77	0.32	0.028	0.038	0.21	0.22
Nickel	0.49	0.32	0.3	0.0	0.0	0.038	0.044
Selenium	0.0						
Thallium	0.0						
Titanium					0.0		
Zinc	48.8	74.0	1.36	0.72	0.046	0.3	0.29
Silver	0.0	0.0	0.0	0.0		0.0	0.0
Phenols, Total	0.015	*	*	*	*	*	0.0
Benzene	0.0	*	0.0	0.0	*	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
111-Trichloroethane	*	*	0.0	*	0.0	0.0	*
Hexachloroethane	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chloroform	*	*	*	*	0.0	*	*
26-Dinitrotoluene	0.0	0.0	0.0		0.0	0.0	0.0
Ethylbenzene	0.0	0.0	0,0	0.0	0.0	0.0	0.0
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naphthalene	*	*	*		0.0	*	*
N-Nitrosodiphenlamin	0.0	0.0	0.0		0.0	0.0	0.048
B2-Ethyhexlphthalate	*	*	0.0		*	0.081	0.0
Butylbenzylphthalate	0.0	0.0	0.0		*	0.0	0.0
Di-N-Octyl Phthalate	0.0	0.0	0.0		0.0	0.0	0.0
Dimethyl Phthalate	0.0	0.0	0.0		0.0	0.0	0.0
Anthracene	*	*	*		0.0	0.018	0.054
Phenanthrene	*	*	*		0.0	0.018	0.054
Tetrachloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toluene	0.0	*	0.0	0.0	0.0	0.0	*
Trichloroethylene	0.0	*	0.0	*	0.0	*	*

Table V-24 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6070
(All Concentrations in mg/l)

SAMPLE POINT	203 Combined Pickling Waste	200 Combined Influent to Treatment	400 Combined Treated Effluent	205 Annealing Water	209 Stainless Steel Annealing Water	210 Combined Oily Waste	410 Treated Oily Waste
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	2.0	4.0	6.8	6.0	5.5	5.5	5.0
Maximum pH	2.0	5.0	9.9	6.5	7.0	6.0	6.0
Temperature °C	30.0	15.0	15.0	72.0	65.0	17.0	17.0
Cyanide, Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyanide Amn. to Chlor	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil & Grease	4.0	21.0	2.0	1.0	60.0	174.0	40.0
Fluorides	0.74	1.17	11.0	1.0	1.2		
Phosphorus	1.04	1.29	0.22	0.62			
Tot Organic Carbon	20.0	37.0	12.0	7.0	31.0	17.0	815.0
Totl Suspendd Solids	64.0	44.0	54.0	2.0	106.0	60.0	134.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.07	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.0	0.005	0.0	0.002	0.0	0.009	0.0
Chromium, Total	0.032	0.086	0.057		0.018	0.007	0.009
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copper	4.19	5.16	0.29	0.052	0.027	0.25	0.71
Iron	5.13	3.75	0.51	0.28	0.38	0.32	0.25
Lead	1.96	0.44	0.0	0.0	0.0	0.0	0.0
Manganese	0.07	0.3	0.47	0.027	0.05	0.3	0.27
Nickel	0.28	0.25	0.38	0.0	0.05	0.05	0.038
Selenium	0.0						
Thallium	0.0						
Zinc	65.0	104.0	2.02	0.87	0.045	0.35	0.41
Silver	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	0.02	0.015	0.015	0.02	0.015	0.0	0.0
Thiocyanate			0.0				
Benzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
111-Trichloroethane	0.0	0.0	0.0	*	*	0.0	*
Hexachloroethane	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chloroform	*	*		*	*	*	*
26-Dinitrotoluene	0.0	0.0	0.0		0.0	0.0	0.0
Ethylbenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Methylene Chloride	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Naphthalene	*	*	*		*	0.012	*
N-Nitrosodiphenlamin	0.0	0.0	0.0		0.0	0.064	0.012
B2-Ethyhexlphthalate	*	0.023	0.0		0.0	*	*
Butylbenzylphthalate	0.0	*	0.0		0.0	0.0	0.0
Di-N-Octyl Phthalate	*	0.0	0.0		0.0	0.0	0.0
Dimethyl Phthalate	*	0.0	0.0		0.0	0.0	0.0
Anthracene	*	0.013	*		*	0.038	0.043
Phenanthrene	*	0.013	*		*	0.038	0.043
Tetrachloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toluene	0.001	0.0	0.0	0.0	0.0	0.0	0.0
Trichloroethylene	0.0	*	*	0.0	0.0	0.0	*

Table V-25

SUMMARY OF SAMPLING DATA FROM PLANT 6058
(All Concentrations in mg/l)

SAMPLE POINT	201	203	204	205	207	210	249
	Combined Waste Sample	Pickling Rinse	Solution Heat Treatment	Combined Waste Sample	Combined Pickling Rinse	Pickling Rinse	Reverse Osmosis Concentrate
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH		1.8	4.1	2.8	2.8	2.8	4.2
Maximum pH		3.2	4.1	5.4	4.8	2.8	4.4
Temperature °C		53.0	32.0	29.0	23.0	30.0	30.0
Cyanide, Total	0.08		*	0.1	*		
Cyanide Amn. to Chlor	0.04		*	0.06	*		
Oil & Grease	0.0		0.0	19.6	1.4		
Fluorides	8.8	1.0	1.05	1.85	1.65	1.1	2.5
Phosphorus	0.53	0.3	0.0		2.63	0.26	0.45
Totl Suspendd Solids	2.7		1.2	350.8	13.6		2.8
Totl Dissolvd Solids							1860.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.016	0.039	0.0	0.007	0.02	0.011	0.008
Chromium, Total	4.13	0.35	0.014	4.27	5.33	1.11	87.0
Chromium, Hexavalent	0.0	0.0	0.0	0.31	0.0	0.0	5.25
Copper	33.6	31.3	0.091	14.2	23.5	32.2	416.0
Iron	0.99	4.11	0.2	0.89	2.07	0.96	0.6
Lead	2.27	0.37	0.0	0.5	0.0	0.77	1.59
Manganese	0.077	0.21	0.018	0.12	0.18	0.24	3.03
Nickel	0.56	0.33	0.0	0.25	0.54	1.04	11.6
Selenium			0.0				
Thallium			0.0				
Zinc	57.0	486.0	1.99	24.3	82.0	38.6	41.4
Silver	0.0	0.016	0.0	0.008	0.004	0.0	0.008
Phenols, Total	0.0		0.0	0.08	*		
Benzene			*				
Chlorobenzene			0.0				
111-Trichloroethane			0.0				
Chloroform			0.0				
Methylene Chloride			*				
Naphthalene			0.0				
B2-Ethyhexlphthalate			0.34				
Diethyl Phthalate			0.0				
Anthracene			0.0				
Phenanthrene			0.0				
Tetrachloroethylene			*				
Toluene			*				
Trichloroethylene			*				

Table V-25 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6058
(All Concentrations in mg/l)

SAMPLE POINT	301 Combined Waste Sample	302 Partially Treated Pickling Waste	346 Partially Treated Pickling Waste	401 Alkaline Cleaning Rinse	403 Reverse Osmosis Permeate	404 Combined Treated Effluent	199 Volatile Organics Trip Blank	219 Pickling Bath
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	4.5	4.2	2.4	3.1	3.5	8.0		
Maximum pH	6.8	4.6	3.4	6.4	6.6	9.0		
Temperature °C	33.0	26.0	25.0	48.0	27.0	26.0		
Cyanide, Total	0.06		0.14	<0.005	0.05	*		0.0
Cyanide Amn. to Chlor	0.05		0.14	<0.005	0.0	*		0.0
Oil & Grease	3.2		4.5	12.2	0.0	6.6		0.0
Fluorides	0.96	7.8	2.5	0.98	2.2	8.3		0.21
Phosphorus	0.0	7.8	1.14	0.0	1.51	0.59		
Totl Suspendd Solids	0.8	0.0	5.6	4.6	0.0	62.4		0.0
Totl Dissolvd Solids		741.0						
Antimony	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0		0.0
Cadmium	0.0	0.12	0.01	0.0	0.0	0.0		
Chromium, Total	0.0	4.88	6.4	0.006	0.88	3.0		19400.0
Chromium, Hexavalent	0.0	0.92	0.93	0.0	0.53	0.0		0.0
Copper	0.059	23.5	22.5	0.2	1.3	8.72		28000.0
Iron	0.13	0.077	1.08	0.11	0.044	0.066		49.5
Lead	0.0	0.22	0.37	0.0	0.0	0.0		78.6
Manganese	0.013	0.18	0.17	0.015	0.009	0.25		10.7
Nickel	0.0	0.7	0.56	0.0	0.04	0.29		0.0
Selenium			0.0	0.0				
Thallium			0.0	0.0				
Zinc	1.83	40.5	38.6	0.7	2.6	11.5		8600.0
Silver	0.003	0.009	0.003	0.003	0.0	0.0		1.3
Phenols, Total	0.0		0.0	*	0.0	0.0		0.0
Benzene				*			*	
Chlorobenzene				*			*	
111-Trichloroethane				*			0.0	
Hexachloroethane							0.0	
Chloroform	0.0			*			*	
Methylene Chloride	0.0			*			*	
Naphthalene				0.0				
B2-Ethyhexlphthalate				*				
Diethyl Phthalate				0.0				
Anthracene				0.0				
Phenanthrene				0.0				
Tetrachloroethylene				*			0.0	
Toluene				0.0			0.013	
Trichloroethylene				0.0			0.0	

Table V-25 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6058
(All Concentrations in mg/l)

SAMPLE POINT	130 Source Municipal Water	200 Combined Influent to Treatment	206 Cold Rolling Spent Lubricant	402 Treated Oily Waste	199 Volatile Organics Trip Blank
	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	6.2	2.4	5.0	5.4	5.4
Maximum pH	8.1	5.5	6.8	7.5	
Temperature °C	19.0	38.0	26.0	24.0	
Cyanide, Total	*	0.14	0.14	0.04	
Cyanide Amn. to Chlor	*	0.04	0.0	0.04	
Oil & Grease	0.0	2.3	395538.0	13.3	
Fluorides	0.98	1.05			
Phosphorus	0.03	0.0		0.0	
Totl Suspendd Solids	0.4	6.5	6552.0	10.3	
Antimony	0.0002	0.0003	0.0044	0.0008	
Arsenic	0.0008	0.0006	0.0005	0.0009	
Beryllium	<0.0001	<0.0001	0.0003	<0.0001	
Cadmium	0.0051	0.0192	0.0123	0.0078	
Chromium, Total	0.0375	<0.0001	0.1125	0.075	
Chromium, Hexavalent	0.0	0.0	0.0	0.0	
Copper	0.55	0.0775	1.035	0.193	
Iron	0.2	0.2	0.61	0.257	
Lead	0.0041	0.0025	0.4	0.0025	
Manganese	0.9	0.8	0.7	0.7	
Mercury	<0.0001	<0.0001	<0.0001	<0.0001	
Nickel	0.0013	<0.0001	0.0375	0.0025	
Selenium	<0.0001	<0.0001	<0.0001	<0.0001	
Thallium	<0.0001	<0.0001	<0.0001	<0.0001	
Titanium	0.0	0.0	0.0	0.0	
Zinc	0.6	0.925	0.41	0.585	
Gold	0.0	0.0	0.0	0.0	
Silver	0.0006	0.0009	0.0016	0.0007	
Phenols, Total	0.0	0.0	0.35	0.0	
Cobalt	0.002	0.002	0.016	0.009	
Acenaphthene	0.0	0.0	0.014	*	
Acrolein	0.0	0.0	0.0	0.0	0.0
Acrylonitrile	0.0	0.0	0.0	0.0	0.0
Benzene	0.0	*	*	*	0.0
Benzidine	0.0	0.0	0.0	0.0	
Carbon Tetrachloride	0.0	0.0	0.0	0.0	0.0
Chlorobenzene	*	0.0	0.014	0.037	0.0
124-Trichlorobenzene	0.0	0.0	0.0	0.0	
Hexachlorobenzene	0.0	0.0	0.0	0.0	
12-Dichloroethane	0.0	0.0	0.0	0.0	0.0
111-Trichloroethane	0.0	*	*	0.0	0.0
Hexachloroethane	0.0	0.0	0.0	*	
11-Dichloroethane	0.0	0.0	0.0	0.0	0.0
112-Trichloroethane	0.0	0.0	0.0	0.0	0.0
1122-Tetrachloroethane	0.0	0.0	0.0	0.0	0.0
Chloroethane	0.0	0.0	0.0	0.0	0.0
Bischloromethylether	0.0	0.0	0.0	0.0	
Bis2chloroethylether	0.0	0.0	*	0.0	

Table V-25 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6058
(All Concentrations in mg/l)

SAMPLE POINT	130 Source Municipal Water	200 Combined Influent to Treatment	206 Cold Rolling Spent Lubricant	402 Treated Oily Waste	199 Volatile Organics Trip Blank
	Day 1	Day 1	Day 1	Day 1	Day 1
2Chloroethlvinylethr	0.0	0.0	0.0	0.0	0.0
2-Chloronaphthalene	0.0	0.0	0.0	0.0	
246-Trichlorophenol	0.0	0.0	0.0	*	
Parachlorometacresol	0.0	0.0	0.0	0.0	
Chloroform	0.0	0.016	0.0	0.018	0.0
2-Chlorophenol	0.0	0.0	0.0	0.0	
12-Dichlorobenzene	0.0	0.0	0.0	0.0	
13-Dichlorobenzene	0.0	0.0	0.0	0.0	
14-Dichlorobenzene	0.0	0.0	0.0	0.0	
33-Dichlorobenzidine	0.0	0.0	0.018	0.0	
11-Dichloroethylene	0.0	0.0	0.0	0.0	0.0
12T-Dichloroethylene	0.0	0.0	0.0	0.0	0.0
24-Dichlorophenol	0.0	0.0	0.0	0.0	
12-Dichloropropane	0.0	0.0	0.0	0.0	0.0
12-Dichloropropylene	0.0	0.0	0.0	0.0	0.0
24-Dimethylphenol	0.0	0.0	0.0	0.0	
24-Dinitrotoluene	0.0	*	0.023	0.0	
26-Dinitrotoluene	0.0	0.0	0.057	0.0	
12-Diphenylhydrazine	0.0	0.0	0.0	0.0	
Ethylbenzene	*	0.0	0.043	0.0	0.0
Fluoranthene	*	*	*	*	
4Clphenylphenylether	0.0	0.0	0.0	*	
4Brphenylphenylether	0.0	0.0	0.0	0.0	
B2chloroisoproplethr	0.0	0.0	0.0	0.0	
B2chloroethoxymethan	0.0	0.0	0.0	0.0	
Methylene Chloride	0.0	0.071	0.031	0.034	*
Methyl Chloride	0.0	0.0	0.0	0.0	0.0
Methyl Bromide	0.0	0.0	0.0	0.0	0.0
Bromoform	0.0	0.0	0.0	0.0	0.0
Dichlorobromomethane	0.0	0.0	0.0	0.0	0.0
Triclorofloromethane	0.0	0.0	0.0	0.0	0.0
Diclorodifloromethan	0.0	0.0	0.0	0.0	0.0
Chlorodibromomethane	0.0	0.0	0.0	0.0	0.0
Hexachlorobutadiene	0.0	0.0	0.0	0.0	
Cl6 Cyclopentadiene	0.0	0.0	0.0	0.0	
Isophorone	0.0	0.0	0.0	0.0	
Naphthalene	0.0	*	0.132	*	
Nitrobenzene	0.0	0.0	0.0	*	
2-Nitrophenol	0.0	0.0	0.0	0.0	
4-Nitrophenol	0.0	0.0	0.0	0.0	
24-Dinitrophenol	0.0	0.0	0.0	0.0	
46-Dinitro-o-cresol	0.0	0.0	0.0	0.0	
N-Nitrosodimethlamin	0.0	0.0	0.0	0.0	
N-Nitrosidiphenlamin	0.0	0.0	0.062	0.13	
NNitrosodinproplamin	0.0	0.0	0.0	0.0	
Pentachlorophenol	0.0	*	0.0	0.0	
Phenol	0.0	0.0	0.0	0.0	

Table V-25 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6058
(All Concentrations in mg/l)

SAMPLE POINT	130 Source Municipal Water	200 Combined Influent to Treatment	206 Cold Rolling Spent Lubricant	402 Treated Oily Waste	199 Volatile Organics Trip Blank
	Day 1	Day 1	Day 1	Day 1	Day 1
B2-Ethyhexlphthalate	*	*	0.029	0.012	
Butylbenzylphthalate	0.0	*	0.0	*	
Di-N-Butyl Phthalate	*	*	0.0	*	
Di-N-Octyl Phthalate	0.0	0.0	*	*	
Diethyl Phthalate	*	*	0.0	*	
Dimethyl Phthalate	0.0	0.0	0.0	*	
12-Benzanthracene	*	0.0	0.0	0.0	
Benzo(a)pyrene	0.0	*	0.0	0.0	
34-Benzofluoranthene	0.0	0.0	0.0	0.0	
Benzo(k)fluoranthene	0.0	0.0	0.0	0.0	
Chrysene	*	0.0	0.0	0.0	
Acenaphthylene	0.0	0.0	0.0	*	
Anthracene	*	*	<0.0128	<0.023	
112-Benzoperylene	0.0	0.0	0.0	0.0	
Fluorene	0.0	*	0.028	*	
Phenanthrene	*	*	<0.128	<0.023	
1256Dibenzanthracene	0.0	0.0	0.0	0.0	
Ideno(123-cd)pyrene	0.0	0.0	0.0	0.0	
Pyrene	*	*	*	*	
Tetrachloroethylene	0.0	0.0	*	0.0	0.0
Toluene	*	*	0.040	0.032	*
Trichloroethylene	0.0	*	0.023	0.048	0.0
Vinyl Chloride	0.0	0.0	0.0	0.0	0.0
Aldrin	0.0	0.0	0.0	0.0	
Dieldrin	0.0	0.0	0.0	0.0	
Chlordane	0.0	0.0	0.0	0.0	
4,4-DDT	0.0	0.0	0.0	0.0	
4,4-DDE (P,P-DDX)	0.0	0.0	0.0	0.0	
4,4-DDD (P,P-TDE)	0.0	0.0	0.0	0.0	
Alpha-Endosulfan	0.0	0.0	0.0	0.0	
Beta-Endosulfan	0.0	0.0	0.0	0.0	
Endosulfan Sulfate	0.0	0.0	0.0	0.0	
Endrin	0.0	0.0	0.0	0.0	
Endrin Aldehyde	0.0	0.0	0.0	0.0	
Heptachlor	0.0	0.0	0.0	0.0	
Heptachlor Epoxide	0.0	0.0	0.0	0.0	
Alpha-BHC	0.0	0.0	0.0	0.0	
Beta-BHC	0.0	0.0	0.0	0.0	
Gamma-BHC (Lindane)	0.0	0.0	0.0	0.0	
Delta-BHC	0.0	0.0	0.0	0.0	
PCB-1242	0.0	0.0	0.0	0.0	
PCB-1254	0.0	0.0	0.0	0.0	
PCB-1221	0.0	0.0	0.0	0.0	
PCB-1232	0.0	0.0	0.0	0.0	
PCB-1248	0.0	0.0	0.0	0.0	
PCB-1260	0.0	0.0	0.0	0.0	
PCB-1016	0.0	0.0	0.0	0.0	
Toxaphene	0.0	0.0	0.0	0.0	
TCDD	0.0	0.0	0.0	0.0	

Table V-25 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6058
(All Concentrations in mg/l)

SAMPLE POINT	201	202	203	204	205	206	207	209
	Combined Waste Sample	Annealing Water	Pickling Rinse	Solution Heat Treatment	Combined Waste Sample	Cold Rolling Spent Lubricant	Combined Pickling Rinse	Annealing Rinse
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH	4.9	5.5	2.0	6.5	2.9	5.4	2.7	6.0
Maximum pH	5.7	5.9	2.2	6.6	5.4	6.3	6.4	7.3
Temperature °C	32.0	35.0	52.0	32.0	27.0	22.0	27.0	18.0
Cyanide, Total	0.06	0.06		*	0.1		0.09	0.1
Cyanide Amn. to Chlor	0.05	0.05		*	0.09		0.08	0.09
Oil & Grease	6.4	0.0		8.3	21.8		2.3	5.8
Fluorides	1.0	0.78	0.94	1.0	1.45		1.15	0.94
Phosphorus	0.41	0.0	0.39	0.25	0.64		1.82	0.13
Totl Suspendd Solids	699.2	3.1		12.6	846.4	3607.6	2.1	2.4
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.0	0.0	0.042	0.0	0.005	0.0	0.008	0.0
Chromium, Total	4.42	0.028	0.31	0.0	3.9	0.0	4.55	0.0
Chromium, Hexavalent	3.83	0.0	0.0	0.0	0.92	0.0	1.04	0.0
Copper	2.64	0.16	4.83	0.075	10.3	0.33	15.8	0.059
Iron	0.19	0.21	5.28	0.2	1.08	0.3	1.21	0.1
Lead	0.0	0.0	2.0	0.04	0.42	0.15	0.37	0.0
Manganese	0.05	0.031	0.26	0.027	0.11	0.028	0.1	0.01
Nickel	1.88	0.0	0.33	0.0	0.44	0.0	0.3	0.0
Selenium				0.0				
Thallium				0.0				
Zinc	12.9	1.86	520.0	0.64	18.2	3.92	70.0	1.5
Silver	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	0.052	*		0.03	*	0.25	0.045	0.05
Benzene				0.0		0.0		
Chlorobenzene				0.0		0.0		
111-Trichloroethane				0.0		0.0		
Hexachloroethane						0.0		
Chloroform		0.0		*	0.0	0.031		0.0
26-Dinitrotoluene						0.0		
Ethylbenzene						0.0		
Methylene Chloride		0.0		*	0.0	*		0.0
Naphthalene				0.0		3.3		
N-Nitrosodiphenlamin						87.0		
B2-Ethyhexlphthalate				0.014		14.0		
Butylbenzylphthalate						*		
Di-N-Octyl Phthalate						0.0		
Diethyl Phthalate				0.0				
Dimethyl Phthalate						0.0		
Anthracene				0.0		22.0		
Phenanthrene				0.0		22.0		
Tetrachloroethylene				*		*		
Toluene				0.0		0.0		
Trichloroethylene				*		0.017		

Table V-25 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6058
(All Concentrations in mg/l)

SAMPLE POINT	210	249	301	302	346	401	402	403
	Pickling Rinse	Reverse Osmosis Concentrate	Combined Waste Sample	Partially Treated Pickling Waste	Partially Treated Pickling Waste	Alkaline Cleaning Rinse	Treated Oily Waste	Reverse Osmosis Permeate
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH		3.2	5.6	3.8	2.8	5.9	5.6	4.0
Maximum pH		3.3	6.1	3.9	3.6	6.9	6.7	6.7
Temperature °C		32.0	32.0	28.0	28.0	51.0	24.0	29.0
Cyanide, Total			*		*	*	0.06	0.1
Cyanide Amn. to Chlor			*		*	*	0.05	0.09
Oil & Grease			0.0		2.6	10.1	24.2	6.9
Fluorides	1.1	4.6	0.74	1.55	1.55	0.9		1.6
Phosphorus	0.38	5.33	0.22	0.79	1.1	0.1	0.12	0.12
Totl Suspendd Solids		18.0	0.9	2.0	4.8	3.3	5.1	0.0
Totl Dissolvd Solids		6294.0		430.0				
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.01	0.093	0.0	0.006	0.01	0.0	0.0	0.0
Chromium, Total	1.49	57.0	0.0	3.78	3.35	0.0	0.0	0.66
Chromium, Hexavalent	0.0	0.0	0.0	0.52	1.05	0.0	0.0	0.58
Copper	39.6	192.0	0.1	15.0	11.8	0.18	0.2	0.89
Iron	0.76	1.1	0.25	0.37	0.72	0.11	0.19	0.044
Lead	1.0	1.57	0.0	0.31	0.25	0.0	0.0	0.0
Manganese	0.27	1.38	0.028	0.098	0.078	0.02	0.033	0.002
Nickel	1.12	3.96	0.0	0.26	0.35	0.08	0.0	0.0
Selenium					0.0	0.0		
Thallium					0.0	0.0		
Zinc	43.9	430.0	1.3	25.7	17.2	1.11	0.58	1.82
Silver	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total			0.02		0.0	0.0	0.08	0.0
Benzene						*	*	
Chlorobenzene						*	0.0	
111-Trichloroethane						*	*	
Hexachloroethane							0.0	
Chloroform			0.0			*	*	
26-Dinitrotoluene							*	
Ethylbenzene							0.011	
Methylene Chloride			0.0			0.0	*	
Naphthalene						*	*	
N-Nitrosodiphenlamin							0.047	
B2-Ethyhexlphthalate						0.16	0.063	
Butylbenzylphthalate							0.0	
Di-N-Octyl Phthalate							0.0	
Diethyl Phthalate						0.0		
Dimethyl Phthalate							*	
Anthracene						0.016	0.014	
Phenanthrene						0.016	0.014	
Tetrachloroethylene						*	*	
Toluene						*	*	
Trichloroethylene						0.0	*	

Table V-25 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6058
(All Concentrations in mg/l)

SAMPLE POINT	201	202	203	204	205	206	207	209
	Combined Waste Sample	Annealing Water	Pickling Rinse	Solution Heat Treatment	Combined Waste Sample	Cold Rolling Spent Lubricant	Combined Pickling Rinse	Annealing Water
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	3.4	5.2	2.2	5.5	3.0	3.7	2.9	5.4
Maximum pH	4.8	5.8	2.8	6.9	3.6	6.0	6.1	6.4
Temperature °C	34.0	40.0	49.0	27.0	26.0	21.0	28.0	20.0
Cyanide, Total	0.14	0.22		0.1	0.07	0.16	0.13	0.11
Cyanide Amn. to Chlor	0.12	0.15		0.09	0.06	0.12	0.03	0.1
Oil & Grease	11.3	2.8		11.0	56.3	53800.0	2.5	8.4
Fluorides	0.56	0.78	0.94	0.8	1.9		1.15	0.9
Phosphorus	3.33	0.09	0.32	0.11	1.69		1.7	0.09
Totl Suspendd Solids	167.6	2.9		2.8	351.0	253.4	2.7	2.5
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.31	0.0	0.0
Cadmium	0.017	0.004	0.022	0.0	0.005	0.008	0.011	0.0
Chromium, Total	28.1	0.0	0.18	0.0	7.8	0.02	3.01	0.014
Chromium, Hexavalent	0.31	0.0	0.0	0.0	1.26	0.0	0.54	0.0
Copper	57.0	0.078	11.5	0.053	19.4	4.4	11.0	0.092
Iron	15.8	0.13	2.99	0.15	1.98	0.92	1.01	0.1
Lead	2.0	0.0	1.36	0.0	0.92	2.18	0.34	0.0
Manganese	0.9	0.024	0.17	0.015	0.24	0.053	0.13	0.013
Nickel	2.05	0.0	0.18	0.0	0.29	0.066	0.3	0.0
Selenium				0.0				
Thallium				0.0				
Zinc	72.0	3.11	380.0	0.51	18.6	8.7	62.0	0.64
Silver	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	0.0	0.0		0.0	0.085	1.05	0.0	*
Benzene				*		0.0		
Chlorobenzene				0.0		*		
111-Trichloroethane				*		0.0		
Hexachloroethane						0.0		
Chloroform	0.0	0.0		*		0.038		0.0
26-Dinitrotoluene						0.0		
Ethylbenzene						0.0		
Methylene Chloride	0.0	0.0		*		*		0.0
Naphthalene				*		3.5		
N-Nitrosodiphenlamin						90.0		
B2-Ethyhexlphthalate				0.13		19.0		
Butylbenzylphthalate						0.011		
Di-N-Octyl Phthalate						0.051		
Diethyl Phthalate				0.0				
Dimethyl Phthalate						0.0		
Anthracene				0.0		27.0		
Phenanthrene				0.0		27.0		
Tetrachloroethylene				*		*		
Toluene				0.013		*		
Trichloroethylene				*		0.018		

Table V-25 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6058
(All Concentrations in mg/l)

SAMPLE POINT	210	249	301	302	346	401	402	403
	Pickling Rinse	Reverse Osmosis Concentrate	Combined Waste Sample	Partially Treated Pickling Waste	Partially Treated Pickling Waste	Alkaline Cleaning Rinse	Treated Oily Waste	Reverse Osmosis Permeate
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	2.8	3.9	5.7	3.9	2.9	5.8	5.0	5.3
Maximum pH	3.4	4.0	6.2	4.0	3.2	8.7	6.6	5.9
Temperature °C	39.0	31.0	34.0	29.0	28.0	47.0	21.0	30.0
Cyanide, Total			0.12		0.11	0.18	0.09	0.13
Cyanide Amn. to Chlor			0.11		0.11	0.07	0.01	0.02
Oil & Grease			0.0		6.8	28.8	16.3	15.1
Fluorides	1.0	4.6	0.92	2.1	2.2	0.84	0.96	17.0
Phosphorus	0.7	8.44	0.195	1.05	1.37	0.04	0.11	0.0
Totl Suspendd Solids		12.0	3.4	1.6	3.5	5.9	5.6	2.3
Totl Dissolvd Solids		4628.0		334.0				
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cadmium	0.006	0.078	0.0	0.006	0.008	0.0	0.0	0.0
Chromium, Total	1.3	55.0	0.0	4.06	6.15	0.0	0.0	0.98
Chromium, Hexavalent	0.0	13.7	0.0	1.53	1.58	0.0	0.0	0.78
Copper	23.0	156.0	0.069	11.0	15.1	0.27	0.13	0.7
Iron	0.98	2.05	0.092	0.35	0.65	0.23	0.2	0.13
Lead	0.86	1.2	0.0	0.17	0.29	0.0	0.0	0.0
Manganese	1.07	0.95	0.021	0.065	0.093	0.018	0.028	0.003
Nickel	0.82	5.81	0.0	0.4	0.35	0.0	0.0	0.0
Selenium					0.0	0.0		
Thallium					0.0	0.0		
Zinc	33.6	390.0	1.0	27.2	28.6	0.78	0.48	1.47
Silver	0.0	0.0	0.005	0.0	0.0	0.0	0.0	
Phenols, Total			0.08		0.0	0.05	*	0.0
Benzene						*	*	
Chlorobenzene						*	0.0	
111-Trichloroethane						*	0.0	
Hexachloroethane							0.0	
Chloroform			0.0			*	*	
26-Dinitrotoluene							0.0	
Ethylbenzene							*	
Methylene Chloride			0.0			0.011	*	
Naphthalene						*	*	
N-Nitrosodiphenlamin							*	
B2-Ethyhexlphthalate						*	*	
Butylbenzylphthalate							0.0	
Di-N-Octyl Phthalate							0.0	
Diethyl Phthalate						*		
Dimethyl Phthalate							0.0	
Anthracene						0.011	*	
Phenanthrene						0.011	*	
Tetrachloroethylene						*	*	
Toluene						*	*	
Trichloroethylene						*	0.011	

Table V-25 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6058
(All Concentrations in mg/l)

SAMPLE POINT	404 Combined Treated Effluent	405 Alkaline Cleaning Bath	406 Alkaline Cleaning Rinse	420 Treated Oily Waste	219 Pickling Bath	220 Combined Waste Sample	199 Volatile Organics Trip Blank
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	8.1	11.9	10.3	6.9	2.0	7.0	
Maximum pH	8.3	11.9	10.3	6.9	2.0	7.0	
Temperature °C	30.0	62.0	62.0	22.0	22.0	22.0	
Cyanide, Total	0.04	1.25	0.11	0.19	0.0	*	
Cyanide Amn. to Chlor	0.04	1.18	0.1	0.08	0.0	0.0	
Oil & Grease	9.1	607.0	0.0	8.3	0.0	19.4	
Fluorides	4.7	22.0	1.75	0.94	0.21	0.92	
Phosphorus	0.6		33.1	0.13		0.045	
Totl Suspendd Solids	74.4	1110.8	61.0	11.6	0.0	4.2	
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	
Arsenic	0.0	0.75	0.08	0.0	0.0	0.0	
Cadmium	0.0	0.0	0.0	0.0	0.12	0.0	
Chromium, Total	2.23	1.7	0.78	0.008	19400.0	0.009	
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.0	
Copper	8.64	24.4	6.13	0.075	28000.0	0.18	
Iron	0.15	24.4	0.77	0.15	49.5	0.11	
Lead	0.04	220.0	3.48	0.0	78.6	0.0	
Manganese	0.21	0.095	0.15	0.018	10.7	0.021	
Nickel	0.51	0.0	0.076	0.0	0.0	0.0	
Selenium		0.0	0.09				
Thallium		0.0	0.0				
Zinc	17.9	42.6	10.2	2.26	8600.0	0.58	
Silver	0.0	0.0	0.0	0.0	1.3	0.0	
Phenols, Total	0.015	0.47	0.704	0.0	0.0	0.05	
Benzene		*	*	*		*	*
Chlorobenzene		*	0.0	0.0		0.0	*
111-Trichloroethane		*	*	*		0.0	0.0
Hexachloroethane				0.0		0.0	0.0
Chloroform		*	0.0	0.0		*	*
26-Dinitrotoluene		0.0		0.0		0.0	
Ethylbenzene				0.0		0.0	0.0
Methylene Chloride		*	0.001	*		*	0.0014
Naphthalene		*	0.0	*		*	
N-Nitrosodiphenlamin		0.012		0.0		0.0	
B2-Ethyhexlphthalate		0.048	*	0.019		0.15	
Butylbenzylphthalate		0.0		0.0		0.0	
Di-N-Butyl Phthalate		*		0.0		0.0	
Di-N-Octyl Phthalate		0.0		0.0		0.0	
Diethyl Phthalate		0.0	0.0	0.0		0.0	
Dimethyl Phthalate		0.0		0.0		0.0	
Anthracene		0.051	*	*		*	
Phenanthrene		0.051	*	*			
Tetrachloroethylene		0.0	*	0.0		*	0.0
Toluene		*	*	0.0		*	*
Trichloroethylene		0.0	*	0.0		*	0.0

Table V-26

SUMMARY OF SAMPLING DATA FROM PLANT 6461
(All Concentrations in mg/l)

SAMPLE POINT	202	215	217	250	251	252	253
	Pickling Rinse	Combined Waste Sample	Raw Wastewater	Raw Wastewater	Raw Wastewater	Raw Wastewater	Raw Wastewater
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	2.4	5.0	9.0	7.0	7.0	7.0	7.0
Maximum pH	4.5	7.0	9.0	7.0	7.0	7.0	7.0
Temperature °C	29.7	4.9	38.1	17.2	15.6	40.0	38.0
Oil & Grease	23.0	110000.0	880.0	70000.0	173000.0	286000.0	18500.0
Fluorides	0.21						
Totl Organic Carbon		160.0	800.0	69900.0	159650.0	63850.0	62850.0
Totl Suspendd Solids	36.0	2440.0	275.0	225.0	6735.0	4580.0	
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.26	0.28	0.0
Chromium, Total	140.0	0.16	0.041	0.56	9.57	11.6	5.93
Chromium, Hexavalent	77.0						
Copper	146.0	5.05	4.89	82.0	510.0	470.0	169.0
Iron	2.97	6.21	0.83	2.85	2.76	30.8	2.6
Lead	4.97	1.81	26.2	0.0	4.36	84.0	22.7
Manganese	0.3	2.03	0.0	0.45	1.3	1.62	2.82
Nickel	0.35	0.021	0.0	5.75	14.8	20.6	37.3
Selenium		0.0					
Thallium		0.0					
Zinc	242.0	2.93	93.0	4.25	14.6	18.3	220.0
Silver	0.0	0.0	0.0	0.23	0.35	1.08	0.269
Benzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.0	*	0.0	0.0
111-Trichloroethane	0.0	0.0	0.0	0.0	0.0	0.0	*
Hexachloroethane	0.0	0.0	*	0.0	0.0	0.0	0.0
Chloroform	0.0	*	0.0	*	*	*	*
26-Dinitrotoluene	0.0	0.0	0.0	0.0	0.28	0.0	0.0
Ethylbenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Methylene Chloride	0.0	*	0.0	0.0	0.0	0.0	0.0
Naphthalene	0.0	0.0	36.0	67.0	6.0	3.9	0.0
N-Nitrosodiphenlamin	0.0	0.0	0.054	0.0	9.6	0.0	0.0
B2-Ethyhexlphthalate	0.0	0.0	*	0.0	6.8	15.0	0.0
Butylbenzylphthalate	0.0	0.0	0.96	0.0	0.021	0.0	0.0
Di-N-Butyl Phthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Di-N-Octyl Phthalate	0.0	0.0	0.013	7.9	0.87	0.0	0.0
Diethyl Phthalate	0.0	0.0	0.0	0.0	0.0	2.3	2.3
Dimethyl Phthalate	0.0	0.0	0.0	0.0	0.17	0.0	0.0
Anthracene	0.0	0.14	23.0	14.0	4.6	0.75	0.0
Phenanthrene	0.0	0.14	23.0	14.0	4.6	0.75	0.0
Tetrachloroethylene	0.0	*	0.0	0.0	0.0	0.0	0.0
Toluene	0.0	0.0	20.0	*	75.0	0.0	0.0
Trichloroethylene	0.0	*	*	*	0.0	0.0	0.0

Table V-26 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6461
(All Concentrations in mg/l)

SAMPLE POINT	201 Combined Waste Sample	203 Pickling Rinse	204 Pickling Rinse	226 Annealing Water	205 Combined Waste Sample	225 Annealing Water	210 Cold Rolling Spent Lubricant	211 Non-Contact Cooling Water
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	2.9	2.5	2.7	5.4	2.6	5.5	5.0	5.0
Maximum pH	3.4	5.5	5.8	5.7	6.4	5.6	5.0	6.0
Temperature °C	22.0	23.5	23.1	48.9	21.1	55.0		17.3
Cyanide, Total						*		0.0
Cyanide Amn. to Chlor						0.0		0.0
Oil & Grease	34.0	10.0	0.0	9.0	8.0	13.0	835000.0	90.0
Fluorides	0.38	0.50	0.50	0.34	0.41	0.31		
Phosphorus		0.95	0.5	0.45	0.49			
Totl Organic Carbon					5.0		390000.0	240.0
Totl Suspendd Solids	0.0	0.0	12.0	0.0	0.0	11.0	19400.0	28.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	8.47	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromium, Total	97.0	0.027	0.03	0.04	0.096	0.013	0.6	0.045
Chromium, Hexavalent		0.0	0.0	0.031	0.0	0.0		
Copper	38.8	15.6	39.6	0.19	37.7	0.66	418.0	19.1
Iron	4.95	0.15	0.16	0.025	0.78	0.057	18.2	0.57
Lead	5.24	0.0	0.0	0.0	0.03	0.0	11.4	0.0
Manganese	0.53	0.3	0.28	0.35	0.35	0.41	1.24	0.29
Nickel	1.11	0.96	0.7	0.0	0.022	0.073	13.3	0.02
Zinc	69.0	10.3	3.5	0.72	9.72	7.2	285.0	4.15
Silver	0.058	0.0	0.0	0.0	0.023	0.0	0.0	0.0
Phenols, Total	0.22			0.0		0.0		
Benzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
111-Trichloroethane	*	0.0	0.0	0.0	0.0	0.0	0.0	*
Hexachloroethane	*	0.0	0.0	0.0	0.0	0.0	0.0	*
Chloroform	*	0.0	0.0	*	0.0	*	0.0	*
26-Dinitrotoluene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ethylbenzene	0.0	0.0	0.0	0.0	0.0	0.0	*	0.0
Methylene Chloride	*	0.0	0.0	*	0.0	0.0	0.0	0.0
Naphthalene	*	0.0	0.0	0.0	0.0	0.0	37.0	0.031
N-Nitrosodiphenlamin	0.0	0.0	0.0	0.0	0.0	0.0	81.0	0.0
B2-Ethyhexlphthalate	0.012	0.0	0.0	0.0	0.0	0.0	0.0	*
Butylbenzylphthalate	0.0	0.0	0.0	0.0	0.0	0.0	37.0	0.063
Di-N-Octyl Phthalate	0.0	0.0	0.0	0.0	0.0	0.0	7.1	0.044
Dimethyl Phthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthracene	*	0.0	0.0	0.0	0.0	0.0	42.0	0.72
Phenanthrene	*	0.0	0.0	0.0	0.0	0.0	42.0	0.72
Tetrachloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*
Toluene	80.0	0.0	0.0	0.0	0.0	0.0	*	20.0
Trichloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*

Table V-26 (Continued)

SUMMARY OF SAMPLING DATA* FROM PLANT 6461
(All Concentrations in mg/l)

SAMPLE POINT	140	219	319	249	349	400
	Source Well Water	Influent to Oil Skimmer	Effluent From Oil Skimmer	Influent to Chromium Reduction	Effluent from Chromium Reduction	Combined Treated Effluent
	Day 1	Day 1	Day 1	Day 1	Day 1	Day 1
Minimum pH	6.0	5.0	5.9	2.3	2.4	8.6
Maximum pH	6.5	6.0	6.8	3.3	2.8	9.4
Temperature °C	12.8					
Cyanide, Total	0.0	0.0				0.0
Cyanide Amn. to Chlor	0.0	0.0				0.0
Oil & Grease	0.0	28.0	22.0	10.0		10.0
Fluorides	0.32	0.31	0.34	0.41	0.44	0.42
Phosphorus	0.3			1.16	0.84	0.39
Totl Organic Carbon		38.0	76.0	7.0		14.0
Totl Suspendd Solids	0.0	22.0	20.0	0.0		38.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0
Chromium, Total	0.027	0.033	0.045	10.3	5.4	1.97
Chromium, Hexavalent	0.0	0.0	0.0	0.013	0.0	0.06
Copper	0.013	0.17	0.29	47.1	43.7	3.93
Iron	0.07	0.33	0.58	1.32	0.15	0.13
Lead	0.0	0.35	0.93	0.24	0.23	0.0
Manganese	0.32	0.35	0.35	0.39	0.35	0.034
Nickel	0.0	0.0	0.0	0.43	0.50	0.057
Zinc	0.26	1.06	2.74	37.5	24.0	3.12
Silver	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	0.0	0.026	0.036			0.58
Benzene	0.0	0.0	0.0	0.0		0.0
Chlorobenzene	0.0	0.0	0.0	*		0.0
111-Trichloroethane	*	*	*	*		*
Hexachloroethane	*	*	0.0	0.0		*
Chloroform	*	*	*	*		*
26-Dinitrotoluene	0.0	0.0	0.0	0.0		0.0
Ethylbenzene	0.0	0.0	0.0	0.0		0.0
Methylene Chloride	0.0	0.0	*	0.0		*
Naphthalene	0.0	0.47	0.31	0.0		0.015
N-Nitrosodiphenlamin	0.0	0.015	0.0	0.0		0.0
B2-Ethyhexlphthalate	0.0		0.0	0.0		*
Butylbenzylphthalate	0.0	*	0.0	0.0		*
Di-N-Butyl Phthalate	*					
Di-N-Octyl Phthalate	0.0	0.0	*	0.0		0.0
Diethyl Phthalate	0.0					
Dimethyl Phthalate	0.0	0.0	0.0	0.0		0.0
Anthracene	0.0	280.0	0.09	*		*
Phenanthrene	0.0	280.0	0.09	*		*
Tetrachloroethylene	*	0.0	0.0	0.0		0.0
Toluene	0.0	0.0	0.0	0.0		30.0
Trichloroethylene	*	0.0	*	0.0		*

Table V-26 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6461
(All Concentrations in mg/l)

SAMPLE POINT	217	252	202	215
	Raw Wastewater	Raw Wastewater	Pickling Rinse	Combined Waste Stream
	Day 2	Day 2	Day 2	Day 2
Minimum pH	9.0	7.0	2.1	5.0
Maximum pH	9.0	7.0	2.8	7.0
Temperature °C	36.7	40.0	39.0	34.3
Oil & Grease	10000.0	286000.0	0.0	
Fluorides			0.13	
Totl Organic Carbon	13300.0	63850.0	4.0	1880.0
Totl Suspendd Solids	4660.0	4580.0	31.0	2525.0
Antimony	0.48	0.0	0.0	0.0
Arsenic	0.1	0.28	0.0	0.0
Chromium, Total	0.01	11.6	174.0	0.29
Chromium, Hexavalent			69.0	
Copper	116.0	470.0	250.0	3.05
Iron	7.29	30.8	1.54	16.7
Lead	181.0	84.0	0.72	3.48
Manganese	0.41	1.62	0.42	5.16
Nickel	0.24	20.6	0.6	0.033
Selenium				0.0
Thallium				0.0
Zinc	804.0	18.3	355.0	6.67
Silver	0.0	1.08	0.0	0.0
Phenols, Total				0.13
Benzene	0.0	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.0
111-Trichloroethane	0.0	0.0	0.0	*
Hexachloroethane	0.0	0.0	0.0	
Chloroform	*	*	0.0	*
26-Dinitrotoluene	0.0	0.0	0.0	
Ethylbenzene	0.0	0.0	0.0	
Methylene Chloride	0.0	0.0	0.0	0.0
Naphthalene	31.0	3.9	0.0	0.0
N-Nitrosodiphenlamin	0.0	0.0	0.0	
B2-Ethyhexlphthalate	0.057	15.0	0.0	0.35
Butylbenzylphthalate	0.065	0.0	0.0	
Di-N-Butyl Phthalate	0.019	0.0		
Di-N-Octyl Phthalate	0.199	0.0	0.0	
Diethyl Phthalate	0.038	2.3		0.0
Dimethyl Phthalate	0.0	0.0	0.0	
Anthracene	30.0	0.75	0.0	0.48
Phenanthrene	30.0	0.75	0.0	0.48
Tetrachloroethylene	*	0.0	0.0	*
Toluene	10.0	0.0	0.0	0.0
Trichloroethylene	0.0	0.0	0.0	*

Table V-26 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6461
(All Concentrations in mg/l)

SAMPLE POINT	201	203	204	226	205	225	210
	Combined Waste Sample	Pickling Rinse	Pickling Rinse	Annealing Water	Combined Waste Sample	Annealing Water	Cold Rolling Spent Lubricant
	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2	Day 2
Minimum pH	2.5	2.0	2.2	5.1	1.7	5.4	5.0
Maximum pH	5.0	3.7	3.9	5.4	2.5	5.8	5.0
Temperature °C	20.1	23.9	24.3	44.7	16.3	49.7	
Cyanide, Total				0.0		0.0	
Cyanide Amn. to Chlor				0.0		0.0	
Oil & Grease	13.0	0.0	0.0	3.0	18.0	0.0	27000.0
Fluorides	0.29	0.41	0.39	0.24	0.31	0.25	
Phosphorus	0.94	0.58	0.52	0.5	0.33	0.32	
Totl Organic Carbon	31.0	2.0	3.0	2.0	3.0	1.0	8950.0
Totl Suspendd Solids	21.0	7.0	0.0	0.0	0.0	8.0	4760.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromium, Total	1.1	0.045	0.035	0.033	0.09	0.016	0.2
Chromium, Hexavalent	0.13	0.0	0.0	0.031	0.0	0.0	
Copper	14.3	25.6	71.0	0.46	38.4	0.53	60.0
Iron	0.76	0.23	0.14	0.7	0.47	0.54	1.79
Lead	0.5	0.062	0.0	0.1	0.0	0.0	0.0
Manganese	0.39	0.3	0.3	0.41	0.36	0.4	0.089
Nickel	0.41	0.96	2.17	0.046	0.21	0.01	1.28
Zinc	7.0	22.6	8.49	1.18	10.3	7.2	2.12
Silver	0.0	0.0	0.0	0.0	0.008	0.0	0.0
Phenols, Total	0.13			0.03		0.18	
Benzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
111-Trichloroethane	*	0.0	0.0	0.0	0.0	0.0	*
Hexachloroethane	0.0	0.0	0.0	0.0	0.0	0.0	*
Chloroform	0.0	0.0	0.0	*	0.0	*	*
26-Dinitrotoluene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ethylbenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Methylene Chloride	0.0	0.0	0.0	*	0.0	*	0.0
Naphthalene	0.0	0.0	0.0	0.0	0.0	0.0	0.33
N-Nitrosodiphenlamin	0.0	0.0	0.0	0.0	0.0	0.0	0.09
B2-Ethyhexlphthalate	*	0.0	0.0	0.0	0.0	0.0	0.0
Butylbenzylphthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Di-N-Octyl Phthalate	*	0.0	0.0	0.0	0.0	0.0	0.0
Diethyl Phthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthracene	*	0.0	0.0	0.0	0.0	0.0	0.29
Phenanthrene	*	0.0	0.0	0.0	0.0	0.0	0.29
Tetrachloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toluene	0.0	0.0	0.0	0.0	0.0	0.0	*
Trichloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	*

Table V-26 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6461
(All Concentrations in mg/l)

SAMPLE POINT	140 Source Well Water Day 2	219 Influent to Oil Skimmer Day 2	319 Effluent from Oil Skimmer Day 2	249 Influent to Chromium Reduction Day 2	349 Effluent from Chromium Reduction Day 2	400 Combined Treated Effluent Day 2	207 Raw Wastewater Day 2	208 Raw Wastewater Day 2
Minimum pH	6.0	5.0	5.0	2.5	2.5	7.8	4.5	6.7
Maximum pH	6.9	2.0	8.0	5.4	5.0	9.2	4.5	6.7
Temperature °C	11.7		19.8	18.5	18.6	17.3	21.1	20.0
Cyanide, Total	0.0	0.0			0.0	0.0		
Cyanide Amn. to Chlor	0.0	0.0			0.0	0.0		
Oil & Grease	0.0	530.0	135.0	0.0	0.0	4.0	0.0	19.0
Fluorides	0.27	0.44	0.34	0.34	0.38	0.47	0.25	0.26
Phosphorus	0.47				0.68	0.44	0.38	0.53
Totl Organic Carbon	1.0	137.0	95.0	3.0		14.0	1.0	56.0
Totl Suspendd Solids	0.0	142.0	86.0	3.0		39.0	5.0	13.0
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromium, Total	0.063	0.027	0.072	3.0	3.82	2.76	0.077	0.023
Chromium, Hexavalent	0.0			0.0	0.0	0.0	0.023	0.0
Copper	0.059	1.66	0.83	88.0	80.0	5.92	0.15	0.18
Iron	0.067	0.18	0.14	1.76	1.65	0.14	0.14	0.45
Lead	0.0	2.15	1.95	0.91	0.17	0.07	0.0	0.0
Manganese	0.39	0.28	0.28	0.35	0.32	0.077	0.38	0.31
Nickel	0.0	0.0	0.0	1.67	1.42	0.10	0.0	0.026
Selenium				0.0				
Thallium				0.0				
Zinc	0.48	5.98	5.72	24.0	22.2	3.63	0.48	0.26
Silver	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	0.17		3.23	0.12	0.017	0.47		0.083
Benzene	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.0		0.0	0.0	0.0
111-Trichloroethane	*	*	*	*		*	0.0	*
Hexachloroethane	0.0	0.0	*	0.0		*	0.0	*
Chloroform	*	*	*	*		*	0.0	*
26-Dinitrotoluene	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Ethylbenzene	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Methylene Chloride	0.0	0.0	0.0	0.0		0.0	0.0	*
Naphthalene	0.0	0.83	0.29	0.0		0.021	0.0	*
N-Nitrosodiphenlamin	0.0	0.04	0.0	0.0		0.0	0.0	0.0
B2-Ethyhexlphthalate	0.0	*	0.0	*		0.0	0.0	*
Butylbenzylphthalate	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Di-N-Butyl Phthalate	*							
Di-N-Octyl Phthalate	0.0	*	0.0	0.0		0.0	0.0	0.0
Diethyl Phthalate	0.0							
Dimethyl Phthalate	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Anthracene	*	0.85	0.18	0.0		*	0.0	*
Phenanthrene	*	0.85	0.18	0.0		*	0.0	*
Tetrachloroethylene	0.0	0.0	0.0	0.0		0.0	0.0	0.0
Toluene	0.0	0.0	*	0.0		0.0	0.0	10.0
Trichloroethylene	*	*	*	*		0.0	0.0	*

Table V-26 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6461
(All Concentrations in mg/l)

SAMPLE POINT	217	253	202	215
	Raw Wastewater	Raw Wastewater	Pickling Rinse	Combined Waste Sample
	Day 3	Day 3	Day 3	Day 3
Minimum pH	9.0	7.0	2.4	5.0
Maximum pH	9.0	7.0	2.6	7.0
Temperature °C	37.8	38.0	39.7	36.6
Oil & Grease	510.0	18500.0	21.0	208000.0
Fluorides			0.15	
Phosphorus			0.53	
Totl Organic Carbon	2590.0	62850.0	8.0	1990.0
Totl Suspendd Solids			20.0	
Antimony	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0
Chromium, Total	0.045	5.93	47.7	0.14
Chromium, Hexavalent			23.3	
Copper	15.5	169.0	61.0	0.8
Iron	0.14	2.6	0.97	6.1
Lead	48.3	22.7	1.91	1.65
Manganese	0.018	2.82	0.38	4.49
Nickel	0.0	37.3	0.16	0.008
Selenium				0.0
Thallium				0.0
Zinc	6.24	220.0	111.0	2.88
Silver	0.0	0.269	0.0	0.0
Phenols, Total				0.085
Benzene	0.0	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.0
111-Trichloroethane	*	*	0.0	*
Hexachloroethane	*	0.0	0.0	
Chloroform	*	*	0.0	0.0
24-Dinitrotoluene			0.0	
26-Dinitrotoluene	0.0	0.0		
Ethylbenzene	*	0.0	0.0	
Methylene Chloride	0.0	0.0	0.0	0.0
Naphthalene	25.0	0.0	0.0	0.0
N-Nitrosodiphenlamin	0.0	0.0	0.0	
B2-Ethyhexlphthalate	0.27	0.0	0.0	*
Butylbenzylphthalate	0.0	0.0	0.0	
Di-N-Butyl Phthalate	0.0	0.0		
Di-N-Octyl Phthalate	0.0	0.0	0.0	
Diethyl Phthalate	0.12	2.3		0.0
Dimethyl Phthalate	0.0	0.0	0.0	
Anthracene	21.0	0.0	0.0	2.5
Phenanthrene	21.0	0.0	0.0	2.5
Tetrachloroethylene	*	0.0	0.0	0.0
Toluene	10.0	0.0	0.0	0.0
Trichloroethylene	*	0.0	0.0	0.0

Table V-26 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6461
(All Concentrations in mg/l)

SAMPLE POINT	201 Combined Waste Sample	203 Pickling Rinse	204 Pickling Rinse	226 Annealing Water	205 Combined Waste Sample	225 Annealing Water	210 Cold Rolling Spent Lubricant
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	2.6	2.4	2.1	5.2	2.0	5.3	5.0
Maximum pH	6.1	5.8	3.7	5.8	5.0	5.7	5.0
Temperature °C	15.8	24.0	23.9	46.1	16.7	53.7	25.6
Cyanide, Total				0.0		0.0	
Cyanide Amn. to Chlor				0.0		0.0	
Oil & Grease	16.0	0.0	0.0	0.0	0.0	0.0	7300.0
Fluorides	0.28	0.47	0.41	0.28	0.30	0.34	
Phosphorus	0.33	0.61	0.62	0.5	0.31	0.39	
Totl Organic Carbon	8.0	2.0	3.0	1.0	5.0	1.0	61950.0
Totl Suspendd Solids	2.0	0.0	0.0	0.0	0.0	17.0	
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chromium, Total	0.25	0.032	0.032	0.03	0.09	0.026	0.14
Chromium, Hexavalent	0.0	0.0	0.0	0.0	0.0	0.02	
Copper	7.09	6.6	79.0	0.18	69.0	0.91	60.0
Iron	1.98	0.12	0.55	0.042	0.95	0.17	1.36
Lead	0.23	0.0	0.0	0.0	0.1	0.0	0.0
Manganese	0.41	0.28	0.29	0.37	0.36	0.57	0.18
Nickel	0.057	0.26	1.76	0.026	0.43	0.039	0.78
Zinc	4.74	6.45	9.73	1.08	19.0	15.1	8.13
Silver	0.006	0.0	0.0	0.0	0.0	0.0	0.0
Phenols, Total	0.063			0.018			
Benzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
111-Trichloroethane	*	0.0	0.0	0.0	0.0	0.0	*
Hexachloroethane	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chloroform	*	0.0	0.0	*	0.0	*	0.0
26-Dinitrotoluene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ethylbenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Methylene Chloride	0.0	0.0	0.0	*	0.0	*	0.0
Naphthalene	0.0	0.0	0.0	0.0	0.0	0.0	0.49
N-Nitrosodiphenlamin	*	0.0	0.0	0.0	0.0	0.0	0.85
B2-Ethyhexlphthalate	*	0.0	0.0	0.0	0.0	0.0	0.0
Butylbenzylphthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Di-N-Octyl Phthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.015
Dimethyl Phthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Anthracene	*	0.0	0.0	0.0	0.0	0.0	0.7
Phenanthrene	*	0.0	0.0	0.0	0.0	0.0	0.7
Tetrachloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Toluene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Trichloroethylene	0.0	0.0	0.0	0.0	0.0	0.0	*

Table V-26 (Continued)

SUMMARY OF SAMPLING DATA FROM PLANT 6461
(All Concentrations in mg/l)

SAMPLE POINT	130 Source Municipal Water	140 Source Well Water	219 Influent to Oil Skimmer	319 Effluent from Oil Skimmer	249 Influent to Chromium Reduction	349 Effluent from Chromium Reduction	400 Combined Treated Effluent	199 Volatile Organics Trip Blank
	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3	Day 3
Minimum pH	6.0	6.0	5.0	5.0	2.7	2.2	7.0	
Maximum pH	6.9	6.3	6.0	6.0	3.2	3.0	9.5	
Temperature °C	10.0	22.3	20.1	17.9	17.6	17.0	18.4	
Cyanide, Total	0.0	0.0		0.0			0.0	
Cyanide Amn. to Chlor	0.0	0.0		0.0			0.0	
Oil & Grease	0.0	0.0	138.0	34.0	0.0		17.0	
Fluorides	1.0	0.32		0.31	0.29	0.36	0.45	
Phosphorus	0.53	0.32		0.7	0.3	2.9	0.15	
Totl Organic Carbon	1.0	1.0	39.0	64.0	4.0		15.0	
Totl Suspendd Solids	0.0	0.0	36.0	40.0	0.0		47.0	
Antimony	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Arsenic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Chromium, Total	0.0	0.028	0.029	0.14	8.18	7.07	3.08	
Chromium, Hexavalent	0.0	0.0	0.0	0.0	2.73	0.0	0.0	
Copper	0.1	0.063	0.25	0.79	59.0	148.0	7.85	
Iron	0.067	0.13	0.12	0.16	0.97	1.65	0.14	
Lead	0.0	0.0	0.35	1.1	0.14	0.24	0.07	
Manganese	0.016	0.32	0.32	0.31	0.35	0.31	0.082	
Nickel	0.0	0.0	0.0	0.0	0.93	2.5	0.14	
Selenium					0.0			
Thallium					0.0			
Zinc	0.036	0.27	1.44	2.64	24.0	30.0	4.61	
Silver	0.0	0.0	0.006	0.0	0.0	0.0	0.0	
Phenols, Total	0.0	0.0	0.33	1.6	0.083		0.43	
Benzene	0.0	0.0	0.0	0.0	0.0		0.0	0.0
Chlorobenzene	0.0	0.0	0.0	0.0	0.0		0.0	0.0
111-Trichloroethane	0.0	0.0	*	*	*		*	0.0
Hexachloroethane	0.0	0.0	*	*	*		0.0	0.0
Chloroform	*	0.0	0.0	*	*		*	*
26-Dinitrotoluene	0.0	0.0	0.0	0.0	0.0		0.0	
Ethylbenzene	0.0	0.0	0.0	0.0	0.0		0.0	0.0
Methylene Chloride	0.0	0.0	0.0	*	*		*	0.0
Naphthalene	0.0	0.0	0.4	0.22	0.0		0.023	
N-Nitrosodiphenlamin	0.0	0.0	0.0	0.0	0.0		0.0	
B2-Ethyhexlphthalate	0.0	*	*	*	0.0		*	
Butylbenzylphthalate	0.0	*	0.0	0.0	0.0		0.0	
Di-N-Butyl Phthalate	*	*						
Di-N-Octyl Phthalate	0.0	*	0.0	*	0.0		*	
Diethyl Phthalate	0.0	0.0						
Dimethyl Phthalate	0.0	0.0	0.0	0.0	0.0		0.0	
Anthracene	0.0	*	0.25	0.059	0.0		*	
Phenanthrene	0.0	*	0.25	0.059	0.0		*	
Tetrachloroethylene	*	0.0	0.0	0.0	0.0		0.0	0.0
Toluene	0.0	0.0	70.0	30.0	*		0.0	0.0
Trichloroethylene	*	*	0.0	*	0.0		*	0.0

Table V-27

METALS REPORTED AS RAW MATERIALS BY COPPER AND COPPER ALLOY PRODUCTS PLANTS
(Amount in 1000's of lbs/yr)

Plant ID# Metal	1053	4094	6064	6106	19019	20068	33042	36031	47432
Copper	73700	30990	11450	48000	17670	24750	118000	1540	86000
Zinc	2050	791	4150	12400	2450	9012	34330		15700
Nickel	180	195	186	50	879	2.0	9.0		1000
Lead		4.0	40.4	870	37.4	4.0		3.9	850
Tin	57	17.9	70	70	32.8	4.0	14	1.3	100
Aluminum		26		30	79.6		9.0		
Manganese		49		8.4	56.6				2.39
Silicon				100	19.1				8.9
Iron				14	0.296				11
Magnesium					5.6				
Vanadium					1.38				
Chromium				8.7					9.4
Phosphorus				2.3	0.48		2		9.6
Antimony		0.5						0.047	
Arsenic					0.057				
Boron								2	

SECTION VI

SELECTION OF POLLUTANT PARAMETERS

INTRODUCTION

The Agency has studied copper forming wastewaters to determine the presence or absence of toxic, conventional and selected nonconventional pollutants. The toxic pollutants and nonconventional pollutants are subject to BAT effluent limitations and new source and pretreatment standards. Conventional pollutants are considered in establishing BPT, BCT, and NSPS.

One hundred and twenty-nine toxic pollutants (known as the 129 priority pollutants) were studied pursuant to the requirements of the Clean Water Act of 1977 (CWA). These pollutant parameters, which are listed in Table V-1 (p. 85), are members of the 65 pollutants and classes of toxic pollutants referred to as Table 1 in Section 307(a)(1) of the CWA.

From the original list of 129 pollutants, three pollutants have been deleted in two separate amendments to 40 CFR Subchapter N, Part 401. Dichlorodifluoromethane and trichlorofluoromethane were deleted first (46 FR 2266, January 8, 1981) followed by the deletion of bis-(chloromethyl) ether (46 FR 10723, February 4, 1981). The Agency has concluded that deleting these compounds will not compromise adequate control over their discharge into the aquatic environment and that no adverse effects on the aquatic environment or on human health will occur as a result of deleting them from the list of toxic pollutants.

Past studies by EPA and others have identified many nontoxic pollutant parameters useful in characterizing industrial wastewaters and in evaluating treatment process removal efficiencies. Certain of these and other parameters may also be selected as reliable indicators of the presence of specific toxic pollutants. For these reasons, a number of nontoxic pollutants were also studied for the copper forming category.

The conventional pollutants considered (total suspended solids, oil and grease, and pH) traditionally have been studied to characterize industrial wastewaters. These parameters are especially useful in evaluating the effectiveness of wastewater treatment processes.

Several nonconventional pollutants were considered. These included phenols (total), fluorides, phosphorus, iron, manganese and total organic carbon (TOC). None of these pollutants were selected for regulation in establishing effluent limitations guidelines for the copper forming category because they did not appear regularly in significant amounts in copper forming wastewater.

RATIONALE FOR SELECTION OF POLLUTANT PARAMETERS

The Settlement Agreement in Natural Resources Defense Council, Inc. vs. Train, 8 ERC 2120 (D.D.C. 1976), modified 12 ERC 1833 (D.D.C. 1979), provides for the exclusion of particular pollutants, categories, and subcategories.

Pollutants that were never detected and those that were never found above their analytical quantification level were eliminated from consideration. The analytical quantification level for a pollutant is the minimum concentration at which that pollutant can be reliably measured. For the toxic pollutants in this study, the analytical quantification levels are: 0.005 mg/l for pesticides, PCB's, chromium, and nickel; 0.010 mg/l for the remaining toxic organic pollutants and cyanide, arsenic, beryllium, and selenium; 10 million fibers per liter (10 MFL) for asbestos; 0.020 mg/l for lead and silver; 0.009 mg/l for copper; 0.002 mg/l for cadmium; and 0.0001 mg/l for mercury.

The pesticide TCDD (2,3,7,8-tetrachloridibenzo-p-dioxin) was not analyzed for because a standard sample was unavailable to the analytical laboratories. Samples collected by the Agency's contractor were not analyzed for asbestos. Data on asbestos content are available for a very small number of samples relevant to this study as a result of the first phase of a screening program for asbestos in a wide range of industrial categories. Of these samples, only a few appear to contain asbestos at analytically significant levels.

Pollutants which were detected below levels considered to be achievable by specific available treatment methods were also eliminated from further consideration. For the toxic metals, the chemical precipitation, sedimentation, and filtration technology treatment effectiveness values, which are presented in Section VII, were used. For the toxic organic pollutants detected above their analytical quantification level, treatment effectiveness values for activated carbon technology were used. These treatment effectiveness values represent the most stringent treatment options considered for pollutant removal. This allows for the most conservative pollutant exclusion based on pollutants detected below treatable levels.

DESCRIPTION OF POLLUTANT PARAMETERS

The following discussion addresses the pollutant parameters detected in any sample of copper forming wastewater. The description of each pollutant provides the following information: the source of the pollutant; whether it is a naturally occuring element, processed metal, or manufactured compound; general physical properties and the form of the pollutant; toxic effects of the pollutant in humans and other animals; and behavior of the pollutant in a POTW at concentrations that might be expected from industrial discharges.

Benzene (4). Benzene (C_6H_6) is a clear, colorless liquid obtained mainly from petroleum feedstocks by several different processes. Some is recovered from light oil obtained from coal carbonization gases. It boils at 80° C and has a vapor pressure of 100 mm Hg at 26° C. It is slightly soluble in water (1.8 g/l at 25° C) and it dissolves in hydrocarbon solvents. Annual U.S. production is three to four million tons.

Most of the benzene used in the U.S. goes into chemical manufacture. About half of that is converted to ethylbenzene which is used to make styrene. Some benzene is used in motor fuels.

Benzene is harmful to human health, according to numerous published studies. Most studies relate effects of inhaled benzene vapors. These effects include nausea, loss of muscle coordination, and excitement, followed by depression and coma. Death is usually the result of respiratory or cardiac failure. Two specific blood disorders are related to benzene exposure. One of these, acute myelogenous leukemia, represents a carcinogenic effect of benzene. However, most human exposure data are based on exposure in occupational settings and benzene carcinogenesis is not considered to be firmly established.

Oral administration of benzene to laboratory animals produced leukopenia, a reduction in number of leukocytes in the blood. Subcutaneous injection of benzene-oil solutions has produced suggestive, but not conclusive, evidence of benzene carcinogenesis.

Benzene demonstrated teratogenic effects in laboratory animals, and mutagenic effects in humans and other animals.

For maximum protection of human health from the potential carcinogenic effects of exposure to benzene through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of benzene estimated to result in additional lifetime cancer risk at levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.000066 mg/l, 0.00066 mg/l, and 0.0066 mg/l, respectively.

Some studies have been reported regarding the behavior of benzene in a POTW. Biochemical oxidation of benzene under laboratory conditions, at concentrations of 3 to 10 mg/l, produced 24, 27, 24, and 20 percent degradation in 5, 10, 15, and 20 days, respectively, using unacclimated seed cultures in fresh water. Degradation of 58, 67, 76, and 80 percent was produced in the same time periods using acclimated seed cultures. Other studies produced similar results. The EPA's most recent study of POTW removal of toxic organics indicates that benzene is 66 percent removed. Other reports indicate that most benzene entering a POTW is removed to the sludge and that influent concentrations of 1 g/l inhibit sludge digestion. There is no information about possible effects of benzene on crops grown in soils amended with sludge containing benzene.

Carbon Tetrachloride (6). Carbon tetrachloride (CCl_4), also called tetrachloromethane, is a colorless liquid produced primarily by the chlorination of hydrocarbons - particularly methane. Carbon tetrachloride boils at 77° C and has a vapor pressure of 90 mm Hg at 20° C. It is slightly soluble in water (0.8 g/l at 25° C) and soluble in many organic solvents. Approximately one-third of a million tons is produced annually in the U.S.

Carbon tetrachloride, which was displaced by perchloroethylene as a dry cleaning agent in the 1930's, is used principally as an intermediate for production of chlorofluoromethanes for refrigerants, aerosols, and blowing agents. It is also used as a grain fumigant.

Carbon tetrachloride produces a variety of toxic effects in humans. Ingestion of relatively large quantities - greater than five grams - has frequently proved fatal. Symptoms are burning sensation in the mouth, esophagus, and stomach, followed by abdominal pains, nausea, diarrhea, dizziness, abnormal pulse, and coma. When death does not occur immediately, liver and kidney damage are usually found. Symptoms of chronic poisoning are not as well defined. General fatigue, headache, and anxiety have been observed, accompanied by digestive tract and kidney discomfort or pain.

Data concerning teratogenicity and mutagenicity of carbon tetrachloride are scarce and inconclusive. However, carbon tetrachloride has been demonstrated to be carcinogenic in laboratory animals. The liver was the target organ.

For maximum protection of human health from the potential carcinogenic effects of exposure to carbon tetrachloride through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of carbon tetrachloride estimated to result in additional lifetime cancer risk at risk levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.00004 mg/l, 0.0004 mg/l, and 0.004 mg/l, respectively.

Data on the behavior of carbon tetrachloride in a POTW are not available. Many of the toxic organic pollutants have been investigated, at least in laboratory-scale studies, at concentrations higher than those expected to be found in most municipal wastewaters. General observations have been developed relating molecular structure to ease of degradation for all of the toxic organic pollutants. The conclusion reached by study of the limited data is that biological treatment produces a moderate degree of removal of carbon tetrachloride in a POTW. No information was found regarding the possible interference of carbon tetrachloride with treatment processes. Based on the water solubility of carbon tetrachloride, and the vapor pressure of this compound, it is expected that some of the undegraded carbon tetrachloride will pass through to the POTW effluent and some will be volatilized in aerobic processes.

Chlorobenzene (7). Chlorobenzene (C_6H_5Cl), also called monochlorobenzene is a clear, colorless, liquid manufactured by the liquid phase chlorination of benzene over a catalyst. It boils at 132° C and has a vapor pressure of 12.5 mm Hg at 25° C. It is almost insoluble in water (0.5 g/l at 30° C), but dissolves in hydrocarbon solvents. U.S. annual production is near 150,000 tons.

Principal uses of chlorobenzene are as a solvent and as an intermediate for dyes and pesticides. Formerly it was used as an intermediate for DDT production, but elimination of production of that compound reduced annual U.S. production requirements for chlorobenzene by half.

Data on the threat to human health posed by chlorobenzene are limited in number. Laboratory animals, administered large doses of chlorobenzene subcutaneously, died as a result of central nervous system depression. At slightly lower dose rates, animals died of liver or kidney damage. Metabolic disturbances occurred also. At even lower dose rates of orally administered chlorobenzene similar effects were observed, but some animals survived longer than at higher dose rates. No studies have been reported regarding evaluation of the teratogenic, mutagenic, or carcinogenic potential of chlorobenzene.

For the prevention of adverse effects due to the organoleptic properties of chlorobenzene in water the recommended criterion is 0.020 mg/l.

Only limited data are available on which to base conclusions about the behavior of chlorobenzene in a POTW. Laboratory studies of the biochemical oxidation of chlorobenzene have been carried out at concentrations greater than those expected to normally be present in POTW influent. Results showed the extent of degradation to be 25, 28, and 44 percent after 5, 10, and 20 days, respectively. In another similar study using a phenol-adapted culture, 4 percent degradation was observed after 3 hours with a solution containing 80 mg/l. On the basis of these results and general conclusions about the relationship of molecular structure to biochemical oxidation, it is concluded that chlorobenzene remaining intact is expected to volatilize from the POTW in aeration processes. The estimated half-life of chlorobenzene in water based on water solubility, vapor pressure and molecular weight is 5.8 hours.

1,1,1-Trichloroethane (11). 1,1,1-Trichloroethane is one of the two possible trichloroethanes. It is manufactured by hydrochlorinating vinyl chloride to 1,1-dichloroethane which is then chlorinated to the desired product. 1,1,1-Trichloroethane is a liquid at room temperature with a vapor pressure of 96 mm Hg at 20° C and a boiling point of 74° C. Its formula is CCl_3CH_3. It is slightly soluble in water (0.48 g/l) and is very soluble in organic solvents. U.S. annual production is greater than one-third of a million tons.

1,1,1-Trichloroethane is used as an industrial solvent and degreasing agent.

Most human toxicity data for 1,1,1-trichloroethane relates to inhalation and dermal exposure routes. Limited data are available for determining toxicity of ingested 1,1,1-trichloroethane, and those data are all for the compound itself, not solutions in water. For the protection of human health from the toxic properties of 1,1,1-trichloroethane ingested through the consumption of water and fish, the ambient water criterion is 18.4 mg/l. The criterion is based on bioassays for possible carcinogenicity.

None of the toxic organic pollutants of this type can be broken down by biological treatment processes as readily as fatty acids, carbohydrates, or proteins.

Biochemical oxidation of many of the toxic organic pollutants has been investigated, at least in laboratory scale studies, at concentrations higher than commonly expected in municipal wastewater. General observations relating molecular structure to ease of degradation have been developed for all of these pollutants. The conclusion reached by study of these limited data is that biological treatment produces a moderate degree of degradation of 1,1,1-trichloroethane. No evidence is available for drawing conclusions about its possible toxic or inhibitory effect on POTW operation. However, for degradation to occur, a fairly constant input of the compound would be necessary.

Its water solubility would allow 1,1,1-trichloroethane, present in the influent and not biodegradable, to pass through a POTW into the effluent. EPA's most recent study of POTW removal of toxic organics indicates that 1,1,1-trichloroethane is approximately 80 percent removed. One factor which has received some attention, but no detailed study, is the volatilization of the lower molecular weight organics from a POTW. If 1,1,1-trichloroethane is not biodegraded, it will volatilize during aeration processes in the POTW.

Chloroform (23). Chloroform, also called trichloromethane, is a colorless liquid manufactured commercially by chlorination of methane. Careful control of conditions maximizes chloroform production, but other products must be separated. Chloroform boils at 61° C and has a vapor pressure of 200 mm Hg at 25° C. It is slightly soluble in water (8.22 g/l at 20° C) and readily soluble in organic solvents.

Chloroform is used as a solvent and to manufacture refrigerants, pharmaceuticals, plastics, and anesthetics. It is seldom used as an anesthetic.

Toxic effects of chloroform on humans include central nervous system depression, gastrointestinal irritation, liver and kidney damage, and possible cardiac sensitization to adrenalin. Carcinogenicity has been demonstrated for chloroform on laboratory animals.

For the maximum protection of human health from the potential carcinogenic effects of exposure to chloroform through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of chloroform estimated to result in additional lifetime cancer risks at the levels of 10^{-7}, 10^{-6}, and 10^{-5} were 0.000019 mg/l, 0.00019 mg/l, and 0.0019 mg/l, respectively.

The biochemical oxidation of this compound was studied in one laboratory scale study at concentrations higher than those expected to be contained by most municipal wastewaters. After 5, 10, and 20 days no degradation of chloroform was observed. The conclusion reached is that biological treatment produces little or no removal by degradation of chloroform in a POTW.

The high vapor pressure of chloroform is expected to result in volatilization of the compound from aerobic treatment steps in a POTW. Remaining chloroform is expected to pass through into the POTW effluent.

In addition, the most recent EPA study of POTW removal of toxic organics indicates that chloroform is only 11 percent removed.

2,6-Dinitrotoluene (36). 2,6-Dinitrotoluene [$(NO_2)_2C_6H_4CH_3$], a yellow crystalline compound, is manufactured as a coproduct with the 2,4-isomer by nitration of nitrotoluene. It melts at 71° C. 2,6-Dinitrotoluene is insoluble in water (0.27 g/l at 22° C) and soluble in a number of organic solvents. Production data for the 2,6-isomer alone are not available. The 2,4- and 2,6-isomers are manufactured in an 80:20 or 65:35 ratio, depending on the process used. Annual U.S. commercial production is about 150 thousand tons of the two isomers. Unspecified amounts are produced by the U.S. government and further nitrated to trinitrotoluene (TNT) for military use. The major use of the dinitrotoluene mixture is for production of toluene diisocyanate used to make polyurethanes. Another use is in production of dyestuffs.

Data on the behavior of 2,6-dinitrotoluene in a POTW are not available. However, biochemical oxidation of the 2,4-dinitrotoluene isomer was investigated in a laboratory scale. At 100 mg/l of 2,4-dinitrotoluene, a concentration considerably higher than that expected in municipal wastewaters, biochemical oxidation by an acclimated, phenol-adapted seed culture produced 52 percent degradation in three hours. Based on this limited information and general observations relating molecular structure to ease of degradation for all the toxic organic pollutants, it was concluded that biological treatment in a POTW removes 2,4-dinitrotoluene to a high degree. It is not known if this conclusion can be expanded to include the 2,6-isomer. No information is available regarding possible interference by 2,6-dinitrotoluene in POTW treatment processes, or on the possible detrimental effect on sludge used to amend soils in which food crops are grown.

Ethylbenzene (38). Ethylbenzene is a colorless, flammable liquid manufactured commercially from benzene and ethylene. Approximately half of the benzene used in the U.S. goes into the manufacture of more than three million tons of ethylbenzene annually. Ethylbenzene boils at 136° C and has a vapor pressure of 7 mm Hg at 20° C. It is slightly soluble in water (0.14 g/l at 15° C) and is very soluble in organic solvents.

About 98 percent of the ethylbenzene produced in the U.S. goes into the production of styrene, much of which is used in the plastics and synthetic rubber industries. Ethylbenzene is a constituent of xylene mixtures used as diluents in the paint industry, agricultural insecticide sprays, and gasoline blends.

Although humans are exposed to ethylbenzene from a variety of sources in the environment, little information on effects of ethylbenzene in man or animals is available. Inhalation can irritate eyes, affect the respiratory tract, or cause vertigo. In laboratory animals ethylbenzene exhibited low toxicity. There are no data available on teratogenicity, mutagenicity, or carcinogenicity of ethylbenzene.

Criteria are based on data derived from inhalation exposure limits. For the protection of human health from the toxic properties of ethylbenzene ingested through water and contaminated aquatic organisms, the ambient water quality criterion is 1.4 mg/l.

Laboratory scale studies of the biochemical oxidation of ethylbenzene at concentrations greater than would normally be found in municipal wastewaters have demonstrated varying degrees of degradation. In one study with phenol-acclimated seed cultures, 27 percent degradation was observed in a half day at 250 mg/l ethylbenzene. Another study at unspecified conditions showed 32, 38, and 45 percent degradation after 5, 10, and 20 days, respectively. Based on these results and general observations relating molecular structure of degradation, the conclusion is reached that biological treatment produces only moderate removal of ethylbenzene in a POTW by degradation.

Other studies suggest that most of the ethybenzene entering a POTW is removed from the aqueous stream to the sludge. The ethylbenzene contained in the sludge removed from the POTW may volatilize.

In addition, the most recent EPA study of POTW removal of toxic organics indicates that ethylbenzene is approximately 86 percent removed.

Methylene Chloride (44). Methylene chloride, also called dichloromethane (CH_2Cl_2), is a colorless liquid manufactured by chlorination of methane or methyl chloride followed by separation from the higher chlorinated methanes formed as coproducts. Methylene chloride boils at 40° C, and has a vapor pressure of 362 mm Hg at 20° C. It is slightly soluble in water (20 g/l at 20°C), and very soluble in organic solvents. U.S. annual production is about 250,000 tons.

Methylene chloride is a common industrial solvent found in insecticides, metal cleaners, paint, and paint and varnish removers.

Methylene chloride is not generally regarded as highly toxic to humans. Most human toxicity data are for exposure by inhalation. Inhaled methylene chloride acts as a central nervous system depressant. There is also evidence that the compound causes heart failure when large amounts are inhaled.

Methylene chloride does produce mutation in tests for this effect. In addition, a bioassay recognized for its extremely high sensitivity to strong and weak carcinogens produced results which were marginally significant. Thus potential carcinogenic effects of methylene chloride are not confirmed or denied, but are under continuous study. These studies are difficult to conduct for two reasons. First, the low boiling point (40° C) of methylene chloride makes it difficult to maintain the compound at 37° C during incubation. Secondly, all impurities must be removed because the impurities themselves may be carcinogenic. These complications also make the test results difficult to interpret.

For the protection of human health from the potential carcinogenic effects due to exposure to methylene chloride through ingestion of contaminated water and contaiminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Thefefore, the levels which may result in incrmental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6} and 10^{-7}. The corresponding recommended criteria are 0.0019 mg/l, 0.00019 mg/l, and 0.000019 mg/l.

The behavior of methylene chloride in POTW has not been studied in any detail. However, the biochemical oxidation of this compound was studied in one laboratory scale at concentrations higher than those expected to be contained by most municipal wastewaters. After five days no degradation of methylene chloride was observed. The conclusion reached is that biological treatment produces little or no removal by degradation of methylene chloride in POTW.

The high vapor pressure of methylene chloride is expected to result in volatilization of the compound from aerobic treatment steps in a POTW. It has been reported that methylene chloride inhibits anerobic processes in a POTW. Methylene chloride that is not volatilized in the POTW is expected to pass through into the effluent.

The most recent EPA study of POTW removal of toxic organics indicates that methylene chloride is approximately 56 percent removed.

Naphthalene (55). Naphthalene is an aromatic hydrocarbon with two orthocondensed benzene rings and a molecular formula of $C_{10}H_8$. As such it is properly classed as a polynuclear aromatic hydrocarbon (PAH). Pure naphthalene is a white crystalline solid melting at 80° C. For a solid, it has a relatively high vapor pressure (0.05 mm Hg at 20° C), and moderate water solubility (19 mg/l at 20° C). Napthalene is the most abundant single component of coal tar. Production is more than a third of a million tons annually in the U.S. About three fourths of the production is used as feedstock for phthalic anhydride manufacture. Most of the remaining production goes into manufacture of insecticide, dyestuffs, pigments, and pharmaceuticals. Chlorinated and partially hydrogenated naphthalenes are used in some solvent mixtures. Naphthalene is also used as a moth repellent.

Naphthalene, ingested by humans, has reportedly caused vision loss (cataracts), hemolytic anemia, and occasionally, renal disease. These effects of naphthalene ingestion are confirmed by studies on laboratory animals. No carcinogenicity studies are available which can be used to demonstrate carcinogenic activity for naphthalene. Naphthalene does bioconcentrate in aquatic organisms. There are insufficient data on which to base any ambient water criterion.

Only a limited number of studies have been conducted to determine the effects of naphthalene on aquatic organisms. The data from those studies show only moderate toxicity.

Biochemical oxidation of many of the toxic organic pollutants has been investigated in laboratory scale studies at concentrations higher than would normally be expected in municipal wastewaters. General observations relating molecular structure to ease of degradation have been developed for all of these pollutants. The conclusion reached by study of the limited data is that biological treatment produces a high removal by degradation of naphthalene. One recent study has shown that microorganisms can degrade naphthalene, first to a dihydro compound, and ultimately to carbon dioxide and water.

Naphthalene has been detected in sewage plant effluents at concentrations up to 0.022 mg/l in studies carried out by the U.S. EPA. Influent levels were not reported. The most recent EPA study of POTW removal of toxic organics indicates that naphthalene is approximately 85 percent removed.

N-nitrosodiphenylamine (62). N-nitrosodiphenylamine [$(C_6H_5)_2NNO$], also call nitrous diphenylamide is a yellow crystalline solid manufactured by nitrosation of diphenylamine. It melts at 66°° C and is insoluble in water, but soluble in several organic solvents other than hydrocarbons. Production in the U.S. has approached 1,500 tons per year. The compound is used as a retarder for rubber vulcanization and as a pesticide for control of scorch (a fungus disease of plants).

N-nitroso compounds are acutely toxic to every animal species tested and are also poisonous to humans. N-nitrosodiphenylamine toxicity in adult rats lies in the mid range of the values for 60

N-nitroso compounds tested. Liver damage is the principal toxic effect. N-nitrosodiphenylamine, unlike many other N-nitrosoamines, does not show mutagenic activity. N-nitrosodiphenylamine has been reported by several investigations to be non-carcinogenic. However, the compound is capable of trans-nitrosation and could thereby convert other amines to carcinogenic N-nitrosoamines. Sixty-seven of 87 N-nitrosoamines studied were reported to have carcinogenic activity. No water quality criterion have been proposed for N-nitrosodiphenylamine.

No data are available on the behavior of N-nitrosodiphenylamine in a POTW. Biochemical oxidation of many of the toxic organic pollutants have been investigated, at least in laboratory scale studies, at concentrations higher than those expected to be contained in most municipal wastewaters. General observations have been developed relating molecular structure to ease of degradation for all the toxic organic pollutants. The conclusion reached by study of the limited data is that biological treatment produces little or no removal of N-nitrosodiphenylamine in a POTW. No information is available regarding possible interference by N-nitrosodiphenylamine in POTW processes, or on the possible detrimental effect on sludge used to amend soils in which crops are grown. However, no interference or detrimental effects are expected because N-nitroso compounds are widely distributed in the soil and water environment, at low concentrations, as a result of microbial action on nitrates and nitrosatable compounds.

Phthalate Esters (66-71). Phthalic acid, or 1,2-benzenedicarboxylic acid, is one of three isomeric benzenedicarboxylic acids produced by the chemical industry. The other two isomeric forms are called isophthalic and terephthalic acids. The formula for all three acids is $C_6H_4(COOH)_2$. Somes esters of phthalic acid are designated as toxic pollutants. They will be discussed as a group here, and specific properties of individual phthalate esters will be discussed afterwards.

Phthalic acid esters are manufactured in the U.S. at an annual rate in excess of one billion pounds. They are used as plasticizers - primarily in the production of polyvinyl chloride (PVC) resins. The most widely used phthalate plasticizer is bis (2-ethylhexyl) phthalate (66) which accounts for nearly one-third of the phthalate esters produced. This particular ester is commonly referred to as dioctyl phthalate (DOP) and should not be confused with one of the less used esters, di-n-octyl phthalate (69), which is also used as a plasticizer. In addition to these two isomeric dioctyl phthalates, four other esters, also used primarily as plasticizers, are designated as toxic pollutants. They are: butyl benzyl phthalate (67), di-n-butyl phthalate (68), diethyl phthalate (70), and dimethyl phthalate (71).

