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Summary of Available Information on the Levels and Control of Toxic Pollutants Discharges in the

Printing and Publishing

Point Source Category

SUMMARY OF AVAILABLE INFORMATION ON THE LEVELS AND CONTROL OF TOXIC POLLUTANT DISCHARGES IN THE PRINTING AND PUBLISHING POINT SOURCE CATEGORY

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ABSTRACT

This document presents the findings of a study of the printing and publishing point source category conducted in fulfillment of the requirements of the Settlement Agreement in Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C. 1979).

The information presented in this document supports the determination that uniform national effluent limitations reflecting the best available technology economically achievable (BAT), new source performance standards (NSPS), and pretreatment standards for new and existing sources (PSNS and PSES) are not appropriate for six subcategories of the printing and publishing point source category pursuant to the provisions of Paragraph 8 (a)(iv) of the Settlement Agreement. This report summarizes data gathering efforts, industry subcategorization, water usage information, toxic pollutant discharge data, and control and treatment technologies employed in the printing and publishing industry.

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SUBCATEGORIZATION

In order to determine whether uniform national effluent regulations were appropriate for the printing and publishing point source category, it was necessary to subcategorize the industry. The Agency established the following preliminary subcategorization scheme based on production processes used in the printing and publishing industry:

Art and Copy Preparation and Composition

Photoprocessing (printing and/or publishing facilities engaged in internal photoprocessing operations)

Nonmetallic Platemaking

Pressroom (Nonwater-Based Inks)

Pressroom (Water-Based Inks)

Finishing and Binding Operations

Metallic Platemaking (now studied as part of metal finishing point source category)

Gravure Cylinder Preparation (now studied as part of metal finishing point source category)

As discussed below, the Agency has decided not to promulgate uniform national regulations for six subcategories of the printing and publishing point source category. If the toxic pollutant raw waste load data gathered by the Agency had shown that regulations were warranted, it is possible that this subcategorization scheme may have been revised to account for such factors as cost of treatment, size and age of facilities, or economic impact.

PARAGRAPH EIGHT DECISION

The Agency has excluded six subcategories of the printing and publishing point source category from national effluent regulations pursuant to the provisions of Paragraph 8 (a)(iv) of the Settlement Agreement in Natural Resources Defense Council, Inc. v. Train 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C. 1979). (1)(2)

Art and copy preparation and composition operations do not involve the use of water and finishing and binding operations are essentially dry processes. Because these two subcategories are dry or result in the discharge of very small quantities of toxic wastewater pollutants, they have been excluded from national regulations under the authority of paragraph 8(a) (iv) of the Settlement Agreement.

Discharge of heavy metals and other toxic pollutants may occur from plants in the photoprocessing, nonmetallic platemaking, pressroom (nonwater-based inks), and pressroom (water-based inks) subcategories. The median discharge volume from individual facilities is between 26 and 50 gallons per day. Even for large plants of which there are few in these subcategories, the total raw wastewater discharge contains less than 1.2 pounds of toxic pollutants per day per plant. Based on EPA's review of all available data, the Agency has excluded these four subcategories from national regulations because the amount and toxicity of the pollutants contained in the raw wastewater discharges do not justify developing national regulations.

The information and data gathered to date regarding the gravure cylinder preparation and metallic platemaking subcategories were not sufficient to make regulatory decisions; however, the data do show that further study of these subcategories is warranted and that these operations are similar to certain metal finishing processes. Therefore, gravure cylinder preparation and metallic platemaking will be further studied in the second phase of the rulemaking effort for the metal finishing point source category.

SECTION II

INTRODUCTION

PURPOSE AND AUTHORITY

The Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500; the Act) established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (see Section 101(a)). By July 1, 1977, existing industrial dischargers were required to achieve "effluent limitations requiring the application of the best practicable control technology currently available" (BPT) (see Section 301(b)(1)(A)). By July 1, 1983, these dischargers were required to achieve "effluent limitations requiring the application of the best available technology economically achievable (BAT), which will result in reasonable further progress toward the national goal of eliminating the discharge of pollutants" (see Section 301(b)(2)(A)). New industrial direct dischargers were required to comply with new source performance standards (NSPS), established under authority of Section 306, based on best available demonstrated technology. New and existing dischargers to publicly owned treatment works were subject to pretreatment standards under Sections 307(b) and (c) of the Act. While the requirements for direct dischargers were to be incorporated into National Pollutant Discharge Elimination System (NPDES) permits issued under Section 402 of the Act, pretreatment standards were made enforceable directly against dischargers to publicly owned treatment works (indirect dischargers).

Although Section 402(a)(1) of the 1972 Act authorized the setting of requirements for direct dischargers on a case-by-case basis in the absence of regulations, Congress intended that, for the most part, control requirements would be based on regulations promulgated by the Administrator of the United States Environmental Protection Agency (EPA). Section 304(b) of the Act requires the Administrator to promulgate regulations providing guidelines for effluent limitations setting forth the degree of effluent reduction attainable through the application of BPT and BAT. Moreover, Sections 304(c) and 306 of the Act require promulgation of regulations for NSPS, and Sections 304(f), 307(b), and 307(c) require promulgation of regulations for pretreatment standards. In addition to these regulations for designated industry categories, Section 307(a) of the Act requires the Administrator to promulgate effluent standards applicable to all dischargers of toxic pollutants. Finally, Section 501(a) of the Act authorizes the Administrator to prescribe any additional regulations "necessary to carry out his functions" under the Act.

The Agency was unable to promulgate many of these toxic pollutant regulations and guidelines within the time periods stated in the Act. In 1976, EPA was sued by several environmental groups and, in settlement of this lawsuit, EPA and the plaintiffs executed a "Settlement Agreement", which was approved by the Court. This Agreement required EPA to develop a program and adhere to a schedule for promulgating, for 21 major industries, BAT effluent limitations guidelines, pretreatment standards, and new source performance standards for 65 toxic pollutants and classes of toxic pollutants [see Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C. 1979)]. (1)(2)

On December 27, 1977, the President signed into law the Clean Water Act of 1977 (P.L. 95-217). Although this law makes several important changes in the Federal water pollution control program, its most significant feature is its incorporation into the Act of many of the basic elements of the Settlement Agreement program for toxic pollution control. Sections 301(b)(2)(A) and 301(b)(2)(C) of the Act now require the achievement by July 1, 1984, of effluent limitations requiring application of BAT for "toxic" pollutants, including the 65 "priority" pollutants and classes of pollutants which Congress declared "toxic" under section 307(a) of the Act. Likewise, EPA's programs for new source performance standards and pretreatment standards are now directed principally at toxic pollutant controls.

STANDARD INDUSTRIAL CLASSIFICATION

The printing and publishing industry is in Standard Industrial Classification (SIC) Major Group 27, and is comprised of establishments engaged in printing by one or more of the common processes, such as letterpress, flexography, lithography, gravure, or screen, and those establishments where services such as bookbinding, typesetting, engraving, photoengraving, and electrotyping are performed for the printing trade.(3) Also included are establishments engaged in publishing newspapers, books, and periodicals, regardless of whether they do their own printing.

PREVIOUS STUDIES

The effluent limitations guidelines program for the printing and publishing point source category has been active since 1977. Prior to 1977, EPA had not collected historical data of consequence, had not assessed industry practices or treatment system performance, and had made no attempt to subcategorize the industry. Published studies included only an abbreviated report on waste characterization prepared in 1974 by the EPA National Field Investigations Center, Denver, Colorado, and the minutes of a 1975 EPA Office of Toxic Substances conference.(4)(5) Neither of these efforts was sufficiently comprehensive to enable EPA to establish effluent guidelines for this industrial category.

PARAMETERS INVESTIGATED IN THIS STUDY

Sixty-five toxic compounds and classes of toxic compounds are listed in the Settlement Agreement between EPA and the National Resources Defense Council (NRDC). (1)(2) This list potentially includes thousands of specific pollutants. The expenditure of resources in government and private laboratories would be overwhelming if analyses were attempted for all of these pollutants. To make the task more manageable, EPA selected 129 specific toxic pollutants (Table II-1) for study. The criteria for selection of these 129 pollutants included frequency of occurrence in water, chemical stability and structure, amount of chemical produced, availability of chemical standards for measurement, and other factors. All 129 specific toxic pollutants, with the exceptions of 2,3,7,8-tetra- chlorodibenzo-p-dioxin (TCDD) and asbestos, were analyzed in this study. TCDD was not analyzed because the necessary laboratory procedures are prohibitively dangerous and the use of this compound in the printing industry was not documented. EPA felt it would be unwise to commit limited resources to asbestos analyses because results of the Agency's literature review indicated asbestos was not used in printing industry processes.

Although this study was focused on the 129 toxic pollutants, some conventional and nonconventional pollutant parameters were also analyzed. Pollutant data are presented in Sections V and VI and in the Appendix.

SUMMARY OF METHODOLOGY

Introduction

EPA's implementation of the Act required a complex development program, described in this section and subsequent sections of this document. Initially, because in many cases no public or private agency had done so, EPA and its laboratories and consultants had to develop analytical methods for toxic pollutant detection and measurement. EPA then gathered technical data about the industry and proceeded to evaluate the need for regulations.

TABLE II-1

TOXIC POLLUTANTS INVESTIGATED IN EPA STUDIES
OF THE 21 MAJOR INDUSTRIES

COMPOUND NAME

1. *acenaphthene
2. *acrolein
3. *acrylonitrile
4. *benzene
5. *benzidine
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-trichloroethane
12. hexachloroethane
13. 1,1-dichloroethane
14. 1,1,2-trichloroethane
15. 1,1,2,2-tetrachloroethane
16. chloroethane

*CHLOROALKYL ETHERS

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

*CHLORINATED NAPHTHALENE

20. 2-chloronaphthalene

*CHLORINATED PHENOLS (other than those listed elsewhere; includes chlorinated cresols)

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

*DICHLOROBENZENES

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

---

* Specific compounds and chemical classes as listed in the consent degree.

TABLE II-1

TOXIC POLLUTANTS INVESTIGATED IN EPA STUDIES
OF THE 21 MAJOR INDUSTRIES
(Continued, Page 2 of 5)

COMPOUND NAME

*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-chloroethoxy) methane

*HALOMETHANES (other than those listed elsewhere)
44. methylene chloride (dichloromethane)
45. methyl chloride (chloromethane)
46. methyl bromide (bromomethane)
47. bromoform (tribromomethane)
48. dichlorobromomethane
49. trichlorofluoromethane

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* Specific compounds and chemical classes as listed in the consent degree.

TABLE II-1

TOXIC POLLUTANTS INVESTIGATED IN EPA STUDIES
OF THE 21 MAJOR INDUSTRIES
(Continued, Page 3 of 5)

COMPOUND NAME

50. dichlorodifluoromethane
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)

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* Specific compounds and chemical classes as listed in the consent degree.

TABLE II-1

TOXIC POLLUTANTS INVESTIGATED IN EPA STUDIES
OF THE 21 MAJOR INDUSTRIES
(Continued, Page 4 of 5)

COMPOUND NAME

74. 3,4-benzofluoranthene
75. benzo(k)fluoranthene (11,12-benzofluoranthene)
76. chrysene
77. acenaphthlene
78. anthracene
79. benzo(ghi)perylene (1,12-benzoperylene)
80. fluorene
81. phenanthrene
82. dibenzo(a,h)anthracene (1,2,5,6-dibenzanthracene)
83. indeno (1,2,3-cd)pyrene (2,3-o-phenylenepyrene)
84. pyrene

85. *tetrachloroethylene
86. *toluene
87. *trichloroethylene
88. *vinyl chloride (chloroethylene)

PESTICIDES AND METABOLITES
89. *aldrin
90. *dieldrin
91. *chlordane (technical mixture & metabolites)

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

*ENDOSULFAN AND METABOLITES
95. a-endosulfan-Alpha
96. b-endosulfan-Beta
97. endosulfan sulfate

*ENDRIN AND METABOLITES
98. endrin
99. endrin aldehyde

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*Specific compounds and chemical classes as listed in the consent degree.

TABLE II-1

TOXIC POLLUTANTS INVESTIGATED IN EPA STUDIES
OF THE 21 MAJOR INDUSTRIES
(Continued, Page 5 of 5)

COMPOUND NAME

*HEPTACHLOR AND METABOLITES
100. heptachlor
101. heptachlor epoxide

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

*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)
113. *toxaphene

114. *antimony (total)
115. *arsenic (total)
116. *asbestos (fibrous)
117. *beryllium (total)
118. *cadmium (total)
119. *chromium (total)
120. *copper (total)
121. *cyanide (total)
122. *lead (total)
123. *mercury (total)
124. *nickel (total)
125. *selenium (total)
126. *silver (total)
127. *thallium (total)
128. *zinc (total)
129. *2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)

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*Specific compounds and chemical classes as listed in the consent degree.

Information and data were collected in a three-step program, as follows:

1. The potential for toxic pollutant use and discharge in the printing industry was investigated in an extensive literature review;

2. A data request survey was mailed to 6,995 plants (at least ten percent of the estimated total number of plants in the industry); and

3. Individual facilities were visited and sampled to collect raw waste data and information on control and treatment system performance.

This program resulted in the compilation of the industry profile presented in Section III, the raw waste data presented in Section V, and the control and treatment data presented in Section VI.

Literature and Other Sources of Information

Available literature was reviewed for information on raw material usage and process chemistry, with particular emphasis on the identification of toxic pollutants contained in raw materials or produced during plant operations. The literature consisted of published texts, trade association and chemical supplier manuals, and information obtained by EPA in a study of the ink industry and toxic pollutants contained in inks. Although comprehensive data regarding most of the proprietary compounds used by the printing industry were unavailable, production processes and potential discharges of significance were identified in the literature.

In addition to the literature review, pollutant information was requested from the ten EPA regional offices and 12 state environmental authorities. Historical pollutant data were obtained from representatives of individual plants, municipal sewer district offices and NPDES permit authorities. Information regarding printing industry contributions to publicly owned sewage systems was requested from 16 large municipalities. In most cases, no analyses of toxic pollutants, with the exception of certain heavy metals, were included in these data.

Data Request Survey

According to Dun and Bradstreet, the printing industry consisted of 57,008 manufacturing establishments in 1976.(6) The Agency developed a mailing list which provided representative coverage of these establishments by product, process, size, and SIC code, and mailed a data request survey to approximately ten percent of the industry.

During preparation of the data request survey and the mailing list, 52 trade association contacts were made. A meeting, which resulted in valuable industry input to the survey, was held with representatives of the following associations:

- Printing Industries of America (PIA)
- Printing Industries of Connecticut (PIC)
- Graphic Arts Technical Foundation (GATF)
- National Association of Printers and Lithographers, Inc. (NAPL)
- Flexographic Technical Association (FTA)
- Gravure Technical Association (GTA)
- Gravure Research Institute (GRI)
- American Newspaper Publishing Association (ANPA)

An industry committee, known as the Environmental Conservation Board was formed. It was comprised of concerned representatives from several groups within the printing and publishing industry and included representatives from various graphic art trade associations, chemical suppliers, and equipment manufacturers, as well as individuals from prominent printing and publishing firms throughout the country. The committee, meeting regularly with EPA from the fall of 1977 until the fall of 1979, provided valuable technical information and served as a forum for exchange of information and opinions. The committee participated in the review and development of the survey form and had considerable input into its content. The committee and its member organizations also provided suggestions regarding the selection of plants to be sampled.