Industrially, phthalate esters are prepared from phthalic anhydride and the specific alcohol to form the ester. Some evidence is available suggesting that phthalic acid esters also may be synthesized by certain plant and animal tissues. The extent to which this occurs in nature is not known.

Phthalate esters used as plasticizers can be present in concentrations up to 60 percent of the total weight of the PVC plastic. The plasticizer is not linked by primary chemical bonds to the PVC resin. Rather, it is locked into the structure of intermeshing polymer molecules and held by van der Waals forces. The result is that the plasticizer is easily extracted. Plasticizers are responsible for the odor associated with new plastic toys or flexible sheet that has been contained in a sealed package.

Although the phthalate esters are not soluble or are only very slightly soluble in water, they do migrate into aqueous solutions placed in contact with the plastic. Thus, industrial facilities with tank linings, wire and cable coverings, tubing, and sheet flooring of PVC are expected to discharge some phthalate esters in their raw waste. In addition to their use as plasticizers, phthalate esters are used in lubricating oils and pesticide carriers. These also can contribute to industrial discharge of phthalate esters.

From the accumulated data on acute toxicity in animals, phthalate esters may be considered as having a rather low order of toxicity. Human toxicity data are limited. It is thought that the toxic effects of the esters is most likely due to one of the metabolic products, in particular the monoester. Oral acute toxicity in animals is greater for the lower molecular weight esters than for the higher molecular weight esters.

Orally administered phthalate esters generally produced enlarging of liver and kidney, and atrophy of testes in laboratory animals. Specific esters produced enlargement of heart and brain, spleenitis, and degeneration of central nervous system tissue.

Subacute doses administered orally to laboratory animals produced some decrease in growth and degeneration of the testes. Chronic studies in animals showed similar effects to those found in acute and subacute studies, but to a much lower degree. The same organs were enlarged, but pathological changes were not usually detected.

A recent study of several phthalic esters produced suggestive but not conclusive evidence that dimethyl and diethyl phthalates have a cancer liability. Only four of the six toxic pollutant esters were included in the study. Phthalate esters do bioconcentrate in fish. The factors, weighted for relative consumption of various aquatic and marine food groups, are used to calculate ambient water quality criteria for four phthalate esters. The values are included in the discussion of the specific esters.

Studies of toxicity of phthalate esters in freshwater and saltwater organisms are scarce. A chronic toxicity test with bis (2-ethylhexyl) phthalate showed that significant reproductive impairment occurred at 0.003 mg/l in the freshwater crustacean, Daphnia magna. In acute toxicity studies, saltwater fish and organisms showed sensitivity differences of up to eight-fold to butyl benzyl, diethyl, and dimethyl phthalates. This suggests that each ester must be evaluated individually for toxic effects.

The behavior of phthalate esters in a POTW has not been studied. However, the biochemical oxidation of many of the toxic organic pollutants has been investigated in laboratory scale studies at concentrations higher than would normally be expected in municipal wastewaters. Three of the phthalate esters were studed. Bis(2-ethylhexyl) phthalate was found to be degraded slightly or not at all and its removal by biological treatment in a POTW is expected to be slight or zero. Di-n-butyl phthalate and diethyl phthalate were degraded to a moderate degree and their removal by biological treatment in a POTW is expected to occur to a moderate degree. Using these data and other observations relating molecular structure to ease of biochemical degradation of other toxic organic pollutants, the conclusion was reached that butyl benzyl phthalate and dimethyl phthalate would be removed in a POTW to a moderate degree by biological treatment. On the same basis, it was concluded that di-n-octyl phthalate would be removed to a slight degree or not at all. An EPA study of seven POTW facilities revealed that for all but di-n-octyl phthalate, which was not studied, removals ranged from 62 to 87 percent.

No information was found on possible interference with POTW operation or the possible effects on sludge by the phthalate esters. The water insoluble phthalate esters - butyl benzyl and di-n-octyl phthalate - would tend to remain in sludge, whereas the other four toxic pollutant phthalate esters with water solubilities ranging from 50 mg/l to 4.5 mg/l would probably pass through into the POTW effluent.

Bis(2-ethylhexyl) phthalate (66). In addition to the general remarks and discussion on phthalate esters, specific information on bis(2-ethylhexyl) phthalate is provided. Little information is available about the physical properties of bis(2-ethylhexyl) phthalate. It is a liquid boiling at 387° C at 5mm Hg and is insoluble in water. Its formula is $C_6H_4(COOC_8H_{17})_2$. This toxic pollutant constitutes about one-third of the phthalate ester production in the U.S. It is commonly referred to as dioctyl phthalate, or DOP, in the plastics industry where it is the most extensively used compound for the plasticization of polyvinyl chloride (PVC). Bis(2-ethylhexyl) phthalate has been approved by the FDA for use in plastics in contact with food. Therefore, it may be found in wastewaters coming in contact with discarded plastic food wrappers as well as the PVC films and shapes normally found in industrial plants. This toxic pollutant is also a commonly used organic diffusion pump oil, where its low vapor pressure is an advantage.

For the protection of human health from the toxic properties of bis(2-ethylhexyl) phthalate ingested through water and through contaminated aquatic organisms, the ambient water quality criterion is determined to be 15 mg/l. If contaminated aquatic organisms alone are consumed, excluding the consumption of water, the ambient water criterion is determined to be 50 mg/l.

Although the behavior of bis(2-ethylhexyl) phthalate in a POTW has not been studied, biochemical oxidation of this toxic pollutant has been studied on a laboratory scale at concentrations higher than would normally be expected in municipal wastewater. In fresh water with a non-acclimated seed culture no biochemical oxidation was observed after 5, 10, and 20 days. However, with an acclimated seed culture, biological oxidation occured to the extents of 13, 0, 6, and 23 percent of theoretical after 5, 10, 15, and 20 days, respectively. Bis(2-ethylhexyl) phthalate concentrations were 3 to 10 mg/l. Little or no removal of bis(2-ethylhexyl) phthalate by biological treatment in a POTW is expected.

Butyl benzyl phthalate (67). In addition to the general remarks and discussion on phthalate esters, specific information on butyl benzyl phthalate is provided. No information was found on the physical properties of this compound.

Butyl benzyl phthalate is used as a plasticizer for PVC. Two special applications differentiate it from other phthalate esters. It is approved by the U.S. FDA for food contact in wrappers and containers; and it is the industry standard for plasticization of vinyl flooring because it provides stain resistance.

No ambient water quality criterion is proposed for butyl benzyl phthalate.

Butyl benzyl phthalate removal in a POTW by biological treatment is expected to occur to a moderate degree.

Di-n-butyl phthalate (68). In addition to the general remarks and discussion on phthalate esters, specific information on di-n-butyl phthalate (DBP) is provided. DBP is a colorless, oil liquid, boiling at 340° C. Its water solubility at room temperature is reported to be 0.4 g/l and 4.5 g/l in two different chemical hand books. The formula for DBP, $C_6H_4(COOC_4H_9)_2$, is the same as for its isomer, di-isobutyl phthalate. DBP production is 1 to 2 percent of total U.S. phthalate ester production.

Dibutyl phthalate is used to a limited extent as a plasticizer for polyvinyl chloride (PVC). It is not approved for contact with food. It is used in liquid lipsticks and as a diluent for polysulfide dental impression materials. DBP is used as a plasticizer for nitrocellulose in making gun powder, and as a fuel in solid propellants for rockets. Further uses are insecticides, safety glass manufacture, textile lubricating agents, printing inks, adhesives, paper coatings, and resin solvents.

For protection of human health from the toxic properties of dibutyl phthalate ingested through water and through contaminated aquatic organisms, the ambient water quality criterion is determined to be 34 mg/l. If contaminated aquatic organisms alone are consumed, excluding the consumption of water, the ambient water criterion is 154 mg/l.

Although the behavior of di-n-butyl phthalate in a POTW has not been studied, biochemical oxidation of this toxic pollutant has been studied on a laboratory scale at concentrations higher than would normally be expected in municipal wastewaters. Biochemical oxidation of 35, 43, and 45 percent of theoretical oxidation were obtained after 5, 10, and 20 days, respectively, using sewage microorganisms as an unacclimated seed culture.

Biological treatment in a POTW is expected to remove di-n-butyl phthalate to a moderate degree.

Di-n-octyl phthalate (69). In addition to the general remarks and discussion on phthalate esters, specific information on di-n-octyl phthalate is provided. Di-n-octyl phthalate is not to be confused with the isomeric bis(2-ethylhexyl) phthalate which is commonly referred to in the plastics industry as DOP. Di-n-octyl phthalate is a liquid which boils at 220° C at 5 mm Hg. It is insoluble in water. Its molecular formula is $C_6H_4(COOC_8H_{17})_2$. Its production constitutes about 1 percent of all phthalate ester production in the U.S.

Industrially, di-n-octyl phthalate is used to plasticize polyvinyl chloride (PVC) resins.

No ambient water quality criterion is proposed for di-n-octyl phthalate.

Biological treatment in a POTW is expected to lead to little or no removal of di-n-octyl phthalate.

Dimethyl phthalate (71). In addition to the general remarks and discussion on phthalate esters, specific information on dimethyl phthalate (DMP) is provided. DMP has the lowest molecular weight of the phthalate esters - M.W. = 194 compared to M.W. of 391 for bis(2-ethylhexyl) phthalate. DMP has a boiling point of 282° C. It is a colorless liquid, soluble in water to the extent of 5 mg/l. Its molecular formula is $C_6H_4(COOCH_2)_2$.

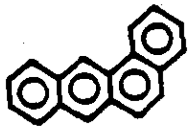
Dimethyl phthalate production in the U.S. is just under one percent of total phthalate ester production. DMP is used to some extent as a plasticizer in cellulosics; however, its principal specific use is for dispersion of polyvinylidene fluoride (PVDF). PVDF is resistant to most chemicals and finds use as electrical insulation, chemical process equipment (particularly pipe), and as a case for long-life finishes for exterior metal siding. Coil coating techniques are used to apply PVDF dispersions to aluminum or galvanized steel siding.

For the protection of human health from the toxic properties of dimethyl phthalate ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 313 mg/l. If contaminated aquatic organisms alone are consumed, excluding the consumption of water, the ambient water criterion is 2,900 mg/l.

Based on limited data and observations relating molecular structure to ease of biochemical degradation of other toxic organic pollutants, it is expected that dimethyl phthalate will be biochemically oxidized to a lesser extent than domestic sewage by biological treatment in a POTW.

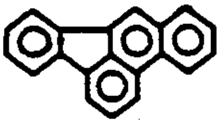
Polynuclear Aromatic Hydrocarbons (72-84). The polynuclear aromatic hydrocarbons (PAH) selected as toxic pollutants are a group of 13 compounds consisting of substituted and unsubstituted polycyclic aromatic rings. The general class of PAH includes heterocyclics, but none of those were selected as toxic pollutants. PAH are formed as the result of incomplete combustion when organic compounds are burned with insufficient oxygen. PAH are found in coke oven emissions, vehicular emissions, and volatile products of oil and gas burning. The compounds chosen as toxic pollutants are listed with their structural formula and melting point (m.p.). All are nearly insoluble in water.

72 Benzo(a)anthracene (1,2-benzanthracene) m.p. 162° C

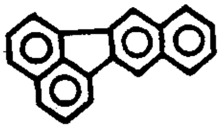


73 Benzo(a)pyrene (3,4-benzopyrene) m.p. 176° C

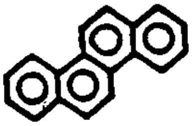
74 3,4-Benzofluoranthene m.p. 168° C



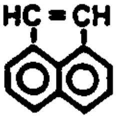
75 Benzo(k)fluoranthene (11,12-benzofluoranthene) m.p. 217° C



76 Chrysene (1,2-benzphenanthrene) m.p.255° C

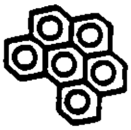


77 Acenaphthylene m.p. 92° C



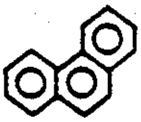
78 Anthracene m.p. 216° C

79 Benzo(ghi)perylene (1,12-benzoperylene) m.p. not reported

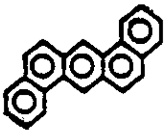


80 Fluorene (alpha-diphenylenemethane) m.p. 116° C

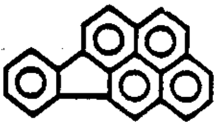
81 Phenanthrene m.p. 101° C



82 Dibenzo(a,h)anthracene (1,2,5,6-dibenzoanthracene) m.p. 269° C



83 Indeno (1,2,3-cd)pyrene (2,3-o-phenylenepyrene) m.p. not available



84 Pyrene m.p. 156° C

Some of these toxic pollutants have commercial or industrial uses. Benzo(a)anthracene, benzo(a)pyrene, chrysene, anthracene, dibenzo(a,h)anthracene, and pyrene are all used as antioxidants. Chrysene, acenaphthylene, anthracene, fluorene, phenanthrene, and pyrene are all used for synthesis of dyestuffs or other organic chemicals. 3,4-Benzofluoranthrene, benzo(k)fluoranthene, benzo-(ghi)perylene, and indeno (1,2,3-cd)pyrene have no known industrial uses, according to the results of a recent literature search.

Several of the PAH toxic pollutants are found in smoked meats, in smoke flavoring mixtures, in vegetable oils, and in coffee. Consequently, they are also found in many drinking water supplies. The wide distribution of these pollutants in complex mixtures with the many other PAHs which have not been designated as toxic pollutants results in exposures by humans that cannot be associated with specific individual compounds.

The screening and verification analysis procedures used for the toxic organic pollutants are based on gas chromatography (GC). Three pairs of the PAH have identical elution times on the column specified in the protocol, which means that the parameters of the pair are not differentiated. For these three pairs anthracene (78) - phenanthrene (81); 3,4-benzofluoranthene (74) - benzo(k)-

fluoranthene (75); and benzo(a)anthracene (72) - chrysene (76) results are obtained and reported as "either-or." Either both are present in the combined concentration reported, or one is present in the concentration reported.

There are no studies to document the possible carcinogenic risks to humans by direct ingestion. Air pollution studies indicate an excess of lung cancer mortality among workers exposed to large amounts of PAH containing materials such as coal gas, tars, and coke-oven emissions. However, no definite proof exists that the PAH present in these materials are responsible for the cancers observed.

Animal studies have demonstrated the toxicity of PAH by oral and dermal administration. The carcinogenicity of PAH has been traced to formation of PAH metabolites which, in turn, lead to tumor formation. Because the levels of PAH which induce cancer are very low, little work has been done on other health hazards resulting from exposure. It has been established in animal studies that tissue damage and systemic toxicity can result from exposure to non-carcinogenic PAH compounds.

Because there were no studies available regarding chronic oral exposures to PAH mixtures, proposed water quality criteria were derived using data on exposure to a single compound. Two studies were selected, one involving benzo(a)pyrene ingestion and one involving dibenzo(a,h)anthracene ingestion. Both are known animal carcinogens.

For the maximum protection of human health from the potential carcinogenic effects of exposure to polynuclear aromatic hydrocarbons (PAH) through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of PAH estimated to result in additional risk of 1 in 100,000 were derived by the EPA and the Agency is considering setting criteria at an interim target risk level in the range of 10^{-7}, 10^{-6}, or 10^{-5} with corresponding criteria of 0.00000028 mg/l, 0.0000028 mg/l, and 0.000028 mg/l, respectively.

No standard toxicity tests have been reported for freshwater or saltwater organisms and any of the 13 PAH discussed here.

The behavior of PAH in a POTW has received only a limited amount of study. It is reported that up to 90 percent of PAH entering a POTW will be retained in the sludge generated by conventional sewage treatment processes. Some of the PAH can inhibit bacterial growth when they are present at concentrations as low as 0.018 mg/l. Biological treatment in activated sludge units has been shown to reduce the concentration of phenanthrene and anthracene to some extent; however, a study of biochemical oxidation of fluorene on a laboratory scale showed no degradation after 5, 10, and 20 days. On the basis of that study and studies of other toxic organic pollutants, some general observations were made relating molecular structure to ease of degradation. Those observations lead to the conclusion that the 13 PAH selected to represent that group as toxic pollutants will be removed only slightly or not at all by biological treatment methods in a POTW. The most recent EPA study of POTW removal of toxic organics indicates that anthracene is 70 percent removed by POTWs and phenanthrene is 73 percent removed by POTWs.

No data are available at this time to support any conclusions about contamination of land by PAH on which sewage sludge containing PAH is spread.

Tetrachloroethylene (85). Tetrachloroethylene (CCl_2 CCl_2), also called perchloroethylene and PCE, is a colorless, nonflammable liquid produced mainly by two methods - chlorination and pyrolysis of ethane and propane, and oxychlorination of dichloroethane. U.S. annual production exceeds 300,000 tons. PCE boils at 121° C and has a vapor pressure of 19 mm Hg at 20° C. It is insoluble in water but soluble in organic solvents.

Approximately two-thirds of the U.S. production of PCE is used for dry cleaning. Textile processing and metal degreasing, in equal amounts consume about one-quarter of the U.S. production.

The principal toxic effect of PCE on humans is central nervous system depression when the compound is inhaled. Headache, fatigue, sleepiness, dizziness, and sensations of intoxication are reported. Severity of effects increases with vapor concentration. High integrated exposure (concentration times duration) produces kidney and liver damage. Very limited data on PCE ingested by laboratory animals indicate liver damage occurs when PCE is administered by that route. PCE tends to distribute to fat in mammalian bodies.

One report found in the literature suggests, but does not conclude, that PCE is teratogenic. PCE has been demonstrated to be a liver carcinogen in B6C3-F1 mice.

For the maximum protection of human health from the potential carcinogenic effects of exposure to tetrachlorethylene through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of tetrachloroethylene estimated to result in additional lifetime cancer risk levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.00008 mg/l, 0.0008 mg/l, and 0.008 mg/l, respectively.

No data were found regarding the behavior of PCE in a POTW. Many of the toxic organic pollutants have been investigated, at least in laboratory scale studies, at concentrations higher than those expected to be contained by most municipal wastewaters. General observations have been developed relating molecular structure to ease of degradation for all of the toxic organic pollutants. The conclusions reached by the study of the limited data is that biological treatment produces a moderate removal of PCE in a POTW by degradation. No information was found to indicate that PCE accumulates in the sludge, but some PCE is expected to be adsorbed onto settling particles. Some PCE is expected to be volatilized in aerobic treatment processes and little, if any, is expected to pass through into the effluent from the POTW.

Toluene (86). Toluene is a clear, colorless liquid with a benzene-like odor. It is a naturally occuring compound derived primarily from petroleum or petrochemical processes. Some toluene is obtained from the manufacture of metallurgical coke. Toluene is also referred to as totuol, methylbenzene, methacide, and phenylmethane. It is an aromatic hydrocarbon with the chemical formula $C_6H_5CH_3$. It boils at 111° C and has a vapor pressure of 30 mm Hg at room temperature. The water solubility of toluene is 535 mg/l, and it is miscible with a variety of organic solvents. Annual production of toluene in the U.S. is greater than two million metric tons. Approximately two-thirds of the toluene is converted to benzene and the remaining 30 percent is divided approximately equally into chemical manufacture, and use as a paint solvent and aviation gasoline additive. An estimated 5,000 metric tons is discharged to the environment anually as a constituent in wastewater.

Most data on the effects of toluene in human and other mammals have been based on inhalation exposure or dermal contact studies. There appear to be no reports of oral administration of toluene to human subjects. A long term toxicity study on female rats revealed no adverse effects on growth, mortality, appearance and behavior, organ to body weight ratios, blood-urea nitrogen levels, bone marrow counts, peripheral blood counts, or morphology of major organs. The effects of inhaled toluene on the central nervous system, both at high and low concentrations, have been studied in humans and animals. However, ingested toluene is expected to be handled differently by the body because it is absorbed more slowly and must first pass through the liver before reaching the nervous system. Toluene is extensively and rapidly metabolized in the liver. One of the principal metabolic products of toluene is benzoic acid, which itself seems to have little potential to produce tissue injury.

Toluene does not appear to be teratogenic in laboratory animals or man. Nor is there any conclusive evidence that toluene is mutagenic. Toluene has not been demonstrated to be positive in any *in vitro* mutagenicity or carcinogenicity bioassay system, nor to be carcinogenic in animals or man.

Toluene has been found in fish caught in harbor waters in the vicinity of petroleum and petrochemical plants. Bioconcentration studies have not been conducted, but bioconcentration factors have been calculated on the basis of the octanol-water partition coefficient.

For the protection of human health from the toxic properties of toluene ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 14.3 mg/l. If contaminated aquatic organisms alone are consumed excluding the consumption of water, the ambient water criterion is 424 mg/l. Available data show that the adverse effects on aquatic life occur at concentrations as low as 5 mg/l.

Acute toxicity tests have been conducted with toluene and a variety of freshwater fish and *Daphnia magna*. The latter appears to be significantly more resistant than fish. No test results have been reported for the chronic effects of toluene on freshwater fish or invertebrate species.

The biochemical oxidation of many of the toxic pollutants has been investigated in laboratory scale studies at concentrations greater than those expected to be contained by most municipal wastewaters. At toluene concentrations ranging from 3 to 250 mg/l, biochemical oxidation proceeded to 50 percent of theoretical or greater. The time period varied from a few hours to 20 days depending on whether or not the seed culture was acclimated. Phenol adapted acclimated seed cultures gave the most rapid and extensive biochemical oxidation.

It is expected that toluene will be biochemically oxidized to a lesser extent than domestic sewage by biological treatment in a POTW. The volatility and relatively low water solubility of toluene lead to the expectation that aeration processes will remove significant quantities of toluene from the POTW. The EPA studied toluene removal in seven POTW facilities. The removals ranged from 40 to 100 percent. Sludge concentrations of toluene ranged from 54 x 100^{-3} to 1.85 mg/l. The latest EPA study of POTW removal of toxic organics indicates that toluene is approximatley 70 percent removed.

Trichloroethylene (87). Trichloroethylene (1,1,2-trichloroethylene or TCE) is a clear, colorless liquid boiling at 87° C. It has a vapor pressure of 77 mm Hg at room temperature and is slightly soluble in water (1 gm/l). U.S. production is greater than 0.25 million metric tons annually. It is produced from tetrachloroethane by treatment with lime in the presence of water.

TCE is used for vapor phase degreasing of metal parts, cleaning and drying electronic components, as a solvent for paints, as a refrigerant, for extraction of oils, fats, and waxes, and for dry cleaning. Its widespread use and relatively high volatility result in detectable levels in many parts of the environment.

Data on the effects produced by ingested TCE are limited. Most studies have been directed at inhalation exposure. Nervous system disorders and liver damage are frequent results of inhalation exposure. In the short term exposures, TCE acts as a central nervous system depressant - it was used as an anesthetic before its other long term effects were defined.

TCE has been shown to induce transformation in a highly sensitive in vitro Fischer rat embryo cell system (F1706) that is used for identifying carcinogens. Severe and persistent toxicity to the liver was recently demonstrated when TCE was shown to produce carcinoma of the liver in mouse strain B6C3F1. One systematic study of TCE exposure and the incidence of human cancer was based on 518 men exposed to TCE. The authors of that study concluded that although the cancer risk to man cannot be ruled out, exposure to low levels of TCE probably does not present a very serious and general cancer hazard.

TCE is bioconcentrated in aquatic species, making the consumption of such species by humans a significant source of TCE. For the protection of human health from the potential carcinogenic effects of exposure to trichloroethylene through ingestion of water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption of this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding recommended criteria are 0.027 mg/l, 0.0027 mg/l, and 0.00027 mg/l.

Only a very limited amount of data on the effects of TCE on freshwater aquatic life are available. One species of fish (fathead minnows) showed a loss of equilibrium at concentrations below those resulting in lethal effects.

In laboratory scale studies of toxic organic pollutants, TCE was subjected to biochemical oxidation conditions. After 5, 10, and 20 days no biochemical oxidation occurred. On the basis of this study and general observations relating molecular structure to ease of degradation, the conclusion was reached that TCE would undergo no removal by biological treatment in a POTW. The volatility and relatively low water solubility of TCE is expected to result in volatilization of some of the TCE in aeration steps in a POTW.

In addition, the lastest EPA study of POTW removal of toxic organics indicates that trichloroethylene is 72 percent removed.

Antimony (114). Antimony (chemical name - stibium, symbol Sb), classified as a non-metal or metalloid, is a silvery white, brittle crystalline solid. Antimony is found in small ore bodies throughout the world. Principal ores are oxides of mixed antimony valences, and an oxysulfide ore. Complex ores with metals are important because the antimony is recovered as a by-product. Antimony melts at 631° C, and is a poor conductor of electricity and heat.

Annual U.S. consumption of primary antimony ranges from 10,000 to 20,000 tons. About half is consumed in metal products - mostly antimonial lead for lead acid storage batteries, and about half in non-metal products. A principal compound is antimony trioxide which is used as a flame retardant in fabrics, and as an opacifier in glass, ceramics, and enamels. Several antimony compounds are used as catalysts in organic chemicals synthesis, as fluorinating agents (the antimony fluoride), as pigments, and in fireworks. Semiconductor applications are economically significant.

Essentially no information on antimony-induced human health effects has been derived from community epidemiology studies. The available data are in literature relating effects observed with therapeutic or medicinal uses of antimony compounds and industrial exposure studies. Large therapeutic doses of antimonial compounds, usually used to treat schistisomiasis, have caused severe nausea, vomiting, convulsions, irregular heart action, liver damage, and skin rashes. Studies of acute industrial antimony poisoning have revealed loss of appetite, diarrhea, headache, and dizziness in addition to the symptoms found in studies of therapeutic doses of antimony.

For the protection of human health from the toxic properties of antimony ingested through water and through contaminated aquatic organisms the ambient water criterion is determined to be 0.146 mg/l. If contaminated aquatic organisms are consumed, excluding the consumption of water, the ambient water criterion is determined to be 45 mg/l. Available data show that adverse effects on aquatic life occur at concentrations higher than those cited for human health risks.

Very little information is available regarding the behavior of antimony in a POTW. The limited solubility of most antimony compounds expected in a POTW, i.e., the oxides and sulfides, suggests that at least part of the antimony entering a POTW will be precipitated and incorporated into the sludge. However, some antimony is expected to remain dissolved and pass through the POTW into the effluent. Antimony compounds remaining in the sludge under anaerobic conditions may be connected to stibine (SbH_3), a very soluble and very toxic compound. There are no data to show antimony inhibits any POTW processes. Antimony is not known to be essential to the growth of plants, and has been reported to be moderately toxic. Therefore, sludge containing large amounts of antimony could be detrimental to plants if it is applied in large amounts to cropland.

Arsenic (115). Aresenic (chemical symbol As), is classified as a non-metal or metalloid. Elemental arsenic normally exists in the alpha-crystalline metallic form which is steel gray and brittle, and in the beta form which is dark gray and amorphous. Arsenic sublimes at 615° C. Arsenic is widely distributed throughout the world in a large number of minerals. The most important commercial source of arsenic is as a by-product from treatment of copper, lead, cobalt, and gold ores. Arsenic is usually marketed as the trioxide (As_2O_3). Annual U.S. production of the trioxide approaches 40,000 tons.

The principal use of arsenic is in agricultural chemicals (herbicides) for controlling weeds in cotton fields. Arsenicals have various applications in medicinal and vetrinary use, as wood preservatives, and in semiconductors.

The effects of arsenic in humans were known by the ancient Greeks and Romans. The principal toxic effects are gastrointestinal disturbances. Breakdown of red blood cells occurs. Symptoms of acute poisoning include vomiting, diarrhea, abdominal pain, lassitude, dizziness, and headache. Longer exposure produced dry, falling hair, brittle, loose nails, eczema, and exfoliation. Arsenicals also exhibit teratogenic and mutagenic effects in humans. Oral administration of arsenic compounds has been associated clinically with skin cancer for nearly one hundred years. Since 1888 numerous studies have linked occupational exposure and therapeutic administration of arsenic compounds to increased incidence of respiratory and skin cancer.

For the maximum protection of human health from the potential carcinogenic effects of exposure to arsenic through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of arsenic estimated to result in additional lifetime cancer risk levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.00000022 mg/l, 0.0000022 mg/l, and 0.000022 mg/l, respectively. If containminated aquatic organisms alone are consumed, excluding the consumption of water, the water concentration should be less than 1.75×10^{-4} to keep the increased lifetime cancer risk below 10^{-5}. Available data show that adverse effects on aquatic life occur at concentrations higher than those cited for human health risks.

A few studies have been made regarding the behavior of arsenic in a POTW. One EPA survey of nine POTW facilities reported influent concentrations ranging from 0.0005 to 0.693 mg/l; effluents from three POTW having biological treatment contained 0.0004 to 0.01 mg/l; two POTW facilities showed arsenic removal efficiencies of 50 and 71 percent in biological treatment. Inhibition of treatment processes by sodium arsenate is reported to occur at 0.1 mg/l in activated sludge, and 1.6 mg/l in anaerobic digestion processes. In another study based on data from 60 POTW facilities, arsenic in sludge ranged from 1.6 to 65.6 mg/kg and the median value was 7.8 mg/kg. Arsenic in sludge spread on cropland may be taken up by plants grown on that land. Edible plants can take up arsenic, but normally their growth is inhibited before the plants are ready for harvest.

Beryllium (117). Beryllium is a dark gray metal of the alkaline earth family. It is relatively rare, but because of its unique properties finds widespread use as an alloying element, especially for hardening copper which is used in springs, electrical contacts, and non-sparking tools. World production is reported to be in the range of 250 tons annually. However, much more reaches the environment as emissions from coal burning operations. Analysis of coal indicates an average beryllium content of 3 ppm and 0.1 to 1.0 percent in coal ash or fly ash.

The principle ores are beryl ($3BeO.Al_2O_3.6SiO_2$) and bertrandite [$Be_6SiO_2O_7(OH_2)$]. Only two industrial facilities produce beryllium in the U.S. because of limited demand and the highly toxic character. About two-thirds of the annual production goes into alloys, 20 percent into heat sinks, and 10 percent into beryllium oxide (BeO) ceramic products.

Beryllium has a specific gravity of 1.846, making it the lightest metal with a high melting point (1,350° C). Beryllium alloys are corrosion resistant, but the metal corrodes in aqueous environments. Most common beryllium compounds are soluble in water, at least to the extent necessary to produce a toxic concentration of beryllium ions.

Most data on toxicity of beryllium are for inhalation of beryllium oxide dust. Some studies on orally administered beryllium in laboratory animals have been reported. Despite the large number of studies implicating beryllium as a carcinogen, there is no recorded instance of cancer being produced by ingestion. However, a recently convened panel of uninvolved experts concluded that epidemiologic evidence is suggestive that beryllium is a carcinogen in man.

In the aquatic environment, beryllium is chronically toxic to aquatic organisms at 0.0053 mg/l. Water softness has a large effect on beryllium toxicity to fish. In soft water, beryllium is reportedly 100 times as toxic as in hard water.

For the maximum production of human health from the potential carcinogenic effects of exposure to beryllium through ingestion of water and contaminated aquatic organisms, the ambient water concentration is zero. Concentrations of beryllium estimated to result in additional lifetime cancer risk levels of 10^{-7}, 10^{-6}, and 10^{-5} are 0.00000037 mg/l, 0.0000037 mg/l, and 0.000037 mg/l, respectively." If contaminated aquatic organisms alone are consumed excluding the consumption of water, the concentration should be less than 0.00117 mg/l to keep the increased lifetime cancer risk below 10^{-5}.

Information on the behavior of beryllium in a POTW is scarce. Because beryllium hydroxide is insoluble in water, most beryllium entering a POTW will probably be in the form of suspended solids. As a result, most of the beryllium will settle and be removed with sludge. However, beryllium has been shown to inhibit several enzyme systems, to interfere with DNA metabolism in liver, and to induce chromosomal and mitotic abnormalities. This interference in cellular processes may extend to interfere with biological treatment processes. The concentration and effects of beryllium in sludge which could be applied to cropland has not been studied.

Cadmium (118). Cadmium is a relatively rare metallic element that is seldom found in sufficient quantities in a pure state to warrant mining or extraction from the earth's surface. It is found in trace amounts of about 1 ppm throughout the earth's crust. Cadmium is, however, a valuable by-product of zinc production.

Cadmium is used primarily as an electroplated metal, and is found as an impurity in the secondary refining of zinc, lead, and copper.

Cadmium is an extremely dangerous cumulative toxicant, causing progressive chronic poisoning in mammals, fish, and probably other organisms. The metal is not excreted.

Toxic effects of cadmium on man have been reported from throughout the world. Cadmium may be a factor in the development of such human pathological conditions as kidney disease, testicular tumors, hypertension, arteriosclerosis, growth inhibition, chronic disease of old age, and cancer. Cadmium is normally ingested by humans through food and water as well as by breathing air contaminated by cadmium dust. Cadmium is cumulative in the liver, kidney, pancreas, and thyroid of humans and other animals. A severe bone and kidney syndrome known as itai-itai disease has been documented in Japan as caused by cadmium ingestion via drinking water and contaminated irrigation water. Ingestion of as little as 0.6 mg/day has produced the disease. Cadmium acts synergistically with other metals. Copper and zinc substantially increase its toxicity.

Cadmium is concentrated by marine organisms, particularly molluscs, which accumulate cadmium in calcareous tissues and in the viscera. A concentration factor of 1,000 for cadmium in fish muscle has been reported, as have concentration factors of 3,000 in marine plants and up to 29,600 in certain marine animals. The eggs and larvae of fish are apparently more sensitive than adult fish to poisoning by cadmium, and crustaceans appear to be more sensitive than fish eggs and larvae.

For the protection of human health from the toxic properties of cadmium ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 0.010 mg/l. Available data show that adverse effects on aquatic life occur at concentrations in the same range as those cited for human health, and they are highly dependent on water hardness.

Cadmium is not destroyed when it is introduced into a POTW, and will either pass through to the POTW effluent or be incorporated into the POTW sludge. In addition, it can interfere with the POTW treatment process.

In a study of 189 POTW facilities, 75 percent of the primary plants, 57 percent of the trickling filter plants, 66 percent of the activated sludge plants, and 62 percent of the biological plants allowed over 90 percent of the influent cadmium to pass through to the POTW effluent. Only two of the 189 POTW facilities allowed less than 20 percent pass-through, and none less than 10 percent pass-through. POTW effluent concentrations ranged from 0.001 to 1.97 mg/l (mean 0.028 mg/l, standard deviation 0.167 mg/l).

Cadmium not passed through the POTW will be retained in the sludge where it is likely to build up in concentration. Cadmium contamination of sewage sludge limits its use on land since it increases the level of cadmium in the soil. Data show that cadmium can be incorporated into crops, including vegetables and grains, from contaminated soils. Since the crops themselves show no adverse effects from soils with levels up to 100 mg/kg cadmium, these contaminated crops could have a significant impact on human health. Two Federal agencies have already recognized the potential adverse human health effects posed by the use of sludge on cropland. The FDA recommends that sludge containing over 30 mg/kg of cadmium should not be used on agricultural land. Sewage sludge contains 3 to 300 mg/kg (dry basis) of cadmium mean = 10 mg/kg; median = 16 mg/kg. The USDA also recommends placing limits on the total cadmium from sludge that may be applied to land.

Chromium (119). Chromium is an elemental metal usually found as a chromite ($FeO.Cr_2O_3$). The metal is normally produced by reducing the oxide with aluminum. A significant proportion of the chromium used is in the form of compounds such as sodium dichromate (Na_2CrO_4), and chromic acid (CrO_3)-both are hexavalent chromium compounds.

Chromium is found as an alloying component of many steels and its compounds are used in electroplating baths, and as corrosion inhibitors for closed water circulation systems.

The two chromium forms most frequently found in industry wastewaters are hexavalent and trivalent chromium. Hexavalent chromium is the form used for metal treatments. Some of it is reduced to trivalent chromium as part of the process reaction. The raw wastewater containing both valence states is usually treated first to reduce remaining hexavalent to trivalent chromium, and second to precipitate the trivalent form as the hydroxide. The hexavalent form is not removed by lime treatment.

Chromium, in its various valence states, is hazardous to man. It can produce lung tumors when inhaled, and induces skin sensitizations. Large doses of chromates have corrosive effects on the intestinal tract and can cause inflammation of the kidneys. Hexavalent chromium is a known human carcinogen. Levels of chromate ions that show no effect in man appear to be so low as to prohibit determination, to date.

The toxicity of chromium salts to fish and other aquatic life varies widely with the species, temperature, pH, valence of the chromium, and synergistic or antagonistic effects, especially the effect of water hardness. Studies have shown that trivalent chromium is more toxic to fish of some types than is hexavalent chromium. Hexavalent chromium retards growth of one fish species at 0.0002 mg/l. Fish food organisms and other lower forms of aquatic life are extremely sensitive to chromium. Therefore, both hexavalent and trivalent chromium must be considered harmful to particular fish or organisms.

For the protection of human health from the toxic properties of chromium (except hexavalent chromium) ingested through water and contaminated aquatic organisms, the ambient water quality criterion is 170 mg/l. If contaminated aquatic organisms alone are consumed, excluding the consumption of water, the ambient water criterion for trivalent chromium is 3,433 mg/l. The ambient water quality criterion for hexavalent chromium is recommended to be identical to the existing drinking water standard for total chromium which is 0.050 mg/l.

Chromium is not destroyed when treated by a POTW (although the oxidation state may change), and will either pass through to the POTW effluent or be incorporated into the POTW sludge. Both oxidation states can cause POTW treatment inhibition and can also limit the usefulness of municipal sludge.

Influent concentrations of chromium to POTW facilities have been observed by EPA to range from 0.005 to 14.0 mg/l, with a median concentration of 0.1 mg/l. The efficiencies for removal of chromium by the activated sludge process can vary greatly, depending on chromium concentration in the influent, and other operating conditions at the POTW. Chelation of chromium by organic matter and dissolution due to the presence of carbonates can cause deviations from the predicted behavior in treatment systems.

The systematic presence of chromium compounds will halt nitrification in a POTW for short periods, and most of the chromium will be retained in the sludge solids. Hexavalent chromium has been reported to severely affect the nitrification process, but trivalent chromium has little or no toxicity to activated sludge, except at high concentrations. The presence of iron, copper, and low pH will increase the toxicity of chromium in a POTW by releasing the chromium into solution to be ingested by microorganisms in the POTW.

The amount of chromium which passes through to the POTW effluent depends on the type of treatment processes used by the POTW. In a study of 240 POTW facilities, 56 percent of the primary plants allowed more than 80 percent pass-through to POTW effluent. More advanced treatment results in less pass-through. POTW effluent concentrations ranged from 0.003 to 3.2 mg/l total chromium (mean = 0.197, standard deviation = 0.48), and from 0.002 to 0.1 mg/l hexavalent chromium (mean = 0.017, standard deviation = 0.020).

Chromium not passed through the POTW will be retained in the sludge, where it is likely to build up in concentration. Sludge concentrations of total chromium of over 20,000 mg/kg (dry basis) have been observed. Disposal of sludges containing very high concentrations of trivalent chromium can potentially cause problems in uncontrolled landfills. Incineration, or similar destructive oxidation processes, can produce hexavalent chromium from lower valence states. Hexavalent chromium is potentially more toxic than trivalent chromium. In cases where high rates of chrome sludge application on land are used, distinct growth inhibition and plant tissue uptake have been noted.

Pretreatment of discharges substantially reduces the concentration of chromium in sludge. In Buffalo, New York, pretreatment of electroplating waste resulted in a decrease in chromium concentrations in POTW sludge from 2,510 to 1,040 mg/kg. A similar reduction occurred in Grand Rapids, Michigan, POTW facilities where the chromium concentration in sludge decreased from 11,000 to 2,700 mg/kg when pretreatment was made a requirement.

<u>Copper (120)</u>. Copper is a metallic element that sometimes is found free, as the native metal, and is also found in minerals such as cuprite (Cu_2O), malechite [$CuCO_3.Cu(OH)_2$], azurite [$2CuCO_3.Cu(OH)_2$], chalcopyrite ($CuFeS_2$), and bormite (Cu_5FeS_4). Copper is obtained from these ores by smelting, leaching, and electrolysis. It is used in the plating, electrical, plumbing, and heating equipment industries, as well as in insecticides and fungicides.

Traces of copper are found in all forms of plant and animal life, and the metal is an essential trace element for nutrition. Copper is not considered to be a cumulative systemic poison for humans as it is readily excreted by the body, but it can cause symptoms of gastroenteritis, with nausea and intestinal irritations, at relatively low dosages. The limiting factor in domestic water supplies is taste. To prevent this adverse organoleptic effect of copper in water, a criterion of 1 mg/l has been established.

The toxicity of copper to aquatic organisms varies significantly, not only with the species, but also with the physical and chemical characteristics of the water, including temperature, hardness, turbidity, and carbon dioxide content. In hard water, the toxicity of copper salts may be reduced by the precipitation of copper carbonate or other insoluble compounds. The sulfates of copper and zinc, and of copper and calcium are synergistic in their toxic effect on fish.

Relatively high concentrations of copper may be tolerated by adult fish for short periods of time; the critical effect of copper appears to be its higher toxicity to young or juvenile fish. Concentrations of 0.02 to 0.03 mg/l have proved fatal to some common fish species. In general the salmonoids are very sensitive and the sunfishes are less sensitive to copper.

The recommended criterion to protect freshwater aquatic life is 0.0056 mg/l as a 24-hour average, and 0.012 mg/l maximum concentration at a hardness of 50 mg/l $CaCO_3$. For total recoverable copper the criterion to protect freshwater aquatic life is 0.0056 mg/l as a 24-hour average.

Copper salts cause undesirable color reactions in the food industry and cause pitting when deposited on some other metals such as aluminum and galvanized steel. To control undesirable taste and odor quality of ambient water due to the organoleptic properties of copper, the estimated level is 1.0 mg/l for total recoverable copper.

Irrigation water containing more than minute quantities of copper can be detrimental to certain crops. Copper appears in all soils, and its concentration ranges from 10 to 80 ppm. In soils, copper occurs in association with hydrous oxides of manganese and iron, and also as soluble and insoluble complexes with organic matter. Copper is essential to the life of plants, and the normal range of concentration in plant tissue is from 5 to 20 ppm. Copper concentrations in plants normally do not build up to high levels when toxicity occurs. For example, the concentrations of copper in snapbean leaves and pods was less than 50 and 20 mg/kg, respectively, under conditions of severe copper toxicity. Even under conditions of copper toxicity, most of the excess copper accumulates in the roots; very little is moved to the aerial part of the plant.

Copper is not destroyed when treated by a POTW, and will either pass through to the POTW effluent or be retained in the POTW sludge. It can interfere with the POTW treatment processes and can limit the usefulness of municipal sludge.

The influent concentration of copper to a POTW has been observed by the EPA to range from 0.01 to 1.97 mg/l, with a median concentration of 0.12 mg/l. The copper that is removed from the influent stream of a POTW is absorbed on the sludge or appears in the sludge as the hydroxide of the metal. Bench scale pilot studies have shown that from about 25 percent to 75 percent of the copper passing through the activated sludge process remains in solution in the final effluent. Four-hour slug dosages of copper sulfate in concentrations exceeding 50 mg/l were reported to have severe effects on the removal efficiency of an unacclimated system, with the system returning to normal in about 100 hours. Slug dosages of copper in the form of copper cyanide were observed to have much more severe effects on the activated sludge system, but the total system returned to normal in 24 hours.

In a recent study of 268 POTW facilities, the median pass-through was over 80 percent for primary plants and 40 to 50 percent for trickling filter, activated sludge, and biological treatment plants. POTW effluent concentrations of copper ranged from 0.003 to 1.8 mg/l (mean 0.126, standard deviation 0.242).

Copper which does not pass through the POTW will be retained in the sludge where it will build up in concentration. The presence of excessive levels of copper in sludge may limit its use on cropland. Sewage sludge contains up to 16,000 mg/kg of copper, with 730 mg/kg as the mean value. These concentrations are significantly greater than those normally found in soil, which usually range from 18 to 80 mg/kg. Experimental data indicate that when dried sludge is spread over tillable land, the copper tends to remain in place down to the depth of the tillage, except for copper which is taken up by plants grown in the soil. Recent investigation has shown that the extractable copper content of sludge-treated soil decreased with time, which suggests a reversion of copper to less soluble forms was occurring.

<u>Cyanide (121)</u>. Cyanides are among the most toxic of pollutants commonly observed in industrial wastewaters. Introduction of cyanide into industrial processes is usually by dissolution of potassium cyanide (KCN) or sodium cyanide (NaCN) in process waters. However, hydrogen cyanide (HCN) formed when the above salts are dissolved in water, is probably the most acutely lethal compound.

The relationship of pH to hydrogen cyanide formation is very important. As pH is lowered to below 7, more than 99 percent of the cyanide is present as HCN and less than 1 percent as cyanide ions. Thus, at neutral pH, that of most living organisms, the more toxic form of cyanide prevails.

Cyanide ions combine with numerous heavy metal ions to form complexes. The complexes are in equilibrium with HCN. Thus, the stability of the metal-cyanide complex and the pH determine the concentration of HCN. Stability of the metal-cyanide anion complexes is extremely variable. Those formed with zinc, copper, and cadmium are not stable - they rapidly dissociate, with production of HCN, in near neutral or acid waters. Some of the complexes are extremely stable. Cobaltocyanide is very resistant to acid distillation in the laboratory. Iron cyanide complexes are also stable, but undergo photodecomposition to give HCN upon exposure to sunlight. Synergistic effects have been demonstrated for the metal cyanide complexes making zinc, copper, and cadmium cyanides more toxic than an equal concentration of sodium cyanide.

The toxic mechanism of cyanide is essentially an inhibition of oxygen metabolism, i.e., rendering the tissues incapable of exchanging oxygen. The cyanogen compounds are true noncumulative protoplasmic poisons. They arrest the activity of all forms of animal life. Cyanide shows a very specific type of toxic action. It inhibits the cytochrome oxidase system. This system is the one which facilitates electron transfer from reduced metabolites to molecular oxygen. The human body can convert cyanide to a non-toxic thiocyanate and eliminate it. However, if the quantity of cyanide ingested is too great at one time, the inhibition of oxygen utilization proves fatal before the detoxifying reaction reduces the cyanide concentration to a safe level.

Cyanides are more toxic to fish than to lower forms of aquatic organisms such as midge larvae, crustaceans, and mussels. Toxicity to fish is a function of chemical form and concentration, and is influenced by the rate of metabolism (temperature), the level of dissolved oxygen, and pH. In laboratory studies free cyanide concentrations ranging from 0.05 to 0.14 mg/l have been proven to be fatal to sensitive fish species including trout, bluegill, and fathead minnows. Levels above 0.2 mg/l are rapidly fatal to most fish species. Long term sublethal concentrations of cyanide as low as 0.01 mg/l have been shown to affect the ability of fish to function normally, e.g., reproduce, grow, and swim.

For the protection of human health from the toxic properties of cyanide ingested through water and through contaminated aquatic organisms, the ambient water quality criterion is determined to be 0.200 mg/l.

Persistence of cyanide in water is highly variable and depends upon the chemical form of cyanide in the water, the concentration of cyanide, and the nature of other constituents. Cyanide may be destroyed by strong oxidizing agents such as permanganate and chlorine. Chlorine is commonly used to oxidize strong cyanide solutions. Carbon dioxide and nitrogen are the products of complete oxidation. But if the reaction is not complete, the very toxic compound, cyanogen chloride, may remain in the treatment system and subsequently be released to the environment. Partial chlorination may occur as part of a POTW treatment, or during the disinfection treatment of surface water for drinking water preparation.

Cyanides can interfere with treatment processes in a POTW, or pass through to ambient waters. At low concentrations and with acclimated microflora, cyanide may be decomposed by microorganisms in anaerobic and aerobic environments or waste treatment systems. However, data indicate that much of the cyanide introduced passes through to the POTW effluent. The mean pass-through of 14 biological plants was 71 percent. In a recent study of 41 POTW facilities the effluent concentrations ranged from 0.002 to 100 mg/l (mean = 2.518, standard deviation = 15.6). Cyanide also enhances the toxicity of metals commonly found in POTW effluents, including the toxic pollutants cadmium, zinc, and copper.

Data for Grand Rapids, Michigan, showed a significant decline in cyanide concentrations downstream from the POTW after pretreatment regulations were put in force. Concentrations fell from 0.66 mg/l before, to 0.01 mg/l after pretreatment was required.

Lead (122). Lead is a soft, malleable, ductile, blueish-gray, metallic element, usually obtained from the mineral galena (lead sulfide, PbS), anglesite (lead sulfate, $PbSO_4$), or cerussite (lead carbonate, $PbCO_3$). Because it is usually associated with minerals of zinc, silver, copper, gold, cadmium, antimony, and arsenic, special purification methods are frequently used before and after extraction of the metal from the ore concentrate by smelting.

Lead is widely used for its corrosion resistance, sound and vibration absorption, low melting point (solders), and relatively high imperviousness to various forms of radiation. Small amounts of copper, antimony and other metals can be alloyed with lead to achieve greater hardness, stiffness, or corrosion resistance than is afforded by the pure metal. Lead compounds are used in glazes and paints. About one third of U.S. lead consumption goes into storage batteries. About half of U.S. lead consumption is from secondary lead recovery. U.S. consumption of lead is in the range of one million tons annually.

Lead ingested by humans produces a variety of toxic effects including impaired reproductive ability, disturbances in blood chemistry, neurological disorders, kidney damage, and adverse cardiovascular effects. Exposure to lead in the diet results in permanent increase in lead levels in the body. Most of the lead entering the body eventually becomes localized in the bones where it accumulates. Lead is a carcinogen or cocarcinogen in some species of experimental animals. Lead is teratogenic in experimental animals. Mutagenicity data are not available for lead.

The ambient water quality criterion for lead is recommended to be identical to the existng drinking water standard which is 0.050 mg/l. Available data show that adverse effects on aquatic life occur at concentrations as low as 7.5×10^{-4} mg/l of total recoverable lead as a 24-hour average with a water hardness of 50 mg/l as $CaCO_3$.

Lead is not destroyed in a POTW, but is passed through to the effluent or retained in the POTW sludge; it can interfere with POTW treatment processes and can limit the usefulness of POTW sludge for application to agricultural croplands. Threshold concentration for inhibition of the activated sludge process is 0.1 mg/l, and for the nitrification process is 0.5 mg/l. In a study of 214 POTW facilities, median pass through values were over 80 percent for primary plants and over 60 percent for trickling filter, activated sludge, and biological process plants. Lead concentration in POTW effluents ranged from 0.003 to 1.8 mg/l (mean = 0.106 mg/l, standard deviation = 0.222).

Application of lead-containing sludge to cropland should not lead to uptake by crops under most conditions because normally lead is strongly bound by soil. However, under the unusual condition of low pH (less than 5.5) and low concentrations of labile phosphorus, lead solubility is increased and plants can accumulate lead.

Mercury (123). Mercury is an elemental metal rarely found in nature as the free metal. Mercury is unique among metals as it remains a liquid down to about 39 degrees below zero. It is relatively inert chemically and is insoluble in water. The principal ore is cinnabar (HgS).

Mercury is used industrially as the metal and as mercurous and mercuric salts and compounds. Mercury is used in several types of batteries. Mercury released to the aqueous environment is subject to biomethylation - conversion to the extremely toxic methyl mercury.

Mercury can be introduced into the body through the skin and the respiratory system as the elemental vapor. Mercuric salts are highly toxic to humans and can be absorbed through the gastrointestinal tract. Fatal doses can vary from 1 to 30 grams. Chronic toxicity of methyl mercury is evidenced primarily by neurological symptoms. Some mercuric salts cause death by kidney failure.

Mercuric salts are extremely toxic to fish and other aquatic life. Mercuric chloride is more lethal than copper, hexavalent chromium, zinc, nickel, and lead towards fish and aquatic life. In the food cycle, algae containing mercury up to 100 times the concentration in the surrounding sea water are eaten by fish which further concentrate the mercury. Predators that eat the fish in turn concentrate the mercury even further.

For the protection of human health from the toxic properties of mercury ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 0.000144 mg/l.

Mercury is not destroyed when treated by a POTW, and will either pass through to the POTW effluent or be incorporated into the POTW sludge. At low concentrations it may reduce POTW removal efficiencies, and at high concentrations it may upset the POTW operation.

The influent concentrations of mercury to POTW have been observed by the EPA to range from 0.0002 to 0.24 mg/l, with a median concentration of 0.001 mg/l. Mercury has been reported in the literature to have inhibiting effects upon an activated sludge POTW at levels as low as 0.1 mg/l. At 5 mg/l of mercury, losses of COD removal efficiency of 14 to 40 percent have been reported. Upset of an activated sludge POTW is reported in the literature to occur near 200 mg/l. The anaerobic digestion process is much less affected by the presence of mercury, with inhibitory effects being reported at 1,365 mg/l.

In a study of 22 POTWs having secondary treatment, the range of removal of mercury from the influent to the POTW ranged from 4 to 99 percent with median removal of 41 percent. Thus significant pass through of mercury may occur.

In sludges, mercury content may be high if industrial sources of mercury contamination are present. Little is known about the form in which mercury occurs in sludge. Mercury may undergo biological methylation in sediments, but no methylation has been observed in soils, mud, or sewage sludge.

The mercury content of soils not receiving additions of POTW sewage sludge lie in the range from 0.01 to 0.5 mg/kg. In soils receiving POTW sludges for protracted periods, the concentration of mercury has been observed to approach 1.0 mg/kg. In the soil, mercury enters into reactions with the exchange complex of clay and organic fractions, forming both ionic and covalent bonds. Chemical and microbiological degradation of mercurials can take place side by side in the soil, the products - ionic or molecular - are retained by organic matter and clay or may be volatilized if gaseous. Because of the high affinity between mercury and the solid soil surfaces, mercury persists in the upper layer of soil.

Mercury can enter plants through the roots, it can readily move to other parts of the plant, and it has been reported to cause injury to plants. In many plants mercury concentrations range from 0.01 to 0.20 mg/kg, but when plants are supplied with high levels of mercury, these concentrations can exceed 0.5 mg/kg. Bioconcentration occurs in animals ingesting mercury in food.

Nickel (124). Nickel is seldom found in nature as the pure elemental metal. It is a relatively plentiful element and is widely distributed throughout the earth's crust. It occurs in marine organisms and is found in the oceans. The chief commercial ores for nickel are pentlandite $[(Fe,Ni)_9S_8]$, and a lateritic ore consisting of hydrated nickel-iron-magnesium silicate.

Nickel has many and varied uses. It is used in alloys and as the pure metal. Nickel salts are used for electroplating baths.

The toxicity of nickel to man is thought to be very low, and systemic poisoning of human beings by nickel or nickel salts is almost unknown. In non-human mammals nickel acts to inhibit insulin release, depress growth, and reduce cholesterol. A high incidence of cancer of the lung and nose has been reported in humans engaged in the refining of nickel.

Nickel salts can kill fish at very low concentrations. However, nickel has been found to be less toxic to some fish than copper, zinc, and iron. Nickel is present in coastal and open ocean water at concentrations in the range of 0.0001 to 0.006 mg/l although the most common values are 0.002 to 0.003 mg/l. Marine animals contain up to 0.4 mg/l and marine plants contain up to 3 mg/l. Higher nickel concentrations have been reported to cause reduction in photosynthetic activity of the giant kelp. A low concentration was found to kill oyster eggs.

For the protection of human health based on the toxic properties of nickel ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 0.0134 mg/l. If contaminated aquatic organisms are consumed, excluding consumption of water, the ambient water criterion is determined to be 0.100 mg/l. Available data show that adverse effects on aquatic life occur for total recoverable nickel concentrations as low as 0.0071 mg/l as a 24-hour average.

Nickel is not destroyed when treated in a POTW, but will either pass through to the POTW effluent or be retained in the POTW sludge. It can interfere with POTW treatment processes and can also limit the usefulness of municipal sludge.

Nickel salts have caused inhibition of the biochemical oxidation of sewage in a POTW. In a pilot plant, slug doses of nickel significantly reduced normal treatment efficiencies for a few hours, but the plant acclimated itself somewhat to the slug dosage and appeared to achieve normal treatment efficiencies within 40 hours. It has been reported that the anaerobic digestion process is inhibited only by high concentrations of nickel, while a low concentration of nickel inhibits the nitrification process.

The influent concentration of nickel to a POTW has been observed by the EPA to range from 0.01 to 3.19 mg/l, with a median of 0.33 mg/l. In a study of 190 POTW facilities, nickel pass-through was greater than 90 percent for 82 percent of the primary plants. Median pass-through for trickling filter, activated sludge, and biological process plants was greater than 80 percent. POTW effluent concentrations ranged from 0.002 to 40 mg/l (mean = 0.410, standard deviation = 3.279).

Nickel not passed through the POTW will be incorporated into the sludge. In a recent two-year study of eight cities, four of the cities had median nickel concentrations of over 350 mg/kg, and two were over 1,000 mg/kg. The maximum nickel concentration observed was 4,010 mg/kg.

Nickel is found in nearly all soils, plants, and waters. Nickel has no known essential function in plants. In soils, nickel typically is found in the range from 10 to 100 mg/kg. Various environemntal exposures to nickel appear to correlate with increased incidence of tumors in man. For example, cancer in the maxillary antrum of snuff users may result from using plant materials grown on soil high in nickel.

Nickel toxicity may develop in plants from application of sewage sludge on acid soils. Nickel has caused reduction of yields for a variety of crops including oats, mustard, turnips, and cabbage. In one study nickel decreased the yields of oats significantly at 100 mg/kg.

Whether nickel exerts a toxic effect on plants depends on several soil factors, the amount of nickel applied, and the contents of other metals in the sludge. Unlike copper and zinc, which are more available from inorganic sources than from sludge, nickel uptake by plants seems to be promoted by the presence of the organic matter in sludge. Soil treatments, such as liming, reduce the solubility of nickel. Toxicity of nickel to plants is enhanced in acidic soils.

<u>Selenium (125)</u>. Selenium (chemical symbol Se) is a non-metallic element existing in several allotropic forms. Gray selenium, which has a metallic appearance, is the stable form at ordinary temperatures and melts at 220°C. Selenium is a major component of 38 minerals and a minor component of 37 others found in various parts of the world. Most selenium is obtained as a by-product of precious metals recovery from electrolytic copper refinery slimes. U.S. annual production at one time reached one million pounds.

Principal uses of selenium are in semi-conductors, pigments, decoloring of glass, zerography, and metallurgy. It also is used to produce ruby glass used in signal lights. Several selenium compounds are important oxidizing agents in the synthesis of organic chemicals and drug products.

While results of some studies suggest that selenium may be an essential element in human nutrition, the toxic effects of selenium in humans are well established. Lassitude, loss of hair, discoloration and loss of fingernails are symptoms of selenium poisoning. In a fatal case of ingestion of a larger dose of selenium acid, peripheral vascular collapse, pulmonary edema, and coma occurred. Selenium produces mutagenic and teratogenic effects, but it has not been established as exhibiting carcinogenic activity.

For the protection of human health from the toxic properties of selenium ingested through water and through contaminated aquatic organisms, the ambient water criterion is determined to be 0.010 mg/l, i.e., the same as the drinking water standard. Available data show that adverse effects on aquatic life occur at concentrations higher than that cited for human toxicity.

Very few data are available regarding the behavior of selenium in a POTW. One EPA survey of 103 POTW facilities revealed one POTW using biological treatment and having selenium in the influent. Influent concentration was 0.0025 mg/l, effluent concentration was 0.0016 mg/l, giving a removal of 37 percent. It is not known to be inhibitory to POTW processes. In another study, sludge from POTW facilities in 16 cities was found to contain from 1.8 to 8.7 mg/kg selenium, compared to 0.01 to 2 mg/kg in untreated soil. These concentrations of selenium in sludge present a potential hazard for humans or other mammals eating crops grown on soil treated with selenium-containing sludge.

Silver (126). Silver is a soft, lustrous, white metal that is insoluble in water and alkali. In nature, silver is found in the elemental state (native silver) and combined in ores such as argentite (Ag_2S), horn silver ($AgCl$), procisite (Ag_3AsS_3), and pyrangyrite (Ag_3SbS_3). Silver is used extensively in several industries, among them electroplating.

Metallic silver is not considered to be toxic, but most of its salts are toxic to a large number of organisms. Upon ingestion by humans, many silver salts are absorbed in the circulatory system and deposited in various body tissues, resulting in generalized or sometimes localized gray pigmentation of the skin and mucous membranes known as argyria. There is no known method for removing silver from the tissues once it is deposited, and the effect is cumulative.

Silver is recognized as a bactericide and doses from 0.000001 to 0.0005 mg/l have been reported as sufficient to sterilize water. The criterion for ambient water to protect human health from the toxic properties of silver ingested through water and through contaminated aquatic organisms is 0.050 mg/l.

The chronic toxic effects of silver on the aquatic environment have not been given as much attention as many other heavy metals. Data from existing literature support the fact that silver is very toxic to aquatic organisms. Despite the fact that silver is nearly the most toxic of the heavy metals, there are insufficient data to adequately evaluate even the effects of hardness on silver toxicity. There are no data available on the toxicity of different forms of silver.

There is no available literature on the incidental removal of silver by a POTW. An incidental removal of about 50 percent is assumed as being representative. This is the highest average incidental removal of any metal for which data are available. (Copper has been indicated to have a median incidental removal rate of 49 percent.)

Bioaccumulation and concentration of silver from sewage sludge has not been studied to any great degree. There is some indication that silver could be bioaccumulated in mushrooms to the extent that there could be adverse physiological effects on humans if they consumed large quantities of mushrooms grown in silver enriched soil. The effect, however, would tend to be unpleasant rather than fatal.

There is little summary data available on the quantity of silver discharged to a POTW. Presumably there would be a tendency to limit its discharge from a manufacturing facility because of its high intrinsic value.

Thallium (127). Thallium (Tl) is a soft, silver-white, dense, malleable metal. Five major minerals contain 15 to 85 percent thallium, but they are not of commercial importance because the metal is produced in sufficient quantity as a by-product of lead-zinc smelting of sulfide ores. Thallium melts at 304° C. U.S. annual production of thallium and its compounds is estimated to be 1,500 pounds.

Industrial uses of thallium include the manufacture of alloys, electronic devices and special glass. Thallium catalysts are used for industrial organic syntheses.

Acute thallium poisoning in humans has been widely described. Gastrointestinal pains and diarrhea are followed by abnormal sensation in the legs and arms, dizziness, and, later, loss of hair. The central nervous system is also affected. Somnolence, delerium or coma may occur. Studies on the teratogenicity of thallium appear inconclusive; no studies on mutagenicity were found; and no published reports on carcinogenicity of thallium were found.

For the protection of human health from the toxic properties of thallium ingested through water and contaminated aquatic organisms, the ambient water criterion is 0.013 mg/l.

No reports were found regarding the behavior of thallium in a POTW. It will not be degraded, therefore it must pass through to the effluent or be removed with the sludge. However, since the sulfide (TlS) is very insoluble, if appreciable sulfide is present dissolved thallium in the influent to a POTW may be precipitated into the sludge. Subsequent use of sludge bearing thallium compounds as a soil amendment to crop bearing soils may result in uptake of this element by food plants. Several leafy garden crops (cabbage, lettuce, leek, and endive) exhibit relatively higher concentrations of thallium than other foods such as meat.

Zinc (128). Zinc occurs abundantly in the earth's crust, concentrated in ores. It is readily refined into the pure, stable, silver-white metal. In addition to its use in alloys, zinc is used as a protective coating on steel. It is applied by hot diping (i.e., dipping the steel in molten zinc) or by electroplating.

Zinc can have an adverse effect on man and animals at high concentrations. Zinc at concentrations in excess of 5 mg/l causes an undesirable taste which persists through conventional treatment. For the prevention of adverse effects due to these organoleptic properties of zinc, 5 mg/l was adopted for the ambient water criterion. Available data show that adverse effects on aquatic life occur at concentrations as low as 0.047 mg/l as a 24-hour average.

Toxic concentrations of zinc compounds cause adverse changes in the morphology and physiology of fish. Lethal concentrations in the range of 0.1 mg/l have been reported. Acutely toxic concentrations induce cellular breakdown of the gills, and possibly the clogging of the gills with mucous. Chronically toxic concentrations of zinc compounds cause general enfeeblement and widespread histological changes to many organs, but not to gills. Abnormal swimming behavior has been reported at 0.04 mg/l. Growth and maturation are retarded by zinc. It has been observed that the effects of zinc poisoning may not become apparent immediately, so that fish removed from zinc-contaminated water may die as long as 48 hours after removal.

In general, salmonoids are most sensitive to elemental zinc in soft water; the rainbow trout is the most sensitive in hard waters. A complex relationship exists between zinc concentration, dissolved zinc concentration, pH, temperature, and calcium and magnesium concentration. Prediction of harmful effects has been less than reliable and controlled studies have not been extensively documented.

The major concern with zinc compounds in marine waters is not with acute lethal effects, but rather with the long-term sub-lethal effects of the metallic compounds and complexes. Zinc accumulates in some marine species, and marine animals contain zinc in the range of 6 to 1,500 mg/kg. From the point of view of acute lethal effects, invertebrate marine animals seem to be the most sensitive organism tested.

Toxicities of zinc in nutrient solutions have been demonstrated for a number of plants. A variety of fresh water plants tested manifested harmful symptoms at concentrations of 0.030 to 21.6 mg/l. Zinc sulfate has also been found to be lethal to many plants and it could impair agricultural uses of the water.

Zinc is not destroyed when treated by a POTW, but will either pass through to the POTW effluent or be retained in the POTW sludge. It can interfere with treatment processes in the POTW and can also limit the usefulness of municipal sludge.

In slug doses, and particularly in the presence of copper, dissolved zinc can interfere with or seriously disrupt the operation of POTW biological processes by reducing overall removal efficiencies, largely as a result of the toxicity of the metal to biological organisms. However, zinc solids in the form of hydroxides or sulfides do not appear to interfere with biological treatment processes, on the basis of available data. Such solids accumulate in the sludge.

The influent concentrations of zinc to a POTW has been observed by the EPA to range from 0.017 to 3.91 mg/l, with a median concentration of 0.33 mg/l. Primary treatment is not efficient in removing zinc; however, the microbial floc of secondary treatment readily adsorbs zinc.

In a study of 258 POTW facilities, the median pass-through values were 70 to 88 percent for primary plants, 50 to 60 percent for trickling filter and biological process plants, and 30 to 40 percent for activated process plants. POTW effluent concentrations of zinc ranged from 0.003 to 3.6 mg/l (mean = 0.330, standard deviation = 0.464).

The zinc which does not pass through the POTW is retained in the sludge. The presence of zinc in sludge may limit its use on cropland. Sewage sludge contains 72 to over 30,000 mg/kg of zinc, with 3,366 mg/kg as the mean value. These concentrations are significantly greater than those normally found in soil, which range from 0 to 195 mg/kg, with 94 mg/kg being a common level. Therefore, application of sewage sludge to soil will generally increase the concentration of zinc in the soil. Zinc can be toxic to plants, depending upon soil pH. Lettuce, tomatoes, turnips, mustard, kale, and beets are especially sensitive to zinc contamination.

Oil and Grease. Oil and grease are taken together as one pollutant parameter. This is a conventional pollutant and some of its components are:

1. Light Hydrocarbons - These include light fuels such as gasoline, kerosene, and jet fuel, and miscellaneous solvents used for industrial processing, degreasing, or cleaning purposes. The presence of these light hydrocarbons may make the removal of other heavier oil wastes more difficult.

2. Heavy Hydrocarbons, Fuels, and Tars - These include the crude oils, diesel oils, #6 fuel oil, residual oils, slop oils, and in some cases, asphalt and road tar.

3. Lubricants and Cutting Fluids - These generally fall into two classes: non-emulsifiable oils such as lubricating oils and greases and emulsifiable oils such as water soluble oils, rolling oils, cutting oils, and drawing compounds. Emulsifiable oils may contain fat, soap, or various other additives.

4. Vegetable and Animal Fats and Oils - These originate primarily from processing of foods and natural products.

These compounds can settle or float and may exist as solids or liquids depending upon factors such as method of use, production process, and temperature of water.

Oil and grease even in small quantities cause troublesome taste and odor problems. Scum lines from these agents are produced on water treatment basin walls and other containers. Fish and water fowl are adversely affected by oils in their habitat. Oil emulsions may adhere to the gills of fish causing suffocation, and the flesh of fish is tainted when microorganisms that were exposed to waste oil are eaten. Deposition of oil in the bottom sediments of water can serve to inhibit normal benthic growth. Oil and grease exhibit an oxygen demand.

Many of the toxic organic pollutants will be found distributed between the oil phase and the aqueous phase in industrial wastewaters. The presence of phenols, PCB's, PAH's, and almost any other organic pollutant in the oil and grease make characterization of this parameter almost impossible. However, all of these other organics add to the objectionable nature of the oil and grease.

Levels of oil and grease which are toxic to aquatic organisms vary greatly, depending on the type and the species susceptibility. However, it has been reported that crude oil in concentrations as low as 0.3 mg/l is extremely toxic to freshwater fish. It has been recommended that public water supply sources be essentially free from oil and grease.

Oil and grease in quantities of 100 l/sq km show up as a sheen on the surface of a body of water. The presence of oil slicks decreases the aesthetic value of a waterway.

Oil and grease is compatible with a POTW activated sludge process in limited quantity. However, slug loadings or high concentrations of oil and grease interfere with biological treatment processes. The oils coat surfaces and solid particles, preventing access of oxygen, and sealing in some microorganisms. Land spreading of POTW sludge containing oil and grease uncontaminated by toxic pollutants is not expected to affect crops grown on the treated land, or animals eating those crops.

pH. Although not a specific pollutant, pH is related to the acidity or alkalinity of a wastewater stream. It is not, however, a measure of either. The term pH is used to describe the hydrogen ion concentration (or activity) present in a given solution. Values for pH range from 0 to 14, and these numbers are the negative logarithms of the hydrogen ion concentrations. A pH of 7 indicates neutrality. Solutions with a pH above 7 are alkaline, while those solutions with a pH below 7 are acidic. The relationship of pH and acidity and alkalinity is not necessarily linear or direct. Knowledge of the water pH is useful in determining necessary measures for corrosion control, sanitation, and disinfection. Its value is also necessary in the treatment of industrial wastewaters to determine amounts of chemicals required to remove pollutants and to measure their effectiveness. Removal of pollutants, especially dissolved solids is affected by the pH of the wastewater.

Waters with a pH below 6.0 are corrosive to water works structures, distribution lines, and household plumbing fixtures and can thus add constituents to drinking water such as iron, copper, zinc, cadmium, and lead. The hydrogen ion concentration can affect the taste of the water, and at a low pH water tastes sour. The bactericidal effect of chlorine is weakened as the pH increases, and it is advantageous to keep the pH close to 7.0. This is significant for providing safe drinking water.

Extremes of pH or rapid pH changes can exert stress conditions or kill aquatic life outright. Even moderate changes from acceptable criteria limits of pH are deleterious to some species.

The relative toxicity to aquatic life of many materials is increased by changes in the water pH. For example, metallocyanide complexes can increase a thousand-fold in toxicity with a drop of 1.5 pH units.

Because of the universal nature of pH and its effect on water quality and treatment, it is selected as a pollutant parameter for many industry categories. A neutral pH range (approximately 6 to 9) is generally desired because either extreme beyond this range has a deleterious effect on receiving waters or the pollutant nature of other wastewater constituents.

Pretreatment for regulation of pH is covered by the "General Pretreatment Regulations for Existing and New Sources of Pollution," 40 CFR 403.5. This section prohibits the discharge to a POTW of "pollutants which will cause corrosive structural damage to the POTW but in no case discharges with pH lower than 5.0 unless the works is specially designed to accommodate such discharges."

Total Suspended Solids (TSS). Suspended solids include both organic and inorganic materials. The inorganic compounds include sand, silt, and clay. The organic fraction includes such materials as grease, oil, tar, and animal and vegetable waste products. These solids may settle out rapidly, and bottom deposits are often a mixture of both organic and inorganic solids. Solids may be suspended in water for a time and then settle to the bed of the stream or lake. These solids discharged with man's wastes may be inert, slowly biodegradable materials, or rapidly decomposable substances. While in suspension, suspended solids increase the turbidity of the water, reduce light penetration, and impair the photosynthetic activity of aquatic plants.

Suspended solids in water interfere with many industrial processes and cause foaming in boilers and incrustations on equipment exposed to such water, especially as the temperature rises. They are undesirable in process water used in the manufacture of steel, in the textile industry, in laundries, in dyeing, and in cooling systems.

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

Disregarding any toxic effect attributable to substances leached out by water, suspended solids may kill fish and shellfish by causing abrasive injuries and by clogging the gills and respiratory passages of various aquatic fauna. Indirectly, suspended solids are inimical to aquatic life because they screen out light, and they promote and maintain the development of noxious conditions through oxygen depletion. This results in the killing of fish and fish food organisms. Suspended solids also reduce the recreational value of the water.

Total suspended solids is a traditional pollutant which is compatible with a well-run POTW. This pollutant, with the exception of those components which are described elsewhere in this section, e.g., heavy metal components, does not interfere with the operation of a POTW. However, since a considerable portion of the innocuous TSS may be inseparably bound to the constituents which do interfere with POTW operation, or produce unusable sludge, or subsequently dissolve to produce unacceptable POTW effluent, TSS may be considered a toxic waste.

POLLUTANT SELECTION FOR COPPER FORMING WASTE STREAMS

The pollutant selection procedure was performed for the following copper forming waste streams to select those toxic pollutants that would be considered for establishing regulations for the Copper Forming Category:

Cold Rolling Spent Lubricant
Hot Rolling Spent Lubricant
Drawing Spent Lubricant
Solution Heat Treatment Contact Cooling Water
Extrusion Press Heat Treatment Contact Cooling Water
Pickling Bath
Pickling Rinse
Alkaline Cleaning Bath
Alkaline Cleaning Rinse
Annealing With Water
Annealing With Oil
Pickling Fume Scrubber Water
Surface Coating
Tumbling or Burnishing
Miscellaneous Waste Streams

Pollutants Not Detected. The toxic pollutants listed in Table VI-1 were not detected in any samples from these wastewater streams as reported in Tables V-15 through V-26 (pp. 107-147);

therefore, they were not selected for consideration in establishing regulations. Some pollutants marked with an asterisk were possibly detected at levels below the quantification level.

Pollutants Detected but Present at Concentrations too Small to be Treated. The two pollutants listed in Table VI-2 were detected in copper forming wastewater; however, they were found at concentrations which were not treatable. Therefore, they were not selected for consideration in establishing regulations.

Pollutants Which Will be Adequately Controlled by the Technologies Upon Which This Regulation is Based. The six pollutants listed in Table VI-3 were found in copper forming wastewater at treatable concentrations; however, it is not necessary to regulate them because they will be adequately controlled by the technologies upon which the regulation is based.

Pollutants Detected in the Effluent of Only One Plant. The pollutant listed in Table VI-4 was detected above its quantifiable level in the effluent from only one plant. It is believed to be uniquely related to that plant and not related to the manufacturing process under study.

Pollutants Selected for Regulation. The 17 toxic pollutants listed in Table VI-5 were those not eliminated from consideration for any of the reasons listed above; therefore, each was selected for consideration in establishing regulations.

The maximum concentrations of these toxic pollutants which are being regulated are presented in Table VI-6.

Table VI-1

POLLUTANTS NOT DETECTED IN COPPER FORMING WASTEWATER

1. acenaphthene
2. acrolein
3. acrylonitrile
5. benzidine
6. carbon tetrachloride*
7. chlorobenzene*
8. 1,2,4-trichlorobenzene
9. hexachlorobenzene
10. 1,2-dichloroethane
12. hexachloroethane
13. 1,1-dichloroethane
14. 1,1,2-trichloroethane
15. 1,1,2,2-tetrachloroethane
16. chloroethane
17. deleted
18. bis(chloroethyl)ether
19. 2-chloroethyl vinyl ether
20. 2-chloronaphthalene
21. 2,4,6-trichlorophenol
22. p-chloro-m-cresol
24. 2-chlorophenol
25. 1,2-dichlorobenzene
26. 1,3-dichlorobenzene
27. 1,4-dichlorobenzene
28. 3,3'-dichlorobenzidine
29. 1,1-dichloroethylene
30. 1,2-trans-dichloroethylene
31. 2,4-dichlorophenol
32. 1,2-dichloropropane
33. 1,3-dichloropropylene
34. 2,4-dimethylphenol
35. 2,4-dinitrotoluene
37. 1,2-diphenylhydrazine
39. fluoranthene
40. 4-chlorophenyl phenyl ether
41. 4-bromophenyl phenyl ether
42. bis(2-chloroisopropyl)ether
43. bis(2-chloroethoxy)methane
45. methyl chloride (chloromethane)
46. methyl bromide (bromomethane)
47. bromoform (tribromomethane)
48. dichlorobromomethane
49. deleted
50. deleted
51. chlorodibromomethane

Table VI-1 (Continued)

POLLUTANTS NOT DETECTED IN COPPER FORMING WASTEWATER

52. hexachlorobutadiene
53. hexachlorocyclopentadiene
54. isophorone
56. nitrobenzene
57. 2-nitrophenol
58. 4-nitrophenol
59. 2,4-dinitrophenol
60. 4,6-dinitro-o-cresol
61. N-nitrosodimethylamine
63. N-nitrosodi-n-propylamine
64. pentachlorophenol
65. phenol
66. bis(2-ethylhexyl)phthalate*
67. butyl benzyl phthalate*
68. di-n-butyl phthalate*
69. di-n-octyl phthalate*
70. diethyl phthalate
71. dimethyl phthalate*
72. benzo(a)anthracene*
73. benzo(a)pyrene*
74. benzo(b)fluoranthene*
75. benzo(k)fluoranthene*
76. chrysene*
77. acenaphthylene*
79. benzo(ghi)perylene*
80. fluorene*
82. dibenzo(a,h)anthracene*
83. indeno(1,2,3-c,d)pyrene*
84. pyrene*
85. tetrachloroethylene*
88. vinyl chloride (chloroethylene)
89. aldrin
90. dieldrin
91. chlordane
92. 4,4'-DDT
93. 4,4'-DDE
94. 4,4'-DDD
95. alpha-endosulfan
96. beta-endosulfan
97. endosulfan sulfate
98. endrin
99. endrin aldehyde
100. heptachlor
101. heptachlor epoxide
102. alpha-BHC

Table VI-1 (Continued)

POLLUTANTS NOT DETECTED IN COPPER FORMING WASTEWATER

103. beta-BHC
104. gamma-BHC
105. delta-BHC
106. PCB-1242 (a)
107. PCB-1254 (a)
108. PCB-1221 (a)
109. PCB-1232 (a)
110. PCB-1248 (b)
111. PCB-1260 (b)
112. PCB-1016 (b)
113. toxaphene
116. asbestos (fibrous)
129. 2,3,7,8-tetrachlorodibenzo-p-dioxin

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*Possibly detected, but below the analytical quantification level.

(a) (b) Phenanthrene and anthracene are reported together since they are not physically distinguishable using approved analytical methods.

Table VI-2

POLLUTANTS EXCLUDED FROM REGULATION BECAUSE THEY ARE PRESENT IN AMOUNTS TOO SMALL TO BE EFFECTIVELY TREATED

123.	Mercury
127.	Thallium

Table VI-3

POLLUTANTS EXCLUDED FROM REGULATION BECAUSE THEY WILL BE EFFECTIVELY CONTROLLED BY THE TECHNOLOGIES UPON WHICH THIS REGULATION IS BASED

114.	Antimony
115.	Arsenic
117.	Beryllium
118.	Cadmium
125.	Selenium
126.	Silver

Table VI-4

POLLUTANTS DETECTED IN THE EFFLUENT OF ONLY ONE PLANT

121.	cyanide

Table VI-5

TOXIC POLLUTANTS REGULATED

4. Benzene
11. 1,1,1-Trichloroethane
23. Chloroform
36. 2,6-Dinitrotoluene
38. Ethylbenzene
44. Methylene Chloride
55. Naphthalene
62. N-Nitrosodiphenylamine
78. Anthracene
81. Phenanthrene
86. Toluene
87. Trichloroethylene
119. Chromium
120. Copper
122. Lead
124. Nickel
128. Zinc

Table VI-6

MAXIMUM CONCENTRATIONS OF TOXIC POLLUTANTS FOUND IN COPPER FORMING WASTEWATERS

	Toxic Pollutant	Maximum Concentration Observed (mg/l)
4.	Benzene	2.0
11.	1,1,1-Trichloroethane	0.087
23.	Chloroform	0.038
36.	2,6-Dinitrotoluene	14.0
38.	Ethylbenzene	0.043
44.	Methylene Chloride	0.053
55.	Naphthalene	3.5
62.	N-Nitrosodiphenylamine	90
78.	Anthracene (a)	27
81.	Phenanthrene (a)	27
86.	Toluene	0.057
87.	Trichloroethylene	0.023
114.	Antimony	2.26
115.	Arsenic	0.80
117.	Beryllium	0.0118
118.	Cadmium	2.83
119.	Chromium	174
120.	Copper	24,000
121.	Cyanide	0.18
122.	Lead	167
123.	Mercury	0.0024
124.	Nickel	385
128.	Zinc	45,000

(a) Phenanthrene and anthracene are reported together since they are not physically distinguishable using approved analytical methods.

SECTION VII

CONTROL AND TREATMENT TECHNOLOGY

This section describes the treatment techniques currently used or available to remove or recover wastewater pollutants normally generated by the copper forming industrial point source category. Included are discussions of individual end-of-pipe treatment technologies and in-plant technologies. These treatment technologies are widely used in many industrial categories and data and information to support their effectiveness have been drawn from a similarly wide range of sources and data bases.

END-OF-PIPE TREATMENT TECHNOLOGIES

In this section, individual recovery and treatment technologies are described which are used or are suitable for use in treating wastewater discharges from copper forming facilities. Each description includes a functional description and discussions of application and performance, advantages and limitations, operational factors (reliability, maintainability, solid waste aspects), and demonstration status. The treatment processes described include both technologies presently demonstrated within the copper forming category, and technologies demonstrated in treatment of similar wastes in other industries.

Copper forming wastewater streams characteristically contain significant levels of toxic inorganics. Chromium, copper, lead, nickel, and zinc are found in copper forming wastewater streams at substantial concentrations. These toxic inorganic pollutants constitute the most significant wastewater pollutants in this category. In general, these pollutants are removed by precipitation of metal hydroxides or carbonates utilizing the reaction with lime, sodium hydroxide, or sodium carbonate.

Discussion of end-of-pipe treatment technologies is divided into three parts: the major technologies, the effectiveness of major technologies, and minor end-of-pipe technologies.

MAJOR TECHNOLOGIES

In Sections IX, X, XI, and XII, the rationale for selecting treatment systems is discussed. The individual technologies used in the system are described here. The major end-of-pipe technologies are: chemical reduction of hexavalent chromium, chemical precipitation of dissolved metals, granular bed filtration, pressure filtration, settling of suspended solids, skimming of oil, chemical emulsion breaking, and thermal emulsion breaking. In practice, precipitation of metals and settling of the resulting precipitates is often a unified two-step operation. Suspended solids originally present in raw wastewaters are not appreciably affected by the precipitation operation and are removed with the precipitated metals in the settling operations. Settling operations can be evaluated independently of hydroxide or other chemical precipitation operations, but hydroxide and other chemical precipitation operations can only be evaluated in combination with a solids removal operation.

1. Chemical Reduction of Chromium

Description of the Process. Reduction is a chemical reaction in which electrons are transferred to the chemical being reduced from the chemical initiating the transfer (the reducing agent). Sulfur dioxide, sodium bisulfite, sodium metabisulfite, and ferrous sulfate form strong reducing agents in aqueous solution and are often used in industrial waste treatment facilities for the reduction of hexavalent chromium to the trivalent form. The reduction allows removal of chromium from solution in conjunction with other metallic salts by alkaline precipitation. Hexavalent chromium is not precipitated as the hydroxide.

Gaseous sulfur dioxide is a widely used reducing agent and provides a good example of the chemical reduction process. Reduction using other reagents is chemically similar. The reactions involved may be illustrated as follows:

$$3SO_2 + 3H_2O \qquad 3H_2SO_3$$

$$3H_2SO_3 + 2H_2CrO_4 \qquad Cr_2(SO_4)_3 + 5H_2O$$

The above reactions are favored by low pH. A pH of from 2 to 3 is normal for situations requiring complete reduction. At pH levels above 5, the reduction rate is slow. Oxidizing agents such as dissolved oxygen and ferric iron interfere with the reduction process by consuming the reducing agent.

A typical treatment consists of 45 minutes retention in a reaction tank. The reaction tank has an electronic recorder-controller device to control process conditions with respect to pH and oxidation-reduction potential (ORP). Gaseous sulfur dioxide is metered to the reaction tank to maintain the ORP within the range of 250 to 300 millivolts. Sulfuric acid is added to maintain a pH level of from 1.8 to 2.0. The reaction tank is equipped with a propeller agitator designed to provide approximately one turnover per minute. Figure VII-1 shows a continuous chromium reduction system.

Application and Performance. Chromium reduction is used in copper forming for treating pickling baths and pickling rinses. Cooling tower blowdown may also contain chromium as a biocide in waste streams. A study of an operational waste treatment facility chemically reducing hexavalent chromium has shown that a 99.7 percent reduction efficiency is easily achieved. Reduction followed by chemical precipitation can achieve final concentrations of 0.05 mg/l, and concentrations of 0.01 mg/l are considered to be attainable by properly maintained and operated equipment.

Advantages and Limitations. The major advantage of chemical reduction of hexavalent chromium is that it is a fully proven technology based on many years of experience. Operation at ambient conditions results in low energy consumption, and the process, especially when using sulfur dioxide, is well suited to automatic control. Furthermore, the equipment is readily obtainable from many suppliers, and operation is straightforward.

One limitation of chemical reduction of hexavalent chromium is that for high concentrations of chromium, the cost of treatment chemicals may be prohibitive. When this situation occurs, other treatment techniques are likely to be more economical. Chemical interference by oxidizing agents is possible in the treatment of mixed wastes, and the treatment itself may introduce pollutants if not properly controlled. Storage and handling of sulfur dioxide is somewhat hazardous.

Operational Factors. Reliability: Maintenance consists of periodic removal of sludge, the frequency of which is a function of the input concentrations of detrimental constituents.

Solid Waste Aspects: Pretreatment to eliminate substances which will interfere with the process may often be necessary. This process produces trivalent chromium which can be controlled by further treatment. There may, however, be small amounts of sludge collected due to minor shifts in the solubility of the contaminants. This sludge can be processed by the main sludge treatment equipment.

Demonstration Status. The reduction of chromium waste by sulfur dioxide or sodium bisulfite is a classic process and is used by numerous plants which have hexavalent chromium compounds in wastewaters from operations such as electroplating and coil coating. Eight copper forming plants report the use of chromium reduction to treat pickling wastewaters.

2. Chemical Precipitation

Dissolved toxic metal ions and certain anions may be chemically precipitated for removal by physical means such as sedimentation, filtration, or centrifugation. Several reagents are commonly used to effect this precipitation.

1. Alkaline compounds such as lime or sodium hydroxide may be used to precipitate many toxic metal ions as metal hydroxides. Lime also may precipitate phosphates as insoluble calcium phosphate and fluorides as calcium fluoride.

2. Both "soluble" sulfides such as hydrogen sulfide or sodium sulfide and "insoluble" sulfides such as ferrous sulfide may be used to precipitate many heavy metal ions as insoluble metal sulfides.

3. Ferrous sulfate, zinc sulfate, or both (as required) may be used to precipitate cyanide as a ferro or zinc ferricyanide complex.

4. Carbonate precipitates may be used to remove metals either by direct precipitation using a carbonate reagent such as calcium carbonate or by converting hydroxides into carbonates using carbon dioxide.

These treatment chemicals may be added to a flash mixer or rapid mix tank, to a presettling tank, or directly to a clarifier or other settling device. Because metal hydroxides tend to be colloidal in nature, coagulating agents may also be added to facilitate settling. After the solids have been removed, final pH adjustment may be required to reduce the high pH created by the alkaline treatment chemicals.

Chemical precipitation as a mechanism for removing metals from wastewater is a complex process of at least two steps - precipitation of the unwanted metals and removal of the precipitate. Some small amount of metal will remain dissolved in the wastewater after complete precipitation. The amount of residual dissolved metal depends on the treatment chemicals used and related factors. The effectiveness of this method of removing any specific metal depends on the fraction of the specific metal in the raw waste (and hence in the precipitate) and the effectiveness of suspended solids removal. In specific instances, a sacrificial ion such as iron or aluminum may be added to aid in the precipitation process and reduce the fraction of a specific metal in the precipitate.

Application and Performance. Chemical precipitation is used in copper forming for precipitation of dissolved metals. It can be used to remove metal ions such as antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, tin, and zinc. The process is also applicable to any substance that can be transformed into an insoluble form such as fluorides, phosphates, soaps, sulfides, and others. Because it is simple and effective, chemical precipitation is extensively used for industrial waste treatment.

The performance of chemical precipitation depends on several variables. The most important factors affecting precipitation effectiveness are:

1. Maintenance of an alkaline pH throughout the precipitation reaction and subsequent settling,
2. Addition of a sufficient excess of treatment ions to drive the precipitation reaction to completion,
3. Addition of an adequate supply of sacrificial ions (such as iron or aluminum) to ensure precipitation and removal of specific target ions, and
4. Effective removal of precipitated solids (see appropriate technologies discussed under "Solids Removal").

Control of pH. Irrespective of the solids removal technology employed, proper control of pH is absolutely essential for favorable performance of precipitation-sedimentation technologies. This is clearly illustrated by solubility curves for selected metals hydroxides and sulfides shown in Figure VII-2, and by plotting effluent zinc concentrations against pH as shown in Figure VII-3. Figure VII-3 was obtained from Development Document for the Proposed Effluent Limitations Guidelines and New Source Performance Standards for the Zinc Segment of Nonferrous Metals Manufacturing Point Source Category, U.S. E.P.A., EPA 440/1-74/033, November, 1974. Figure VII-3 was plotted from the sampling data from several facilities with metal finishing operations. It is partially illustrated by data obtained from three consecutive days of sampling at one metal processing plant (47432) as displayed in Table VII-1. Flow through this system is approximately 49,263 l/hr (13,000 gal/hr).

This treatment system uses lime precipitation (pH adjustment) followed by coagulant addition and sedimentation. Samples were taken before (in) and after (out) the treatment system. The best treatment for removal of copper and zinc was achieved on day one, when the pH was maintained at a satisfactory level. The poorest treatment was found on the second day, when the pH slipped to an unacceptably low level and intermediate values were achieved on the third day, when pH values were less than desirable but in between the first and second days.

Sodium hydroxide is used by one facility (plant 439) for pH adjustment and chemical precipitation, followed by settling (sedimentation and a polishing lagoon) of precipitated solids. Samples were taken prior to caustic addition and following the polishing lagoon. Flow through the system is approximately 22,700 l/hr (6,000 gal/hr). Metals removal data for this system are presented in Table VII-2.

These data indicate that the system was operated efficiently. Effluent pH was controlled within the range of 8.6 to 9.3, and while raw waste loadings were not unusually high, most toxic metals were removed to very low concentrations.

Lime and sodium hydroxide are sometimes used to precipitate metals. Data developed from plant 40063, a facility with a metal-bearing wastewater, exemplify efficient operation of a chemical precipitation and settling system. Table VII-3 shows sampling data from this system, which uses lime and sodium hydroxide for pH adjustment, chemical precipitation, polyelectrolyte flocculant addition, and sedimentation. Samples were taken of the raw waste influent to the system and of the clarifier effluent. Flow through the system is approximately 19,000 l/hr (5,000 gal/hr).

At this plant, effluent TSS levels were below 15 mg/l on each day, despite average raw waste TSS concentrations of over 3,500 mg/l. Effluent pH was maintained at approximately 8, lime addition was sufficient to precipitate the dissolved metal ions, and the flocculant addition and clarifier retention served to remove effectively the precipitated solids.

Sulfide precipitation is sometimes used to precipitate metals resulting in improved metals removals. Most metal sulfides are less soluble than hydroxides and the precipitates are frequently more effectively removed from water. Solubilities for selected metal hydroxide, carbonate, and sulfide precipitates are shown in Table VII-4 (Source: Lange's Handbook of Chemistry). Sulfide precipitation is particularly effective in removing specific metals such as silver and mercury. Sampling data from three industrial plants using sulfide precipitation appear in Table VII-5. The data were obtained from three sources:

1. Summary Report, Control and Treatment Technology for the Metal Finishing Industry: Sulfide Precipitation, U.S. EPA, EPA No. 625/8/80-003, 1979.

2. Industry Finishing, Vo. 35, No. 11, November, 1979.

3. Electroplating sampling data from plant 27045.

In all cases except iron, effluent concentrations are below 0.1 mg/l and in many cases below 0.04 mg/l for the three plants studied.

Sampling data from several chlorine-caustic manufacturing plants using sulfide precipitation demonstrate effluent mercury concentrations varying between 0.009 and 0.03 mg/l. As shown in Figure VII-2, the solubilities of PbS and Ag_2S are lower at alkaline pH levels than either of the corresponding hydroxides or other sulfide compounds. This implies that removal performance for lead and silver sulfides should be comparable to or better than that for the heavy metal hydroxides. Bench scale tests on several types of metal finishing and manufacturing wastewater indicate that metals removal to levels of less than 0.05 mg/l and in some cases less than 0.01 mg/l are common in systems using sulfide precipitation followed by clarification. Some of the bench scale data, particularly in the case of lead, do not support such low effluent concentrations. However, lead is consistently removed to very low levels (less than 0.02 mg/l) in systems using hydroxide and carbonate precipitation and sedimentation.

Of particular interest is the ability of sulfide to precipitate hexavalent chromium (Cr+6) without prior reduction to the trivalent state as is required in the hydroxide process. When ferrous sulfide is used as the precipitant, iron and sulfide act as reducing agents for the hexavalent chromium according to the reaction:

$$CrO_3 + FeS + 3H_2O -> Fe\ (OH)_3 + Cr\ (OH)_3 + S$$

The sludge produced in this reaction consists mainly of ferric hydroxides, chromic hydroxides, and various metallic sulfides. Some excess hydroxyl ions are generated in this process, possibly requiring a downward readjustment of pH.

Based on the available data, Table VII-6 shows the minimum reliably attainable effluent concentrations for sulfide precipitation-sedimentation systems. These values are used to calculate performance predictions of sulfide precipitation-sedimentation systems. Table VII-6 is based on two reports:

1. Summary Report, Control and Treatment Technology for the Metal Finishing Industry: Sulfide Precipitation, U.S. EPA, EPA No. 625/8/80-003, 1979.

2. Addendum to Development Document for Effluent Limitations Guidelines and New Source Performance Standards, Major Inorganic Products Segment of

Inorganics Point Source Category, U.S. EPA, EPA Contract No. EPA/68-01-3281 (Task 7), June, 1978.

Carbonate precipitation is sometimes used to precipitate metals, especially where precipitated metals are to be recovered. The solubility of most metal carbonates is intermediate between hydroxide and sulfide solubilities; in addition, carbonates form easily filtered precipitates.

Carbonate ions appear to be particularly useful in precipitating lead and antimony. Sodium carbonate has been observed being added at treatment to improve lead precipitation and removal in some industrial plants. The lead hydroxide and lead carbonate solubility curves displayed in Figure VII-4 ("Heavy Metals Removal," by Kenneth Lanovette, Chemical Engineering/Deskbook Issue, Oct. 17, 1977) explain this phenomenon.

Co-precipitation with Iron - The presence of substantial quantities of iron in metal-bearing wastewaters before treatment has been shown to improve the removal of toxic metals. In some cases this iron is an integral part of the industrial wastewater; in other cases iron is deliberately added as a preliminary or first step of treatment. The iron functions to improve toxic metal removal by three mechanisms: the iron co-precipitates with toxic metals forming a stable precipitate which desolubilizes the toxic metal; the iron improves the settleability of the precipitate; and the large amount of iron reduces the fraction of toxic metal in the precipitate. Co-precipitation with iron has been practiced for many years incidentally when iron was a substantial constituent of raw wastewater and intentionally when iron salts were added as a coagulant aid. Aluminum or mixed iron-aluminum salts also have been used.

Co-precipitation using large amounts of ferrous iron salts is known as ferrite co-precipitation because magnetic iron oxide or ferrite is formed. The addition of ferrous salts (sulfate) is followed by alkali precipitation and air oxidation. The resultant precipitate is easily removed by filtration and may be removed magnetically. Data illustrating the performance of ferrite co-precipitation are shown in Table VII-7. The data are from:

Sources and Treatment of Wastewater in the Nonferrous Metals Industry, U.S. EPA, EPA No. 600/2-80-074, 1980.

Advantages and Limitations. Chemical precipitation has proven to be an effective technique for removing many pollutants from industrial wastewater. It operates at ambient conditions and is well suited to automatic control. The use of chemical precipitation may be limited because of interference by chelating agents, because of possible chemical interference of mixed wastewaters and treatment chemicals, or because of the potentially hazardous situation involved with the storage and handling of those chemicals. Lime is usually added as a slurry when used in hydroxide precipitation. The slurry must be kept well mixed and the addition lines periodically checked to prevent blocking of the lines, which may result from a buildup of solids. Also, hydroxide precipitation usually makes recovery of the precipitated metals difficult, because of the heterogeneous nature of most hydroxide sludges.

The major advantage of the sulfide precipitation process is that the extremely low solubility of most metal sulfides promotes very high metal removal efficiencies; the sulfide process also has the ability to remove chromates and dichromates without preliminary reduction of the chromium to its trivalent state. In addition, sulfide can precipitate metals complexed with most complexing agents. The process demands care, however, in maintaining the pH of the solution at approximately 10 in order to prevent the generation of toxic hydrogen sulfide gas. For this reason, ventilation of the treatment tanks may be a necessary precaution in most installations. The use of insoluble sulfides reduces the problem of hydrogen sulfide evolution. As with hydroxide precipitation, excess sulfide ion must be present to drive the precipitation reaction to completion. Since the sulfide ion itself is toxic, sulfide addition must be carefully controlled to maximize heavy metals precipitation with a minimum of excess sulfide to avoid the necessity of post treatment. At very high excess sulfide levels and high pH, soluble mercury-sulfide compounds may also be formed. Where excess sulfide is present, aeration of the effluent stream can aid in oxidizing residual sulfide to the less harmful sodium sulfate (Na_2SO_4). The cost of sulfide precipitants is high in comparison with hydroxide precipitants, and disposal of metallic sulfide sludges may pose problems. An essential element in effective sulfide precipitation is the removal of precipitated solids from the wastewater and proper disposal in an appropriate site. Sulfide precipitation will also generate a higher volume of sludge than hydroxide precipitation, resulting in higher disposal and dewatering costs. This is especially true when ferrous sulfide is used as the precipitant.

Sulfide precipitation may be used as a polishing treatment after hydroxide precipitation-sedimentation. This treatment configuration may provide the better treatment effectiveness of sulfide precipitation while minimizing the variability caused by changes in raw waste and reducing the amount of sulfide precipitant required.

<u>Operational Factors</u>. Reliability: Alkaline chemical precipitation is highly reliable, although proper monitoring and

control are required. Sulfide precipitation systems provide similar reliability.

Maintainability: The major maintenance needs involve periodic upkeep of monitoring equipment, automatic feeding equipment, mixing equipment, and other hardware. Removal of accumulated sludge is necessary for efficient operation of precipitation-sedimentation systems.

Solid Waste Aspects: Solids which precipitate out are removed in a subsequent treatment step. Ultimately, these solids require proper disposal.

Demonstration Status. Chemical precipitation of metal hydroxides is a classic waste treatment technology used by most industrial waste treatment systems. Chemical precipitation of metals in the carbonate form alone has been found to be feasible and is commercially used to permit metals recovery and water reuse. Full scale commercial sulfide precipitation units are in operation at numerous installations. As noted earlier, sedimentation to remove precipitates is discussed separately. Chemical precipitation is currently demonstrated at 36 copper forming plants.

3. Granular Bed Filtration

Filtration occurs in nature as the surface ground waters are cleansed by sand. Silica sand, anthracite coal, and garnet are common filter media used in water treatment plants. These are usually supported by gravel. The media may be used singly or in combination. The multi-media filters may be arranged to maintain relatively distinct layers by virtue of balancing the forces of gravity, flow, and buoyancy on the individual particles. This is accomplished by selecting appropriate filter flow rates (gpm/sq-ft), media grain size, and density.

Granular bed filters may be classified in terms of filtration rate, filter media, flow pattern, or method of pressurization. Traditional rate classifications are slow sand, rapid sand, and high rate mixed media. In the slow sand filter, flux or hydraulic loading is relatively low, and removal of collected solids to clean the filter is therefore relatively infrequent. The filter is often cleaned by scraping off the inlet face (top) of the sand bed. In the higher rate filters, cleaning is frequent and is accomplished by a periodic backwash, opposite to the direction of normal flow.

A filter may use a single medium such as sand or diatomaceous earth (Figure VII-5a), but dual (Figure VII-5d) and mixed (multiple) media (Figure VII-5e) filters allow higher flow rates and efficiencies. The dual media filter usually consists of a fine bed of sand under a coarser bed of anthracite coal. The coarse coal removes most of the influent solids, while the fine sand performs a polishing function. At the end of the backwash, the fine sand settles to the bottom because it is denser than the coal, and the filter is ready for normal operation. The mixed media filter operates on the same principle, with the finer, denser media at the bottom and the coarser, less dense media at the top. The usual arrangement is garnet at the bottom (outlet end) of the bed, sand in the middle, and anthracite coal at the top. Some mixing of these layers occurs and is, in fact, desirable.

The flow pattern is usually top-to-bottom, but other patterns are sometimes used. Upflow filters (Figure VII-5b) are sometimes used, and in a horizontal filter the flow is horizontal. In a biflow filter (Figure VII-5c), the influent enters both the top and the bottom and exits laterally. The advantage of an upflow filter is that with a downflow backwash the particles of a single filter medium are distributed and maintained in the desired coarse-to-fine (bottom-to-top) arrangement. The disadvantage is that the bed tends to become fluidized, which lowers filtration efficiency. The biflow design is an attempt to overcome this problem.

The classic granular bed filter operates by gravity flow; however, pressure filters are fairly widely used. They permit higher solids loadings before cleaning and are advantageous when the filter effluent must be pressurized for further downstream treatment. In addition, pressure filter systems are often less costly for low to moderate flow rates.

Figure VII-6 depicts a high rate, dual media, gravity downflow granular bed filter, with self-stored backwash. Both filtrate and backwash are piped around the bed in an arrangement that permits gravity upflow of the backwash, with the stored filtrate serving as backwash. Addition of the indicated coagulant and polyelectrolyte usually results in a substantial improvement in filter performance.

Auxiliary filter cleaning is sometimes employed in the upper few inches of filter beds. This is conventionally referred to as surface wash and is accomplished by water jets just below the surface of the expanded bed during the backwash cycle. These jets enhance the scouring action in the bed by increasing the agitation.

An important feature for successful filtration and backwashing is the underdrain. This is the support structure for the bed. The underdrain provides an area for collection of the filtered water without clogging from either the filtered solids or the media grains. In addition, the underdrain prevents loss of the media with the water, and during the backwash cycle it provides even flow distribution over the bed. Failure to dissipate the velocity head during the filter or backwash cycle will result in bed upset and the need for major repairs.

Several standard approaches are employed for filter underdrains. The simplest one consists of a parallel porous pipe imbedded under a layer of coarse gravel and manifolded to a header pipe for effluent removal. Other approaches to the underdrain system are known as the Leopold and Wheeler filter bottoms. Both of these incorporate false concrete bottoms with specific porosity configurations to provide drainage and velocity head dissipation.

Filter system operation may be manual or automatic. The filter backwash cycle may be on a timed basis, a pressure drop basis with a terminal value which triggers backwash, or a solids carry-over basis from turbidity monitoring of the outlet stream. All of these schemes have been used successfully.

Application and Performance. Wastewater treatment plants often use granular bed filters for polishing after clarification, sedimentation, or other similar operations. Granular bed filtration thus has potential application to nearly all industrial plants. Chemical additives which enhance the upstream treatment equipment may or may not be compatible with or enhance the filtration process. Normal operation flow rates for various types of filters are as follows:

Slow Sand	2.04 - 5.30 l/sq m-hr
Rapid Sand	40.74 - 51.48 l/sq m-hr
High Rate Mixed Media	81.48 - 122.22 l/sq m-hr

Suspended solids are commonly removed from wastewater streams by filtering through a deep 0.3 to 0.9 m (1 to 3 feet) granular filter bed. The porous bed formed by the granular media can be designed to remove practically all suspended particles. Even colloidal suspensions (roughly 1 to 100 microns) are adsorbed on the surface of the media grains as they pass in close proximity in the narrow bed passages.

Properly operated filters following some preliminary treatment to reduce suspended solids below 200 mg/l should produce water with less than 10 mg/l TSS. For example, multimedia filters produced the effluent qualities shown in Table VII-8.

Advantages and Limitations. The principal advantages of granular bed filtration are its comparatively (to other filters) low initial and operating costs, reduced land requirements over other methods to achieve the same level of solids removal, and elimination of chemical additions to the discharge stream. However, the waste stream may require preliminary treatment if the solids level is high (over 100 mg/l). Operator training must be somewhat extensive due to the controls and periodic backwashing involved, and backwash must be stored and dewatered for economical disposal.

Operational Factors. Reliability: The recent improvements in filter technology have significantly improved filtration reliability. Control systems, improved designs, and good operating procedures have made filtration a highly reliable method of water treatment.

Maintainability: Deep bed filters may be operated with either manual or automatic backwash. In either case, they must be periodically inspected for media attrition, partial plugging, and leakage. Where backwashing is not used, collected solids must be removed by shoveling, and filter media must be at least partially replaced.

Solid Waste Aspects: Filter backwash is generally recycled within the wastewater treatment system, so that the solids ultimately appear in the clarifier sludge stream for subsequent dewatering. Alternatively, the backwash stream may be dewatered directly or, if there is no backwash, the collected solids may be disposed of in a suitable landfill. In either of these situations there is a solids disposal problem similar to that of clarifiers.

Demonstration Status. Deep bed filters are in common use in municipal treatment plants. Their use in polishing industrial clarifier effluent is increasing, and the technology is proven and conventional. Granular bed filtration is currently used at six copper forming plants.

4. Pressure Filtration

Pressure filtration works by pumping the liquid through a filter material which is impenetrable to the solid phase. The positive pressure exerted by the feed pumps or other mechanical means provides the pressure differential which is the principal driving force.

A typical pressure filtration unit consists of a number of plates or trays which are held rigidly in a frame to ensure alignment and which are pressed together between a fixed end and a traveling end. On the surface of each plate is mounted a filter made of cloth or a synthetic fiber. The feed stream is pumped into the unit and passes through holes in the trays along the length of the press until the cavities or chambers between the trays are completely filled. The solids are then entrapped, and a cake begins to form on the surface of the filter material. The water passes through the fibers, and the solids are retained.

At the bottom of the trays are drainage ports. The filtrate is collected and discharged to a common drain. As the filter medium becomes coated with sludge, the flow of filtrate through the filter drops sharply, indicating that the capacity of the filter has been exhausted. The unit must then be cleaned of the sludge. After the cleaning or replacement of the filter media, the unit is again ready for operation.

Application and Performance. Pressure filtration may be used in copper forming for sludge dewatering and also for direct removal of precipitated and other suspended solids from wastewater.

Because dewatering is such a common operation in treatment systems, pressure filtration is a technique which can be found in many industries concerned with removing solids from their waste stream.

In a typical pressure filter, chemically preconditioned sludge detained in the unit for one to three hours under pressures varying from 5 to 13 atmospheres exhibited a final dry solids content between 25 and 50 percent.

Advantages and Limitations. The pressures which may be applied to a sludge for removal of water by filter presses that are currently available range from 5 to 13 atmospheres. As a result, pressure filtration may reduce the amount of chemical pretreatment required for sludge dewatering. Sludge retained in the form of the filter cake has a higher percentage of solids than that from a centrifuge or vacuum filter. Thus, it can be easily accommodated by materials handling systems.

As a primary solids removal technique, pressure filtration requires less space than clarification and is well suited to streams with high solids loadings. The sludge produced may be disposed of without further dewatering. The amount of sludge is increased by the use of filter precoat materials (usually diatomaceous earth). Also, cloth pressure filters often do not achieve as high a degree of effluent clarification as clarifiers or granular media filters.

Two disadvantages associated with pressure filtration in the past have been the short life of the filter cloths and lack of automation. New synthetic fibers have largely offset the first of these problems. Also, units with automatic feeding and pressing cycles are now available.

For larger operations, the relatively high space requirements, as compared to those of a centrifuge, could be prohibitive in some situations.

Operational Factors. Reliability: With proper pretreatment, design, and control, pressure filtration is a highly dependable system.

Maintainability: Maintenance consists of periodic cleaning or replacement of the filter media, drainage grids, drainage piping, filter pans, and other parts of the system. If the removal of the sludge cake is not automated, additional time is required for this operation.

Solid Waste Aspects: Because it is generally drier than other types of sludges, the filter sludge cake can be handled with relative ease. The accumulated sludge may be disposed by any of the accepted procedures depending on its chemical composition. The levels of toxic metals present in sludge from treating copper forming wastewater necessitate proper disposal.

Demonstration Status. Pressure filtration is a commonly used technology in many commercial applications. No copper forming plants use pressure filtration.

5. Settling

Settling is a process which removes solid particles from a liquid matrix by gravitational force. This is done by reducing the velocity of the feed stream in a large volume tank or lagoon so that gravitational settling can occur. Figure VII-7 shows two typical settling devices.

Settling is often preceded by chemical precipitation which converts dissolved pollutants to solid form and by coagulation which enhances settling by coagulating suspended precipitates into larger, faster settling particles.

If no chemical pretreatment is used, the wastewater is fed into a tank or lagoon where it loses velocity and the suspended solids are allowed to settle out. Long retention times are generally required. Accumulated sludge can be collected either periodically or continuously and either manually or mechanically. Simple settling, however, may require excessively large catchments, and long retention times (days as compared with hours) to achieve high removal efficiencies. Because of this, addition of settling aids such as alum or polymeric flocculants is often economically attractive.

In practice, chemical precipitation often precedes settling, and inorganic coagulants or polyelectrolytic flocculants are usually added as well. Common coagulants include sodium sulfate, sodium aluminate, ferrous or ferric sulfate, and ferric chloride. Organic polyelectrolytes vary in structure, but all usually form larger floc particles than coagulants used alone.

Following this pretreatment, the wastewater can be fed into a holding tank or lagoon for settling, but is more often piped into a clarifier for the same purpose. A clarifier reduces space requirements, reduces retention time, and increases solids removal efficiency. Conventional clarifiers generally consist of a circular or rectangular tank with a mechanical sludge collecting device or with a sloping funnel-shaped bottom designed for sludge collection. In advanced settling devices, inclined plates, slanted tubes, or a lamellar network may be included within the clarifier tank in order to increase the effective settling area, increasing capacity. A fraction of the sludge stream is often recirculated to the inlet, promoting formation of a denser sludge.

Application and Performance. Settling and clarification are used in the copper forming category to remove precipitated metals. Settling can be used to remove most suspended solids in a particular waste stream; thus it is used extensively by many different industrial waste treatment facilities. Because most metal ion pollutants are readily converted to solid metal hydroxide precipitates, settling is of particular use in those industries associated with metal production, metal finishing, metal working, and any other industry with high concentrations of metal ions in their wastewaters. In addition to toxic metals, suitably precipitated materials effectively removed by settling include aluminum, iron, manganese, cobalt, antimony, beryllium, molybdenum, fluoride, phosphate, and many others.

A properly operated settling system can efficiently remove suspended solids, precipitated metal hydroxides, and other impurities from wastewater. The performance of the process depends on a variety of factors, including the density and particle size of the solids, the effective charge on the suspended particles, and the types of chemicals used in pretreatment. The site of flocculant or coagulant addition also may significantly influence the effectiveness of clarification. If the flocculant is subjected to too much mixing before entering the clarifier, the complexes may be sheared and the settling effectiveness diminished. At the same time, the flocculant must have sufficient mixing and reaction time in order for effective set-up and settling to occur. Plant personnel have observed that the line or trough leading into the clarifier is often the most efficient site for flocculant addition. The performance of simple settling is a function of the retention time, particle size and density, and the surface area of the basin.

The data displayed in Table VII-9 indicate suspended solids removal efficiencies in settling systems.

The mean effluent TSS concentration obtained by the plants shown in Table VII-9 is 10.1 mg/l. Influent concentrations averaged 838 mg/l. The maximum effluent TSS value reported is 23 mg/l. These plants all use alkaline pH adjustment to precipitate metal hydroxides, and most add a coagulant or flocculant prior to settling.

<u>Advantages and Limitations</u>. The major advantage of simple settling is its simplicity as demonstrated by the gravitational settling of solid particulate waste in a holding tank or lagoon. The major problem with simple settling is the long retention time necessary to achieve an acceptable effluent, especially if the specific gravity of the suspended matter is close to that of water. Some materials cannot be effectively removed by simple settling alone.

Settling performed in a clarifier is effective in removing slow-settling suspended matter in a shorter time and in less space than a simple settling system. Also, effluent quality is often better from a clarifier. The cost of installing and maintaining a clarifier, however, is substantially greater than the cost associated with simple settling.

Inclined plate, slant tube, and lamellar settlers have even higher removal efficiencies than conventional clarifiers, and greater capacities per unit area are possible. Installed costs for these advanced clarification systems are claimed to be one half the cost of conventional systems of similar capacity.

<u>Operational Factors</u>. Reliability: Settling can be a highly reliable technology for removing suspended solids. Sufficient retention time and regular sludge removal are important factors affecting the reliability of all settling systems. Proper control of pH adjustment, chemical precipitation, and coagulant or flocculant addition are additional factors affecting settling efficiencies in systems (frequently clarifiers) where these methods are used.

Those advanced settlers using slanted tubes, inclined plates, or a lamellar network may require prescreening of the waste in order to eliminate any fibrous materials which could potentially clog the system. Some installations are especially vulnerable to shock loadings, as by storm water runoff, but proper system design will prevent this.

Maintainability: When clarifiers or other advanced settling devices are used, the associated system utilized for chemical pretreatment and sludge dragout must be maintained on a regular basis. Routine maintenance of mechanical parts is also necessary. Lagoons require little maintenance other than periodic sludge removal.

Demonstration Status. Settling represents the typical method of solids removal and is employed extensively in industrial waste treatment. The advanced clarifiers are just beginning to appear in significant numbers in commercial applications. Thirty-six copper forming plants use sedimentation or clarification.

6. Skimming

Pollutants with a specific gravity less than water will often float unassisted to the surface of the wastewater. Skimming removes these floating wastes. Skimming normally takes place in a tank designed to allow the floating material to rise and remain on the surface, while the liquid flows to an outlet located below the floating layer. Skimming devices are therefore suited to the removal of non-emulsified oils from raw waste streams. Common skimming mechanisms include the rotating drum type, which picks up oil from the surface of the water as it rotates. A doctor blade scrapes oil from the drum and collects it in a trough for disposal or reuse. The water portion is allowed to flow under the rotating drum. Occasionally, an underflow baffle is installed after the drum; this has the advantage of retaining any floating oil which escapes the drum skimmer. The belt type skimmer is pulled vertically through the water, collecting oil which is scraped off from the surface and collected in a drum. Gravity separators (Figure VII-8), such as the API type, utilize overflow and underflow baffles to skim a floating oil layer from the surface of the wastewater. An overflow-underflow baffle allows a small amount of wastewater (the oil portion) to flow over into a trough for disposition or reuse while the majority of the water flows underneath the baffle. This is followed by an overflow baffle, which is set at a height relative to the first baffle such that only the oil bearing portion will flow over the first baffle during normal plant operation. A diffusion device, such as a vertical slot baffle, aids in creating a uniform flow through the system and increasing oil removal efficiency.

Application and Performance. Skimming is applicable to any waste stream containing pollutants which float to the surface. It is commonly used to remove free oil, grease, and soaps. Skimming is often used in conjunction with air flotation or clarification in order to increase its effectiveness.

The removal efficiency of a skimmer is partly a function of the retention time of the water in the tank. Larger, more buoyant particles require less retention time than smaller particles. Thus, the efficiency also depends on the composition of the waste stream. The retention time required to allow phase separation and subsequent skimming varies from 1 to 15 minutes, depending on the wastewater characteristics.

API or other gravity-type separators tend to be more suitable for use where the amount of surface oil flowing through the system is continuous and substantial. Drum and belt type skimmers are applicable to waste streams which evidence smaller amounts of floating oil and where surges of floating oil are not a problem. Using an API separator system in conjunction with a drum type skimmer would be a very effective method of removing floating contaminants from non-emulsified oily waste streams. Sampling data shown in Table VII-10 illustrate the capabilities of the technology with both extremely high and moderate oil influent levels.

This data is intended to be illustrative of the very high level of oil and grease removals attainable in a simple two stage oil removal system. Based on the performance of installations in a variety of manufacturing plants and permit requirements that are constantly achieved, it is determined that effluent oil levels may be reliably reduced below 10 mg/l with moderate influent concentrations. Very high concentrations of oil such as the 22 percent shown in Table VII-10 may require two step treatment to achieve this level.

Skimming which removes oil may also be used to remove base levels of organics. Plant sampling data show that many organic compounds tend to be removed in standard wastewater treatment equipment. Oil separation not only removes oil but also organics that are more soluble in oil than in water. Clarification removes organic solids directly and probably removes dissolved organics by adsorption on inorganic solids.

The source of these organic pollutants is not always known with certainty, although in metal forming operations they seem to derive mainly from various process lubricants. They are also sometimes present in the plant water supply, as additives to proprietary formulations of cleaners, or due to leaching from plastic liners and other materials.

High molecular weight organics in particular are much more soluble in organic solvents than in water. Thus they are much more concentrated in the oil phase that is skimmed than in the wastewater. The ratio of solubilities of a compound in oil and water phases is called the partition coefficient. The logarithm of the partition coefficients for 15 polynuclear aromatic hydrocarbon (PAH) compounds in octanol and water are:

PAH Priority Pollutant		Log Octanol/Water Partition Coefficient
1.	Acenaphthene	4.33
30.	Fluoranthene	5.33
72.	Benzo(a)anthracene	5.61
73.	Benzo(a)pyrene	6.04
74.	3,4-Benzofluoranthene	6.57
75.	Benzo(k)fluoranthene	6.84
76.	Chrysene	5.61
77.	Acenaphthylene	4.07
78.	Anthracene	4.45
79.	Benzo(ghi)perylene	7.23
80.	Fluorene	4.18
81.	Phenanthrene	4.46
82.	Dibenzo(a,h)anthracene	5.97
83.	Indeno(1,2,3,cd)pyrene	7.66
84.	Pyrene	5.32

Figure VII-9 shows the relationship between the concentrations of total toxic organics and oil and grease in wastewater samples from copper forming plants. It can be seen that if a daily maximum oil and grease concentration of 20 mg/l is achieved, the concentration of total toxic organics is expected to be below 0.5 mg/l. This conclusion is also supported by data from copper forming plants which practice oil skimming on wastewaters which contain toxic organics as well as oil and grease. Data from three days of sampling at two copper forming plants which practice oil skimming and achieve effluent oil and grease concentrations of 20 mg/l or less are presented in Table VII-11. It can be seen that the concentration of total toxic organics in these effluent samples never exceeds 0.31 mg/l.

Advantages and Limitations. Skimming as a pretreatment is effective in removing naturally floating waste material. It also improves the performance of subsequent downstream treatments. Many pollutants, particularly dispersed or emulsified oil, will not float "naturally" but require additional treatments. Therefore, skimming alone may not remove all the pollutants capable of being removed by air flotation or other more sophisticated technologies.

Operational Factors. Reliability: Because of its simplicity, skimming is a very reliable technique.

Maintainability: The skimming mechanism requires periodic lubrication, adjustment, and replacement of worn parts.

Solid Waste Aspects: The collected layer of debris must be disposed of by contractor removal, landfill, or incineration. Because relatively large quantities of water are present in the collected wastes, incineration is not always a viable disposal method.

Demonstration Status. Skimming is a common operation utilized extensively by industrial waste treatment systems. It is presently used at 10 copper forming plants.

7. Chemical Emulsion Breaking

Chemical treatment is often used to break stable oil-in-water (O-W) emulsions. An O-W emulsion consists of oil dispersed in water, stabilized by electrical charges and emulsifying agents. A stable emulsion will not separate or break down without some form of treatment.

Once an emulsion is broken, the difference in specific gravities allows the oil to float to the surface of the water. Solids usually form a layer between the oil and water, since some oil is retained in the solids. The longer the retention time, the more complete and distinct the separation between the oil, solids, and water will be. Often other methods of gravity differential separation, such as air flotation or rotational separation (e.g., centrifugation), are used to enhance and speed separation. A schematic flow diagram of one type of application is shown in Figure VII-10.

The major equipment required for chemical emulsion breaking includes: reaction chambers with agitators, chemical storage tanks, chemical feed systems, pumps, and piping.

Emulsifiers may be used in the plant to aid in stabilizing or forming emulsions. Emulsifiers are surface-active agents which alter the characteristics of the oil and water interface. These sufactants have rather long polar molecules. One end of the molecule is particularly soluble in water (e.g., carboxyl, sulfate, hydroxyl, or sulfonate groups) and the other end is readily soluble in oils (an organic group which varies greatly with the different surfactant type). Thus, the surfactant emulsifies or suspends the organic material (oil) in water. Emulsifiers also lower the surface tension of the O-W emulsion as a result of solvation and ionic complexing. These emulsions must be destabilized in the treatment system.

Application and Performance. Emulsion breaking is applicable to waste streams containing emulsified oils or lubricants such as rolling and drawing emulsions.

Treatment of spent O-W emulsions involves the use of chemicals to break the emulsion followed by gravity differential separation. Factors to be considered for breaking emulsions are type of chemicals, dosage and sequence of addition, pH, mechanical shear and agitation, heat, and retention time.

Chemicals, e.g., polymers, alum, ferric chloride, and organic emulsion breakers, break emulsions by neutralizing repulsive charges between particles, precipitating or salting out emulsifying agents, or altering the interfacial film between the oil and water so it is readily broken. Reactive cations, e.g., H(+1), Al(+3), Fe(+3), and cationic polymers, are particularly effective in breaking dilute O-W emulsions. Once the charges have been neutralized or the interfacial film broken, the small oil droplets and suspended solids will be adsorbed on the surface of the floc that is formed, or break out and float to the top. Various types of emulsion-breaking chemicals are used for the various types of oils.

If more than one chemical is required, the sequence of addition can make quite a difference in both breaking efficiency and chemical dosages.

pH plays an important role in emulsion breaking, especially if cationic inorganic chemicals, such as alum, are used as coagulants. A depressed pH in the range of 2 to 4 keeps the aluminum ion in its most positive state where it can function most effectively for charge neutralization. After some of the oil is broken free and skimmed, raising the pH into the 6 to 8 range with lime or caustic will cause the aluminum to hydrolyze and precipitate as aluminum hydroxide. This floc entraps or adsorbs destabilized oil droplets which can then be separated from the water phase. Cationic polymers can break emulsions over a wider pH range and thus avoid acid corrosion and the additional sludge generated from neutralization; however, an inorganic flocculant is usually required to supplement the polymer emulsion breaker's adsorptive properties.

Mixing is important in breaking O-W emulsions. Proper chemical feed and dispersion is required for effective results. Mixing also causes collisions which help break the emulsion, and subsequently helps to agglomerate droplets.

In all emulsions, the mix of two immiscible liquids has a specific gravity very close to that of water. Heating lowers the viscosity and increases the apparent specific gravity differential between oil and water. Heating also increases the frequency of droplet collisions, which helps to rupture the interfacial film.

Oil and grease and suspended solids performance data are shown in Table VII-12. Data were obtained from sampling at operating plants and a review of the current literature. This type of treatment is proven to be reliable and is considered the current state-of-the-art for copper forming emulsified oily wastewaters.

Advantages and Limitations. Advantages gained from the use of chemicals for breaking O-W emulsions are the high removal efficiency potential and the possibility of reclaiming the oily waste. Disadvantages are corrosion problems associated with acid-alum systems, skilled operator requirements for batch treatment, chemical sludges produced, and poor cost-effectiveness for low oil concentrations.

Operational Factors. Reliability: Chemical emulsion breaking is a very reliable process. The main control parameters, pH and temperature, are fairly easy to control.

Maintainability: Maintenance is required on pumps, motors, and valves, as well as periodic cleaning of the treatment tank to remove any accumulated solids. Energy use is limited to mixers and pumps.

Solid Waste Aspects: The surface oil and oily sludge produced are usually hauled away by a licensed contractor. If the recovered oil has a sufficiently low percentage of water, it may be burned for its fuel value or processed and reused.

Demonstration Status. Four plants in the copper forming industry currently use chemical emulsion breaking.

8. Thermal Emulsion Breaking

Dispersed oil droplets in a spent emulsion can be destabilized by the application of heat to the waste. One type of technology commonly used in the metals and mechanical products industries is the evaporation-decantation-condensation process, also called thermal emulsion breaking (TEB), which separates the emulsion waste into distilled water, oils and other floating materials, and sludge. Raw waste is fed to a main reaction chamber. Warm air is passed over a large revolving drum which is partially submerged in the waste. Some water evaporates from the surface of the drum and is carried upward through a filter and a condensing unit. The condensed water is discharged or reused as process makeup, while the air is reheated and returned to the evaporation stage. As the water evaporates in the main chamber, oil concentration increases. This enhances agglomeration and gravity separation of oils. The separated oils and other floating materials flow over a weir into a decanting chamber. A rotating drum skimmer picks up oil from the surface of the decanting chamber and discharges it for possible reprocessing or contractor removal. Meanwhile, oily water is being drawn from the bottom of the decanting chamber, reheated, and sent back into the main conveyorized chamber. Solids which settle out in the main chamber are removed by a conveyor belt. This conveyor belt, called a flight scraper, moves slowly so as not to interfere with the settling of suspended solids.

Application and Performance. Thermal emulsion breaking technology can be applied to the treatment of spent emulsions in the copper forming category.

The performance of a thermal emulsion breaker is dependent primarily on the characteristics of the raw waste and proper maintenance and functioning of the process components. Some emulsions may contain volatile compounds which could escape with the distilled water. In systems where the water is recycled back to process, however, this problem is essentially elminated. Experience in at least two copper forming plants has shown that trace organics or other contaminants found in the condensed water will not adversely affect the lubricants when this water is used for process emulsions. In one copper forming plant, typical oil and grease level in the condensed water was 1 mg/l.

Advantages and Limitations. Advantages of the thermal emulsion breaking process include high percentages of oil removal (at least 99 percent in most cases), the separation of floating oil from settleable sludge solids, and the production of distilled water which is available for process reuse. In addition, no chemicals are required and the operation is automated, factors which reduce operating costs. Disadvantages of the process are the energy requirement for water evaporation and, if intermittently operated, the necessary installation of a large storage tank.

Operational Factors. Reliability: Thermal emulsion breaking is a very reliable process for the treatment of emulsified oil wastes.

Maintainability: The thermal emulsion breaking process requires minimal routine maintenance of the process components, and periodic disposal of the sludge and oil.

Solid Waste Aspects: The thermal emulsion breaking process generates sludge which must be properly disposed of.

Demonstration Status. Thermal emulsion breaking is used in metals and mechanical products industries. It is a proven method of effectively treating emulsified wastes. Six copper forming plants currently use thermal emulsion breaking.

MAJOR TECHNOLOGY EFFECTIVENESS

The performance of individual treatment technologies was presented above. Performance of operating systems is discussed here. Two different systems are considerred: L&S (hydroxide precipitation and sedimentation or lime and settle) and LS&F (hydroxide precipitation, sedimentation, and filtration or lime, settle, and filter). Subsequently, an analysis of effectiveness of such systems is made to develop one-day maximum and ten-day and thirty-day average concentration levels to be used in regulating pollutants. Evaluation of the L&S and the LS&F systems is carried out on the assumption that chemical reduction of chromium, cyanide precipitation, oil skimming, and emulsion breaking are installed and operating properly where appropriate.

L&S Performance - Combined Metals Data Base (CMDB)

A data base known as the "combined metals data base" (CMDB) was used to determine treatment effectiveness of lime and settle treatment for certain pollutants. The CMDB was developed over several years and has been used in a number of regulations.

Before proposal, chemical analysis data were collected of raw waste (treatment influent) and treated waste (treatment effluent) from 55 plants (126 data days) sampled by EPA (or its contractor) using EPA sampling and chemical analysis protocols. These data were the initial data base for determining the effectiveness of L&S technology in treating nine pollutants. Each of these plants belongs to at least one of the following industry categories: copper forming, battery manufacturing, coil coating, aluminum forming, electroplating and porcelain enameling. All of the plants employ pH adjustment and hydroxide precipitation using lime or caustic, followed by Stokes law settling (tank, lagoon or clarifier) for solids removal. Most also add a coagulant or flocculant prior to solids removal.

An analysis of this data was presented in the development documents for the proposed regulations for coil coating and porcelain enameling (January 1981). Prior to analyzing the data, some values were deleted from the data base. These deletions were made to ensure that the data reflect properly operated treatment systems. The following criteria were used in making these deletions:

- Plants where malfunctioning processes or treatment systems at the time of sampling were identified.
- Data days where pH was less than 7.0 for extended periods of time or TSS was greater than 50 mg/l (these are prima facie indications of poor operation).

In response to the coil coating and copper forming proposals, some commenters claimed that it was inappropriate to use data from some categories for regulation of other categories. In response to these comments, the Agency reanalyzed the data. An analysis of variance was applied to the data for the 126 days of sampling to test the hypothesis of homogeneous plant mean raw and treated effluent levels across categories by pollutant. This analysis is described in the report, "A Statistical Analysis of the Combined Metals Industries Effluent Data" which is in the administrative record supporting this rulemaking. The main conclusion drawn from the analysis of variance is that, with the exception of electroplating, the categories included in the data base are generally homogeneous with regard to mean pollutant concentrations in both raw and treated effluent. That is, when data from electroplating facilities are included in the analysis, the hypothesis of homogeneity across categories is rejected. When the electroplating data are removed from the analysis the conclusion changes substantially and the hypothesis of homogeneity across categories is not rejected. On the basis of this analysis, the electroplating data were removed from the data base used to determine limitations for the final coil coating and porcelain enameling regulations and proposed regulations for copper forming, aluminum forming and battery manufacturing.

The statistical analysis provides support for the technical engineering judgment that electroplating wastewaters are sufficiently different from the wastewaters of the other industrial categories in the data base to warrant the removal of electroplating data from the data base.

For the purpose of determining treatment effectiveness, additional data were deleted from the data base. These deletions were made, almost exclusively, in cases where effluent data points were associated with low influent values. This was done in two steps. First, effluent values measured on the same day as influent values that were less than or equal to 0.1 mg/l were deleted. Second, the remaining data were screened for cases in which all influent values at a plant were low although slightly above the 0.1 mg/l value. These data were deleted not as individual data points but as plant clusters of data that were consistently low and thus not relevant to assessing treatment. A few data points were also deleted where malfunctions not previously identified were recognized.

After all deletions, 148 data points from 19 plants remained. These data were used to establish the concentration bases of the limitations and standards for the copper forming proposal.

Following the proposal of the copper forming regulation, the CMDB was reviewed. Comments pointed out a few errors in the data and the Agency's review identified a few transcription errors and some data points that were appropriate for inclusion in the data that had not been used previously because of errors in data record identification numbers. Documents in the record of this rulemaking identify all the changes, the reasons for the changes, and the effects of these changes on the data base.

The revised data base was re-examined for homogeneity. The earlier conclusions were unchanged. The categories show good overall homogeneity with respect to concentrations of the nine pollutants in both raw and treated wastewaters with the exception of electroplating.

The same procedures used in developing proposed limitations from the combined metals data base were then used on the revised data base. That is, certain effluent data associated with low influent values were deleted, and then the remaining data were fit to a lognormal distribution to determine limitations values. The deletion of data was done again in two steps. First, effluent values measured on the same day as influent values that were less than or equal to 0.1 mg/l were deleted. Second, the remaining data were screened for cases in which all influent values at a plant were low although slightly above the 0.1 mg/l value. These data were deleted not as individual data points but as plant clusters of data that were consistently low and thus not relevant to assessing treatment.

The revised combined metals data base used for this final regulation consists of 162 data points from 18 plants in the same industrial categories used at proposal. The changes that were made since proposal resulted in slight upward revisions of the concentration bases for the limitations and standards for zinc and nickel. The limitations for iron decrease slightly. The other limitations were unchanged. A comparison of Table VII-20 in the final development document with Table VII-21 in the proposal development document will show the exact magnitude of the changes.

The Agency is confident that the concentrations calculated from the combined metals data base accurately reflect the ability of lime and settle systems in copper forming plants to reduce the concentrations of the toxic metals in their raw waste streams. The Agency confirmed this judgment by comparing available discharge monitoring report (DMR) data from 15 discharge points in copper forming plants. This comparison led to the conclusion that the concentrations calculated from the combined metals data base were being achieved by most discharge points over long periods of time. The analysis of the DMR data is documented in the record of this rulemaking.

One-Day Effluent Values

The same procedures used to determine the concentration basis of the limitations for lime and settle treatment from the CMDB at proposal were used on the revised CMDB for the final limitations. The basic assumption underlying the determination of treatment effectiveness is that the data for a particular pollutant are lognormally distributed by plant. The lognormal has been found to provide a satisfactory fit to plant effluent data in a number of effluent guidelines categories and there was no evidence that the lognormal was not suitable in the case of the combined metals data. Thus, the measurements of each pollutant from a particular plant, denoted by X, were assumed follow a lognormal distribution with a log mean μ and log variance σ^2. The mean, variance, and 99th percentile of X are then:

$$\text{mean of } X = E(X) = \exp(\mu + \sigma^2/2)$$
$$\text{variance of } X = V(X) = \exp(2\mu + \sigma^2)\,[\exp(\sigma^2) - 1]$$
$$\text{99th percentile} = X_{.99} = \exp(\mu + 2.33\,\sigma)$$

where exp is e, the base of the natural logarithm. The term lognormal is used because the logarithm of X has a normal distribution with mean μ and variance σ^2. Using the basic assumption of lognormality, the actual treatment effectiveness was determined using a lognormal distribution that, in a sense, approximates the distribution of an average of the plants in the data base, i.e., an "average plant" distribution. The notion of an "average plant" distribution is not a strict statistical concept but is used here to determine limits that would represent the performance capability of an average of the plants in the data base.

This "average plant" distribution for a particular pollutant was developed as follows: the log mean was determined by taking the average of all the observations for the pollutant across plants. The log variance was determined by the pooled within plant variance. This is the weighted average of the plant variances. Thus, the log mean represents the average of all the data for the pollutant and the log variance represents the average of the plant log variances or average plant variability for the pollutant.

The one-day effluent values were determined as follows:

Let X_{ij} = the jth observation on a particular pollutant at

plant i where

$i = 1, \ldots, I$
$j = 1, \ldots, J_i$

I = total number of plants
Ji = number of observations at plant i.

Then $Yij = \ln X\,ij$

where ln means the natural logarithm.

Then y = log mean over all plants

$$= \overset{I}{\underset{i=1}{}} \quad \overset{Ji}{\underset{j=1}{}} \qquad Yij/n$$

where n = total number of observations

$$= \overset{I}{\underset{i=1}{}} \qquad Ji$$

and $V(y)$ = pooled log variance

$$= \frac{\overset{I}{\underset{i=1}{}} \quad (Ji-1)Si^2}{\overset{I}{\underset{i=1}{}} \quad (Ji-1)}$$

where Si^2 = log variance at plant i.

$$= \overset{Ji}{\underset{j=1}{}} \qquad (yij - yi)^2/(Ji-1)$$

yi = log mean at plant i.

Thus, y and V(y) are the log mean and log variance, respectively, of the lognormal distribution used to determine the treatment effectiveness. The estimated mean and 99th percentile of this distribution form the basis for the long term average and daily maximum effluent limitations, respectively. The estimates are

$$\text{mean} = E(X) = \exp(y)\ n(0.5V(y))$$

$$\text{99th percentile} = X_{.99} = \exp\ [y + 2.33 \quad V\ (y)\ ]$$

where (.) is a Bessel function and exp is e, the base of the natural logarithms (see Aitchison, J. and J. A. C. Brown, The Lognormal Distribution, Cambridge University Press, 1963). In cases where zeros were present in the data, a generalized form of the lognormal, known as the delta distribution was used (see Aitchison and Brown, op. cit., Chapter 9).

For certain pollutants, this approach was modified slightly to ensure that well operated lime and settle plants in all CMDB categories could meet the concentrations calculated from this data. For instance, after excluding the electroplating data and other data that did not reflect pollutant removal or proper treatment, the effluent copper data from the copper forming plants were statistically significantly greater than the copper data from the other plants. This indicated that copper forming plants might have difficulty achieving an effluent concentration value calculated from copper data from all the CMDB categories. Thus, copper effluent values shown in Table VII-13 are based only on the copper effluent data from the copper forming plants. That is, the log mean for copper is the mean of the logs of all copper values from the copper forming plants only and the log variance is the pooled log variance of the copper forming plant data only. In the case of cadmium, after excluding the electroplating data and data that did not reflect removal or proper treatment, there were insufficient data to estimate the log variance for cadmium. The variance used to determine the values shown in Table VII-13 for cadmium was estimated by pooling the within plant variances for all the other metals. Thus, the cadmium variability is the average of the plant variability averaged over all the other metals. The log mean for cadmium is the mean of the logs of the cadmium observations only. A complete discussion of the data and calculations for all the metals is contained in the administrative record for this rulemaking.

Monthly Average Effluent Values

Average effluent values that form the basis for the monthly limitations were developed in a manner consistent with the method used to develop one-day treatment effectiveness in that the lognormal distribution used for the one-day effluent values was also used as the basis for the average values. That is, we assume a number of consecutive measurements are drawn from the distribution of daily measurements. The average of ten consecutive daily measurements (but not necessarily taken on ten consecutive days) was used as the basis of the monthly average limitations. The approach used for the 10 measurement monthly limitations values was employed previously in regulations for other categories and was proposed for the copper forming category. That is, the distribution of the average of 10 samples from a lognormal was approximated by another lognormal distribution. Although the approximation is not precise theoretically, there is empirical evidence based on effluent data from a number of categories that the lognormal is an adequate approximation for the distribution of small samples. In the course of previous work the approximation was verified in a computer simulation study. (See "Development Document for Existing Sources Pretreatment Standards for the Electroplating Point Source Category," EPA 440/1-79/003, U.S. Environmental Protection Agency, Washington, D.C., August, 1979). The average values were developed assuming independence of the observations although no particular sampling scheme was assumed.

Ten-Sample Average:

The formulas for the 10-sample limitations were derived on the basis of simple relationships between the mean and variance of the distributions of the daily pollutant measurements and the average of 10 measurements. We assume the daily concentration measurements for a particular pollutant, denoted by X, follow a lognormal distribution with log mean and log variance denoted by μ and σ^2, respectively. Let X_{10} denote the mean of 10 consecutive measurements. The following relationships then hold assuming the daily measurements are independent:

$$\text{mean of } X_{10} = E\,(X_{10}) = E(x)$$
$$\text{variance of } X_{10} = V(X_{10}) = V(x) \div 10,$$

where E(X) and V(X) are the mean and variance of X, respectively, defined above. We then assume that X_{10} follows a lognormal distribution with log mean μ_{10} and log standard deviation $\sigma^2{}_{10}$ The mean and variance of X_{10} are then

$$E(X_{10}) = \exp(\mu_{10} + 0.5\sigma^2{}_{10})$$

$$V(X_{10}) = \exp(2\mu_{10} + \sigma^2{}_{10})[\exp(\sigma^2{}_{10}) - 1]$$

Now, $\mu 10$ and $\sigma^2{}_{10}$ can be derived in terms of μ and σ^2 as

$$\mu_{10} = \mu + \sigma^2/2 + 0.5\ln[1 + (\exp(\sigma^2 - 1)/N]$$

$$\sigma^2{}_{10;\mu_1;\sigma_1} = \ln[1 + (\exp(\sigma^2) - 1)/N].$$

Therefore, μ_{10} and $\sigma^2{}_{10}$ can be estimated using the above relationships and the estimates of μ and σ^2 obtaned for the underlying lognormal distribution. The 10 sample limitation value was determined by the estimate of the approximate 99th percentile of the distribution of the 10 sample average given by

$$X_{10}\ (.99) = \exp\ (\mu_{10} + 2.33\ \mu_{10})$$

where μ_{10} and μ_{10} are the estimates of μ_{10} and σ_{10}, respectively.

30 Sample Average:

The average values based on 30 measurements are determined on the basis of a statistical result known as the Central Limit Theorem. This Theorem states that, under general and nonrestrictive assumptions, the distribution of a sum of a number of random variables, say n, is approximated by the normal distribution. The approximation improves as the number of variables, n, increases. The Theorem is quite general in that no particular distributional form is assumed for the distribution of the individual variables. In most applications (as in approximating the distribution of 30-day averages) the Theorem is used to approximate the distribution of the average of n observations of a random variable. The result makes it possible to compute approximate probability statements about the average in a wide range of cases. For instance, it is possible to compute a value below which a specified percentage (e.g., 99 percent) of the averages of n observations are likely to fall. Most textbooks state that 25 or 30 observations are sufficient for the approximation to be valid. In applying the Theorem to the determination of 30 day average effluent values, we approximate the distribution of the average of 30 observations drawn from the distribution of daily measurements and use the estimated 99th percentile of this distribution. The monthly limitations based on 10 consecutive measurements were determined using the lognormal approximation described above because 10 measurements were, in this case, considered too small a number for use of the Central Limit Theorem.

30 Sample Average Calculation

The formulas for the 30 sample average were based on an application of the Central Limit Theorem. According to the Theorem, the average of 30 observations drawn from the distribution of daily measurements, denoted by X_{30}, is approximately normally distributed. The mean and variance of X_{30} are

$$\text{mean of } X_{30} = E(X_{30}) = E(X)$$

$$\text{variance of } X_{30} = V(X_{30}) = V(X) \div 30.$$

The 30 sample average value was determined by the estimate of the approximate 99th percentile of the distribution of the 30 sample average given by

$$X_{30}(.99) = E(X) + 2.33 \quad V(X) \qquad 30$$

$$\text{where} \qquad E(X) = \exp(y) \quad n(0.5V(y))$$

and $V(X) = \exp(2y)[\ n(2V(y)) = n\ \underline{n-2}\ V(y)\ ].$

The formulas for E(X) and V(X) are estimates of E(X) and V(X), respectively given in Aitchison, J. and J.A.C. Brown, The Lognormal Distribution, Cambridge University Press, 1963, page 45.

Application

In response to the proposed coil coating and porcelain enameling regulations, the Agency received comments pointing out that permits usually required less than 30 samples to be taken during a month while the monthly average used as the basis for permits and pretreatment requirements is based on the average of 30 samples.

In applying the treatment effectiveness values to regulations we have considered the comments, examined the sampling frequency required by many permits, and considered the change in values of averages depending on the number of consecutive sampling days in the averages. The most common frequency of sampling required in permits is about 10 samples per month or slightly greater than twice weekly. The 99th percentiles of the distribution of averages of 10 consecutive sampling days are not substantially different from the 99th percentile of the distribution's 30 day average. (Compared to the one-day maximum, the 10-day average is about 80 percent of the difference between one and 30-day values). Hence, the 10-day average provides a reasonable basis for a monthly average and is typical of the sampling frequency required by existing permits.

The monthly average is to be achieved in all permits and pretreatment standards regardless of the number of samples required to be analyzed and averaged by the permit writer or the pretreatment authority.

Additional Pollutants

A number of other pollutant parameters were considered with regard to the performance of lime and settle treatment systems in removing them from industrial wastewater. Performance data for these parameters is not readily available, so data available to the Agency in other categories has been selectively used to determine the long-term average performance of lime and settle technology for each pollutant. These data indicate that the concentrations shown in Table VII-14 are reliably attainable with hydroxide precipitation and settling.

In establishing which data were suitable for use in Table VII-14 two factors were heavily weighed: (1) the nature of the wastewater; and (2) the range of pollutants or pollutant matrix in the raw wastewater. These data have been selected from processes that generate dissolved metals in the wastewater and which are generally free from complexing agents. The pollutant matrix was evaluated by comparing the concentrations of pollutants found in the raw wastewaters with the range of pollutants in the raw wastewaters of the combined metals data set. These data are displayed in Tables VII-15 and VII-16 and indicate that there is sufficient similarity in the raw wastes to logically assume transferability of the treated pollutant concentrations to the combined metals data base. The available data on these added pollutants do not allow homogeneity analysis as was performed on the combined metals data base. The data source for each added pollutant is discussed separately.

Antimony (Sb) - The achievable performance for antimony is based on data from a battery and secondary lead plant. Both EPA sampling data and recent permit data (1978 - 1982) confirm the achievability of 0.70 mg/l in the battery manufacturing wastewater matrix included in the combined data set.

Arsenic (As) - The achievable performance of 0.51 mg/l for arsenic is based on permit data from two nonferrous metals manufacturing plants. The untreated wastewater matrix shown in Table VII-16 is comparable with the combined data set matrix.

Beryllium (Be) - The treatability of beryllium is transferred from the nonferrous metals manufacturing industry. The 0.3 performance is achieved at a beryllium plant with the comparable untreated wastewater matrix shown in Table VII-16.

Mercury (Hg) - The 0.06 mg/l treatability of mercury is based on data from four battery plants. The untreated wastewater matrix at these plants was considered in the combined metals data set.

Selenium (Se) - The 0.30 mg/l treatability of selenium is based on recent permit data from one of the nonferrous metals manufacturing plants also used for antimony performance. The untreated wastewater matrix for this plant is shown in Table VII-16.

Silver (Ag) - The treatability of silver is based on a 0.1 mg/l treatability estimate from the inorganic chemicals industry. Additional data supporting a treatability as stringent or more stringent than 0.1 mg/l is also available from seven nonferrous metals manufacturing plants. The untreated wastewater matrix for these plants is comparable and summarized in Table VII-16.

Thallium (Th) - The 0.50 mg/l treatability for thallium is transferred from the inorganic chemicals industry. Although no untreated wastewater data are available to verify comparability with the combined metals data set plants, no other sources of data for thallium treatability could be identified.

Aluminum (Al) - The 2.24 mg/l treatability of aluminum is based on the mean performance of three aluminum forming plants and one coil coating plant. All of these plants are from categories considered in the combined metals data set, assuring untreated wastewater matrix comparability.

Cobalt (Co) - The 0.05 mg/l treatability is based on nearly complete removal of cobalt at a porcelain enameling plant with a mean untreated wastewater cobalt concentration of 4.31 mg/l. In this case, the analytical detection using aspiration techniques for this pollutant is used as the basis of the treatability. Porcelain enameling was considered in the combined metals data base, assuring untreated wastewater matrix comparability.

Fluoride (F) - The 14.5 mg/l treatability of fluoride is based on the mean performance of an electronics and electrical component manufacturing plant. The untreated wastewater matrix for this plant shown in Table VII-16 is comparable to the combined metals data set.

LS&F Performance

Tables VII-17 and VII-18 show long-term data from two plants which have well operated precipitation-settling treatment followed by filtration. The wastewaters from both plants contain pollutants from metals processing and finishing operations (multi-category). Both plants reduce hexavalent chromium before neutralizing and precipitating metals with lime. A clarifier is used to remove much of the solids load and a filter is used to "polish" or complete removal of suspended solids. Plant A uses pressure filtration, while Plant B uses a rapid sand filter.

Raw waste data was collected only occasionally at each facility and the raw waste data is presented as an indication of the nature of the wastewater treated. Data from Plant A was received as a statistical summary and is presented as received. Raw laboratory data was collected at Plant B and reviewed for spurious points and discrepancies. The method of treating the data base is discussed below under lime, settle, and filter treatment effectiveness.

Table VII-19 shows long-term data for zinc and cadmium removal at Plant C, a primary zinc smelter, which operates a LS&F system. This data represents about four months (103 data days) taken immediately before the smelter was closed. It has been arranged similarily to Plants A and B for comparison and use.

These data are presented to demonstrate the performance of precipitation-settling-filtration (LS&F) technology under actual operating conditions and over a long period of time.

It should be noted that the iron content of the raw waste of plants A and B is high while that for Plant C is low. This results, for plants A and B, in co-precipitation of toxic metals with iron. Precipitation using high-calcium lime for pH control yields the results shown in Table VII-19. Plant operating personnel indicate that this chemical treatment combination (sometimes with polymer assisted coagulation) generally produces better and more consistent metals removal than other combinations of sacrificial metal ions and alkalis.

The LS&F performance data presented here are based on systems that provide polishing filtration after effective L&S treatment. As previously shown, L&S treatment is equally applicable to wastewaters from the five categories because of the homogeneity of its raw and treated wastewaters, and other factors. Because of the similarity of the wastewaters after L&S treatment, the Agency believes these wastewaters are equally amenable to treatment using polishing filters added to the L&S treatment system. The Agency has made the determination that wastewaters from porcelain enameling and copper forming are similar in all material aspects based on engineering considerations and the analysis of the combined data set for L&S treatment. Similarly, the Agency determined that the wastewater from one nonferrous metals plant that uses lime, settle, and filter is similar in all material respects to the raw wastewaters in the combined metals data base. Therefore, the performance of lime and settle, and filter technology from these plants is directly applicable to the copper forming category as well as the aluminum forming, battery manufacturing, coil coating, metal molding, and casting categories.

Analysis of Treatment System Effectiveness

Data are presented in Table VII-13 showing the mean, one day, 10-day, and 30-day values for nine pollutants examined in the L&S metals data base. The mean variability factor for eight pollutants (excluding cadmium because of the small number of data points) was determined and is used to estimate one day, 10-day, and 30-day values. (The variability factor is the ratio of the value of concern to the mean: the average variability factors are: one day maximum - 4.100; ten-day average - 1.821; and 30-day average - 1.618.) For values not calculated from the common data base as previously discussed, the mean value for pollutants shown in Table VII-14 were multiplied by the variability factors to derive the value to obtain the one, ten- and 30-day values. These are tabulated in Table VII-20.

LS&F technology data are presented in Tables VII-17 and VII-18. These data represent two operating plants (A and B) in which the technology has been installed and operated for some years. Plant A data was received as a statistical summary and is presented without change. Plant B data was received as raw laboratory analysis data. Discussions with plant personnel indicated that operating experiments and changes in materials and reagents and occasional operating errors had occurred during the data collection period. No specific information was available on those variables. To sort out high values probably caused by methodological factors from random statistical variability, or data noise, the Plant B data were analyzed. For each of the four pollutants (chromium, nickel, zinc, and iron), the mean and standard deviation (sigma) were calculated for the entire data set. A data day was removed from the complete data set when any individual pollutant concentration for that day exceeded the sum of the mean plus three sigma for that pollutant. Fifty-one data days (from a total of about 1,300) were eliminated by this method.

Another approach was also used as a check on the above method of eliminating certain high values. The minimum values of raw wastewater concentrations from Plant B for the same four pollutants were compared to the total set of values for the corresponding pollutants. Any day on which the pollutant concentration exceeded the minimum value selected from raw wastewater concentrations for that pollutant was discarded. Forty-five days of data were eliminated by that procedure. Forty-three days of data in common were eliminated by other procedures. Since common engineering practice (mean plus 3 sigma) and logic (treated waste should be less than raw waste) seem to coincide, the data base with the 51 spurious data days eliminated is the basis for all further analysis. Range, mean, standard deviation and mean plus two standard deviations are shown in Tables VII-17 and VII-18 for Cr, Cu, Ni, Zn, and Fe.

The Plant B data were separated into 1979, 1978, and total data base (six years) segments. With the statistical analysis from Plant A for 1978 and 1979 this in effect created five data sets in which there is some overlap between the individual years and total data sets from Plant B. By comparing these five parts it is apparent that they are quite similar and all appear to be from the same family of numbers. The largest mean found among the five data sets for each pollutant was selected as the long-term mean for LS&F technology and is used as the LS&F mean in Table VII-20.

Plant C data were used as a basis for cadmium removal performance and as a check on the zinc values derived from plants A and B. The cadmium data is displayed in Table VII-19 and is incorporated into Table VII-20 for LS&F. The zinc data were analyzed for compliance with the one-day and 30-day values in Table VII-21; no zinc value of the 103 data points exceeded the one-day zinc value of 1.02 mg/l. The 103 data points were separated into blocks of 30 points and averaged. Each of the three full 30-day averages was less than the Table VII-21 value of 0.31 mg/l. Additionally, the Plant C raw wastewater pollutant concentrations (Table VII-19) are well within the range of raw wastewater concentrations of the combined metals data base (Table VII-15), further supporting the conclusion that Plant C wastewater data is compatible with similar data from plants A and B.

Concentration values for regulatory use are displayed in Table VII-20. Mean one-day, ten-day, and 30-day values for L&S for nine pollutants were taken from Table VII-14; the remaining L&S values were developed using the mean values in Table VII-14 and the mean variability factors discussed above.

LS&F mean values for Cd, Cr, Ni, Zn, and Fe are derived from plants A, B, and C as discussed above. One, ten, and 30-day values are derived by applying the variability factor developed from the pooled data base for the specific pollutant to the mean for that pollutant. Other LS&F values are calculated using the long-term average or mean and the appropriate variability factors. Mean values for LS&F for pollutants not already discussed are derived by reducing the L&S mean by one-third. The one-third reduction was established after examining the percent reduction in concentrations going from L&S to LS&F data for Cd, Cr, Ni, Zn, and Fe. The average reduction is 0.3338 or one-third.

Copper levels achieved at plants A and B may be lower than generally achievable because of the high iron content and low copper content of the raw wastewaters. Therefore, the mean concentration value achieved is not used; LS&F mean used is derived from the L&S technology.

L&S cyanide mean levels are ratioed to one-day, ten-day, and 30-day values using mean variability factors. LS&F mean cyanide is calculated by applying the ratios of removals for L&S and LS&F as discussed previously for LS&F metals limitations. The cyanide performance was arrived at by using the average metal variability factors. The treatment method used here is cyanide precipitation. Because cyanide precipitation is limited by the same physical processes as the metal precipitation, it is expected that the variabilities will be similar. Therefore, the average of the metal variability factors has been used as a basis for calculating the cyanide one-day, ten-day, and 30-day average treatment effectiveness values.

The filter performance for removing TSS as shown in Table VII-8 yields a mean effluent concentration of 2.61 mg/l and calculates to a ten-day average of 4.33, 30-day average of 3.36 mg/l; a one-day maximum of 8.88. These calculated values more than amply support the classic values of 10 and 15, respectively, which are used for LS&F.

Although iron was reduced in some LS&F operations, some facilities using that treatment introduce iron compounds to aid settling. Therefore, the one-day, ten-day, and 30-day values for iron at LS&F were held at the L&S level so as to not unduly penalize the operations which use the relatively less objectionable iron compounds to enhance removals of toxic metals.

Subsequent to proposal, three commenters criticized the use of the combined metals data base (CMDB) to determine treatment effectiveness for lime and settle treatment. One commmenter complained about the small size of the data base and the statistical methods used in analyzing it. Specifically, the commmenter complained that the data base was too limited to reflect the effectiveness of lime and settle treatment and that variability was ill-defined by the available data. In addition, this commenter criticized the use of a lognormal basis to model the data, the use of a bessel function, and the methods used to estimate variability. The commenter recommended that EPA use the electroplating (metal finishing) data base as an alternative.

Another commenter criticized the inclusion of specific data points in the CMDB because they did not meet the pH concentration requirements set by the Agency, and questioned the representativeness of the copper forming wastewaters treated by the copper forming plants in the data base. A third commenter questioned the achievability of specific metal concentrations considering the spread of minimum solubilities at a range of pH values.

The Agency used the largest available data base that was statistically homogeneous and which represented good operation of lime and settle treatment systems. This data base was analyzed using widely known, state-of-the-art statistical procedures for estimating the necessary mean and maximum (99th percentile) values. A lognormal distribution was used because it provides a satisfactory fit to effluent data under a wide range of circumstances. The use of lognormal distribution and pooled variance among plants is an appropriate method for analyzing this type of data. A full discussion of the statistical methods used in the analysis of the combined metals data base is in the document entitled A Statistical Analysis of the Combined Metals Industries Effluent Data, which is in the public record supporting this regulation.

The Agency points out that the electroplating (metal finishing) data were determined not to be homogeneous and were removed from the combined data base. As such, electroplating data are not appropriate for determining lime and settle treatment effectiveness for the copper forming category.

The Agency carefully examined the data points which industry criticized as being incorrectly included in the combined metals data base. Of the four copper forming plants in the combined metals data base, four data days show a pH below 7.0. In eliminating data from use in the data base, a pH editing rule which excludes data in cases where the pH is below 7.0 for extended periods of time (i.e., over two hours) was used. The time periods of low pH for the points in question cannot be determined from existing data; however, because large amounts of metals were removed and low effluent concentrations were being achieved, the pH at the point of precipitation necessarily had to be well above pH 7.0. The reason for the effluent pH falling below 7.0 cannot be determined from the available data, but it is presumed to be a pH rebound. This phenomenon is often encountered when a slow reacting acidic material is neutralized or reacts late in the treatment cycle. The Agency believes that the lime and settle process was being operated in an acceptable manner and the data should be retained in the CMDB. The commenter complained that two data points which were included in the data base should have been excluded because their influent copper concentrations were less than their effluent copper concentrations. In the case of one of these points, the comment was due to a typographical error in the development document which has been corrected; the raw concentration was in fact greater than the effluent concentration. As for the second data point, the comment is correct with regard to the copper concentrations; however, this point was not used to determine the CMDB treatability limit for copper.

In response to the comment about the representativeness of sampled plants, the Agency points out that copper forming operations produce three types of wastewaters which are similar regardless of the associated forming operation; rinse waters from surface treatment, oily emulsions, and contact cooling waters. All of these types of wastewaters are contained in the wastewaters of the copper forming plants in the data base and thus, the plants used are representative of wastewaters generated in the category.

In response to the theoretical question about achievability of specific metal concentrations, our treatment effectiveness values are based on observed performance of treatment systems rather than theoretical calculations. Therefore, theoretical solubility of pollutants alone is not relevant and our treatment effectiveness data do reflect actual treatment performance for a wide range of metals. We believe that the actual performance data in the CMDB reflect these theoretical considerations.

The Agency performed a number of evaluations to confirm and establish the use of the combined metals data base. We looked at the data from the four copper forming plants alone to examine treatment effectiveness. Treatment effectiveness values from these copper forming plants were compared to the values contained in the combined metals data base. These values were determined using the same statistical methods discussed earlier in this section. The values determined in this manner were essentially the same as the corresponding CMDB values. This supports the determination that the combined metals data base is a good representation of the performance that can be achieved in the copper forming category.

MINOR TECHNOLOGIES

Several other treatment technologies were considered for possible application in BPT or BAT. These technologies are presented here with a full discussion for most of them. A few are described only briefly because of limited technical development.

9. Carbon Adsorption

The use of activated carbon to remove dissolved organics from water and wastewater is a long demonstrated technology. It is one of the most efficient organic removal processes available. This sorption process is reversible, allowing activated carbon to be regenerated for reuse by the application of heat and steam or solvent. Activated carbon has also proved to be an effective adsorbent for many toxic metals, including mercury. Regeneration of carbon which has adsorbed significant amounts of metals, however, may be difficult.

The term activated carbon applies to any amorphous form of carbon that has been specially treated to give high adsorption capacities. Typical raw materials include coal, wood, coconut shells, petroleum base residues, and char from sewage sludge pyrolysis. A carefully controlled process of dehydration, carbonization, and oxidation yields a product which is called activated carbon. This material has a high capacity for adsorption due primarily to the large surface area available for adsorption, 500 to 1,500 sizes generally range from 10 to 100 angstroms in radius.

Activated carbon removes contaminants from water by the process of adsorption, or the attraction and accumulation of one substance on the surface of another. Activated carbon preferentially adsorbs organic compunds over other species and, because of this selectivity, is particularly effective in removing organic compounds from aqueous solution.

Carbon adsorption requires preliminary treatment to remove excess suspended solids, oils, and greases. Suspended solids in the influent should be less than 50 mg/l to minimize backwash requirements; a downflow carbon bed can handle much higher levels (up to 2,000 mg/l), but requires frequent backwashing. Backwashing more than two or three times a day is not desirable; at 50 mg/l suspended solids, one backwash will suffice. Oil and grease should be less than about 10 mg/l. A high level of dissolved inorganic material in the influent may cause problems with thermal carbon reactivation (i.e., scaling and loss of activity) unless appropriate preventive steps are taken. Such steps might include pH control, softening, or the use of an acid wash on the carbon prior to reactivation.

Activated carbon is available in both powdered and granular form. A flow diagram of activated carbon treatment and regeneration is shown in Figure VII-20. A schematic of an individual adsorption column is shown in Figure VII-21. Powdered carbon is less expensive per unit weight and may have slightly higher adsorption capacity, but it is more difficult to handle and to regenerate.

Application and Performance. Isotherm tests have indicated that activated carbon is very effective in adsorbing 65 percent of the toxic organic pollutants and is reasonably effective for another 22 percent. Specifically, activated carbon is very effective in removing 2,4-dimethylphenol, fluoranthene, isophorone, naphthalene, all phthalates, and phenanthrene. Activated carbon is reasonably effective on 1,1,1-trichloroethane, 1,1-dichloroethane, phenol, and toluene.

Table VII-21 summarizes the treatment effectiveness for most of the toxic organic pollutants by activated carbon as compiled by EPA. Table VII-22 summarizes classes of organic compounds together with samples of organics that are readily adsorbed on carbon. Table VII-23 lists the effectiveness of activated carbon in removing seven toxic organic pollutants from actual manufacturing process wastewater streams in the nonferrous metals industries and foundry industries that are very similar to copper forming wastewater streams.

Advantages and Limitations. The major benefits of carbon treatment include applicability to a wide variety of organics and high removal efficiency. Inorganics such as cyanide, chromium, and mercury are also removed effectively. Variations in concentration and flow rate are well tolerated. The system is compact, and recovery of adsorbed materials is sometimes practical. However, destruction of adsorbed compounds often occurs during thermal regeneration. If carbon cannot be thermally regenerated, it must be disposed of along with any adsorbed pollutants. The capital and operating costs of thermal regeneration are relatively high. Cost surveys show that thermal regeneration is generally economical when carbon usage exceeds about 1,000 lbs/day. Carbon cannot remove low molecular weight or highly soluble organics. It also has a low tolerance for suspended solids, which must be removed in most systems to at least 50 mg/l in the influent water.

Operational Factors. Reliability: This system should be very reliable with upstream protection and proper operation and maintenance procedures.

Maintainability: This system requires periodic regeneration or replacement of spent carbon and is dependent upon raw waste load and process efficiency.

Solid Waste Aspects: Solid waste from this process is contaminated activated carbon that requires disposal. Carbon that undergoes regeneration reduces the solid waste problem by reducing the frequency of carbon replacement.

Demonstration Status. Carbon adsorption systems have been demonstrated to be practical and economical in reducing COD, BOD, and related parameters in secondary municipal and industrial wastewaters; in removing toxic or refractory organics from isolated industrial wastewaters; in removing and recovering certain organics from wastewaters; and in removing, and sometimes recovering, selected inorganic chemicals from aqueous wastes. Carbon adsorption is a viable and economic process for organic waste streams containing up to 1 to 5 percent of refractory or toxic organics. Its applicability for removal of inorganics such as metals has also been demonstrated.

10. Flotation

Flotation is the process of causing particles such as metal hydroxides or oil to float to the surface of a tank where they can be concentrated and removed. This is accomplished by releasing gas bubbles which attach to the solid particles, increasing their buoyancy and causing them to float. In principle, this process is the opposite of sedimentation. Figure VII-22 shows one type of flotation system.

Flotation is used primarily in the treatment of wastewater streams that carry heavy loads of finely divided suspended solids or oil. Solids having a specific gravity only slightly greater than 1.0, which would require abnormally long sedimentation times, may be removed in much less time by flotation.

This process may be performed in several ways: foam, dispersed air, dissolved air, gravity, and vacuum flotation are the most commonly used techniques. Chemical additives are often used to enhance the performance of the flotation process.

The principal difference among types of flotation is the method of generating the minute gas bubbles (usually air) in a suspension of water and small particles. Chemicals may be used to improve the efficiency with any of the basic methods. The following paragraphs describe the different flotation techniques and the method of bubble generation for each process.

Froth Flotation - Froth flotation is based on differences in the physiochemical properties in various particles. Wettability and surface properties affect the ability of the particles to attach themselves to gas bubbles in an aqueous medium. In froth flotation, air is blown through the solution containing flotation reagents. The particles with water repellant surfaces stick to air bubbles as they rise and are brought to the surface. A mineralized froth layer, with mineral particles attached to air bubbles, is formed. Particles of other minerals which are readily wetted by water do not stick to air bubbles and remain in suspension.

Dispersed Air Flotation - In dispersed air flotation, gas bubbles are generated by introducing the air by means of mechanical agitation with impellers or by forcing air through porous media.

Dispersed air flotation is used mainly in the metallurgical industry.

Dissolved Air Flotation - In dissolved air flotation, bubbles are produced by releasing air from a superstaturated solution under relatively high pressure. There are two types of contact between the gas bubbles and particles. The first type is predominant in the flotation of flocculated materials and involves the entrapment of rising gas bubbles in the flocculated particles as they increase in size. The bond between the bubble and particle is one of physical capture only. The second type of contact is one of adhesion. Adhesion results from the intermolecular attraction exerted at the interface between the solid particle and the gaseous bubble.

Vacuum Flotation - This process consists of saturating the wastewater with air either directly in an aeration tank, or by permitting air to enter on the suction of a wastewater pump. A partial vacuum is applied, which causes the dissolved air to come out of solution as minute bubbles. The bubbles attach to solid particles and rise to the surface to form a scum blanket, which is normally removed by a skimming mechanism. Grit and other heavy solids that settle to the bottom are generally raked to a central sludge pump for removal. A typical vacuum flotation unit consists of a covered cylindrical tank in which a partial vacuum is maintained. The tank is equipped with scum and sludge removal mechanisms. The floating material is continuously swept to the tank periphery, automatically discharged into a scum trough, and removed from the unit by a pump also under partial vacuum. Auxiliary equipment includes an aeration tank for saturating the wastewater with air, a tank with a short retention time for removal of large bubbles, vacuum pumps, and sludge pumps.

Application and Performance. Flotation is used primarily in the treatment of wastewater streams that carry heavy loads of finely divided suspended solids or oil. Solids having a specific gravity only slightly greater than 1.0, which would require abnormally long sedimentation times, may be removed in much less time by flotation.

The primary variables for flotation design are pressure, feed solids concentration, and retention period. The suspended solids in the effluent decrease, and the concentration of solids in the float increases, with increasing retention period. When the flotation process is used primarily for clarification, a retention period of 20 to 30 minutes is adequate for separation and concentration.

Advantages and Limitations. Some advantages of the flotation process are the high levels of solids separation achieved in many applications, the relatively low energy requirements, and the adaptability to meet the treatment requirements of different waste types. Limitations of flotation are that it often requires addition of chemicals to enhance process performance and that it generates large quantities of solid waste.

Operational Factors. Reliability: Flotation systems normally are very reliable with proper maintenance of the sludge collector mechanism and the motors and pumps used for aeration.

Maintainability: Routine maintenance is required on the pumps and motors. The sludge collector mechanism is subject to possible corrosion or breakage and may require periodic replacement.

Solid Waste Aspects: Chemicals are commonly used to aid the flotation process by creating a surface or a structure that can easily adsorb or entrap air bubbles. Inorganic chemicals, such as the aluminum and ferric salts, and activated silica, can bind the particulate matter together and create a structure that can entrap air bubbles. Various organic chemicals can change the nature of either the air-liquid interface or the solid-liquid interface, or both. These compounds usually collect on the interface to bring about the desired changes. The added chemicals plus the particles in solution combine to form a large volume of sludge which must be further treated or properly disposed.

Demonstration Status. Flotation is a fully developed process and is readily available for the treatment of a wide variety of industrial waste streams. Dissolved air flotation technology is used by can manufacturing plants to remove oil and grease in the wastewater from can wash lines. It is not currently used to treat copper forming wastewaters.

11. Centrifugation

Centrifugation is the application of centrifugal force to separate solids and liquids in a liquid-solid mixture or to effect concentration of the solids. The application of centrifugal force is effective because of the density differential normally found between the insoluble solids and the liquid in which they are contained. As a waste treatment procedure, centrifugation is most often applied to dewatering of sludges. One type of centrifuge is shown in Figure VII-23.

There are three common types of centrifuges: the disc, basket, and conveyor type. All three operate by removing solids under the influence of centrifugal force. The fundamental difference between the three types is the method by which solids are collected in and discharged from the bowl.

In the disc centrifuge, the sludge feed is distributed between narrow channels that are present as spaces between stacked conical discs. Suspended particles are collected and discharged continuously through small orifices in the bowl wall. The clarified effluent is discharged through an overflow weir.

A second type of centrifuge which is useful in dewatering sludges is the basket centrifuge. In this type of centrifuge, sludge feed is introduced at the bottom of the basket, and solids collect at the bowl wall while clarified effluent overflows the lip ring at the top. Since the basket centrifuge does not have provision for continuous discharge of collected cake, operation requires interruption of the feed for cake discharge for a minute or two in a 10 to 30 minute overall cycle.

The third type of centrifuge commonly used in sludge dewatering is the conveyor type. Sludge is fed through a stationary feed pipe into a rotating bowl in which the solids are settled out against the bowl wall by centrifugal force. From the bowl wall, they are moved by a screw to the end of the machine, at which point they are discharged. The liquid effluent is discharged through ports after passing the length of the bowl under centrifugal force.

Application and Performance. Virtually all industrial waste treatment systems producing sludge can use centrifugation to dewater it. Centrifugation is currently being used by a wide range of industrial concerns.

The performance of sludge dewatering by centrifugation depends on the feed rate, the rotational velocity of the drum, and the sludge composition and concentration. Assuming proper design and operation, the solids content of the sludge can be increased to 20 to 35 percent.

Advantages and Limitations. Sludge dewatering centrifuges have minimal space requirements and show a high degree of effluent clarification. The operation is simple, clean, and relatively inexpensive. The area required for a centrifuge system installation is less than that required for a filter system or sludge drying bed of equal capacity, and the initial cost is lower.

Centrifuges have a high power cost that partially offsets the low initial cost. Special consideration must also be given to providing sturdy foundations and soundproofing because of the vibration and noise that result from centrifuge operation. Adequate electrical power must also be provided since large motors are required. The major difficulty encountered in the operation of centrifuges has been the disposal of the concentrate which is relatively high in suspended, non-settling solids.

Operational Factors. Reliability: Centrifugation is highly reliable with proper control of factors such as sludge feed, consistency, and temperature. Pretreatment such as grit removal and coagulant addition may be necessary, depending on the composition of the sludge and on the type of centrifuge employed.

Maintainability: Maintenance consists of periodic lubrication, cleaning, and inspection. The frequency and degree of inspection required varies depending on the type of sludge solids being dewatered and the maintenance service conditions. If the sludge is abrasive, it is recommended that the first inspection of the rotating assembly be made after approximately 1,000 hours of operation. If the sludge is not abrasive or corrosive, then the initial inspection might be delayed. Centrifuges not equipped with a continuous sludge discharge system require periodic shutdowns for manual sludge cake removal.

Solid Waste Aspects: Sludge dewatered in the centrifugation process may be disposed of by landfill. The clarified effluent (centrate), if high in dissolved or suspended solids, may require further treatment prior to discharge.

Demonstration Status. Centrifugation is currently used in a great many commercial applications to dewater sludge. Work is underway to improve the efficiency, increase the capacity, and lower the costs associated with centrifugation.

12. Coalescing

The basic principle of coalescence involves the preferential wetting of a coalescing medium by oil droplets which accumulate on the medium and then rise to the surface of the solution as they combine to form larger particles. The most important requirements for coalescing media are wettability for oil and large surface area. Monofilament line is sometimes used as a coalescing medium.

Coalescing stages may be integrated with a wide variety of gravity oil separation devices, and some systems may incorporate several coalescing stages. In general, a preliminary oil skimming step is desirable to avoid overloading the coalescer.

One commercially marketed system for oily waste treatment combines coalescing with inclined plate separation and filtration. In this system, the oily wastes flow into an inclined plate settler. This unit consists of a stack of inclined baffle plates in a cylindrical container with an oil collection chamber at the top. The oil droplets rise and impinge upon the undersides of the plates. They then migrate upward to a guide rib that directs the oil to the oil collection chamber, from which oil is discharged for reuse or disposal.