As mentioned previously, EPA mailed survey forms to 6,995 plants. Of the 5,675 forms returned (88.2 percent), 5,004 provided usable information. Data from the other plants were not useable for such reasons as (a) the plant had gone out of business or (b) printing was not performed on site. The results of the survey formed the primary basis for the industry profile presented in Section III.

Plant Visitation and Sampling Program

Sixty-two plants were visited and 17 were sampled. The purposes of the visitations were to: gain a better understanding of the industry, its processes, and its complexities; qualify historical data and obtain current process information; and determine whether the plant was a candidate for sampling. Two sampling programs, screening and verification, were implemented based on information obtained from plant visits and the data request survey.

The purpose of the screening sampling program was to establish the presence or absence of toxic pollutants in printing and publishing wastewater discharges. Plants selected for screening employed various processes for which the maximum amount of toxic pollutant information could be obtained. Specific criteria for selecting plants were as follows:

1. The plant should be representative in terms of size, age, geographical location, and processes,

2. Operations at the plant should involve the greatest number of commonly used chemical additives, preservatives, anti-foamants, and cleaning solutions (this allows EPA to obtain the maximum amount of toxic pollutant information),

3. The plant should have segregated process and nonprocess wastewater streams,

4. The plant should have complete treatment to provide data on toxic pollutant reduction through application of various treatment alternatives,

5. The plant's raw wastewater and treated effluent should be physically accessible.

All sampling and analyses procedures for screening as well as verification followed the <u>Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants</u>, (U.S. Environmental Protection Agency, Cincinnati, Ohio, April 1977). (7)

Upon review of the screening sampling data, the Agency decided to exclude the photoprocessing, nonmetallic platemaking, and pressroom (nonwater-based inks) subcategories from national regulations pursuant to the provisions of Paragraph 8 (a)(iv) of the Settlement Agreement; therefore, no verification sampling was conducted for these subcategories. The data also showed that further investigation of the pressroom (water-based inks) subcategory was warranted and verification sampling was conducted at two plants to obtain additional information.

The purposes of verification sampling were to (a) verify results obtained in the screening sampling program, (b) quantify pollutant loadings of raw and treated wastewater, (c) provide additional information to aid in industry subcategorization, and

(d) determine pollutant reduction and treatment efficiency of in-place treatment technology. Specific criteria applied in selecting a plant were the same as for screening sampling.

Subcategorization

The accumulated information and data were assessed to determine whether differences in raw materials, final products, manufacturing processes, equipment, water usage, wastewater constituents, or other factors required the development of separate effluent limitations and standards of performance for different segments (subcategories) of the industry. This required the identification of raw waste and treated effluent characteristics, including: (a) the sources and volumes of water used, the manufacturing processes employed, and the sources of pollutants and wastewaters within the plant; and (b) the toxic pollutant constituents of wastewaters. Subcategorization is addressed in Section IV of this document.

Identification of Control and Treatment Technology

Raw waste load data are presented in Section V of this document. Reduction of toxic pollutants in treatment systems employed at plants visited during this study is discussed in Section VI.

Analysis of Treatment Alternatives, Cost, and Energy Data

Because the Agency determined that the amount and toxicity of the pollutants contained in the raw wastewater discharges do not justify developing national regulations, study of this industry was terminated in its early stages. Control and treatment options were not developed, nor were cost, energy, or nonwater quality aspects evaluated in detail. Effluent reduction attainable through application of specific control and treatment technologies also was not determined; however, Section VI of this document presents effluent data for existing pretreatment and treatment systems employed in the printing and publishing industry.

SECTION III

DESCRIPTION OF THE INDUSTRY

INTRODUCTION

The printing and publishing point source category includes manufacturing establishments whose operations fall within Major Group 27 of the 1972 Standard Industrial Classification Manual. (3) The SIC list is oriented toward the collection of economic data related to gross production, sales, and unit costs. The list is useful because it divides American industry into discrete product-related segments. It is, however, only generally related to the nature of the industry in terms of actual plant operations, production processes, or water pollution control considerations.

Major Group 27 consists of (a) manufacturing establishments primarily engaged in printing, using one or more of the common processes such as letterpress, flexography, lithography, gravure, or screen, and (b) those establishments which perform services for the printing trade such as typesetting, engraving, photoengraving, electrotyping, and binding. Table III-1 lists the 17 specific SIC codes investigated during this study and the more common mixes of products and processes that are likely to occur because of similarities in equipment and expertise; almost any combination of printing processes is possible.

A substantial amount of in-plant printing is performed by establishments whose major activities fall outside the definition of SIC 27. Examples of industries extensively using graphic arts technologies include: the converted paper industry, the textile industry, and the growing field of circuit printing. In many instances, it is difficult to classify a plant due to the diversity and overlap of processes and products. For the purposes of developing the industry profile, only data from plants whose primary line of business falls within SIC 27 were used.

PROCESS DESCRIPTIONS

Introduction

This section presents information on printing plant operations with emphasis on the chemical and water usage aspects. Many of the technical terms used in this discussion are defined in the glossary. The basic production steps (process operations) common to lithographic, letterpress, flexographic, gravure, and screen printing are illustrated in Figure III-1.

TABLE III-1

SPECIFIC SIC CODES INVESTIGATED IN EPA'S
STUDY OF THE PRINTING AND PUBLISHING INDUSTRY

SIC	Primary SIC Code	Common Secondary Activities
2711	Newspapers	2751, 2752, 2754, 2793
2721	Periodicals	2731, 2741
2731	Book Publishing	2721, 2741
2732	Book Printing	2751, 2752, 2791
2741	Miscellaneous Publishing	2721, 2731
2751	Commercial Printing, Letterpress	2732, 2752, 2754
2752	Commercial Printing, Lithographic	2732, 2751, 2753, 2761, 2771, 2791, 2795
2753	Engraving and Plate Printing	2751, 2752
2754	Commercial Printing, Gravure	2751, 2793
2761	Manifold Business Forms	2751, 2752
2771	Greeting Card Publishing	2649[1], 2752
2782	Blankbooks, Looseleaf Binders, and Devices	2648[2], 2752, 2789
2789	Bookbinding and Related Work	2731, 2751, 2782
2791	Typesetting	2732, 2752, 2794
2793	Photoengraving	2753, 2754, 2794, 2795
2794	Electrotyping and Stereotyping	2753
2795	Lithographic Platemaking & Related Services	2793

[1] Converted Paper Products--SIC 2649.
[2] Stationery Products--SIC 2648.

Source: Dun and Bradstreet, 1976.

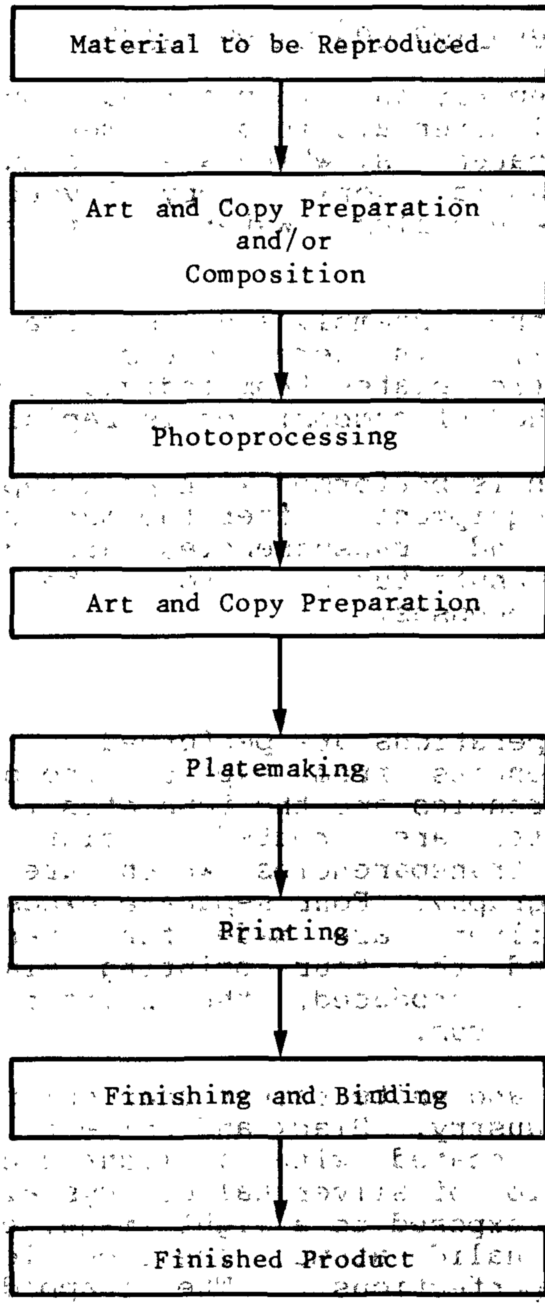

FIGURE III-1. GENERAL MANUFACTURING STEPS FOR PRINTING PROCESSES WHICH INVOLVE PHOTOMECHANICAL PLATEMAKING

Art and Copy Preparation and Composition

Art and copy preparation involves manual operations employed to transform original materials into a camera ready form and to prepare the transparencies, which are subsequently developed, for platemaking. Camera work, copy layout, and transparency stripping are some examples. Water is not used in art and copy preparation.

Composition is the assembly and justification of type. In the traditional sense, this term refers to the manufacture of letterpress printing plates from individual metallic type faces. This outdated method of composition is rapidly becoming obsolete.

Modern composition is performed with phototypesetting machines or cathode ray tube equipment. After the manuscript is composed, it is photographed and transparencies are developed. Printing plates are manufactured from the transparencies by photomechanical processes.

Photoprocessing

Photoprocessing operations are performed at printing plants to produce transparencies from exposed photographic films. In printing, transparencies are the templates from which the images on printing plates are created. Color printed products are manufactured from transparencies which are produced by color separation photography. Four separate exposures, each through a different color filter, are made for every original. Using special inks and the four printing plates made from the transparencies thus produced, the printer can reproduce the entire visible spectrum.

In general, black and white rather than color film is used in the graphic arts industry. Black and white film consists of a base material which is coated with a light-sensitive emulsion (a colloidal suspension of silver halide crystals in gelatin). When the emulsion is exposed to a light image, electrons are ejected from the impacted halide atoms. The free electrons are trapped by crystal imperfections. The trapped electrons attract positively charged free silver ions and clusters of metallic silver form at the trap sites. These clusters of metallic silver, still very small, form a latent image of the original light exposure pattern.

During processing, the developer solution causes additional silver to be formed at the cluster sites to the extent that the clusters grow, aggregate, and form a visible image. The most common developer for black and white film is hydroquinone (pdihydroxybenzene). Metol (methyl-para-aminophenol sulfate) is another commercially important developing agent. These compounds ionize in alkaline solutions and are capable of reducing exposed silver halides to metallic silver at a rate which is much greater than the rate at which they reduce unexposed silver halides. Potassium or sodium carbonate is used to increase the pH of the solution, thus increasing the activity of the developing agent. A preservative, usually sodium sulfite, inhibits aerial oxidation of the developing solution. Potassium bromide or another restrainer is used to minimize chemical fogging of the film.

When the film is contacted with a fixing solution, development stops and the silver images formed during development become permanent. The major constituents of a typical fixing solution are acetic acid, thiosulfate salts, and potassium alum. Acetic acid arrests the developing action which depends on alkaline conditions. A thiosulfate salt, usually ammonium thiosulfate, converts unexposed silver halides to a water soluble form. Potassium alum hardens the gelatin and renders it insoluble in water. After it is fixed, the finished transparency is washed with water and dried.

Current industry trends are toward automatic film processing as opposed to tray developing. Rinse water usage in automatic film processors ranges from 4 to 15 liters per minute (1 to 4 gallons per minute) per processor. The water may run continuously; however, many processors are equipped with water-saving solenoid valves so that rinse water only runs when film is in the processor. Almost all automatic film processors are equipped with silver recovery units. Silver recovery is discussed below.

Silver Recovery. The fix and wash water solutions contain essentially all of the silver removed during photoprocessing. The most common methods of silver recovery are metallic replacement and electrolytic recovery.

Metallic Replacement - Metallic replacement occurs when a metal, such as iron, comes in contact with a solution containing dissolved ions of a less active metal, such as silver. The dissolved silver, which is present in the form of a thiosulfate complex, reacts with solid metal (iron). The more active metal goes into solution as an ion, and an ion of the less active metal becomes solid metal (silver).

Silver ions will displace ions of many of the common metals from their solid state. Because of its economy and convenience, iron in the form of steel wool is most often used. Zinc, as a replacement metal, can also be effective, but it is seldom used because of its relatively higher toxicity and greater cost.

Aluminum is not commonly used as a replacement metal because of the simultaneous generation of hydrogen gas.

For most efficient operation, the pH of the solution passing through the metallic replacement unit should be between 4 and 6.5, with an optimum between 5 and 5.5. Below a pH of 4, the dissolution of the steel wool is too rapid. Above a pH of 6.5, the replacement reaction may be so slow that an excessive amount of silver would be lost because of the long reaction time required.

Silver recovery by metallic replacement is most often carried out using commercially available units consisting of a steel wool filled plastic bucket with appropriate plumbing. Typical practice is to feed waste fix to two or more canisters in series or series-parallel combinations. For two canisters in series, the first canister removes the bulk of the silver and the second unit polishes the effluent of the first and acts as a safety factor if the first unit is overused. When the first unit is exhausted, it is common to replace it with the second and put a new unit in place of the second. It has been reported that silver concentrations in the effluent from a single unit average 40 to 100 mg/l over the life of the unit versus a range of 0.1 to 50 mg/l when two canisters are used in series.(8)

Desilvered fix is not recycled because of the iron contamination. The average iron concentration in the canister effluent, over the life of the canister, is 4,000 mg/l.

<u>Electrolytic Recovery</u> - The application of direct current across two electrodes in a silver-bearing solution causes metallic silver to deposit on the cathode. Sulfite and thiosulfate are oxidized at the anode as follows:

$$H_2O + SO_3^{-2} = SO_4^{-2} + 2e^- + 2H^+ \quad \text{(Anode)}$$

$$SO_3^{-2} + S_2O_3^{-2} = S_3O_6^{-2} + 2e^- \quad \text{(Anode)}$$

$$Ag^+ + e^- = Ag^0 \quad \text{(Cathode)}$$

Approximately 1 gram of sodium sulfite is oxidized for each gram of silver plated. Considerable agitation and large plating surface areas are necessary to achieve good plating efficiency and high quality silver (up to 96-98 percent pure). If multiple units are used in series, lower silver purity levels are generally achieved in the tail cells. The cathodes are removed periodically, and the silver is stripped off. To prevent "sulfiding", the current density in the cell must be controlled. Sulfiding is the result of decomposition of thiosulfate at the cathode. The sulfide contaminates the deposited silver and reduces recovery efficiency. The higher the silver concentration, the higher that the current density can be without danger of sulfiding. As the silver is plated out of solution, the current density must be reduced.