The oily water continues on through another cylinder containing replaceable filter cartridges that remove suspended particles from the waste. From there the wastewater enters a final cylinder in which the coalescing material is housed. As the oily water passes through the many small, irregular, continuous passages in the coalescing material, the oil droplets coalesce and rise to an oil collection chamber.

Application and Performance. Coalescing is used to treat oily wastes that do not separate readily in simple gravity systems. The three stage system described above has achieved effluent concentrations of 10 to 15 mg/l oil and grease from raw waste concentrations of 1,000 mg/l or more.

Advantages and Limitations. coalescing allows removal of oil droplets too finely dispersed for conventional gravity separation-skimming technology. It also can significantly reduce the residence times (and therefore separator volumes) required to achieve separation of oil from some wastes. Because of its simplicity, coalescing provides generally high reliability and low capital and operating costs. Coalescing is not generally effective in removing soluble or chemically stabilized emulsified oils. To avoid plugging, coalescers must be protected by pretreatment from the very high concentrations of free oil and grease and suspended solids. Frequent replacement of prefilters may be necessary when raw waste oil concentrations are high.

Operational Factors. Reliability: Coalescing is inherently highly reliable since there are no moving parts and the coalescing substrate (monofilament, etc.) is inert in the process and therefore not subject to frequent regeneration or replacement requirements. Large loads or inadequate preliminary treatment, however, may result in plugging or bypass of coalescing stages.

Maintainability: Maintenance requirements are generally limited to replacement of the coalescing medium on an infrequent basis.

Solid Waste Aspects: No appreciable solid waste is generated by this process.

Demonstration Status. Coalescing has been fully demonstrated in industries generating oily wastewater. A few are known to be in use at copper forming plants.

13. Evaporation

Evaporation is a concentration process. Water is evaporated from a solution, increasing the concentration of solute in the remaining solution. If the resulting water vapor is condensed back to liquid water, the evaporation-condensation process is called distillation. However, to be consistent with industry terminology, evaporation is used in this report to describe both processes. Both atmospheric and vacuum evaporation are commonly used in industry today. Specific evaporation techniques are shown in Figure VII-27 and discussed below.

Atmospheric evaporation could be accomplished simply by boiling the liquid. To aid evaporation, heated liquid is sprayed on an evaporation surface, and air is blown over the surface and subsequently released to the atmosphere. Thus, evaporation occurs by humidification of the air stream, similar to a drying process. Equipment for carrying out atmospheric evaporation is quite similar for most applications. The major element is generally a packed column with an accumulator bottom. Accumulated wastewater is pumped from the base of the column, through a heat exchanger, and back into the top of the column, where it is sprayed into the packing. At the same time, air drawn upward through the packing by a fan is heated as it contacts the hot liquid. The liquid partially vaporizes and humidifies the air stream. The fan then blows the hot, humid air to the outside atmosphere. A scrubber is often unnecessary because the packed column itself acts as a scrubber.

Another form of atmospheric evaporator also works on the air humidification principle, but the evaporated water is recovered for reuse by condensation. These air humidification techniques operate well below the boiling point of water and can utilize waste process heat to supply the energy required.

In vacuum evaporation, the evaporation pressure is lowered to cause the liquid to boil at reduced temperatures. All of the water vapor is condensed and, to maintain the vacuum condition, noncondensible gases (air in particular) are removed by a vacuum pump. Vacuum evaporation may be either single or double effect. In double effect evaporation, two evaporators are used, and the water vapor from the first evaporator (which may be heated by steam) is used to supply heat to the second evaporator. As it supplies heat, the water vapor from the first evaporator condenses. Approximately equal quantities of wastewater are evaporated in each unit; thus, the double effect system evaporates twice the amount of water that a single effect system does, at nearly the same cost in energy but with added capital cost and complexity. The double effect technique is thermodynamically possible because the second evaporator is maintained at lower pressure (higher vacuum) and, therefore, lower evaporation temperature. Another means of increasing energy efficiency is vapor recompression (thermal or mechanical), which enables heat to be transferred from the condensing water vapor to the evaporating wastewater. Vacuum evaporation equipment may be classified as submerged tube or climbing film evaporation units.

In the most commonly used submerged tube evaporator, the heating and condensing coil are contained in a single vessel to reduce capital cost. The vacuum in the vessel is maintained by an eductor-type pump, which creates the required vacuum by the flow of the condenser cooling water through a venturi. Wastewater accumulates in the bottom of the vessel, and it is evaporated by means of submerged steam coils. The resulting water vapor condenses as it contacts the condensing coils in the top of the vessel. The condensate then drips off the condensing coils into a collection trough that carries it out of the vessel. Concentrate is removed from the bottom of the vessel.

The major elements of the climbing film evaporator are the evaporator, separator, condenser, and vacuum pump. Wastewater is "drawn" into the system by the vacuum so that a constant liquid level is maintained in the separator. Liquid enters the steamjacketed evaporator tubes, and part of it evaporates so that a mixture of vapor and liquid enters the separator. The design of the separator is such that the liquid is continuously circulated from the separator to the evaporator. The vapor entering the separator flows out through a mesh entrainment separator to the condenser, where it is condensed as it flows down through the condenser tubes. The condensate, along with any entrained air, is pumped out of the bottom of the condenser by a liquid ring vacuum pump. The liquid seal provided by the condensate keeps the vacuum in the system from being broken.

Application and Performance. Both atmospheric and vacuum evaporation are used in many industrial plants, mainly for the concentration and recovery of process solutions. Many of these evaporators also recover water for rinsing. Evaporation has also been applied to recovery of phosphate metal-cleaning solutions.

In theory, evaporation should yield a concentrate and a deionized condensate. Actually, carry-over has resulted in condensate metal concentrations as high as 10 mg/l, although the usual level is less than 3 mg/l, pure enough for most final rinses. The condensate may also contain organic brighteners and antifoaming agents. These can be removed with an activated carbon bed, if necessary. Samples from one plant showed 1,900 mg/l zinc in the feed, 4,570 mg/l in the concentrate, and 0.4 mg/l in the condensate. Another plant had 416 mg/l copper in the feed and 21,800 mg/l in the concentrate. Chromium analysis for that plant indicated 5,060 mg/l in the feed and 27,500 mg/l in the concentrate. Evaporators are available in a range of capacities, typically from 15 to 75 gph, and may be used in parallel arrangements for processing of higher flow rates.

Advantages and Limitations. Advantages of the evaporation process are that it permits recovery of a wide variety of process chemicals, and it is often applicable to concentration or removal of compounds which cannot be accomplished by any other means. The major disadvantage is that the evaporation process consumes relatively large amounts of energy for the evaporation of water. The recovery of waste heat from many industrial processes (e.g., diesel generators, incinerators, boilers, and furnaces) should be considered as a source of this heat for a totally integrated evaporation system. Also, in some cases solar heating could be inexpensively and effectively applied to evaporation units. For some applications, preliminary treatment may be required to remove solids or bacteria which tend to cause fouling in the condenser or evaporator. The buildup of scale on the evaporator surfaces reduces the heat transfer efficiency and may present a maintenance problem or increase operating cost. It has been demonstrated that fouling of the heat transfer surfaces can be avoided or minimized for certain dissolved solids by maintaining a seed slurry which provides preferential sites for precipitate deposition. In addition, low temperature differences in the evaporator will eliminate nucleate boiling and supersaturation effects. Steam distillable impurities in the process stream are carried over with the product water and must be handled by preliminary or post treatment.

Operational Factors. Reliability: Proper maintenance will ensure a high degree of reliability for the system. Without such attention, rapid fouling or deterioration of vacuum seals may occur, especially when handling corrosive liquids.

Maintainability: Operating parameters can be automatically controlled. Preliminary treatment may be required, as well as periodic cleaning of the system. Regular replacement of seals, especially in a corrosive environment, may be necessary.

Solid Waste Aspects: With only a few exceptions, the process does not generate appreciable quantities of solid waste.

Demonstration Status. Evaporation is a fully developed, commercially available wastewater treatment system. It is used extensively to recover plating chemicals in the electroplating industry and a pilot scale unit has been used in connection with phosphating of aluminum. Proven performance in silver recovery indicates that evaporation could be a useful treatment operation for the photographic industry, as well as for metal finishing.

14. Gravity Sludge Thickening

In the gravity thickening process, dilute sludge is fed from a primary settling tank or clarifier to a thickening tank where rakes stir the sludge gently to densify it and to push it to a central collection well. The supernatant is returned to the primary settling tank. The thickened sludge that collects on the bottom of the tank is pumped to dewatering equipment or hauled away. Figure VII-28 shows the construction of a gravity thickener.

Application and Performance. Thickeners are generally used in facilities where the sludge is to be further dewatered by a compact mechanical device such as a vacuum filter or centrifuge. Doubling the solids content in the thickener substantially reduces capital and operating cost of the subsequent dewatering device and also reduces cost for hauling. The process is potentially applicable to almost any industrial plant.

Organic sludges from sedimentation units of 1 to 2 percent solids concentration can usually be gravity thickened to 6 to 10 percent; chemical sludges can be thickened to 4 to 6 percent.

Advantages and Limitations. The principal advantage of a gravity sludge thickening process is that it facilitates further sludge dewatering. Other advantages are high reliability and minimum maintenance requirements.

Limitations of the sludge thickening process are its sensitivity to the flow rate through the thickener and the sludge removal rate. These rates must be low enough not to disturb the thickened sludge.

Operational Factors. Reliability: Reliability is high with proper design and operation. A gravity thickener is designed on the basis of square feet per pound of solids per day, in which the required surface area is related to the solids entering and leaving the unit. Thickener area requirements are also expressed in terms of mass loading, kilograms of solids per square meter per day (lbs/sq ft/day).

Maintainability: Twice a year, a thickener must be shut down for lubrication of the drive mechanisms. Occasionally, water must be pumped back through the system in order to clear sludge pipes.

Solid Waste Aspects: Thickened sludge from a gravity thickening process will usually require further dewatering prior to disposal, incineration, or drying. The clear effluent may be recirculated in part, or it may be subjected to further treatment prior to discharge.

Demonstration Status. Gravity sludge thickeners are used throughout industry to reduce sludge water content to a level where the sludge may be efficiently handled. Further dewatering is usually practiced to minimize costs of hauling the sludge to approved landfill areas.

15. Ion Exchange

Ion exchange is a process in which ions, held by electrostatic forces to charged functional groups on the surface of the ion exchange resin, are exchanged for ions of similar charge from the solution in which the resin is immersed. This is classified as a sorption process because the exchange occurs on the surface of the resin, and the exchanging ion must undergo a phase transfer from solution phase to solid phase. Thus, ionic contaminants in a waste stream can be exchanged for the harmless ions of the resin.

Although the precise technique may vary slightly according to the application involved, a generalized process description follows. The wastewater stream being treated passes through a filter to remove any solids, then flows through a cation exchanger which contains the ion exchange resin. Here, metallic impurities such as copper, iron, and trivalent chromium are retained. The stream then passes through the anion exchanger and its associated resin. Hexavalent chromium (in the form of chromate or dichromate), for example, is retained in this stage. If one pass does not reduce the contaminant levels sufficiencly, the stream may then enter another series of exchangers. Many ion exchange systems are equipped with more than one set of exchangers for this reason.

The other major portion of the ion exchange process concerns the regeneration of the resin, which now holds those impurities retained from the waste stream. An ion exchange unit with in-place regeneration is shown in Figure VII-29. Metal ions such as nickel are removed by an acid, cation exchange resin, which is regenerated with hydrochloric or sulfuric acid, replacing the metal ion with one or more hydrogen ions. Anions such as dichromate are removed by a basic anion exchange resin, which is regenerated with sodium hydroxide, replacing the anion with one or more hydroxyl ions. The three principal methods employed by industry for regenerating the spent resin are:

(A) Replacement Service: A regeneration service replaces the spent resin with regenerated resin, and regenerates the spent resin at its own facility. The service then has the problem of treating and disposing of the spent regenerant.

(B) In-Place Regeneration: Some establishments may find it less expensive to do their own regeneration. The spent resin column is shut down for perhaps an hour, and the spent resin is regenerated. This results in one or more waste streams which must be treated in an appropriate manner. Regeneration is performed as the resins require it, usually every few months.

(C) Cyclic Regeneration: In this process, the regeneration of the spent resins takes place within the ion exchange unit itself in alternating cycles with the ion removal process. A regeneration frequency of twice an hour is typical. This very short cycle time permits operation with a very small quantity of resin and with fairly concentrated solutions, resulting in a very compact system. Again, this process varies according to application, but the regeneration cycle generally begins with caustic being pumped through the anion exchanger, carrying out hexavalent chromium, for example, as sodium dichromate. The sodium dichromate stream then passes through a cation exchanger, converting the sodium dichromate to chromic acid. After concentration by evaporation or other means, the chromic acid can be returned to the process line. Meanwhile, the cation exchanger is regenerated with sulfuric acid, resulting in a waste acid stream containing the metallic impurities removed earlier. Flushing the exchangers with water completes the cycle. Thus, the wastewater is purified and, in this example, chromic acid is recovered. The ion exchangers, with newly regenerated resin, then enter the ion removal cycle again.

Application and Performance. The list of pollutants for which the ion exchange system has proven effective includes aluminum, arsenic, cadmium, chromium (hexavalent and trivalent), copper, cyanide, gold, iron, lead, manganese, nickel, selenium, silver, tin, zinc, and others. Thus, it can be applied to a wide variety of industrial concerns. Because of the heavy concentrations of metals in their wastewater, the metal finishing industries utilize ion exchange in several ways. As an end-of-pipe treatment, ion exchange is certainly feasible, but its greatest value is in recovery applications. It is commonly used as an integrated treatment to recover rinse water and process chemicals. Some electroplating facilities use ion exchange to concentrate and purify plating baths. Also, many industrial concerns, including a number of aluminum forming plants, use ion exchange to reduce salt concentrations in incoming water sources.

Ion exchange is highly efficient at recovering metal-bearing solutions. Recovery of chromium, nickel, phosphate solution, and sulfuric acid from anodizing is common. A chromic acid recovery efficiency of 99.5 percent has been demonstrated. Typical data for purification of rinse water are displayed in Table VII-24.

Advantages and Limitations. Ion exchange is a versatile technology applicable to a great many situations. This flexibility, along with its compact nature and performance, makes ion exchange a very effective method of wastewater treatment. However, the resins in these systems can prove to be a limiting factor. The thermal limits of the anion resins, generally in the vicinity of 60° C, could prevent its use in certain situations. Similarly, nitric acid, chromic acid, and hydrogen peroxide can all damage the resins, as will iron, manganese, and copper when present with sufficient concentrations of dissolved oxygen. Removal of a particular trace contaminant may be uneconomical because of the presence of other ionic species that are preferentially removed. The regeneration of the resins presents its own problems. The cost of the regenerative chemicals can be high. In addition, the waste streams originating from the regeneration process are extremely high in pollutant concentrations, although low in volume. These must be further processed for proper disposal.

Operational Factors. Reliability: With the exception of occasional clogging or fouling of the resins, ion exchange has proved to be a highly dependable technology.

Maintainability: Only the normal maintenance of pumps, valves, piping, and other hardware used in the regeneration process is required.

Solid Waste Aspects: Few, if any, solids accumulate within the ion exchangers, and those which do appear are removed by the regeneration process. Proper prior treatment and planning can eliminate solid buildup problems altogether. The brine resulting from regeneration of the ion exchange resin most usually must be treated to remove metals before discharge. This can generate solid waste.

Demonstration Status. All of the ion exchange applications discussed in this section are in commercial use, and industry sources estimate the number of ion exchange units currently in the field at well over 120. The research and development in ion exchange is focusing on improving the quality and efficiency of the resins, rather than new applications. Work is also being done on a continuous regeneration process whereby the resins are contained on a fluid-transfusible belt. The belt passes through a compartmented tank with ion exchange, washing, and regeneration sections. The resins are therefore continually used and regenerated. No such system, however, has been reported beyond the pilot stage.

16. Insoluble Starch Xanthate

Insoluble starch xanthate is essentially an ion exchange medium used to remove dissolved heavy metals from wastewater. The water may then either be reused (recovery application) or discharged (end-of-pipe application). In a commercial electroplating operation, starch xanthate is coated on a filter medium. Rinse water containing dragged out heavy metals is circulated through the filters and then reused for rinsing. The starch-heavy metal complex is disposed of and replaced periodically. Laboratory tests indicate that recovery of metals from the complex is feasible, with regeneration of the starch xanthate. Besides electroplating, starch xanthate is potentially applicable to aluminum forming, coil coating, porcelain enameling, copper forming, and any other industrial plants where dilute metal wastewater streams are generated. Its present use is limited to one electroplating plant.

17. Peat Adsorption

Peat moss is a complex natural organic material containing lignin and cellulose as major constituents. These constituents, particularly lignin, bear polar functional groups, such as alcohols, aldehydes, ketones, acids, phenolic hydroxides, and ethers, that can be involved in chemical bonding. Because of the polar nature of the material, its adsorption of dissolved solids such as transition metals and polar organic molecules is quite high. These properties have led to the use of peat as an agent for the purification of industrial wastewater.

Peat adsorption is a "polishing" process which can achieve very low effluent concentrations for several pollutants. If the concentrations of pollutants are above 10 mg/l, then peat adsorption must be preceded by pH adjustment for metals precipitation and subsequent clarification. Pretreatment is also required for chromium wastes using ferric chloride and sodium sulfide. The wastewater is then pumped into a large metal chamber called a kier which contains a layer of peat through which the waste stream passes. The water flows to a second kier for further adsorption. The wastewater is then ready for discharge. This system may be automated or manually operated.

Application and Performance. Peat adsorption can be used in copper forming plants for removal of residual dissolved metals from clarifier effluent. Peat moss may be used to treat wastewaters containing heavy metals such as mercury, cadmium, zinc, copper, iron, nickel, chromium, and lead, as well as organic matter such as oil, detergents, and dyes. Peat adsorption is currently used commercially at a textile plant, a newsprint facility, and a metal reclamation operation.

Table VII-25 contains performance figures obtained from pilot plant studies. Peat adsorption was preceded by pH adjustment for precipitation and by clarification.

In addition, pilot plant studies have shown that chelated metal wastes, as well as the chelating agents themselves, are removed by contact with peat moss.

Advantages and Limitations. The major advantages of the system include its ability to yield low pollutant concentrations, its broad scope in terms of the pollutants eliminated, and its capacity to accept wide variations of wastewater composition.

Limitations include the cost of purchasing, storing, and disposing of the peat moss; the necessity for regular replacement of the peat may lead to high operation and maintenance costs. Also, the pH adjustment must be altered according to the composition of the waste stream.

Operational Factors. Reliability: The question of long-term reliability is not yet fully answered. Although the manufacturer reports it to be a highly reliable system, operating experience is needed to verify the claim.

Maintainability: The peat moss used in this process soon exhausts its capacity to adsorb pollutants. At that time, the kiers must be opened, the peat removed, and fresh peat placed inside. Although this procedure is easily and quickly accomplished, it must be done at regular intervals, or the system's efficiency drops drastically.

Solid Waste Aspects: After removal from the kier, the spent peat must be eliminated. If incineration is used, precautions should be taken to ensure that those pollutants removed from the water are not released again in the combustion process. Presence of sulfides in the spent peat, for example, will give rise to sulfur dioxide in the fumes from burning. The presence of significant quantities of toxic heavy metals in copper forming wastewater will in general preclude incineration of peat used in treating these wastes.

Demonstration Status. Only three facilities currently use commercial adsorption systems in the United States - a textile manufacturer, a newsprint facility, and a metal reclamation firm. No data have been reported showing the use of peat adsorption in copper forming plants.

18. Membrane Filtration

Membrane filtration is a treatment system for removing precipitated metals from a wastewater stream. It must therefore be preceded by those treatment techniques which will properly prepare the wastewater for solids removal. Typically, a membrane filtration unit is preceded by pH adjustment or sulfide addition for precipitation of the metals. These steps are followed by the addition of a proprietary chemical reagent which causes the precipitate to be non-gelatinous, easily dewatered, and highly stable. The resulting mixture of pretreated wastewater and reagent is continuously recirculated through a filter module and back into a recirculation tank. The filter module contains tubular membranes. While the reagent-metal hydroxide precipitate mixture flows through the inside of the tubes, the water and any dissolved salts permeate the membrane. When the recirculating slurry reaches a concentration of 10 to 15 percent solids, it is pumped out of the system as sludge.

Application and Performance. Membrane filtration appears to be applicable to any wastewater or process water containing metal ions which can be precipitated using hydroxide, sulfide, or carbonate precipitation. It could function as the primary treatment system, but also might find application as a polishing treatment (after precipitation and settling) to ensure continued compliance with metals limitations. Membrane filtration systems are being used in a number of industrial applications, particularly in the metal finishing area. They have also been used for heavy metals removal in the metal fabrication industry and the paper industry.

The permeate is claimed by one manufacturer to contain less than the effluent concentrations shown in Table VII-26, regardless of the influent concentrations. These claims have been largely substantiated by the analysis of water samples at various plants in various industries.

In the performance predictions for this technology, pollutant concentrations are reduced to the levels shown in Table VII-26 unless lower levels are present in the influent stream.

Advantages and Limitations. A major advantage of the membrane filtration system is that installations can use most of the conventional end-of-pipe systems that may already be in place. Removal efficiencies are claimed to be excellent, even with sudden variation of pollutant input rates; however, the effectiveness of the membrane filtration system can be limited by clogging of the filters. Because pH changes in the waste stream greatly intensify clogging problems, the pH must be carefully monitored and controlled. Clogging can force the shutdown of the system and may interfere with production. In addition, relatively high capital cost of this system may limit its use.

Operational Factors. Reliability: Membrane filtration has been shown to be a very reliable system, provided that the pH is strictly controlled. Improper pH can result in the clogging of the membrane. Also, surges in the flow rate of the waste stream must be controlled in order to prevent solids from passing through the filter and into the effluent.

Maintainability: The membrane filters must be regularly monitored, and cleaned or replaced as necessary. Depending on the composition of the waste stream and its flow rate, frequent cleaning of the filters may be required. Flushing with hydrochloric acid for six to 24 hours will usually suffice. In addition, the routine maintenance of pumps, valves, and other plumbing is required.

Solid Waste Aspects: When the recirculating reagent-precipitate slurry reaches 10 to 15 percent solids, it is pumped out of the system. It can then be disposed of directly to a landfill or it can undergo a dewatering process. Because this sludge contains toxic metals, it requires proper disposal.

Demonstration Status. There are more than 25 membrane filtration systems presently in use on metal finishing and similar wastewaters. Bench scale and pilot studies are being run in an attempt to expand the list of pollutants for which this system is known to be effective. Although there are no data on the use of membrane filtration in copper forming plants, the concept has been successfully demonstrated using coil coating plant wastewater.

19. Reverse Osmosis

The process of osmosis involves the passage of a liquid through a semipermeable membrane from a dilute to a more concentrated solution. Reverse osmosis (RO) is an operation in which pressure is applied to the more concentrated solution, forcing the permeate to diffuse through the membrane and into the more dilute solution. This filtering action produces a concentrate and a permeate on opposite sides of the membrane. The concentrate can then be further treated or returned to the original production operation for continued use, while the permeate water can be recycled for use as clean water. Figure VII-30 depicts a reverse osmosis system.

As illustrated in Figure VII-31, there are three basic configurations used in commercially available RO modules: tubular, spiral-wound, and hollow fiber. All of these operate on the principle described above, the major difference being their mechanical and structural design characteristics.

The tubular membrane module uses a porous tube with a cellulose acetate membrane-lining. A common tubular module consists of a length of 2.5 cm (1 inch) diameter tube wound on a supporting spool and encased in a plastic shroud. Feed water is driven into the tube under pressures varying from 40 to 55 atm (600 to 800 psi). The permeate passes through the walls of the tube and is collected in a manifold while the concentrate is drained off at the end of the tube. A less widely used tubular RO module uses a straight tube contained in a housing, under the same operating conditions.

Spiral-wound membranes consist of a porous backing sandwiched between two cellulose acetate membrane sheets and bonded along three edges. The fourth edge of the composite sheet is attached to a large permeate collector tube. A spacer screen is then placed on top of the membrane sandwich and the entire stack is rolled around the centrally located tubular permeate collector.

The rolled up package is inserted into a pipe able to withstand the high operating pressures employed in this process, up to 55 atm (800 psi) with the spiral-wound module. When the system is operating, the pressurized product water permeates the membrane and flows through the backing material to the central collector tube. The concentrate is drained off at the end of the container pipe and can be reprocessed or sent to further treatment facilities.

The hollow fiber membrane configuration is made up of a bundle of polyamide fibers of approximately 0.0075 cm (0.003 in.) OD and 0.043 cm (0.0017 in.) ID. A commonly used hollow fiber module contains several hundred thousand of the fibers placed in a long tube, wrapped around a flow screen, and rolled into a spiral. The fibers are bent in a U-shape and their ends are supported by an epoxy bond. The hollow fiber unit is operated under 27 atm (400 psi), the feed water being dispersed from the center of the module through a porous distributor tube. Permeate flows through the membrane to the hollow interiors of the fibers and is collected at the ends of the fibers.

The hollow fiber and spiral-wound modules have a distinct advantage over the tubular system in that they are able to load a very large membrane surface area into a relatively small volume. However, these two membrane types are much more susceptible to fouling than the tubular system, which has a larger flow channel. This characteristic also makes the tubular membrane much easier to clean and regenerate than either the spiral-wound or hollow fiber modules. One manufacturer claims that their helical tubular module can be physically wiped clean by passing a soft porous polyurethane plug under pressure through the module.

Application and Performance. In a number of metal processing plants, the overflow from the first rinse in a countercurrent setup is directed to a reverse osmosis unit, where it is separated into two streams. The concentrated stream contains dragged out chemicals and is returned to the bath to replace the loss of solution due to evaporation and dragout. The dilute stream (the permeate) is routed to the last rinse tank to provide water for the rinsing operation. The rinse flows from the last tank to the first tank and the cycle is complete.

The closed-loop system described above may be supplemented by the addition of a vacuum evaporator after the RO unit in order to further reduce the volume of reverse osmosis concentrate. The evaporated vapor can be condensed and returned to the last rinse tank or sent on for further treatment.

The largest application has been for the recovery of nickel solutions. It has been shown that RO can generally be applied to most acid metal baths with a high degree of performance, providing that the membrane unit is not overtaxed. The limitations most critical here are the allowable pH range and maximum operating pressure for each particular configuration.

Adequate prefiltration is also essential. Only three membrane types are readily available in commercial RO units, and their overwhelming use has been for the recovery of various acid metal baths. For the purpose of calculating performance predictions of this technology, a rejection ratio of 98 percent is assumed for dissolved salts, with 95 percent permeate recovery.

Advantages and Limitations. The major advantage of reverse osmosis for handling process effluents is its ability to concentrate dilute solutions for recovery of salts and chemicals with low power requirements. No latent heat of vaporization or fusion is required for effecting separations; the main energy requirement is for a high pressure pump. It requires relatively little floor space for compact, high capacity units, and it exhibits good recovery and rejection rates for a number of typical process solutions. A limitation of the reverse osmosis process for treatment of process effluents is its limited temperature range for satisfactory operation. For cellulose acetate systems, the preferred limits are 18° C to 30° C (65° F to 85° F); higher temperatures will increase the rate of membrane hydrolysis and reduce system life, while lower temperatures will result in decreased fluxes with no damage to the membrane. Another limitation is inability to handle certain solutions. Strong oxidizing agents, strongly acidic or basic solutions, solvents, and other organic compounds can cause dissolution of the membrane. Poor rejection of some compounds such as borates and low molecular weight organics is another problem. Fouling of membranes by slightly soluble components in solution or colloids has caused failures, and fouling of membranes by feed waters with high levels of suspended solids can be a problem. A final limitation is inability to treat or achieve high concentration with some solutions. Some concentrated solutions may have initial osmotic pressures which are so high that they either exceed available operating pressures or are uneconomical to treat.

Operational Factors. Reliability: Very good reliability is achieved so long as the proper precautions are taken to minimize the chances of fouling or degrading the membrane. Sufficient testing of the waste stream prior to application of an RO system will provide the information needed to insure a successful application.

Maintainability: Membrane life is estimated to range from six months to three years, depending on the use of the system. Down time for flushing or cleaning is on the order of two hours as often as once each week; a substantial portion of maintenance time must be spent on cleaning any prefilters installed ahead of the reverse osmosis unit.

Solid Waste Aspects: In a closed loop system utilizing RO there is a constant recycle of permeate and a minimal amount of solid waste. Prefiltration eliminates many solids before they reach the module and helps keep the buildup to a minimum. These solids require proper disposal.

Demonstration Status. There are presently at least one hundred reverse osmosis wastewater applications in a variety of industries. In addition to these, there are 30 to 40 units being used to provide pure process water for several industries. Despite the many types and configurations of membranes, only the spiral- wound cellulose acetate membrane has had widespread success in commercial applications. One copper forming plant currently uses reverse osmosis.

20. Sludge Bed Drying

As a waste treatment procedure, sludge bed drying is employed to reduce the water content of a variety of sludges to the point where they are amenable to mechanical collection and removal to a landfill. These beds usually consist of 15 to 45 cm (6 to 18 in.) of sand over a 30 cm (12 in.) deep gravel drain system made up of 3 to 6 mm (1/8 to 1/4 in.) graded gravel overlying drain tiles. Figure VII-32 shows the construction of a drying bed.

Drying beds are usually divided into sectional areas approximately 7.5 meters (25 ft) wide x 30 to 60 meters (100 to 200 ft) long. The partitions may be earth embankments, but more often are made of planks and supporting grooved posts.

To apply liquid sludge to the sand bed, a closed conduit or a pressure pipeline with valved outlets at each sand bed section is often employed. Another method of application is by means of an open channel with appropriately placed side openings which are controlled by slide gates. With either type of delivery system, a concrete splash slab should be provided to receive the falling sludge and prevent erosion of the sand surface.

Where it is necessary to dewater sludge continuously throughout the year regardless of the weather, sludge beds may be covered with a fiberglass reinforced plastic or other roof. Covered drying beds permit a greater volume of sludge drying per year in most climates because of the protection afforded from rain or snow and because of more efficient control of temperature. Depending on the climate, a combination of open and enclosed beds will provide maximum utilization of the sludge bed drying facilities.

Application and Performance. Sludge drying beds are a means of dewatering sludge from clarifiers and thickeners. They are widely used both in municipal and industrial treatment facilities.

Dewatering of sludge on sand beds occurs by two mechanisms: filtration of water through the bed and evaporation of water as a result of radiation and convection. Filtration is generally complete in one to two days and may result in solids concentrations as high as 15 to 20 percent. The rate of filtration depends on the drainability of the sludge.

The rate of air drying of sludge is related to temperature, relative humidity, and air velocity. Evaporation will proceed at a constant rate to a critical moisture content, then at a falling rate to an equilibrium moisture content. The average evaporation rate for a sludge is about 75 percent of that from a free water surface.

Advantages and Limitations. The main advantage of sludge drying beds over other types of sludge dewatering is the relatively low cost of construction, operation, and maintenance.

Its disadvantages are the large area of land required and long drying times that depend, to a great extent on climate and weather.

Operational Factors. Reliability: Reliability is high with favorable climatic conditions, proper bed design, and care to avoid excessive or unequal sludge application. If climatic conditions in a given area are not favorable for adequate drying, a cover may be necessary.

Maintainability: Maintenance consists basically of periodic removal of the dried sludge. Sand removed from the drying bed with the sludge must be replaced and the sand layer resurfaced.

The resurfacing of sludge beds is the major expense item in sludge bed maintenance, but there are other areas which may require attention. Underdrains occasionally become clogged and have to be cleaned. Valves or sludge gates that control the flow of sludge to the beds must be kept watertight. Provision for drainage of lines in winter should be provided to prevent damage from freezing. The partitions between beds should be tight so that sludge will not flow from one compartment to another. The outer walls or banks around the beds should also be watertight.

Solid Waste Aspects: The full sludge drying bed must either be abandoned or the collected solids must be removed to a landfill. These solids contain whatever metals or other materials were settled in the clarifier. Metals will be present as hydroxides, oxides, sulfides, or other salts. They have the potential for leaching and contaminating ground water, whatever the location of the semidried solids. Thus the abandoned bed or landfill should include provision for runoff control and leachate monitoring.

Demonstration Status. Sludge beds have been in common use in both municipal and industrial facilities for many years. However, protection of ground water from contamination is not always adequate.

21. Ultrafiltration

Ultrafiltration (UF) is a process which uses semipermeable polymeric membranes to separate emulsified or colloidal materials suspended in a liquid phase by pressurizing the liquid so that it permeates the membrane. The membrane of an ultrafilter forms a molecular screen which retains molecular particles based on their differences in size, shape, and chemical structure. The membrane permits passage of solvents and lower molecular weight molecules. At present, an ultrafilter is capable of removing materials with molecular weights in the range of 1,000 to 100,000 and particles of comparable or larger sizes.

In an ultrafiltration process, the feed solution is pumped through a tubular membrane unit. Water and some low molecular weight materials pass through the membrane under the applied pressure of 10 to 100 psig. Emulsified oil droplets and suspended particles are retained, concentrated, and removed continuously. In contrast to ordinary filtration, retained materials are washed off the membrane filter rather than held by it. Figures VII-33 and VII-34 represent the ultrafiltration process.

Application and Performance. Ultrafiltration has potential application to copper forming plants for separation of oils and residual solids from a variety of waste streams. In treating copper forming wastewater its greatest applicability would be as a polishing treatment to remove residual precipitated metals after chemical precipitation and clarification. Successful commercial use, however, has been primarily for separation of emulsified oils from wastewater. Over one hundred such units now operate in the United States, treating emulsified oils from a variety of industrial processes. Capacities of currently operating units range from a few hundred gallons a week to 50,000 gallons per day. Concentration of oily emulsions to 60 percent oil or more are possible. Oil concentrates of 40 percent or more are generally suitable for incineration, and the permeate can be treated further and in some cases recycled back to the process. In this way, it is possible to eliminate contractor removal costs for oil from some oily waste streams.

Table VII-27 indicates ultrafiltration performance (note that UF is not intended to remove dissolved solids). The removal percentages shown are typical, but they can be influenced by pH and other conditions. The high TSS level is unusual for this technology and ultrafiltration is assumed to reduce the TSS level by one-third after mixed media filtration.

The permeate or effluent from the ultrafiltration unit is normally of a quality that can be reused in industrial applications or discharged directly. The concentrate from the ultrafiltration unit can be disposed of as any oily or solid waste.

Advantages and Limitations. Ultrafiltration is sometimes an attractive alternative to chemical treatment because of lower capital equipment, installation, and operating costs, very high oil and suspended solids removal, and little required pretreatment. It places a positive barrier between pollutants and effluent which reduces the possibility of extensive pollutant discharge due to operator error or upset in settling and skimming systems. Alkaline values in alkaline cleaning solutions can be recovered and reused in the process.

A limitation of ultrafiltration for treatment of process effluents is its narrow temperature range (18° C to 30° C) for satisfactory operation. Membrane life decreases with higher temperatures, but flux increases at elevated temperatures. Therefore, surface area requirements are a function of temperature and become a tradeoff between initial costs and replacement costs for the membrane. In addition, ultrafiltration cannot handle certain solutions. Strong oxidizing agents, solvents, and other organic compounds can dissolve the membrane. Fouling is sometimes a problem, although the high velocity of the wastewater normally creates enough turbulence to keep fouling at a minimum. Large solids particles can sometimes puncture the membrane and must be removed by gravity settling or filtration prior to the ultrafiltration unit.

Operational Factors. Reliability: The reliability of an ultrafiltration system is dependent on the proper filtration, settling, or other treatment of incoming waste streams to prevent damage to the membrane. Careful pilot studies should be done in each instance to determine necessary pretreatment steps and the exact membrane type to be used. It is advisable to remove any free, floating oil prior to ultrafiltration. Although free oil can be processed, membrane performance may deteriorate.

Maintainability: A limited amount of regular maintenance is required for the pumping system. In addition, membranes must be periodically changed. Maintenance associated with membrane plugging can be reduced by selection of a membrane with optimum physical characteristics and sufficient velocity of the waste stream. It is often necesary to occasionally pass a detergent solution through the system to remove an oil and grease film which accumulates on the membrane. With proper maintenance, membrane life can be greater than 12 months.

Solid Waste Aspects: Ultrafiltration is used primarily to recover solids and liquids. It therefore eliminates solid waste problems when the solids (e.g., paint solids) can be recycled to the process. Otherwise, the stream containing solids must be treated by end-of-pipe equipment. In the most probable applications within the copper forming category, the ultrafilter would remove concentrated oily wastes which can be recovered for reuse or used as a fuel.

Demonstration Status. The ultrafiltration process is well developed and commercially available for treatment of wastewater or recovery of certain high molecular weight liquid and solid contaminants. Currently, no plants in the copper forming category use ultrafiltration. One aluminum forming plant ultrafilters its spent rolling oils. Ultrafiltration is well suited for highly concentrated emulsions, for example, rolling and drawing oils, although it is not suitable for free oil.

22. Vacuum Filtration

In wastewater treatment plants, sludge dewatering by vacuum filtration generally uses cylindrical drum filters. These drums have a filter medium which may be cloth made of natural or synthetic fibers or a wire-mesh fabric. The drum is suspended above and dips into a vat of sludge. As the drum rotates slowly, part of its circumference is subject to an internal vacuum that draws sludge to the filter medium. Water is drawn through the porous filter cake thorugh the drum fabric to a discharge port, and the dewatered sludge, loosened by compressed air, is scraped from the filter mesh. Because the dewatering of sludge on vacuum filters is relatively expensive per kilogram of water removed, the liquid sludge is frequently thickened prior to processing. A vacuum filter is shown in Figure VII-35.

Application and Performance. Vacuum filters are frequently used both in municipal treatment plants and in a wide variety of industries. They are most commonly used in larger facilities, which may have a thickener to double the solids content of clarifier sludge before vacuum filtering. Often a precoat is used to inhibit filter blinding.

The function of vacuum filtration is to reduce the water content of sludge, so that the solids content increases from about 5 percent to between 20 and 30 percent, depending on the waste characteristics.

Advantages and Limitations. Although the initial cost and area requirement of the vacuum filtration system are higher than those of a centrifuge, the operating cost is lower, and no special provisions for sound and vibration protection need be made. The dewatered sludge from this process is in the form of a moist cake and can be conveniently handled.

Operational Factors. Reliability: Vacuum filter systems have proven reliable at many industrial and municipal treatment facilities. At present, the largest municipal installation is at the West Southwest wastewater treatment plant of Chicago, Illinois, where 96 large filters were installed in 1925, functioned approximately 25 years, and then were replaced with larger units. Original vacuum filters at Minneapolis-St. Paul, Minnesota now have over 28 years of continuous service, and Chicago has some units with similar or greater service life.

Maintainability: Maintenance consists of the cleaning or replacement of the filter media, drainage grids, drainage piping, filter pans, and other parts of the equipment. Experience in a number of vacuum filter plants indicates that maintenance consumes approximately 5 to 15 percent of the total time. If carbonate buildup or other problems are unusually severe, maintenance time may be as high as 20 percent. For this reason, it is desirable to maintain one or more spare units.

If intermittent operation is used, the filter equipment should be drained and washed each time it is taken out of service. An allowance for this wash time must be made in filtering schedules.

Solid Waste Aspects: Vacuum filters generate a solid cake which is usually trucked directly to landfill. All of the metals extracted from the plant wastewater are concentrated in the filter cake as hydroxides, oxides, sulfides, or other salts.

Demonstration Status. Vacuum filtration has been widely used for many years. It is a fully proven, conventional technology for sludge dewatering. Several copper forming plants report its use.

IN-PLANT CONTROL TECHNIQUES (FLOW REDUCTION)

This section presents a discussion of flow reduction techniques which are applicable to copper forming plants for the purpose of reducing the volume of wastewater discharged to treatment. Flow reduction is a control technique which, in conjunction with the treatment processes previously discussed, can further reduce the mass of pollutants discharged. The primary flow reduction techniques which are applicable to copper forming plants are recycle, alternative rinsing techniques, particularly spray rinsing and countercurrent rinsing, contract hauling and reduction of water use.

23. Recycle

Nearly all copper forming plants recycle some process wastewater streams. The most commonly recycled streams include lubricating solutions, annealing contact cooling water and solution heat treatment contact cooling water. In general, some treatment is required to allow process wastewater recycle in this industry. At present, the most common treatment practices prior to recycle in copper forming plants are suspended solids removal, oil skimming, and cooling. Wastewater is most often returned to the process operation from which it originated, but may also be used in other operations.

Recycle is highly effective in reducing pollutant discharges, often eliminating a continuous discharge completely. Periodic batch dumps of recycled process water are still usually required, but the volume of wastewater requiring treatment is greatly reduced and often is contract hauled. Recycle often reduces requirements for process materials.

Where recycle is presently practiced, the rate of recycle varies from approximately 30 to 100 percent. Many copper forming plants currently achieve zero discharge of some waste streams through natural evaporation or land application; however, these options are not available to many plants in the industry. The Agency recognizes that discharge of wastewater from particular sources may not be avoided. This is discussed in greater detail in the context of specific sources.

Cold Rolling, Hot Rolling and Drawing Lubricants. Lubricants used in cold rolling and drawing are commonly recirculated to such an extent that contract removal of the total discharge is practical. Factors which limit the extent of recirculation include heat removal, degradation of lubricants which results in staining of the product, or build-up of dissolved or suspended solids. Some of these limitations may often be overcome by the application of more advanced treatment techniques than those presently in common use, as discussed below.

The use of water soluble oil and emulsified oil lubricants in cold rolling processes makes it easier to recirculate lubricants than in cases where non-emulsified oil--water mixtures are in use. In addition, most drawing operations use emulsified lubricants. Emulsified lubricants are commonly used repeatedly and dumped when contamination forces replacement of the solution. This type of technology uses much less process water and oil on a yearly basis than most processes which have continuous oil--water mixture applications; therefore, both process material costs and treatment or disposal costs can be reduced.

The most common problems encountered in the use of soluble oil lubricants are the accumulation of heavy metals (especially copper) and other suspended solids, and the degradation of the emulsion due to heat and stress. Several methods are used to prolong the life of the solutions, resulting in even lower end-of-pipe treatment and disposal costs. Most recirculating lubricant systems have a storage tank from which the lubricant is drawn and to which it is returned following application to the process material. This storage tank serves the dual purpose of allowing solids to settle and the lubricant to cool prior to recycle. Some of these tanks are baffled to enhance settling. In some copper and copper alloy plants, paddle type devices traveling on a conveyorized belt scrape out solids which have accumulated on the bottom of lubricant recirculation tanks. This helps minimize the contamination of the lubricant by avoiding the build-up of solids on the bottom of the tank. The sludge removed is often rich enough in copper fines to be sent out for reclamation. Cartridge and membrane filtration is also known to remove solids from lubricant streams. These filters must be cleaned or replaced as they become clogged with solids.

Annealing Contact Cooling Water. Annealing quenches using only water are commonly recycled. Treatment of annealing quench water prior to recycle is typically limited to settling and heat removal; however, many sites reported recycle with no prior treatment.

Because annealing quench operations are characteristically intermittent, retention and equalization tanks are generally required for recycle. These tanks can also serve as a settling basin for removal of suspended solids. Sufficient cooling and temperature equalization may occur so that a significant portion of the quench water can be recycled without addition of non-contact cooling water or the use of a cooling tower.

Total recycle may be prohibited by the presence of dissolved solids for plants which can not take advantage of natural evaporation or land application. Dissolved solids (e.g., sulfates and chlorides) entering a totally recycled waste stream may precipitate, forming scale if the solubility limits of the dissolved solids are exceeded. A bleed stream may be necessary to prevent maintenance problems (pipe plugging or scaling, etc.) that would be created by the precipitation of dissolved solids.

Hardware necessary for recycle is highly site-specific. Recycling through cooling towers is the most common practice. Basic items include the cooling tower, pumps and piping. Additional materials are necessary if water treatment occurs before the water is recycled. Chemicals may be necessary to control scale buildup, slime, and corrosion problems, especially with recycled cooling water. Maintenance and energy use are limited to that required by the pumps, and solid waste generation is dependent on the type of treatment system in place. A typical flow diagram for a system using a cooling tower to recycle water is shown in Figure VII-36.

Solution Heat Treatment Contact Cooling Water. Water quenches (solution heat treatment) are widely used in copper forming plants following hot deformation processes to rapidly reduce product temperatures in order to limit surface oxidation and allow safe handling of the material. The quench water becomes contaminated with metals, suspended solids, and lubricants, but the primary effect of this use is elevation of the water temperature. Because only minor chemical changes are produced in the quench solutions, extensive recycle and reuse is possible without deleterious effects on production.

In general, quench water associated with solution heat treatment produces relatively large volumes of water which contain low concentrations of pollutants. As a result, treatment effectiveness is somewhat limited unless in-process control techniques are employed. Recycle and reuse of the quench water and a reduction of water use can reduce the volume of effluent requiring treatment and increase pollutant concentrations to more treatable levels.

24. Alternative Rinsing Techniques

Reduction in the amount of water used and discharged in copper and copper alloy manufacturing can be realized through the installation and use of efficient rinsing techniques. The techniques discussed are alternatives to stagnant rinsing. These techniques can result in water cost savings, reduced waste treatment chemical costs and improved waste treatment efficiency. The design of rinse systems for minimum water use depends on the maximum level of contamination allowed to remain on the workpiece (without reducing product quality) as well as on the efficiency or effectiveness of each rinse stream.

Rinsing is used after pickling and alkaline cleaning baths to dilute the concentration of contaminants adhering to the surface of a workpiece to an acceptable level before the workpiece passes on to the next process step. The amount of water required to dilute the bath solution depends on the quantity of chemical drag-in from the upstream bath tank, the allowable concentration of chemicals in the rinse water, and the contacting efficiency between the workpiece and the water.

25. Countercurrent Cascade Rinsing

Process variations such as countercurrent cascade rinsing may cause a decrease in process water use. This technique reduces water use by countercurrent multiple stage rinsing of the copper products. Clean rinse water first contacts the copper in the last stage. The water, somewhat more contaminated, is routed stage by stage up the rinsing line. After use in the first rinse stage, the contaminated water is discharged to treatment.

As an example, Figure VII-37 illustrates three rinsing operations, each designed to remove the residual acid in the water on the surface of a workpiece. In Figure VII-37a the piece is dipped into one tank with continuously flowing water. In this case, the acid on the surface of the workpiece is essentially diluted to the required level. In Figure VII-37b, the first step towards countercurrent operation is taken with the addition of a second tank. The workpiece is now moving in a direction opposite to the rinse water. The piece is rinsed with fresh makeup water prior to moving down the assembly line. However, the fresh water from this final rinse tank is directed to a second tank, where it meets the incoming, more-contaminated workpiece. Fresh makeup water is used to give a final rinse to the article before it moves out of the rinsing section, but the slightly contaminated water is reused to clean the article just coming into the rinsing section. By increasing the number of stages, as shown in Figure VII-37c, further water reduction can be achieved. Theoretically, the amount of water required is the amount of acid being removed by single-stage requirements divided by the highest tolerable concentration in the outgoing rinsewater. This theoretical reduction of water by a countercurrent multistage operation is shown in the curve graph in Figure VII-38. The actual flow reduction obtained is a function of the dragout and the type of contact occurring in the tanks. If reasonably good contact is maintained major reductions in water use are possible.

Significant flow reductions can be achieved by the addition of only one additional stage in the rinsing operation, as discussed above. As shown in Figure VII-38 the largest reductions are made by adding the first few stages. Additional rinsing stages cost additional money. The actual number of stages added depends on site-specific layout and operating conditions. With higher costs for water and waste treatment, more stages might be economical. With very low water costs, fewer stages would be economical. In considering retrofit applications, the space available for additional tanks is also important. Many other factors will affect the economics of countercurrent cascade rinsing; an evaluation must be done for each individual plant.

Rinse water requirements and the benefits of countercurrent cascade rinsing may be influenced by the volume of solution drag-out carried into each rinse stage by the material being rinsed, by the number of rinse stages used, by the initial concentrations of impurities being removed, and by the final product cleanliness required. The influence of these factors is expressed in the rinsing equation which may be stated simply as:

$$Vr = \frac{Co}{Cf}^{1/n} \times VD$$

Vr is the flow through each rinse stage.
Co is the concentration of the contaminant(s) in the initial process bath.
Cf is the concentration of the contaminant(s) in the final rinse to give acceptable product cleanliness.
n is the number of rinse stages employed.
VD is the dragout carried into each rinse stage, expressed as a flow.

For a multi-stage rinse, the total volume of rinse wastewater is equal to n times Vr while for a countercurrent rinse the total volume of wastewater discharge equals Vr. Drag-out is solution which remains on the surface of material being rinsed when it is removed from process baths or rinses.

In the copper forming category, countercurrent cascade rinsing can be applied to pickling and alkaline cleaning rinsing operations. To calculate the benefits of countercurrent rinsing for copper forming, it can be assumed that a two-stage countercurrent cascade rinse is installed after pickling. The mass of copper in one square meter of sheet that is 6 mm (0.006 m) in thickness can be calculated using the density of copper, 8.90 kkg/m³ (556 lbs/cu ft), as follows:

$$= (0.006 \text{ m}) \times (8.90 \text{ kkg/m}^3) = 0.053 \text{ kkg/m}^2 \text{ of sheet.}$$

Using the mean pickling rinse water use from Table V-12 (p. 103),

Vr can then be calculated as follows:

$$Vr = 0.053\frac{\text{kkg}}{\text{m}^2} \times 4{,}000\frac{1}{\text{kkg}}$$

$$= 213.6 \text{ l/m}^2 \text{ of sheet}$$

If the film on a piece of copper sheet is 0.015 mm (0.6 mil) thick, (equivalent to the film on a well-drained vertical surface) then the volume of process solution, VD, carried into the rinse tank on one square meter of sheet will be:

$$VD = (0.015 \text{ mm}) \text{ X } \frac{1}{1000} \text{ m/mm x } (1000 \text{ 1/m}^3)$$

$$= 0.015 \text{ l/m}^2 \text{ of sheet}$$

Let $r = \frac{Co}{Cf}$, then $r\ 1/n = \frac{Vr}{VD}$

For single stage rinsing $n = 1$

Therefore $r = \frac{Vr}{VD}$

and $r = \frac{213.7}{0.015} = 14{,}240$

For a 2-stage countercurrent cascade rinse to obtain the same r, that is the same product cleanliness,

$$\frac{Vr}{VD} = r^{1/2} \text{ and:}$$

$$\frac{Vr}{VD} = 119.3$$

But VD = 0.015 l/m^2 of sheet.

Therefore for 2-stage countercurrent cascade rinsing Vr is:

Vr = 119.3 x 0.015 = 1.79 l/m^2 of sheet.

In this example, two-stage countercurrent cascade rinsing achieved 99.2 percent reduction in the water used. The actual numbers may vary depending on efficiency of squeegees or air knives, and the rinse ratio desired.

Countercurrent cascade rinsing has been widely used as a flow reduction technique in the metal finishing industry. Countercurrent cascade rinsing is currently practiced at four copper forming plants. In aluminum conversion coating lines that are subject to the coil coating limitations, countercurrent cascade rinsing is currently used in order to reduce costs of wastewater treatment systems (through smaller systems) for direct dischargers and to reduce sewer costs for indirect dischargers.

26. Spray Rinsing

Spray rinsing is another method used to dilute the concentration of contaminants adhering to the surface of a workpiece. The basis of this approach is to spray water onto the surface of the workpiece as opposed to submerging it into a tank. The amount of water contacting the workpiece is minimized as is the amount of water discharged. The water use and discharge rates can be further reduced through recirculation of the rinse water. Copper forming plants practicing spray rinsing discharge typically 60 percent less water than those plants using only stagnant rinses.

The equipment required for spray rinsing includes piping, spray nozzles, a pump, a holding tank, and a collection basin. The holding tank may serve as the collection basin to collect the rinse water prior to recirculation as a method of space economization.

27. Contract Hauling

Contract hauling refers to the industry practice of contracting a firm to collect and transport wastes for off-site disposal. This practice is particularly applicable to low-volume, high concentration waste streams. Examples of such waste streams in the copper forming industry are pickling baths, drawing lubricants, cold rolling lubricants, annealing oil and extrusion press solution heat treatment.

28. Reduction of Water Use

The reduction of process water use has been found to be an effective approach to reducing treatment costs and pollutant discharges at many copper forming plants. In most cases, substantial reduction may be achieved by simple actions involving little or no cost. It is often found that satisfactory operation may be achieved with much smaller rinse or contact cooling water flows than have generally been used. Many of the copper forming plants visited reported recent significant reductions in process water use and discharge.

Many production units in copper forming plants operate intermittently or at widely varying production rates. The practice of shutting off process water streams during periods when the unit is inoperative and of adjusting flow rates during periods of low activity can prevent much unnecessary dilution of wastes and reduce the volume of water to be treated and discharged. Water may be shut off and adjusted manually or through automatically controlled valves. Manual adjustment involves minimal capital cost and can be just as reliable in actual practice. Automatic shut off valves are used in some copper forming operations to turn off water flows when production units are inactive. Automatic adjustment of flow rates according to production levels requires more sophisticated control systems incorporating temperature or conductivity sensors. Further reduction in water use may be made possible by changes in production techniques and equipment.

The potential for reducing the water use at many copper forming facilities is evident in the water use and discharge data presented in Section V of this report. While it may be argued that variations in water flow per unit of production are the necessary result of variations in process conditions, on-site observations indicate that they are more frequently the result of imprecise control of water use. This is confirmed by analysis data from pickling and alkaline cleaning rinses which show a very wide range of the concentrations of materals removed from product surfaces, and by on-site temperature observations in contact cooling streams.

Reduction of water use in quenches may also significantly reduce discharge volumes. Design of spray quenches to ensure that a high percentage of the water contacts the product and adjustments of make-up water flow rates on quench baths and recirculating spray quench systems to the minimum practical value can significantly reduce effluent volumes.

Pollutant discharges from pickling and alkaline cleaning may also be controlled through the use of drag-out reduction technologies. The volume of water used and discharged from rinsing operations may be substantially reduced without adversely affecting the surface condition of the product processed. Available technologies to achieve these reductions include techniques which limit the amount of material to be removed from product surfaces by rinsing.

On automatic lines which continuously process strip through alkaline cleaning and pickling operations, measures are normally taken to reduce the amount of process bath solutions which are dragged out with the product into subsequent rinses. The most commonly used means of accomplishing this are through the use of squeegee rolls and air knives. Both mechanisms are found at the point at which the strip exits from the process bath. Squeegee rolls, one situated above the strip and another below, return process solutions as they apply pressure to both sides of the continuously moving strip. Air knives continuously force a jet of air across the width of each side of the strip, forcing solutions to remain in the process tank or chamber. These methods are also used to reduce drag-out from soap and other lubricant tanks which are often found as a final step in automatic strip lines.

Heating the tank containing the process bath can also help reduce drag-out of process solutions in two ways: by decreasing the viscosity and the surface tension of the solution. A lower viscosity allows the liquid to flow more rapidly and therefore drain at a faster rate from the product following application in a process bath, thereby reducing the amount of process solution which dragged out into suceeding rinses. Likewise, a higher temperature will result in lower surface tension in the solution. The amount of work required to overcome the adhesive force between a liquid film and a solid surface is a function of the surface tension of the liquid and the contact angle. Lowering the surface tension reduces the amount of work required to remove the liquid and reduces the edge effect (the bead of liquid adhering to the edges of a product).

Operator performance can have a substantial effect on the amount of drag-out which results from manual dip tank processes. Specifically, proper draining time and techniques can reduce the amount of process solution dragged out into rinses. After dipping the material into the process tank, drag-out can be reduced significantly by simply suspending the product above the process tank while solution drains off. Fifteen to 20 seconds generally seems sufficient to accomplish this. When processing tubing, especially, lowering one end of the load during this drain time allows solution to run off from inside the tubes.

All of the water use reduction techniques discussed in this section may be used at copper forming plants to achieve the average production normalized flows at plants which presently discharge excessive amounts of wastewater to treatment.

CURRENT INDUSTRY PRACTICE

Out of 18 plants which reported a discharge of annealing water, six currently practice cooling and recycle. Reported recycle rates range from 50 to 98 percent. Of 24 plants which reported the use of water for solution heat treatment, eight plants also reported the use of recycle with recycle rates from 85 to 100 percent.

A large number of plants which practice drawing, cold rolling or annealing with oil reported the practice of extensive recycling of the lubricant streams with treatment or contract hauling of the small amount of spent lubricant which is periodically discharged.

The use of alternate rinsing techniques in pickling operations was reported by approximately one-third of the 42 plants which have pickling operations. The most frequently reported alternate rinsing technique for pickling is spray rinsing. Spray rinsing of pickling rinse water is practiced in 16 copper forming plants. Countercurrent cascade rinsing and multi-stage rinsing were also reported. Countercurrent cascade rinsing is currently practiced by four plants in the copper forming industry.

Table VII-1

pH CONTROL EFFECT ON METALS REMOVAL

	Day 1		Day 2		Day 3	
	In	Out	In	Out	In	Out
pH Range	2.4-3.4	8.5-8.7	1.0-3.0	5.0-6.0	2.0-5.0	6.5-8.1
(mg/l)						
TSS	39	8	16	19	16	7
Copper	312	0.22	120	5.12	107	0.66
Zinc	250	0.31	32.5	25.0	43.8	0.66

Table VII-2

EFFECTIVENESS OF SODIUM HYDROXIDE FOR METALS REMOVAL

	Day 1		Day 2		Day 3	
	In	Out	In	Out	In	Out
pH Range	2.1-2.9	9.0-9.3	2.0-2.4	8.7-9.1	2.0-2.4	8.6-9.1
(mg/l)						
Cr	0.097	0.0	0.057	0.005	0.068	0.005
Cu	0.063	0.018	0.078	0.014	0.053	0.019
Fe	9.24	0.76	15.5	0.92	9.41	0.95
Pb	1.0	0.11	1.36	0.13	1.45	0.11
Mn	0.11	0.06	0.12	0.044	0.11	0.044
Ni	0.077	0.011	0.036	0.009	0.069	0.011
Zn	0.054	0.0	0.12	0.0	0.19	0.037
TSS		13		11		11

Table VII-3

EFFECTIVENESS OF LIME AND SODIUM HYDROXIDE FOR METALS REMOVAL

	Day 1		Day 2		Day 3	
	In	Out	In	Out	In	Out
pH Range	9.2-9.6	8.3-9.8	9.2	7.6-8.1	9.6	7.8-8.2
(mg/l)						
Al	37.3	0.35	38.1	0.35	29.9	0.35
Co	3.92	0.0	4.65	0.0	4.37	0.0
Cu	0.65	0.003	0.63	0.003	0.72	0.003
Fe	137	0.49	110	0.57	208	0.58
Mn	175	0.12	205	0.012	245	0.12
Ni	6.86	0.0	5.84	0.0	5.63	0.0
Se	28.6	0.0	30.2	0.0	27.4	0.0
Ti	143	0.0	125	0.0	115	0.0
Zn	18.5	0.027	16.2	0.044	17.0	0.01
TSS	4,390	9	3,595	13	2,805	13

Table VII-4

THEORETICAL SOLUBILITIES OF HYDROXIDES AND SULFIDES OF SELECTED METALS IN PURE WATER

Metal	Solubility of Metal Ion, mg/l		
	As Hydroxide	As Carbonate	As Sulfide
Cadmium (Cd++)	2.3×10^{-5}	1.0×10^{-4}	6.7×10^{-10}
Chromium (Cr+++)	8.4×10^{-4}		No precipitate
Cobalt (Co++)	2.2×10^{-1}		1.0×10^{-8}
Copper (Cu++)	2.2×10^{-2}		5.8×10^{-18}
Iron (Fe++)	8.9×10^{-1}		3.4×10^{-5}
Lead (Pb++)	2.1	7.0×10^{-3}	3.8×10^{-9}
Manganese (Mn++)	1.2		2.1×10^{-3}
Mercury (Hg++)	3.9×10^{-4}	3.9×10^{-2}	9.0×10^{-20}
Nickel (Ni++)	6.9×10^{-3}	1.9×10^{-1}	6.9×10^{-8}
Silver (Ag+)	13.3	2.1×10^{-1}	7.4×10^{-12}
Tin (Sn++)	1.1×10^{-4}		3.8×10^{-8}
Zinc (Zn++)	1.1	7.0×10^{-4}	2.3×10^{-7}

Table VII-5

SAMPLING DATA FROM SULFIDE PRECIPITATION-SEDIMENTATION SYSTEMS

	Lime, FeS, Polyelectrolyte, Settle, Filter		Lime, FeS, Polyelectrolyte, Settle, Filter		NaOH, Ferric Chloride, Na_2S, Clarify (1 Stage)	
Treatment	In	Out	In	Out	In	Out
pH	5.0-6.8	8-9	7.7	7.38		
(mg/l)						
Cr+6	25.6	<0.014	0.022	<0.020	11.45	<.005
Cr	32.3	<0.04	2.4	<0.1	18.35	<.005
Cu	--	--	--	--	0.029	0.003
Fe	0.52	0.10	108	0.6	--	--
Ni	--	--	0.68	<0.1	--	--
Zn	39.5	<0.07	33.9	<0.1	0.060	0.009

Table VII-6

SULFIDE PRECIPITATION-SEDIMENTATION PERFORMANCE

Parameter	Treated Effluent (mg/l)
Cd	0.01
Cr (Total)	0.05
Cu	0.05
Pb	0.01
Hg	0.03
Ni	0.05
Ag	0.05
Zn	0.01

Table VII-7

FERRITE CO-PRECIPITATION PERFORMANCE

Metal	Influent (mg/l)	Effluent (mg/l)
Mercury	7.4	0.001
Cadmium	240	0.008
Copper	10	0.010
Zinc	18	0.016
Chromium	10	<0.010
Manganese	12	0.007
Nickel	1,000	0.200
Iron	600	0.06
Bismuth	240	0.100
Lead	475	0.010

Table VII-8

MULTIMEDIA FILTER PERFORMANCE

Plant ID #	TSS Effluent Concentration, mg/l
06097	0.0, 0.0, 0.5
13924	1.8, 2.2, 5.6, 4.0, 4.0, 3.0, 2.2, 2.8 3.0, 2.0, 5.6, 3.6, 2.4, 3.4
18538	1.0
30172	1.4, 7.0, 1.0
36048	2.1, 2.6, 1.5
Mean	2.61

Table VII-9

PERFORMANCE OF SELECTED SETTLING SYSTEMS

Plant ID	Settling Device	SUSPENDED SOLIDS CONCENTRATION (mg/l) Day 1 In	Day 1 Out	Day 2 In	Day 2 Out	Day 3 In	Day 3 Out
01057	Lagoon	54	6	56	6	50	5
09025	Clarifier + Settling Ponds	1,100	9	1,900	12	1,620	5
11058	Clarifier	451	17	--	--	--	--
12075	Settling Pond	284	6	242	10	502	14
19019	Settling Tank	170	1	50	1	--	5
33617	Clarifier & Lagoon	--	--	1,662	16	1,298	4
40063	Clarifier	4,390	9	3,595	13	2,805	13
44062	Clarifier	182	13	118	14	174	23
46050	Settling Tank	295	10	42	10	153	8

Table VII-10

SKIMMING PERFORMANCE

Plant	Skimmer Type	Oil & Grease (mg/l) In	Oil & Grease (mg/l) Out
06058	API	224,669	17.9
06058	Belt	19.4	8.3

Table VII-11

SAMPLING DATA FROM COPPER FORMING PLANTS WHICH PRACTICE OIL SKIMMING AND ACHIEVE EFFLUENT OIL AND GREASE CONCENTRATIONS OF 20 mg/l OR LESS

	Influent Concentration (mg/l)		Effluent Concentration (mg/l)	
Plant	Oil and Grease	TTO	Oil and Grease	TTO
06058	53,800	166.2	16.3	0.02
	395,538	0.51	13.3	0.31
47432	7,070	10.39	15	0.04
	1,004	0.11	5	0.01

Table VII-12

CHEMICAL EMULSION BREAKING EFFICIENCIES

Parameter	Concentration (mg/l)		Reference
	Influent	Effluent	
O&G	6,060	98	Sampling data*
TSS	2,612	46	
O&G	13,000	277	Sampling data+
	18,400	--	
	21,300	189	
TSS	540	121	
	680	59	
	1,060	140	
O&G	2,300	52	Sampling data**
	12,500	27	
	13,800	18	
TSS	1,650	187	
	2,200	153	
	3,470	63	
O&G	7,200	80	Katnick and Pavilcius, 1978++

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*Oil and grease and total suspended solids were taken as grab samples before and after batch emulsion breaking treatment which used alum and polymer on emulsified rolling oil wastewater.

+Oil and grease (grab) and total suspended solids (grab) samples were taken on three consecutive days from emulsified rolling oil wastewater. A commercial demulsifier was used in this batch treatment.

**Oil and grease (grab) and total suspended solids (composite) samples were taken on three consecutive days from emulsified rolling oil wastewater. A commercial demulsifier (polymer) was used in this batch treatment.

++This result is from a full-scale batch chemical treatment system for emulsified oils from a steel rolling mill.

Table VII-13

COMBINED METALS DATA EFFLUENT CONCENTRATIONS (mg/l)

	Mean	One-Day Max.	10-Day Avg. Max.	30-Day Avg. Max.
Cd	0.079	0.34	0.15	0.13
Cr	0.084	0.44	0.18	0.12
Cu	0.58	1.90	1.00	0.73
Pb	0.12	0.15	0.13	0.12
Ni	0.74	1.92	1.27	1.00
Zn	0.33	1.46	0.61	0.45
Fe	0.41	1.23	0.63	0.51
Mn	0.21	0.43	0.34	0.27
TSS	12.0	41.0	20.0	15.5

Table VII-14

L&S PERFORMANCE
ADDITIONAL POLLUTANTS

Pollutant	Average Performance (mg/l)
Sb	0.70
As	0.51
Be	0.30
Hg	0.06
Se	0.30
Ag	0.10
Th	0.50
Al	2.24
Co	0.05
F	14.5

Table VII-15

COMBINED METALS DATA SET - UNTREATED WASTEWATER

Pollutant	Min. Conc. (mg/l)	Max. Conc. (mg/l)
Cd	<0.1	3.83
Cr	<0.1	90.0
Cu	<0.1	89.0
Pb	<0.1	29.2
Ni	<0.1	11.6
Zn	<0.1	337.
Fe	<0.1	208.0
Mn	<0.1	245.0
TSS	4.6	4,390

Table VII-16

MAXIMUM POLLUTANT LEVEL IN UNTREATED WASTEWATER
ADDITIONAL POLLUTANTS
(mg/l)

Pollutant	As & Se	Be	Ag	F
As	4.2	--	--	--
Be	--	10.24	--	--
Cd	<0.1	--	<0.1	<0.1
Cr	0.18	8.60	0.23	22.8
Cu	33.2	1.24	110.5	2.2
Pb	6.5	0.35	11.4	5.35
Ni	--	--	100	0.69
Ag	--	--	4.7	--
Zn	3.62	0.12	1,512	<0.1
F	--	--	--	760
Fe	--	646	--	--
O&G	16.9	--	16	2.8
TSS	352	796	587.8	5.6

Table VII-17

PRECIPITATION-SETTLING-FILTRATION (LS&F) PERFORMANCE
PLANT A

Parameters	No. Points	Range (mg/l)	Mean ± Std. Dev.	Mean + 2 Std. Dev.
For 1979-Treated Wastewater				
Cr	47	0.015 - 0.13	0.045 ± 0.029	0.10
Cu	12	0.01 - 0.03	0.019 ± 0.006	0.03
Ni	47	0.08 - 0.64	0.22 ± 0.13	0.48
Zn	47	0.08 - 0.53	0.17 ± 0.09	0.35
Fe				
For 1978-Treated Wastewater				
Cr	47	0.01 - 0.07	0.06 ± 0.10	0.26
Cu	28	0.005 - 0.055	0.016 ± 0.010	0.04
Ni	47	0.10 - 0.92	0.20 ± 0.14	0.48
Zn	47	0.08 - 2.35	0.23 ± 0.34	0.91
Fe	21	0.26 - 1.1	0.49 ± 0.18	0.85
Raw Waste				
Cr	5	32.0 - 72.0		
Cu	5	0.08 - 0.45		
Ni	5	1.65 - 20.0		
Zn	5	33.2 - 32.0		
Fe	5	10.0 - 95.0		

Table VII-18

PRECIPITATION-SETTLING-FILTRATION (LS&F) PERFORMANCE
PLANT B

Parameters	No. Points	Range (mg/l)	Mean ± Std. Dev.	Mean + 2 Std. Dev.
For 1979-Treated Wastewater				
Cr	175	0.0 - 0.40	0.068 ± 0.075	0.22
Cu	176	0.0 - 0.22	0.024 ± 0.021	0.07
Ni	175	0.01 - 1.49	0.219 ± 0.234	0.69
Zn	175	0.01 - 0.66	0.054 ± 0.064	0.18
Fe	174	0.01 - 2.40	0.303 ± 0.398	1.10
TSS	2	1.00 - 1.00		
For 1978-Treated Wastewater				
Cr	144	0.0 - 0.70	0.059 ± 0.088	0.24
Cu	143	0.0 - 0.23	0.017 ± 0.020	0.06
Ni	143	0.0 - 1.03	0.147 ± 0.142	0.43
Zn	131	0.0 - 0.24	0.037 ± 0.034	0.11
Fe	144	0.0 - 1.76	0.200 ± 0.223	0.47
Total 1974-1979-Treated Wastewater				
Cr	1,288	0.0 - 0.56	0.038 ± 0.055	0.15
Cu	1,290	0.0 - 0.23	0.011 ± 0.016	0.04
Ni	1,287	0.0 - 1.88	0.184 ± 0.211	0.60
Zn	1,273	0.0 - 0.66	0.035 ± 0.045	0.13
Fe	1,287	0.0 - 3.15	0.402 ± 0.509	1.42
Raw Waste				
Cr	3	2.80 - 9.15	5.90	
Cu	3	0.09 - 0.27	0.17	
Ni	3	1.61 - 4.89	3.33	
Zn	2	2.35 - 3.39		
Fe	3	3.13 - 35.9	22.4	
TSS	2	177 - 446		

Table VII-19

PRECIPITATION-SETTLING-FILTRATION (LS&F) PERFORMANCE
PLANT C

Parameters	No. Points	Range (mg/l)	Mean ± Std. Dev.	Mean + 2 Std. Dev.
For Treated Wastewater				
Cd	103	0.010 - 0.500	0.049 ± 0.049	0.147
Zn	103	0.039 - 0.899	0.290 ± 0.131	0.552
TSS	103	0.100 - 5.00	1.244 ± 1.043	3.33
pH	103	7.1 - 7.9	9.2*	
For UnTreated Wastewater				
Cd	103	0.039 - 2.319	0.542 ± 0.381	1.304
Zn	103	0.949 - 29.8	11.009 ± 6.933	24.956
Fe	3	0.107 - 0.46	0.255	
TSS	103	0.80 - 19.6	5.616 ± 2.896	11.408
pH	103	6.8 - 8.2	7.6*	

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*pH value is median of 103 values.

TABLE VII - 20
SUMMARY OF TREATMENT EFFECTIVENESS (mg/1)

Pollutant Parameter		L & S Technology System				LS&F Technology System				Sulfide Precipitation Filtration			
		Mean	One Day Max.	Ten Day Avg.	Thirty Day Avg.	Mean	One Day Max.	Ten Day Avg.	Thirty Day Avg.	Mean	One Day Max.	Ten Day Avg.	Thirty Day Avg.
114	Sb	0.70	2.87	1.28	1.14	0.47	1.93	0.86	0.76				
115	As	0.51	2.09	0.86	0.83	0.34	1.39	0.57	0.55				
117	Be	0.30	1.23	0.51	0.49	0.20	0.82	0.34	0.32				
118	Cd	0.079	0.34	0.15	0.13	0.049	0.20	0.08	0.08	0.01	0.04	0.018	0.016
119	Cr	0.084	0.44	0.18	0.12	0.07	0.37	0.15	0.10	0.08	0.21	0.091	0.081
120	Cu	0.58	1.90	1.00	0.73	0.39	1.28	0.61	0.49	0.05	0.21	0.091	0.081
121	CN	0.07	0.29	0.12	0.11	0.047	0.20	0.08	0.08				
122	Pb	0.12	0.42	0.20	0.16	0.08	0.28	0.13	0.11	0.01	0.04	0.018	0.016
123	Hg	0.06	0.25	0.10	0.10	0.036	0.15	0.06	0.06	0.03	0.13	0.0555	0.049
124	Ni	0.74	1.92	1.27	1.00	0.22	0.55	0.37	0.29	0.05	0.21	0.091	0.081
125	Se	0.30	1.23	0.55	0.49	0.20	0.82	0.37	0.33				
126	Ag	0.10	0.41	0.17	0.16	0.07	0.29	0.12	0.10	0.05	0.21	0.091	0.081
127	Tl	0.50	2.05	0.84	0.81	0.34	1.40	0.57	0.55				
128	Zn	0.33	1.46	0.61	0.45	0.23	1.02	0.42	0.31	0.01	0.04	0.018	0.016
	Al	2.24	6.43	3.20	2.52	1.49	6.11	2.71	2.41				
	Co	0.05	0.21	0.09	0.08	0.034	0.14	0.07	0.06				
	F	14.5	59.5	26.4	23.5		59.5	26.4	23.5				
	Fe	0.41	1.20	0.61	0.50	0.28	1.20	0.61	0.50				
	Mn	0.16	0.68	0.29	0.21	0.14	0.30	0.23	0.19				
	P	4.08	16.7	6.83	6.60	2.72	11.2	4.6	4.4				
	O&G		20.0	12.0	10.0		10.0	10.0	10.0				
	TSS	12.0	41.0	19.5	15.5	2.6	15.0	12.0	10.0				

Table VII-21
TREATABILITY RATING OF PRIORITY POLLUTANTS UTILIZING CARBON ADSORPTION

Priority Pollutant	*Removal Rating
1. acenaphthene	H
2. acrolein	L
3. acrylonitrile	L
4. benzene	M
5. benzidine	H
6. carbon tetrachloride (tetrachloromethane)	M
7. chlorobenzene	H
8. 1,2,3-trichlorobenzene	H
9. hexachlorobenzene	H
10. 1,2-dichloroethane	M
11. 1,1,1-trichloroethane	M
12. hexachloroethane	H
13. 1,1-dichloroethane	M
14. 1,1,2-trichloroethane	M
15. 1,1,2,2-tetrachlorethane	H
16. chloroethane	L
17. bis(chloromethyl) ether	-
18. bis(2-chloroethyl) ether	M
19. 2-chloroethylvinyl ether (mixed)	L
20. 2-chloronaphthalene	H
21. 2,4,6-trichlorophenol	H
22. parachlorometa cresol	H
23. chloroform (trichloromethane)	L
24. 2-chlorophenol	H
25. 1,2-dichlorobenzene	H
26. 1,3-dichlorobenzene	H
27. 1,4-dichlorobenzene	H
28. 3,3'-dichlorobenzidine	H
29. 1,1-dichloroethylene	L
30. 1,2-trans-dichloroethylene	L
31. 2,4-dichlorophenol	H
32. 1,2-dichloropropane	M
33. 1,2-dichloropropylene (1,3-dichloropropene)	M
34. 2,4-dimethylphenol	H
35. 2,4-dinitrotoluene	H
36. 2,6-dinitrotoluene	H
37. 1,2-diphenylhydrazine	H
38. ethylbenzene	M
39. fluoranthene	H
40. 4-chlorophenyl phenyl ether	H
41. 4-bromophenyl phenyl ether	H
42. bis(2-chloroisopropyl)ether	M
43. bis(2-chloroethoxy)methane	M
44. methylene chloride (dichloromethane)	L
45. methyl chloride (chloromethane)	L
46. methyl bromide (bromomethane)	L
47. bromoform (tribromomethane)	H
48. dichlorobromomethane	M
49. trichlorofluoromethane	M
50. dichlorodifluoromethane	L
51. chlorodibromomethane	M
52. hexachlorobutadiene	H
53. hexachlorocyclopentadiene	H
54. isophorone	H
55. naphthalene	H
56. nitrobenzene	H
57. 2-nitrophenol	H
58. 4-nitrophenol	H
59. 2,4-dinitrophenol	H
60. 4,6-dinitro-o-cresol	H
61. N-nitrosodimethylamine	M
62. N-nitrosodiphenylamine	H
63. N-nitrosodi-n-propylamine	M
64. pentachlorophenol	H
65. phenol	M
66. bis(2-ethylhexyl)phthalate	H
67. butyl benzyl phthalate	H
68. di-n-butyl phthalate	H
69. di-n-octyl phthalate	H
70. diethyl phthalate	H
71. dimethyl phthalate	H
72. 1,2-benzanthracene (benzo(a)anthracene)	H
73. benzo(a)pyrene (3,4-benzopyrene)	H
74. 3,4-benzofluoranthene (benzo(b)fluoranthene)	H
75. 11,12-benzofluoranthene (benzo(k)fluoranthene)	H
76. chrysene	H
77. acenaphthylene	H
78. anthracene	H
79. 1,12-benzoperylene (benzo (ghi)-perylene)	H
80. fluorene	H
81. phenanthrene	H
82. 1,2,3,6-dibenzanthracene (dibenzo(a,h) anthracene)	H
83. indeno (1,2,3-cd) pyrene (2,3-o-phenylene pyrene)	H
84. pyrene	-
85. tetrachloroethylene	M
86. toluene	M
87. trichloroethylene	L
88. vinyl chloride (chloroethylene)	L
106. PCB-1242 (Aroclor 1242)	H
107. PCB-1254 (Aroclor 1254)	H
108. PCB-1221 (Aroclor 1221)	H
109. PCB-1332 (Aroclor 1232)	H
110. PCB-1248 (Aroclor 1248)	H
111. PCB-1260 (Aroclor 1260)	H
112. PCB-1016 (Aroclor 1016)	H

*Note Explanation of Removal Ratings

Category H (high removal)

adsorbs at levels ≥ 100 mg/g carbon at $C_f = 10$ mg/l

adsorbs at levels ≥ 100 mg/g carbon at $C_f < 1.0$ mg/l

Category M (moderate removal)

adsorbs at levels ≥ 100 mg/g carbon at $C_f = 10$ mg/l

adsorbs at levels ≤ 100 mg/g carbon at $C_f < 1.0$ mg/l

Category L (low removal)

adsorbs at levels < 100 mg/g carbon at $C_f = 10$ mg/l

adsorbs at levels < 10 mg/g carbon at $C_f < 1.0$ mg/l

C_f = final concentrations of priority pollutant at equilibrium

TABLE VII - 22

CLASSES OF ORGANIC COMPOUNDS ADSORBED ON CARBON

Organic Chemical Class	Examples of Chemical Class
Aromatic Hydrocarbons	benzene, toluene, xylene
Polynuclear Aromatics	naphthalene, anthracene biphenyls
Chlorinated Aromatics	chlorobenzene, polychlorinated biphenyls, aldrin, endrin, toxaphene, DDT
Phenolics	phenol, cresol, resorcenol and polyphenyls
Chorinated Phenolics	trichlorophenol, pentachlorophenol
*High Molecular Weight Aliphatic and Branch Chain hydrocarbons	gasoline, kerosine
Chlorinated Aliphatic hydrocarbons	carbon tetrachloride, perchloroethylene
*High Molecular Weight Aliphatic Acids and Aromatic Acids	tar acids, benzoic acid
*High Molecular Weight Aliphatic Amines and Aromatic Amines	aniline, toluene diamine
*High Molecular Weight Ketones, Esters, Ethers and Alcohols	hydroquinone, polyethylene glycol
Surfactants	alkyl benzene sulfonates
Soluble Organic Dyes	methylene blue, indigo carmine

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* High Molecular Weight includes compounds in the broad range of from 4 to 20 carbon atoms

Table VII-23

ACTIVATED CARBON PERFORMANCE

Type of Industry	Pollutant Parameter	Mean Pollutant Levels ug/1 In	Out
NFM	Fluoranthene	55	13
Foundries	N-nitrosodiphenylamine	250	190
NFM	Benzo(a)anthracene	13	0.7
NFM	Chrysene	160	3.8
NFM	Anthracene	43	6.6
NFM	Phenanthrene	46	4.6
NFM	Pyrene	130	11

Table VII-24

ION EXCHANGE PERFORMANCE
(All Values mg/l)

Parameter	Plant A		Plant B	
	Prior to Purification	After Purification	Prior to Purification	After Purification
Al	5.6	0.20	--	--
Cd	5.7	0.00	--	--
Cr+3	3.1	0.01	--	--
Cr+6	7.1	0.01	--	--
Cu	4.5	0.09	43.0	0.10
CN	9.8	0.04	3.40	0.09
Au	--	--	2.30	0.10
Fe	7.4	0.01	--	--
Pb	--	--	1.70	0.01
Mn	4.4	0.00	--	--
Ni	6.2	0.00	1.60	0.01
Ag	1.5	0.00	9.10	0.01
SO_4	--	--	210.00	2.00
Sn	1.7	0.00	1.10	0.10
Zn	14.8	0.40	--	--

Table VII-25

PEAT ADSORPTION PERFORMANCE

Pollutant	Influent (mg/l)	Effluent (mg/l)
Cr+6	35,000	0.04
Cu	250	0.24
CN	36.0	0.7
Pb	20.0	0.025
Hg	1.0	0.02
Ni	2.5	0.07
Ag	1.0	0.05
Sb	2.5	0.9
Zn	1.5	0.25

Table VII-26

MEMBRANE FILTRATION SYSTEM EFFLUENT
(All Values in mg/l)

Specific Metal	Manufacturer's Guarantee	Plant 19066		Plant 31022		Predicted Perfor-mance
		In	Out	In	Out	
Al	0.5	--	--	--	--	--
Cr,(+6)	0.02	0.46	0.01	5.25	<0.005	--
Cr (T)	0.03	4.13	0.018	98.4	0.057	0.05
Cu	0.1	18.8	0.043	8.00	0.222	0.20
Fe	0.1	288	0.3	21.1	0.263	0.30
Pb	0.05	0.652	0.01	0.288	0.01	0.05
CN	0.02	<0.005	<0.005	<0.005	<0.005	0.02
Ni	0.1	9.56	0.017	194	0.352	0.40
Zn	0.1	2.09	0.046	5.00	0.051	0.10
TSS	--	632	0.1	13.0	8.0	1.0

Table VII-27

ULTRAFILTRATION PERFORMANCE

Parameter	Feed (mg/l)	Permeate (mg/l)
Oil (freon extractable)	95	22*
	1,540	52*
	1,230	4
COD	8,920	148
TSS	791	19*
	1,262	26*
	5,676	13*
	1,380	13
Total Solids	2,900	296

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*From samples at aluminum forming Plant B.

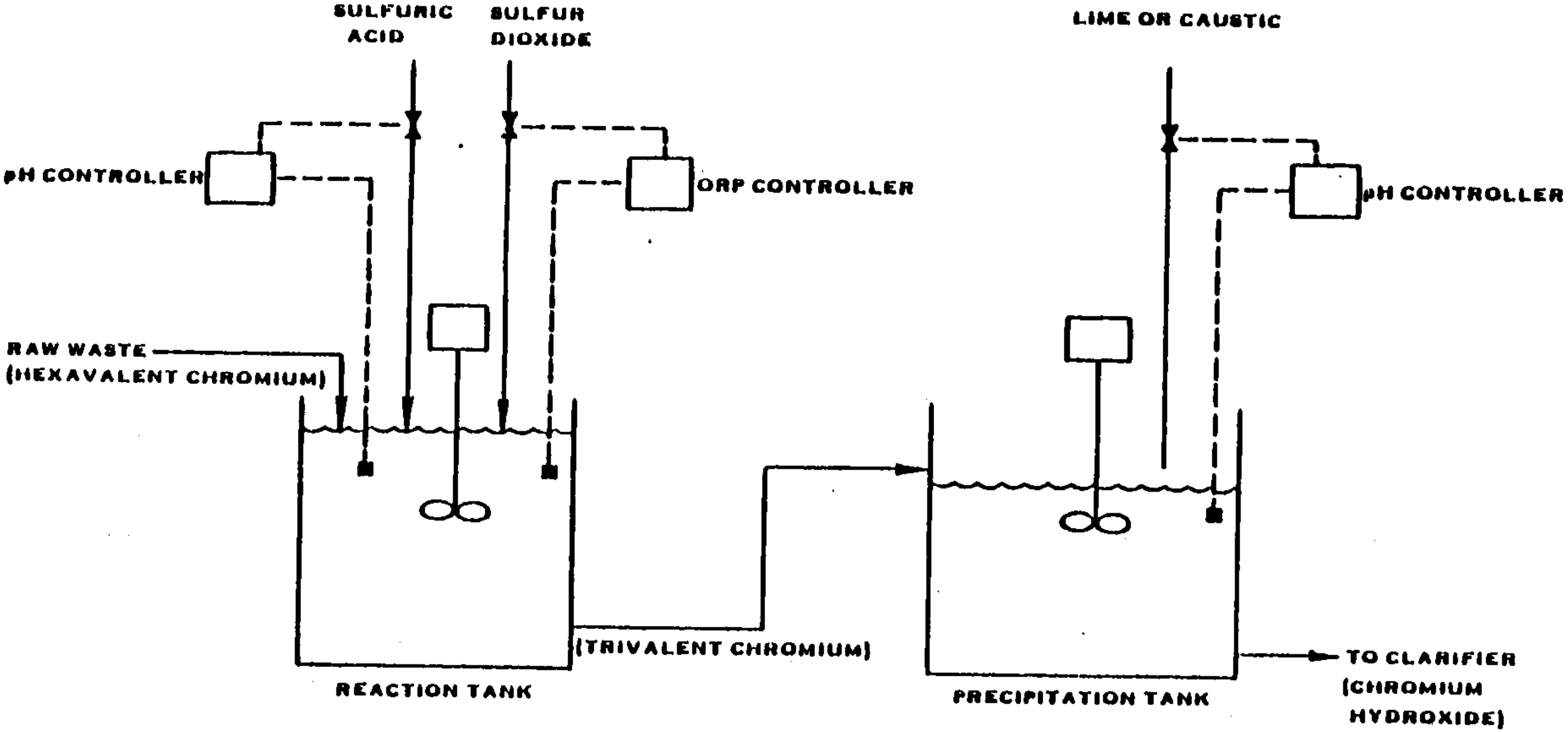


Figure VII-1

HEXAVALENT CHROMIUM REDUCTION WITH SULFUR DIOXIDE

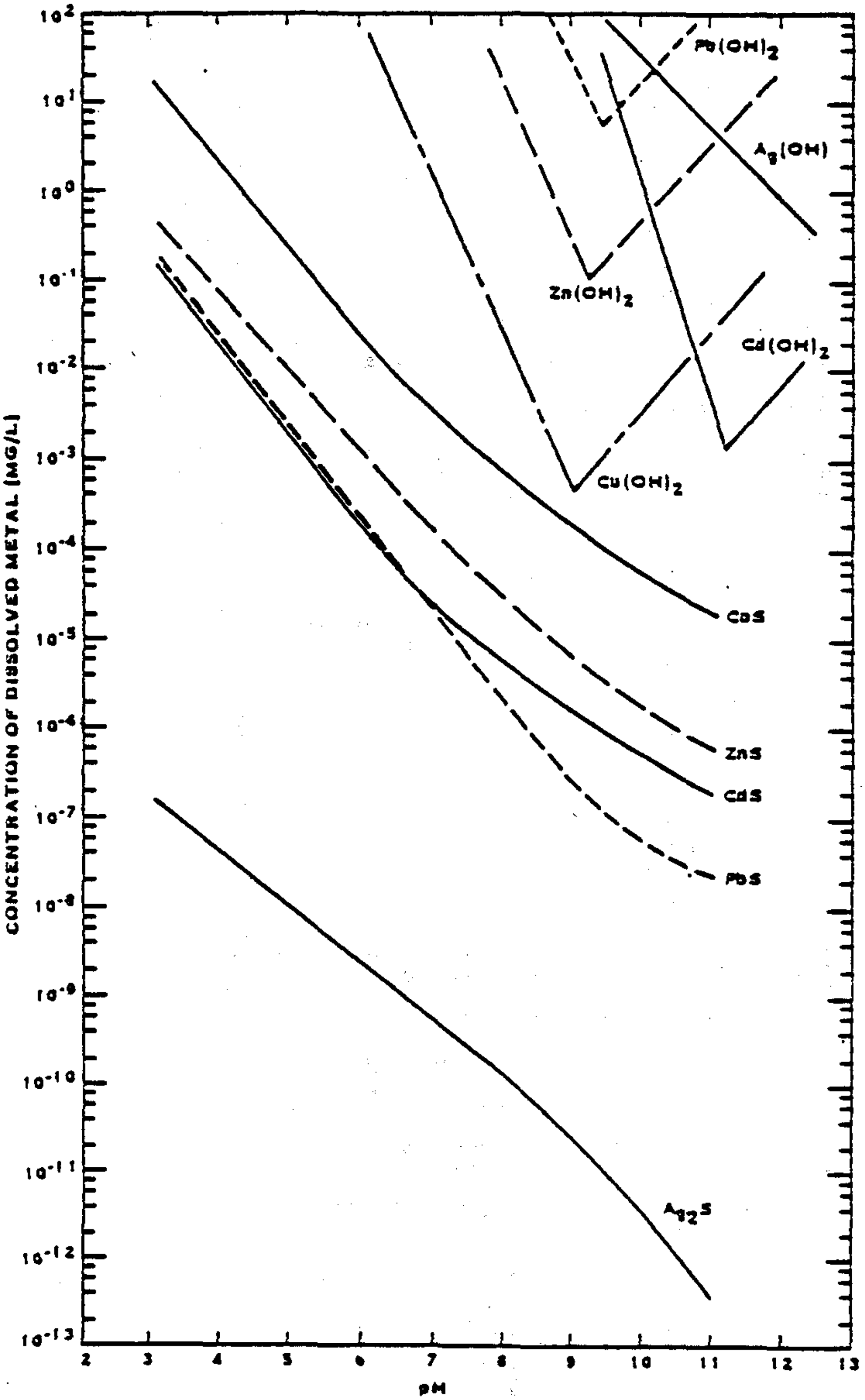


Figure VII-2

COMPARATIVE SOLUBILITIES OF METAL HYDROXIDES AND SULFIDE AS A FUNCTION OF pH

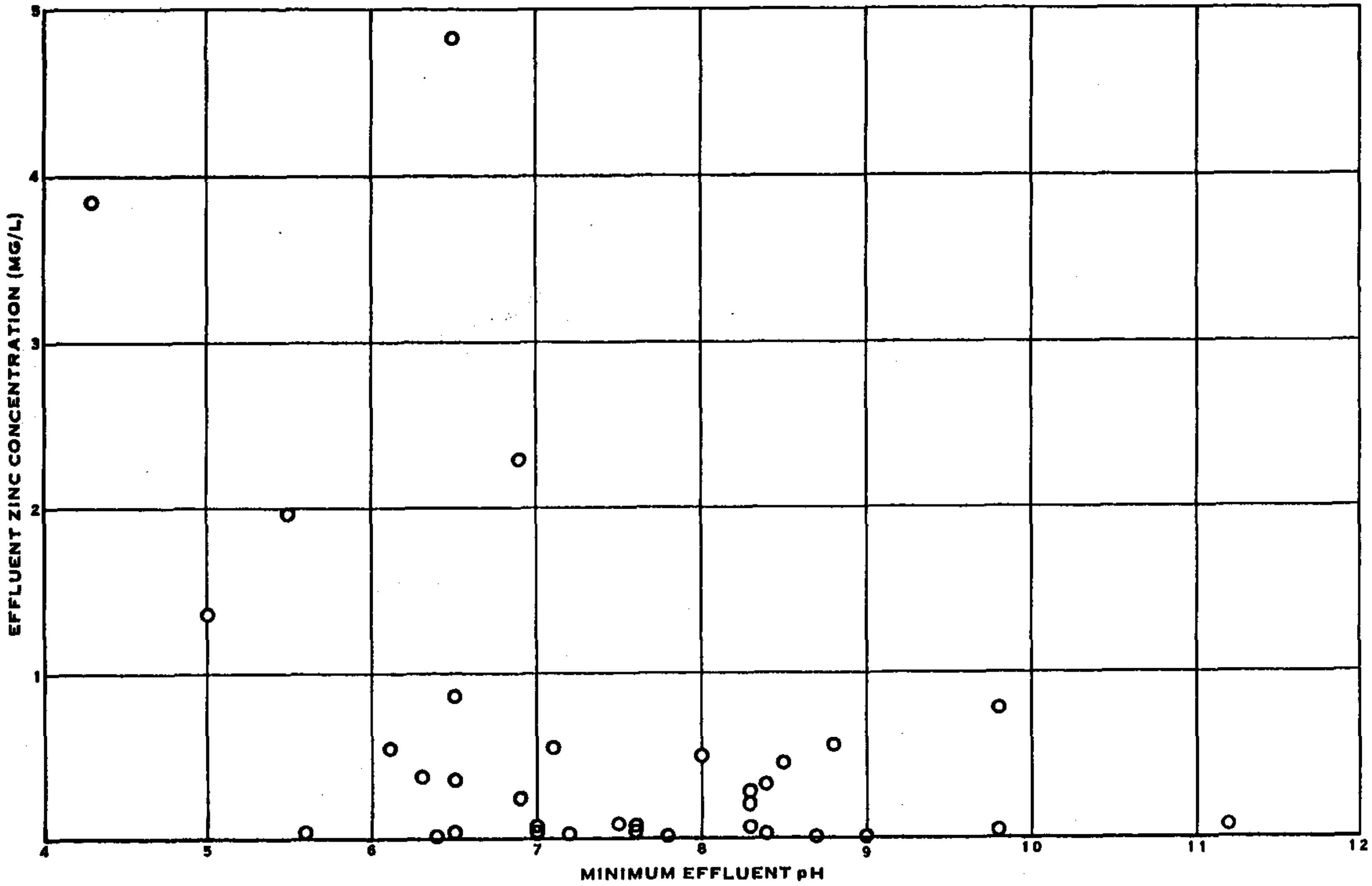


FIGURE VII-3. EFFLUENT ZINC CONCENTRATION VS. MINIMUM EFFLUENT pH

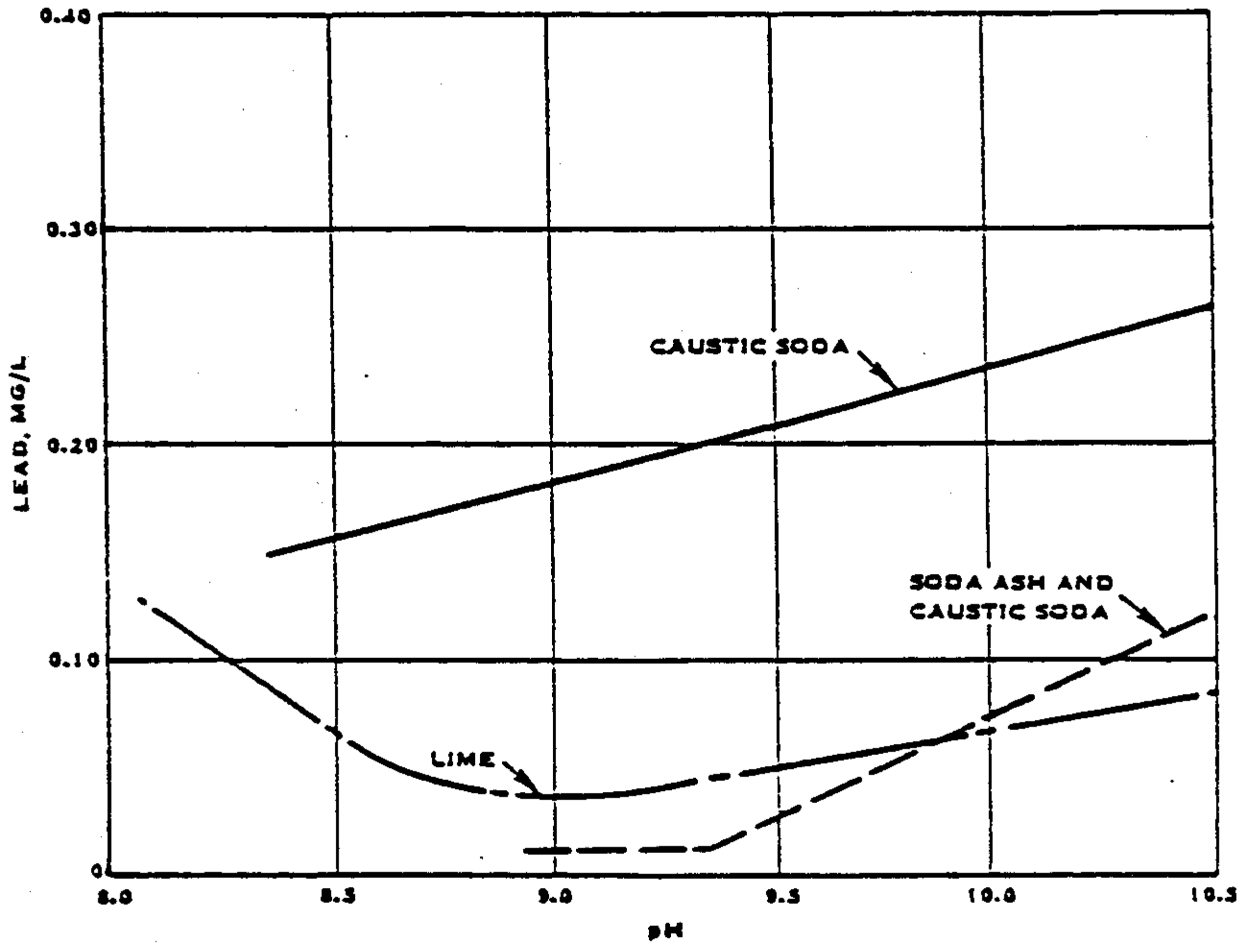


Figure VII-4

LEAD SOLUBILITY IN THREE ALKALIES

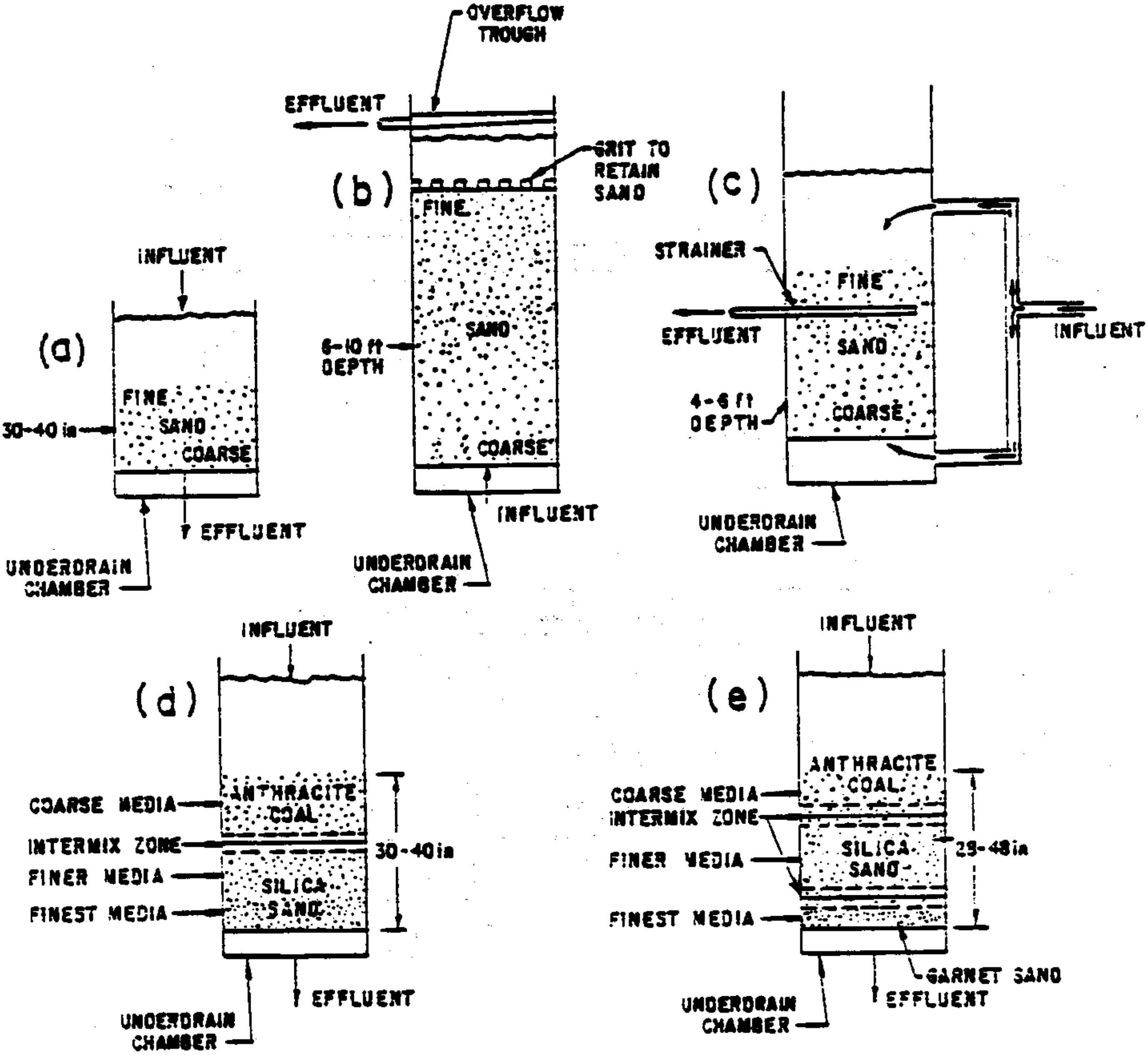


Figure VII-5

FILTER CONFIGURATIONS

(a) Single-Media Conventional Filter.
(b) Single-Media Upflow Filter.
(c) Single-Media Biflow Filter.
(d) Dual-Media Filter.
(e) Mixed-Media (Triple-Media) Filter.

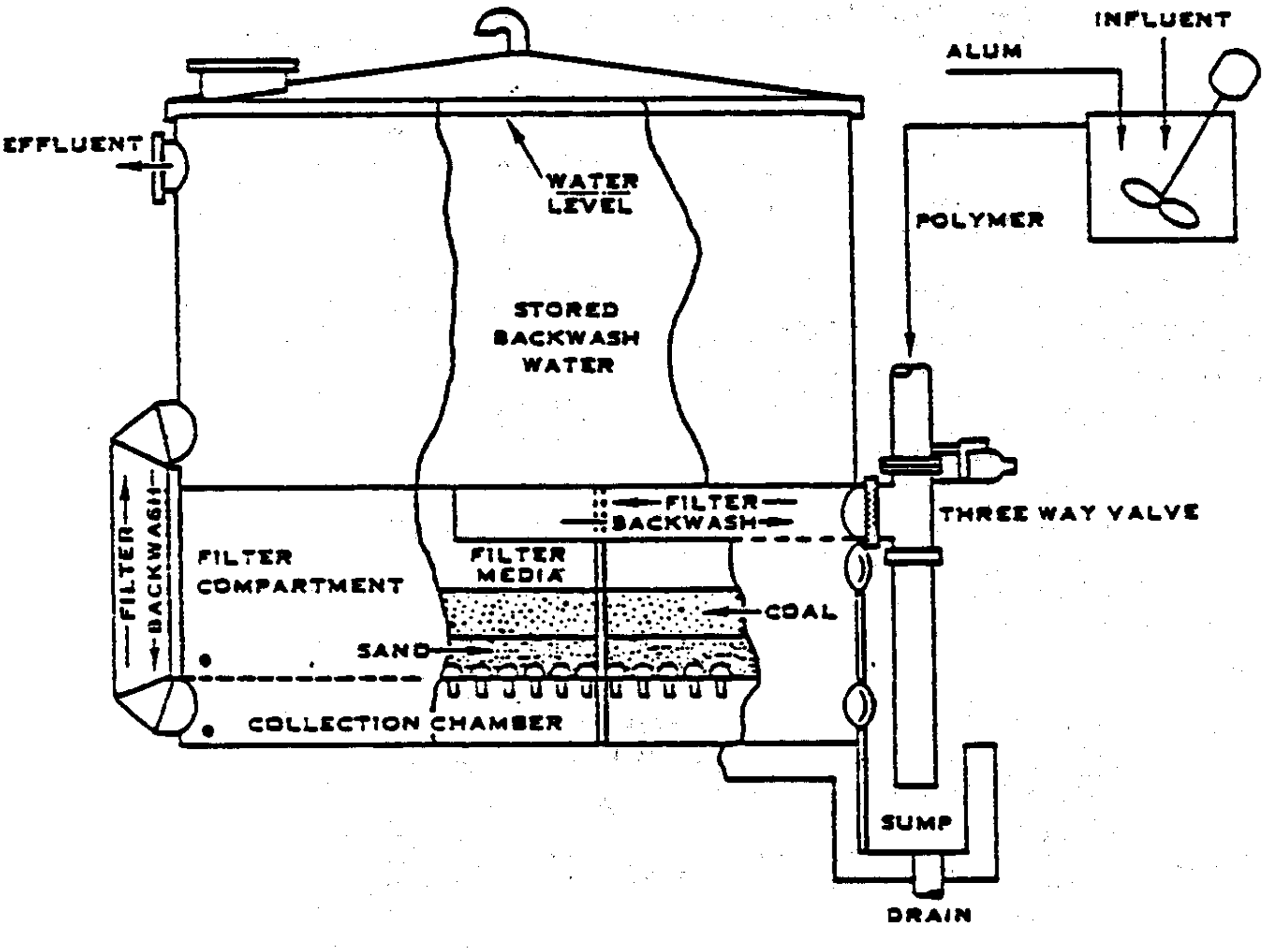
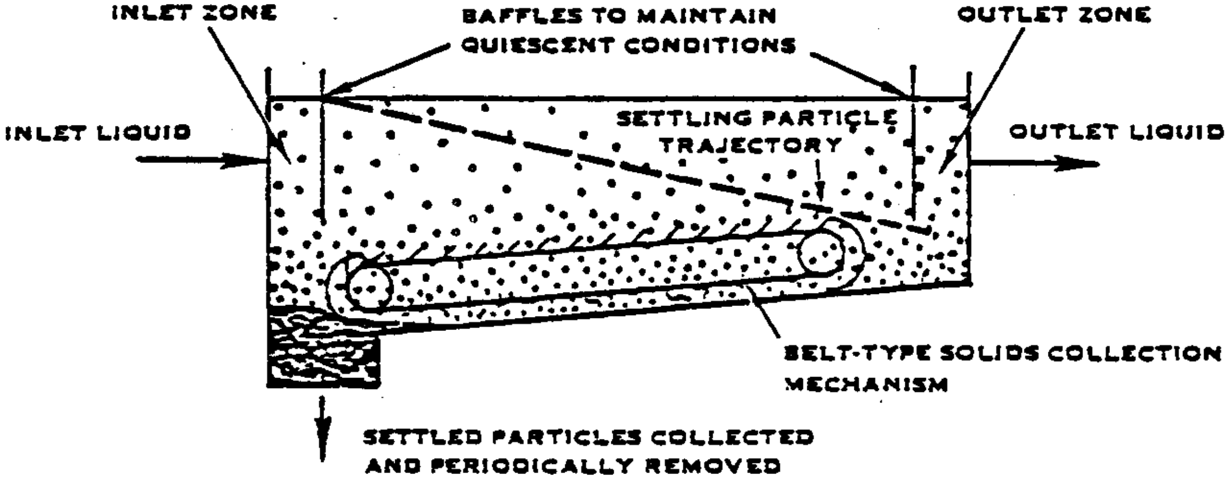


Figure VII-6

GRANULAR BED FILTRATION

SEDIMENTATION BASIN



CIRCULAR CLARIFIER

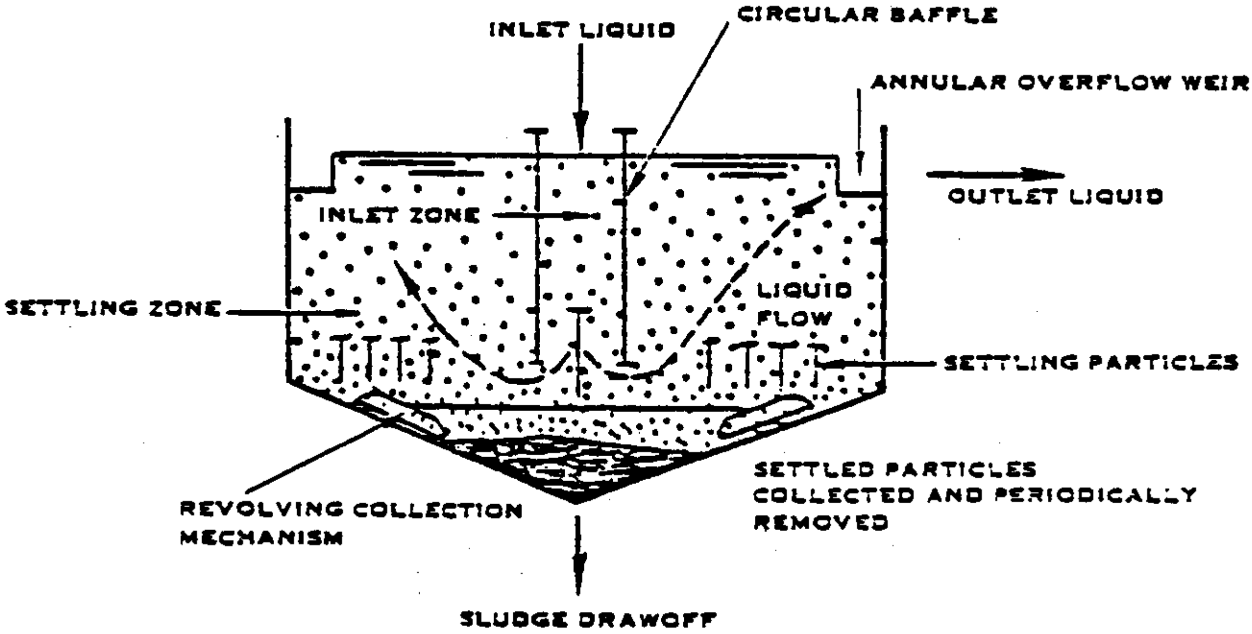


Figure VII-7

REPRESENTATIVE TYPES OF SEDIMENTATION

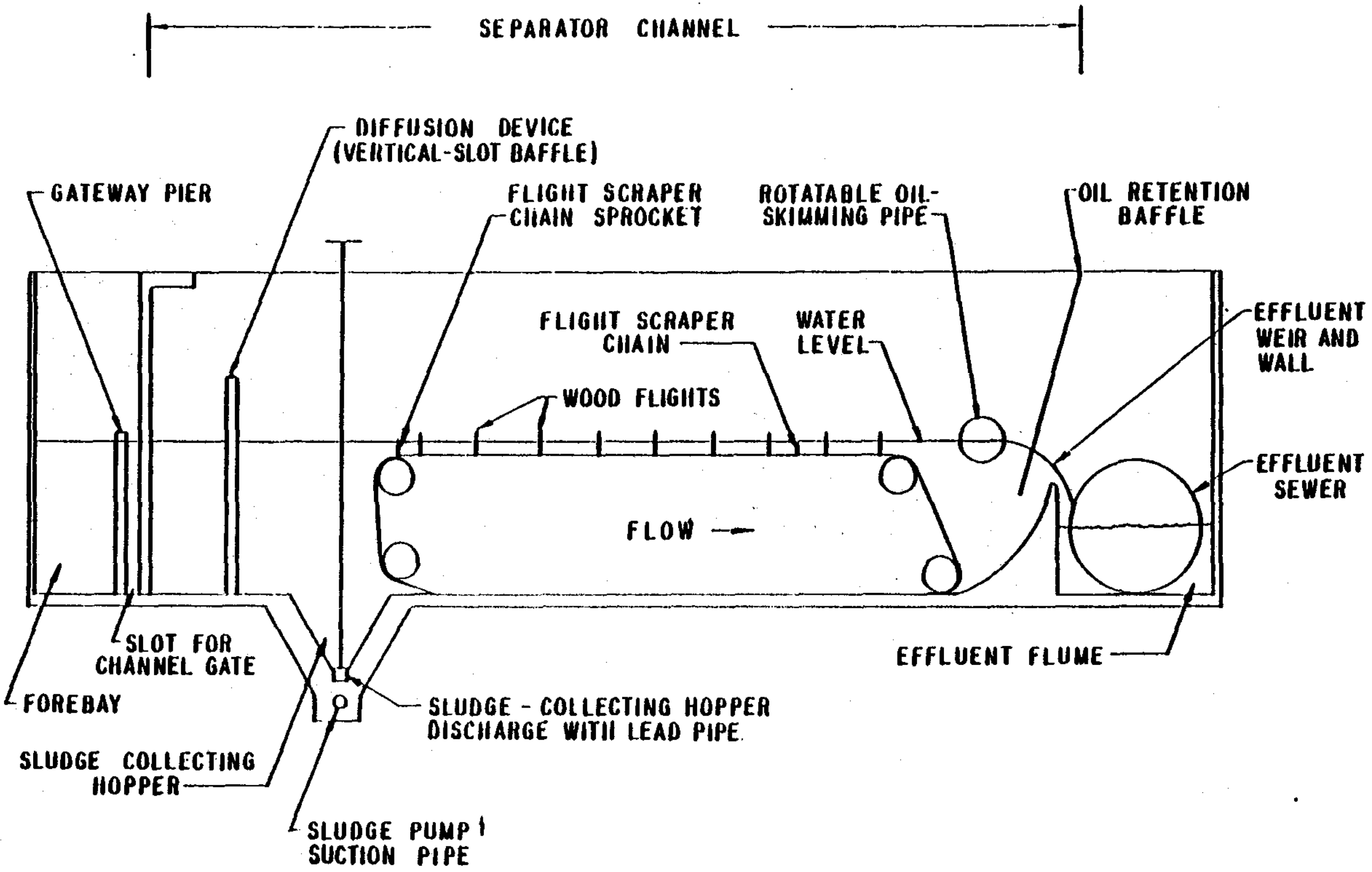


Figure VII-8

GRAVITY OIL-WATER SEPARATOR

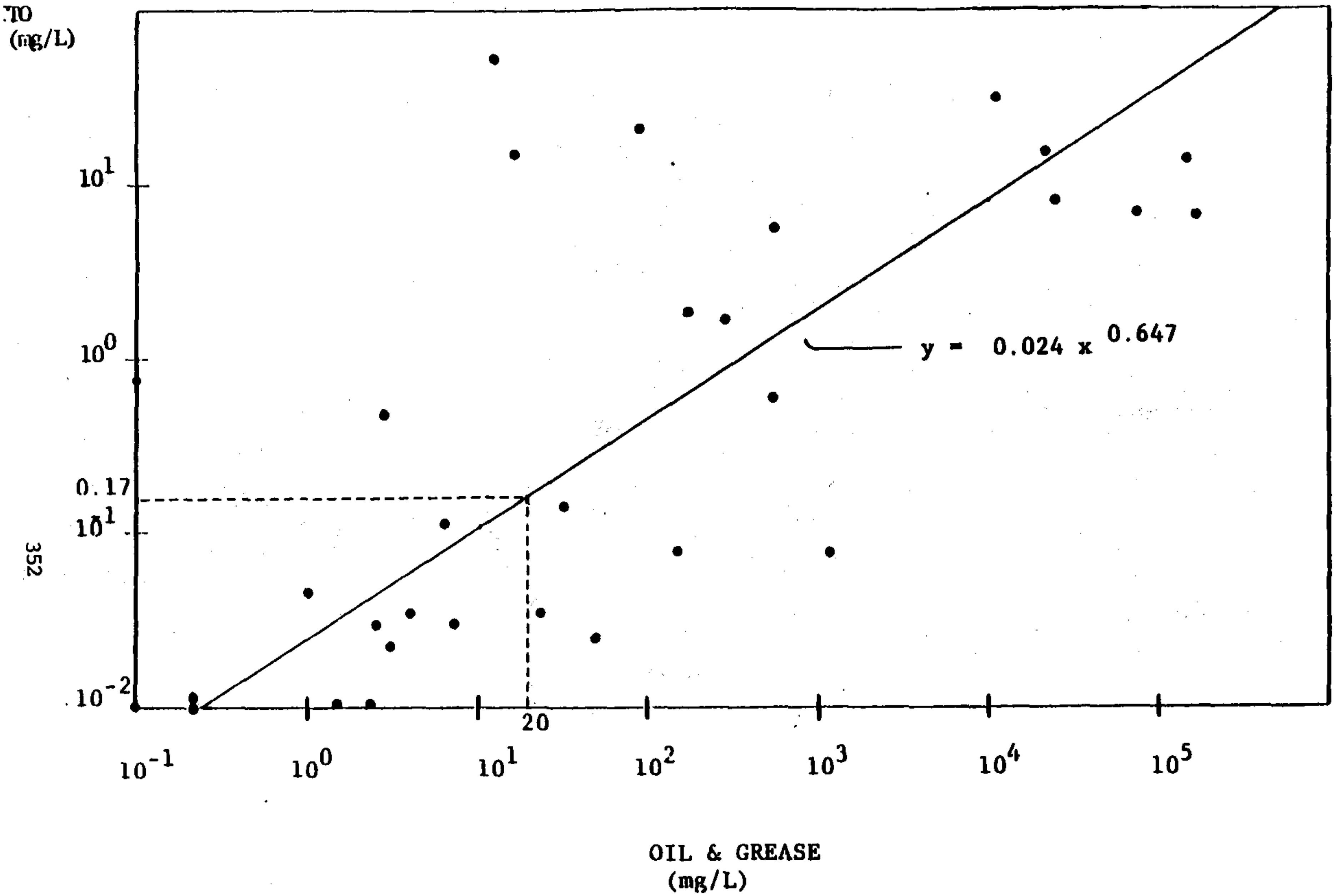


Figure VII-9

RELATIONSHIP BETWEEN TOTAL TOXIC ORGANICS (TTO) AND OIL AND GREASE CONCENTRATIONS

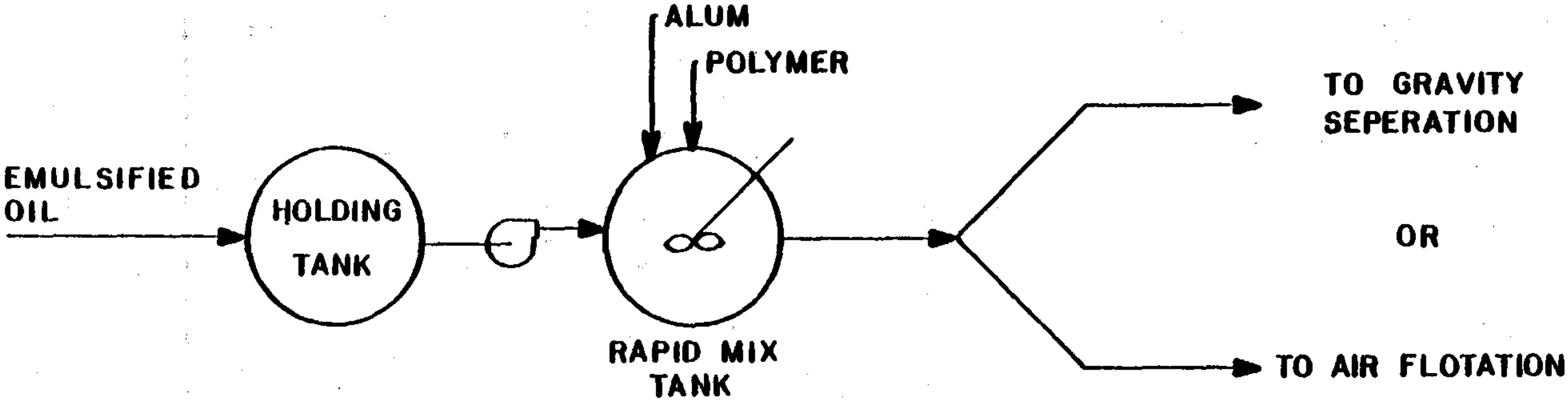
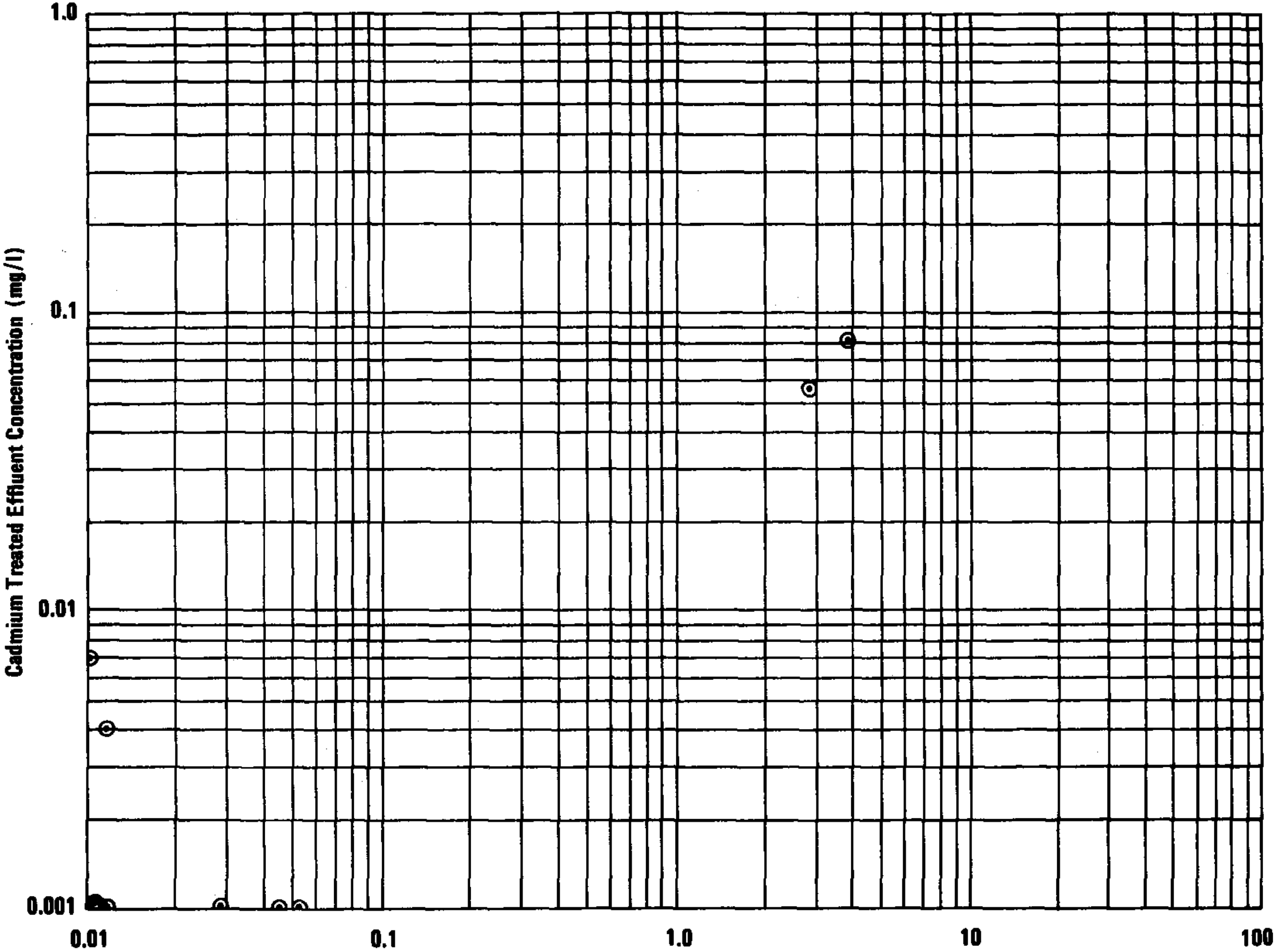


Figure VII-10

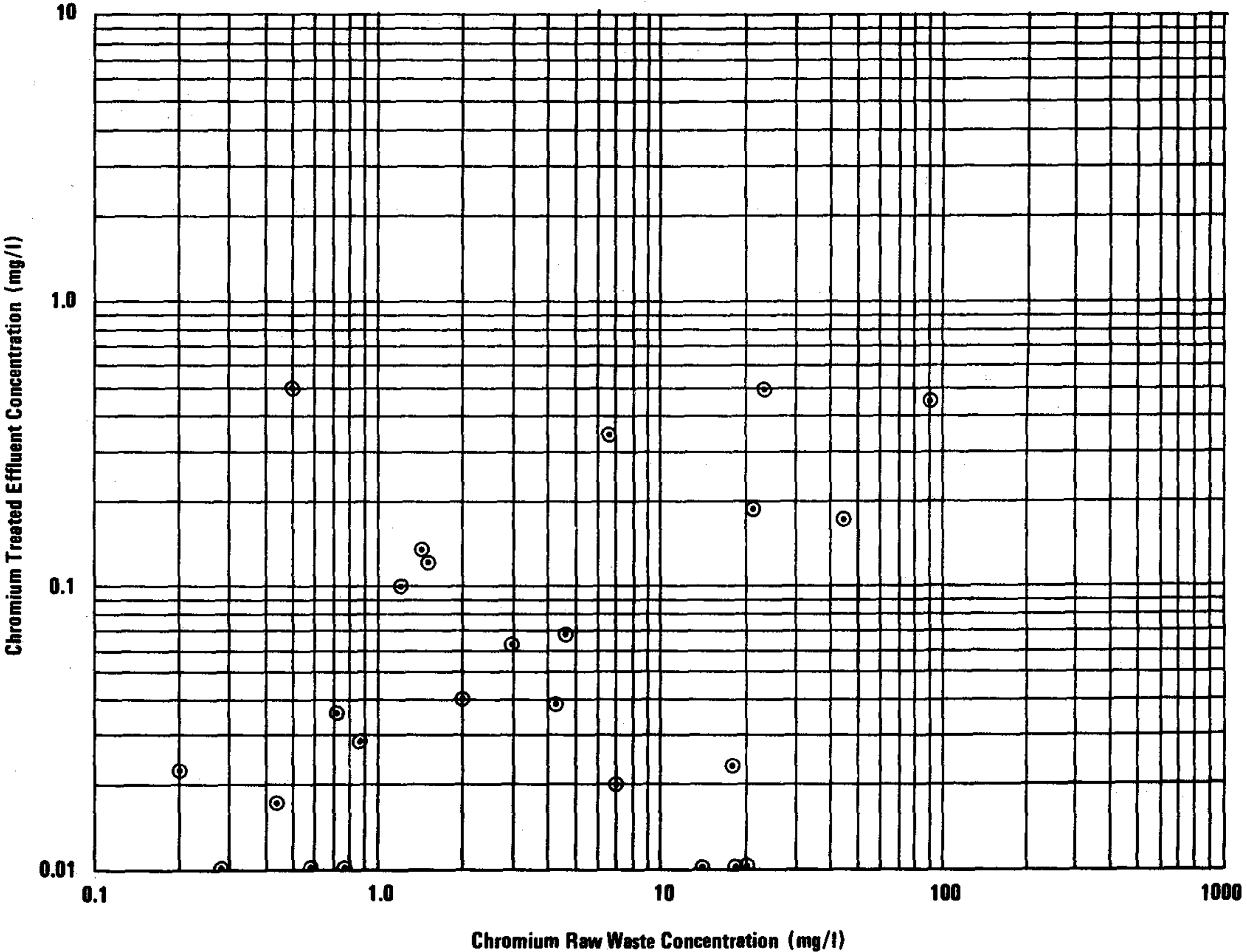
FLOW DIAGRAM FOR EMULSION BREAKING WITH CHEMICALS



(Number of observations = 2)

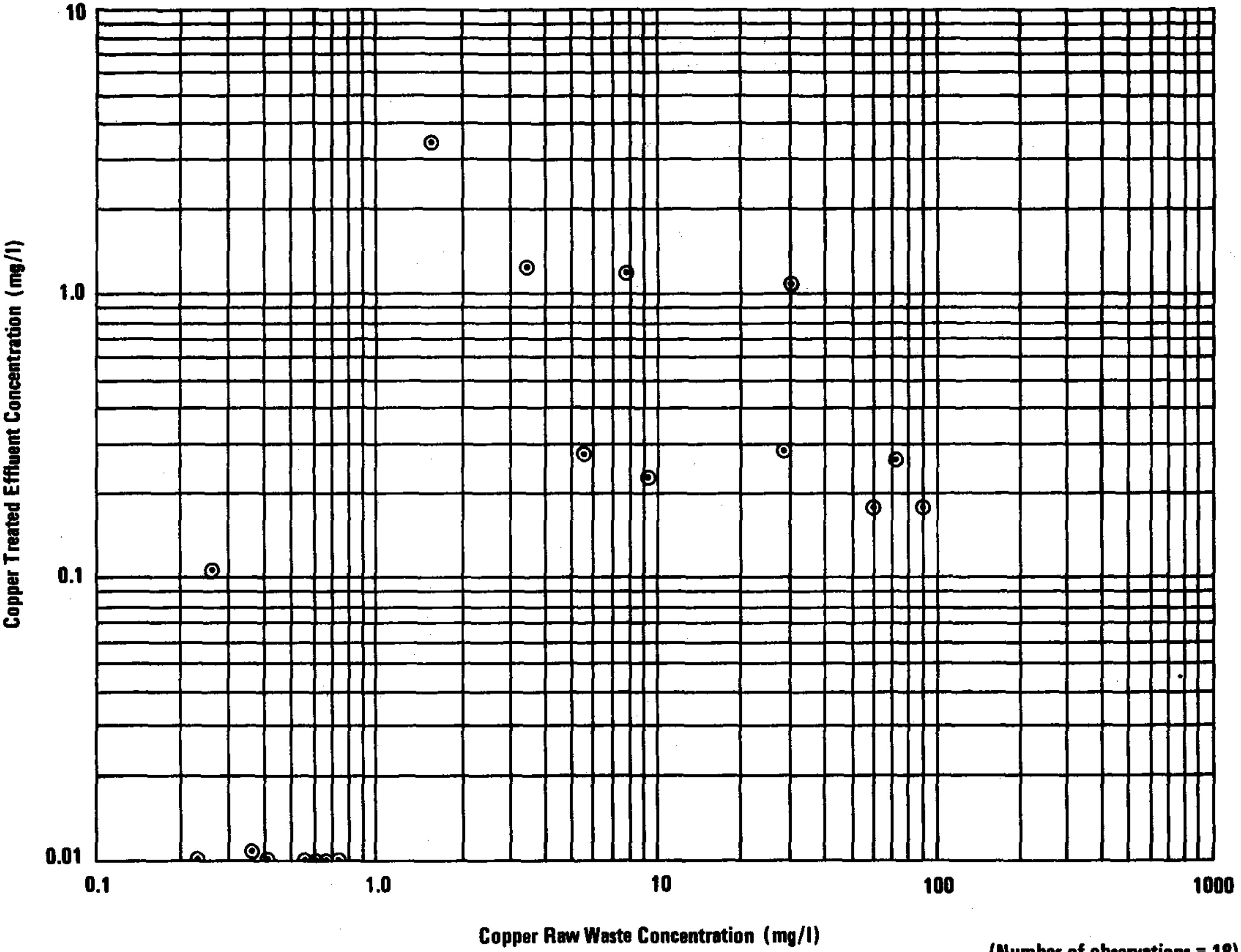
Data points with a raw waste concentration less than 0.1 mg/l were not included in treatment effectiveness calculations.

FIGURE VII-11
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
CADMIUM



(Number of observations = 25)

FIGURE VII-12
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
CHROMIUM



(Number of observations = 18)

FIGURE VII-13
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
COPPER

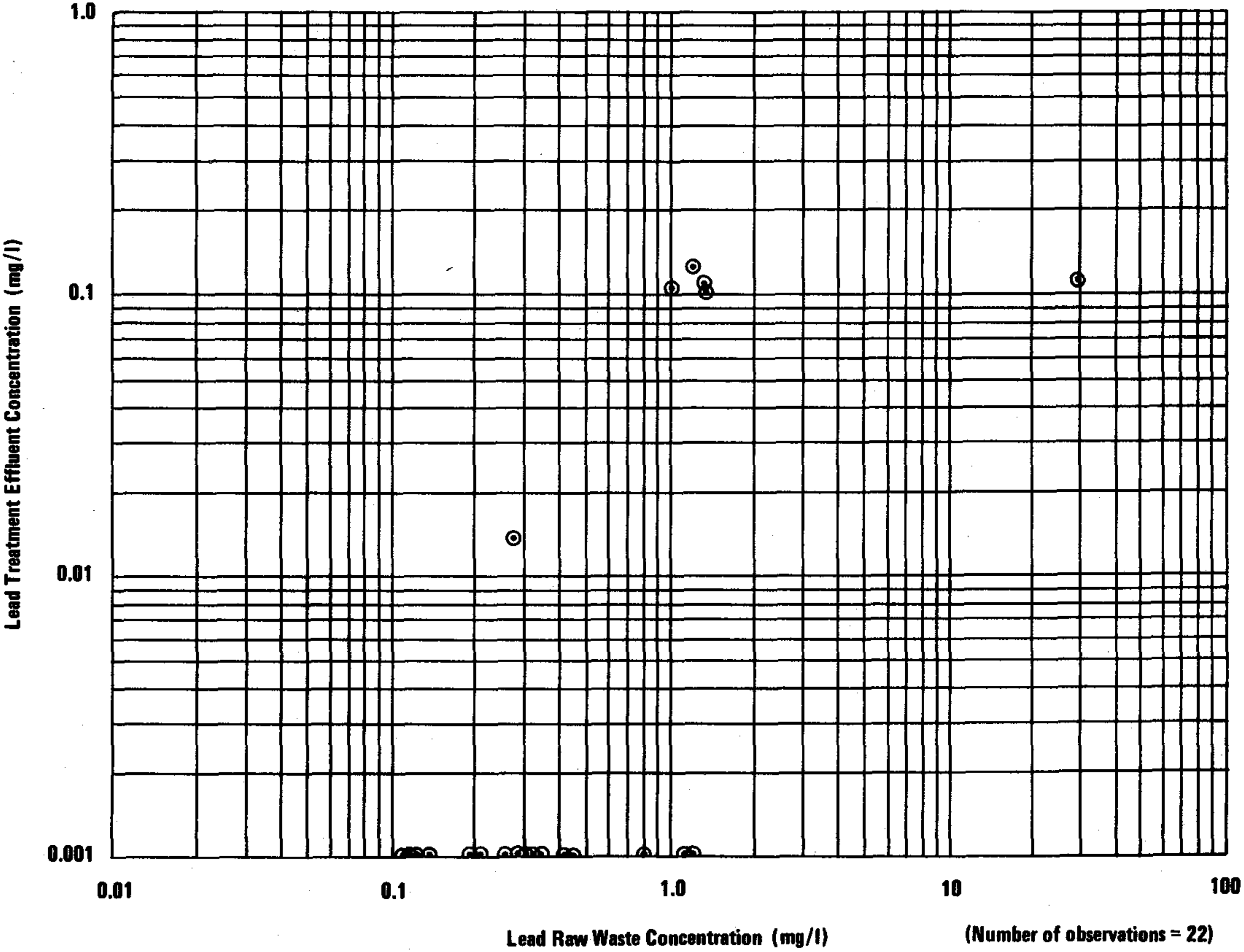


FIGURE VII-14
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
LEAD

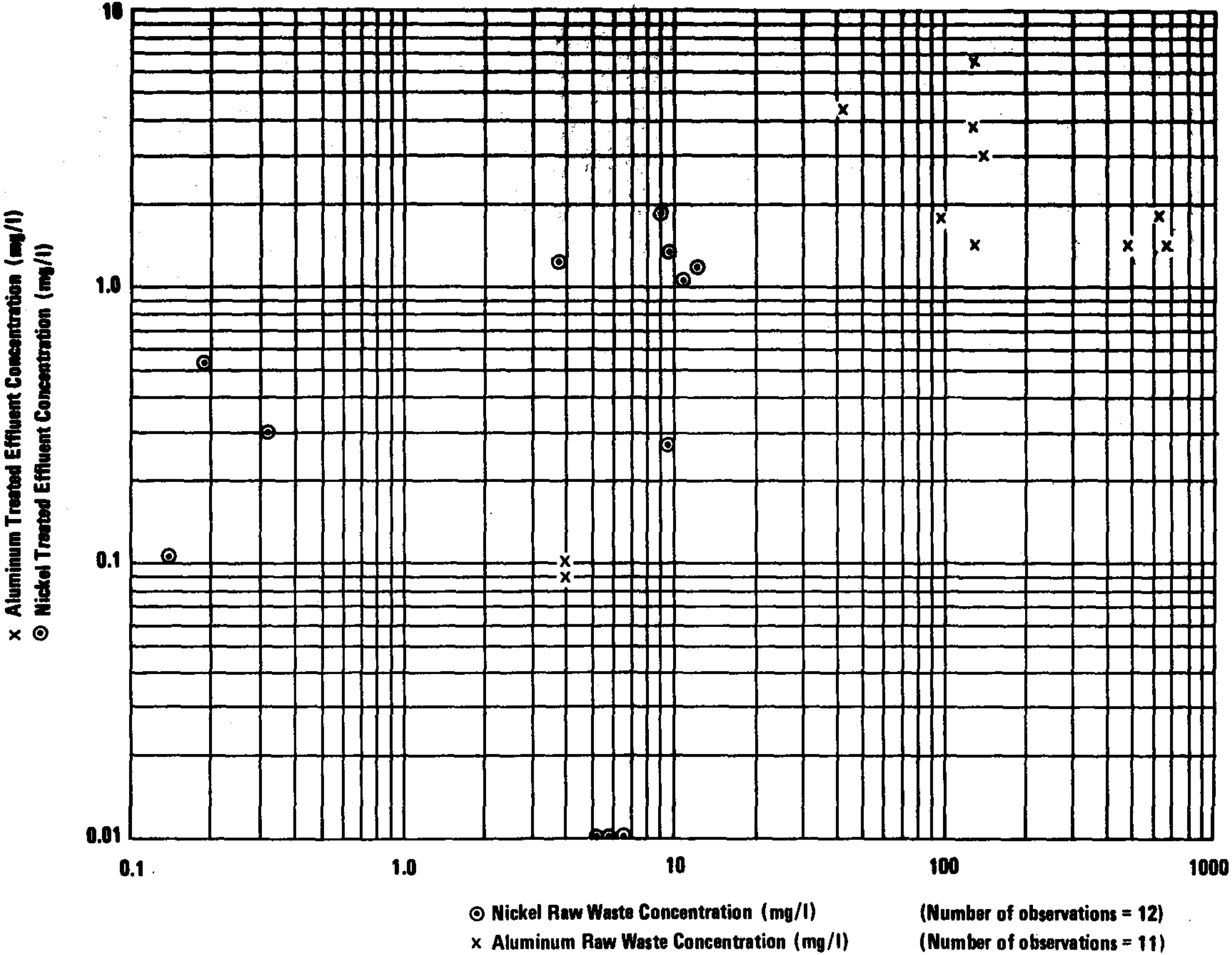
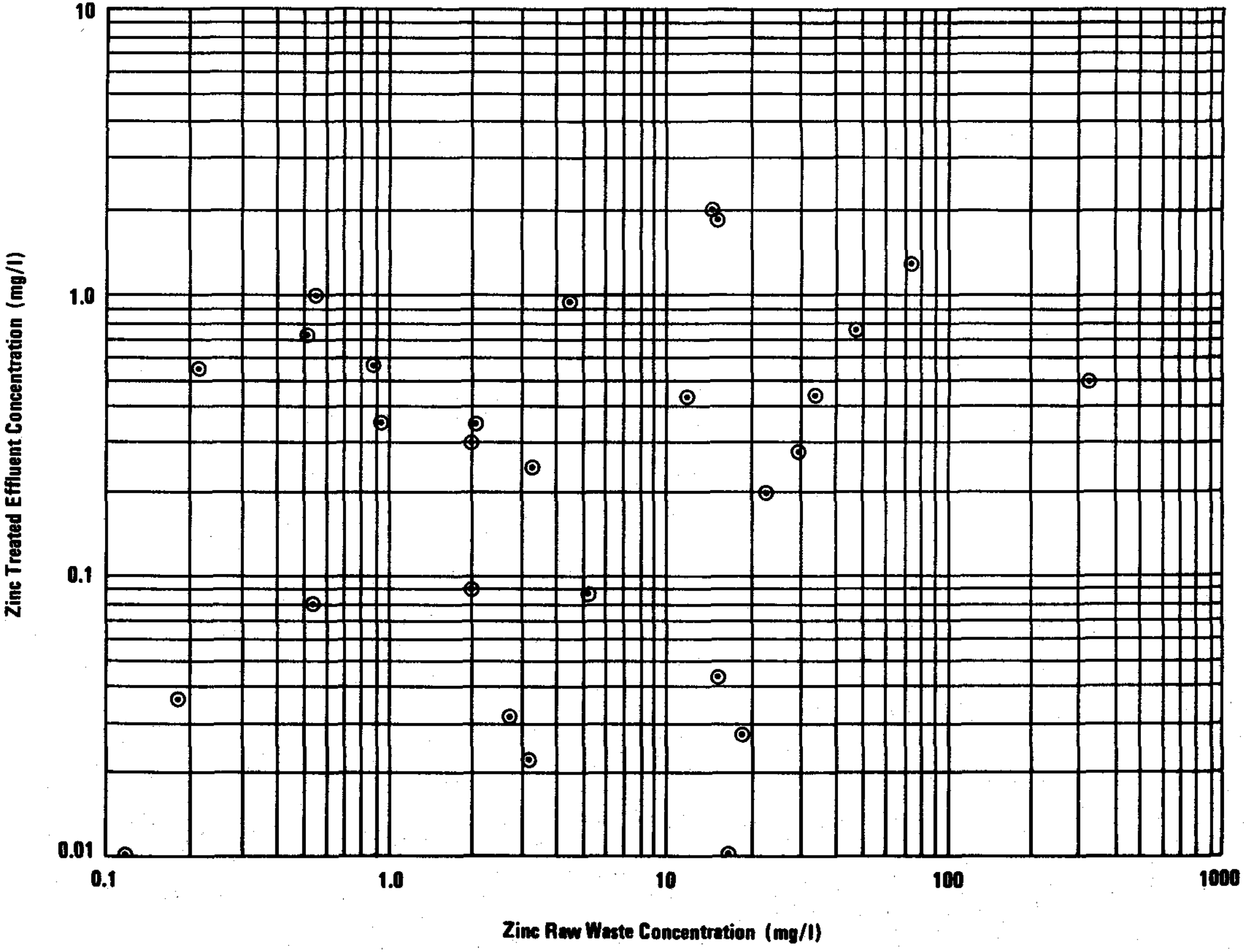
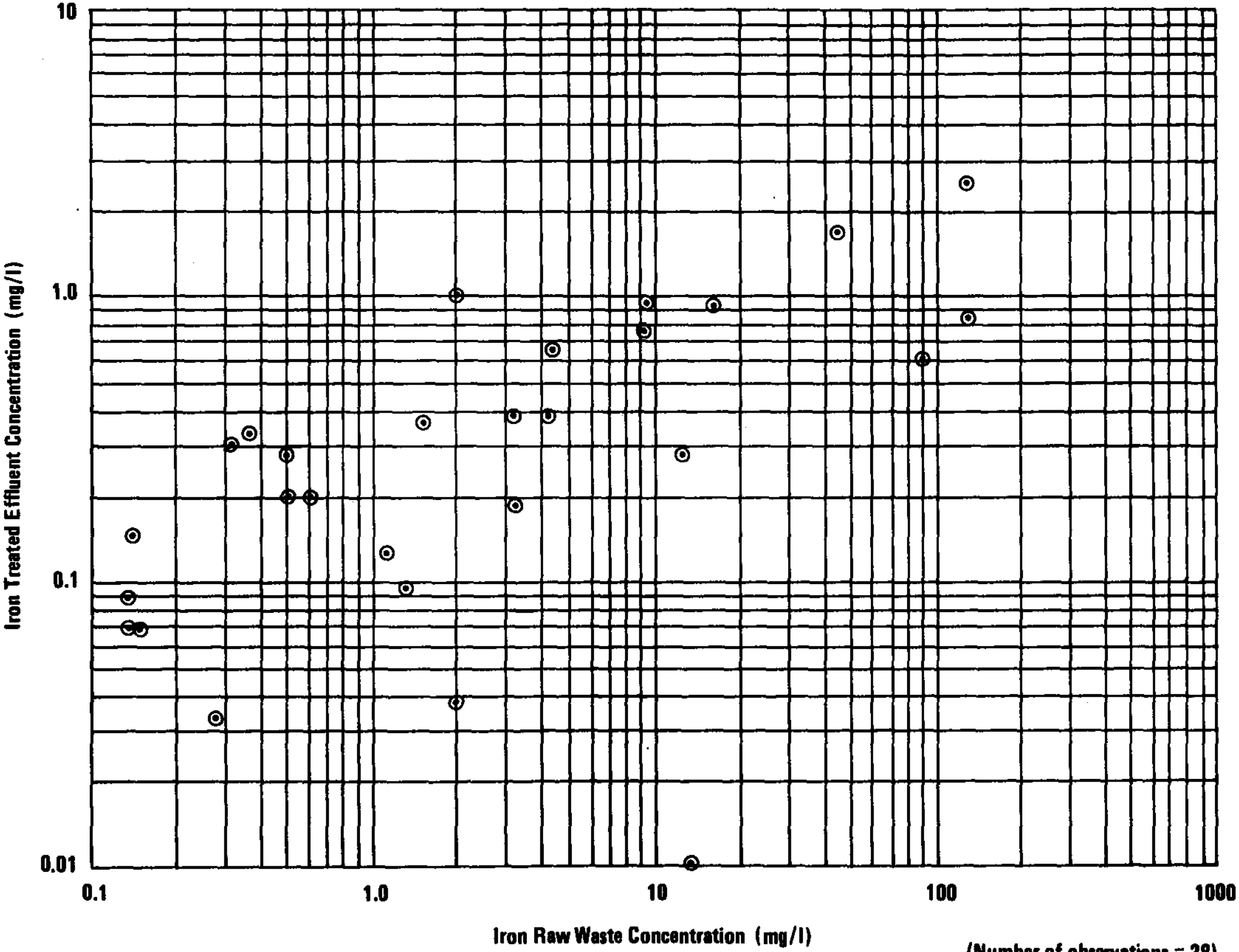


FIGURE VII-15
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
NICKEL AND ALUMINUM



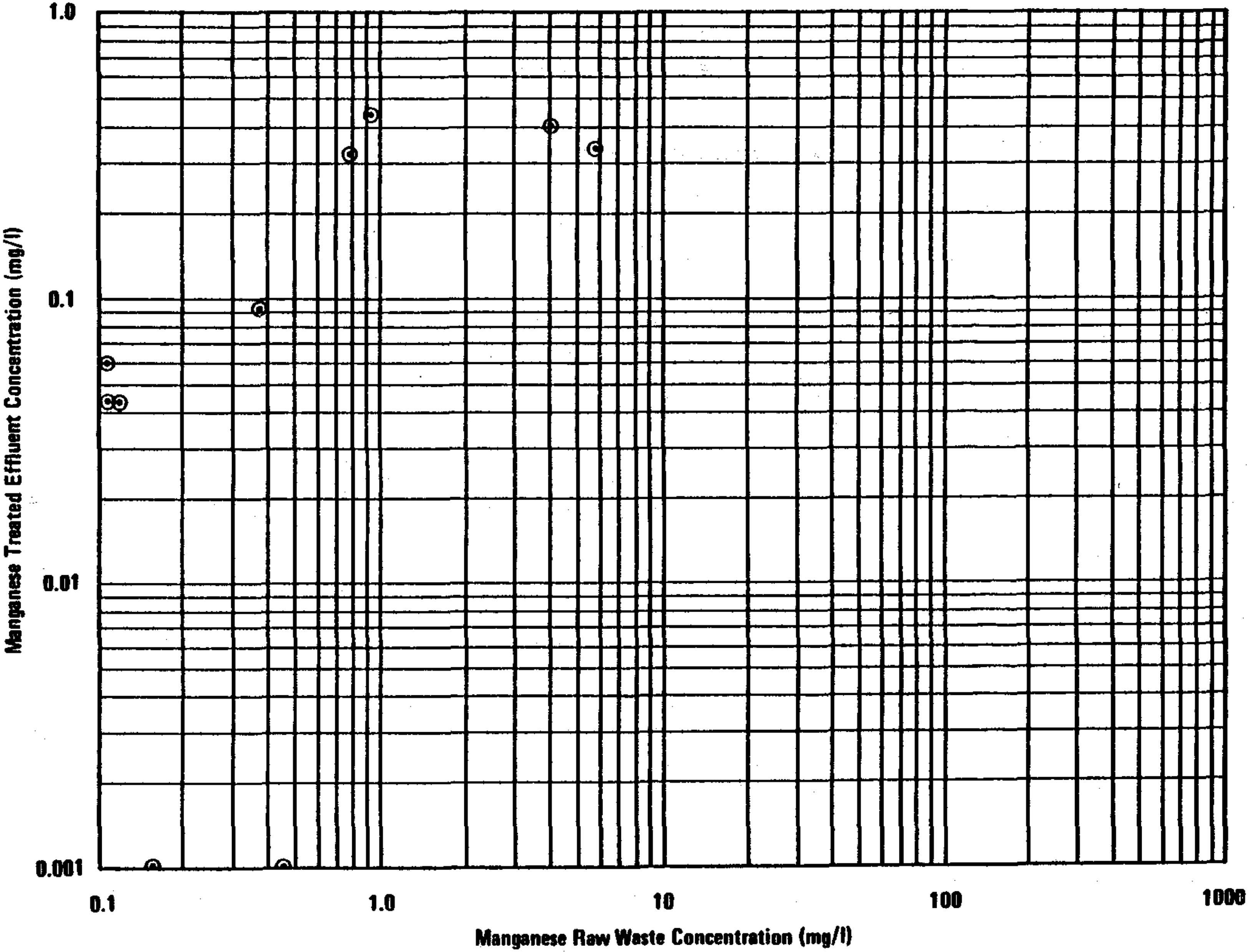
(Number of observations = 28)

FIGURE VII-16
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
ZINC



(Number of observations = 28)

FIGURE VII-17
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
IRON



(Number of observations = 10)

FIGURE VII-18
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
MANGANESE

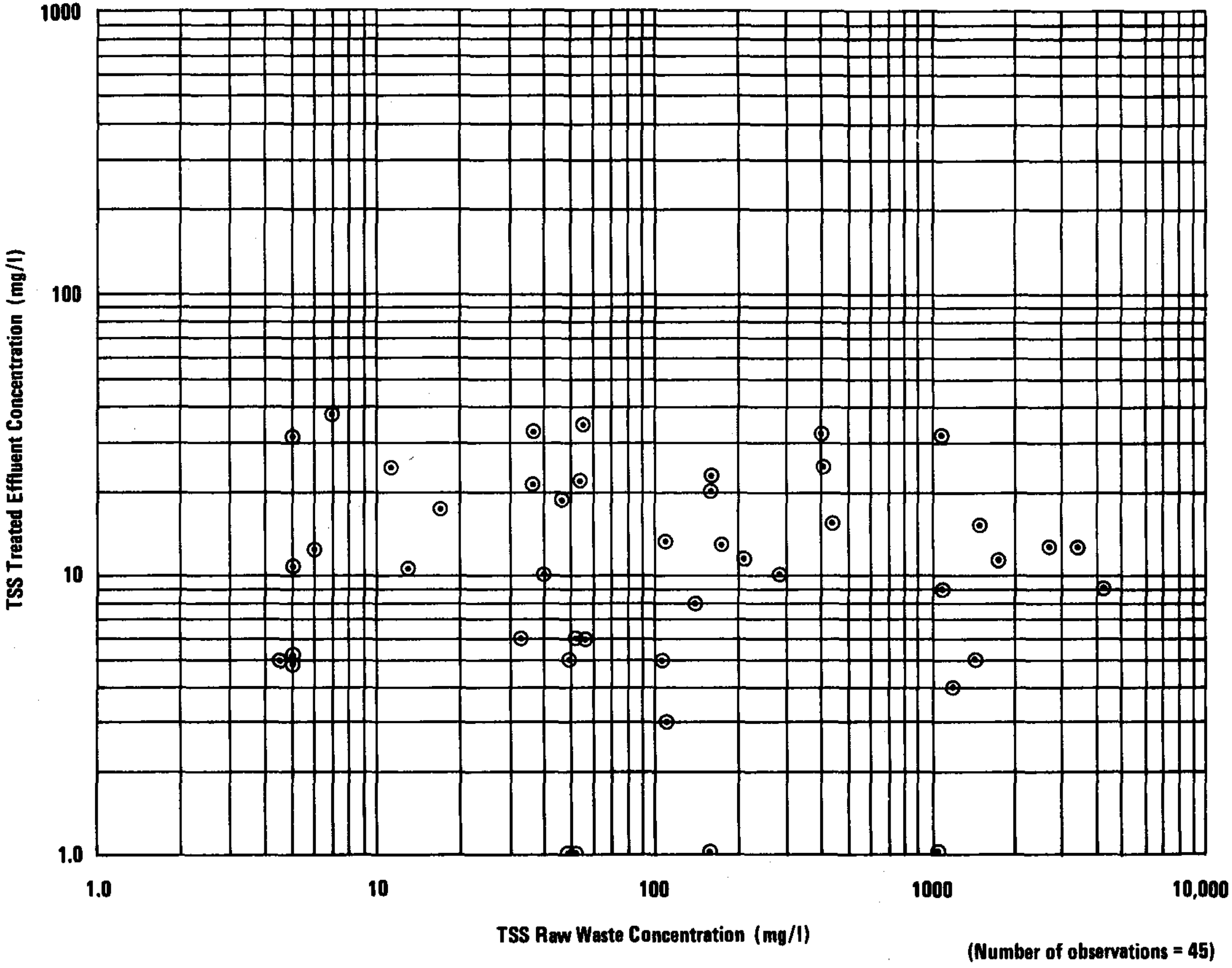


FIGURE VII-19
HYDROXIDE PRECIPITATION SEDIMENTATION EFFECTIVENESS
TSS

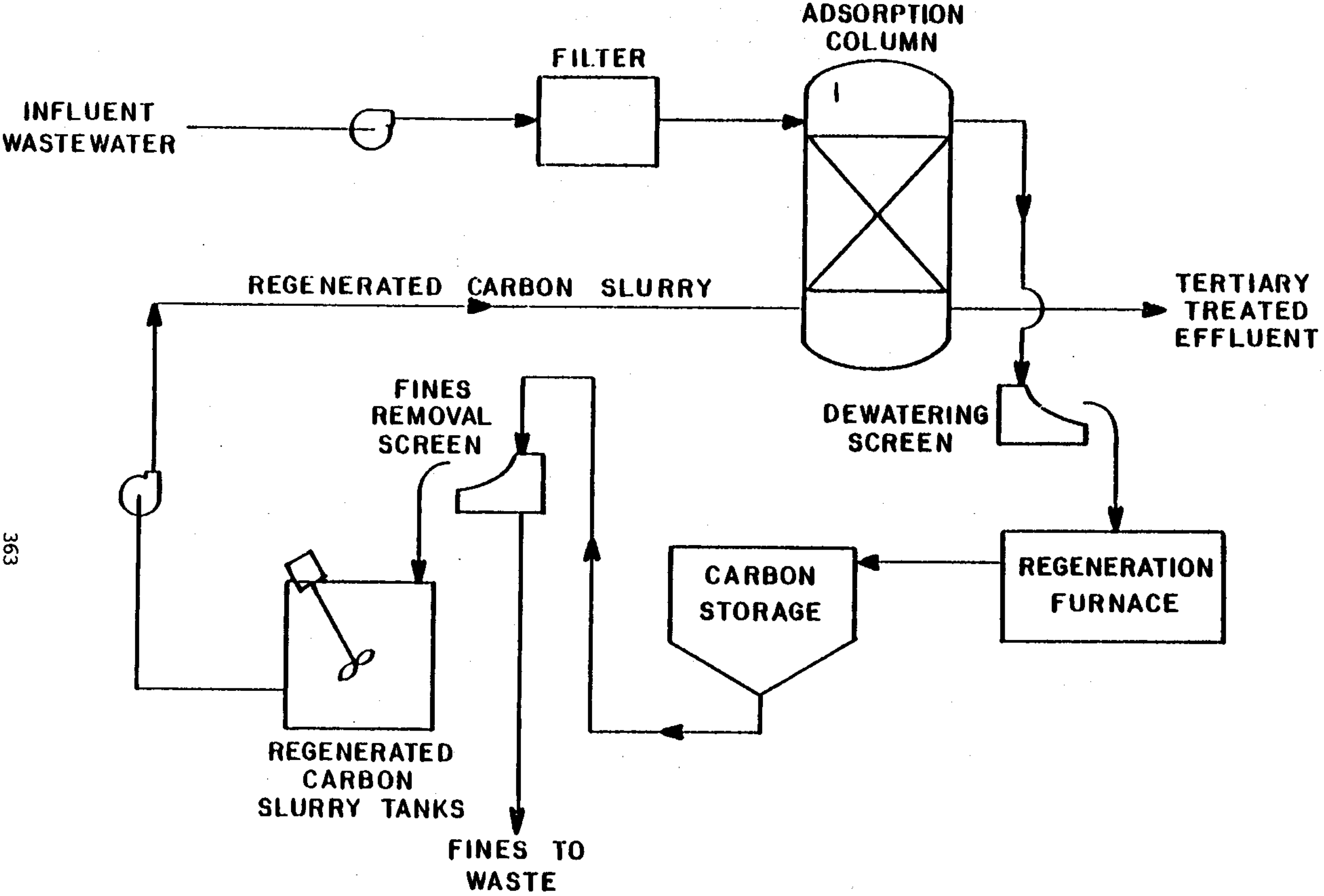


Figure VII-20

FLOW DIAGRAM OF ACTIVATED CARBON ADSORPTION WITH REGENERATION

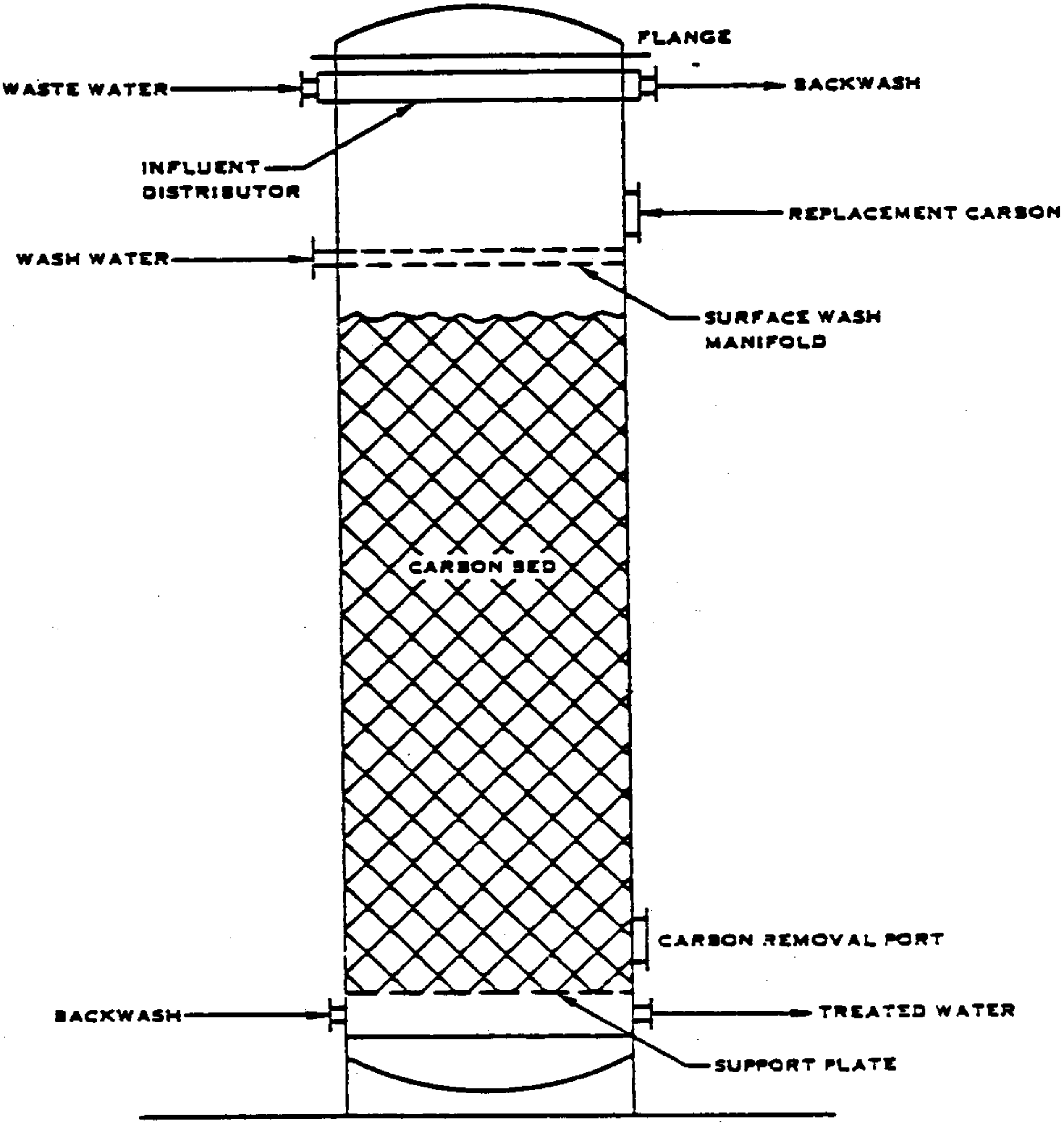


Figure VII-21

ACTIVATED CARBON ADSORPTION COLUMN

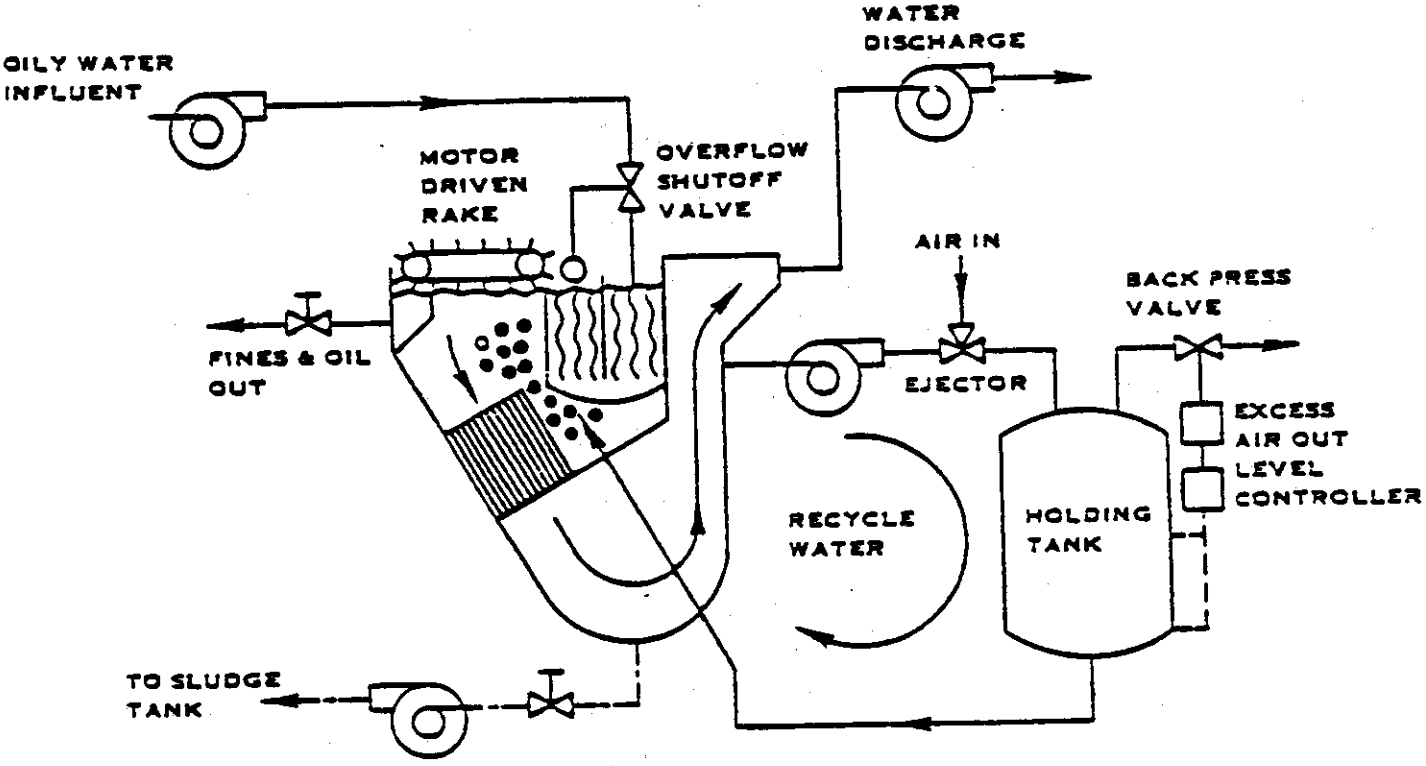


Figure VII-22

DISSOLVED AIR FLOTATION

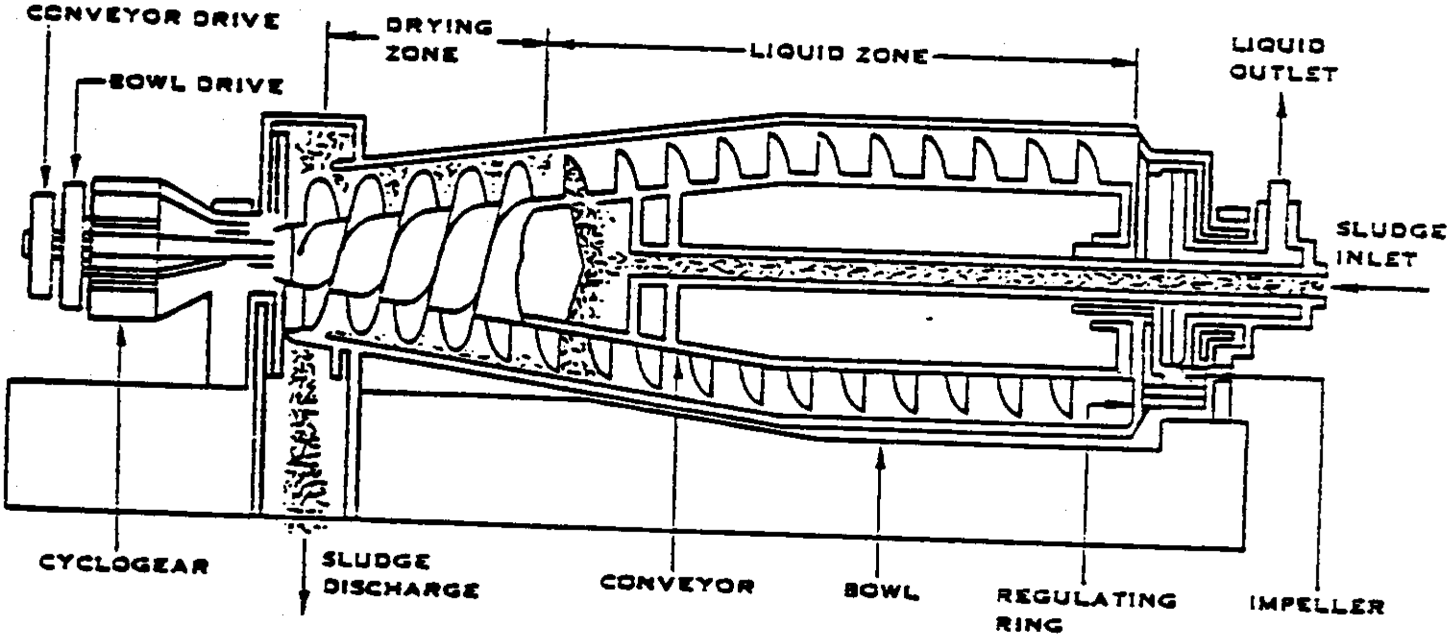
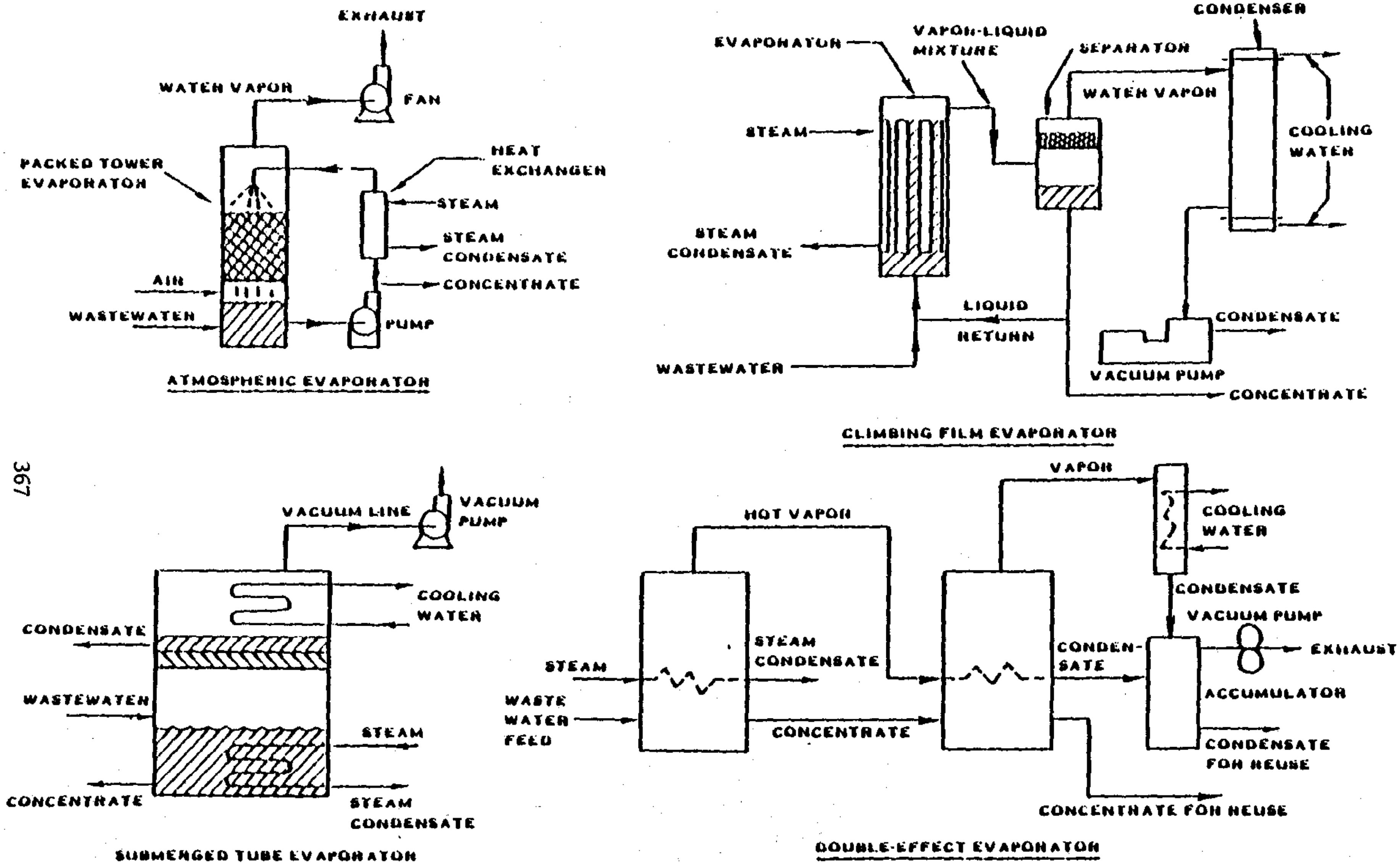