Batch electrolytic recovery units can be used for primary or secondary silver recovery. Overflow fix from a process line or lines is collected in a tank. When sufficient volume is reached, the waste fix is pumped to an electrolytic cell for the silver removal process. The desilvered fix is either discharged or reused. Primary batch system cells are usually designed to desilver the fix at fairly high starting silver concentrations of about 5,000 mg/l. The silver concentration in the effluent is typically about 200-500 mg/l, but can be reduced to 20-50 mg/l with additional treatment time and careful control of current density. A secondary batch system cell typically achieves the lower range because the process can be optimized for low starting silver concentrations.(8)

Continuous electrolytic recovery units remove silver from the fix solution at approximately the rate at which silver is being added by processing. The recovery cell is included "in-line" as part of a recirculation system. This continuous removal technique has the particular advantage of maintaining a relatively low silver concentration in the fix processing solution so that the amount of silver carried out with the processed material into the wash tank is minimized. The silver concentration in the fix can be maintained in the range of 500 to 1,000 mg/l, the lower limit being primarily a function of residence time in the cell (i.e., system flow rate).

The recycling of desilvered fix solution, whether by an "in-line" continuous system or by a batch system, requires adequate monitoring and process control to protect product quality. Parameters which should be monitored to maintain the physical and chemical properties of the fix solution include pH, silver, and sulfite concentrations.

Platemaking

An image carrier is a plate, cylinder, or screen used on a printing press to transfer an ink image to a substrate. The various methods of image carrier manufacture are collectively termed "platemaking". Most platemaking methods are based on the principles of photomechanics.

In photomechanics, the plate is coated with a light-sensitive material and exposed to light transmitted or reflected from transparencies. The physical properties of the material change upon exposure to light. In most cases, the exposed areas harden proportionally to the amount of exposure. An image is formed when the unexposed areas dissolve in water or other solvents during subsequent processing. This image may become the image carrier or may serve as a template which allows acid solutions to etch the uncovered areas of the underlying metal. In the latter case, the light-sensitive material is called a resist and the etched metal serves as the image carrier. Photomechanical and other image carrier preparation processes are discussed below.

Lithographic Platemaking. On a lithographic printing plate, the image areas are on the same plane as the non-image areas. The image areas have an affinity for solvent-based inks and the non-image areas are hydrophilic and repel solvent-based inks.

The printing plates used most often in large lithographic printing operations are surface plates, deep-etch plates, and bimetallic plates. Surface plates are used for short and medium length press runs while deep-etch and bimetallic plates are generally used for longer press runs.

Surface Plates - Surface plates are classified as "presensitized" (coated by the manufacturer) or "wipe-on" (coated by the printer). The plate backing is smooth or finely grained aluminum which has been anodized or treated with silicates so that the coating will adhere to the plate and not react with the metal.

Presensitized and wipe-on plates are usually coated with diazonium resins. Diazonium coatings are easy to work with and are resistant to changes in physical properties caused by temperature or relative humidity. Presensitized plates are the most widely used but, because presensitized plates have limited storage life, wipe-on plates are preferred for some applications.

A typical wipe-on coating is 4-diazo-diphenylamine polymerized with formaldehyde. The coating is dissolved in a suitable solvent, usually a mixture of denatured alcohol and water, and applied to the plate with a two-roll coater or a sponge. The shelf life of the solution is not more than a few days and unused portions are disposed of regularly.

Diazo-coated plates are usually exposed to negative transparencies and developed by one of a number of related processes. A typical example is the emulsion developer process. An emulsion developer is an acidic aqueous solution which contains dissolved gum arabic and an emulsified lacquer. During development, the lacquer deposits on the hardened (exposed) coating, and gum arabic precipitates on the aluminum, which is uncovered as the unexposed coating dissolves.

Following development, the plate is rinsed with water, treated with an aqueous gum arabic solution, and allowed to dry. The image area, which is covered with the dryed lacquer, accepts ink, but refuses water. The aluminum in the non-image area is covered by a thin film of gum arabic. Gum arabic serves to enhance the ink repellance of the aluminum.

Although some printers process these plates manually, the use of processing machines for diazo-coated plates is quite common. In general, water usage is less when the plates are processed by machine.

Photopolymer plates, which are always precoated by the manufacturer, are capable of longer press runs than diazo-coated plates. Two of the more common photopolymer coatings are (a) polyacrylate compounds and (b) cinnamate esters. Polyacrylate compounds are esters of acrylic acid derivatives and alcohols. Photoinitiators accelerate the light induced hardening (polymerization) of these compounds. The photoinitiator may be a peroxide, a diazonium salt, a silver halide, or a polyhalogenated alkane. Cinnamate esters, which do not require photoinitiators, are another common photopolymer coating material. Photopolymer plates are usually processed by machines; the processing solutions are specific to the plate chemistry.

Deep-Etch Plates - Deep-etch platemaking is usually a manual operation and requires skilled craftsman. It was once a predominant process, but is now gradually becoming obsolete with the advent of photopolymer plates which are capable of longer press runs. In general, this process generates more wastewater than any other lithographic platemaking operation. The term deep-etch is a misnomer. The image areas on these plates are only slightly below the non-image areas.

A typical procedure for deep-etch platemaking is outlined below.

(a) The grained aluminum plate is counter etched (i.e., cleaned and conditioned with harsh chemical solutions). The plate is immersed in an aqueous solution of three percent phosphoric acid by volume. This is followed by treatment in an 11 liter (3 gallon) aqueous bath containing 0.09 liters (0.02 gallons) of 48 percent hydrofluoric acid and 0.80 liters (0.21 gallons) of 20 percent aqueous ammonium dichromate.

(b) The plate is coated with a photographic resist on a rotating table called a whirler. The pH of the coating, an aqueous solution of gum arabic and ammonium dichromate, is adjusted to nine with ammonium hydroxide. The coating is poured onto the plate and dries by the rotating action of the whirler. Excess coating spins off the table and is cleaned up with water.

(c) The plate is exposed to a positive transparency.

(d) The plate is developed in a solution which dissolves the unexposed coating. The developing solution is an aqueous mixture of calcium chloride and lactic acid. After development, the aluminum in the unexposed areas is bare, and the remainder of the plate is covered with an acid resistant stencil.

(e) The plate is etched in an aqueous solution composed of ferric chloride, hydrochloric acid, and calcium chloride. An image is formed as the unprotected aluminum is attacked.

(f) The plate is washed four or more times with anhydrous alcohol, isopropanol, or Cellosolve and allowed to dry. The stencil is destroyed in this step.

(g) In some cases, the image areas are copperized. Copper increases the press life of the plate and is more receptive to solvent-based inks and lacquers than is aluminum. The copperizing solution consists of cuprous chloride and hydrochloric acid dissolved in isopropanol.

(h) The entire plate is coated with a film of ink receptive lacquer and allowed to dry. The lacquer is a vinyl resin dissolved in a solvent such as methyl ethyl ketone or Cellosolve.

(i) The plate is covered with a greasy ink.

(j) The plate is placed in a water bath and scrubbed with a brush. This removes the lacquer and ink covering the aluminum in the non-image areas but, does not remove the lacquer and ink in the image areas.

(k) The plate is treated with an aqueous solution of phosphoric acid and gum arabic. Gum arabic enhances the ink repellance of the aluminum.

Bimetallic Plates - Bimetallic plates are the most expensive lithographic printing plates and are capable of the longest press runs. The image areas are copper, which has an affinity for greasy inks, and the non-image areas are relatively hydrophilic metals such as aluminum, chromium, nickel, or stainless steel. The plate is coated with a resist, exposed to a positive transparency, and developed. The non-image areas on the developed plate are protected by an acid resistant stencil. The image areas are formed by etching away the hydrophilic metal (in the areas unprotected by the stencil) to uncover the copper. The process is similar to deep-etch platemaking.

Letterpress and Flexographic Platemaking. Flexography is a modern variation of letterpress, which is the oldest commercial printing process. Letterpress and flexography are relief printing methods; i.e., the image areas on the printing plates are raised relative to the non-image areas. The primary difference between the two methods is that flexographic plates are rubber rather than metal or hard plastic. The porous structure of rubber is ideal for certain printing applications.

The traditional letterpress plates (stereotypes and electrotypes) are duplicates of original plates which are compositions of metallic type faces or photoengravings. Because composition and photoengraving are time consuming processes, it is convenient to use the original to make duplicate plates which are used for the actual printing.

Photopolymer plates are gradually replacing the traditional plates. Photopolymer plates are manufactured by modern photomechanical methods and, although they are sometimes used to make duplicate plates, are generally used directly on the printing press.

Photoengraving - Photoengraving was the first photomechanical platemaking process. First, zinc, copper, or magnesium plates are coated with a resist and exposed to negative transparencies. Next, the plate is developed and the exposed coating forms an acid resistant stencil. Finally, a positive relief image is formed by chemical etching of the plate areas unprotected by the stencil. After the resist is removed the original photoengraving can be used directly on the press, but is more commonly used to make duplicate plates.

The most common resist is polyvinyl alcohol sensitized with a diazonium salt or ammonium dichromate. The resist is applied on a whirler in a manner similar to that previously discussed for deep-etch platemaking. The developed stencil is usually hardened by treatment with chromic acid. A typical aqueous etching solution for magnesium and zinc contains between 10 and 20 percent nitric acid, 4.5 percent urea derivatives, and 1 percent surfactant which is composed of sulfates and alkyl benzenes. Aqueous solutions of ferric chloride and hydrochloric acid are typically used for copper etching.

Stereotype Plates - Stereotype plates are lead alloys which were once widely used for printing newspapers, books, and other publications. A malleable matrix composed of paper pulp and thermosetting phenolic resins is placed over the original plate under pressure and heated. (Recall that the image areas on letterpress plates are raised relative to the non-image areas.) The mold thus produced is the intaglio counterpart of the original relief plate. Molten lead is cast in the mold and a stereotype is formed.

Electrotype Plates - The use of electrotype plates is declining, but they are still employed to some extent in the manufacture of high quality commercial products (e.g., books). Electrotype platemaking is quite involved and is only briefly discussed here. Intaglio molds are made from original relief plates in a manner similar to that discussed previously for stereotypes, except that the matrix is made of plastic rather than paper pulp. The molds are sprayed with light coats of silver to make them conductive and electroplated with copper, nickel, or chromium. The metal shell thus formed is separated from the mold and backed with a molten metal or plastic. Finished electrotypes are high fidelity duplicate plates capable of long press runs.

Plastic and Rubber Duplicate Plates - Duplicate plastic and rubber printing plates are cast from intaglio molds. The molds are made from original plates in a manner similar to that previously discussed for stereotypes. The mold matrix is composed of paper pulp and thermosetting phenolic resins.

<u>Photopolymer</u> <u>Plates</u> - Photopolymer letterpress plates are used to print beverage containers, certain types of books, and many newspapers. Some of these plates are manufactured from proprietary liquid photopolymers. The liquid is poured into a trough on a plastic base and exposed to light through a transparency. As the action of the light hardens the exposed portion of the liquid, a compressed air stream removes the unexposed portion, which is collected and reused.

Precoated letterpress photopolymer plates are exposed and developed with aqueous solutions containing caustic and alcohols. Typical coating materials include polyesters derived from acrylic acid, esters based on the derivatives of cinnamic acid, polyamides, and other proprietary compounds. A photoinitiator, such as benzoin ethyl ether, is usually present in the coatings.

Flexographic photopolymer plates are used to print packaging material, business forms, tags, labels, books, and wrapping paper. These plates are manufactured in the same manner as precoated letterpress plates. The only difference is that the photopolymer coatings contain butadienes and other elastomers. The presence of elastomeric compounds gives the flexographic plates a rubbery character.

<u>Gravure</u> <u>Cylinder</u> <u>Preparation</u>. Gravure cylinders, large heavy steel cores coated with copper, are prepared for printing by highly skilled craftsman. A general discussion of traditional gravure platemaking is presented here; however, the reader should realize that many variations exist in this intricate process. New gravure cylinder preparation procedures, including laser etching of cylinders, are gradually coming into use.

Gravure printing is an intaglio process; the ink is transfered to the paper from grooves or impressions which are etched into the cylinder.

The steps involved in gravure cylinder preparation are outlined below.

1. The cylinder is cleaned. In a typical procedure the cylinder is scrubbed with caustic, rinsed with water, and scrubbed with a solution of acetic acid and salt. Mild abrasives may also be used.

2. A gravure resist is exposed to a fine transparent grid on an otherwise opaque background. The resist hardens proportionally

to the amount of light reaching it during exposure. The area of the resist exposed to the grid hardens uniformly. The surface area of the cylinder protected by the resist, which is thus hardened, will become the cell boundaries on the finished cylinder. The cell boundaries serve the mechanical purpose of providing a surface of uniform height on the finished cylinder. Such a surface is required to facilitate the doctor blade which rides on the cylinder and removes ink from the non-image areas during printing.

After the resist is exposed to the grid, it is then exposed to positive transparencies and applied to the cylinder. (Note that the resist may be applied to the cylinder prior to the exposures to the grid and transparencies). Three commonly used gravure resists are discussed below.

(a) Carbon tissue is a mechanical suspension of materials in gelatin on a paper backing. The suspended materials include pigment, dyes, and alum. This formulation is not light-sensitive; it must be sensitized with dichromates. This may be accomplished by soaking the carbon tissue in an aqueous solution of 2 to 4 percent potassium dichromate.

Following exposure, the hardened tissue is applied to the cylinder with the gelatin side in contact with the copper surface of the cylinder. The cylinder is wet with water so that the gelatin will adhere. Denatured alcohol is poured onto the cylinder until the carbon tissue is saturated. The cylinder is then immersed in warm water. The water soaks through the paper backing, which is peeled off. Some of the unexposed gelatin dissolves during this treatment. Finally, the cylinder is soaked for about five minutes in an aqueous solution of about 50 to 80 percent alcohol, and allowed to dry.

(b) Gravure resists may be aqueous solutions of gelatin and dichromates which are sprayed or poured onto the cylinder and allowed to dry.

(c) A special photographic film developed for use as a resist in gravure platemaking consists of a silver halide emulsion separated from an acetate backing by a layer of polyvinylpyrrolidone. (The polyvinylpyrrolidone allows the acetate backing to be stripped away without damaging the silver halide emulsion.) The film is exposed, developed, and fixed manually by conventional photoprocessing procedures (see Photoprocessing). The processed film is applied to the cylinder with the emulsion side in contact with the cylinder surface. After application, water and acetone are poured onto the cylinder to facilitate removal of the acetate base. Acetone also dissolves the polyvinylpyrrolidone, thus baring the silver halide emulsion.

3. The dichromate and gelatin resists discussed under (a) and (b) above are developed with a warm water spray. This removes coating in proportion to the amount of exposure. When developed, the resist covers the entire cylinder surface and varies in thickness and hardness except for the area which protects the gravure cell boundaries.

4. In many cases, both type and continuous tone pictures are to be reproduced and are etched in separate stages. The areas not to be etched in a given stage are covered with an turpentine-benzol-asphalt varnish.

5. The cylinder is etched, usually in aqueous solutions of ferric chloride, ferric sulfate, and copper salts. Some etching is performed electrolytically in aqueous baths of ammonium chloride and sodium chloride. Etching solutions penetrate the softest and thinnest areas of the resist more readily than they penetrate the hardest and thickest areas. Wasterwater from etching contains iron and copper salts.

6. The resist is removed from the cylinder manually, usually with the aid of solvents.

7. The cylinder is inked, placed on a proof press, and used to produce a proof. The proof is checked for errors.

8. After proofing, the areas which need correction are re-etched. Corrections can be a significant source of wastewater.

9. The cylinder is electroplated with chrome to increase its press life. The electroplating bath contains chromic acid, sulfuric acid, and catalysts such as sulfates and fluorides. Electroplating baths are easily renewed and are rarely wasted. Oxide films must be removed from the cylinder before electroplating. This is accomplished by scrubbing the cylinder with hot caustic and then treating it with hydrochloric or sulfuric acid.

After a press run, used gravure cylinders are reclaimed by mechanically stripping off the chrome plating, grinding the etched copper smooth, and then electroplating a new layer of copper onto the cylinder. The metal wastes generated by grinding are usually sold. The copper electroplating solutions, which contain copper sulfate and sulfuric acid, are wasted occasionally.

Screen Preparation. Finely woven framed screens covered with stencils are used in screen printing. The stencils can be manufactured manually, without the use of water, or photomechanically. Photomechanical stencils are discussed below.

The screen is coated with a light-sensitive material, usually an aqueous solution of polyvinyl alcohol and diazonium salts, and exposed to ultraviolet light through positive transparencies. The light converts the exposed areas to a water insoluble form. The screen is subjected to high-pressure water which washes away the unexposed areas and produces a stencil. The stencil protects the non-image areas. After a press run, the screen is reclaimed by removing the stencil with hot caustic.

Printing

In printing, printing plates are placed on presses, inked, and used to transfer an ink image to a substrate. The following discussion contains brief descriptions of lithographic, letterpress, flexographic, gravure, and screen printing. Printing presses are either web-fed or sheet-fed. Web-fed presses utilize a continuous roll of paper while sheet-fed presses print on individual sheets of paper. Sheet-fed presses are slower than web-fed presses.

Lithographic Printing. A lithographic printing plate consists of an image area which is in essentially the same plane as the non-image area. The image area is ink receptive and repels water. Conversely, the non-image area is receptive to water but repels ink.

The major categories of lithographic printing are direct and offset. In direct lithography, the printed image is transferred directly from the plate to the printed material, whereas in offset lithography the image is transferred first to a blanket, or roller, and then from the blanket to the printing stock. The ink repellance of the non-image areas on lithographic printing plates must be maintained chemically by dampening the plate with fountain solutions.

The conventional and Dahlgren dampering systems are used in long-run lithographic printing. In the conventional system, the fountain solution is applied to the plate from a rubber roller. In the Dahlgren system, the dampening solution is applied to an ink covered roller; then the fountain solution and ink are simultaneously applied to the plate. Conventional fountain solutions are aqueous solutions containing gum arabic, phosphoric acid, a bactericide, and an etch. The etch, usually a dichromate or magnesium nitrate, minimizes the corrosion of aluminum plates. Dahlgren dampening solutions are similar to the conventional solutions, except that they contain up to 35 percent isopropanol. Fountain solutions readily accumulate ink constituents and, as a result, must be replaced periodically. At a large lithographic printing plant, 57 to 76 liters (15 to 20 gallons) of spent fountain solutions may be disposed of each week.

Lithographic printing inks used on sheet-fed presses are composed of pigment, polyethylene wax, plasticizer, solvents, drying oil, and a catalyst. The catalyst, which is a naphthenate of cobalt and manganese, accelerates the polymerization of the drying oil. These inks dry by evaporation of the solvents and by polymerization of the drying oil. The inks used on web-fed presses are composed of pigment, solvated resins, and a varnish. These inks dry by evaporation of the varnish, without a polymerization reaction.

Letterpress Printing. In this process, the ink is transferred to the printing stock from the image surface, which is raised relative to the non-image area of the plate. The plate is inked in the press, and the image is transferred directly to the paper under pressure. Letterpress ink characteristics vary with press speed, paper, and job type. These inks are, in general, very similar to web-fed lithographic inks and include news inks (the single largest type of ink manufactured), oxidative drying inks, and moisture set inks. Moisture set inks are a special class of water-based letterpress inks. Water insoluble resins are made soluble in moisture set inks with glycols such as ethylene glycol, diethylene glycol, propylene glycol, or dipropylene glycol. When the printed product is exposed to steam or a fine water mist, the resin precipitates and forms a permanent image.

Flexographic Printing. In flexographic printing, ink is transferred to the printing stock from a raised plate surface as in letterpress. The primary difference between letterpress and flexography is that flexographic plates are rubber, rather than metal or plastic. Flexography is used extensively to print flexible packages. The porous surface structure of the rubber plates permits the use of fluid inks. Thus, the inking system of flexographic presses is much simpler than of presses on which highly viscous inks are used. Most flexographic inks are classified as either alcohol or water-base. Alcohol inks consist of pigments, vehicles, and binders. Shellac, which is often used as the primary resin, is made water soluble by caustic soda or an amine such as triethanolamine. A typical water-based ink formulation consists of a pigment such as calcium lithol (19 percent), alkali solubilized shellac and water varnish (60 percent), polyethylene wax (5 percent), water (15.75 percent), and silicone oil (0.25 percent).

Gravure Printing. In gravure printing, an etched cylinder is placed on a high speed press and rotated in ink to fill the etched image areas with ink. Excess ink on the cylinder surface is wiped clean with a doctor blade, a strip of metal running the length of the cylinder. The doctor blade touches the rotating cylinder, wiping off excess ink without disturbing the ink in the cells.

The ink is volatile, of low viscosity, and contains solvents such as toluene and xylene (with benzene impurities). It is generally circulated in closed piping systems from storage to the press, because of its volatility. Solvent evaporation can create air pollution problems. Solvents are usually recovered by piping the exhaust fumes to activated carbon solvent recovery beds.

Activated carbon adsorption is currently the most widely used method for the control of solvent vapor emissions from gravure printing presses. Activated carbon air pollution control systems involve the use of at least two packed bed adsorption vessels. At any time, solvents are being adsorbed in one bed while another bed is being regenerated.

Activated carbon is a highly porous solid. The adsorption process is a physical phenomenon in which Van der Waals' forces cause the solvent molecules to adhere to surface of the pores. Initially, the adsorption process is rapid and complete. During the course of the adsorption cycle, the outlet solvent vapor concentration remains relatively constant until breakthrough occurs. The percent breakthrough is defined as the percentage of the inlet solvent vapor concentration measured at the outlet. Before an unacceptable level of breakthrough is reached, the air flow is transferred to a fresh bed and the saturated bed is regenerated.

Regeneration is usually accomplished by backflushing the carbon bed with low-pressure steam. This operation is generally called the stripping cycle. The steam heats the bed and provides the heat of desorption of the solvent. The steam also functions as a diluent, lowering the partial pressure of the solvent. The solvent-laden steam is condensed and the organic and aqueous phases are allowed to separate by gravity. The solvent is recovered by decanting the immisible liquid phases.

Screen Printing. Screen printing is used primarily for printing on materials of odd sizes and shapes. The screens are finely woven cloths and metals. A stencil protects the non-image areas. Printing is accomplished by spreading a viscous ink over the screen, forcing it through the areas not covered by the stencil onto the printing stock. A typical screen printing ink is composed of chalk, linseed oil, mineral spirits, and a drying agent.

Finishing and Binding

Except in small jobs, such as the printing of handbills, finishing and binding operations follow printing. Even though some form of finishing or binding operation is employed at nearly all printing plants, printers also purchase these services from independent paper converting businesses as the need arises.

The term finishing refers to a wide variety of decorative processes, some of which also enhance the products durability. Although finishing operations can be performed manually, they are more often performed with specialized machinery.

The typical finishing of a printed piece may include liquid coating operations (such as lacquering, varnishing, and waxing), other coating operations (e.g., laminating), or other decorative processes (such as flocking, die cutting, and embossing). Laminating differs from the other coating processes mentioned in that the coating is a thin transparent piece of plastic applied with glue, heat, and pressure, rather than a liquid applied with a roller. Flocking is the process of adhering colored textiles to greeting cards or similar printed goods.

Die-cutting means cutting printed materials into irregular shapes. Steel-dies are placed on special machines which force the die upon the printed material under pressure. Embossing is a method of raising a printed image above the plane of the paper. This effect is achieved by pressing the material to be embossed between a female die and a male bed. Embossing is used on speciality products, such as business cards, or resumes.

Except for wastewater generated during cleanup operations or from excess lacquers and varnishes, finishing operations do not involve the use of water or other solvents. From observations during visits, at most plants where extensive lacquering or varnishing operations are employed, the resulting wastes are drummed and contract hauled. Those finishing operations involving liquids generate extremely small volumes of wastewater, generally less than 95 liters per week (25 gal per week).

The vast majority of binding operations are performed on high speed machines where paper is folded, collated, sewed, glued, rounded, and backed. During the binding process, solid wastes are produced from paper cutting and trimming. However, little or no liquid wastes are generated. As indicated in the Data Request Survey, the most common types of glues used are hot melt glues, supplied in solid form, and animal glues. Animal glues utilized were approved by the Food and Drug Administration for food processing. Representatives of 15 of the 2,944 plants where it was indicated on the Data Request Survey that binding operations are used, reported on-site formulation of some or all glues. Small volumes of wastewater may be discharged from cleanup or wasting of excess glue mixes. In general, however, binding is a dry process.

INDUSTRY PROFILE

General

The printing and publishing industry is the largest of the 20 United States manufacturing industries defined in the SIC manual.(3) Tables III-2 and III-3 present estimates of the number and the status of establishments whose primary operations are in SIC 27.(6) In 1976, approximately 86 percent (49,198) of the manufacturers were single location operations. Economic forecasts predicted an average growth ranging between 5 and 6 percent through the 1970's. By 1980, graphic industries shipments totalled at least $49 billion dollars. Economic performance during the past two decades has closely followed that of the total economy. For the most part, the industry is characterized by a large number of small businesses, although the large printing and publishing companies are among the largest companies in the nation. At least 80 percent of all United States printing is done by about 20 percent of the companies. The industry is continually undergoing rapid technical change as a result of new products and innovations by chemical and equipment suppliers, resulting in faster more highly automated printing. (9)(10)(11)(12)(13)(14)

Web offset lithography has experienced enormous growth in recent years due to the advent of phototypesetting equipment, cathode ray tube composers, and other electronic equipment. Most of the success of lithographers came at the expense of letterpress operations, especially in the newspaper field where computerization and new platemaking methods have replaced the traditional lead relief plate.(15) Automated platemaking, cheaper and better plates, and faster and better presses have also been instrumental in the growth of lithography.

TABLE III-2

ESTIMATED NUMBER OF ESTABLISHMENTS WITH PRIMARY OPERATIONS IN
SIC MAJOR GROUP 27

SIC	1972 (1977) Census[1] Total Number	1972 (1977) Census[1] Those with Over 20 Employees	Number Manufacturing Sites 1976 Dun and Bradstreet
2711	8,022	2,071	9,574
2721	2,510	447	3,231
2731	1,186	300	3,156
2732	685	276	390
2741	2,000	255	2,191
2751	13,086	1,135	17,830
2752	8,304	2,111	13,984
2753	553 (547)	126 (112)	926
2754	127	82	298
2761	658	368	581
2771	195	79	290
2782	450 (501)	232 (283)	508
2789	994 (988)	294 (288)	1,058
2791	1,853	355	2,126
2793	584 (493)	129 (56)	588
2794	80 (40)	24 (5)	78
2795	298	98	199
TOTAL	41,585	8,382	57,008

[1] Not including firms with fewer than 10 employees.

Source: U.S. Bureau of Census, 1972 and 1977.
Dun and Bradstreet, 1976.

TABLE III-3

STATUS OF ESTABLISHMENTS WITH PRIMARY OPERATIONS IN SIC MAJOR GROUP 27

SIC	Status[1]	Manufacturers	Non-Manufacturers	Total No. Plants
2711	A	7,163	179	7,342
	B	1,167	35	1,202
	C	1,244	63	1,307
2721	A	2,526	85	2,611
	B	417	31	448
	C	288	13	301
2731	A	2,554	116	2,670
	B	335	29	364
	C	267	8	275
2732	A	300	8	308
	B	32	2	34
	C	58	1	59
2741	A	1,775	68	1,843
	B	240	16	256
	C	176	10	186
2751	A	16,408	256	16,664
	B	727	28	755
	C	695	20	715
2752	A	12,693	222	12,915
	B	716	23	739
	C	575	16	591
2753	A	815	14	829
	B	47	3	50
	C	64	0	64
2754	A	270	3	273
	B	8	0	8
	C	20	1	21
2761	A	342	6	348
	B	79	9	88
	C	160	6	166
2771	A	223	10	233
	B	38	1	39
	C	29	0	29
2782	A	367	7	374
	B	42	5	47
	C	99	6	105

[1] Status Code A = Not multi-unit affiliated (single location operation).
B = Headquarters location of a multi-unit operation.
C = Branch location of a multi-unit operation.

TABLE III-3

STATUS OF ESTABLISHMENTS WITH PRIMARY OPERATIONS
IN SIC MAJOR GROUP 27
(Continued, Page 2 of 2)

SIC	Status[1]	Manufacturers	Non-Manufacturers	Total No. Plants
2789	A	983	13	996
	B	31	2	33
	C	44	2	46
2791	A	1,998	34	2,032
	B	72	3	75
	C	56	1	57
2793	A	530	5	535
	B	35	1	36
	C	23	1	24
2794	A	71	5	76
	B	3	2	5
	C	4	0	4
2795	A	180	1	181
	B	12	0	12
	C	7	0	7
TOTAL		57,008	1,370	58,378

[1] Status Code A = Not multi-unit affiliated (single location operation).
B = Headquarters location of a multi-unit operation.
C = Branch location of a multi-unit operation.

Source: Dun and Bradstreet, 1976.

Letterpress is still commonly used to print periodicals, labels, advertising materials, catalogs, and financial papers. This will continue to be a major printing process primarily because it generates less paper waste than lithography and allows the printer the flexibility of making corrections on printing plates.