Figure VII-23

CENTRIFUGATION



ATMOSPHERIC EVAPORATOR

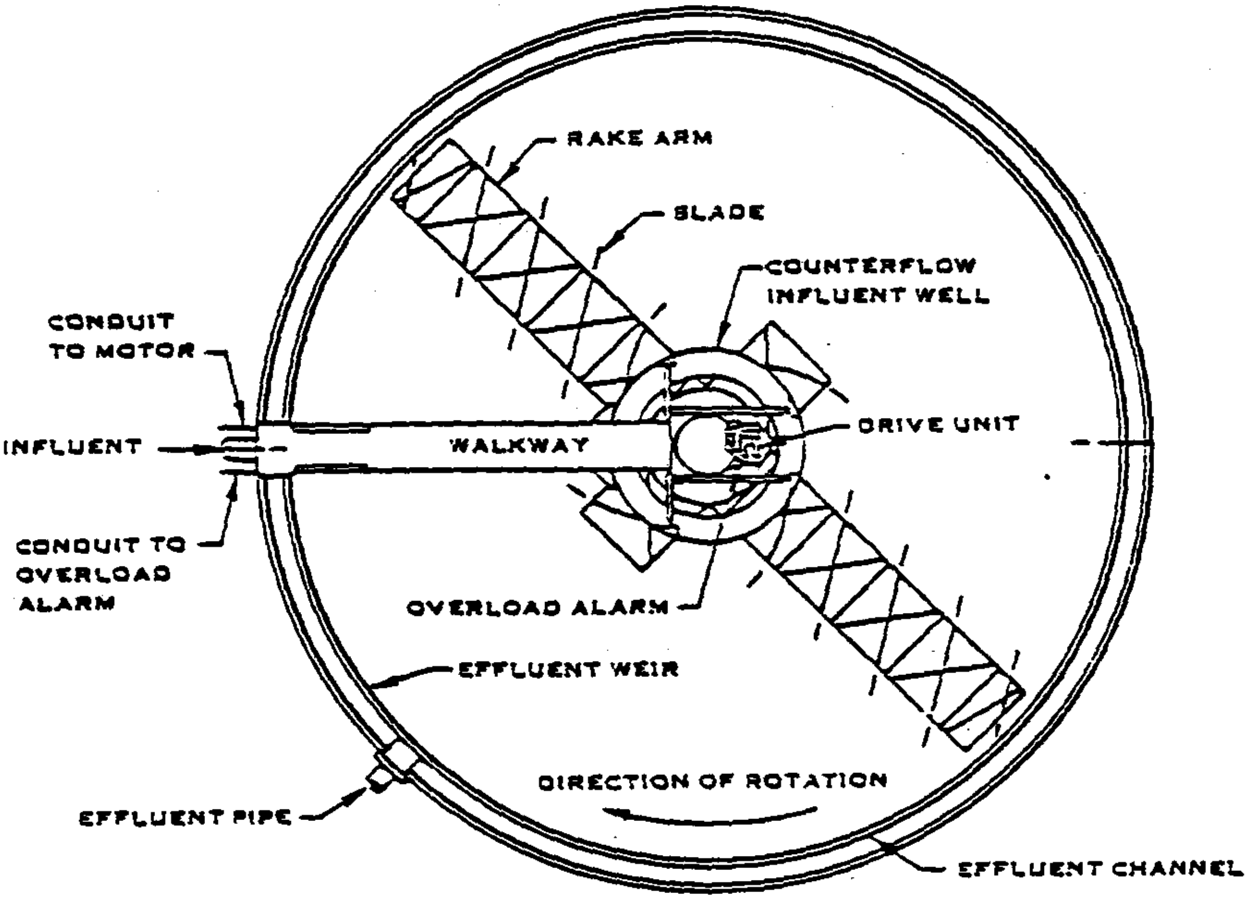
CLIMBING FILM EVAPORATOR

SUBMERGED TUBE EVAPORATOR

DOUBLE-EFFECT EVAPORATOR

Figure VII-24

TYPES OF EVAPORATION EQUIPMENT



PLAN

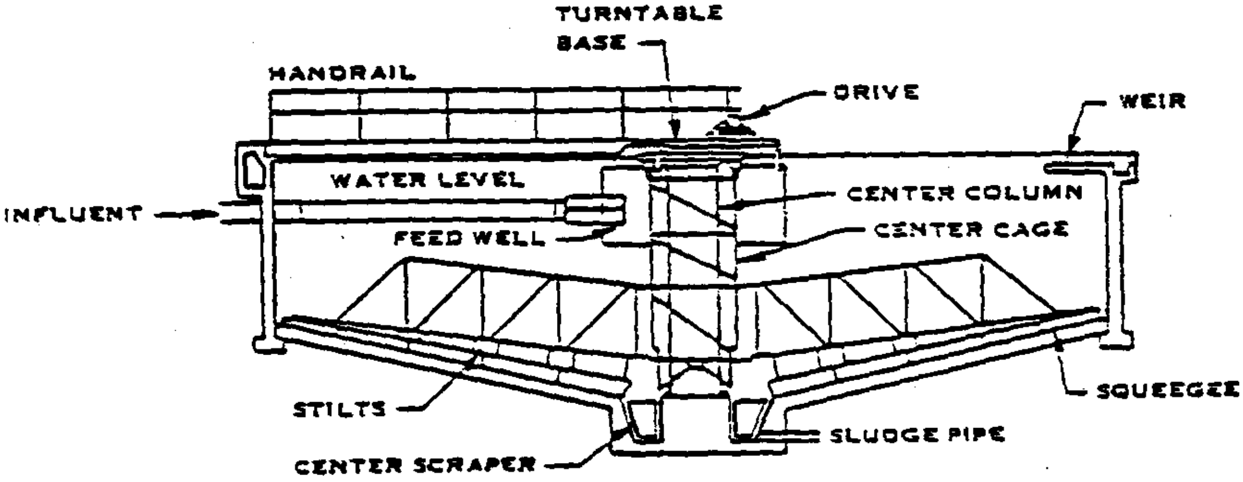


Figure VII-25

GRAVITY THICKENING

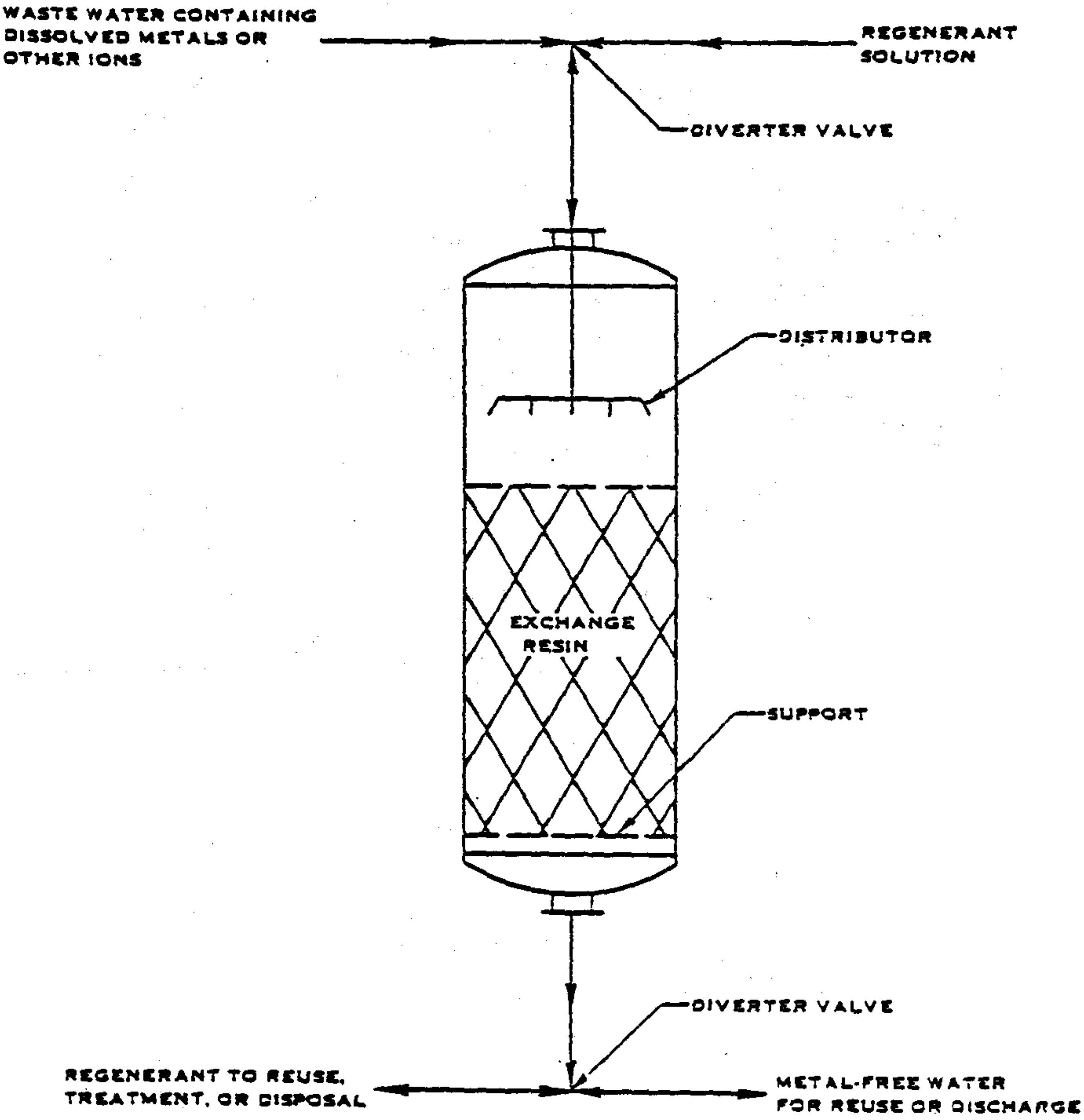


Figure VII-26

ION EXCHANGE WITH REGENERATION

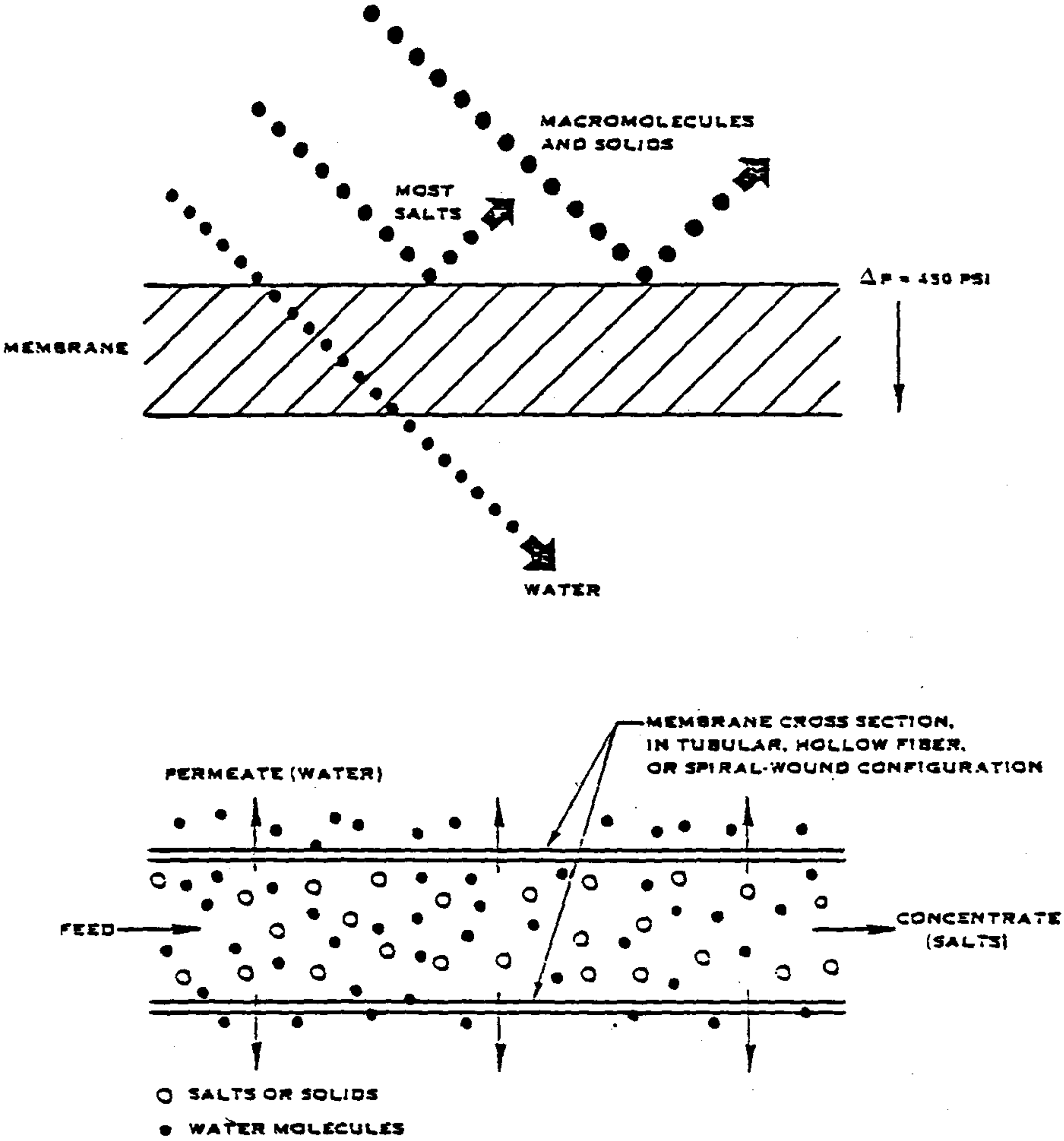
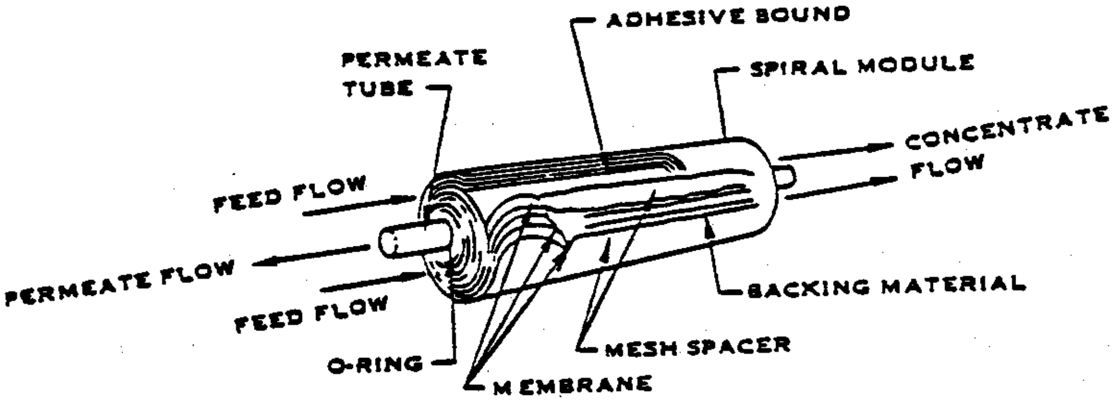
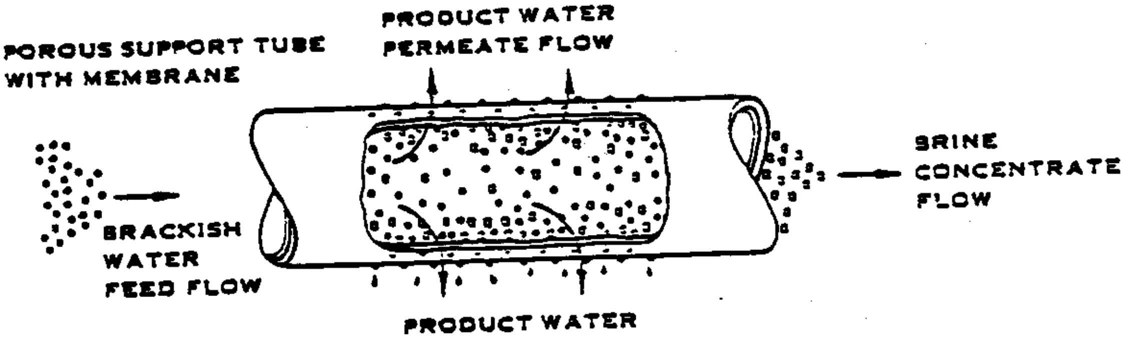


Figure VII-27

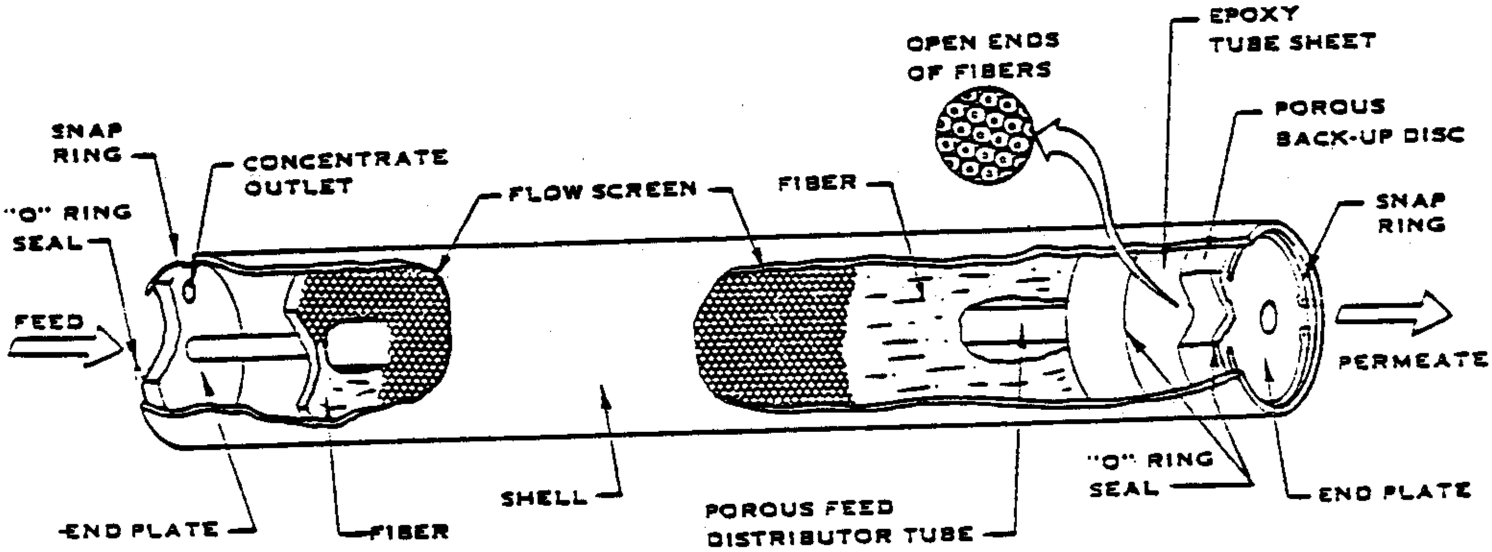
SIMPLIFIED REVERSE OSMOSIS SCHEMATIC



SPIRAL MEMBRANE MODULE



TUBULAR REVERSE OSMOSIS MODULE



HOLLOW FIBER MODULE

Figure VII-28

REVERSE OSMOSIS MEMBRANE CONFIGURATIONS

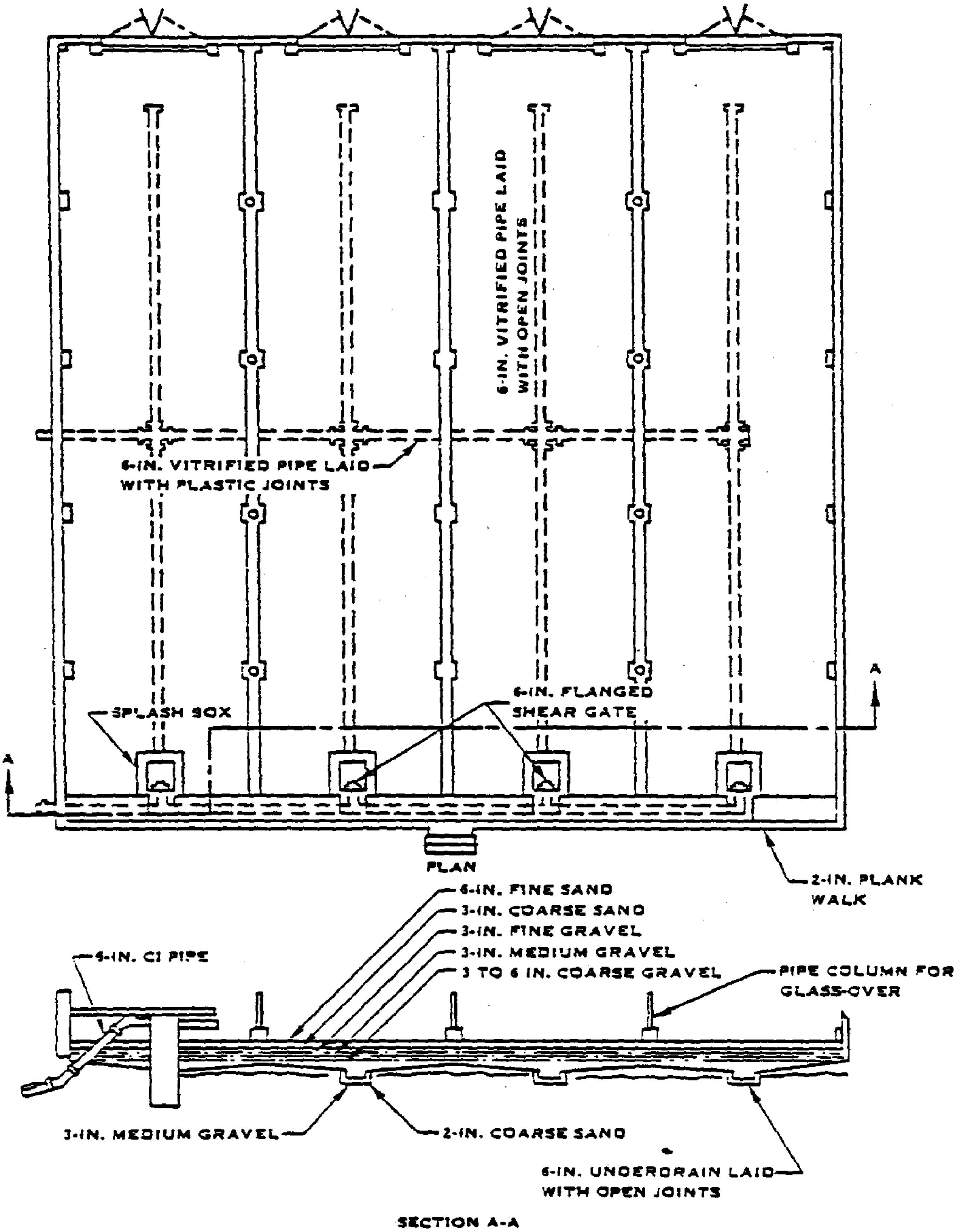


Figure VII-29

SLUDGE DRYING BED

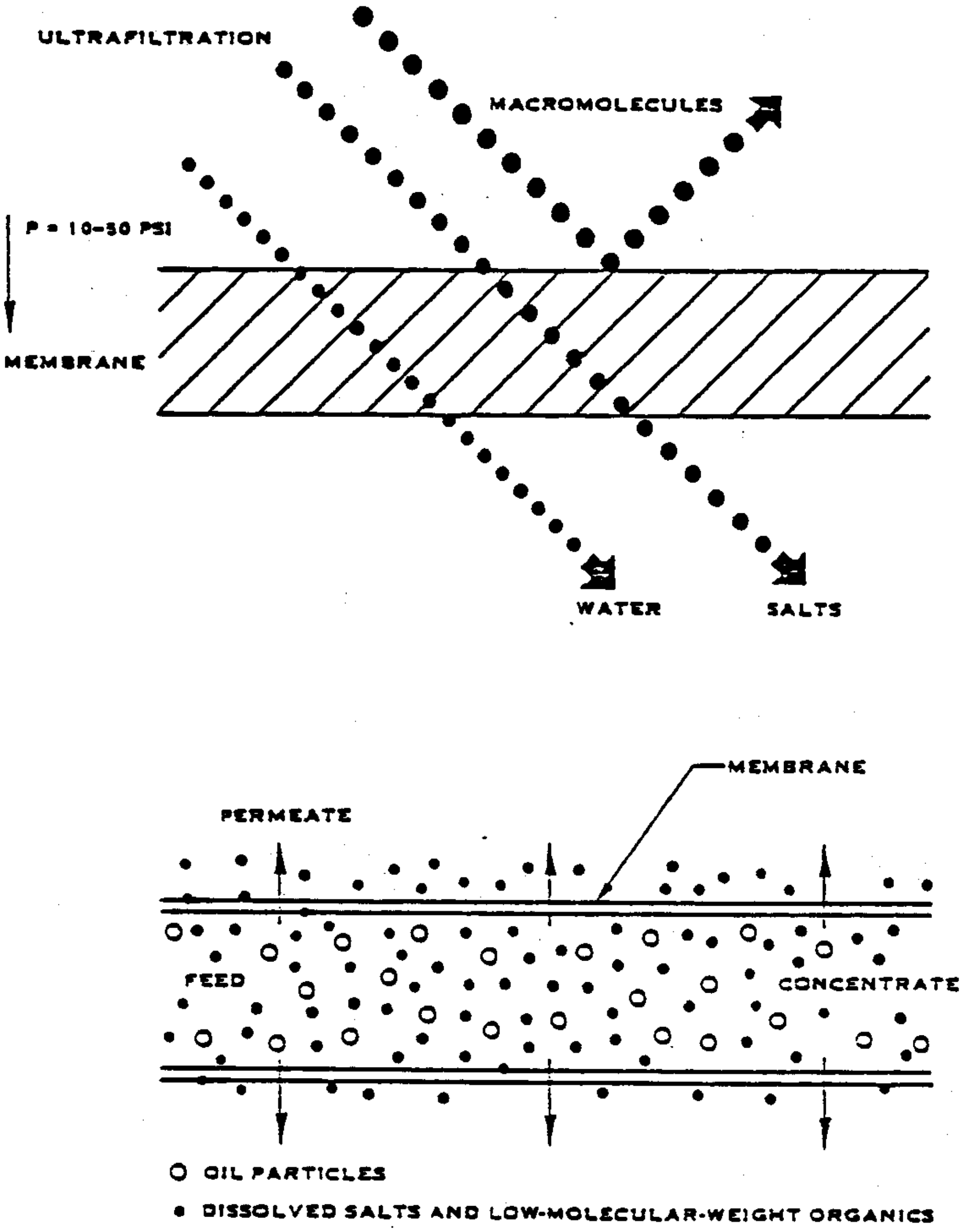


Figure VII-30

SIMPLIFIED ULTRAFILTRATION FLOW SCHEMATIC

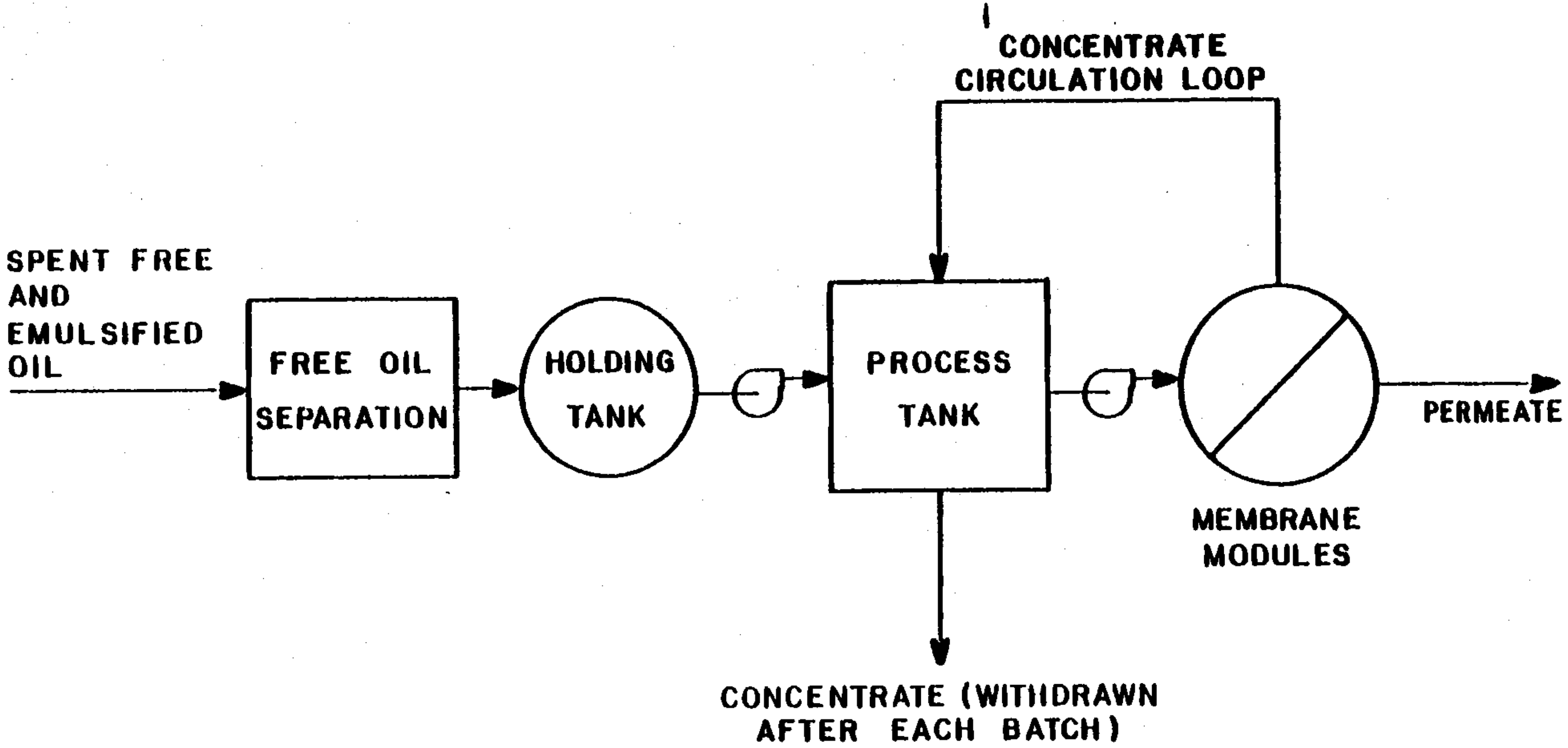


Figure VII-31

FLOW DIAGRAM FOR A BATCH TREATMENT ULTRAFILTRATION SYSTEM

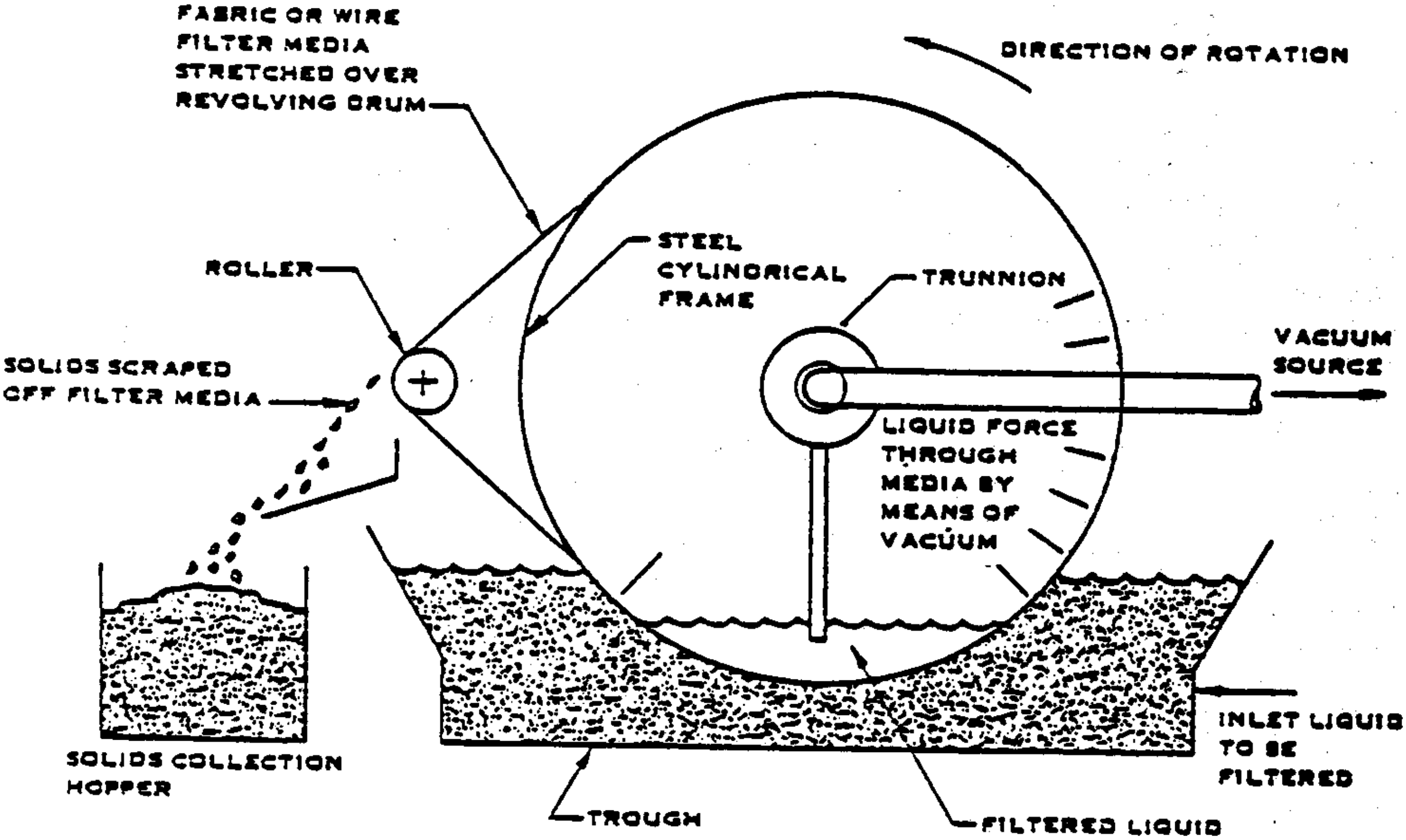


Figure VII-32

VACUUM FILTRATION

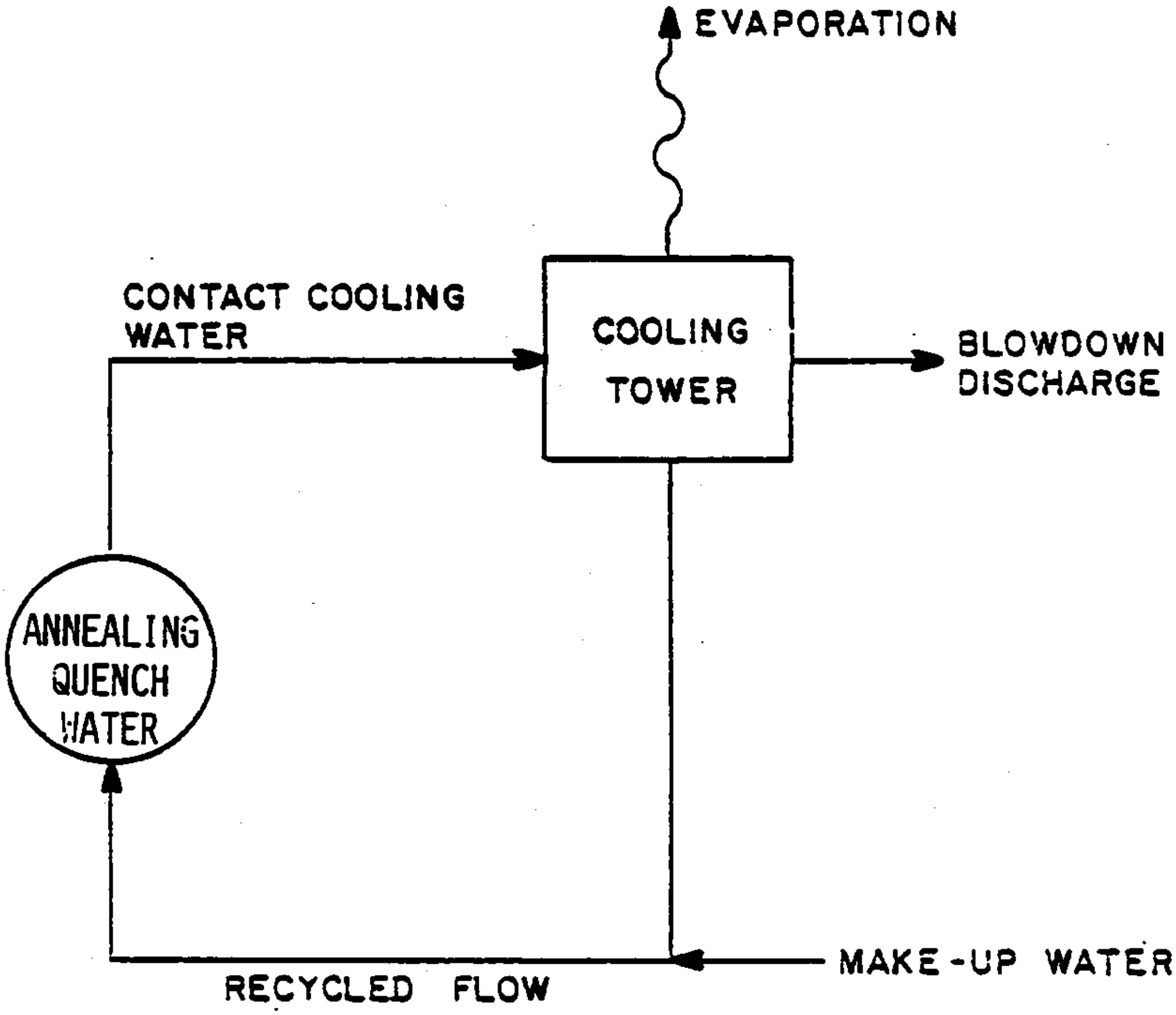


Figure VII-33

FLOW DIAGRAM FOR RECYCLING WITH A COOLING TOWER

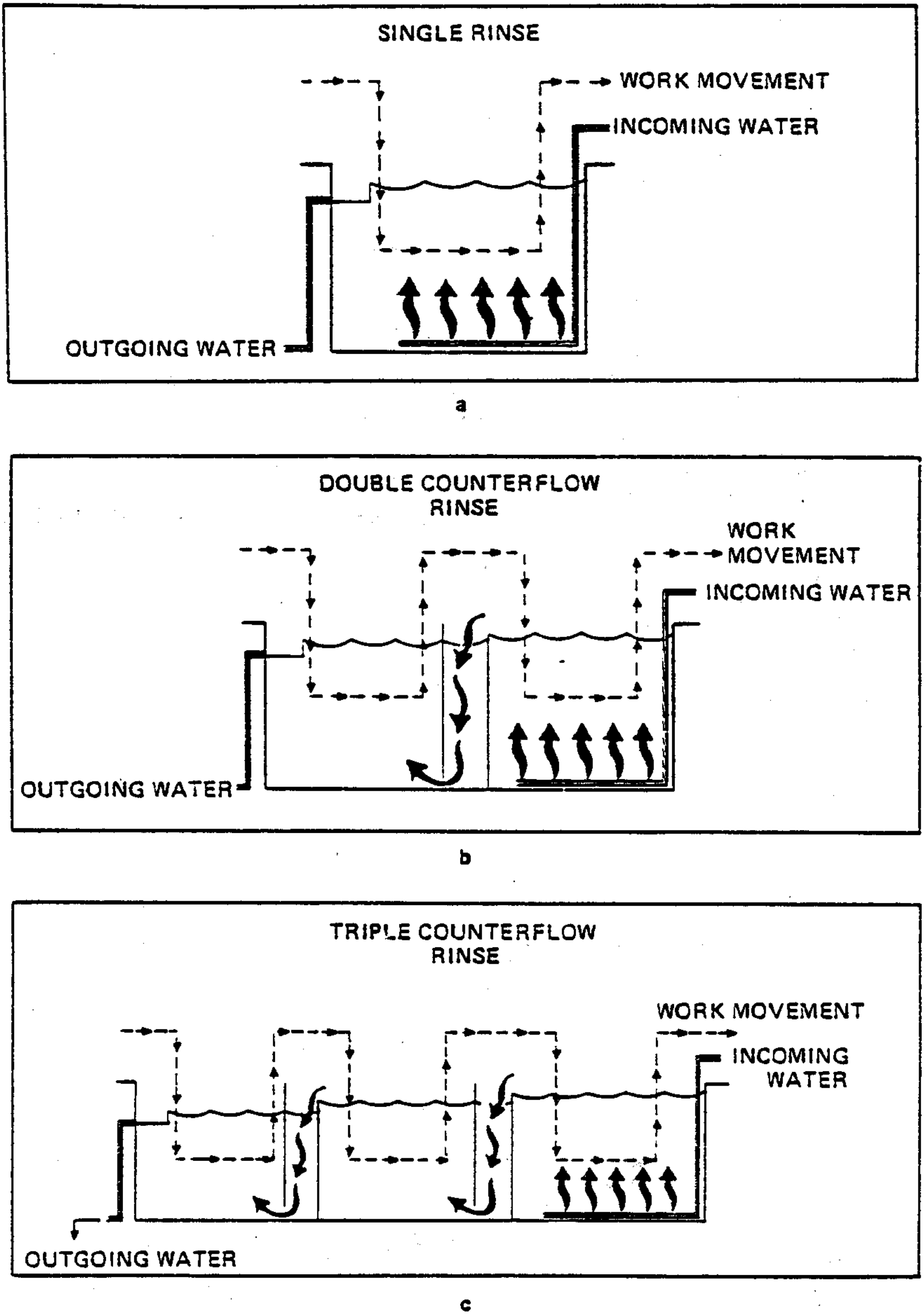


Figure VII-34

COUNTER CURRENT RINSING (TANKS)

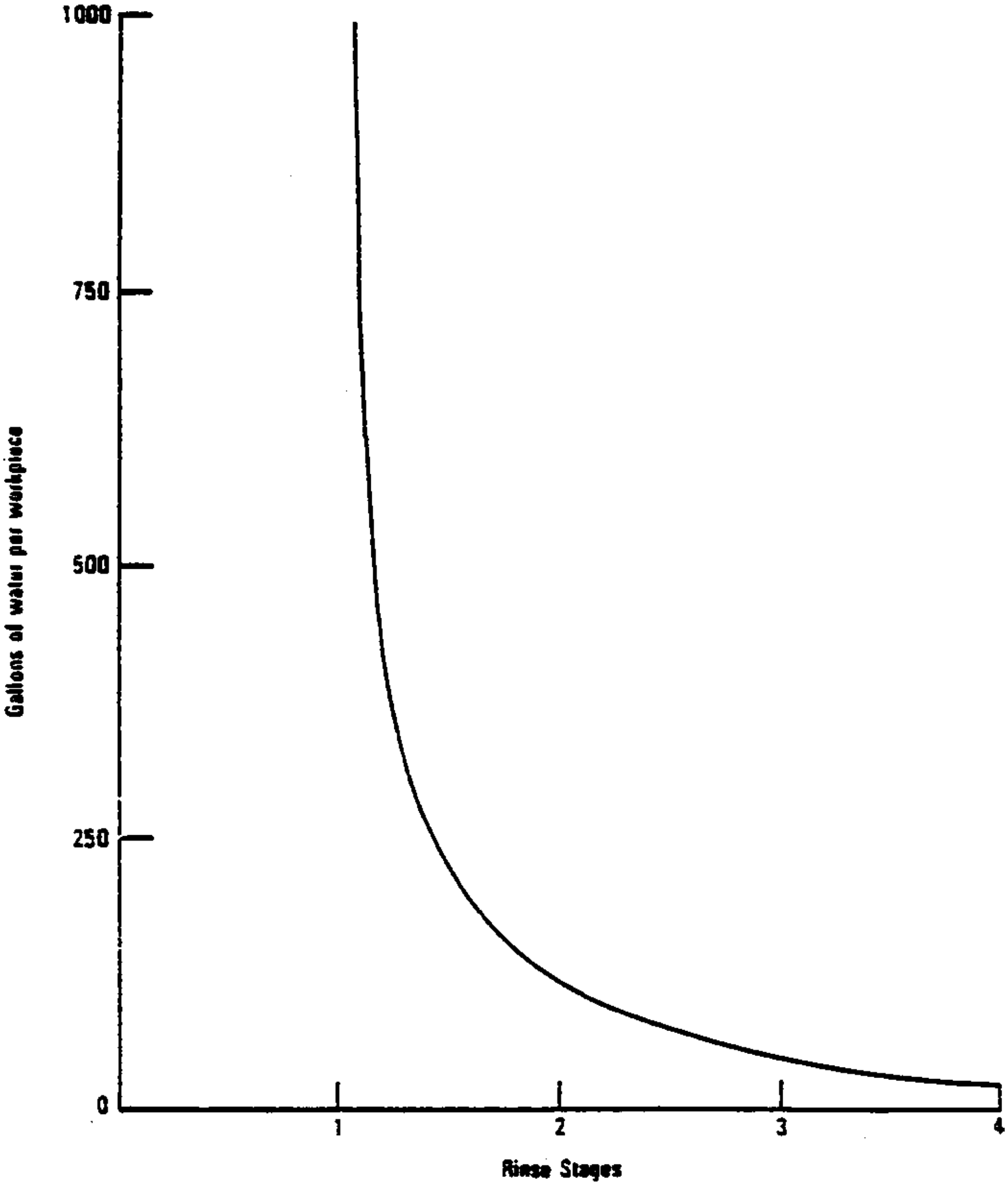


Figure VII-35

EFFECT OF ADDED RINSE STAGES ON WATER USE

SECTION VIII

COST OF WASTEWATER TREATMENT AND CONTROL

This section presents estimates of the costs of implementing the major wastewater treatment and control technologies described in Section VII. These cost estimates, together with the estimated pollutant reduction performance for each treatment and control option presented in Sections IX, X, XI, and XII, provide a basis for evaluating the options presented and identification of the best practicable technology currently available (BPT), best available technology economically achievable (BAT), best demonstrated technology (BDT), and the appropriate technology for pretreatment. The cost estimates also provide the basis for determining the probable economic impact on the copper forming category of regulation at different pollutant discharge levels. In addition, this section addresses nonwater quality environmental impacts of wastewater treatment and control alternatives, including air pollution, solid wastes, and energy requirements.

The first part of this section describes the general methodology used to estimate compliance costs including representative plant selection and the projection of the costs to the entire copper forming industry. In the second part, the general assumptions and terminology used in determining the costs are discussed. The third part describes the computer model which was used to estimate the costs generated since proposal. The fourth part describes in detail the individual treatment technology modules. In the fifth part, estimates for each of the five Treatment and Control Options are discussed. Next, normal plant costs are presented and discussed. Finally, energy requirements and nonwater quality aspects of the regulation are considered.

COST ESTIMATING METHODOLOGY

Estimates of the costs that plants would incur to comply with the various treatment options were determined in the following manner: first, a representative population of plants was chosen, considering such factors as production, wastewater flows, number and type of operations, treatment in place, and discharge status. Costs for these plants were then determined with the aid of a computer model. The sum of these costs was multiplied by the ratio of the total number of plants in the industry to the number of plants in the representative population to obtain the estimated cost impact on the entire industry.

The plants that were used for cost estimation were selected to represent the characteristics of the total population of plants in the copper forming category in terms of number and type of manufacturing operations present, wastewater treatment in place, and production. In the copper forming category, 55 percent of the direct dischargers and 52 percent of the indirect dischargers practice only one major forming operation. In comparison, 57 percent of the direct dischargers and 58 percent of the indirect dischargers chosen for cost estimation practice only one forming operation. A comparison of the distribution of the number of operations throughout the copper forming category with that of the costed plants is presented in Table VIII-1.

The costed plants were also chosen so that the percentage of plants in the costed group performing each operation approximated the percentage of plants in industry performing that operation. For example, 30 percent of the direct dischargers in the copper forming industry perform hot rolling; 29 percent of the direct dischargers in the costed group perform hot rolling. The costed plants were also chosen so that their wastewater treatment in place was representative of the copper forming industry. Plants were divided into three categories with respect to the amount of treatment they have in place: 'None' (no treatment at all); 'Some' (lime and settle, with or without oil skimming); and 'Extensive' (lime and settle and two or more additional treatment steps). The percentage of plants from the costed group that fits into each category approximates the percentage of plants from industry that fits into each category. Table VIII-1 presents a detailed comparison of industry and the costed group. In addition, the range of production among the costed plants (9 kkg to 180,000 kkg annually) approximates the range of production of plants in the copper forming category.

Eight of the 12 plants that were visited and sampled as part of the data gathering effort were chosen for costing because they are representative of plants in the category in terms of treatment costs. While the remaining four sampled plants provide wastewater characterization data which were representative of the major forming and ancillary operations found in the category, they were not used to determine treatment costs. The inclusion of these plants would have skewed the sample population towards plants with multiple forming operations. Accordingly, several non-sampled plants which practice single forming operations were selected for costing. The plants selected for costing represent a population comprised of approximately 54 percent single forming operation plants and approximately 46 percent multiple forming operation plants. As previously discussed, this distribution approximates the makeup of dischargers in the category.

Costs were determined for 14 direct dischargers. For each plant, a wastewater treatment system which accounted for any required treatment already in place was designed for each technology option. The computer model then performed a detailed treatment system design and costed any additional equipment required for the system. The model also estimated the annual cost of operating and maintaining the treatment system.

The costs for the 14 direct dischargers were then added, and the sum was multiplied by 37/14, which is the ratio of the total number of direct dischargers in the category (37) to the number of plants selected for costing (14).

A similar approach was taken for indirect dischargers. Costs were determined for 17 indirect dischargers. The sum of these 17 cost estimates was multiplied by 45/17, which is the ratio of the total number of indirect dischargers in the copper forming category (45) to the number of indirect dischargers selected for costing (17).

DETERMINATION OF COSTS

Sources of Cost Data

Capital and annual cost data for the selected treatment processes were obtained from three sources: (1) equipment manufacturers, (2) literature data, and (3) cost data from existing plants. The major source of equipment costs was contacts with equipment vendors, while the majority of annual cost information was obtained from the literature. Additional cost and design data were obtained from data collection portfolios when possible.

Components of Costs

Capital Costs

Capital costs consist of two components: equipment capital costs and system capital costs. Equipment costs include: (1) the purchase price of the manufactured equipment and any accessories assumed to be necessary; (2) delivery charges, which account for the cost of shipping the purchased equipment a distance of 500 miles; and (3) installation, which includes labor, excavation, site work, and materials. The correlating equations used to generate equipment costs are shown in Table VIII-2.

Capital system costs include contingency, engineering, and contractor's fees. These system costs, each expressed as a percentage of the equipment cost, are combined into a factor which is multiplied by the equipment cost to yield the total capital investment. The components of the total capital investment are listed in Table VIII-3.

Annual Costs

The total annualized costs also consist of a direct and a system component. The components of the total annualized costs are listed in Table VIII-4. Direct annual costs include the following:

- Raw materials - These costs are for chemicals used in the treatment processes, which include lime, sulfuric acid, alum, polyelectrolyte, and sulfur dioxide.
- Operating labor and materials - These costs account for the labor and materials directly associated with operation of the process equipment. Labor requirements are estimated in terms of manhours per year. A labor rate of 21 dollars per manhour was used to convert the manhour requirements into an annual cost. This composite labor rate included a base labor rate of nine dollars per hour for skilled labor, 15 percent of the base labor rate for supervision and plant overhead at 100 percent of the total labor rate. Nine dollars per hour is the Bureau of Labor national wage rate for skilled labor.
- Maintenance and repair - These costs account for the labor and materials required for repair and routine maintenance of the equipment. Maintenance and repair costs were usually assumed to be 5 percent of the direct capital costs based on information from literature sources unless more reliable data could be obtained from vendors.
- Energy - Energy, or power, costs are calculated based on total nominal horsepower requirements (in kw-hrs), an electricity charge of $.0483/kilowatt-hour and an operating schedule of 24 hours/day, 250 days/year unless specified otherwise. The electricity charge rate (March 1982) is based on the industrial cost derived from the Department of Energy's Monthly Energy Review.

System annual costs include monitoring, insurance and amortization (which is the major component). Monitoring refers to the periodic sampling analysis of wastewater to ensure that discharge limitations are being met. The annual cost of monitoring was calculated using an analytical lab fee of $120 per wastewater sample and a sampling frequency based on the wastewater discharge rate, as shown in Table VIII-5.

Insurance cost is assumed to be one percent of the total depreciable capital investment (see Item 23 of Table VIII-3). Amortization costs, which account for depreciation and the cost of financing, were calculated using a capital recovery factor (CRF).

A CRF value of 0.22 was used, which is multiplied by the total capital investment (see Item 24 of Table VIII-4) to give the annual amortization cost. Detailed information regarding the CRF is provided in Appendix 2A to the Economic Impact Analysis for the Effluent Standards and Limitations for the Copper Forming Point Source Category.

Cost Update Factors

All costs are standardized by adjusting to the first quarter of 1982. The cost indices used for particular components of costs are described below.

Capital Investment - Investment costs were adjusted using the EPA-Sewage Treatment Plant Construction Cost Index. The value of this index for March 1982 is 414.0.

Operation and Maintenance Labor - The Engineering News-Record Skilled Labor Wage Index is used to adjust the portion of Operation and Maintenance costs attributable to labor. The March 1982 value is 325.0.

Maintenance Materials - The producer price index published by the Department of Labor, Bureau of Statistics is used. The March 1982 value of this index is 276.5.

Chemicals - The Chemical Engineering Producer Price Index for industrial chemicals is used. This index is published biweekly in *Chemical Engineering* magazine. The March 1982 value of this index is 362.6.

Energy - Power costs are adjusted by using the price of electricity on the desired date and multiplying it by the energy requirements for the treatment module in kw-hr equivalents.

COST ESTIMATION MODEL

Cost estimation was accomplished using a computer model which accepts inputs specifying the required treatment system chemical characteristics of the raw waste streams, flow rates and treatment system entry points of these streams, and operating schedules. This model utilizes a computer-aided design of a wastewater treatment system containing modules that are configured to reflect the appropriate equipment at an individual plant. The model designs each treatment module and then executes a costing routine that contains the cost data for each module. The capital and annual costs from the costing routine are combined with capital and annual costs for the other modules to yield the total costs for that regulatory option. The process is repeated for each regulatory option.

Each module was developed by coupling theoretical design information from the technical literature with actual design data from operating plants. This permits the most representative design approach possible to be used, which is a very important element in accurately estimating costs. The fundamental units for design and costing are not the modules themselves but the components within each module, e.g., the lime feed system within the chemical precipitation module. This is a significant feature of this model for two reasons. First, it does not limit the model to certain fixed relationships between various components of each module. For instance, cost data for chemical precipitation systems are typically presented graphically as a family of curves with lime (or other alkali) dosage as a parametric function. The model, however, sizes the lime feed system as a funtion of the required mass addition rate (kg/hr) of lime. The model thus selects a feed system specifically designed for that plant. Second, this approach more closely reflects the way a plant would actually design and purchase its equipment. The resulting costs are thus closer to the actual costs that would be incurred by the facility.

Overall Structure

The cost estimation model consists of two main parts: a design portion and a costing portion. The design portion uses input provided by the user to calculate design parameters for each module included in the treatment system. The design parameters are then used as input to the costing routine, which contains cost equations for each discrete component in the system. The structure of the program is such that the entire system is designed before any costs are estimated.

The pollutants or parameters which are tracked by the model are shown in Table VIII-6.

An overall logic diagram of the computer programs is depicted in Figure VIII-1. First, constants are initialized and certain variables such as the modules to be included, the system configuration, plant and wastewater flows, compositions, and entry points are specified by the user. Each module is designed utilizing the flow and composition data for influent streams. The design values are transmitted to the cost routine. The appropriate cost equations are applied, and the module costs and system costs are computed. Figures VIII-2 and VIII-3 depict the logic flow diagrams in more detail for the two major segments of the program.

System Input Data

Several data inputs are required to run the computer model. First, the treatment modules to be costed and their sequence must be specified. Next, information on hours of operation per day and number of days of operation per year is required. The flow values and characteristics must be specified for each wastewater stream entering the treatment system, as well as each stream's point of entry into the wastewater treatment system. These values will dictate the size and other parameters of equipment to be costed. The derivation of each of these inputs for costed plants in the copper forming category will be discussed in turn.

Choice of the appropriate modules and their sequence for a plant that is to be costed are determined by applying the treatment technology for each option (see Figures X-1 through X-5 pp. 465-469). These option diagrams were adjusted to accurately reflect the treatment system that the plant being costed would actually require. For example, if it were determined by examining a plant's dcp that sodium bichromate was not used in the plants pickling operation, then a chromium reduction module would not be included in the treatment required for that plant. In addition, if a plant had a particular treatment module in place, that module would not be costed. Flow reduction modules were not costed for plants whose waste stream flow rates were already lower than the regulatory flows. The information on hours of operation per day and days of operation per year was obtained from the data collection portfolio of the plant being costed.

The flow used to size the treatment equipment was derived as follows: production and flow information was obtained from the plant's dcp, or from sampling data where possible, and a production normalized flow in liters per kkg was calculated for each waste stream. This flow was compared to the regulatory flow, also in liters per kkg, and the lower of the two flows was used to size the treatment equipment. Regulatory flow was also assigned to any stream for which production or flow data was not reported in the dcp. The average raw waste concentrations of the sampled plants were used as raw waste values for all costed plants.

Model Results

For a given plant, the model will generate comprehensive material balances for each parameter (pollutant, temperature and flowrate) tracked at any point in the system. It will also summarize design values for key equipment in each treatment module, and provide a tabulation of costs for each piece of equipment in each module, module subtotals, total equipment costs, and system capital and annual costs.

COST ESTIMATES FOR INDIVIDUAL TREATMENT TECHNOLOGIES

Introduction

Treatment technologies have been selected from among the larger set of available alternatives discussed in Section VII after considering such factors as raw waste characteristics, typical plant characteristics (e.g., location, production schedules, product mix, and land availability), and present treatment practices. Specific rationale for selection is addressed in Sections IX, X, XI, and XII. Cost estimates for each technology addressed in this section include investment costs and annual costs for depreciation, capital, operation and maintenance, and energy.

The basic cost data came from several sources. Some of the data were obtained during on-site surveys. The majority of the cost data were obtained through discussions with waste treatment equipment manufacturers.

The specific assumptions for each wastewater treatment module are listed under the subheadings to follow. Costs are presented as a function of influent wastewater flow rate except where noted in the process assumptions.

Costs are presented for the following control and treatment technologies:

- Lime Precipitation and Gravity Settling,
- Vacuum Filtration,
- Multimedia Filtration,
- Chemical Emulsion Breaking,
- Oil Skimming,
- Chromium Reduction,
- Recycle-Cooling,
- Spray Rinsing and Recirculation of the Rinse Water,
- Countercurrent Cascade Rinsing, and
- Contract Hauling.

Lime Precipitation and Gravity Settling

Precipitation using lime followed by gravity settling is a fundamental technology for metals removal. In practice, either quicklime (CaO) or hydrated lime ($Ca(OH)_2$) can be used to precipitate toxic and other metals. Hydrated lime is more economical for low lime requirements since the use of slakers, which are necessary for quicklime usage, are practical only for large-volume application of lime.

Lime is used to adjust the pH of the influent waste stream to a value of approximately 9, at which optimum precipitation of the metals is assumed to occur (see Section VII, page 243), and to react with the metals to form metal hydroxides. The lime dosage is calculated as a theoretical stoichiometric requirement based on the influent metals concentrations and pH. The actual lime dosage requirement is obtained by assuming an excess of 10 percent of the theoretical lime dosage. The effluent concentrations are based on the Agency's combined metals data base lime precipitation treatment effectiveness values.

The costs of lime precipitation and gravity settling were based on one of three operation modes, depending on the influent flowrate: continuous, normal batch, and "low flow" batch. The use of a particular mode for costing purposes was determined on a least (total annualized) cost basis for a given flowrate. The economic breakpoint between continuous and normal batch was estimated to be 11,800 liters/hour. Below 2,000 liters/hour, it was found that the "low flow" batch system was most economical (Figure VIII-4).

For a continuous operation, the following equipment were included in the determination of capital and annual costs:

- Lime feed system (continuous)
    1. Storage units (sized for 30-day storage)
    2. Slurry mix tank (5 minute retention time)
    3. Feed pumps
    4. Instrumentation (pH control)
- Polymer feed system
    1. Storage hopper
    2. Chemical mix tank
    3. Chemical metering pump
- pH adjustment system
    1. Rapid mix tank, fiberglass (5 minute retention time)
    2. Agitator (velocity gradient is 300/second)
    3. Control system
- Gravity settling system
    1. Clarifier, circular, steel (overflow rate is 0.347 gpm/sq. ft., underflow solids is 3 percent)

2. Sludge pumps (1), (to transfer flow to and from clarifier)

Ten percent of the clarifier underflow stream is recycled to the pH adjustment tank to serve as seed material for the incoming waste stream.

The direct capital costs of the lime and polymer feed were based on the respective chemical feed rates (dry lbs/hour), which are dependent on the influent waste stream characteristics. The flexibility of this feature (i.e., costs are independent of other module components) was previously noted in the description of the cost estimation model. The remaining equipment costs (e.g., for tanks, agitators, pumps) were developed as a function of the influent flowrate (either directly or indirectly, when coupled with the design assumptions).

Direct annual costs for the continuous system include operating and maintenance labor for the feed systems and the clarifier, the cost of lime and polymer, maintenance materials and energy costs required to run the agitators and pumps.

The normal batch treatment system (used for 2,000 liters/hour< flow < 11,800 liters/hour) consists of the following equipment:

- Lime feed system (batch)

  1. Slurry tank (5 minute retention time)
  2. Agitator
  3. Feed pump

- Polymer feed system

  1. Chemical mix tank
  2. Agitator
  3. Chemical metering pump

- pH adjustment system

  1. Reaction tanks, (2), (8 hour retention time each)
  2. Agitators (2), (velocity gradient is 300/second)
  3. Sludge pumps (1), (to transfer sludge to dewatering)
  4. pH control system

The reaction tanks used in pH adjustment are sized to hold the wastewater volume accumulated for one batch period (assumed to be 8 hours). The tanks are arranged in a parallel setup so that treatment occurs in one tank while wastewater is accumulating in the other tank. A separate gravity settler is not necessary since settling will occur in the reaction tank after precipitation has taken place. The settled sludge is then pumped to the dewatering stage.

If additional tank capacity is required in the pH adjustment system in excess of 25,000 gallons (largest single fiberglass tank capacity for which cost data were compiled), additional tanks are added in pairs. A sludge pump and agitator are costed for each tank.

The cost of operating labor is the major component of the direct annual costs for the normal batch system. For operation of the batch lime feed system, labor requirements range from 15 to 60 minutes per batch, depending on the lime feed rate (5 to 1,000 pounds/batch). This labor is associated with the manual addition of lime (stored in 50 pound bags). For pH adjustment, required labor is assumed to be one hour per batch (for pH control, sampling, valve operation, etc.). Both the pH adjustment tank and the lime feed system are assumed to require 52 hours per year (one hour/week) of maintenance labor. Labor requirements for the polymer feed system are approximately one hour/day, which accounts for manual addition of dry polymer and maintenance associated with the chemical feed pump and agitator.

Direct annual costs also include the cost of chemicals (lime, polymer) and energy required for the pumps and agitators. The costs of lime and polymer used in the model are $47.30/kkg of lime (43/ton) and $4.96/kg of polymer ($2.25/pound), based on rates obtained from the Chemical Weekly Reporter (lime) and quotations from vendors (polymer).

For small influent flowrates (less than 2,000 liters/hour) it is more economical on a total annualized cost basis to select the "low flow" batch treatment system. The lower flowrates allow an assumption of five days for the batch duration, or holdup, as opposed to eight hours for the normal batch system. However, whenever the total batch volume (based on a five day holdup) exceeds 25,000 gallons, the maximum single batch tank capacity, the holdup is decreased accordingly to maintain the batch volume under this level. Capital and annual costs for the low flow system are based on the following equipment:

- pH adjustment system

    1. Rapid mix/holdup tank (5 days or less retention time)
    2. Agitator
    3. Transfer pump

Only one tank is required for both holdup and treatment because treatment is assumed to be accomplished during non-operating hours (since the holdup time is much greater than the time required for treatment). A lime feed system is not costed since lime addition at low application rates can be assumed to be done manually by the operator. A common pump is used for transfer of both the supernatant and sludge through an appropriate valving arrangement. Addition of polymer was assumed to be unnecessary due to the extended settling time available.

As in the normal batch case, annual costs are comprised mainly of labor costs for the low flow batch system. Labor requirements are constant at 1.5 hours per batch for operation (e.g., pH control, sampling, etc.) and 52 hours per year (one hour per week) for maintenance. Labor is also required for the manual addition of lime directly to the batch tank, ranging from 0.25 to 1.5 hours per batch depending on the lime requirement (1 to 500 pounds per batch). Annual costs also include energy costs associated with the pump and agitator.

Vacuum Filtration

The underflow from the clarifier is routed to a rotary precoat vacuum filter, which dewaters the hydroxide sludge (it may also include calcium fluoride) to a cake of 20 percent dry solids. The dewatered sludge is disposed of by contract hauling and the filtrate is recycled to the rapid mix tank as seed material for sludge formation.

The capacity of the vacuum filter, expressed as square feet of filtration area, is based on a yield value of 14.6 kg of dry solids/hr per square meter of filter area (3 $lbs/hr/ft^2$), with a solids capture of 95 percent. It was assumed that the filter was operated 8 hours/day.

Cost data were compiled for vacuum filters ranging from .87 to 69.7 m^2 (9.4 to 750 ft^2) in filter surface area (Figure VIII-5). Based on an annualized cost comparison, it was assumed that it was more economical to directly contract haul clarifier underflow streams which were less than 42 l/hr (0.185 gpm), rather than dewater by vacuum filtration before hauling.

The capital costs for the vacuum filtration include the following:

- Vacuum filter with precoat but no sludge conditioning,
- Housing, and
- Influent transfer pump.

Housing the filter, which approximately doubles the capital cost of the module, is assumed to be required for this technology.

Operating labor cost is the major component of annual costs, which also include maintenance and energy costs.

Multimedia Filtration

Multimedia filtration is used as a wastewater treatment polishing device to remove suspended solids not removed in previous treatment processes. The filter beds consist of graded layers of gravel, coarse anthracite coal, and fine sand. The equipment used to determine capital and annual costs are as follows:

- Influent storage tank sized for one backwash volume;
- Gravity flow, vertical steel cylindrical filters with media (anthracite, sand, and garnet);
- Backwash tank sized for one backwash volume;
- Backwash pump to provide necessary flow and head for backwash operations;
- Influent transfer pump; and
- Piping, valves, and a control system.

The hydraulic loading rate is 7,335 lph/m^2 (180 gph/ft^2) and the backwash loading rate is 29,340 lph/m^2 (720 gph/ft^2). The filter is backwashed once per 24 hours for 10 minutes. The backwash volume is provided from the stored filtrate (see Figure VIII-6).

Effluent pollutant concentrations are based on the Agency's combined metals data base for treatability of pollutants by filtration technology.

Chemical Emulsion Breaking

Chemical emulsion breaking involves the separation of relatively stable oil-water mixtures by chemical addition. Alum, polymer, and sulfuric acid are commonly used to destabilize oil-water mixtures. In the determination of capital and annual costs based on continuous operation, 400 mg/l of alum and 2 mg/l of polymer are added to waste streams containing emulsified oil (see Figure VIII-7). The equipment included in the capital and annual costs for continuous chemical emulsion breaking are as follows:

- Alum and polymer feed systems:

  1. Storage units
  2. Dilution tanks
  3. Conveyors and chemical feed lines
  4. Chemical feed pumps

- Equalization tank (retention time of eight hours; agitator sized for .03 horsepower per 3,785 liter (1,000 gallon) capacity)

- Rapid mix tank (retention time of 15 minutes; mixer velocity gradient is 300/sec)

- Flocculation tank (retention time of 45 minutes; mixer velocity gradient is 100/sec)

- Pump

Following the flocculation tank, the stabilized oil-water mixture enters the oil skimming module. In the determination of capital and annual costs based on batch operation, sulfuric acid is added to waste streams containing emulsified oil until a pH of 3 is reached. The following equipment is included in the determination of capital and annual costs based on batch operation:

- Sulfuric acid feed systems
    1. SO_2 cost at $0.55/kg ($0.25 /lb),

    1. Storage tanks or drums
    2. Chemical feed lines
    3. Chemical feed pumps

- Two tanks equipped with agitators (retention time of 8 hrs., mixer velocity gradient is 300/sec)

- Two belt oil skimmers

- Two waste oil pumps

- Two effluent water pumps

- One waste oil storage tank (sized to retain the waste oil from ten batches)

The capital and annual costs for continuous and batch chemical emulsion breaking were determined by summing the costs from the above equipment. Alum, polymer and sulfuric acid costs were assumed to be $.257 per kg ($.118 per pound), $4.95 per kg ($2.25 per pound) and $0.08 per kg of 93 percent acid ($.037 per pound of 93 percent acid), respectively. (See Chemical Weekly Reporter, March, 1982).

Operation and maintenance and energy costs for the different types of equipment which comprise the batch and continuous systems were drawn from various literature sources and are included in the annual costs.

The cutoff flow for determining the operation mode (batch or continuous) is 5,000 liters per hour, above which the continuous system is costed; at lower flows, the batch system is costed.

Oil Skimming

Oil skimming refers to the separation of the de-emulsified oil-water mixture obtained from the continuous chemical emulsion breaking operation. This separation is accomplished with a coalescent plate-type separator (which is essentially an enhanced API-type oil-water separator). Coalescent plate separators were not required following batch chemical emulsion breaking since the batch tank, in conjunction with a belt type oil skimmer, served as the oil-water separation tank. The costs of the belt skimmer in this case, was included as part of the chemical emulsion breaking costs (see Figure VIII-7).

Although the required separator capacity is dependent on many factors, the sizing was based primarily on the influent wastewater flow rate, with the following design values assumed for the remaining parameters of importance:

Parameter	Nominal Design Value
Specific gravity of oil	0.85
Operating temperature (° F)	68
Influent oil concentration (mg/l)	30,000

Extreme operating conditions, such as influent oil concentrations greater than 30,000 mg/l, or temperatures lower than 68° F were accounted for in the sizing of the separator.

The capital and annual costs of oil skimming included the following equipment:

- Coalescent plate separator with automatic shutoff valve and level sensor
- Oily waste storage tanks (2-week retention time)
- Oily waste discharge pump
- Effluent discharge pump

Influent flow rates up to 159,100 l/hr (700 gpm) are costed for a single unit; flows greater than 700 gpm require multiple units.

The direct annual costs for oil skimming include the cost of operating and maintenance labor and replacement parts. Annual costs for the coalescent separators alone are minimal and involve only periodic clean out and replacement of the coalescent plates.

Chromium Reduction

This technology can be applied to waste streams containing significant concentrations of hexavalent chromium. Chromium in this form will not precipitate until it has been reduced to the trivalent form. The waste stream is treated by addition of acid and gaseous SO_2 dissolved in water in an agitated reaction vessel. The SO_2 is oxidized to sulfate while it reduces the chromium.

The equipment required for this continuous stream includes an SO_2 feed system (sulfonator), an H_2SO_4 feed system, a reactor vessel and agitator, and a pump. The reaction pH is 2.5 and the SO_2 dosage is a function of the influent loading of hexavalent chromium. A conventional sulfonator is used to meter SO_2 to the reaction vessel. The mixer velocity gradient is 100/sec.

Annual costs are as follows:

- SO_2 feed system
    1. SO_2 cost at $0.55/kg ($0.25/lb),
    2. Operation and maintenance labor requirements vary from 437 hrs/yr at 4.5 kg SO_2/day (10 lbs SO_2/day) to 5,440 hrs/yr at 4,540 kg SO_2/day (10,000 lbs SO_2/day),
    3. Energy requirements at 570 kwh/yr at 4.5 kg SO_2/day (10 lbs SO_2/day) to 31,000 kwh/yr at 4,540 kg SO_2/day (10,000 lbs SO_2/day).
- H_2 SO_4 feed system
    1. Operating and maintenance labor at 72 hrs/yr at 37.8 lpd (10 gpd) of 93 percent H_2SO_4 to 200 hrs/yr at 3,780 lpd (1,000 gpd),
    2. Maintenance materials at 3 percent of the equipment cost,
    3. Energy requirements for metering pump and storage heating and lighting.
- Reactor vessel and agitator
    1. Operation and maintenance labor at 120 hrs/yr,

2. Electrical requirements for agitator.

Figure VIII-8 presents the cost curve for chromium reduction.

Cooling Towers/Tanks

Cooling towers are used to recycle annealing water and solution heat treatment wastewaters as a flow reduction measure for recirculating flow rates above 3,400 l/hr (15 gpm). The minimum flow rate represents the smallest cooling tower commercially available from the vendors contacted. Conventional holding tanks are used to recycle flow rates less than 15 gpm.

The required cooling tower capacity is based on the amount of heat removed, which takes into account both the flow rate and temperature range (decrease in cooling water temperature). The recirculation flow rate through the cooling tower is based on the BPT flow rate. The temperature range was based on a cold water temperature of 85° F and an average hot water temperature for a particular waste stream (calculated from sampling data). When the hot water temperature was not available, or found to be below 95° F, a value of 95° F was assumed, resulting in a range of 10°F (95-85° F). The remaining significant design parameters, the wet bulb temperature (ambient temperature at 100 percent relative humidity) and the approach (of cold water temperature to the wet bulb temp) are assumed to be constant at 75° F and 8° F, respectively.

The capital costs of cooling tower systems include the following equipment:

- Cooling tower (crossflow, mechanically-induced) and typical accessories
- Piping and valves (305 meters (1000 ft.) carbon steel)
- Cold water storage tank (2 hour retention time)
- Recirculation pump, centrifugal
- Chemical treatment system (for pH, slime and corrosion control)

For nominal recirculation flow rates greater than 159,100 l/hr (700 gpm), multiple cooling towers are assumed to be required. A holding tank system would consist of a holding tank and a recirculation pump.

The direct capital costs include purchased equipment cost, installation and delivery. Installation costs for cooling towers were assumed to be 200 percent of the cooling tower cost based on information supplied by vendors. Piping costs were the major components of the cooling tower capital costs (see Figure VIII-9).

Direct annual costs included raw chemicals for water treatment, fan energy requirements, and maintenance and operating labor was assumed to be constant at 60 hours per year. The water treatment chemical cost was based on $5/gpm of recirculated water.

Spray Rinsing

Spray rinsing is the model treatment technology used for reduction of pickling rinse water. The flow used to determine spray rinsing costs is equal to the regulatory pickling rinse flow.

A spray rinsing system consists of the following equipment:

- Tank/collection basin with level controller
- Spray nozzle and piping system
- Pump
- Conductivity meter

Capital costs of spray rinsing do not include the tank with level controller since such a tank was already installed for existing plants in this category (see Figure VIII-10).

The tank was converted to a spray rinsing operation by installing the additional equipment previously listed. Teflon-lined steel piping (48 feet), a stainless steel spray nozzle system complete with a liquid strainer and shutoff valves, a pressure gauge, conductivity meter and a centrifugal pump are assumed to be required.

Installation of 50 percent and a retrofit allowance of 15 percent of the purchased equipment costs were added to obtain the capital costs.

Annual costs included five percent of the plant operating hours as maintenance labor, maintenance materials cost as two percent of the total purchased equipment cost and operating and maintenance costs associated with pumping.

Countercurrent Cascade Rinsing

This technology is used to reduce water use in pickling rinse operations for new plants. It involves a multiple stage rinsing, with product and rinse water moving in opposite directions (more detail may be found in Section VII p. 310). This allows for significantly reduced flow over single stage rinsing by contacting the most contaminated rinse water with the incoming product.

The countercurrent rinsing system is a three stage rinsing line, consisting of the following equipment:

- Tanks (3), fiberglass
- Transfer pump (1), centrifugal

Agitation costs were also included as part of the countercurrent cascade rinsing costs. A rinsing system was costed for each separate line reported by a plant to be costed. In the case of multiple lines, it was assumed that the total rinsing flow was divided evenly among each line (see Figure VIII-10).

The capacity of each tank is usually determined by the size of the product holding rack. Each tank is assumed to be 13,627 liters (3,600 gallons) and constructed of fiberglass (to handle the dilute acidic solutions). Agitation was provided for the last two tanks to ensure thorough rinsing. A centrifugal pump was included to transfer water to the rinsing system. Flow between tanks was accomplished by gravity.

Annual costs are based mainly on operation and maintenance costs for the agitators and pump.

Contract Hauling

Concentrated sludge and waste oils are removed on a contract basis for off-site disposal. The cost of contract hauling depends on the classification of the waste as being either hazardous or nonhazardous. For nonhazardous wastes, a rate of $0.106/liter ($0.40/gallon) was used in determining contract hauling costs. This value is based on reviewing information from several sources, including a paint industry survey, comments from the aluminum forming industry, and literature sources. This cost was within $0.013/liter of the cost data submitted by copper formers during the comment period and obtained by telephone contacts. The contract hauling cost for nonhazardous waste was used in this cost estimation because the Agency believes that the wastes generated from copper forming plants are not hazardous as defined under 40 CFR 261. The capital cost associated with contract hauling is assumed to be zero.

COSTS FOR TREATMENT AND CONTROL OPTIONS

The components of the five control and treatment options which were considered as the bases for BPT, BAT, PSES, NSPS, and PSNS are presented below. The five options are discussed in greater detail in Section X (p. 447).

Option 1

For Option 1, costs were estimated for the following treatment processes:

- Lime precipitation and clarification,
- Vacuum filtration,
- Chemical emulsion breaking,
- Oil skimming,
- Chromium reduction,
- Contract hauling,
- Spray Rinsing and recirculation of the pickling rinse water for forged parts, and
- Recycle of hot rolling spent lubricant.

Option 2

For Option 2, costs were estimated for the following treatment processes:

- All Option 1 processes, plus
- Cooling towers for annealing water and solution heat treatment water, and
- Spray rinsing and recirculation of all pickling rinse water.

Option 3

For Option 3, costs were estimated for the following treatment processes:

- All Option 2 processes, plus
- End-of-pipe polishing multimedia filtration.

Option 4

For Option 4, costs were estimated for new plants for the following treatment processes:

- All Option 3 processes, plus
- Countercurrent cascade rinsing in pickling operations.

Option 4 is the model treatment technology for new sources. As discussed in Section X, p. 450, the Agency believes taht existing copper forming plants do not have sufficient space to add countercurrent cascade rinsing. The Agency believes that the cost of installing countercurrent rinsing in a new plant would not be greater than the cost of installing single stage or spray rinsing at existing plants and in some cases may actually be less because of decreased water use and pumping requirements.

NORMAL PLANT COSTS

A normal plant is a theoretical plant which has each of the manufacturing operations covered by the category at a production level that is the average level of the direct and indirect dischargers in the category. The Agency developed a normal plant in order to estimate pollutant removals, sludge generation, energy requirements, and costs for new source dischargers. The characteristics of a copper forming normal plant are presented in Table VIII-7. The production attributable to each waste stream is calculated by totaling the reported production for all dischargers through that waste stream (from the dcp) and then dividing by the number of dischargers in the industry (82). The normal plant flows are the characteristic production times the production normalized flow allowance at each option. In addition, a normal plant was assumed to operate 16 hours per day, 5 days per week, 50 weeks per year.

The Agency has prepared engineering costs for the first four options described above using a normal plant to provide an indication of the relative costs of these options for new plants to install treatment.

The capital, annual operation and maintenance, and annualized costs are shown in Table VIII-8. For plants with no treatment in place, the cost of Option 4 is comparable to the cost for Option 2. Recalling that Option 4 is identical to Option 2 except that Option 4 includes additional flow reduction and an end-of-pipe polishing filter (multimedia), it can be seen that the reduction in costs due to lower flows almost offsets the additional cost of the polishing filter. The Agency did not include savings in water costs between Options 2 and 4. When these savings are taken into account, the difference in the costs between Option 2 and Option 4 is further reduced.

ENERGY AND NONWATER QUALITY ASPECTS

The following are the nonwater quality environmental impacts (including energy requirements) associated with these regulations.

A. Air Pollution

Imposition of BPT and BAT limitations and NSPS, PSES, and PSNS will not create any substantial air pollution problems. The technologies used as the basis for this regulation precipitate pollutants found in wastewater which are then settled or filtered from the discharged wastewater. These technologies do not emit pollutants into the air.

B. Solid Waste

EPA estimates that direct and indirect dischargers in the copper forming category generated 39,000 kkg of solid wastes (wet basis) in 1978 as a result of wastewater treatment in place. These wastes were comprised of treatment system sludges containing toxic metals, (including chromium, copper, lead, nickel, and zinc), oil removed during oil skimming, and chemical emulsion breaking sludges that contain toxic organics.

EPA estimates that BPT will contribute an additional 13,000 kkg per year of solid wastes over that which is currently being generated by the direct and indirect dischargers in the copper forming category. BAT and PSES will increase these wastes by approximately 11,000 kkg per year beyond BPT levels. These sludges will necessarily contain additional quantities (and concentrations) of toxic metal pollutants. The normal plant was used to estimate the sludge generated at NSPS and PSNS and is estimated to be a 10 percent increase over BAT and PSES. The final rule provides a flow allowance for drawing spent lubricant, in contrast to the proposed rule which was based on contract hauling of this wastewater stream. The decrease in the total amount of sludge generated from this change will not be significant.

Estimates of the amount of solid waste generated currently by copper formers and the incremental amount of solid waste generated as a result of installing the proposed options were calculated using the following approach. The amount of solid waste generated by treatment in place was estimated using the current discharge flows for direct and indirect dischargers. For the purposes of estimating the volume of sludge generated by chemical precipitation and sedimentation it was assumed that the treatment system was operated using ten percent excess lime, and that the hydroxide sludge resulting from sedimentation was concentrated to 20 percent solids using vacuum filtration. Thus applying the percentage of the industry with treatment in place (70 percent of direct dischargers and 31 percent of indirect dischargers), the amount of sludge currently generated was calculated. The incremental amount of sludge generated under the proposed BPT were then calculated by assuming that the portion of the flow not currently treated would be treated using chemical precipitation and sedimentation. The incremental amount of sludge generated under the proposed BAT and PSES was calculated based on the assumption that flow reduction measures selected reduce the overall plant flow by approximately 60 percent.

The final rule is based on an increase from 0 to 85 l/kkg in the flow allowance for drawing spent lubricant. This flow allowance permits the treatment of drawing spent lubricant and thereby may decrease the estimated total solid waste generated by the copper forming industry as a result of this regulation.

The Agency examined the solid wastes that would be generated at copper forming plants by the suggested treatment technologies and believes they will not be considered hazardous under Section 3001 of the Resource Conservation and Recovery Act (RCRA). This judgment is made based on the recommended technology of lime precipitation. By the addition of a 10 percent excess of lime during treatment, similar sludges, specifically toxic metal bearing sludges, generated by other industries such as the iron and steel industry passed the EP toxicity test. See 40 CFR Part 261.24 (45 FR 33084 (May 19, 1980)). Data from one copper forming plant indicated that the lime and settle sludge failed the EP toxicity test but further investigation revealed that the plant was not using excess lime as required by the model technology. Additional data from another copper forming plant indicates that their wastewater sludges are not hazardous by RCRA standards. Thus, the Agency believes that the copper forming wastewater sludges will not be found toxic if the recommended technology is applied. Since the copper forming solid wastes are not believed to be hazardous, no estimates were made of costs for disposing of hazardous wastes in accordance with RCRA requirements.

Although it is the Agency's view that solid wastes generated as a result of these guidelines are not expected to be classified as hazardous under the regulations implementing Subtitle C of the Resource Conservation and Recovery Act (RCRA), generators of these wastes must test the waste to determine if the wastes meet any of the characteristics of hazardous waste. See 40 CRF Part 262.11 (45 FR 12732-12733 (February 26, 1980)). The Agency may also list these sludges as hazardous pursuant to 40 CFR Part 261.11 (45 FR at 33121 (May 19, 1980), as amended at 45 FR 76624 (November 19, 1980)).

If these wastes are identified as hazardous, they will come within the scope of RCRA's "cradle to grave" hazardous waste management program, requiring regulation from the point of generation to point of final disposition. EPA's generator standards require generators of hazardous copper forming wastes to meet containerization, labeling, record keeping, and reporting requirements; if copper formers dispose of hazardous wastes off-site, they would have to prepare a manifest which would track the movement of the wastes from the generator's premises to a permitted off-site treatment, storage, or disposal facility. See 40 CFR Part 262.20. The transporter regulations require transporters of hazardous wastes to comply with the manifest system to assure that the wastes are delivered to a permitted facility. See 40 CFR Part 263.20 (1981). Finally, RCRA regulations establish standards for hazardous waste treatment, storage, and disposal facilities allowed to receive such wastes. See 40 CFR Parts 264 and 265.

Even if these wastes are not identified as hazardous, they still must be disposed in a manner that will not violate the open dumping prohibition of Section 4005 of RCRA. The Agency has calculated as part of the costs for wastewater treatment the cost of hauling and disposing of these wastes in accordance with this requirement.

C. Consumptive Water Loss

Treatment and control technologies that require extensive recycling and reuse of water may require cooling mechanisms. Evaporative cooling mechanisms can cause water loss and contribute to water scarcity problems--a primary concern in arid and semi-arid regions. While this regulation assumes water reuse, the quantity of water involved is not regionally significant. We conclude that the consumptive water loss is insignificant and that the pollution reduction benefits of recycle technologies outweigh their impact on consumptive water loss.

D. Energy Requirements

The Agency believes that most direct dischargers will move directly into compliance with BAT from existing treatment; therefore, EPA estimates that the achievement of BAT effluent limitations will result in a net increase in electrical energy consumption of approximately 0.6 million kilowatt-hours per year. To achieve the recommended BAT effluent limitations, a typical direct discharger will increase total energy consumption by less than 1 percent of the energy consumed for production purposes. NSPS will not significantly add to total energy consumption because new source equipment and pumps will be smaller and will therefore use less energy (due to the decreased flows). A normal plant was used to estimate the energy requirements for a new source. A new source wastewater treatment system will add 122,000 kilowatt-hours per year to the total industry energy requirements.

The Agency estimates that recommended PSES will result in a net increase in electrical energy consumption of approximately 0.5 million kilowatt-hours per year. To achieve recommended PSES, a typical existing indirect discharger will increase energy consumption by less than 2 percent of the energy consumed for production purposes. PSNS, like NSPS, will not significantly add to total energy consumption based on a normal plant calculation.