Gravure printing is primarily concentrated in the publication and advertising markets. It is especially suited to high quality color illustrations and, unlike lithography or letterpress, can be used to print on almost any substrate. Because of its flexibility, gravure is a printing process commonly employed in the packaging industry and in other industries which print on specialty items and are not included in SIC 27. New developments in gravure cylinder technology include the use of dry processes such as color scanners, automatic cylinder engraving, and electronic engraving. This segment of the printing industry is expected to experience steady growth.(16)(17)

Screen printing, the least used of the major printing processes, is used primarily in the production of signs, displays, posters, decals, pressure-sensitive labels, and, to a small extent, in the greeting card industry. This segment of the printing industry is expected to continue growing as more automatic screen printing equipment comes into use.(13)

Segments of the industry rapidly declining in number of plants and employees are in SIC Code 2794, Electrotyping and Stereotyping, and SIC Code 2794, Photoengraving. These operations are being replaced by modern technology as in-place equipment is fully depreciated and replaced, mainly because of the high cost of raw materials and scarcity of skilled labor.(11)

As discussed in Section II, EPA conducted a data request survey to obtain basic data regarding plant operations, products and processes, waste sources, treatment, and discharge methods. The survey was sent to 6,995 plants (12 percent of those plants known to be operating in the continental United States). The coverage included facilities of all sizes engaged in the five major printing processes and allied service trades. A total of 5,675 responses were received; 5,004 supplied usable information. The remaining responses indicated that 671 facilities were not engaged in operations covered by the study. The final data base of 5,004 usable responses represented a survey of 8.9 percent of the estimated total population of 56,337 United States manufacturing sites. In some cases, where survey responses needed clarification, contact was made by telephone to ensure correct interpretation of the response. The results of the data request survey are presented below.

Geographic Distribution

Printing plants are located in all 50 states and are concentrated in urban areas. Table III-4 lists the number of manufacturing sites in each state by SIC code. Ten states, including New York, California, Illinois, Texas, Pennsylvania, Ohio, New Jersey, Florida, Michigan, and Massachusetts, account for approximately 57 percent of all United States printing plants; over half of all commercial printing is done in the four states of New York, California, Illinois, and Pennsylvania.(6) The major production areas for publishing of periodicals are in the cities of New York, Philadelphia, and Chicago. Book publishing is concentrated in these same cities and in Boston and Los Angeles.

Process Operations Statistics

As a result of the Agency's data gathering program, it was determined that some combination of eight basic process operations are used at most printing plants. An estimate of the number of plants performing each process operation is shown in Table III-5.

Plant Age

Almost 42 percent of the respondents indicated that their facilities were more than 20 years old; of these, only 34 percent had not been renovated within the past 10 years. A large number of respondents, particularly those representing plants in the allied service industries (especially lithographic platemaking), indicated major plant renovations within the last 2 to 4 years.

Plant Size

The diverse nature of the printing and publishing industry makes it difficult to identify standard production indicators which can be used to calculate wasteloads on a mass discharge per unit of production basis. Therefore, production data were not requested in the survey.

Waste Generation and Disposal

The flow data obtained from the data request survey is summarized in Table III-6. At approximately 70 percent of the plants wastewater is not generated or the volume generated is 190 liters (50 gallons) per day or less; at only four percent is the volume greater than 19,000 liters (5,000 gallons) per day. The most common sources of wastewater were photoprocessing and lithographic platemaking. As shown in Table III-7, based on NPDES permits or permit applications on file in 1977, there were

84 printing plants where wastewater was discharged to navigable waters. Upon inspection of the permits, the Agency determined that 30 of these plants discharged only nonprocess wastewater and that six plants were no longer operating. Data request surveys were sent to the 48 remaining plants. Responses were received from 35 of the 48 plants. Eighteen of the 35 respondents reported direct discharge of process wastewaters. EPA learned that the other 17 discharged only nonprocess wastewater. The 18 direct dischargers were all large multi-process facilities. Table III-8 lists some pertinent information regarding operations at these 18 direct discharging plants.

An estimate of the number of indirect and zero dischargers is presented in Table III-9. More than 99.8 percent of the estimated 56,337 printing and publishing plants discharge all process wastewater to publicly owned treatment works or do not discharge process wastewater. Approximately four percent of the 5,004 survey respondents reported some form of wastewater treatment prior to discharge. Landfills are the primary method of sludge disposal at these plants. One hundred thirty-five respondents reported biological treatment and 262 reported chemical treatment. In many instances, however, survey respondents who reported chemical treatment were referring to silver recovery of photoprocessing wastes for economic purposes. Less than eight percent of the survey respondents reported wastewater recycle of any degree. Only seven respondents reported complete reuse of process wastewater. Eighty-seven plants contained their process wastewater on site; landfills were used at 18 of these plants; land disposal was used at 16 plants; wastewaters were evaporated at 48 plants and wastewaters were incinerated at three plants.[1]

Toxic pollutants present in raw materials used in printing and publishing manufacturing processes are listed in Table III-10. This information was collected from literature, chemical supplier manuals, EPA study of the ink industry, and from historical data. Historical data were obtained wherever possible from representatives of individual plants, municipal sewer district offices, and NPDES permit authorities. In most cases, analyses of toxic pollutants, other than of a few heavy metals, did not exist. Historical data are presented in the Appendix.

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[1]The terms "landfill", "land disposal", and "evaporation" are defined in the glossary.

TABLE III-4

GEOGRAPHICAL DISTRIBUTION OF U.S. PRINTING AND PUBLISHING PLANTS (SIC MAJOR GROUP 27)[1]

	SIC Codes																
State	2711	2721	2731	2732	2741	2751	2752	2753	2754	2761	2771	2782	2789	2791	2793	2794	2795	TOTAL
AL	123	19	23	7	10	227	103	5	4	4	0	5	6	12	6	1	1	556
AK	20	8	--	--	2	15	19	--	--	--	--	--	--	1	--	--	--	65
AZ	73	32	21	6	19	143	138	2	4	6	2	3	6	16	--	7	1	479
AR	137	15	4	3	5	119	51	1	--	2	1	3	3	2	3	--	--	349
CA	723	437	506	52	313	1897	2035	105	26	59	38	54	139	295	70	4	20	6773
CO	170	40	30	2	22	231	211	8	3	10	5	1	8	32	7	1	2	783
CT	85	75	86	15	34	284	196	25	9	12	1	11	15	38	18	2	1	907
DE	19	4	4	1	2	33	29	--	--	--	--	--	2	4	1	--	1	100
DC	41	70	42	6	35	76	97	10	2	2	3	--	9	31	2	2	2	430
FL	281	116	100	10	84	596	667	29	11	21	7	12	24	64	23	5	7	2057
GA	214	58	41	4	23	372	242	14	18	17	2	8	21	37	7	1	3	1082
HI	22	13	14	--	10	54	35	1	--	--	3	1	3	6	1	--	--	163
ID	79	2	5	1	3	34	55	--	--	--	1	--	2	2	1	--	--	185
IL	559	304	251	21	175	1305	1050	76	22	43	38	58	89	185	40	12	26	4254
IN	260	43	51	13	25	434	247	19	7	11	1	7	16	39	14	2	2	1191
IA	385	27	12	2	35	247	87	4	5	7	1	2	12	17	9	1	--	853
KS	256	33	22	3	16	193	114	9	3	11	6	4	5	16	2	1	2	696
KY	160	18	12	--	10	174	121	13	3	3	3	2	2	10	6	--	2	539
LA	146	33	20	8	18	197	161	9	2	7	--	3	7	10	8	1	--	630
ME	56	10	7	2	5	65	37	--	--	1	--	1	4	1	1	--	--	190
MD	84	45	56	12	30	247	254	11	2	8	4	7	18	49	6	3	2	838
MA	210	135	154	20	64	653	436	28	11	17	18	29	54	80	23	3	1	1936
MI	344	83	90	7	84	800	427	31	8	13	9	11	23	76	21	5	8	2040
MN	362	67	53	2	46	356	225	12	4	13	6	17	16	34	5	1	7	1226
MO	349	74	51	11	34	459	319	28	12	16	5	18	32	75	15	3	5	1506
MT	81	9	7	1	3	20	46	2	1	--	1	1	1	1	--	--	--	174
NE	202	11	16	6	7	123	74	4	5	1	2	3	9	9	3	1	2	478
NV	30	10	3	1	5	43	33	4	--	1	--	2	--	5	1	--	--	138

1 Some establishments are listed under more than one SIC code.

TABLE III-4

GEOGRAPHICAL DISTRIBUTION OF U.S. PRINTING AND PUBLISHING PLANTS (SIC MAJOR GROUP 27)[1]
(Continued, Page 2 of 2)

	SIC Codes																	
State	2711	2721	2731	2732	2741	2751	2752	2753	2754	2761	2771	2782	2789	2791	2793	2794	2795	TOTAL
NH	35	16	16	2	--	86	50	2	2	6	3	1	4	4	2	--	1	230
NJ	234	113	153	19	85	690	625	69	12	31	10	24	72	124	38	--	16	2315
NM	49	12	11	--	6	70	48	2	--	1	2	2	3	3	3	--	--	212
NY	531	714	739	54	536	2150	1950	154	34	69	74	110	258	354	77	8	26	7838
NC	192	29	38	7	8	369	277	19	8	18	1	10	6	31	12	3	1	1029
ND	94	1	2	1	5	36	6	3	--	--	--	--	--	--	2	--	--	150
OH	398	96	98	11	63	785	814	47	14	41	20	25	41	103	30	7	24	2617
OK	228	27	19	1	14	203	164	5	2	11	1	2	8	21	4	1	1	712
OR	127	27	29	6	18	202	170	4	--	8	--	3	6	22	7	1	--	630
PA	366	101	147	23	93	1130	625	42	11	50	16	26	60	107	43	6	8	2854
RI	26	5	8	3	3	121	63	11	4	3	4	2	4	10	3	--	1	271
SC	110	16	13	2	8	162	73	9	8	2	--	1	2	4	5	--	--	415
SD	143	4	3	--	3	40	9	--	--	2	--	--	--	--	1	--	--	205
TN	161	38	37	9	57	316	209	14	10	8	1	10	8	28	4	5	7	922
TX	718	182	154	23	136	1048	798	52	17	26	5	21	38	99	29	4	6	3356
UT	50	15	25	--	11	77	83	6	2	1	--	1	4	10	2	--	2	289
VT	29	9	11	2	7	47	35	1	4	1	1	1	1	3	--	--	--	152
VA	162	43	56	5	27	291	194	16	4	12	2	6	9	31	6	--	1	865
WA	194	43	17	2	24	283	195	12	2	10	1	6	9	20	9	--	1	828
WV	99	4	6	--	2	95	34	7	--	3	--	--	--	--	--	--	1	251
WI	282	58	38	12	50	405	248	17	3	16	4	8	13	41	17	1	8	1221
WY	39	5	1	2	4	22	12	--	--	--	--	--	--	--	--	--	--	85
TOTAL	9738	3349	3302	400	2274	18025	14191	942	299	604	302	522	1072	2162	589	92	199	58065

[1] The total is greater than 57,008 because some establishments are listed under more than one SIC code.

Source: Dun and Bradstreet, 1976.

TABLE III-5

ESTIMATED NUMBER OF PLANTS EMPLOYING
EIGHT PRINTING PROCESS OPERATIONS

Process Operation	Number of Plants in Survey Response	Extrapolated Total Number U.S. Plants[1,2]
Art and copy preparation and composition	2,816	32,000
Photoprocessing	3,673	41,000
Nonmetallic platemaking	3,853	43,000
Pressroom (nonwater-based inks)	4,062	46,000
Pressroom (water-based inks)	50	600
Finishing and binding operations	511	6,000
Gravure cylinder preparation	134	1,500
Metallic platemaking	751	8,500

1 Based on 5,004 responses and 56,337 total United States plants.
2 Inspection of the survey responses revealed that 671 of the 57,008 manufacturing establishments listed in Tables III-2 and III-3 were not engaged in operations covered by this study.

TABLE III-6

WASTEWATER FLOWS REPORTED BY DATA REQUEST SURVEY RESPONDENTS

Daily Process Wastewater Generation[1] 1/day	(gal/day)	Number of Respondents[2]	Percent of Total Survey Response[3]	Estimated Total Number of Industry Plants[4]
0	(0)	1,418	29	16,338
0-95	(0-25)	1,589	33	18,591
96-190	(26-50)	386	7.9	4,450
190-380	(51-100)	373	7.6	4,282
380-950	(101-250)	253	5.1	2,873
950-1,900	(251-500)	221	4.5	2,535
1,900-3,800	(501-1,000)	171	3.5	1,972
3,800-19,000	(1,001-5,000)	271	5.5	3,099
19,000-38,000	(5,001-10,000)	65	1.3	732
38,000-76,000	(10,001-20,000)	69	1.4	789
>76,000	(>20,000)	59	1.2	676
TOTAL		4,875	100.0	56,337

1 Not all process wastewater generated daily is discharged.

2 Industry flow data include responses for plants performing gravure cylinder preparation and metallic platemaking operations.

3 3,457 respondents indicated process wastewater is generated; 1,418 respondents indicated no process wastewater is generated.

4 Based on an estimated total population of 56,337 plants and the survey responses for 4,875 plants; 129 of the 5,004 usable surveys contained no responses to the process flow questions.

TABLE III-7

NUMBER OF DIRECT DISCHARGERS WITH NPDES PERMITS OR APPLICATIONS ON FILE IN 1977

SIC Code	Total No. Plants	Estimated Number Discharging Only Nonprocess Wastewater	Estimated Number Discharging Process Wastewater	Plants[1] with Historical Data
2711	10	2	8	0
2721	4	4	0	0
2731	8	2	6	0
2732	8	1	7	0
2741	0	0	0	0
2751	14	7	7	2
2752	17	3	14	0
2753	0	0	0	0
2754	1	1	0	1
2761	8	2	6	0
2771	2	2	0	0
2782	0	0	0	0
2789	2	1	1	1
2791	0	0	0	0
2793	4	2	2	2
2794	0	0	0	0
2795	1	0	1	0
Unknown	5	3	2	1
TOTAL	84	30	54	7

[1]Conventional parameters and metals data only.

TABLE III-8

SELECTED DATA REQUEST SURVEY INFORMATION FOR DIRECT DISCHARGERS

Plant Code	Employment	Film Processing[1]	Types of Plates[2]	Printing Processes[3]	Wastewater Sources[4] Questions 71-76	Process Flow, gpd	Type of Treatment
663	1,001-1,500	A	A,B,C	LP,S,L	71 D; 72 A,B,C; 73 B,C; 75 A,B,E; 76 B,D	501-1,000	Chemical
767	21-100	A,B	B,C	LP,S,L	72 B,C; 73 C; 75 E	1,001-5,000	Chemical
116	21-100	A,B,C,E	C	—	71 D; 72 C; 76 E	5,001-10,000	Chemical
345	11-20	A,B,C,D,E	B	L	71 D	101-250	Physical, Chemical
318	1,001-1,500	A,B,C	A,B,C	LP,F,L	71 D,E; 72 A,B,C; 74 D; 75 A,B; 76 B	>20,000	Chemical

1 A = black and white
B = halftone
C = color or color separation
D = scanning
E = continuous process

2 A = lithographic
B = presensitized lithographic
C = photoengraving
D = stereotype
E = electrotype

3 L = lithography
LP = letterpress
F = flexography
G = gravure
S = screen

4 71A = cold composition
D = black and white film processing
E = color film processing
72A = lithographic platemaking
B = presensitized lithographic platemaking
C = photoengraving
D = stereotype platemaking
73C = engraving or etching
75A = sheet fed offset or photo offset lithography
B = web fed offset or photo offset lithography
76A = finishing operations
B = binding operations
C = ink formulation
D = glue formulation
E = other printing and related processes

73B=photopolymer platemaking

74D=flexographic printing with solvent-based inks

75E=screen printing

TABLE III-8

SELECTED DATA REQUEST SURVEY INFORMATION FOR DIRECT DISCHARGERS
(Continued, Page 2 of 4)

Plant Code	Employment	Film Processing[1]	Types of Plates[2]	Printing Processes[3]	Wastewater Sources[4] Questions 71-76	Process Flow, gpd	Type of Treatment
408	101-250	A,B,C	B	L	71 A,D,E; 72 B; 75 A,B; 76 A,B	1,001-5,000	Biological
999	251-500	A,B,C	A,B	LP,F,L	71 A,C,D; 72 A,B; 74 D; 75 A,B; 76 A,B,C,D	>20,000	Physical, Chemical Biological
424	11-20	A,B,C	B	LP,L	71 D; 75A; 76C	0-25	Biological
202	>3,000	A,B,C	A,B[5]	LP,S,L	71 B,D,E,; 72 A,B; 73 A,B; 75 B; 76 B,D	>20,000	Chemical, Biological

1 A = black and white
B = halftone
C = color or color separation
D = scanning
E = continuous process

2 A = lithographic
B = presensitized lithographic
C = photoengraving
D = stereotype
E = electrotype

3 L = lithography
LP = letterpress
F = flexography
G = gravure
S = screen

4 71A = cold composition
D = black and white film processing
E = color film processing
72A = lithographic platemaking
B = presensitized lithographic platemaking
C = photoengraving
D = stereotype platemaking
73C = engraving or etching
75A = sheet fed offset or photo offset lithography
B = web fed offset or photo offset lithography
76A = finishing operations
B = binding operations
C = ink formulation
D = glue formulation
E = other printing and related processes
71B=hot composition
71C=other methods of composition
73A=plastic platemaking
73B=photopolymer platemaking
74D=flexographic printing with solvent-based inks

5 Plant 202 also reported processing of plastic and photopolymer plates

TABLE III-8

SELECTED DATA REQUEST SURVEY INFORMATION FOR DIRECT DISCHARGERS
(Continued, Page 3 of 4)

Plant Code	Employment	Film Processing[1]	Types of Plates[2]	Printing Processes[3]	Wastewater Sources[4] Questions 71-76	Process Flow, gpd	Type of Treatment
738	251-500	A,B,C	A	L	76 E	>20,000	—
594	101-250	A,B,C	B	LP,L	71 D,E; 72 A, 75 A,B	1,001-5,000	Physical
305	1.001-1,500	A,B,C,D,E	—	F,G	71 D,E; 73 C; 76 E	>20,000	Physical, Chemical
557	101-250	A,B	A	L	71 D; 72 A; 75 A; 76 B	1,001-5,000	Biological
766	1,001-1,500	A,B,C	B	L	71 D; 72 A,B; 75 A,B	>20,000	Physical

1 A = black and white
B = halftone
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D = scanning
E = continuous process

2 A = lithographic
B = presensitized lithographic
C = photoengraving
D = stereotype
E = electrotype

3 L = lithography
LP = letterpress
F = flexography
G = gravure
S = screen

4 71A = cold composition
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72A = lithographic platemaking
B = presensitized lithographic platemaking
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D = stereotype platemaking
73C = engraving or etching
75A = sheet fed offset or photo offset lithography
B = web fed offset or photo offset lithography
76A = finishing operations
B = binding operations
C = ink formulation
D = glue formulation
E = other printing and related processes

TABLE III-8

SELECTED DATA REQUEST SURVEY INFORMATION FOR DIRECT DISCHARGERS
(Continued, Page 4 of 4)

Plant Code	Employment	Film Processing[1]	Types of Plates[2]	Printing Processes[3]	Wastewater Sources[4] Questions 71-76	Process Flow, gpd	Type of Treatment
733	21-100	A,B,E	B	LP,L	71 D; 72 B; 75 A	—	Physical
547	1,501-3,000	A,B,C,E	D	L	71 A,D; 72 C,D; 73 C	>20,000	Chemical
659	101-250	A,E	A	LP,F,L	—	251-500	Chemical
826	11-20	A,B	C	—	71 D; 72 C; 73 C	251-500	Chemical

[1] A = black and white
B = halftone
C = color or color separation
D = scanning
E = continuous process

[2] A = lithographic
B = presensitized lithographic
C = photoengraving
D = stereotype
E = electrotype

[3] L = lithography
LP = letterpress
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[4] 71A = cold composition
D = black and white film processing
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73C = engraving or etching
75A = sheet fed offset or photo offset lithography
B = web fed offset or photo offset lithography
76A = finishing operations
B = binding operations
C = ink formulation
D = glue formulation
E = other printing and related processes

TABLE III-9

SUMMARY OF INDUSTRY DISCHARGE STATUS[1,2]

Type of Discharge	No. Plants	Percentage of Industry
Direct	84[3]	0.15
Indirect	38,679	68.65
Zero Discharge	17,574	31.2
TOTAL	56,337	100.00

[1] Data includes dischargers employing metallic platemaking and gravure cylinder preparation processes.

[2] The number of direct dischargers is based on NPDES permits on file in 1977. The indirect and zero discharge numbers are based on an extrapolation of the results of the data request survey.

[3] Data from EPA regional NPDES files; includes 30 plants discharging only nonprocess wastewater (see Table III-7).

TABLE III-10

TOXIC POLLUTANTS PRESENT IN RAW MATERIALS USED IN PRINTING AND PUBLISHING MANUFACTURING PROCESSES

Toxic Pollutant Present	Information Source: Literature	Chemical Supplier	EPA Ink Study	Historical Data
1. Acenaphthene	X	X		
2. Benzene	X	X	X	
3. Carbon Tetrachloride	X	X	X	
4. 1,2,4-Trichlorobenzene	X	X	X	
5. 1,2-Dichloroethane	X	X	X	
6. 1,1,1-Trichloroethane	X	X	X	
7. 1,1-Dichloroethane	X	X	X	
8. 1,1,2-Trichloroethane	X	X	X	
9. 1,1,2,2-Tetrachloroethane	X	X	X	
10. Chloroform	X	X	X	
11. 1,1-Dichloroethylene	X	X	X	
12. 1,2-Trans-Dichloroethylene	X	X	X	
13. Dimethylphthalate	X	X	X	
14. Ethylbenzene	X	X	X	
15. Methylene Chloride	X	X	X	
16. Isophorone	X		X	
17. Naphthalene	X		X	
18. Pentachlorophenol	X	X	X	
19. Phenol	X	X	X	
20. Bis(2-ethylhexyl)phthalate	X	X	X	
21. Butyl benzyl phthalate	X	X	X	
22. Di-n-butyl phthalate	X	X	X	
23. Diethyl phthalate	X	X	X	
24. Toluene	X	X	X	
25. Trichloroethylene	X	X	X	
26. Antimony	X	X	X	
27. Arsenic	X	X	X	X
28. Cadmium	X	X	X	X
29. Chromium	X	X	X	X
30. Copper	X	X	X	X
31. Cyanide	X	X	X	X
32. Lead	X	X	X	X
33. Mercury	X	X	X	X
34. Nickel	X	X	X	X
35. Selenium	X	X	X	X
36. Silver	X	X	X	X
37. Zinc	X	X	X	X

SECTION IV

SUBCATEGORIZATION

The purpose of subcategorization is to group together plants of similar characteristics to allow for the development of effluent guidelines and standards representative of each group (subcategory) of plants, enabling permits to be issued on a uniform basis. The effluent limitations guidelines program for the printing and publishing point source category has been active since 1977. Prior to 1977, EPA had not collected historical data of consequence, had not assessed industry practices or treatment system performance, and had made no attempt to subcategorize the industry.

To arrive at a subcategorization scheme, the Agency reviewed the five major printing processes (letterpress, lithography, gravure, flexography, and screen) and the products manufactured through the application of these processes. EPA determined that each of the five major printing processes involves some combination of eight basic manufacturing steps (process operations). The Agency established a preliminary subcategorization scheme based on these process operations. This scheme involves use of a building block approach; it accounts for the fact that several process operations can be employed at any given plant. The eight subcategories are:

1. Art and Copy Preparation and Composition

   Art and copy preparation and composition includes all work related to the preparation and assembly of copy prior to the development of transparencies and all work related to assembling finished transparencies for use in plate preparation. Camera work, copy layout, transparency stripping, and paste-up preparation are some examples. No water is used in these operations.

2. Photoprocessing

   Photoprocessing operations are employed at printing plants to produce transparencies. In printing, transparencies are the templates from which the images on printing plates are created. Processing of exposed film involves contacting the film with a developing solution, usually hydroquinone, which reduces the exposed silver halides to elemental silver. A fixing solution, which usually contains ammonium thiosulfate, is applied to dissolve the unexposed silver salts. Finally, the film is washed with water and dried.

Retouching and dot etching of finished transparancies are also considered photoprocessing operations.

3. Nonmetallic Platemaking

Nonmetallic platemaking is the developing of a photographic image on the light-sensitive coatings of printing plates or screens. The basic steps involved in nonmetallic platemaking include exposing a plate or screen covered with a light-sensitive coating to a light source through a transparency, removing the unexposed areas with solvents or other developing solutions, rinsing with aqueous solutions, and drying. (Platemaking operations which involve chemical etching of metal surfaces are not nonmetallic platemaking operations. In addition, the process of electroplating printing plates is not considered a nonmetallic platemaking operation.)

4. Metallic Platemaking

Metallic platemaking is the creation of an image on a metallic surface by any means except gravure cylinder preparation. Etching, electroplating, engraving, and casting of metal surfaces are metallic platemaking operations.

5. Gravure Cylinder Preparation

Gravure cylinder preparation is the pre-press preparation of cylinders or wrap-around metallic plates for use in gravure printing. This includes cleaning and rinsing of cylinders, copper and chrome plating of cylinders, grinding or polishing of cylinders, transfer of photographic images to cylinders, and etching, staging, and re-etching of cylinders.

6. Pressroom (Nonwater-Based Inks)

Plants where products are printed with solvent-based inks are included in the pressroom (nonwater-based inks) subcategory. In a typical solvent-based ink formulation, resins, lacquers, clays, and pigments are dispersed in an oily solvent. Presses are cleaned with rags and solvents are used to aid the cleaning process. Sources of wastewater from these operations include press cleanup, lithographic fountain solutions, and air pollution solvent recovery systems.

7. Pressroom (Water-Based Inks)

Plants where products are printed with water-based inks are included in the pressroom (water-based inks) subcategory. The inks are used primarily in flexographic printing on absorbent paper stocks such as kraft or lightweight paper. Typical constituents of water-based flexographic inks include pigments and binders such as ammonia or amine solubilized protein, casein, shellac, and acrylic copolymers. Small quantities of water are used to clean the presses after a run.

8. Finishing and Binding Operations

Finishing and binding operations include lacquering, varnishing, laminating, flocking, die cutting, embossing, or otherwise preparing printed material for delivery to a customer. In recent years, most finishing operations have become highly automated. During the binding process, solid wastes are produced from paper cutting and trimming. However, little or no wastewater is generated in any finishing or binding operation.

The Agency conducted a program of sampling and analyzing raw and treated printing and publishing plant effluents, as discussed in Section II. The results of this program indicate that the amount and toxicity of the toxic pollutants contained in the raw wastewater discharges from the photoprocessing, nonmetallic platemaking, pressroom (nonwater-based inks), and pressroom (water-based inks) subcategories do not justify developing national regulations. Art and copy preparation and composition do not involve the use of water. No significant amount of wastewater is discharged as the result of any finishing or binding operation. Therefore, the Agency excluded these six subcategories from national regulations under the provisions of Paragraph 8(a)(iv) of the Settlement Agreement.(1)(2)

The information and data gathered to date regarding the gravure cylinder preparation and metallic platemaking subcategories were not sufficient to make regulatory decisions; however, the data do show that further study of these subcategories is warranted and that these operations are similar to certain metal finishing processes. Therefore, gravure cylinder preparation and metallic platemaking will be further studied in the second phase of the rulemaking effort for the metal finishing point source category.

Had the Agency decided to develop uniform national regulations for the printing and publishing point source category, analyses would have been performed to determine the effect of plant size, age of facilities, geographical location, and raw material usage on wastewater characteristics. In addition, the cost of control and treatment systems would have been considered in an economic impact analysis. This subcategorization scheme might have been revised had these factors been taken into account and should be considered a preliminary subcategorization of the printing and publishing point source category.

SECTION V

WASTEWATER CHARACTERISTICS

INTRODUCTION

In this section, information is presented on the raw wastewater characteristics of plants in the photoprocessing, nonmetallic platemaking, and pressroom subcategories. Raw wastewater data are presented for toxic pollutants and, where available, for such traditional pollutants as COD, oil and grease, and BOD_5.

The term "raw wastewater" refers to the liquid effluent from a printing process or processes prior to any form of wastewater treatment. Process steps designed primarily to recover materials from a wastewater stream (i.e., silver recovery) are considered to be in-plant controls. Wastewater data were obtained from screening and verification sampling at printing plants. Representatives of some plants, municipal sewer districts, and state and federal agencies also supplied historical data which is contained in the Appendix. Long-term data were, in general, not available. Therefore, data from screening and verification sampling are emphasized because sampling techniques, individual plant operations, and waste stream components are known and can be documented. The Agency could not identify standard production indicators which could be used to calculate raw wasteloads on a mass discharge per unit of production basis.

GENERAL CHARACTERISTICS

The major sources of process wastewater in the printing industry, include (a) photoprocessing, (b) platemaking, and (c) pressroom operations. In general, these processes are not performed on a continuous basis. Film processing rarely occurs on all three shifts of a three-shift operation. Platemaking operations may only be employed a limited number of hours each day or week. Length of pressrun varies with the nature and volume of the material being printed. Thus, wastewater is not generated continuously and its constituents vary depending on which processes are in operation at a particular time.

At the majority of printing plants, process wastewater is not segregated from nonprocess streams such as noncontact cooling water or sanitary wastes. In addition, process waste streams generally contain wastewater from more than one subcategory operation.

The volume of wastewater discharged from printing plants is low compared to other industries. A discharge of 76,000 liters/day (20,000 gpd) is a very large flow in this industry and is extremely rare; at most plants fewer than 190 liters/day (50 gpd) of wastewater are discharged.

PHOTOGRAPHIC PROCESSING WASTEWATER

As reported in Section III, film processing involves applying a developer solution to the film, contacting the film with a fixing solution, and washing the film in water to remove excess fix. In recent years, much film processing has been done automatically using film processing equipment rather than manually in sinks and trays.

Process wastewater includes spent fixing and developing solutions and rinse water. The wastewater contains hydroquinone and other developers, sulfates, sulfites, acetic acid, and soluble silver salts of thiosulfates. Most automatic film processors are equipped with electrolytic or metallic replacement silver recovery units to reclaim silver before discharge. In the metallic replacement system, the silver content is reduced by substituting other metals for silver. In most cases, iron, in the form of steel wool, is substituted; however, in some cases water soluble sulfur compounds of zinc are substituted for the silver. Developer and fix consumption varies from less than 4 liters per week (1 gal/wk) in small shops to more than 380 liters/wk (100 gal/wk) in large establishments. Most film processing machines are designed such that the rinse water runs the entire time the machine is on. Rinse water flow varies from 4 to 15 liters/minute (1 to 4 gal/minute) per processor, and usually provides considerable dilution of the discharged developing and fixing solution. Some film processors have been equipped with solenoid valves which allow the rinse water to flow only when film is in the processor.