Table VIII-1

DISTRIBUTION OF COSTED COPPER FORMING PLANTS

DIRECT DISCHARGERS

Distribution by Operation

Operation	Percent of Direct Dischargers	Percent of Costed Group
Hot Rolling	30	4/14 = 29
Cold Rolling	40	6/14 = 43
Drawing	68	10/14 = 71
Forging	5	2/14 = 14
Extrusion	33	5/14 = 36

Distribution by Number of Operations at a Given Plant

Number of Operations	Percent of Direct Dischargers	Percent of Costed Group
1	55	8/14 = 57
2	25	2/14 = 14
3	8	1/14 = 7
4	10	3/14 = 21

Distribution by Treatment-in-Place

Treatment-in-Place	Percent of Direct Dischargers	Percent of Costed Group
None	35	5/14 = 36
Some	52	8/14 = 57
Extensive	13	1/14 = 7

Table VIII-1 (Continued)

DISTRIBUTION OF COSTED COPPER FORMING PLANTS

INDIRECT DISCHARGERS

Distribution by Operation

Operation	Percent of Indirect Dischargers	Percent of Costed Group
Hot Rolling	30	5/17 = 29
Cold Rolling	41	7/17 = 41
Drawing	80	14/17 = 82
Forging	6	1/17 = 6
Extrusion	19	3/17 = 18

Distribution by Number of Operations at a Given Plant

Number of Operations	Percent of Indirect Dischargers	Percent of Costed Group
1	52	10/17 = 58
2	26	3/17 = 18
3	11	3/17 = 18
4	9	1/17 = 6

Distribution by Treatment-in-Place

Treatment-in-Place	Percent of Indirect Dischargers	Percent of Costed Group
None	44	8/17 = 47
Some	39	6/17 = 35
Extensive	17	3/17 = 18

Table VIII-2

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES

Equipment	Equation	Range of Validity
Agitators, C-clamp	$C = 839.1 + 587.5\ (HP)$ $A = 2739.89 + 403.365\ (HP) + 0.7445\ (HP)^2$	$0.25 < HP < 0.33$
Agitators, Top Entry	$C = 1585.55 + 125.302\ (HP) - 3.27437\ (HP)^2$ $A = 2739.89 + 403.365\ (HP) + 0.7445\ (HP)^2$	$0.33 < HP < 5.0$
Clarifier, Concrete	$C = 78400 + 32.65\ (S) - 7.5357 \times 10^{-4}\ (S)^2$ $A = \exp[9.40025 - 0.539825\ (\ln S) + 0.551186\ (\ln S)^2]$	$500 < S < 12{,}000$
Clarifier, Steel	$C = 41197.1 + 72.0979(S) + 0.0106542(S)^2$ $A = \exp[9.40025 - 0.539825\ (\ln S) + 0.0551186\ (\ln S)^2]$	$50 < S < 2800$
Contract Hauling	$C = 0$ $A = 0.40\ (G)(HPY)$ $A = \exp[-0.0240857 + 1.02731\ (\ln G) - 0.0196787\ (\ln G)^2](HPY)$	 Non Hazardous Hazardous
Cooling Tower System	$C = \exp[8.76408 + 0.07048\ (\ln T) + 0.050949\ (\ln T)^2]$ $A = \exp[9.08702 - 0.75544\ (\ln T) + 0.140379\ (\ln T)^2]$	$1 < T < 700$
Feed System Alum	$C = \exp[16.2911 - 0.206595\ (\ln F) + 0.06448\ (\ln F)^2]$ $A = [0.52661 + 0.11913\ (F) + 1.964 \times 10^{-8} (F)^2]\ HPY$	$10 < F < 1000$

Table VIII-2 (Continued)

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES

Equipment	Equation	Range of Validity
Feed System, Batch Line	$C = 1697.79 + 19.489\ (B) - 0.036824\ (B)^2$ $C = 16149.2 + 10.2512\ (B) - 1.65864 \times 10^{-3} (B)^2$ $A = \exp[2.91006 - 0.44837\ (\ln B) + 0.0840605\ (\ln B)^2] BPY + 1090$	$5 < B < 1000$
Feed System, Lime	$C = \exp[8.64445 + 0.790902\ (\ln F) - 0.04556\ (\ln F)^2]$ $A = \exp[-1.90739 + 0.60058\ (\ln F) + 0.017236\ (\ln F)^2] (HPY)$	$10 < F < 10{,}000$
Feed System, Polymer	$C = 24190 + 1024.38\ (F) + 46.3977\ (F)^2$ $A = [0.479342 + 2.25578\ (F) + 8.49822 \times 10^{-4} (F)^2] (HPY)$	$0.04 < F < 10$
Feed System, Sulfuric Acid	$C = 10858.2 + 33.3414\ (F) - 3.3325 \times 10^{-3} (F)^2$ $A = \exp[-2.31035 + 0.707633\ (\ln F) + 0.0215896\ (\ln F)^2] (HPY)$	$6 < F < 3200$
Multimedia Filter	$C = 10.888 + 277.85\ (SA) - 0.154337\ (SA)^2$ $A = \exp[8.20771 + 0.275272\ (\ln SA) + 0.0323124\ (\ln SA)^2]$	$7 < SA < 500$
Oil/Water Separator	$C = 12927.1 + 73.2945\ (Y) - 0.029595\ (Y)^2$ $A = 783.04 + 6.3616\ (X) - 0.001736\ (X)^2$	$0 < Y < 700$
Pumps	$C = 2801.42 + 2.83218\ (Y) + 3.66908 \times 10^{-4} (Y)^2$ $A = \exp[6.67588 + 0.01335\ (\ln Y) + 0.062016\ (\ln Y)^2$	$20 < Y < 3500$

Table VIII-2 (Continued)

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES

Equipment	Equation	Range of Validity
Spray Rinsing System	$C = 3212.72 - 0.009005\ (X) + 1.004 \times 10^{-6}\ (X)^2$ $A = N[1.05(HPY) + 64.246 - 1.801 \times 10^{-4}(X) + 2.008 \times 10^{-8}(X)^2]$	
Sulfonator	$C = 14336.3 + 38.1582\ (F) - 0.156326\ (F)^2$ $A = 6934.09 + 2704.2\ (F) - 1.08636\ (F)^2$	$4.0 < F < 350$
Tank, Batch Reactor	$C = 3100.44 + 1.19041\ (V) - 1.7288 \times 10^{-5}(V)^2$ $A = \exp[8.65018 - 0.0558684\ (\ln X) + 0.0145276\ (\ln X)^2]$	$500 < V < 24{,}000$ $100 < X < 100{,}000$
Tank, Concrete	$C = 5800 + 0.8V$ $A = 0$	$6000 < V < 24{,}000$
Tank, Fiberglass	$C = 3100.44 + 1.19041\ (V) - 1.7288 \times 10^{-5}(V)^2$ $A = 0$	$500 < V < 24{,}000$
Tank, Large Steel	$C = 3128.83 + 2.37281\ (V) - 7.10689 \times 10^{-5}(V)^2$ $A = 0$	$500 < V < 12{,}000$
Tank, Small Steel	$C = 692.824 + 6.16706\ (V) - 3.95367 \times 10^{-3}(V)^2$ $A = 0$	$100 < V < 500$
Vacuum Filter	$C = 67595.1 + 504.701\ (SA) - 0.520067\ (SA)^2$ $A = 44096.8 + 138.057\ (SA) - 0.0485584\ (SA)^2$	$5 < SA < 500$
Vacuum Filter Housing	$C = 70509 + 349.708\ (SA) - 1.28989(SA)^2$ $A = 0$	$5 < SA < 500$

Table VIII-2 (Continued)

COST EQUATIONS FOR RECOMMENDED TREATMENT AND CONTROL TECHNOLOGIES

C = Direct capital, or equipment costs (1982 dollars)
A = Direct annual costs (1982 dollars/year)
B = Batch chemical feed rate (pounds/hour)
BPY = Number of batches per year
F = Chemical feed rate (pounds/hour)
G = Sludge disposal rate (gallons/hour)
HP = Power requirement (horsepower)
HPY = Plant operating hours (hours/year)
S = Clarifier surface area (square feet)
SA = Filter surface area (square feet)
T = Cooling capcity in evaporative tons (°F gallons/minute)
V = Tank capacity
X = Wastewater flowrate (liters/hour)
Y = Wastewater flowrate (gallons/minute)

Table VIII-3

COMPONENTS OF TOTAL CAPITAL INVESTMENT

Item Number	Item	Cost
1	Bare Module Capital Costs	Direct capital costs from model[a]
2	Electrical & instrumentation	0% of item 1
3	Yard piping	0% of item 2
4	Enclosure	Included in item 1
5	Pumping	Included in item 1
6	Retrofit allowance	See footnote b
7	Total Module Cost	Item 1 + items 2 through 6
8	Engineering/admin. & legal	12.5% of item 7
9	Construction/yardwork	0% of item 7
10	Monitoring	See footnote c
11	Total Plant Cost	Items 7 + items 8 through 10
12	Contingency	15% of item 11
13	Contractor's fee	10% of item 11
14	Total Construction Cost	Item 11 + items 12 through 13
15	Interest during construction	0% of item 14
16	Total Depreciable Investment	Item 14 + item 15
17	Land	0% of item 16
18	Working capital	0% of item 16
19	Total Capital Investment	Item 16 + items 17 through 18

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[a] Direct capital costs include costs of equipment and required accessories, installation, and delivery.

[b] Piping costs were assumed to be $6,900 for each stream that was rerouted to treatment.

[c] See Page ___ for an explanation of how monitoring costs were determined.

Table VIII-4

COMPONENTS OF TOTAL ANNUALIZED COSTS

Item Number	Item	Cost
20	Bare Module Annual Costs	Direct annual costs from model[a]
21	Overhead	0% of item 16[b]
22	Monitoring	See footnote c
23	Insurance	1% of item 16
24	Amortization	CRF x item 16[d]
25	Total Annualized Costs	Item 20 + items 21 through 24

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[a] Direct annual costs include costs of raw materials, energy, operating labor, maintenance and repair.

[b] Item 16 is the total depreciable investment obtained from Table 1.

[c] See page ___ for an explanation of the determination of monitoring costs.

[d] The capital recovery factor (CRF) was used to account for depreciation and the cost of financing.

Table VIII-5

WASTEWATER SAMPLING FREQUENCY

Wastewater Discharge (Liters Per Day)	Sampling Frequency
0 - 37,850	Once per month
37,851 - 189,250	Twice per month
189,251 - 378,500	Once per week
378,501 - 946,250	Twice per week
946,250+	Three times per week

Table VIII-6

COST PROGRAM POLLUTANT PARAMETERS

Parameter	Units
Flowrate	liters/hour
pH	pH units
Temperature	°F
Total Suspended Solids	mg/l
Acidity (as $CaCO_3$)	mg/l
Aluminum	mg/l
Ammonia	mg/l
Antimony	mg/l
Arsenic	mg/l
Cadmium	mg/l
Chromium (trivalent)	mg/l
Chromium (hexavalent)	mg/l
Cobalt	mg/l
Copper	mg/l
Cyanide (free)	mg/l
Cyanide (total)	mg/l
Fluoride	mg/l
Iron	mg/l
Lead	mg/l
Manganese	mg/l
Nickel	mg/l
Oil and Grease	mg/l
Phosphorous	mg/l
Selenium	mg/l
Silver	mg/l
Thallium	mg/l
Zinc	mg/l

Table VIII-7

CHARACTERISTICS OF THE COPPER FORMING NORMAL PLANT

Manufacturing Operation/ Waste Stream	Production (kkg/yr)	Flow (l/yr x 10^{-6})		
		Options 1 and 5	Options 2 and 3	Option 4
Hot Rolling Spent Lubricant	18,900	1.95	1.95	1.95
Cold Rolling Spent Lubricant	8,800	3.33	3.33	3.33
Drawing Spent Lubricant	14,700	1.25	1.25	1.25
Solution Heat Treatment	13,800	35.00	8.90	8.90
Extrusion Press Heat Treatment	2,500	0.005	0.005	0.005
Annealing Water	15,200	85.95	18.81	18.81
Annealing Oil	4,240	0.00	0.00	0.00
Alkaline Cleaning Bath	810	0.04	0.04	0.04
Alkaline Cleaning Rinse	810	3.40	3.40	3.40
Pickling Bath	35,600	4.13	4.13	4.13
Pickling Rinse	35,600	129.10	46.55	20.85

Table VIII-7 (Continued)

CHARACTERISTICS OF THE COPPER FORMING NORMAL PLANT

Manufacturing Operation/ Waste Stream	Production (kkg/yr)	Flow (l/yr x 10^{-6})		
		Options 1 and 5	Options 2 and 3	Option 4
Pickling Fume Scrubber	11,900	7.44	7.44	7.44
Forging Alkaline Cleaning Rinse	106	1.34	1.34	1.34
Forging Pickling Rinse	160	1.74	0.63	0.28
Tumbling or Burnishing	200	0.12	0.12	0.12
Surface Coating	1,619	1.20	1.20	1.20
Miscellaneous Waste Streams	1,619	0.04	0.04	0.04

Table VIII-8

SUMMARY OF COPPER FORMING NORMAL PLANT COSTS ($1982)

	Capital Cost
Option 1	1,194,900
Option 2	1,182,800
Option 3	1,232,900
Option 4	1,233,200

	Annual Operation and Maintenance Cost (O&M)	Annualized[1] Cost
Option 1	763,800	1,026,700
Option 2	756,800	1,017,000
Option 3	779,200	1,050,500
Option 4	779,900	1,051,200

[1] Using a capital recovery factor of 0.22.

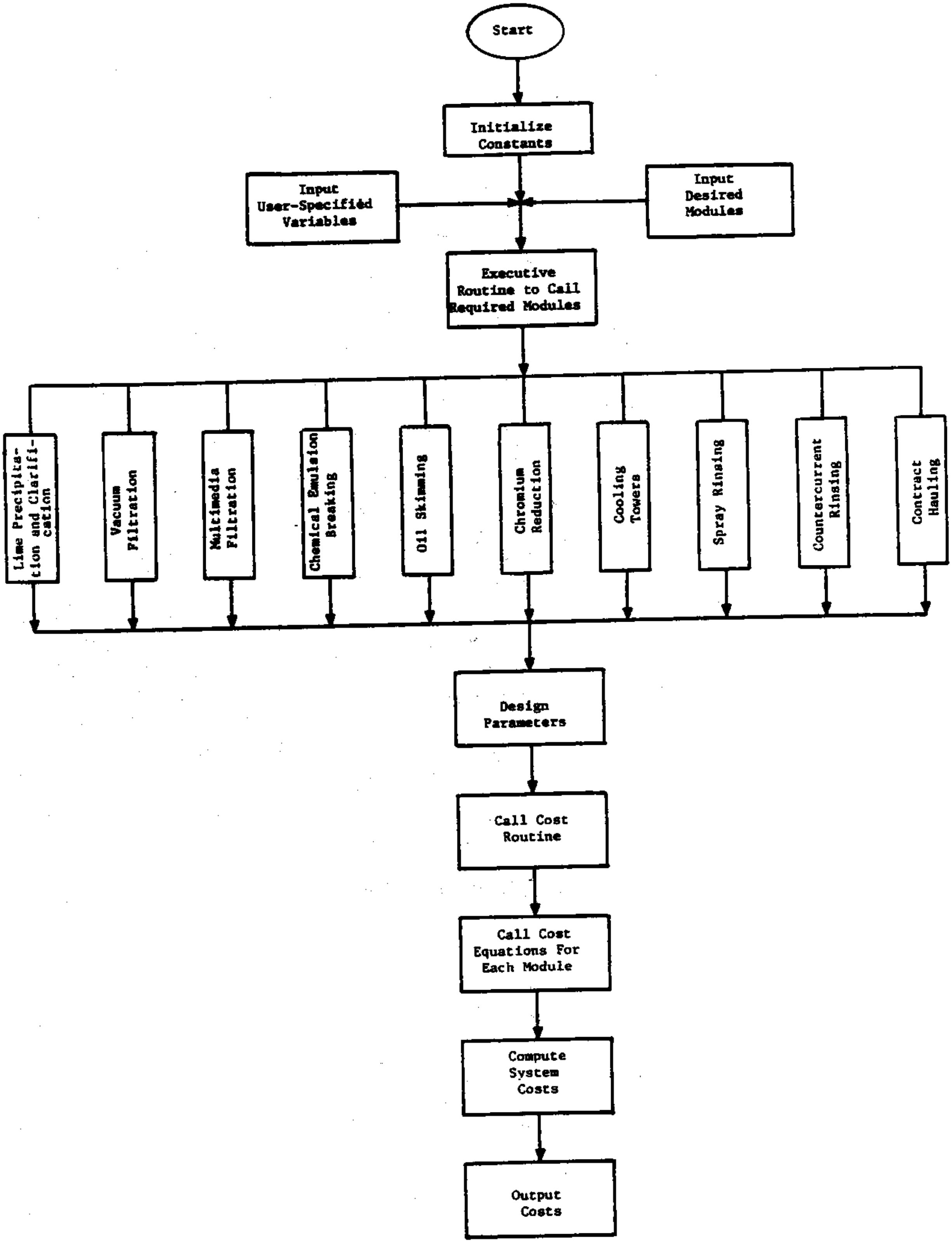


Figure VIII-1

GENERAL LOGIC DIAGRAM OF COMPUTER COST MODEL

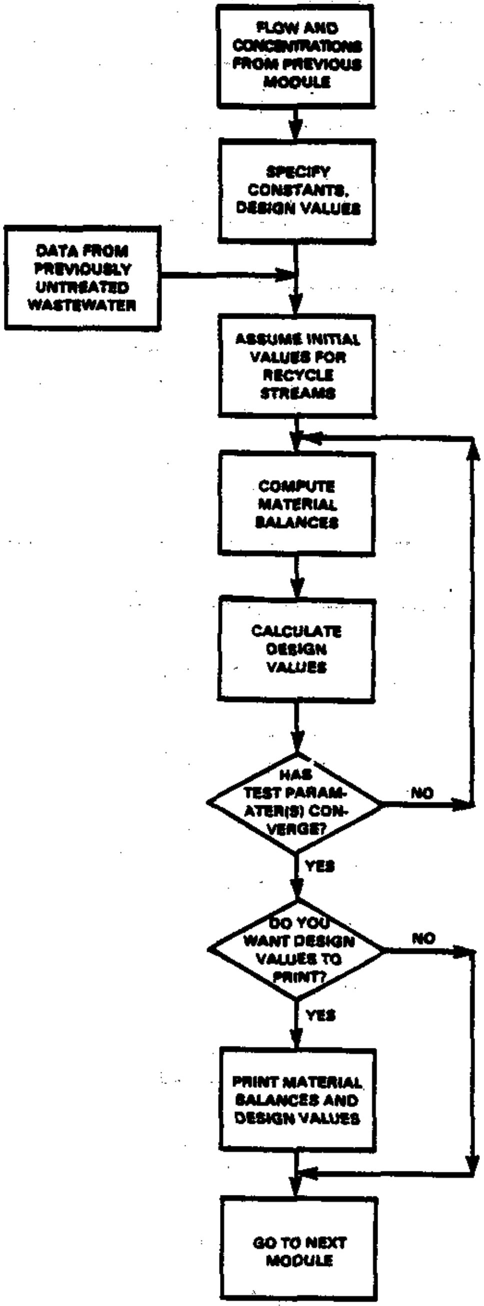


Figure VIII-2

LOGIC DIAGRAM OF MODULE DESIGN PROCEDURE

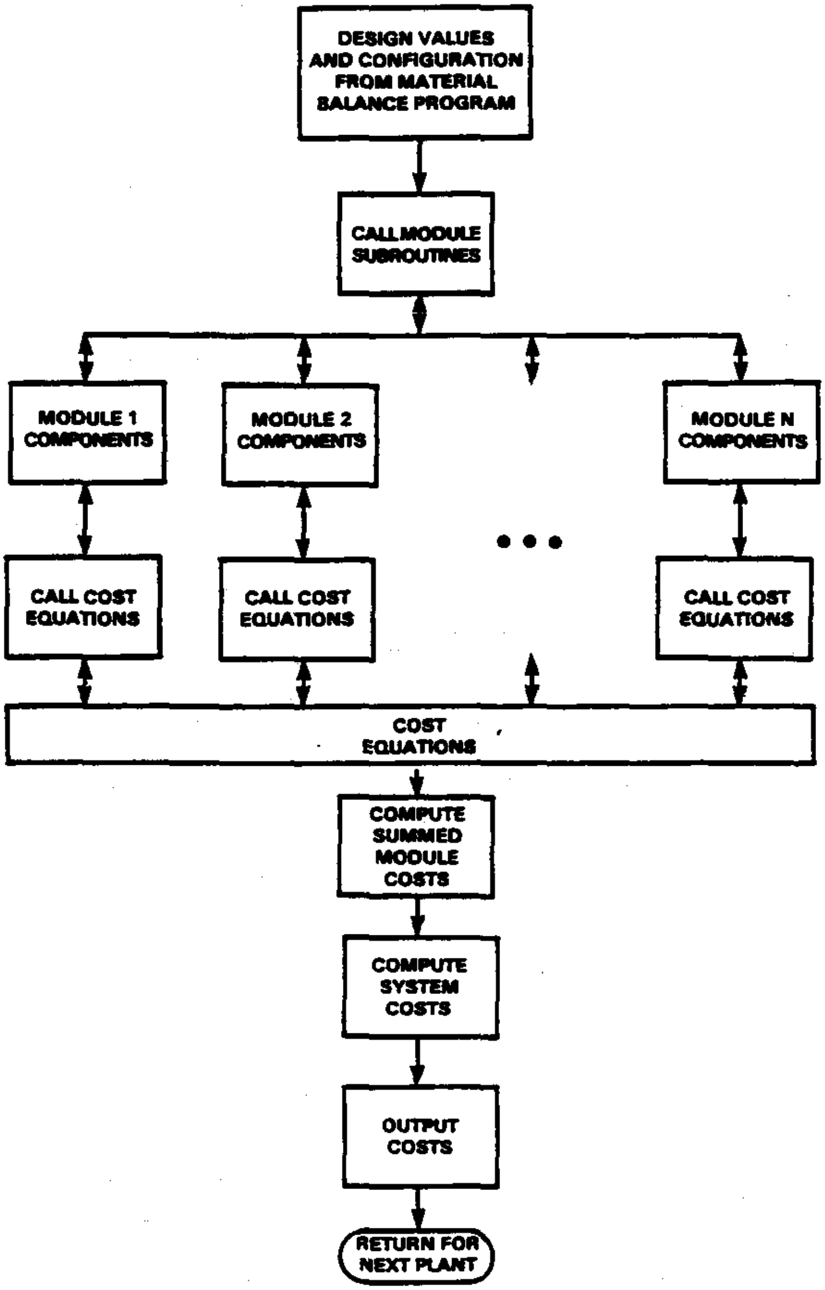
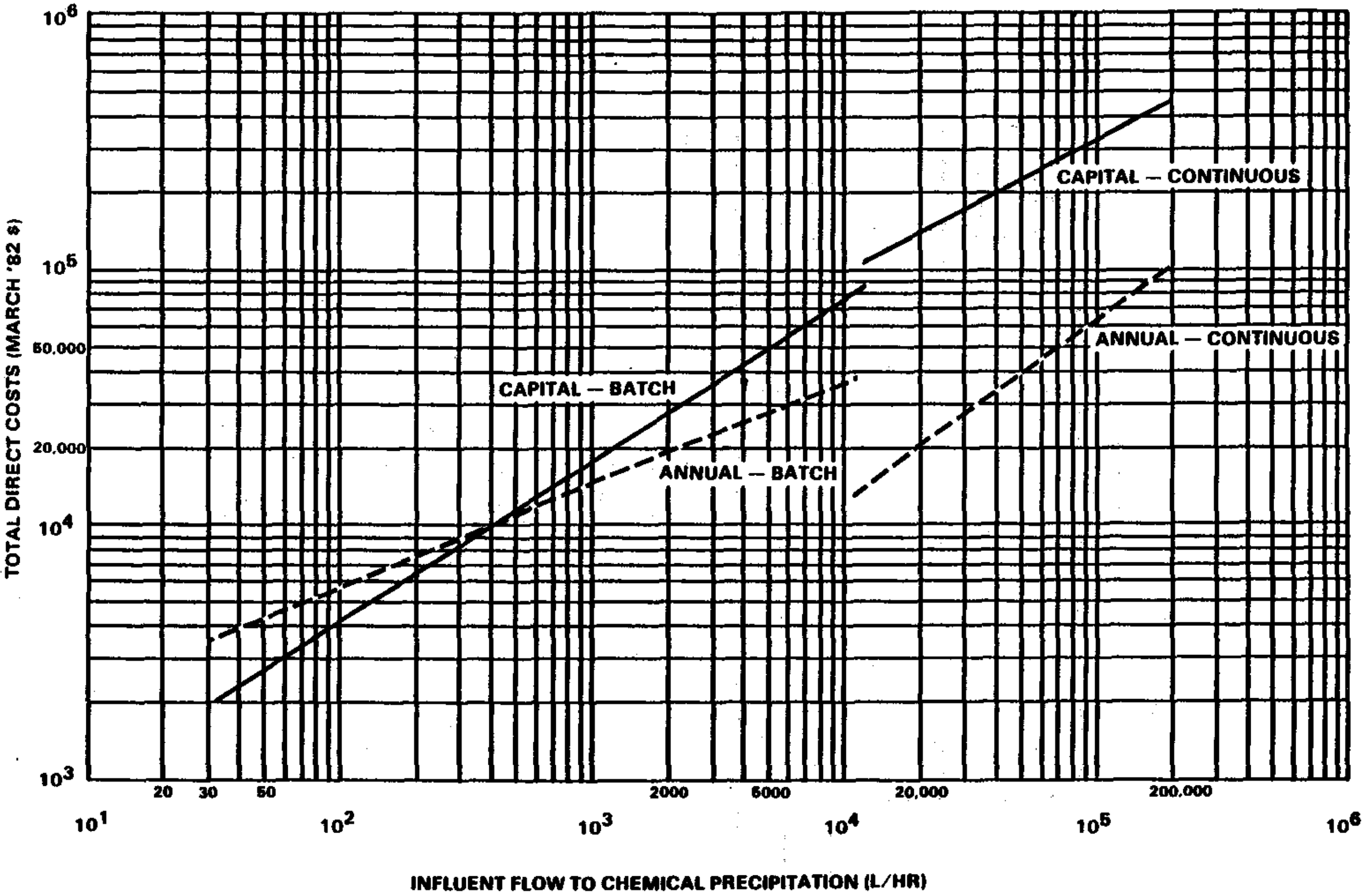


Figure VIII-3

LOGIC DIAGRAM OF THE COSTING ROUTINE



NOTE: LIME DOSAGE 2,000 mg/l

Figure VIII-4

COSTS OF CHEMICAL PRECIPITATION AND SEDIMENTATION

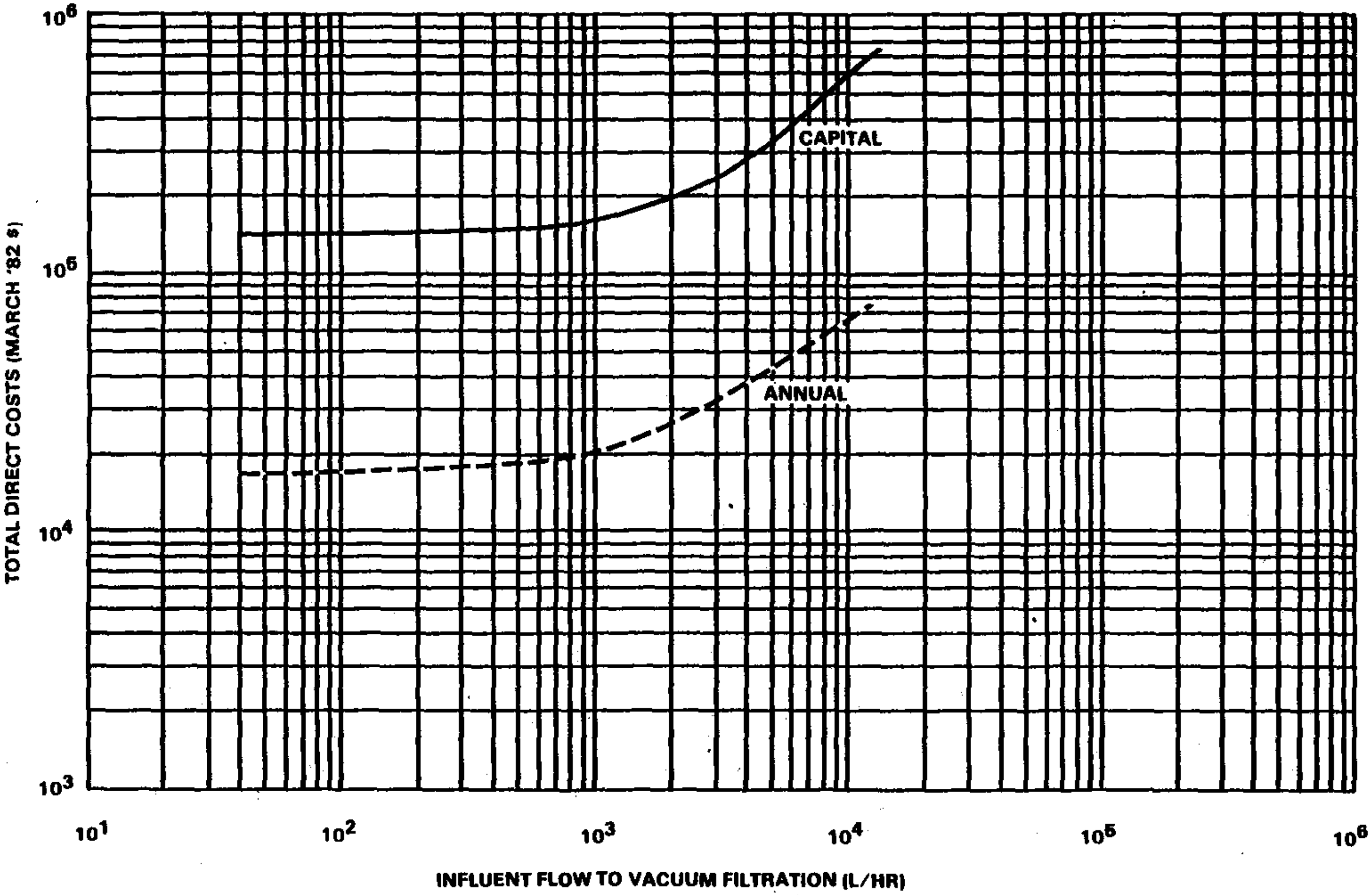


Figure VIII-5

COSTS OF VACUUM FILTRATION

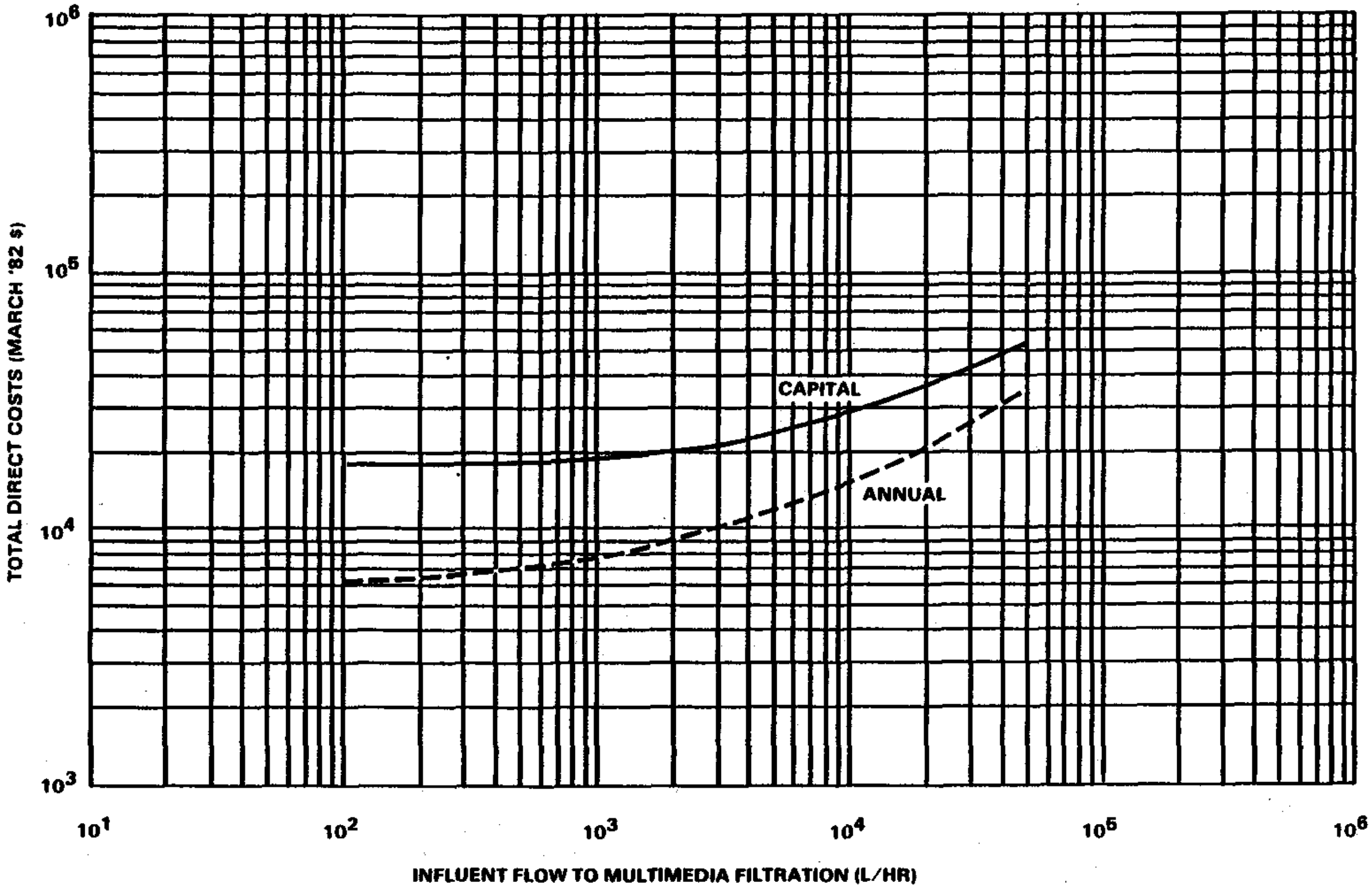


Figure VIII-6

COSTS OF MULTIMEDIA FILTRATION

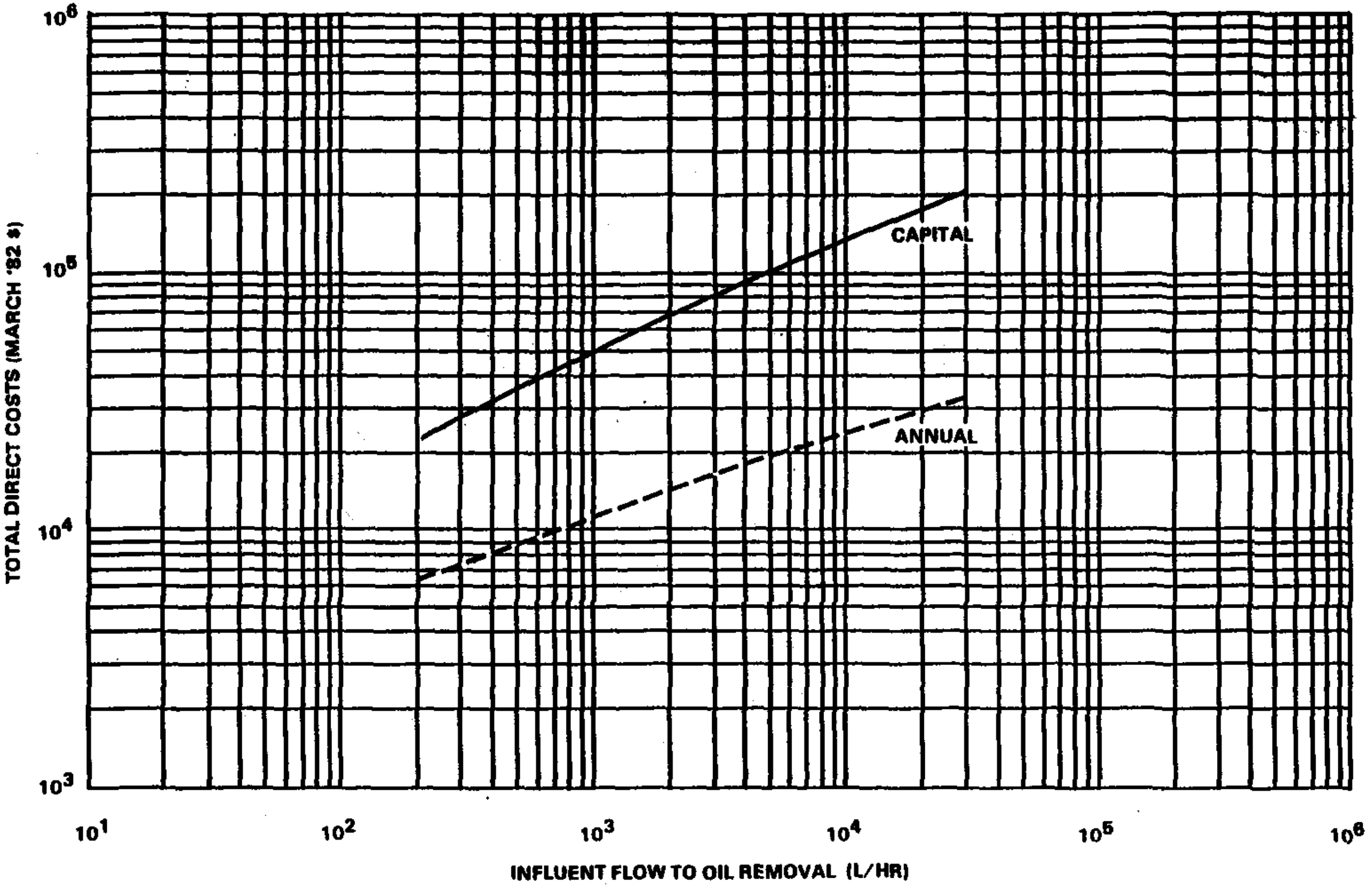


Figure VIII-7

COSTS OF OIL REMOVAL

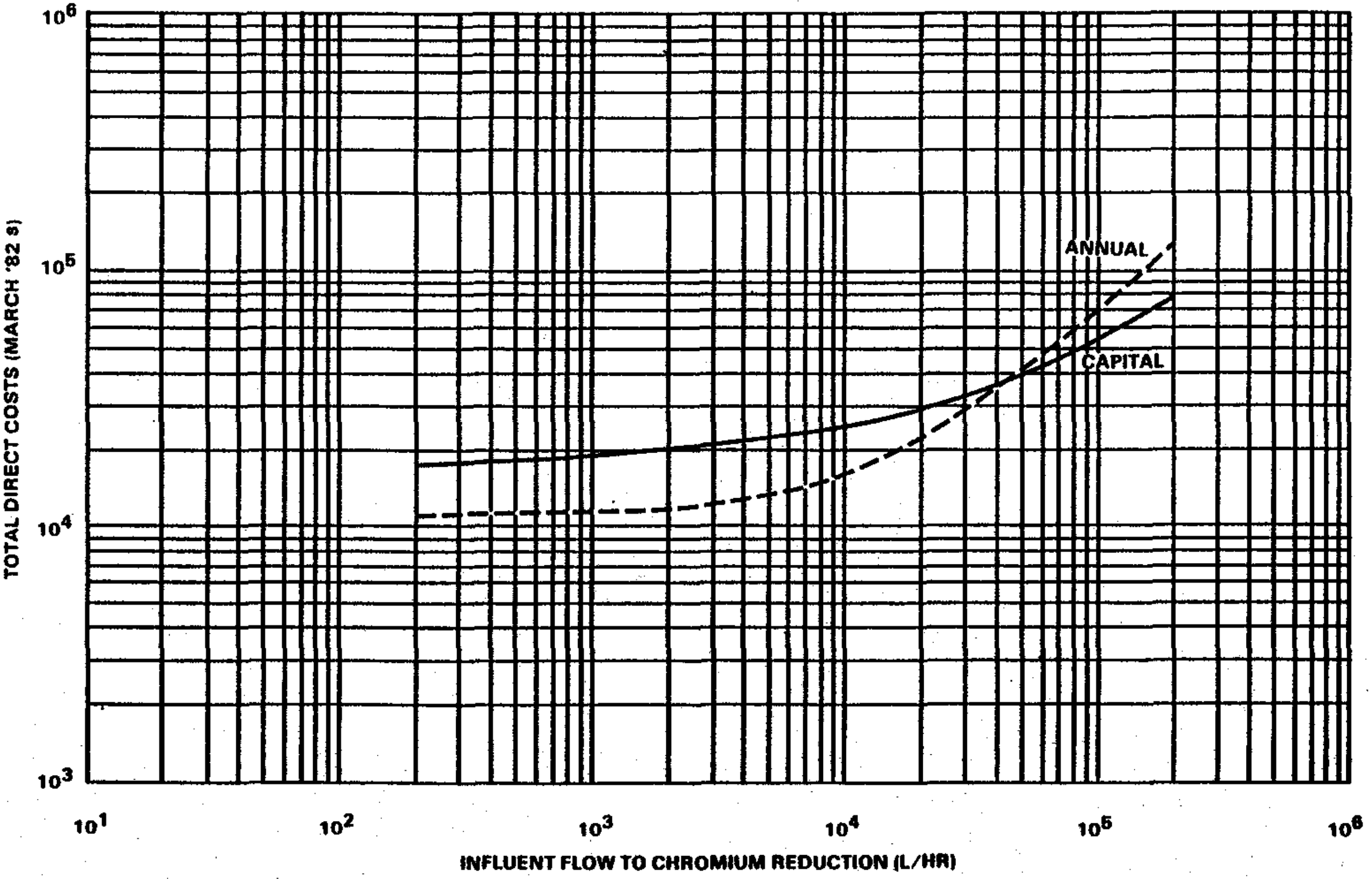


Figure VIII-8

COSTS OF CHROMIUM REDUCTION

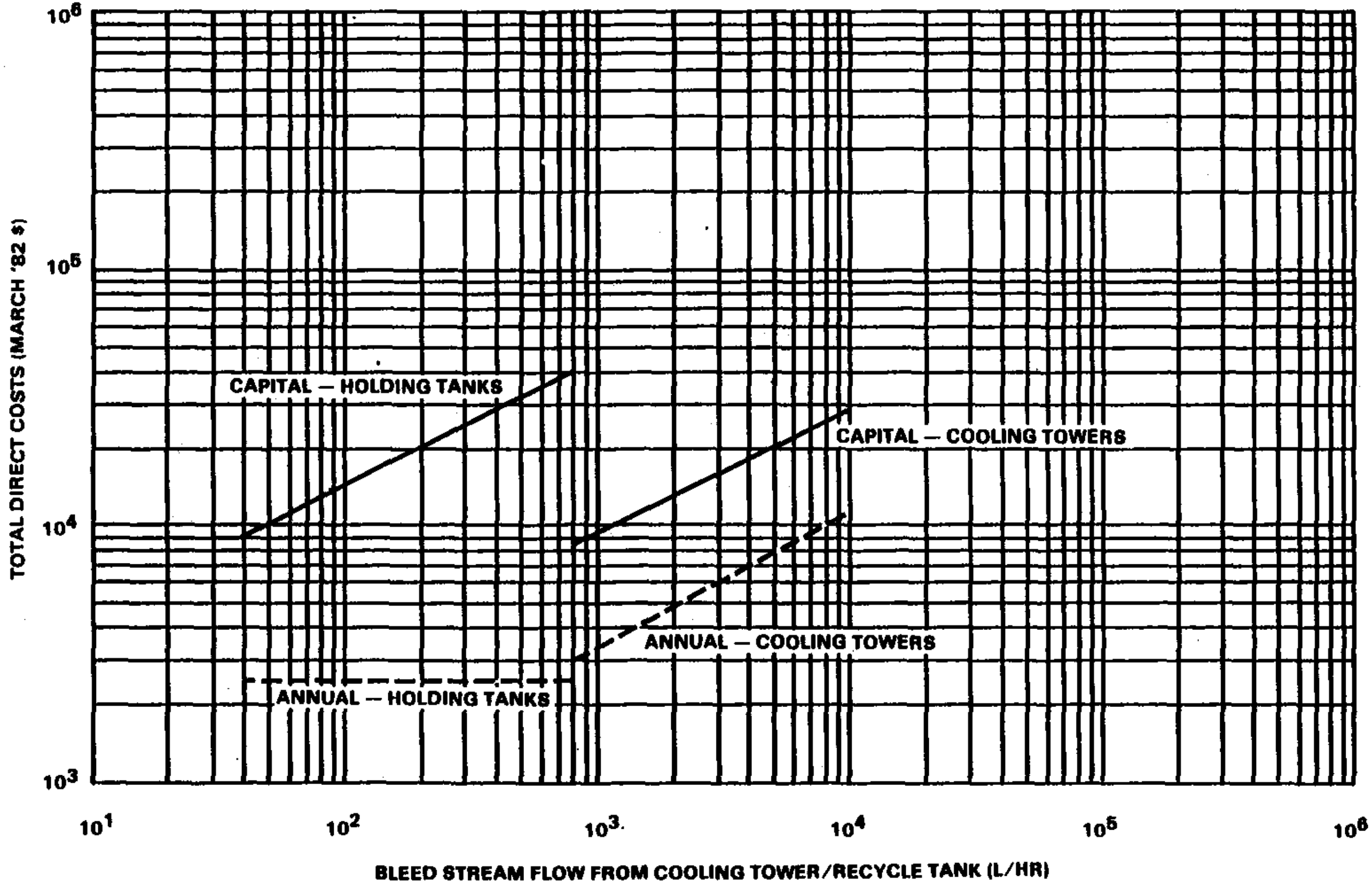


Figure VIII-9

COSTS OF COOLING TOWERS/TANKS

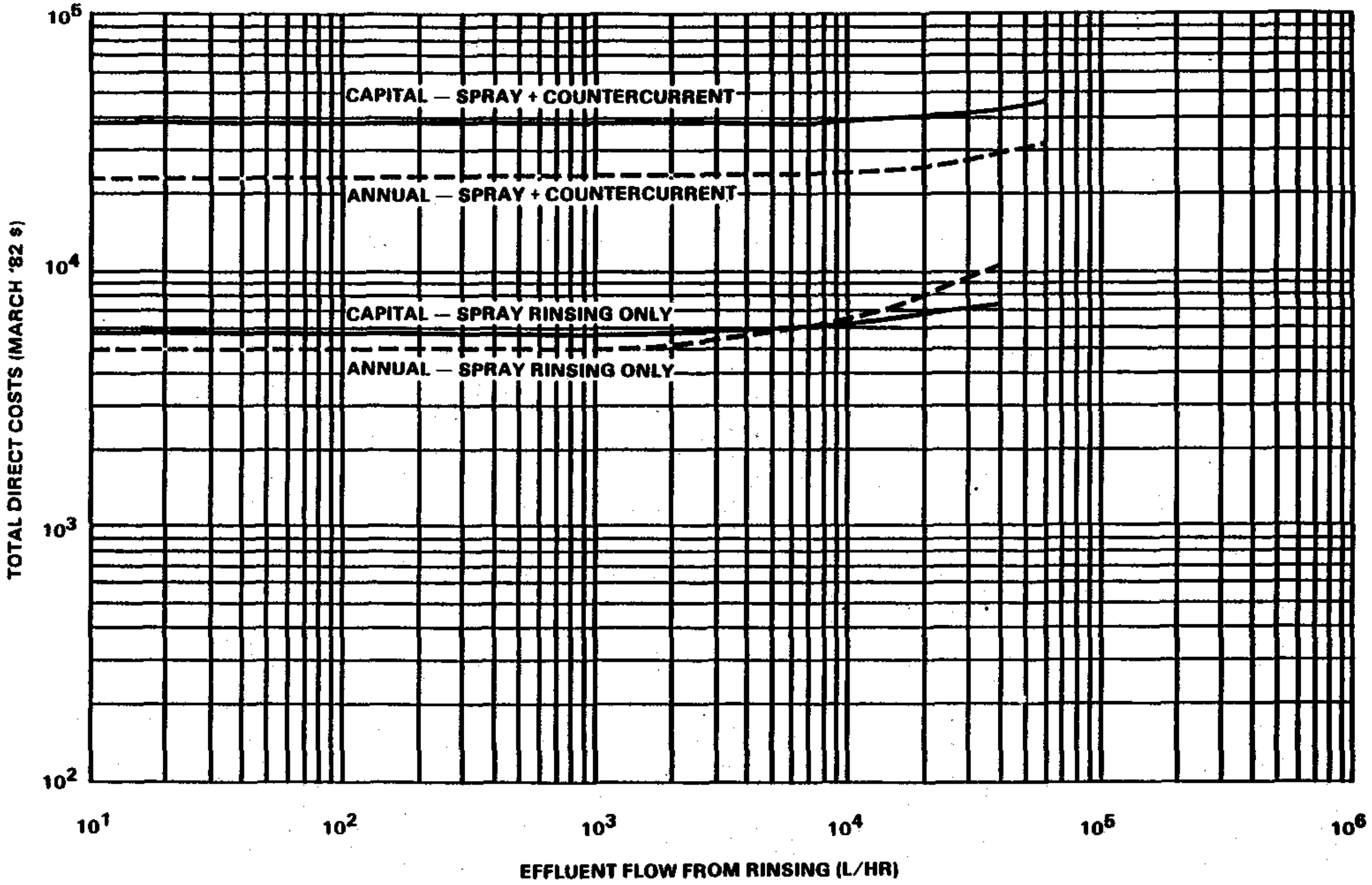


Figure VIII-10

COSTS OF RINSING

SECTION IX

BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

This section identifies the effluent characteristics attainable through the application of best practicable control technology currently available (BPT), Section 301(b)(1)(A). BPT reflects the existing performance by plants of various sizes, ages, and manufacturing processes within the copper forming category, as well as the established performance of the recommended treatment technologies. Particular consideration is given to the treatment already in place at plants within the data base.

The factors considered in identifying BPT include the total cost of applying the technology in relation to the effluent reduction benefits from such application, the age of equipment and facilities involved, the manufacturing processes employed, and nonwater quality environmental impacts (including energy requirements). In general, the BPT level represents the average of the best existing performances of plants of various ages, sizes, processes, or other common characteristics. Where existing performance is uniformly inadequate, BPT may be transferred from a different subcategory or category. Limitations based on transfer of technology are supported by a rationale concluding that the technology is, indeed, transferable, and a reasonable prediction that it will be capable of achieving the prescribed effluent limits (see Tanner's Council of America v. Train, 540 F.2d 1188 (4th Cir. 1976). BPT focuses on end-of-pipe treatment rather than process changes or internal controls, except where such practices are common industry practice.

TECHNICAL APPROACH TO BPT

The Agency studied the copper forming category to identify the manufacturing processes used and wastewaters generated during copper forming. EPA collected information from industry by data collection portfolios, and by sampling and analyzing wastewaters from specific plants.

Some of the factors which must be considered in establishing effluent limitations based on BPT have already been discussed. The age of equipment and facilities and processes employed were taken into account in the discussion of subcategorization (Section IV, p. 67). Nonwater quality impacts and energy requirements are considered in Section VIII (p. 399).

In making technical assessments of data and reviewing manufacturing processes, indirect and direct dischargers have been considered as a single group. An examination of plants and processes did not indicate any process differences based on the type of discharge, whether it be direct or indirect. However, in determining the technical basis representing the average of the best existing performance, EPA considered only direct dischargers.

Wastewater produced by the deformation operations contains significant concentrations of oil and grease, toxic organics, suspended solids, and toxic metals. Surface cleaning produces a rinse water in which significant concentrations of oil and grease, toxic organics, suspended solids, and toxic metals are found. The other surface treatment wastewaters have similar characteristics.

BPT for the copper forming category is based upon common treatment of combined streams. The general treatment scheme for BPT is to apply lime and settle technology to remove metals and solids from the combined wastewaters. Separate preliminary treatment steps for chromium reduction, chemical emulsion breaking, and oil skimming are to be utilized when required, as well as spray rinsing of forged parts. The BPT effluent concentrations are based on the performance of chemical precipitation and sedimentation (lime and settle) when applied to a broad range of metal-bearing wastewaters. The basis for lime and settle performance is set forth in substantial detail in Section VII (p. 263).

For each of the wastewater sources, a specific approach was followed for the development of BPT mass limitations. To account for the fact that plants with greater production will require greater water usage, a unit of production or production normalizing parameter (PNP) was determined for each waste stream which could then be related to the flow from the process to determine a production normalized flow. Selection of the PNP for each process element is discussed in Section IV. Each process was then analyzed to determine (1) whether or not included operations generated wastewater, (2) specific flow rates generated, and (3) the specific production normalized flows for each process.

Production normalized flows presented in Section V were analyzed to determine which flow was to be used as part of the basis for BPT mass limitations. The selected flow (referred to as a BPT regulatory flow or BPT flow) reflects the water use controls which are common practices within the industry. The BPT flow is based on the average of all applicable data.

The general assumption was made that all wastewaters generated were combined for treatment in a single or common treatment system. A disadvantage of common treatment is that some loss in pollutant removal effectiveness may result where waste streams containing specific pollutants at treatable levels are combined with other streams in which these same pollutants are absent or present at very low concentrations. Since treatment systems considered as the basis for BPT are primarily for metals, oil and grease, and suspended solids removal, and because they are found in most waste streams in treatable quantities the Agency did not reject common treatment. In addition, existing plants had one common treatment system in place, and a common treatment system is reasonable in terms of cost and effectiveness. Both treatment in place at copper forming plants and treatment in other categories having similar wastewaters were evaluated (see Section VII).

The overall effectiveness of end-of-pipe treatment for the removal of wastewater pollutants is improved by the application of water flow controls within the process to limit the volume of wastewater requiring treatment. The controls or in-process technologies recommended under BPT include only those measures which are demonstrated within the category: water conservation, recycle of hot rolling process water, recirculation of cold rolling and drawing lubricants, and for forged parts, spray rinsing and recirculation of pickling rinse water. Methods of water conservation are discussed in detail in Section VII under 'Reduction of Water Use' (p. 307); spray rinsing is also discussed in Section VII. Recycle of hot rolling process water was included because it is widely demonstrated in the copper forming catgory; nine of the twelve plants that reported water application and discharge rates reported recycling. Recycle rates ranged from 87 percent to 99.9 percent.

The Agency usually establishes wastewater pollutant limitations in terms of mass rather than concentration. This approach limits the total amount of pollutants discharged, thereby preventing the use of dilution as a treatment method. For the development of effluent limitations, mass loadings were calculated for each operation. This calculation was made for each forming and ancillary operation. The mass loadings (milligrams of pollutant per off-kilogram of production unit - mg/off-kg) were calculated by multiplying the BPT flow (l/kkg) by the concentration achievable using the BPT treatment system (mg/l) for each pollutant parameter regulated under BPT. The flows may be found in Table IX-1; the treatment effectiveness concentrations are presented in Table VII-20 (p. 336).

REGULATED POLLUTANT PARAMETERS

Pollutant parameters were selected for regulation in the copper forming category because of their frequent presence at high concentrations in untreated wastewaters. Chromium, copper, lead, nickel, and zinc, oil and grease, total suspended solids, and pH are regulated.

Total suspended solids, in addition to being present at high concentrations in raw wastewater from copper forming operations, are an important control parameter for metals removal in chemical precipitation and sedimentation treatment systems. The metals are precipitated as insoluble metal hydroxides, and effective solids removal is required in order to ensure reduced levels of toxic metals in the treatment system effluent. Total suspended solids are also regulated as a conventional pollutant to be removed from the wastewater prior to discharge.

Oil and grease is found at elevated concentrations in waste streams associated with lubrication and cooling, and alkaline cleaning, as well as heat treatment when oil is used as the heat treating medium. Generally the compounds measured by the analytical procedure for determining oil and grease are removed in skimming operations. When emulsions are used for lubrication it may be necessary to apply chemical emulsion breaking technology prior to oil skimming.

The importance of pH control for environmental reasons is documented in Section VI (p. 228), and its importance in metals removal technology is documented in Section VII (p. 243). Even small excursions from the optimum pH level can result in less than optimum functioning of the system and inability to achieve specified results. The optimum operating level is usually found to be pH 8.7 to 9.3. To allow a reasonable operating margin above this level and preclude the need for final pH adjustment, the effluent pH is specified to be within the range of 7.5 to 10 rather than the more common 6.0 to 9.0.

Hexavalent chromium and trivalent chromium, the two common valence states of chromium, comprise the total chromium parameter. Hexavalent chromium is found at high concentrations in wastewaters from pickling operations using sodium dichromate. Because chemical precipitation and settling only controls the trivalent form of chromium, the BPT model treatment technology also includes chemical reduction of chromium. As a result, although hexavalent chromium is not specifically regulated, it will be adequately controlled by the limitation on total chromium.

The toxic metals copper, lead, nickel, and zinc are regulated under BPT since they are present in the wastewater in significant concentrations from a large number of plants. As discussed in Section III (p. 54), lead, nickel, and zinc are used as alloying agents. Other toxic metals may be present in copper forming wastewaters when used as alloying additives or found as contaminants in copper and copper alloys. These metals, which include antimony, arsenic, beryllium, cadmium, silver, and selenium will be adequately controlled when the regulated metals are treated to the levels achievable by the model treatment technology.

DISCHARGE FLOWS

The BPT regulatory flows for the copper forming waste streams are presented in Table IX-1. The flows are expressed as liters per off metric ton of production (l/kkg). A discussion of how each of these flows was determined is presented below.

The flows which are used to calculate mass limitations and standards based on Option 1 technology were derived in the following manner. EPA examined the reported discharge flows for each operation, and then averaged the flows from plants demonstrating water use practices consistent with the majority of plants. In some instances, flows are based on in-process control when these controls are common industry practice.

Hot Rolling Spent Lubricant. The production normalized flow data for hot rolling spent lubricants are presented in Table V-2 (p. 90). Twenty-one plants reported information regarding wastewater discharge flows from hot rolling. Of the 21 plants, four reported no discharge from this operation and the remaining 17 reported discharges. Nine of the 17 reported recycle. The regulatory flow is based on the average of nine plants which reported recycle. Based on the magnitude of the reported discharge flow rates, the Agency believes that other plants practice recycle or some other method of flow reduction; however, we did not include these plants in the average because the plants did not specifically report recycle. Of the 21 plants which submitted discharge information for hot rolling spent lubricant, 15 are presently at or below the BPT regulatory flow. The BPT flow is 103 l/kkg.

Cold Rolling Spent Lubricant. The production normalized flow data for cold rolling spent lubricant are presented in Table V-3 (p. 91). The BPT flow allowance of 379 l/kkg is based on the average discharge flow rate of all 28 plants which reported a discharge.

Drawing Spent Lubricant. The production normalized flow data for drawing spent lubricant are presented in Table V-4 (p. 92). Of the 85 plants which have drawing operations, 63 currently achieve zero discharge through extensive recycling and contract hauling. However, zero discharge for this stream based on contract hauling may not provide any environmental benefit. Contract haulers merely transfer the waste to a waste treatment facility or an oil reclaimer who in turn processes the waste by recovering the oil component and discharging the water fraction either with or without treatment. The model treatment technologies used to establish BPT limits would effectively treat drawing spent lubricants.

Therefore, the Agency has decided to establish a flow allowance for this waste stream of 85 l/kkg, which is the average discharge reported by the 22 plants that discharge spent drawing lubricant. These plants routinely recirculated the lubricant as much as possible before discharging it, usually 95 to 99 percent. The flow allowance applies only to those drawers who treat their spent drawing lubricant and discharge the treated effluent at the copper forming site.

Solution Heat Treatment Contact Cooling Water. The production normalized flow data for solution heat treatment are presented in Table V-5 (p. 95). A review of these data revealed that the amount of water used and discharged does not vary significantly as a function of which major forming operation it follows. The BPT flow allowance is based on the average discharge flow rate of the 21 plants which reported a discharge of solution heat treatment wastewater. While three other plants reported zero discharge, the Agency believes that plants have to discharge a portion of the recirculating flow to prevent the buildup of dissolved solids. Therefore, these plants were not included in the average. The resulting flow allowance is 2,541 l/kkg.

Extrusion Press Solution Heat Treatment. The production normalized flow data for extrusion press solution heat treatment are presented in Table V-6 (p. 96). The BPT flow allowance of 2.00 l/kkg is based on the average discharge flow rate of the three plants which reported a discharge of extrusion press solution heat treatment wastewater.

Alkaline Cleaning Bath. The production normalized flow data for alkaline cleaning bath wastewater are presented in Table V-7 (p. 97). The BPT flow allowance of 46.7 l/kkg is based on the smaller of the two discharge flows reported. The larger reported flow (2,790 l/kkg) was not averaged because it is believed to be incorrectly reported. This flow was reported by a plant with a very small production of approximately 10 tons per year of copper tubing. This plant does not report rinsing following alkaline cleaning and therefore is probably showing a flow for both the bath and rinse streams.

Alkaline Cleaning Rinse. The production normalized flow data for alkaline cleaning rinses are presented in Table V-8 (p. 98). Only one plant reported recycle of alkaline cleaning rinse water. The BPT flow allowance of 4,214 l/kkg is based on the average flow of all five plants which reported a discharge of alkaline cleaning rinse wastewater. The plant practicing recycle was included in the average because flow was not significantly different from flows from plants without recycle.

Alkaline Cleaning Rinse for Forged Parts. The BPT flow allowance of 12,642 l/kkg is based on the production normalized flow of the one plant reporting a discharge of this waste stream for forged parts. A separate flow allowance for alkaline cleaning rinse for forged parts is established because rinsing of forged parts requires a greater amount of water than rinsing of other parts.

Annealing with Water. The production normalized flow data for annealing water are presented in Table V-9 (p. 99). Twenty-two of the 33 plants using annealing water reported a discharge. Eleven plants reported zero discharge of annealing water; however, they generally achieve zero discharge through natural evaporation or land application. Natural evaporation and land application is not available to all plants. The Agency believes that a periodic discharge from this waste is necessary to control levels of dissolved solids. Therefore, the BPT flow allowance is based on the average flow of all plants which reported a discharge. The BPT flow allowance is 5,667 l/kkg.

Annealing with Oil. The production normalized flow data for annealing oil are presented in Table V-10 (p. 101). Zero discharge is typically achieved through contract hauling of the relatively small quantities of annealing oil which are periodically dumped. There are no direct dischargers of annealing oil.

Pickling Bath. The production normalized flow data for pickling baths are presented in Table V-11 (p. 102). The BPT flow allowance of 116 l/kkg is based on the average flow of the 11 plants which reported discharges from pickling baths.

Pickling Rinse. The production normalized flow data for pickling rinses are presented in Table V-12 (p. 103). The reported values ranged from 65.58 to 257,000 l/kkg. Two plants reported production normalized flows approximately four times higher than any other reported values. The BPT flow allowance of 3,622 l/kkg is based on the median flow of all 40 plants which reported pickling rinse discharges. The median was used rather than the average to lessen the influence of the two extreme values.

Pickling Rinse of Forged Parts. The BPT flow allowance for pickling rinse for forged parts is established as 3,918 l/kkg. This is based on data from two forging plants that provided data on rinsing of forged parts (see Table V-14, p. 106). Other forging plants that reported rinsing flows did not practice recirculation or recirculated spray rinsing. Recirculated spray rinsing is more efficient than non-recirculated spray rinsing and is as efficient as the cascade rinsing reported. Recirculated spray rinsing is widely demonstrated on other pickling rinses within the category. Therefore, spray rinsing is the technology basis for the BPT flow and space constraints do not apply because additional tankage above presently available tankage is not required.

Pickling Fume Scrubbers. The production normalized flow data for pickling fume scrubbers are presented in Table V-13 (p. 105). The BPT flow allowance of 626 l/kkg is based on the average flow from two of the three plants which reported pickling fume scrubbers. The third and highest value was not included in the average because the Agency believes that it was incorrectly reported.

Tumbling or Burnishing. A regulatory flow allowance of 583 l/kkg is being established for the tumbling or burnishing waste stream. This allowance is based on the one plant that reported a discharge of this stream.

Surface Coating (Hot Coating). A surface coating operation may have any of the following wastewater sources associated with it: emission scrubbing water, the liquid flux bath, and the spent abrasive. The Agency was unable to obtain enough flow data for these sources to justify establishing a separate flow allowance for each of the sources; the flow data that the Agency was able to obtain was reported for the surface coating operation as a whole. Therefore, the Agency is setting one flow allowance for the surface coating waste stream. This flow allowance of 743 l/kkg is based on the data obtained from the one plant reporting a discharge from this stream. Direct process wastewater and fume scrubber blowdown are included in this allowance.

Miscellaneous Waste Streams. Miscellaneous waste streams include hydrotesting, sawing, surface milling, and maintenance. Three plants each submitted flow and production data on hydrotesting, sawing, and maintenance, respectively. It is believed that surface milling requires the same amount of process water as sawing because the operations are similar and water is used in both operations for lubrication and cooling. The sum of the production normalized flows for these four streams is 22.3 l/kkg, which has been established as the regulatory flow for miscellaneous waste streams.

Plants discharging greater than regulatory flows for a given stream may have to reduce their discharge rate for that process. Alternatively, in that plants are only required to comply with a total discharge mass based limit, plants have the option of substantially reducing their water discharges from other process operations by any means. Information from plant visits shows that many plants with large flows use water based on historical considerations without regard for actual process requirements. Consequently, the Agency believes that plants can achieve the BPT regulatory flows without engineering modifications and therefore should not incur significant costs.

WASTEWATER TREATMENT TRAIN

Option 1 discussed in Section X on page 451 represents the average of the best existing performance of pollution control technology currently used by copper forming plants. There are 36 plants in the copper forming category that use hydroxide precipitation and sedimentation. Twenty-five of these plants are direct dischargers. There are ten plants that use oil skimming and eight plants that practice hexavalent chromium reduction as preliminary treatment prior to chemical precipitation and sedimentation. Spray rinsing of pickled forged parts is demonstrated in two plants. Recycle of hot rolling spent lubricant is demonstrated in at least 13 plants in the category.

The BPT treatment train consists of chemical precipitation and sedimentation and preliminary treatment, where necessary, consisting of chemical emulsion breaking, oil skimming, and hexavalent chromium reduction. The effluent from preliminary treatment is combined with other wastewaters for common treatment by chemical precipitation and sedimentation. The hot rolling spent lubricant, cold rolling spent lubricant, annealing oil, extrusion press heat treatment, alkaline cleaning bath, alkaline cleaning rinse, alkaline cleaning rinse for forged parts, solution heat treatment, drawing spent lubricant, tumbling or burnishing, surface coating, and maintenance waste streams may require chemical emulsion breaking and oil skimming prior to combined treatment. The pickling bath and rinse and pickling rinse for forged parts waste streams may require hexavalent chromium treatment prior to combined treatment. The pickling fume scrubber and annealing water waste streams generally will not require any preliminary treatment. This treatment train is presented in Figure IX-1.

EFFLUENT LIMITATIONS

The effluent concentrations resulting from the application of the BPT technology are identical for all wastewater streams; however, the mass limitations vary for each waste stream depending on the regulatory flow. The effluent concentrations which were used as the basis for BPT mass limitations are presented in Table VII-20, p. 336, and the regulatory flows are summarized in Table IX-1, p. 437.

The treatment performance data discussed in Section VII are used to obtain maximum daily and monthly average pollutant concentrations. These concentrations (mg/l) along with the copper forming regulatory flows (l/kkg of copper processed) are used to obtain the maximum daily and monthly average values (mg/kg) for effluent limitations and standards. The monthly average values are based on the average of 10 consecutive sampling days. The 10 day average value was selected as the minimum number of consecutive samples which need to be averaged to arrive at a stable slope on a statistically based curve relating one day and 30 day average values, and it approximates the most frequent monitoring requirement of direct discharge permits. The monthly average numbers shown in the regulation are to be used by permit writers in writing direct discharge permits.

Effluent limitations representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available (BPT) are shown in Tables IX-1 through IX-8.

COMPLIANCE COSTS AND ENVIRONMENTAL BENEFITS

In establishing BPT, EPA considered the cost of treatment and control in relation to the effluent reduction benefits. BPT will remove 27,000 kilograms of toxic pollutants (metals and organics) and 56,000 kilograms of conventional and nonconventional pollutants per year beyond current discharge levels. The estimated capital investment cost to comply with BPT is $6.4 million (1982 dollars), with a total annual cost of $6.6 million. The Agency has determined that the effluent reduction benefits justify the cost of complying with this regulation.

Table IX-1

BAT REGULATORY FLOWS FOR COPPER FORMING WASTE STREAMS

Waste Stream	BAT Flow (l/kkg)
Hot Rolling Spent Lubricant	103
Cold Rolling Spent Lubricant	379
Drawing Spent Lubricant	85
Annealing Water	5,667
Annealing Oil	0
Solution Heat Treatment	2,541
Extrusion Press Heat Treatment	2
Pickling Fume Scrubber	626
Pickling Bath	116
Alkaline Bath	46.7
Pickling Rinse (Forged Parts)	3,918
Pickling Rinse (All Other Parts)	3,622
Alkaline Rinse (Forged Parts)	12,642
Alkaline Rinse (All Other Parts)	4,214
Tumbling or Burnishing	583
Surface Coating	743
Miscellaneous Waste Streams	22.3

Table IX-2

BPT FOR HOT ROLLING SPENT LUBRICANT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy hot rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy hot rolled		
Chromium	0.045	0.018
Copper	0.195	0.103
Lead	0.015	0.013
Nickel	0.197	0.130
Zinc	0.150	0.062
Oil and Grease	2.060	1.236
TSS	4.223	2.008
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-3

BPT FOR COLD ROLLING SPENT LUBRICANT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy cold rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy cold rolled		
Chromium	0.166	0.068
Copper	0.720	0.379
Lead	0.056	0.049
Nickel	0.727	0.481
Zinc	0.553	0.231
Oil and Grease	7.580	4.548
TSS	15.539	7.390
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-4

BPT FOR DRAWING SPENT LUBRICANT[1]

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy drawn English Units - lb/1,000,000 off-lbs of copper or copper alloy drawn		
Chromium	0.037	0.015
Copper	0.161	0.085
Lead	0.012	0.011
Nickel	0.163	0.107
Zinc	0.124	0.051
Oil and Grease	1.700	1.020
TSS	3.485	1.657
pH	(2)	(2)

[1] Applicable only to drawers who treat and discharge spent drawing lubricants.

[2] Within the range of 7.5 to 10.0 at all times.

Table IX-5

BPT FOR SOLUTION HEAT TREATMENT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated		
Chromium	1.118	0.457
Copper	4.827	2.541
Lead	0.381	0.330
Nickel	4.878	3.227
Zinc	3.709	1.550
Oil and Grease	50.820	30.492
TSS	104.181	49.549
pH	(2)	(2)

[2] Within the range of 7.5 to 10.0 at all times.

Table IX-6

BPT FOR EXTRUSION HEAT TREATMENT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated on an extrusion press English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated on an extrusion press		
Chromium	0.00088	0.00036
Copper	0.003	0.002
Lead	0.0003	0.00026
Nickel	0.003	0.002
Zinc	0.002	0.001
Oil and Grease	0.040	0.024
TSS	0.082	0.039
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-7

BPT FOR ANNEALING WITH WATER

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with water English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with water		
Chromium	2.493	1.020
Copper	10.767	5.667
Lead	0.850	0.736
Nickel	10.880	7.197
Zinc	8.273	3.456
Oil and Grease	113.340	68.004
TSS	232.347	110.506
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-8

BPT FOR ANNEALING WITH OIL

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with oil English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with oil		
Chromium	0	0
Copper	0	0
Lead	0	0
Nickel	0	0
Zinc	0	0
Oil and Grease	0	0
TSS	0	0
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-9

BPT FOR ALKALINE CLEANING RINSE

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	1.854	0.758
Copper	8.006	4.214
Lead	0.632	0.547
Nickel	8.090	5.351
Zinc	6.152	2.570
Oil and Grease	84.280	50.568
TSS	172.774	82.173
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-10

BPT FOR ALKALINE CLEANING RINSE FOR FORGED PARTS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts alkaline cleaned		
Chromium	5.562	2.275
Copper	24.019	12.642
Lead	1.896	1.643
Nickel	24.272	16.055
Zinc	18.457	7.711
Oil and Grease	252.840	151.704
TSS	518.322	246.519
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-11

BPT FOR ALKALINE CLEANING BATH

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	0.020	0.0084
Copper	0.089	0.046
Lead	0.0070	0.0060
Nickel	0.089	0.059
Zinc	0.068	0.028
Oil and Grease	0.93	0.56
TSS	1.91	0.91
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-12

BPT FOR PICKLING RINSE

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	1.593	0.651
Copper	6.881	3.622
Lead	0.543	0.470
Nickel	6.954	4.599
Zinc	5.288	2.209
Oil and Grease	72.440	43.464
TSS	148.502	70.629
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-13

BPT FOR PICKLING RINSE FOR FORGED PARTS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts pickled		
Chromium	1.723	0.705
Copper	7.444	3.918
Lead	0.587	0.509
Nickel	7.522	4.975
Zinc	5.720	2.389
Oil and Grease	78.360	47.016
TSS	160.638	76.401
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-14

BPT FOR PICKLING BATH

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.051	0.020
Copper	0.220	0.116
Lead	0.017	0.015
Nickel	0.222	0.147
Zinc	0.169	0.070
Oil and Grease	2.320	1.392
TSS	4.756	2.262
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-15

BPT FOR PICKLING FUME SCRUBBER

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.275	0.112
Copper	1.189	0.626
Lead	0.093	0.081
Nickel	1.201	0.795
Zinc	0.913	0.381
Oil and Grease	12.520	7.512
TSS	25.666	12.207
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-16

BPT FOR TUMBLING OR BURNISHING

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy tumbled or burnished English Units - lb/1,000,000 off-lbs of copper or copper alloy tumbled or burnished		
Chromium	0.256	0.104
Copper	1.107	0.583
Lead	0.087	0.075
Nickel	1.119	0.740
Zinc	0.851	0.355
Oil and Grease	11.660	6.996
TSS	23.903	11.368
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-17

BPT FOR SURFACE COATING

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy surface coated English Units - lb/1,000,000 off-lbs of copper or copper alloy surface coated		
Chromium	0.326	0.133
Copper	1.411	0.743
Lead	0.111	0.096
Nickel	1.426	0.943
Zinc	1.084	0.453
Oil and Grease	14.680	8.916
TSS	30.463	14.488
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table IX-18

BPT FOR MISCELLANEOUS WASTE STREAMS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy formed English Units - lb/1,000,000 off-lbs of copper or copper alloy formed		
Chromium	0.009	0.003
Copper	0.041	0.021
Lead	0.003	0.002
Nickel	0.041	0.027
Zinc	0.031	0.013
Oil and Grease	0.436	0.261
TSS	0.893	0.425
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

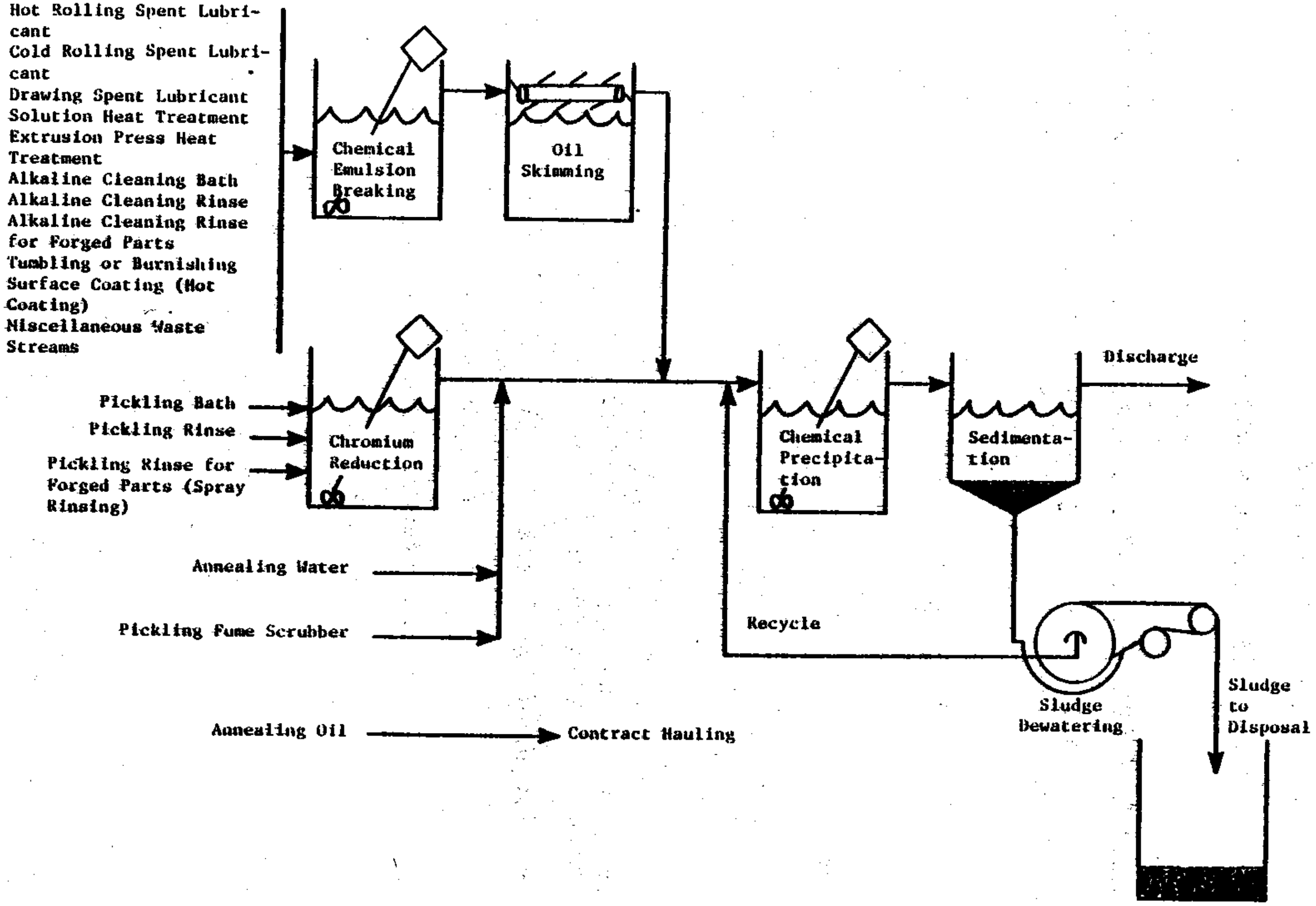


Figure IX-1

BPT TREATMENT TRAIN

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SECTION X

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

The factors considered in assessing best available technology economically achievable (BAT) include the age of equipment and facilities involved, the process employed, process changes, non-water quality environmental impacts (including energy requirements) and the costs of application of such technology (Section 304(b)(2)(B)). In general, the BAT technology level represents, at a minimum, the best existing economically achievable performance of plants of various ages, sizes, processes or other shared characteristics. As with BPT, in those categories where existing performance is universally inadequate, BAT may be transferred from a different subcategory or category. BAT may include process changes or internal controls, even when not common industry practice.

TECHNICAL APPROACH TO BAT

The Agency reviewed a wide range of technology options and evaluated the available possibilities to ensure that the most effective and beneficial technologies were used as the basis of BAT. To accomplish this, the Agency elected to examine technology alternatives which could be applied to copper forming as BAT options and which would represent substantial progress toward prevention of polluting the environment above and beyond progress achievable by BPT. The statutory assessment of BAT considers costs, but does not require a balancing of costs against effluent reduction benefits see [Weyerhaeuser v. Costle, 11 ERC 2149 (D.C. Cir. 1978)]; however, in assessing the proposed BAT, the Agency has given substantial weight to the reasonableness of costs.

At proposal, we evaluated five BAT options. Option 1 is the recommended BPT treatment. Option 2 is the recommended BPT treatment plus flow reduction. Option 3 provides additional treatment by including end-of-pipe filtration technology, and Option 4 is Option 3 plus additional flow reduction of pickling rinsewater through the use of countercurrent cascade rinsing. Option 5 adds filtration as an end-of-pipe treatment process to Option 1 which does not include flow reduction. Each treatment technology option is based on common treatment of all waste streams and results in the same concentrations of pollutants in the effluent regardless of the number and combinations of copper forming waste streams entering the treatment system. Mass limitations derived from these options may vary because of the impact of different regulatory flows. The derivation of these regulatory flows is discussed later in this section.

In summary form, the treatment technologies considered for BAT for copper forming are:

Option 1 (Figure X-1) based on:

- Lime and settle (chemical precipitation of metals, followed by sedimentation), and where required
- Chemical emulsion breaking,
- Oil skimming,
- Chemical reduction of hexavalent chromium, and
- Spray rinsing and recirculation of the pickling rinse stream for forged parts, and
- Recycle of hot rolling lubricant.

This option is equivalent to the technologies on which BPT limitations are based.

Option 2 (Figure X-2) based on:

Option 1, plus process wastewater flow reduction by the following methods:

- Recycle of solution heat treatment contact cooling water,
- Recycle of annealing contact cooling water, and
- Spray rinsing and recirculation of the pickling rinse stream for all pickling operations.

This option is equivalent to the technology on which BAT limitations are based.

Option 3 (Figure X-3) based on:

Option 2, plus polishing filtration (multimedia).

Option 4 (Figure X-4) based on:

Option 3, plus further reduction of flow through the use of countercurrent cascade rinsing on the pickling rinse stream.

Option 5 (Figure X-5) based on:

Option 1, plus polishing filtration (multimedia).

The Agency considered but ultimately rejected thermal emulsion breaking as a treatment component of BAT. Thermal emulsion breaking is practiced at six copper forming plants. This process removes water from oil emulsions, allowing the water to be reused and the oil to be reused or disposed of efficiently, usually by contract hauling. Thermal emulsion breaking has high energy requirements and, with the rapid escalation of energy costs over the last decade, is a high cost technology. EPA did not include thermal emulsion breaking as part of the BAT model technology because plants using chemical emulsion breaking in combination with oil skimming will achieve the same level of oil removal as plants using thermal emulsion breaking. Most copper forming plants will use chemical emulsion breaking because it will be less expensive than thermal emulsion breaking; however, plants with waste heat available may want to use thermal emulsion breaking to achieve the BPT oil and grease limitation.

OPTION 1

Option 1 represents the BPT end-of-pipe treatment technology. This treatment train consists of preliminary treatment, when necessary, of chemical emulsion breaking and oil skimming, and hexavalent chromium reduction. The effluent from preliminary treatment is combined with other wastewaters for common treatment by lime and settle. Option 1 is also based on spray rinsing and recirculation of the pickling rinse stream for forged parts.

OPTION 2

Option 2 builds upon the BPT end-of-pipe treatment technologies of skimming, lime and settle with preliminary treatment to reduce hexavalent chromium and chemically break emulsions. Flow reduction measures, based on in-process changes, are the mechanisms for reducing pollutant discharges at Option 2. The flow reduction measures concentrate the pollutants present in these waste streams. Treatment of a more concentrated stream allows a greater net removal of pollutants and economies of treating a reduced flow. The methods for reducing process wastewater generation include recycle of solution heat treatment contact cooling water and annealing contact cooling water through cooling towers and recirculation. Spray rinsing and recirculation of the rinsewater is the method for reducing wastewater discharges from the pickling rinse waste stream. These in-plant control measures were discussed in detail in Section VII (p. 307).

OPTION 3

Option 3 builds upon the technical basis of Option 2 by adding conventional multimedia filtration after the Option 2 treatment train and the in-process flow reduction controls. Gravity, mixed-media filtration was used as the technical basis for establishing treatment performance of filtration in Section VII (p. 273). EPA believes that other filtration technologies such as pressure filtration are equally applicable.

OPTION 4

Option 4 builds upon the technologies established for Option 3 by adding another in-process flow reduction control, countercurrent cascade rinsing for the pickling rinse waste stream.

OPTION 5

Option 5 builds upon the technical basis of Option 1 by adding conventional multimedia filtration after the Option 1 treatment train.

BAT OPTION SELECTION

For BAT, EPA is promulgating limitations based on Option 2. Option 2 treatment technology will result in substantial reduction of toxic pollutants above the removal achievable by BPT. This technology option is comprised of Option 1 (BPT) plus flow reduction. Flow reduction consists of recycle of the annealing water and solution heat treatment streams, and spray rinsing and recirculation of all pickling rinse water. End-of-pipe treatment in this technology is equivalent to Option 1, which consists of chemical precipitation and sedimentation and, where required, chemical emulsion breaking, oil skimming, and hexavalent chromium reduction. All wastes are treated centrally. The recommended BAT treatment achieves the concentrations discussed in Section VII (p. 263). These concentrations, called treatment effectiveness values for lime and settle, are the same for both BPT and BAT. The incremental pollutant removal brought about by BAT results solely from in-process flow reduction. Flow reduction results in greater removal of pollutants because the lower volume of wastewater discharge at BAT contains the same concentrations of pollutants as the higher volume discharged at BPT. The discharge flows and the rationale for the selection of these flows are presented in a later subsection, entitled Discharge Flows (p. 453).

The Agency has decided not to include filtration as part of the model BAT technology. Of the 8,000 kg/yr of toxic pollutants discharged after BPT, BAT model treatment technology is estimated to remove 4,000 kg/yr of toxic pollutants or a total removal of 89 percent of the total current discharge. The addition of filtration would remove approximately 5,000 kg/yr of toxic pollutants discharged after BPT or a total removal of 91 percent of the total current discharge. This equates to an additional removal of approximately 0.1 kg of toxic pollutants per day per discharger. The incremental costs of these effluent reductions are $1.4 million in capital cost and $1.1 million in total annual costs for all direct dischargers. The Agency believes that given all of these factors, the costs involved do not warrant selection of filtration as a part of the BAT model treatment technology.

The Agency has decided to reject Option 4, which is based on the installation of countercurrent cascade rinsing for pickling because it is only demonstrated at four copper forming plants and because most of the other existing plants lack sufficient space to add the additional rinse tank and associated piping necessary for countercurrent cascade rinsing.

The Agency has decided to reject Option 5, which is based on filtration added to Option 1 because it provides only one-fourth as much pollutant removal as Option 2 at approximately the same costs.

REGULATED POLLUTANT PARAMETERS

In implementing the terms of the Settlement Agreement in NRDC v. Train, 8 ERC 2120 (D.D.C. 1976); modified, 12 ERC 1833 (D.D.C. 1979) and in accordance with 33 U.S.C. 1314(b)(2)(A and B) (1976), the Agency places particular emphasis on the toxic pollutants. The raw wastewater concentrations from the individual operations and the category as a whole were examined to select those pollutant parameters found at frequencies and concentrations warranting regulation.

The toxic metals regulated are chromium, copper, lead, nickel and zinc. Six toxic metals, antimony, arsenic, beryllium, cadmium, silver, and selenium, which are not specifically regulated will be adequately controlled when the regulated metals are treated to the levels achievable by the model treatment technology. The toxic organics selected for regulation in Section VI are not specifically regulated at BAT because the oil and grease limitation at BPT will provide effective removal. Refer to Section VII (p. 256) for an expanded discussion of the removal effectiveness of the toxic organics with the application of oil skimming. (See Table VII-10 and Figure VII-9, pp. 326 and 352).

DISCHARGE FLOWS

EPA studied each of the waste streams to assess the potential for flow reduction at BAT by using the information provided in the dcp and by observing examples of flow reduction during the sampling trips. Flow reduction techniques demonstrated in this category include recycle of solution heat treatment contact cooling water and annealing contact cooling water through cooling towers, spray rinsing of recirculated rinse water, and countercurrent cascade rinsing. Spray rinsing is practiced on pickling lines in 16 plants and likewise four plants use countercurrent rinsing.