At a small plant, only one automatic film processor may be operated for 8 hours or less per day; at a large plant, more than 10 processors may be operated for two or more shifts per day. Thus, wastewater volume varies considerably with plant size from less than 190 liters/day (50 gal/day) to more than 38,000 liters/day (10,000 gal/day).

PLATEMAKING WASTEWATER

Unlike photoprocessing, platemaking methods depend on the printing process (lithography, letterpress, gravure, flexography, or screen). Alternate platemaking procedures exist for each printing process. The number of plates produced and, hence, the volume of wastewater generated vary with level of production and length of press run. Generally, platemaking operations produce less wastewater than photographic operations. However, the wastewater is more likely to contain heavy metals and other contaminants because of the acids, salts, and solvents used to etch or develop the metal, plastic, and photopolymer plate surfaces. At many of the plants visited, part or all of the platemaking wastewaters (average volume of less than 1,900 liters/day (500 gpd)) were hauled from the plant or pretreated to meet local effluent standards prior to discharge to publicly owned treatment works.

PRINTING WASTEWATER

The process of transferring ink from an image carrier to paper does not generate wastewater except in lithographic printing where fountain solutions are replaced periodically. Typical wastewater sources are processes other than the actual printing such as press cleanup or activated carbon solvent recovery systems used at gravure printing plants.

Lithographic Fountain Solutions

In lithographic printing, the ink repellance of the non-image areas of the printing plate must be maintained chemically by dampening the plate with a fountain solution. There are two major dampening systems used on lithographic printing presses. In the conventional system, the fountain solution is applied to the plate from a rubber roller. In the Dahlgren system, the dampening solution is applied to an ink covered roller; then the fountain solution and ink are simultaneously applied to the plate. Conventional fountain solutions are aqueous solutions containing gum arabic, phosphoric acid, a bactericide, and an etch. The etch, usually a dichromate or magnesium nitrate, minimizes the corrosion of aluminum plates. Dahlgren dampening solutions are similar to the conventional solutions, except that they contain up to 30 percent isopropanol. Fountain solutions readily accumulate ink constituents and, as a result, must be replaced periodically. At a large lithographic printing plant, 57 to 76 liters (15 to 20 gallons) of spent fountain solutions may be disposed of each week.

Press Cleanup

After a run, nonwater-based inks are removed from the presses with rags and cleaning solvents. The particular solvent used depends on the type of ink. Typical solvents include: (1) aliphatic hydrocarbons, (2) aromatics, (3) ketones, (4) chlorinated hydrocarbons, (5) alcohols, and (6) miscellaneous solvents such as ethylacetate or proprietary solvent mixtures such as Cellosolves. Due to its low cost, kerosene is also widely used.

Some waste ink and solvents may be combined with other waste streams and discharged. In most cases, however, the wastes are small in volume--4 to 40 liters/day (1 to 10 gpd) per press--and are usually stored in 210-liter (55-gallon) drums and hauled from the premises. The rags used in press cleanup are usually sent to commercial laundries for cleaning.

In pressroom operations where water-based inks are used, press cleanup involves a water wash of the press inking system between ink color changes. The number of times this occurs depends on the nature of the plant business. Wastewater generated per ink change typically varies from 40 to 230 liters (10 to 60 gallons) per press, depending on whether an ink change involves only a change in ink shade or a full color change. At some plants, all press waste is contract hauled to disposal. The volume of wastewater discharged varies from 0 to 1,900 liters/day (0 to 500 gpd). Representatives of 50 plants where water-based inks are used responded to the data request survey; only two reported wastewater discharges of more than 190 liters/day (50 gpd). Toxic pollutants present in these discharges are usually components of the ink such as lead, chromium, and zinc.

Currently, the use of water-based inks is governed by the type of substrate to be printed. According to industry contacts, virtually all water-based inks are used in flexographic printing on kraft substrates (corrugated containers and bags or labels). Limited use of water-based inks also occurs within SIC 2754 (gravure printing). Research is ongoing within the ink industry to manufacture a water-based ink for use on a nonabsorbent substrate. Advantages of water-based inks include good press stability and printability, absence of fire hazard (although water-based ink containing sufficient alcohol will burn), convenience, and economy of water for cleanup. Also, these inks do not cause the air pollution problems associated with certain solvent-based inks, especially the volatile inks used in gravure printing.

OTHER WASTEWATERS

Wastewater may also be generated from mixing and blending of inks, screen reclamation in screen printing, and from gravure solvent recovery. At plants where inks are blended or mixed, small amounts of wastes are generated during cleanup. These wastes may be discharged or drummed. In screen printing, screens may be recovered after a press run by washing the screens with a caustic solution to remove the stencils. Resulting wastewater contains stencil materials and ink constituents such as precipitated chalk, pigments, and oil varnishes. At gravure printing plants, air laden with volatile solvents is vented to activated carbon beds. The beds are steam cleaned and the solvents are recovered by decanting and, in some cases, distilling the condensate. Wastewater from the solvent recovery process is contaminated with water-miscible solvents.

RAW WASTEWATER DATA

When screening sampling was performed, Agency efforts to subcategorize the printing and publishing industry had only begun. As a result, samples of total plant effluent were collected. Thus, most samples were composed of wastes from more than one subcategory operation and, in many cases, included nonprocess wastewater streams. The Agency believes that these nonprocess wastewater streams contribute few, if any, toxic pollutants, unless otherwise indicated. Table V-1 lists the plants and process operations sampled.

Screening and Verification Sampling Data

Table V-2 lists the number of toxic pollutants detected in raw wastewaters by subcategory. Tables V-3 and V-4 present available toxic, conventional, and nonconventional pollutant data for photoprocessing subcategory raw wastewaters. Table V-5 describes the sampling sites at plants where photoprocessing and nonmetallic platemaking operations are performed. Toxic pollutant data for combined photoprocessing and nonmetallic platemaking raw wastewaters are presented in Table V-6. Toxic pollutant data for the pressroom (nonwater-based inks) subcategory are presented in Table V-7. Toxic, conventional, and nonconventional pollutant data for the pressroom (water-based inks) subcategory are presented in Tables V-8 and V-9.

Data are reported for toxic pollutants which were detected. A value reported as less than (<) signifies that traces of the substance were identified. Pollutant loadings are shown in parentheses where flow data are available. Screening sampling data were used to determine presence or absence of toxic pollutants.

The verification sampling results for two water-based ink plants are summarized in Table V-8 and Table V-9. As discussed in Section II, the use of water-based inks received additional attention after preliminary subcategorization to determine whether exclusion from regulation under Paragraph 8(a)(iv) of the Settlement Agreement was justified.

Historical Data

Historical wastewater data were obtained from plant representatives and from local, state, and federal government personnel. These data are presented in the Appendix.

TABLE V-1

PRINTING PLANTS SAMPLED IN
SCREENING AND VERIFICATION PROGRAM

Plant Code	Subcategory	Flow, gpd	Total Toxic Raw Waste Load lb/day	Type of Discharge
4975	Photoprocessing	3230	0.050[1]	Indirect
6372		6000	0.74[2]	Indirect
9011		24000[3]	<0.31	Indirect
8190	Combined	20000[3]	<0.33	Direct
9020	Photoprocessing	Unknown	Unknown[4]	Indirect
6653	and	11500[3]	<0.175	Indirect
9012	Nonmetallic	15000[3]	<0.163	Indirect
1303	Platemaking	20000[3]	<0.19	Indirect
5478		27000[3]	<0.26	Direct
2382		3000	<0.02[1]	Indirect
7194		Unknown	Unknown[1,4]	Indirect
8038	Pressroom	Unknown	Unknown[4]	Indirect
1303	(Nonwater-Based Inks)	100	<0.012	Indirect
9002		200	<0.02	Indirect
5478	Pressroom	500	<0.085[5]	Direct
5478	(Water-Based Inks)	300 Average[6]	<0.65	Direct
9018		164 Average[6]	<0.92	Indirect

[1] Data not reported for acid extractable, base/neutral extractable, or pesticide fractions of screening samples collected at these plants.
[2] Not including chromium used for cooling tower water treatment only.
[3] Flows include nonprocess wastewater.
[4] Raw waste load calculated only for plants with flow data.
[5] Not including chromium (0.455 lb) and lead (2.01 lb) found at substantially lower levels in subsequent verification sampling at the same plant.
[6] Average of three days data from verification sampling; all other data are from one day screening sampling.

TABLE V-2

NUMBER OF TOXIC POLLUTANTS DETECTED IN SCREENING AND VERIFICATION PROGRAM[1]

	Subcategory			
	Photo-Processing	Combined Photo-processing and Nonmetallic Platemaking[2]	Pressroom (Nonwater-Based Inks)	Pressroom (Water-Based Inks)[3]
Number of Plants Sampled	2	9	3	2
Number of Toxic Pollutants Detected	15	30	27	29
# of VOAs	4	11	12	7
# of Acid Extractables	2	1	0	2
# of Base/Neutral Extractables	0	3	3	5
# of Metals	8	10	10	13
# of Pesticides and PCBs[4]	0	4	1	1
# of Other	1 (cyanide)	1 (cyanide)	1 (cyanide)	1 (cyanide)

[1] All data obtained from one day screening sampling unless otherwise noted.

[2] Photoprocessing and nonmetallic platemaking data combined due to nonsegregated discharge from plants sampled.

[3] Data obtained from three day verification sampling.

[4] Pesticides tentatively identified by gas chromatography (electron capture) but not confirmed by gas chromatography/mass spectrometry.

TABLE V-3

AVAILABLE SCREENING SAMPLING RAW WASTE DATA
PHOTOPROCESSING SUBCATEGORY OPERATIONS AT PLANT 4975[1]

Pollutant	Concentration ug/l	Raw Waste Load[2] lb/day
Cadmium	600	0.0162
Chromium	30	0.00081
Copper	60	0.0016
Nickel	50	0.0013
Silver	560	0.0151
Zinc	560	0.0151
TOTAL[3]		0.050

[1] Raw wastewater is from film processing and sanitary sewage.
[2] Process wastewater flow 3,230 gallons per day.
[3] No data were reported for the acid extractable, base/neutral extractable, or pesticide fractions of the screening sample collected at this plant.

TABLE V-4

SCREENING SAMPLING RAW WASTE DATA
PHOTOPROCESSING SUBCATEGORY OPERATIONS AT PLANT 6372[1]

Pollutant	Toxic Pollutants ug/l	Toxic Pollutants lb/day
Methylene chloride	2	0.0001
Chloroform	11	0.00055
Trichloroethylene	13	0.00065
Toluene	5	0.0003
Phenol	18	0.0009
p-chloro-m-creosol	12	0.0006
Arsenic	77	0.0039
Cadmium	10	0.0005
Copper	260	0.013
Chromium[2]	36,000	1.8
Lead	14	0.0007
Nickel	3,600	0.18
Silver	390	0.020
Zinc	9,300	0.47
Cyanide	840	0.04
TOTAL[3]		0.74

	Conventional and Nonconventional Pollutants mg/l	Conventional and Nonconventional Pollutants lb/day
Ammonia	43.0	2.15
TKN	52.3	2.62
T-phosphorus	3.14	0.16
COD	264	13.21
Suspended Solids	6.5	0.33
Dissolved Solids	758	37.93
Volatile Solids	141	7.06
Total Solids	764	38.23
Total Phenols	36	1.8
BOD_5	24.2	1.21
Oil & Grease	18	0.9

[1] Wastewater flow 6,000 gpd.
[2] Chromium added as part of cooling tower water treatment program is not used in photoprocessing. Data for chromium were not included in daily raw waste load.
[3] Data from one 24-hour flow proportioned composite sample.

TABLE V-5

SAMPLING SITE DESCRIPTIONS FOR PLANTS IN THE PHOTOPROCESSING AND NONMETALLIC PLATEMAKING SUBCATEGORIES

Plant 9011:	Raw wastewater from photoprocessing, nonmetallic platemaking, and pressroom (nonwater-based inks) operations combined with sanitary sewage.
Plant 8190[1]:	Raw wastewater from photoprocessing, nonmetallic platemaking, press roller washing, truck and battery washing, and cooling tower blowdown.
Plant 9020:	Raw wastewater from photoprocessing, nonmetallic platemaking, and pressroom (nonwater-based inks) operations combined with sanitary sewage.
Plant 6653:	Raw wastewater from photoprocessing and nonmetallic platemaking.
Plant 9012:	Raw wastewater from photoprocessing and nonmetallic platemaking.
Plant 1303:	Raw wastewater from photoprocessing and nonmetallic platemaking combined with sanitary sewage.
Plant 5478:	Raw wastewater from photoprocessing and nonmetallic platemaking combined with pretreated pressroom (water-based inks) effluent and sanitary sewage.
Plant 2382:	Raw wastewater from photoprocessing, nonmetallic platemaking, and pressroom (nonwater-based inks) operations combined with sanitary sewage.
Plant 7194:	Raw wastewater from photoprocessing, nonmetallic platemaking, pressroom (nonwater-based inks) operations, and cooling tower blowdown.

[1] This plant prints with nonwater-based inks. Press rollers are taken off the press and washed with an aqueous caustic solution. Batteries are used as a direct current source for electroplating.

TABLE V-6

TOXIC POLLUTANT SCREENING SAMPLING RAW WASTE DATA
COMBINED PHOTOPROCESSING AND NONMETALLIC PLATEMAKING SUBCATEGORIES

Pollutant/Plant Code	Raw Waste Data, ug/l (lb/day) 9011	8190	9020[2]	6653	9012	1303	5478	2382[5]	7194[2,5]	Range of Concentration ug/l	Range of Loadings for Those Plants Where the Pollutant was Detected and for Which Flow Data Were Available[2]	Number of Facilities in Which Pollutant Found in Concentrations Greater than Detection Limit
Benzene	<10 (<0.002)	10 (0.002)	10	ND[3]	<10 (<0.001)	<10 (<0.002)	ND	—	—	ND to 10	<0.001 to 0.002	5
1,1,1-Trichloroethane	ND	250 (0.042)	ND	ND	ND	ND	ND	—	—	ND to 250	0.042	1
Chloroform	130 (0.026)	140 (0.023)	70	100 (0.010)	70 (0.009)	<10 (<0.002)	ND	—	—	ND to 140	<0.002 to 0.026	6
1,1-Dichloroethylene	ND	ND	ND	ND	<10 (<0.001)	<10 (<0.002)	ND	—	—	ND to <10	<0.001 to <0.002	2
1,2-trans-Dichloroethylene	ND	10 (0.002)	ND	ND	ND	<10 (<0.002)	ND	—	—	ND to 10	<0.002 to 0.002	2
Ethylbenzene	130 (0.026)	ND	10	10 (0.001)	ND	30 (0.005)	ND	—	—	ND to 130	0.001 to 0.026	4
Methylene chloride	130 (0.026)	10 (0.002)	130	130 (0.012)	130 (0.016)	40 (0.007)	ND	—	—	ND to 130	0.002 to 0.026	6
Dichlorobromomethane	ND	ND	ND	30 (0.003)	ND	ND	ND	—	—	ND to 30	0.003	1
Chlorodibromomethane	ND	ND	ND	10 (0.001)	ND	ND	ND	—	—	ND to 10	0.001	1
Phenol	ND	ND	40	290 (0.028)	38 (0.004)	ND	ND	—	—	ND to 290	0.004 to 0.028	3
Bis (2-ethylhexyl) phthalate	ND	ND	<10	16 (0.0015)	44 (0.006)	400 (0.067)	ND	—	—	ND to 400	0.0015 to 0.067	4
Di-n-butyl phthalate	ND	ND	<10	<10 (<0.001)	ND	ND	ND	—	—	ND to <10	<0.001	2
Diethyl phthalate	ND	ND	<10	ND	ND	ND	ND	—	—	ND to <10		1
Toluene	140 (0.028)	890 (0.149)	210	<10 (<0.001)	ND	20 (0.003)	ND	—	—	ND to 890	0.003 to 0.149	5
Trichloroethylene	ND	<10 (<0.002)	70	ND	ND	<10 (<0.002)	ND	—	—	ND to 70	<0.002	3

1 Pesticides tentatively identified by gas chromatography (electron capture) but not confirmed by gas chromatography/mass spectrometry.
2 Waste loads (lb/day) calculated only for plants with flow information.
3 ND means not detected.
4 Chromium added as part of cooling tower water treatment program at Plant 8190 and is not used in photoprocessing or nonmetallic platemaking. Data for chromium was not included in the raw waste load for this plant.
5 No data (—) were reported for the acid extractable and base/neutral extractable fractions of the screening samples for these plants.