In the case of pickling and alkaline cleaning rinse allowances for forged parts, the Agency considered countercurrent rinsing for additional flow reduction beyond the BPT basis of spray rinsing. However, as at proposal, it was determined that most existing plants that perform forging operations do not have sufficient space to install the tanks required for countercurrent rinsing. Therefore, the BAT regulatory flow allowances for these two streams are equivalent to those provided at BPT. In the case of drawing spent lubricant, the BPT regulatory flow allowance is based on extensive recycle; the Agency has no data available to support flow reduction for this stream beyond that required at BPT. Tumbling or burnishing, surface coating, and miscellanoues waste stream allowances are based on current reported industry practice and do not require in-process flow reduction controls. These streams have extremely low flows and will only increase BAT pollutant discharges above proposed levels by less than two percent. Accordingly, further flow reduction would not have a significant impact on pollutant removal.

Therefore, the BAT regulatory flow allowances are equal to the BPT flow allowances for all of the copper forming waste streams except solution heat treatment, annealing water, and pickling rinse. The BAT flow allowances for these three streams are presented in Table X-1. A discussion of how each of these three flows was determined follows.

Solution Heat Treatment. The production normalized flow data for solution heat treatment are presented in Table V-5 (p. 95). Recycle is practiced by eight of the 24 plants which reported solution heat treatment. The reported recycle rates range from 85 percent to 100 percent. The plants currently recycling this water are using cooling towers to remove excess heat. Although three plants reported no discharge of wastewater from solution heat treatment, the Agency believes that most plants have to discharge a portion of the recirculating flow to prevent the buildup of dissolved solids. Consequently, these three plants were not used to obtain the average. The Agency based the BAT regulatory flow allowance of 646 l/kkg on the average of the flows reported by the five plants which not only practice recycle but also reported discharge flow rates.

Annealing with Water. The production normalized flow data for annealing water are presented in Table V-9 (p. 99). Eleven plants reported zero discharge of annealing water. The Agency did not select zero discharge for BAT because they generally achieve zero discharge through natural evaporation or land application. This disposal method requires large amounts of land and is not feasible for most existing plants. Six of the 22 plants which discharge annealing water practice recycle. The reported recycle rates for these six plants range from 50 percent to 98 percent. Plants recycling this water do so in the same manner as plants recycling solution heat treatment water. As such, EPA based the regulatory flow allowance of 1,240 l/kkg on the average flow reported by the six discharging plants which practice recycle.

Pickling Rinse. The production normalized flow data for pickling rinses are presented in Table V-12 (p. 103). Sixteen of the 42 plants reporting pickling rinse water use spray rinsing. Five other plants did not indicate in the dcp that spray rinsing was used, but based on the reported discharge flow rates the Agency believes that these plants are using spray rinsing or an equivalent flow reduction technique to attain these flows. EPA based the BAT regulatory flow on the average of the 21 plants which represent the lower fifthieth percentile of the reported production normalized flows. The BAT regulatory flow is 1,300 l/kkg.

WASTEWATER TREATMENT TRAIN

EPA has selected Option 2 as the basis for BAT in this category. Again, this option uses the same technology as BPT, with the addition of measures to reduce the flows from selected waste streams. The end-of-pipe treatment configuration is shown in Figure X-2. The combination of in-process control and treatment technology significantly increases the removals of pollutants over that achieved by BPT.

EFFLUENT LIMITATIONS

Table VII-20 (p. 336) presents the treatment effectiveness corresponding to the BAT treatment train for the pollutants selected. Effluent concentrations (one day maximum and ten day average values) are multiplied by the regulatory discharge flows summarized in Table X-1 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Table X-2 through X-8.

COMPLIANCE COSTS AND ENVIRONMENTAL BENEFITS

In establishing BAT, EPA considered the cost of treatment and control in relation to the effluent reduction benefits. The application of the proposed BAT will remove 31,000 kilograms per year of toxic pollutants (metals and organics) from current discharge levels. The estimated capital investment cost is $6.5 million (1982 dollars) for equipment and in-process changes not presently in place and a total annual cost of $6.3 million for all equipment and in-process changes.

The incremental effluent reduction benefits of BAT above BPT are the removal annually of 4,000 kg of toxic pollutants. The incremental costs of these benefits are $0.10 million capital cost; there are no additional annual costs required. Thus, we conclude that the costs to achieve the effluent reduction benefits associated with the BAT limitations are economically achievable.

Table X-1

BAT REGULATORY FLOWS FOR COPPER FORMING WASTE STREAMS

Waste Stream	BAT Flow (1/kkg)
Hot Rolling Spent Lubricant	103
Cold Rolling Spent Lubricant	379
Drawing Spent Lubricant	85
Annealing Water	1,240
Annealing Oil	0
Solution Heat Treatment	646
Extrusion Press Heat Treatment	2
Pickling Fume Scrubber	626
Pickling Bath	116
Alkaline Bath	46.7
Pickling Rinse (Forged Parts)	3,918
Pickling Rinse (All Other Parts)	1,300
Alkaline Rinse (Forged Parts)	12,642
Alkaline Rinse (All Other Parts)	4,214
Tumbling or Burnishing	583
Surface Coating	743
Miscellaneous Waste Streams	22.3

Table X-2

BAT FOR HOT ROLLING SPENT LUBRICANT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy hot rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy hot rolled		
Chromium	0.045	0.018
Copper	0.195	0.103
Lead	0.015	0.013
Nickel	0.197	0.130
Zinc	0.150	0.062

Table X-3

BAT FOR COLD ROLLING SPENT LUBRICANT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy cold rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy cold rolled		
Chromium	0.166	0.068
Copper	0.720	0.379
Lead	0.056	0.049
Nickel	0.727	0.481
Zinc	0.553	0.231

Table X-4

BAT FOR DRAWING SPENT LUBRICANT[1]

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy drawn English Units - lb/1,000,000 off-lbs of copper or copper alloy drawn		
Chromium	0.037	0.015
Copper	0.161	0.085
Lead	0.012	0.011
Nickel	0.163	0.107
Zinc	0.124	0.051

[1] Applicable only to drawers who treat and discharge spent drawing lubricants.

Table X-5

BAT FOR SOLUTION HEAT TREATMENT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated		
Chromium	0.284	0.116
Copper	1.227	0.646
Lead	0.096	0.083
Nickel	1.240	0.820
Zinc	0.943	0.394

Table X-6

BAT FOR EXTRUSION HEAT TREATMENT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated on an extrusion press English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated on an extrusion press		
Chromium	0.00088	0.00036
Copper	0.003	0.0020
Lead	0.0003	0.00026
Nickel	0.003	0.002
Zinc	0.002	0.001

Table X-7

BAT FOR ANNEALING WITH WATER

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with water English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with water		
Chromium	0.545	0.223
Copper	2.356	1.240
Lead	0.186	0.161
Nickel	2.380	1.574
Zinc	1.810	0.756

Table X-8

BAT FOR ANNEALING WITH OIL

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with oil English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with oil		
Chromium	0	0
Copper	0	0
Lead	0	0
Nickel	0	0
Zinc	0	0

Table X-9

BAT FOR ALKALINE CLEANING RINSE

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	1.854	0.758
Copper	8.006	4.214
Lead	0.632	0.547
Nickel	8.090	5.351
Zinc	6.152	2.570

Table X-10

BAT FOR ALKALINE CLEANING RINSE FOR FORGED PARTS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts alkaline cleaned		
Chromium	5.562	2.275
Copper	24.019	12.642
Lead	1.896	1.643
Nickel	24.272	16.055
Zinc	18.457	7.711

Table X-11

BAT FOR ALKALINE CLEANING BATH

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	0.020	0.0084
Copper	0.088	0.046
Lead	0.0070	0.0060
Nickel	0.089	0.059
Zinc	0.068	0.028

Table X-12

BAT FOR PICKLING RINSE

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.574	0.235
Copper	2.481	1.306
Lead	0.195	0.169
Nickel	2.507	1.658
Zinc	1.906	0.796

Table X-13

BAT FOR PICKLING RINSE FOR FORGED PARTS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts pickled		
Chromium	1.723	0.705
Copper	7.444	3.918
Lead	0.587	0.509
Nickel	7.522	4.975
Zinc	5.720	2.389

Table X-14

BAT FOR PICKLING BATH

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.051	0.020
Copper	0.220	0.116
Lead	0.017	0.015
Nickel	0.222	0.147
Zinc	0.169	0.070

Table X-15

BAT FOR PICKLING FUME SCRUBBER

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.275	0.112
Copper	1.189	0.626
Lead	0.093	0.081
Nickel	1.201	0.795
Zinc	0.913	0.381

Table X-16

BAT FOR TUMBLING OR BURNISHING

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy tumbled or burnished English Units - lb/1,000,000 off-lbs of copper or copper alloy tumbled or burnished		
Chromium	0.256	0.104
Copper	1.107	0.583
Lead	0.087	0.075
Nickel	1.119	0.740
Zinc	0.851	0.355

Table X-17

BAT FOR SURFACE COATING

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy surface coated English Units - lb/1,000,000 off-lbs of copper or copper alloy surface coated		
Chromium	0.326	0.133
Copper	1.411	0.743
Lead	0.111	0.096
Nickel	1.426	0.943
Zinc	1.084	0.453

Table X-18

BAT FOR MISCELLANEOUS WASTE STREAMS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy formed English Units - lb/1,000,000 off-lbs of copper or copper alloy formed		
Chromium	0.009	0.003
Copper	0.041	0.021
Lead	0.003	0.002
Nickel	0.041	0.027
Zinc	0.031	0.013

Table X-19

POLLUTANT REDUCTION BENEFITS - NORMAL PLANT

Pollutant	Raw Waste	Option 1		Option 2		Option 3		Option 4	
Flow (l/yr)	450×10^6	276.2×10^6		99.1×10^6		99.1×10^6		73.1×10^6	
	kg/yr	Removed kg/yr	Discharged kg/yr	Removed kg/yr	Discharged kg/yr	Removed kg/yr	Discharged kg/yr	Removed kg/yr	Discharged kg/yr
114. Antimony	4.9	0.0	4.9	0.0	4.9	0.0	4.9	0.0	4.9
115. Arsenic	22.8	0.0	22.8	0.0	22.8	0.0	22.8	0.0	22.8
118. Cadmium	15.2	0.0	15.2	7.4	7.8	10.4	4.9	11.7	3.6
119. Chromium	2,428.4	2,405.2	23.2	2,420.0	8.3	2,421.4	6.9	2,423.3	5.1
120. Copper	43,229.1	43,068.9	160.2	43,171.6	57.5	43,190.4	38.6	43,200.5	28.5
122. Lead	228.0	194.8	33.1	216.1	11.9	220.0	7.9	221.1	5.8
~~124. Nickel~~	~~525.5~~	~~321.1~~	~~204.4~~	~~452.2~~	~~73.3~~	~~503.7~~	~~21.8~~	~~509.4~~	~~16.1~~
125. Selenium	250.4	167.6	82.9	220.7	29.7	230.6	19.8	235.8	14.6
126. Silver	7.1	0.0	7.1	0.0	7.1	0.2	6.9	2.0	5.1
128. Zinc	41,971.1	41,879.9	91.1	41,938.3	32.7	41,948.3	22.8	41,954.2	16.8
TTO	374.5	344.2	30.4	363.6	10.9	363.6	10.9	366.5	8.0
Fluoride	1,446.5	0.0	1,446.5	9.5	1,437.0	9.5	1,437.0	386.5	1,060.0
Iron	871.4	758.2	113.2	830.8	40.6	843.7	27.7	850.9	20.5
TSS	499,121.5	495,807.1	3,314.4	497,932.3	1,189.2	498,863.8	257.7	498,931.4	190.1
Oil and Grease	538,952.5	536,190.5	2,762.0	537,961.5	991.0	537,961.5	991.0	538,221.5	731.0
TOTAL TOXIC METALS	88,684.4	88,039.4	645.0	88,428.3	256.1	88,527.0	157.4	88,561.1	123.4
TOTAL TOXICS	89,059.0	88,383.6	675.4	88,792.0	267.0	88,890.7	168.3	88,927.6	131.4
TOTAL NONCONVENTIONALS	2,317.9	758.2	1,559.7	840.3	1,477.6	853.2	1,464.7	1,237.5	1,080.4
TOTAL CONVENTIONALS	1,038,074.0	1,031,997.6	6,076.4	1,035,893.8	2,180.2	1,036,825.3	1,248.7	1,037,152.9	921.1
TOTAL POLLUTANTS	1,129,450.9	1,121,139.3	8,311.5	1,125,526.1	3,924.8	1,126,569.2	2,881.7	1,127,318.0	2,009.5
Sludge (kg/yr)		5,923,600		5,951,100		5,958,200		5,966,300	

Table X-20

TREATMENT PERFORMANCE - NORMAL PLANT

Pollutant	Combined Raw Waste		Option 1		Option 2		Option 3		Option 4	
Flow l/kkg	2,702		1,658		595		595		439	
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
114. Antimony	0.01	27.0	0.02	27.0	0.05	27.0	0.05	27.0	0.07	27.0
115. Arsenic	0.05	135.1	0.08	135.1	0.23	135.1	0.23	135.1	0.31	135.1
118. Cadmium	0.03	81.1	0.06	81.1	0.08	47.6	0.05	29.8	0.05	22.0
119. Chromium	5.40	14,590.8	0.08	132.6	0.08	47.6	0.07	41.7	0.07	30.7
120. Copper	96.06	259,554.1	0.58	961.6	0.58	345.1	0.39	232.1	0.39	171.2
122. Lead	0.51	1,378.0	0.12	199.0	0.12	71.4	0.08	47.6	0.08	35.1
124. Nickel	1.17	3,161.3	0.74	1,226.9	0.74	440.3	0.22	130.9	0.22	96.6
125. Selenium	0.56	1,513.1	0.30	497.4	0.30	178.5	0.20	119.0	0.20	87.8
126. Silver	0.02	54.0	0.03	54.0	0.072	54.0	0.07	41.7	0.07	30.7
128. Zinc	93.27	252,015.5	0.33	547.1	0.33	196.35	0.23	136.9	0.23	101.0
TTO	0.83	2,242.7	0.11	182.4	0.11	65.45	0.11	65.5	0.11	48.3
Fluoride	3.21	8,673.4	5.24	8,673.4	14.50	8,627.5	14.50	8,627.5	14.50	6,368.4
Iron	1.94	5,241.9	0.41	679.8	0.41	244.0	0.28	166.6	0.28	123.0
TSS	1,109.16	2,996,950.3	12.00	19,896.0	12.00	7,140.0	2.60	1,547.0	2.60	1,141.9
Oil and Grease	1,197.67	3,236,104.3	10.00	16,580.0	10.00	5,950.0	10.00	5,950.0	10.00	4,390.0

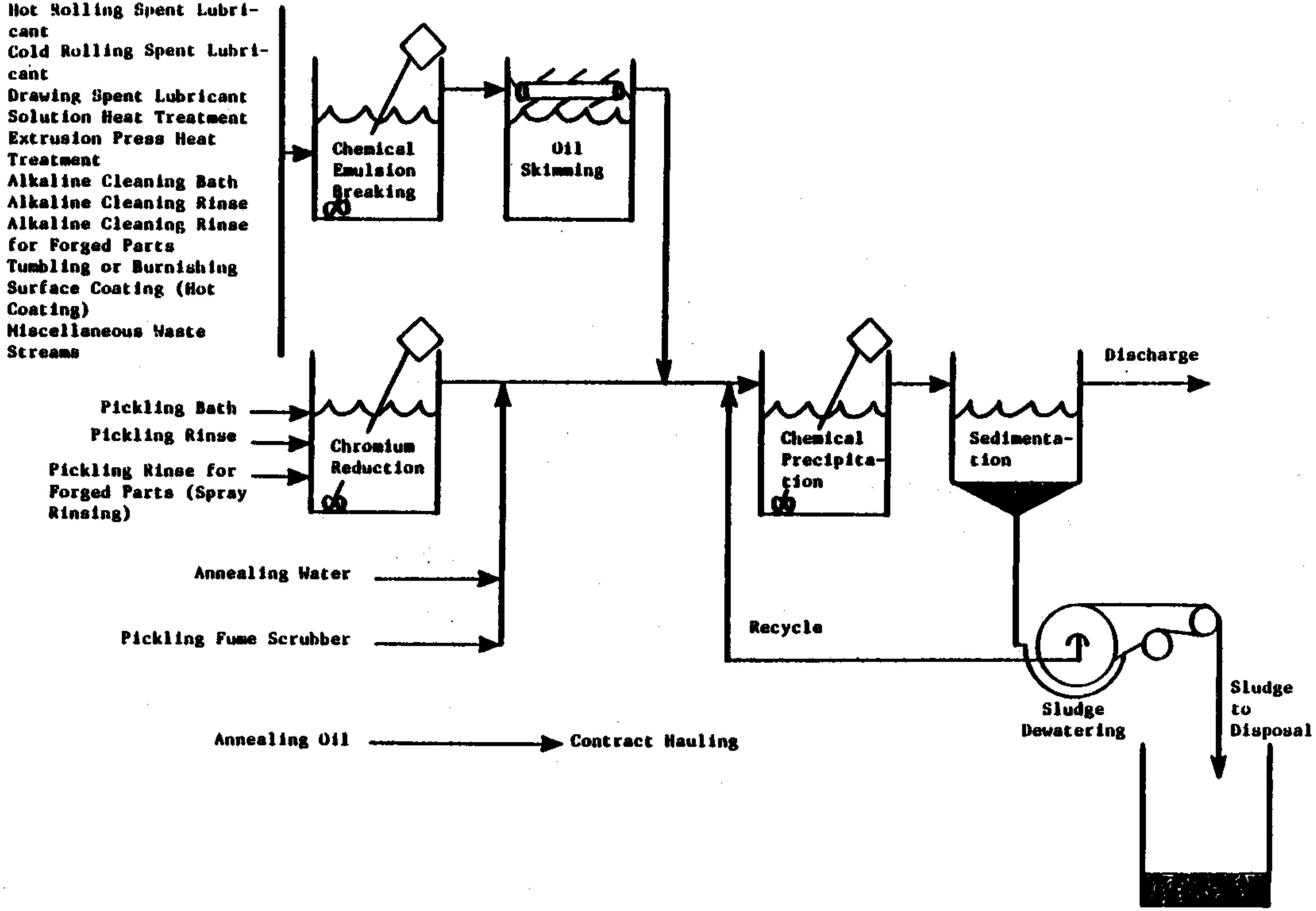

Figure X-1

OPTION 1 TREATMENT TRAIN

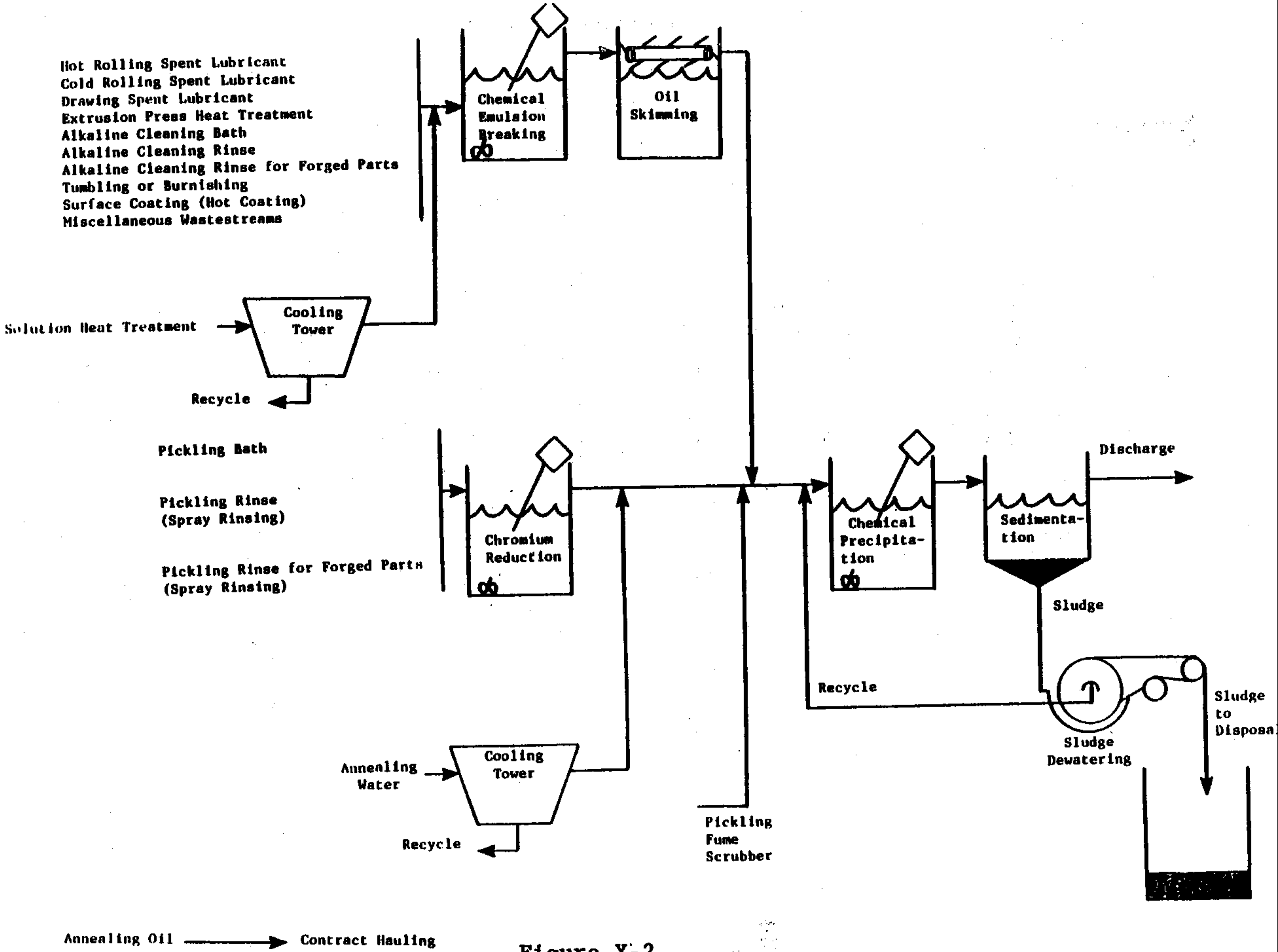

Figure X-2

OPTION 2 TREATMENT TRAIN

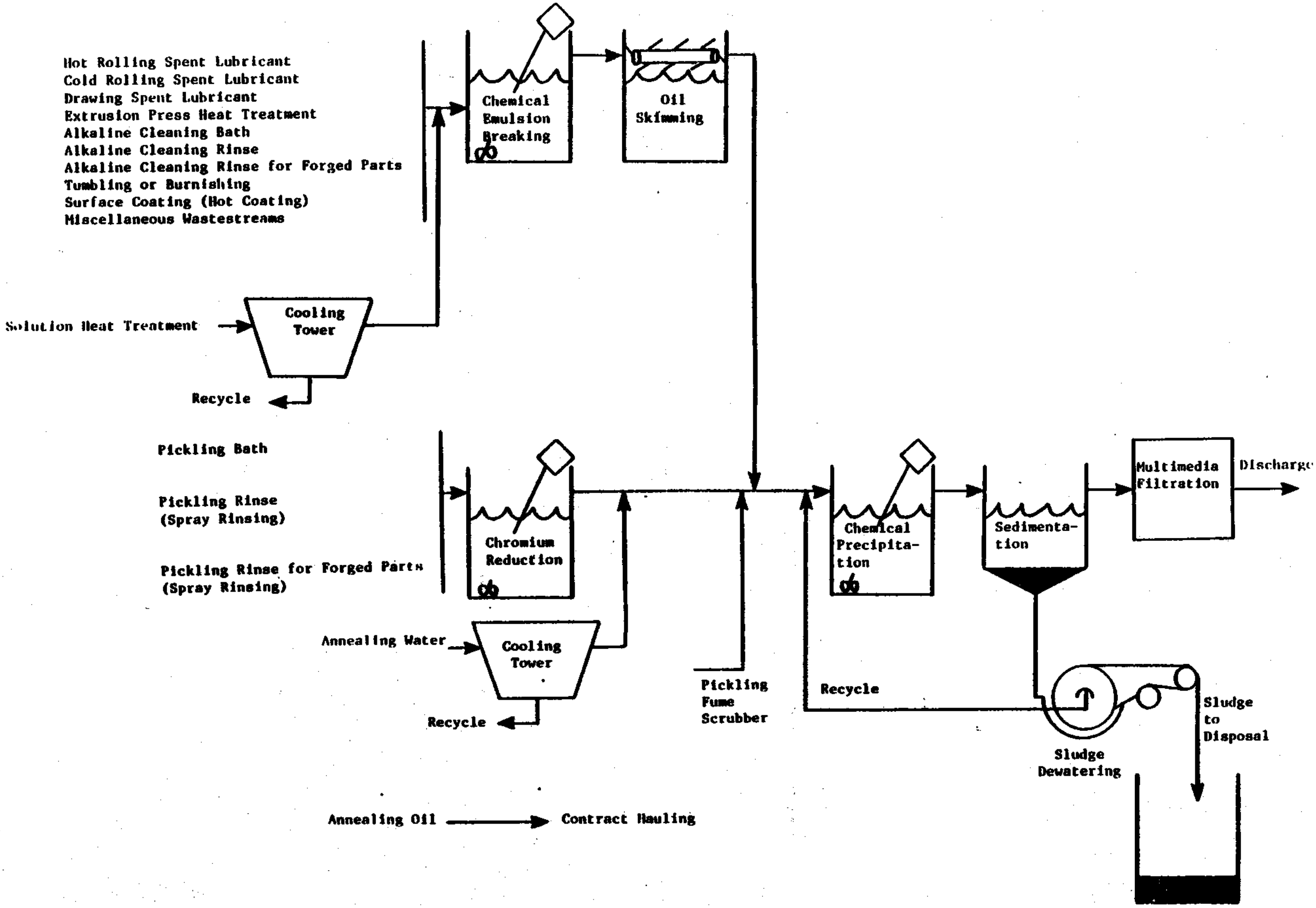

Figure X-3

OPTION 3 TREATMENT TRAIN

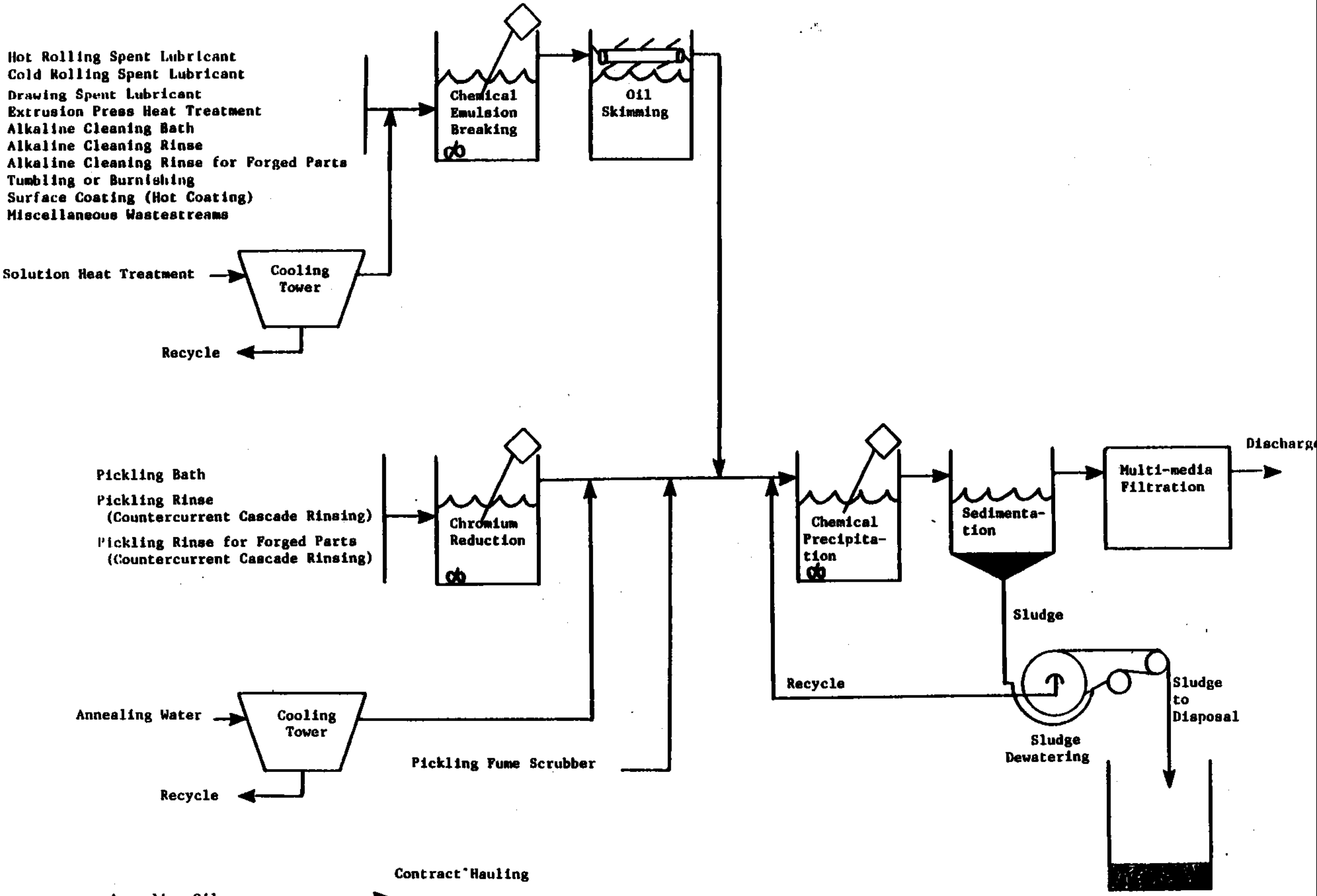

Figure X-4

OPTION 4 TREATMENT TRAIN

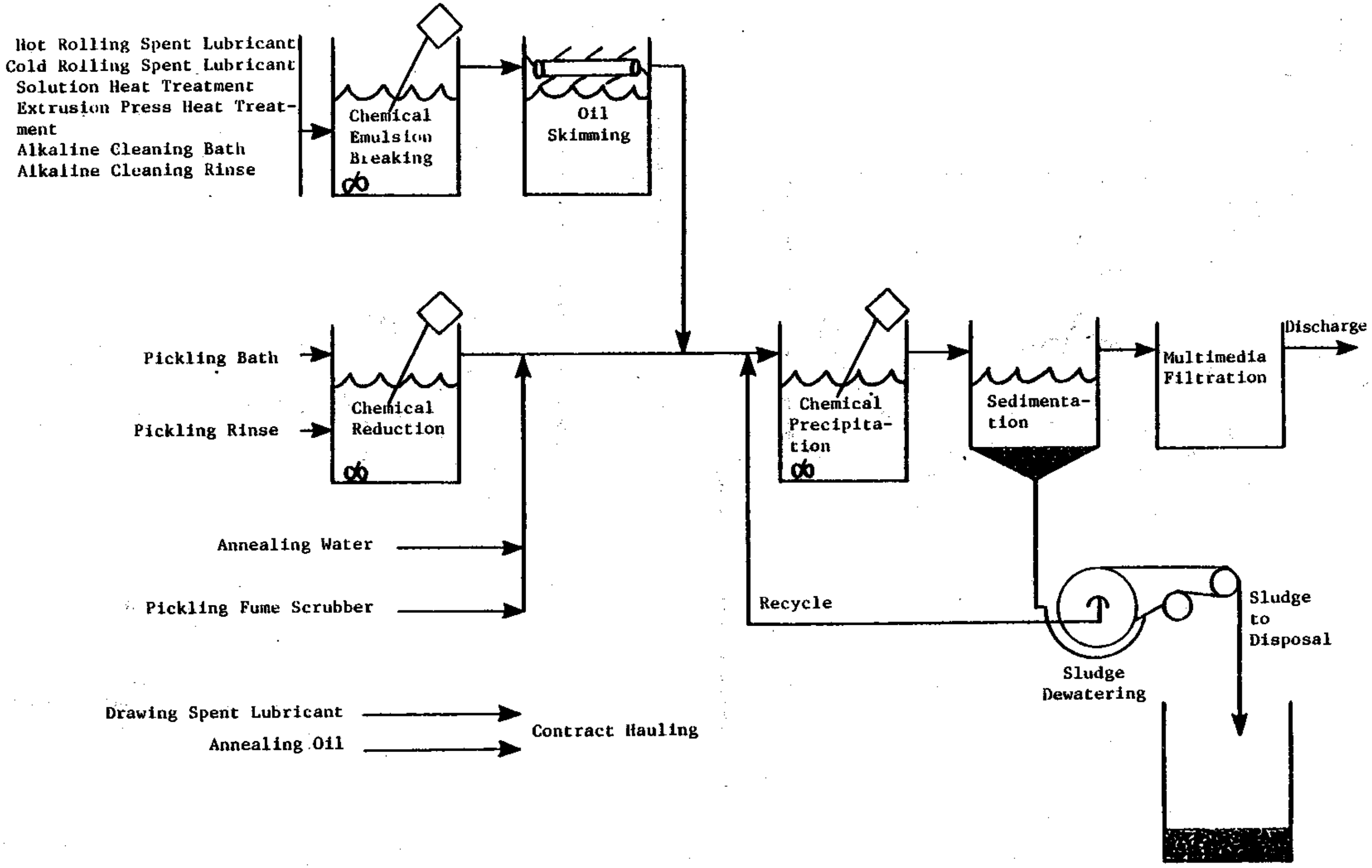

Figure X-5

OPTION 5 TREATMENT TRAIN

SECTION XI

NEW SOURCE PERFORMANCE STANDARDS

The basis for new source performance standards (NSPS) under Section 306 of the Clean Water Act is the best available demonstrated technology (BDT). New plants have the opportunity to design the best and most efficient production processes and wastewater treatment technologies. Therefore, BDT includes process changes, in-plant controls (including elimination of wastewater streams), operating procedure changes, and end-of-pipe treatment technologies to reduce pollution to the maximum extent possible. This section describes the control technology for treatment of wastewater from new sources and presents mass discharge limitations of regulated pollutants for NSPS, based on the described control technology.

TECHNICAL APPROACH TO NSPS

All wastewater reduction and process changes applicable to a new source have been considered previously for the BAT options. These options are summarized below and presented in greater detail in Section X (p. 451).

In summary form, the treatment technologies considered for new copper forming facilities are:

Option 1 based on:

- Lime and settle (chemical precipitation of metals followed by sedimentation), and where required,
- Hexavalent chromium reduction,
- Chemical emulsion breaking,
- Oil skimming, and
- Spray rinsing and recirculation of the rinse water for pickled forged parts, and
- Recycle of hot rolling spent lubricant.

Option 2 based on:

Option 1, plus process wastewater flow reduction by the following methods:

- Recycle of solution heat treatment contact cooling water,

- Recycle of annealing contact cooling water, and
- Spray rinsing and recirculation of pickling rinsewater. for all products.

Option 3 based on:

Option 2, plus polishing filtration (multimedia) at the end of the Option 2 treatment train.

Option 4 based on:

Option 3, plus countercurrent cascade rinsing applied to the pickling rinse stream for all products.

Option 5 based on:

Option 1, plus polishing filtration (multimedia) at the end of the Option 1 treatment train.

NSPS OPTION SELECTION

EPA is establishing the best available demonstrated technology for the copper forming category to be equivalent to BAT technology with the addition of countercurrent cascade rinsing for pickling rinsewater and the addition of filtration prior to discharge (Option 4). The Agency recognizes that new sources have the opportunity to implement more advanced levels of treatment without incurring the costs of retrofit equipment, the costs of partial or complete shutdown to install new equipment and the costs to start up and stabilize the treatment system, as existing systems would have to do.

Six copper forming plants use filtration technology as end-ofpipe treatment prior to discharge or recycle of process water into the plant. Four plants use countercurrent cascade rinsing on pickling rinse lines. A technical description of these control and treatment options is provided in Section VII. Countercurrent cascade rinsing and filtration are appropriate technologies for NSPS because they are demonstrated in this category and because new plants have the opportunity to design and implement the most efficient processes without retrofit costs and space availability limitations. In addition, the Agency does not believe that standards for new sources based on Option 4 will create a barrier to entry.

REGULATED POLLUTANT PARAMETERS

The Agency has no reason to believe that the pollutants that will be found in significant quantities in wastewater from new sources will be any different than those from existing sources. Consequently, pollutants were selected for regulation in accordance with the rationale of Section VI. These are the toxic metals (chromium, copper, lead, nickel, and zinc), oil and grease, TSS, and pH. Toxic organics are not regulated because they are effectively controlled by the oil and grease limit. As discussed under BAT, several toxic metals are not being specifically regulated because they will be adequately controlled when the regulated metals are treated to the levels achievable by the model treatment technlogy. These metals include antimony, arsenic, beryllium, cadmium, silver, and selenium.

DISCHARGE FLOWS

The discharge flows for NSPS are identical to those for BAT for all waste streams except pickling rinse and pickling rinse for forged parts. As was the case for BAT, the Agency reviewed the water use and discharge practices of copper forming plants with regard to each of the waste streams (Tables V-2 through V-13, pp. 90-105). EPA determined that additional flow reduction beyond that developed for BAT was not demonstrated except for pickling rinse water. As discussed in Section VII, countercurrent cascade rinsing substantially improves the efficiencies of water use for rinsing. For example, the use of a two-stage countercurrent cascade rinse can reduce water usage to approximately one-tenth of that needed for a single-stage rinse and achieve the same level of product cleanliness (refer to example in Section VII, p. 310). Similarly, a three-stage countercurrent cascade rinse would reduce water usage to approximately one-thirtieth of the original amount. Countercurrent cascade rinsing is practiced at four copper forming plants.

The NSPS flow for pickling rinse water for other than forged parts is based on the lowest production normalized flow observed at a copper forming plant which uses countercurrent cascade rinsing for pickling rinse. The NSPS regulatory flow is 585 l/kkg for pickling rinse.

The NSPS regulatory flow for pickling rinse for forged parts is calculated by assuming that the turndown ratio from BAT pickling rinse to NSPS pickling rinse will also be achieved for forged parts. This turndown ratio is 2.22. Therefore, the NSPS regulatory flow for forged parts is 1760 l/kkg.

COSTS AND ENVIRONMENTAL BENEFITS

The Agency developed a "normal" plant in order to estimate pollutant removals and costs for new sources. The normal plant is a theoretical plant which has each of the manufacturing operations covered by the category and production that is the average level of the dischargers in the category. Section VIII (p. 398) of this document presents in detail the composition of the copper forming normal plant. A new direct discharge normal plant having the industry average annual production level would generate a raw waste of 1,837 kg per year of toxic metal and organic pollutants. The NSPS technology would reduce these pollutant levels to 75 kg per year of these same toxic pollutants. The total capital investment cost for a new normal plant to install NSPS technology is estimated to be $1.23 million, compared with investment costs of $1.18 million to install technology equivalent to BAT. Similar figures for total annual costs are $1.05 milion for NSPS and $1.02 million for BAT. Therefore, new sources, regardless of whether they result from major modifications of existing facilities or are constructed as greenfield sites, will have costs approximately equivalent to the costs existing sources without treatment will incur in achieving BAT. The new source performance standards will not pose a barrier to entry.

EFFLUENT STANDARDS

Table VII-20 (p. 336) presents the treatment effectiveness corresponding to the NSPS treatment train for the pollutants selected. Effluent concentrations (one day maximum and ten day average values) are multiplied by the regulatory discharge flows summarized in Table XI-1 to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations are shown in Tables XI-2 through XI-18.

Table XI-1

NEW SOURCE REGULATORY FLOWS FOR COPPER FORMING WASTE STREAMS

Waste Stream	New Source Flow (l/kkg)
Hot Rolling Spent Lubricant	103
Cold Rolling Spent Lubricant	379
Drawing Spent Lubricant	85
Annealing Water	1,240
Annealing Oil	0
Solution Heat Treatment	646
Extrusion Press Heat Treatment	2
Pickling Fume Scrubber	626
Pickling Bath	116
Alkaline Bath	46.7
Pickling Rinse (Forged Parts)	1,760
Pickling Rinse (All Other Parts)	585
Alkaline Rinse (Forged Parts)	12,642
Alkaline Rinse (All Other Parts)	4,214
Tumbling or Burnishing	583
Surface Coating	743
Miscellaneous Waste Streams	22.3

Table XI-2

NSPS FOR HOT ROLLING SPENT LUBRICANT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy hot rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy hot rolled		
Chromium	0.038	0.015
Copper	0.131	0.062
Lead	0.010	0.0092
Nickel	0.056	0.038
Zinc	0.105	0.043
Oil and Grease	1.030	1.030
TSS	1.545	1.236
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-3

NSPS FOR COLD ROLLING SPENT LUBRICANT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy cold rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy cold rolled		
Chromium	0.140	0.056
Copper	0.485	0.231
Lead	0.037	0.034
Nickel	0.208	0.140
Zinc	0.386	0.159
Oil and Grease	3.790	3.790
TSS	5.685	4.548
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-4

NSPS FOR DRAWING SPENT LUBRICANT[2]

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy drawn English Units - lb/1,000,000 off-lbs of copper or copper alloy drawn		
Chromium	0.031	0.012
Copper	0.108	0.051
Lead	0.0085	0.0076
Nickel	0.046	0.031
Zinc	0.086	0.035
Oil and Grease	0.85	0.85
TSS	1.275	1.020
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

[2] Applicable only to drawers who treat and discharge spent drawing lubricants.

Table XI-5

NSPS FOR SOLUTION HEAT TREATMENT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated		
Chromium	0.239	0.096
Copper	0.826	0.394
Lead	0.064	0.058
Nickel	0.355	0.239
Zinc	0.658	0.271
Oil and Grease	6.460	6.460
TSS	9.690	7.752
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-6

NSPS FOR EXTRUSION HEAT TREATMENT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated on an extrusion press English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated on an extrusion press		
Chromium	0.00074	0.00030
Copper	0.0020	0.0010
Lead	0.00020	0.00018
Nickel	0.0010	0.00074
Zinc	0.0020	0.00084
Oil and Grease	0.020	0.020
TSS	0.030	0.024
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-7

NSPS FOR ANNEALING WITH WATER

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed		
Chromium	0.458	0.186
Copper	1.587	0.756
Lead	0.124	0.111
Nickel	0.682	0.458
Zinc	1.264	0.520
Oil and Grease	12.400	12.400
TSS	18.600	14.880
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-8

NSPS FOR ANNEALING WITH OIL

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed		
Chromium	0	0
Copper	0	0
Lead	0	0
Nickel	0	0
Zinc	0	0
Oil and Grease	0	0
TSS	0	0
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-9

NSPS FOR ALKALINE CLEANING RINSE

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	1.559	0.632
Copper	5.393	2.570
Lead	0.421	0.379
Nickel	2.317	1.559
Zinc	4.298	1.769
Oil and Grease	42.140	42.140
TSS	63.210	50.568
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-10

NSPS FOR ALKALINE CLEANING RINSE FOR FORGED PARTS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts alkaline cleaned		
Chromium	4.667	1.896
Copper	16.181	7.711
Lead	1.264	1.137
Nickel	6.953	4.677
Zinc	12.894	5.309
Oil and Grease	126.420	126.420
TSS	189.630	151.704
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-11

NSPS FOR ALKALINE CLEANING BATH

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	0.017	0.0070
Copper	0.059	0.028
Lead	0.0046	0.0042
Nickel	0.025	0.017
Zinc	0.047	0.019
Oil and Grease	0.46	0.46
TSS	0.70	0.56
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-12

NSPS FOR PICKLING RINSE

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.216	0.087
Copper	0.748	0.356
Lead	0.058	0.052
Nickel	0.321	0.216
Zinc	0.596	0.245
Oil and Grease	5.850	5.850
TSS	8.775	7.020
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-13

NSPS FOR PICKLING RINSE FOR FORGED PARTS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts pickled		
Chromium	0.649	0.263
Copper	2.246	1.070
Lead	0.175	0.157
Nickel	0.965	0.649
Zinc	1.790	0.737
Oil and Grease	17.550	17.550
TSS	26.325	21.060
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-14

NSPS FOR PICKLING BATH

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.042	0.017
Copper	0.148	0.070
Lead	0.011	0.010
Nickel	0.063	0.042
Zinc	0.118	0.048
Oil and Grease	1.160	1.160
TSS	1.740	1.392
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-15

NSPS FOR PICKLING FUME SCRUBBER

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.231	0.093
Copper	0.801	0.381
Lead	0.062	0.056
Nickel	0.344	0.231
Zinc	0.638	0.262
Oil and Grease	6.260	6.260
TSS	9.390	7.512
pH	(1)	(1)

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-16

NSPS FOR TUMBLING OR BURNISHING

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy tumbled or burnished English Units - lb/1,000,000 off-lbs of copper or copper alloy tumbled or burnished		
Chromium	0.215	0.087
Copper	0.746	0.355
Lead	0.058	0.052
Nickel	0.320	0.215
Zinc	0.594	0.244
Oil and Grease	5.830	5.830
TSS	8.745	6.996
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-17

NSPS FOR SURFACE COATING

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy surface coated English Units - lb/1,000,000 off-lbs of copper or copper alloy surface coated		
Chromium	0.274	0.111
Copper	0.951	0.453
Lead	0.074	0.066
Nickel	0.408	0.274
Zinc	0.757	0.312
Oil and Grease	7.430	7.430
TSS	11.145	8.916
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

Table XI-18

NSPS FOR MISCELLANEOUS WASTE STREAMS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy formed English Units - lb/1,000,000 off-lbs of copper or copper alloy formed		
Chromium	0.008	0.003
Copper	0.027	0.013
Lead	0.0021	0.0019
Nickel	0.011	0.008
Zinc	0.022	0.009
Oil and Grease	0.218	0.218
TSS	0.327	0.261
pH	([1])	([1])

[1] Within the range of 7.5 to 10.0 at all times.

SECTION XII

PRETREATMENT STANDARDS

Section 307(b) of the Clean Water Act requires EPA to promulgate pretreatment standards for existing sources (PSES), which must be achieved within three years of promulgation. PSES are designed to prevent the discharge of pollutants which pass through, interfere with, or are otherwise incompatible with the operation of publicly owned treatment works (POTW). The Clean Water Act amendment of 1977 adds a new dimension by requiring pretreatment for pollutants, such as heavy metals, that limit POTW sludge management alternatives, including the beneficial use of sludges on agricultural lands. The legislative history of the 1977 Act indicates that pretreatment standards are to be technology based, analogous to the best available technology for removal of toxic pollutants.

Section 307(c) of the Act requires EPA to promulgate pretreatment standards for new sources (PSNS) at the same time that it promulgates NSPS. New indirect discharge facilities, like new direct discharge facilities, have the opportunity to incorporate the best available demonstrated technologies, including process changes, in-plant controls, and end-of-pipe treatment technologies, and to use plant site selection to ensure adequate treatment system installation.

The General Pretreatment Regulations for Existing and New Sources which serve as the framework for the final copper forming pretreatment standards are in 40 CFR Part 403, 46 FR 9404 (January 28, 1981). These regulations describe the Agency's overall policy for establishing and enforcing pretreatment standards for new and existing users of a POTW and delineate the responsibilities and deadlines applicable to each part in this effort. In addition, 40 CFR Part 403, Section 403.5(b), outlines prohibited discharges which apply to all users of a POTW.

This section describes the treatment and control technology for pretreatment of process wastewaters from existing sources and new sources, and presents mass discharge limitations of regulated pollutants for existing and new sources, based on the described control technology.

DISCHARGE OF COPPER FORMING WASTEWATERS TO A POTW

There are approximately 45 plants in the copper forming category which discharge to a POTW. The plants that may be affected by pretreatment standards represent about 26 percent of all of the copper forming plants.

Pretreatment standards are established to ensure removal of pollutants which interfere with, pass through, or are otherwise incompatible with a POTW. A determination of which pollutants may pass through or be incompatible with POTW operations, and thus be subject to pretreatment standards, depends on the level of treatment employed by the POTW. In general, more pollutants will pass through or interfere with a POTW employing primary treatment (usually physical separation by settling) than one which has installed secondary treatment (settling plus biological treatment).

Many of the pollutants contained in copper forming wastewater are not biodegradable and are, therefore, ineffectively treated by such systems. Furthermore, these wastes have been known to pass through or interfere with the normal operations of these systems. Problems associated with the discharge of pollutant parameters identified in copper forming process wastewaters to POTW were discussed in Section VI. The discussion covered pass-through, interference and sludge use.

The Agency based the selection of pretreatment standards for the copper forming category on pass through of toxic pollutants at POTW. For each toxic pollutant, the Agency compared the removal rate achieved by the BAT model treatment system with the removal rate at well operated POTW achieving secondary treatment. The POTW removal rates were determined through a study conducted by the Agency at over 40 POTW. (See Fate of Priority Pollutants in Publicly Owned Treatment Works, EPA 440/1-82-303, September 1982.)

The average percentage of the toxic metals removed by a well-operated POTW meeting secondary treatment requirements is about 50 percent (varying from 20 to 70 percent), whereas the percentage that can be removed by a copper forming direct discharger applying the best available technology economically achievable is more than 90 percent. Specific percent removals can be found in Table XII-1. Accordingly, these pollutants pass through a POTW.

In addition to pass through of toxic metals, available information shows that many of the toxic organics from copper forming facilities also pass through a POTW. As previously mentioned, toxic organics are not specifically regulated at BAT because, for direct dischargers, the BPT oil and grease limit will adequately control toxic organics. As demonstrated by the data presented in Section VII, Table VII-10 (p. 326), and Table XII-1, direct dischargers who comply with the BPT limitation for oil and grease will remove a greater percentage of the toxic organics than a well operated POTW achieving secondary treatment. POTW removal of those toxic organic pollutants found in the sampled plants averaged 62 percent; while the oil skimming component of the BPT technology basis achieves removals ranging from 85 to 97 percent. Accordingly, EPA is promulgating a pretreatment standard for toxic organics. The standard is referred to as total toxic organics (TTO) and defined as the sum of the masses or concentrations of each of the 12 toxic organics listed in Table XII-2 and found at concentrations above the quantification level (0.01 mg/l).

Other toxic organics may be found at copper forming facilities. Toxic organic compounds originate in lubricants and these compounds can vary considerably depending on the formulation of the lubricant. Many polyaromatic hydrocarbons and organic solvents that perform the same function can be substituted for one another. If substitution does occur, the Agency believes that these other toxic organics are likely to be adequately controlled by the PSES model technology. However, regulation of these other toxic organics should be considered on a plant-by-plant basis by the permitting authority.

The analysis of wastewaters for toxic organics is costly and requires sophisticated equipment. Data indicate that the toxic organics are in the oil and grease and by removing the oil and grease, the toxic organics should also be removed. Therefore, the Agency is promulgating an oil and grease standard as an alternative to monitoring for TTO.

The pretreatment options selected provide for significantly more removal of toxic pollutants than would occur if copper forming wastewaters were discharged untreated to a POTW. Thus, pretreatment standards will control the discharge of toxic pollutants to POTW and prevent pass-through.

Mass-based limitations, which are the only method used for designating pretreatment standards, are set forth below. Regulation on the basis of concentration only is not appropriate because it does not ensure that plants will achieve pollutant reductions consistent with plants implementing the flow reduction components of the model treatment technology. Therefore, the Agency is not promulgating alternative concentration-based pretreatment standards (40 CFR Part 403.6(c)).

TECHNICAL APPROACH TO PRETREATMENT

Under these standards, five levels of PSES and PSNS were evaluated for the category. Option 1 is BPT treatment. Option 2 is BPT treatment plus flow reduction. Option 3 includes a filter in addition to Option 2 treatment technology. Option 4 includes all of the elements of Option 3 plus further reduction of the pickling rinse flow through countercurrent cascade rinsing. Option 5 adds filtration as an end-of-pipe treatment process to Option 1.

Each treatment technology option is based on central treatment of all waste streams and results in the same concentrations of pollutants in the effluent regardless of the number and combinations of copper forming waste streams entering the treatment system. Mass limitations derived from these options may vary between plants because of the impact of different regulatory flows. The derivation of these regulatory flows is discussed later in this section.

In summary form, the treatment technologies considered for PSES and PSNS for copper forming are:

<u>Option 1</u> based on:

- Lime and settle (chemical precipitation of metals, followed by sedimentation), and where required
- Chemical emulsion breaking,
- Oil skimming,
- Hexavalent chromium reduction,
- Spray rinsing and recirculation of the rinse water for forged parts, and
- Recycle of hot rolling spent lubricant.

Option 1 is equivalent to the technologies on which BPT is based.

<u>Option 2</u> based on:

Option 1, plus process wastewater flow reduction by the following methods:

- Recycle of solution heat treatment contact cooling water,
- Recycle of annealing contact cooling water, and
- Spray rinsing and recirculation of pickling rinse water.

<u>Option 3</u> based on:

Polishing filtration (multimedia) at the end of the Option 2 treatment train.

<u>Option 4</u> based on:

Option 3, plus further reduction of the pickling rinse flow through the use of countercurrent cascade rinsing.

Option 5 based on:

Option 1, plus polishing filtration (multimedia) at the end of the Option 1 treatment train.

PSES OPTION SELECTION

EPA is promulgating PSES based on the application of technology Option 2. Option 2, which is also the basis for BAT limitations, consists of chemical precipitation and sedimentation, flow reduction, and preliminary treatment, where necessary, consisting of chromium reduction, chemical emulsion breaking, and oil skimming.

Compliance with PSES based on this model treatment technology will prevent pass through of toxic metals and organics.

In the proposed rule we stated that if BAT was promulgated with filters then PSES would need to include filtration to prevent "pass through." Because this is not the case, PSES does not include filtration. Option 4 was not chosen as the basis for PSES for similar reasons.

Option 4 is based on the installation of countercurrent cascade rinsing for rinse water associated with pickling. This technology option was rejected for PSES because it was not chosen for BAT, because it is only demonstrated at four copper forming plants, and because most of the other existing plants lack sufficient space to add the additional rinse tank and associated piping required for countercurrent cascade rinsing.

Option 5 is based on filtration added to Option 1. Option 5 was considered and ultimately rejected because as compared to Option 2 it provides only one-fourth as much pollutant removal at approximately the same costs.

PSNS OPTION SELECTION

The technology basis for PSNS is Option 4, which is equivalent to the technology basis for NSPS. The Agency has determined that PSNS based on Option 4 is necessary to prevent pass through of toxic metals and organics. In selecting the technology basis for PSNS, the Agency compares the toxic pollutant removal achieved by a well-operated POTW to that achieved by a direct discharger meeting NSPS. New indirect dischargers, like new direct dischargers, have the opportunity to design and implement the most efficient processes without retrofit costs and space availability limitations.

COSTS AND ENVIRONMENTAL BENEFITS OF PSES AND PSNS

The application of PSES will remove 18,700 kilograms per year of toxic pollutants (metals and organics) beyond current discharge levels. EPA estimates that the capital investment costs of complying with PSES is $9.2 million with a total annual cost of $7.7 million (1982 dollars).

The Agency developed a normal plant to estimate costs and pollutant removals for new sources (PSNS). The copper forming normal plant is described in detail in Section VIII of this document. A new indirect discharge normal plant having the industry average annual production level would generate a raw waste of 1,837 kg of toxic metal and organic pollutants. The PSNS technology would reduce these pollutant levels to 75 kg toxic pollutants. The total capital investment cost for a new normal plant to install PSNS technology is estimated to be $1.23 million, compared with investment costs of $1.18 million to install technology equivalent to PSES. Similar figures for total annual costs are $1.05 million for NSPS and $1.02 million for BAT. Therefore, new sources, regardless of whether they result from major modifications of existing facilities or are constructed as greenfield sites, will have costs approximately equivalent to the costs existing sources without treatment will incur in achieving PSES. The new source performance pretreatment standards will not pose a barrier to entry.

REGULATED POLLUTANT PARAMETERS

Twelve toxic organics have been selected since they may pass through a POTW as discussed above. They are listed in Table XII-2. As discussed above, oil and grease is being promulgated as an alternate monitoring parameter for both PSES and PSNS, since removal of oil and grease through the application of oil skimming effectively removes these 12 toxic organics. The toxic metals selected are chromium (total), copper, lead, nickel, and zinc. TSS is not regulated since it is adequately handled by a POTW and will not interfere with its operation.

EFFLUENT STANDARDS

Table VII-20 (p. 336) presents the treatment effectiveness corresponding to the BAT treatment train for the pollutants selected, which is equivalent to the PSES and PSNS treatment train. Effluent concentrations (one day maximum and ten day average values) are multiplied by the regulatory discharge flows summarized in Table X-1 (p. 457) for PSES and Table XI-1 (p. 477) for PSNS to calculate the mass of pollutants allowed to be discharged per mass of product. The results of these calculations for PSES are shown in Tables XII-3 through XII-19, and for PSNS are shown in Tables XII-20 through XII-36.

Table XII-1

PERCENT REMOVAL BY A POTW OF POLLUTANTS REGULATED AT PSES

Chromium (total)	65
Copper	58
Lead	48
Nickel	19
Zinc	65
Benzene	66
1,1,1-Trichloroethane	80
Chloroform	11
2,6-Dinitrotoluene	No data available
Ethylbenzene	86
Methylene Chloride	3
Naphthalene	85
N-nitrosodiphenylamine	No data available
Anthracene	70
Phenanthrene	73
Toluene	70
Trichloroethylene	72

Table XII-2

TOXIC ORGANICS THAT COMPRISE TTO

1. Benzene (4)*
2. 1,1,1-Trichloroethane (11)
3. Chloroform (23)
4. 2,6-Dinitrotoluene (36)
5. Ethylbenzene (38)
6. Methylene chloride (44)
7. Napthalene (55)
8. N-nitrosodiphenylamine (62)
9. Anthracene (78)
10. Phenanthrene (81)
11. Toluene (86)
12. Trichloroethylene (87)

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*The number in parentheses refers to the number of this organic on the list of 129 toxic pollutants (see Table V-1).

Table XII-3

PSES FOR HOT ROLLING SPENT LUBRICANT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy hot rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy hot rolled		
Chromium	0.045	0.018
Copper	0.195	0.103
Lead	0.015	0.013
Nickel	0.197	0.130
Zinc	0.150	0.062
TTO	0.066	0.035
Oil and Grease (for alternate monitoring)	2.060	1.236

Table XII-4

PSES FOR COLD ROLLING SPENT LUBRICANT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy cold rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy cold rolled		
Chromium	0.166	0.068
Copper	0.720	0.379
Lead	0.056	0.049
Nickel	0.727	0.481
Zinc	0.553	0.231
TTO	0.246	0.128
Oil and Grease (for alternate monitoring)	7.580	4.548

Table XII-5

PSES FOR DRAWING SPENT LUBRICANT[1]

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy drawn English Units - lb/1,000,000 off-lbs of copper or copper alloy drawn		
Chromium	0.037	0.015
Copper	0.161	0.085
Lead	0.012	0.011
Nickel	0.163	0.107
Zinc	0.124	0.051
TTO	0.055	0.028
Oil and Grease (for alternate monitoring)	1.700	1.020

[1] Applicable only to drawers who treat and discharge spent drawing lubricants.

Table XII-6

PSES FOR SOLUTION HEAT TREATMENT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated		
Chromium	0.284	0.116
Copper	1.227	0.646
Lead	0.096	0.083
Nickel	1.240	0.820
Zinc	0.943	0.394
TTO	0.419	0.219
Oil and Grease (for alternate monitoring)	12.920	7.752

Table XII-7

PSES FOR EXTRUSION HEAT TREATMENT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy heat treated on an extrusion press English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated on an extrusion press		
Chromium	0.00088	0.00036
Copper	0.0030	0.0020
Lead	0.00030	0.00026
Nickel	0.0030	0.0020
Zinc	0.0020	0.0010
TTO	0.0010	0.00068
Oil and Grease (for alternate monitoring)	0.040	0.024

Table XII-8

PSES FOR ANNEALING WITH WATER

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with water English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with water		
Chromium	0.545	0.223
Copper	2.356	1.240
Lead	0.186	0.161
Nickel	2.380	1.574
Zinc	1.810	0.756
TTO	0.806	0.421
Oil and Grease (for alternate monitoring)	24.800	14.880

Table XII-9

PSES FOR ANNEALING WITH OIL

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with oil English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with oil		
Chromium	0	0
Copper	0	0
Lead	0	0
Nickel	0	0
Zinc	0	0
TTO	0	0
Oil and Grease (for alternate monitoring)	0	0

Table XII-10

PSES FOR ALKALINE CLEANING RINSE

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	1.854	0.758
Copper	8.006	4.214
Lead	0.632	0.547
Nickel	8.090	5.351
Zinc	6.152	2.570
TTO	2.739	1.432
Oil and Grease (for alternate monitoring)	84.280	50.568

Table XII-11

PSES FOR ALKALINE CLEANING RINSE FOR FORGED PARTS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts alkaline cleaned		
Chromium	5.562	2.275
Copper	24.019	12.642
Lead	1.896	1.643
Nickel	24.272	16.055
Zinc	18.457	7.711
TTO	8.217	4.298
Oil and Grease (for alternate monitoring)	252.840	151.704

Table XII-12

PSES FOR ALKALINE CLEANING BATH

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	0.020	0.0084
Copper	0.088	0.046
Lead	0.0070	0.0060
Nickel	0.089	0.059
Zinc	0.068	0.028
TTO	0.030	0.015
Oil and Grease (for alternate monitoring)	0.93	0.56

Table XII-13

PSES FOR PICKLING RINSE

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.574	0.235
Copper	2.481	1.306
Lead	0.195	0.169
Nickel	2.507	1.658
Zinc	1.906	0.796
TTO	0.848	0.444
Oil and Grease (for alternate monitoring)	26.120	15.672

Table XII-14

PSES FOR PICKLING RINSE FOR FORGED PARTS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts pickled		
Chromium	1.723	0.705
Copper	7.444	3.918
Lead	0.587	0.509
Nickel	7.522	4.975
Zinc	5.720	2.389
TTO	2.546	1.332
Oil and Grease (for alternate monitoring)	78.360	47.016

Table XII-15

PSES FOR PICKLING BATH

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.051	0.020
Copper	0.220	0.116
Lead	0.017	0.015
Nickel	0.222	0.147
Zinc	0.169	0.070
TTO	0.075	0.039
Oil and Grease (for alternate monitoring)	2.320	1.392

Table XII-16

PSES FOR PICKLING FUME SCRUBBER

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.275	0.112
Copper	0.189	0.626
Lead	0.093	0.081
Nickel	1.201	0.795
Zinc	0.913	0.381
TTO	0.406	0.212
Oil and Grease (for alternate monitoring)	12.520	7.512

Table XII-17

PSES FOR TUMBLING OR BURNISHING

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy tumbled or burnished English Units - lb/1,000,000 off-lbs of copper or copper alloy tumbled or burnished		
Chromium	0.256	0.104
Copper	1.107	0.583
Lead	0.087	0.075
Nickel	1.119	0.740
Zinc	0.851	0.355
TTO	0.378	0.198
Oil and Grease (for alternate monitoring)	11.660	6.996

Table XII-18

PSES FOR SURFACE COATING

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy surface coated English Units - lb/1,000,000 off-lbs of copper or copper alloy surface coated		
Chromium	0.326	0.133
Copper	1.411	0.743
Lead	0.111	0.096
Nickel	1.426	0.943
Zinc	1.084	0.453
TTO	0.482	0.252
Oil and Grease (for alternate monitoring)	14.860	8.916

Table XII-19

PSES FOR MISCELLANEOUS WASTE STREAMS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy formed English Units - lb/1,000,000 off-lbs of copper or copper alloy formed		
Chromium	0.009	0.003
Copper	0.041	0.021
Lead	0.003	0.002
Nickel	0.041	0.027
Zinc	0.031	0.013
TTO	0.014	0.007
Oil and Grease (for alternate monitoring)	0.436	0.261

Table XII-20

PSNS FOR HOT ROLLING SPENT LUBRICANT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy hot rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy hot rolled		
Chromium	0.038	0.015
Copper	0.131	0.062
Lead	0.010	0.0092
Nickel	0.056	0.038
Zinc	0.105	0.043
TTO	0.035	0.035
Oil and Grease (for alternate monitoring)	1.030	1.030

Table XII-21

PSNS FOR COLD ROLLING SPENT LUBRICANT

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy cold rolled English Units - lb/1,000,000 off-lbs of copper or copper alloy cold rolled		
Chromium	0.140	0.056
Copper	0.485	0.231
Lead	0.037	0.034
Nickel	0.208	0.140
Zinc	0.386	0.159
TTO	0.128	0.128
Oil and Grease (for alternate monitoring)	3.790	3.790

Table XII-22

PSNS FOR DRAWING SPENT LUBRICANT[1]

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy drawn English Units - lb/1,000,000 off-lbs of copper or copper alloy drawn		
Chromium	0.031	0.012
Copper	0.108	0.051
Lead	0.0085	0.0076
Nickel	0.046	0.031
Zinc	0.086	0.035
TTO	0.028	0.028
Oil and Grease (for alternate monitoring)	0.850	0.850

[1] Applicable only to drawers who treat and discharge spent drawing lubricants.

Table XII-23

PSNS FOR SOLUTION HEAT TREATMENT

Metric Units - mg/off-kg of copper or copper alloy heat treated
English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Chromium	0.239	0.096
Copper	0.826	0.394
Lead	0.064	0.058
Nickel	0.355	0.239
Zinc	0.658	0.271
TTO	0.219	0.219
Oil and Grease (for alternate monitoring)	6.460	6.460

Table XII-24

PSNS FOR EXTRUSION HEAT TREATMENT

Metric Units - mg/off-kg of copper or copper alloy heat treated on an extrusion press
English Units - lb/1,000,000 off-lbs of copper or copper alloy heat treated on an extrusion press

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Chromium	0.00074	0.00030
Copper	0.0020	0.0010
Lead	0.00020	0.00018
Nickel	0.0010	0.00074
Zinc	0.0020	0.0084
TTO	0.00068	0.00068
Oil and Grease (for alternate monitoring)	0.020	0.020

Table XII-25

PSNS FOR ANNEALING WITH WATER

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with water English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with water		
Chromium	0.458	0.186
Copper	1.587	0.756
Lead	0.124	0.111
Nickel	0.682	0.458
Zinc	1.264	0.520
TTO	0.421	0.421
Oil and Grease (for alternate monitoring)	12.400	12.400

Table XII-26

PSNS FOR ANNEALING WITH OIL

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy annealed with oil English Units - lb/1,000,000 off-lbs of copper or copper alloy annealed with oil		
Chromium	0	0
Copper	0	0
Lead	0	0
Nickel	0	0
Zinc	0	0
TTO	0	0
Oil and Grease (for alternate monitoring)	0	0

Table XII-27

PSNS FOR ALKALINE CLEANING RINSE

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	1.559	0.632
Copper	5.393	2.570
Lead	0.421	0.379
Nickel	2.317	1.559
Zinc	4.298	1.769
TTO	1.432	1.432
Oil and Grease (for alternate monitoring)	42.140	42.140

Table XII-28

PSNS FOR ALKALINE CLEANING RINSE FOR FORGED PARTS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts alkaline cleaned		
Chromium	4.677	1.896
Copper	16.181	7.711
Lead	1.264	1.137
Nickel	6.953	4.677
Zinc	12.894	5.309
TTO	4.298	4.298
Oil and Grease (for alternate monitoring)	126.420	126.420

Table XII-29

PSNS FOR ALKALINE CLEANING BATH

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy alkaline cleaned English Units - lb/1,000,000 off-lbs of copper or copper alloy alkaline cleaned		
Chromium	0.017	0.0070
Copper	0.059	0.028
Lead	0.0046	0.0042
Nickel	0.025	0.017
Zinc	0.047	0.019
TTO	0.015	0.015
Oil and Grease (for alternate monitoring)	0.46	0.46

Table XII-30

PSNS FOR PICKLING RINSE

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.216	0.087
Copper	0.748	0.356
Lead	0.058	0.052
Nickel	0.321	0.216
Zinc	0.596	0.245
TTO	0.198	0.198
Oil and Grease (for alternate monitoring)	5.850	5.850

Table XII-31

PSNS FOR PICKLING RINSE FOR FORGED PARTS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy forged parts pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy forged parts pickled		
Chromium	0.649	0.263
Copper	2.246	1.070
Lead	0.175	0.157
Nickel	0.965	0.649
Zinc	1.790	0.737
TTO	0.596	0.596
Oil and Grease (for alternate monitoring)	17.550	17.550

Table XII-32

PSNS FOR PICKLING BATH

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.042	0.017
Copper	0.148	0.070
Lead	0.011	0.010
Nickel	0.063	0.042
Zinc	0.118	0.048
TTO	0.039	0.039
Oil and Grease (for alternate monitoring)	1.160	1.160

Table XII-33

PSNS FOR PICKLING FUME SCRUBBER

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy pickled English Units - lb/1,000,000 off-lbs of copper or copper alloy pickled		
Chromium	0.231	0.093
Copper	0.801	0.381
Lead	0.062	0.056
Nickel	0.344	0.231
Zinc	0.638	0.262
TTO	0.212	0.212
Oil and Grease (for alternate monitoring)	6.260	6.260

Table XII-34

PSNS FOR TUMBLING OR BURNISHING

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy tumbled or burnished English Units - lb/1,000,000 off-lbs of copper or copper alloy tumbled or burnished		
Chromium	0.215	0.087
Copper	0.746	0.355
Lead	0.058	0.052
Nickel	0.320	0.215
Zinc	0.594	0.244
TTO	0.198	0.198
Oil and Grease (for alternate monitoring)	5.830	5.830

Table XII-35

PSNS FOR SURFACE COATING

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy surface coated English Units - lb/1,000,000 off-lbs of copper or copper alloy surface coated		
Chromium	0.274	0.111
Copper	0.951	0.453
Lead	0.074	0.066
Nickel	0.408	0.274
Zinc	0.757	0.312
TTO	0.252	0.252
Oil and Grease (for alternate monitoring)	7.430	7.430

Table XII-36

PSNS FOR MISCELLANEOUS WASTE STREAMS

Pollutant or Pollutant Property	Maximum For Any One Day	Maximum for Monthly Average
Metric Units - mg/off-kg of copper or copper alloy formed English Units - lb/1,000,000 off-lbs of copper or copper alloy formed		
Chromium	0.008	0.003
Copper	0.027	0.0013
Lead	0.0021	0.0019
Nickel	0.011	0.008
Zinc	0.022	0.009
TTO	0.007	0.007
Oil and Grease (for alternate monitoring)	0.218	0.218

SECTION XIII

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY

The 1977 Amendments added Section 301(b)(2)(E) to the Act establishing "best conventional pollutant control technology" (BCT) for discharges of conventional pollutants from existing industrial point sources. Conventional pollutants are those defined in Section 304(a)(4) biological oxygen demanding pollutants (BOD), total suspended solids (TSS), fecal coliform, and pH, and any additional pollutants defined by the Administrator as "conventional" [oil and grease, 44 FR 44501, July 30, 1979].

BCT is not an additional limitation but replaces BAT for the control of conventional pollutants. In addition to the other factors specified in Section 304(b)(4)(B), the Act requires that BCT limitations be assessed in light of a two-part "cost reasonableness" test. American Paper Institute v. EPA, 660 F.2d 954 (4th Cir. 1981). The first test compares the costs for private industry to reduce its conventional pollutants with the costs to publicly owned treatment works for similar levels of reduction in their discharge of these pollutants. The second test examines the cost effectiveness of additional industrial treatment beyond BPT. EPA must find that limitations are "reasonable" under both tests before establishing them as BCT. In no case may BCT be less stringent than BPT.

EPA published its methodology for carrying out the BCT analysis on August 19, 1979 (44 FR 50732). In the case mentioned above, the Court of Appeals ordered EPA to correct data errors underlying EPA's calculation of the first test and to apply the second cost test. (EPA had argued that a second cost test was not required). On October 29, 1982, the Agency proposed a revised BCT methodology (47 FR 49176). We are deferring proposal of BCT limitations for this category until the final methodology for BCT development has been promulgated.

SECTION XIV

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SECTION XV

GLOSSARY

This section is an alphabetical listing of technical terms, abbreviations, and acronyms used in this document which may not be familiar to the reader.

4-AAP Colorimetric Method

An analytical method for total phenols and total phenolic compounds that involves reaction with the color developing agent 4-aminoantipyrine.

Acid Dip

Using any acid for the purpose of cleaning any material. Two methods of acid cleaning are pickling and oxidizing.

Acidity

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

The Act

The Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. 1251 et. seq.), as amended by the Clean Water Act of 1977 (PL 95-217).

Agency

The United States Environmental Protection Agency.

Aging

A change in the properties of certain metals and alloys that occurs at ambient or moderately elevated temperatures after hot working or heat treatment (quench aging in ferrous alloys, natural or artificial aging in ferrous and nonferrous alloys) or after a cold working operation (strain aging).

Alkaline Cleaning

A process where dirt, mineral and animal fats, and oils are removed from the metal surface by exposure to solutions at high temperatures containing alkaline compounds, such as caustic soda, soda ash, alkaline silicates, and alkaline phosphates.

Alkaline Cleaning Bath

A bath consisting of an alkaline cleaning solution through which a workpiece is processed.

Alkaline Cleaning Rinse

A rinse following an alkaline cleaning bath through which a workpiece is processed. A rinse consisting of a series of rinse tanks is considered as a single rinse.

Alkalinity

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. It is measured by titration with a standardized acid to a specified end point, and is usually reported in milligrams per liter of calcium carbonate.

Amortization

The allocation of a cost or account according to a specified schedule, based on the principal, interest and period of cost allocation.

Analytical Quantification Level

The minimum concentration at which quantification of a specified pollutant can be reliably measured.

Ancillary Operation

Any operation associated with a primary forming operation. These ancillary operations include surface and heat treatment, hydrotesting, sawing, and surface coating.

Annealing

A generic term describing a metals treatment process that is used primarily to soften metallic materials, but also to simultaneously produce desired changes in other properties or in microstructure. The purpose of such changes may be, but is not confined to, improvement of machinability, facilitation of cold work, improvement of mechanical or electrical properties, and/or increase in stability of dimensions. Annealing consists of heating and cooling the metal at varying rates to achieve the desired properties.

Annealing with Oil

The use of oil to quench a workpiece as it passes from an annealing furnace.

Annealing with Water

The use of a water spray or bath, of which water is the major constituent, to quench a workpiece as it passes from an annealing furnace.

Backwashing

The operation of cleaning a filter or column by reversing the flow of liquid through it and washing out matter previously trapped.

Batch Treatment

A waste treatment method where wastewater is collected over a period of time and then treated prior to discharge. Treatment is not continuous, but collection may be continuous.

Bench Scale Pilot Studies

Experiments providing data concerning the treatability of a wastewater stream or the efficiency of a treatment process conducted using laboratory-size equipment.

Best Available Demonstrated Technology (BDT)

Treatment technology upon which new source performance standards are based, as defined by Section 306 of the Act.

Best Available Technology Economically Achievable (BAT)

Level of technology applicable to toxic and nonconventional pollutants on which effluent limitations are established. These limitations are to be achieved by July 1, 1984 by industrial discharges to surface waters as defined by Section 301(b)(2)(C) of the Act.

Best Conventional Pollutant Control Technology (BCT)

Level of technology applicable to conventional pollutant effluent limitations to be achieved by July 1, 1984 for industrial discharges to surface waters as defined in Section 301(b)(2)(E) of the act.

Best Management Practices (BMP)

Regulations intended to control the release of toxic and hazardous pollutants from plant runoff, spillage, leaks, solid waste disposal, and drainage from raw material storage. These regulations are defined in Section 304(e) of the Act.

Best Practicable Control Technology Currently Available (BPT)

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

Billet

A long slender cast product used as raw material in subsequent forming operations.

Biochemical Oxygen Demand (BOD)

The quantity of oxygen used in the biochemical oxidation of organic matter under specified conditions for a specified time.

Blowdown

The minimum discharge of circulating water for the purpose of discharging dissolved solids or other contaminants contained in the water, the further buildup of which would cause concentration in amounts exceeding limits established by best engineering practice.

Catalyst

An agent that (1) reduces the energy required for activating a chemical reaction and (2) is not consumed by that reaction.

Chelation

The formation of coordinate covalent bonds between a central metal ion and a liquid that contains two or more sites for combination with the metal ion.

Chemical Finishing

Producing a desired finish on the surface of a metallic product by immersing the workpiece in a chemical bath.

Chemical Oxygen Demand (COD)

A measure of the oxygen-consuming capacity of the organic and inorganic matter present in the water or wastewater.

Clean Water Act (see the Act)

Cold Rolling

The process of rolling a workpiece below the recrystallization temperature of the copper or copper alloy.

Colloid

Suspended solids whose diameter may vary between less than one micron and fifteen microns.

Composite Samples

A series of samples collected over a period of time but combined into a single sample for analysis. The individual samples can be taken after a specified amount of time has passed (time composited), or after a specified volume of water has passed the sampling point (flow composited). The sample can be automatically collected and composited by a sampler or can be manually collected and combined.

Consent Decree (Settlement Agreement)

Agreement between EPA and various environmental groups, as instituted by the United States District Court for the District of Columbia, directing EPA to study and promulgate regulations for the toxic pollutants (NRDC, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976); modified 12 ERC 1833, D.D.C. 1979); modified by order dated October 26, 1982.

Contact Water

Any water or oil that comes into direct contact with the copper, whether it is raw material, intermediate product, waste product, or finished product.

Continuous Casting

A casting process that produces sheet, rod, or other long shapes by solidifying the metal while it is being poured through an open-ended mold using little or no contact cooling water. Thus, no restrictions are placed on the length of the product and it is not necessary to stop the process to remove the cast product.

Continuous Treatment

Treatment of waste streams operating without interruption as opposed to batch treatment. Sometimes referred to as flowthrough treatment.

Contractor Removal (Contract Hauling)

Disposal of oils, spent solutions, or sludge by a commercial firm.

Conventional Pollutants

Constitutents of wastewater as determined by Section 304(a)(4) of the Act, including but not limited to pollutants classified as biological-oxygen-demanding, oil and grease, suspended solids, fecal coliform, and pH.

Cooling Tower

A hollow, vertical structure with internal baffles designed to break up falling water so that it is cooled by upward-flowing air and the evaporation of water.

Countercurrent Cascade Rinsing

A staged process that employs recycled, often untreated water as a rinsing medium to clean metal products. Water flow is opposite to product flow so that the most contaminated water encounters the incoming product first.

Data Collection Portfolio (dcp)

The questionnaire used in the survey of the copper forming industry.

Desmutting

A process that removes a residual silt (smut) by immersing the product in an acid solution, usually nitric acid.

Direct Discharger

Any point source that discharges or may discharge pollutants to a surface water.

Dragout

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

Drawing

Pulling the workpiece through a die or succession of dies to reduce the diameter or alter the shape.

Drying Beds

Areas for dewatering of sludge by evaporation and seepage.

Effluent

Wastewater discharge from a point source.

Effluent Limitation

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

Electrostatic Precipitator (ESP)

A gas cleaning device that induces an electrical charge on a solid particle which is then attracted to an oppositely charged collector plate. The collector plates are intermittently vibrated to discharge the collected dust to a hopper.

Emulsifying Agent

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

Emulsions

Stable dispersions of two immiscible liquids.

End-of-Pipe Treatment

The reduction of pollutants by wastewater treatment just prior to discharge or reuse, after all product contact is finished.

Extrusion

The application of pressure to a copper workpiece, forcing the copper to flow through a die orifice.

Extrusion Heat Treatment

The spray application of water to a workpiece immediately following extrusion for the purpose of heat treatment.

Finishing

The coating or polishing of a metal surface.

Forging

A process that exerts pressure on die or rolls surrounding heated copper stock forcing the stock to take the shape of the dies.

Gas Chromatography/Mass Spectroscopy (GC/MS)

Chemical analytical instrumentation used for quantitative organic analysis.

Grab Sample

A single sample of wastewater taken without regard to time or flow.

Heat Treatment

The application or removal of heat to a workpiece to change the physical properties of the metal.

Indirect Discharger

Any point source that discharges or may discharge pollutants to a publicly owned treatment works.

Inductively-Coupled Argon Plasma Spectrophotometer (ICAP)

A laboratory device used for the analysis of metals.

Ingot

A large, block-shaped casting produced by various methods. Ingots are intermediate products from which other products are made.

In-Process Control Technology

Any procedure or equipment used to conserve chemicals and water throughout the production operations, resulting in a reduction of the wastewater volume.

New Source Performance Standards (NSPS)

Effluent limitations for new industrial point sources as defined by Section 306 of the Act.

Nonconventional Pollutant

Parameters selected for use in performance standards that have not been previously designated as either conventional or toxic pollutants.

Non-Water Quality Environmental Impact

The ecological impact as a result of solid, air, or thermal pollution due to the application of various wastewater technologies to achieve the effluent guidelines limitations. Also associated with the non-water quality aspect is the energy impact of wastewater treatment.

NPDES Permits

Permits issued by EPA or an approved state program under the National Pollution Discharge Elimination System, Section 402 of the Act.

Off-Gases

Gases, vapors, and fumes produced as a result of a copper forming operation.

Off-Kilogram (Off-Pound)

The mass of copper or copper alloy removed from a forming or ancillary operation at the end of a process cycle for transfer to a different machine or process.

Oil and Grease (O&G)

Any material that is extracted by freon from an acidified sample and that is not volatilized during the analysis, such as hydrocarbons, fatty acids, soaps, fats, waxes, and oils.

pH

The pH is the negative logarithm of the hydrogen ion activity of a solution.

Pickling

The process of removing scale, oxide, or foreign matter from the surface of metal by immersing it in a bath containing a suitable chemical reagent, often sulfuric acid that will attack the oxide or scale, but will not act appreciably upon the metal during the period of pickling. Frequently it is necessary to immerse the metal in a detergent solution or to degrease it before pickling.

Pickling Bath

Any chemical bath (other than alkaline cleaning) through which a workpiece is processed.

Pickling Fume Scrubber

The process of using an air pollution control device to remove particulates and fumes from air above a pickling bath by entraining the pollutants in water.

Pickling Rinse

A rinse, other than an alkaline cleaning rinse, through which a workpiece is processed. A rinse consisting of a series of rinse tanks is considered as a single rinse.

Plate

A flat, extended, rigid body of copper having a thickness greater than or equal to 6.3 mm (0.25 inches).

Pollutant Parameters

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

Priority Pollutants

The 129 specific pollutants established by the EPA from the 65 pollutants and classes of pollutants as outlined in the consent decree of June 8, 1976.

Process Water

Water used in a production process that contacts the product, raw materials, or reagents.

Production Normalizing Parameter (PNP)

The unit of production specified in the regulations used to determine the mass of pollution a production facility may discharge.

Pretreatment Standards for Existing Sources (PSES)

Pretreatment standards (effluent regulations) for existing sources of indirect discharges under Section 307(b) of the Act.

Pretreatment Standards for New Sources (PSNS)

Pretreatment standards (effluent regulations) for new sources of indirect discharges under Section (b) and (c) of the Act.

Publicly Owned Treatment Works (POTW)

A waste treatment facility that is owned by a state or municipality.

Quantification Level (see Analytical Quantification Level).

Recycle

Returning treated or untreated wastewater to the production process from which it originated for use as process water.

Reduction

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

Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (Pub. L. 94-580) of 1976, Amendments to the Solid Waste Disposal Act.

Reuse

The use of treated or untreated process wastewater in a different production process.

Rinsing

A process in which water is used to wash cleaning chemicals from the surface of metal.

Rolling

A reduction in the thickness or diameter of a workpiece by passing it between rollers.

Scrubber Liquor

The untreated wastewater stream produced by wet scrubbers cleaning gases produced by aluminum forming operations.

Seal Water

A water curtain used as a barrier between the annealing furnance atmosphere and the outside atmosphere.

Semi-Continuous Casting (see Direct Chill Casting)

Semi-Fabricated Products

Intermediate products that are the final product of one process and the raw material for a second process.

Settlement Agreement (see Consent Decree)

Solution Heat Treatment

The process of introducing a workpiece into a quench bath for the purpose of heat treatment following rolling, drawing, or extrusion.

Spent Lubricant

Water or an oil-water mixture which is used in forming operations to reduce friction, heat and wear and ultimately discharged.

Stationary Casting

A process in which the molten copper is poured into molds and allowed to air-cool. It is often used to recycle in-house scrap.

Strain-Hardening (see work-hardening)

Subcategorization

The process of segmentation of an industry into groups of plants for which uniform effluent limitations can be established.

Surface Water

Any visible stream or body of water, natural or man-made. This does not include bodies of water whose sole purpose is wastewater retention or the removal of pollutants, such as holding ponds or lagoons.

Surfactants

Surface active chemicals that tend to lower the surface tension between liquids.

Swaging

A process in which a solid point is formed at the end of a tube, rod, or bar by the repeated blows of one or more pairs of opposing dies. It is often the initial step in the drawing process.

Total Dissolved Solids (TDS)

Organic and inorganic molecules and ions that are in true solution in the water or wastewater.

Total Organic Carbon (TOC)

A measure of the organic contaminants in a wastewater. The TOC analysis does not measure as much of the organics as the COD or BOD tests, but is much quicker than these tests.

Total Recycle

The complete reuse of a stream, with makeup water added for evaporative losses. There is no blowdown stream from a totally recycled flow and the process water is not periodically or continuously discharged.

Total Suspended Solids (TSS)

Solids in suspension in water, wastewater, or treated effluent. Also known as suspended solids.

Total Toxic Organics (TTO)

The sum of the masses or concentrations of each of the following toxic organic compounds which is found at a concentration greater than 0.010 mg/l: benzene, 1,1,1-trichloroethane, chloroform, 2,6-dinitrotoluene, ethylbenzene, methylene chloride, naphthalene, N-nitrosodiphenylamine, anthracene, phenanthrene, toluene, trichloroethylene.

Tubing Blank

A sample taken by passing one gallon of distilled water through a composite sampling device before initiation of actual wastewater sampling.

Volatile Substances

Materials that readily vaporize at relatively low temperatures.

Wet Scrubbers

Air pollution control devices used for removing pollutants from a gas as it passes through a liquid spray.

Wire

A slender strand of copper with a diameter of less than 9.5 mm (3/8 inches).

Work-Hardening

An increase in hardness and strength and a loss of ductility that occurs in the workpiece as a result of passing through cold forming or cold working operations. (Also known as strain-hardening).

Zero Discharger

Any industrial or municipal facility that does not discharge wastewater.

SECTION XVI

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