TABLE V-6

TOXIC POLLUTANT SCREENING SAMPLING RAW WASTE DATA
COMBINED PHOTOPROCESSING AND NONMETALLIC PLATEMAKING SUBCATEGORIES
(Continued, Page 2 of 3)

Pollutant/Plant Code	Raw Waste Data, ug/1 (lb/day) 9011	8190[4]	9020[2]	6653	9012	1303	5478	2382[5]	7194[2,5]	Range of Concentration ug/1	Range of Loadings for Those Plants Where the Pollutant was Detected and for Which Flow Data Were Available[2]	Number of Facilities in Which Pollutant Found in Concentrations Greater than Detection Limit
B-endosulfan-beta[1]	ND	ND	ND	ND	ND	<10 (<0.001)	ND	ND	ND	ND to <10	<0.001	1
R-BHC-Lindane Gamma[1]	ND	30 (0.005)	ND	ND	ND	ND	ND	ND	ND	ND to 30	0.005	1
Dieldrin[1]	ND	ND	ND	ND	ND	ND	ND	<10 (<0.001)	ND	ND to <10	<0.001	1
4,4'-DDT[1]	ND	ND	ND	ND	ND	ND	ND	<10 (<0.001)	ND	ND to <10	<0.001	1
Antimony	ND	<10 (<0.002)	ND	ND	ND	10 (<0.002)	ND	ND	ND	ND to 10	<0.002	2
Arsenic	ND	<10 (<0.002)	ND	ND	ND	ND	<10 (<0.002)	ND	12	ND to <10	<0.002	3
Cadmium	<10 (<0.002)	<10 (<0.002)	254	71 (0.0068)	319 (0.040)	<10 (<0.002)	<10 (<0.002)	20 (0.002)	545	<10 to 545	<0.002 to 0.040	9
Chromium	12 (0.002)	1190 (0.198)	39	281 (0.0270)	11 (0.001)	65 (0.011)	117 (0.026)	30 (0.001)	310	11 to 1190	0.001 to 0.270[4]	9
Copper	941 (0.188)	52 (0.009)	47	180 (0.017)	65 (0.008)	280 (0.048)	102 (0.022)	30 (0.001)	5775	30 to 5775	0.001 to 0.188	9
Cyanide	20 (0.004)	20 (0.003)	40	40 (0.004)	560 (0.070)	40 (0.007)	20 (0.004)	ND	114	ND to 560	0.003 to 0.070	8
Lead	<10 (<0.002)	46 (0.008)	1.5	22 (0.0021)	<10 (<0.001)	113 (0.019)	199 (0.045)	ND	ND	ND to 199	<0.001 to 0.045	7
Mercury	11 (0.0011)	ND	1	11 (0.0011)	3 (0.001)	1 (0.001)	ND	0.22 (0.000006)	6.2	ND to 11	0.000006 to 0.0011	7

1 Pesticides tentatively identified by gas chromatography (electron capture) but not confirmed by gas chromatography/mass spectrometry.
2 Waste loads (lb/day) calculated only for plants with flow information.
3 ND means not detected.
4 Chromium added as part of cooling tower water treatment program at Plant 8190 and is not used in photoprocessing or nonmetallic platemaking. Data for chromium was not included in the raw waste load for this plant.
5 No data (—) were reported for the acid extractable and base/neutral extractable fractions of the screening samples for these plants.

TABLE V-6

TOXIC POLLUTANT SCREENING SAMPLING RAW WASTE DATA
COMBINED PHOTOPROCESSING AND NONMETALLIC PLATEMAKING SUBCATEGORIES
(Continued, Page 3 of 3)

Pollutant/Plant Code	Raw Waste Data, ug/l (lb/day) 9011	8190	9020	6653	9012	1303	5478	2382[5]	7194[5]	Range of Concentration ug/l	Range of Loadings for Those Plants Where the Pollutant was Detected and for Which Flow Data Were Available[2]	Number of Facilities in Which Pollutant Found in Concentrations Greater than Detection Limit
Nickel	ND	48 (0.008)	8	ND	ND	<10 (<0.002)	<10 (<0.002)	30 (<0.001)	35	ND to 48	<0.001 to 0.008	6
Silver	<10 (<0.002)	<10 (<0.002)	19	51 (0.005)	<10 (<0.001)	<10 (<0.002)	<10 (<0.002)	320 (0.008)	1285	<10 to 1285	<0.001 to 0.008	9
Zinc	ND	395 (0.066)	147	553 (0.053)	35 (0.004)	197 (0.003)	689 (0.155)	160 (0.004)	2450	35 to 689	0.003 to 0.155	8
TOTAL[2]	(<0.31)	(<0.33)	UK[6]	(<0.18)	(<0.17)	(<0.19)	(<0.26)	(<0.02)	UK			
Flow (gallons per day)	24,000	20,000	NA[7]	11,500	15,000	20,000	27,000	3,000	NA			

1 Pesticides tentatively identified by gas chromatography (electron capture) but not confirmed by gas chromatography/mass spectrometry.
2 Waste loads (lb/day) calculated only for plants with flow information.
3 ND means not detected.
4 Chromium added as part of cooling tower water treatment program at Plant 8190 and is not used in photoprocessing or nonmetallic platemaking. Data for chromium was not included in the raw waste load for this plant.
5 No data (—) were reported for the acid extractable and base/neutral extractable fractions of the screening samples for these plants.
6 UK means unknown.
7 NA means not available.

TABLE V-7

TOXIC POLLUTANT SCREENING SAMPLING RAW WASTE DATA
PRESSROOM (NONWATER-BASED INKS) SUBCATEGORY

Pollutant	Raw Waste Data, ug/l (lb/day) Plant Code 8038[1]	1303[2]	9002[3]
Benzene	<10	ND[4]	60 (0.0001)
Carbon Tetrachloride	ND	ND	10 (0.00002)
1,2-Dichloroethane	ND	ND	10 (0.00002)
1,1,1-Trichloroethane	180	ND	10 (0.00002)
1,1-Dichloroethane	30	ND	ND
1,1,2,2-Tetrachloroethane	ND	20 (0.00002)	ND
Bis(2-chloroethyl)ether	ND	2600 (0.0022)	ND
Chloroform	20	<10 (<0.000008)	70 (0.0001)
Ethylbenzene	10	2500 (<0.0021)	260 (0.00043)
Methylene Chloride	130	<10 (<0.000008)	130 (0.00022)

1 Raw wastewater from electrotype platemaking combined with sanitary sewage.
2 Drummed waste ink from lithographic printing process.
3 Decant from activated carbon solvent recovery of air emissions from gravure printing presses.
4 ND means not detected.

TABLE V-7

TOXIC POLLUTANT SCREENING SAMPLING RAW WASTE DATA
PRESSROOM (NONWATER-BASED INKS) SUBCATEGORY
(Continued, Page 2 of 3)

	Raw Waste Data, ug/l (lb/day)		
	Plant Code		
Pollutant	8038[1]	1303[2]	9002[3]
Naphthalene	ND[4]	2600 (0.0022)	ND
Bis(2-ethylhexyl)pthalate	<10	ND	16 (0.000027)
Di-n-butyl phthalate	<10	ND	<10 (<0.00002)
Toluene	<10	370 (0.00031)	190 (0.00032)
Trichloroethylene	ND	<10 (<0.000008)	ND
B-endosulfan-beta[5]	ND	ND	1 (0.000002)
Antimony	<10	<10 (<0.000008)	ND
Cadmium	10	<10 (<0.000008)	<10 (<0.00002)
Chromium	24	79 (0.000066)	24 (0.000040)

[1] Raw wastewater from electrotype platemaking combined with sanitary sewage.
[2] Drummed waste ink from lithographic printing process.
[3] Decant from activated carbon solvent recovery of air emissions from gravure printing presses.
[4] ND means not detected.
[5] Pesticide tentatively identified by gas chromatography (electron capture) but not confirmed by gas chromatography/mass spectrometry.

TABLE V-7

TOXIC POLLUTANT SCREENING SAMPLING RAW WASTE DATA
PRESSROOM (NONWATER-BASED INKS) SUBCATEGORY
(Continued, Page 3 of 3)

Pollutant	Raw Waste Data, ug/l (lb/day) Plant Code		
	8038[1]	1303[2]	9002[3]
Copper	57	1800 (0.0015)	73 (0.00012)
Cyanide	40	110 (0.00009)	200 (0.00033)
Lead	60	3740 (0.0031)	40 (0.000067)
Mercury	3.7	0.55 (0.00000046)	1.9 (0.0000032)
Nickel	<10	ND[4]	17 (0.000028)
Selenium	<10	<10 (<0.000008)	ND
Silver	<10	<10 (<0.000008)	<10 (<0.00002)
Zinc	90	86	ND
TOTAL[6]	UK[7]	(<0.012)	(<0.002)
Flow (gallons per day)	NA[8]	100	200

[1] Raw wastewater from electrotype platemaking combined with sanitary sewage.
[2] Drummed waste ink from lithographic printing process.
[3] Decant from activated carbon solvent recovery of air emissions from gravure printing presses.
[4] ND means not detected.
[5] Pesticide tentatively identified by gas chromatography (electron capture) but not confirmed by gas chromatography/mass spectrometry.
[6] Total toxic pollutant raw waste load (lb/day) calculated only for plants with flow data.
[7] UK means unknown.
[8] NA means not available.

TABLE V-8

TOXIC POLLUTANT RAW WASTE DATA
PRESSROOM (WATER-BASED INKS) SUBCATEGORY

Pollutant	Plant 5478 Flexographic Ink Waste Screening Sampling[1] ug/l (lb/day)	Plant 5478 Flexographic Ink Waste Verification Sampling[2] ug/l (lb/day)	Plant 9018 Gravure Ink Waste Verification Sampling[2] ug/l (lb/day)
Benzene	190 (0.00079)	ND[3]	ND
1,1,1-trichloroethane	760 (0.0032)	140 (0.00035)	1200 (0.0017)
1,1,2,2-tetrachloroethene	ND	790 (0.0020)	ND
Ethylbenzene	1780 (0.0074)	120 (0.00030)	290 (0.00040)
Chloroform	900 (0.004)	ND	ND
Methylene chloride	130 (0.00054)	ND	ND
Toluene	370 (0.0015)	120 (0.00030)	420 (0.00057)
Phenol	ND	41 (0.00010)	800 (0.001)
Pentachlorophenol	ND	5900 (0.015)	ND
Pyrene	ND	39 (0.000018)	ND
Diethyl phthalate	ND	15 (0.000038)	ND
Di-n-butyl phthalate	ND	21 (0.000053)	ND
Butyl benzyl phthalate	ND	16 (0.000040)	ND
Bis(2-ethylhexyl)phthalate	ND	41 (0.00010)	29 (0.000040)
B-endosulfan-beta[4]	1 (0.000004)	ND	ND
Antimony	<10 (<0.00004)	ND	4.8 (0.0000066)
Arsenic	33 (0.00014)	120 (0.00030)	ND
Beryllium	ND	ND	<2.1 (<0.0000029)
Cadmium	<10 (<0.00004)	6.4 (0.000016)	6.4 (0.0000088)

1 Data from one day screening sampling.
2 Average of data obtained from three day verification sampling.
3 ND means not detected.
4 Pesticide tentatively identified by gas chromatography (electron capture) but not confirmed by gas chromatography/mass spectrometry.

TABLE V-8

TOXIC POLLUTANT RAW WASTE DATA
PRESSROOM (WATER-BASED INKS) SUBCATEGORY
(Continued, Page 2 of 2)

Pollutant	Plant 5478 Flexographic Ink Waste Screening Sampling[1] ug/l (lb/day)	Plant 5478 Flexographic Ink Waste Verification Sampling[2] ug/l (lb/day)	Plant 9018 Gravure Ink Waste Verification Sampling[2] ug/l (lb/day)
Chromium	109,000 (0.455)	44,000 (0.11)	132,500 (0.1813)
Copper	4,610 (0.019)	8,700 (0.022)	1,800 (0.0024)
Lead	482,000 (2.01)	193,000 (0.483)	512,600 (0.7015)
Mercury	ND[3]	<0.30 (<0.0000008)	0.88 (0.0000012)
Nickel	74 (0.00031)	92 (0.00023)	<46 (<0.00063)
Silver	<10 (<0.00004)	28 (0.000070)	8.6 (0.000012)
Thallium	<10 (<0.00004)	ND	ND
Selenium	ND	<12 (<0.000030)	ND
Zinc	10,700 (0.0446)	2700 (0.0068)	17,500 (0.0240)
Cyanide	430 (0.0018)	ND	ND
TOTAL	(<2.6)[5]	(<0.65)	(<0.92)
Flow (gallons per day)	500	300	164

1 Data from one day screening sampling.
2 Average of data obtained from three day verification sampling.
3 ND means not detected.
4 Pesticide tentatively identified by gas chromatography (electron capture) but not confirmed by gas chromatography/mass spectrometry.
5 Total toxic pollutant raw waste load at Plant 5478 was 0.085 lb/day (during screening) if chromium and lead are not included in the total. Both chromium and lead were found at substantially lower levels during subsequent verification sampling at this plant.

TABLE V-9

VERIFICATION SAMPLING CONVENTIONAL
AND NONCONVENTIONAL POLLUTANT RAW WASTE DATA
PRESSROOM (WATER-BASED INKS) SUBCATEGORY[1]

Pollutant	Plant 5478 Flexographic Ink Waste mg/l (lb/day)	Plant 9018 Gravure Ink Waste mg/l (lb/day)
Total Phenols	510 (0.0013)	18,000 (0.025)
BOD_5	3,000 (8)	3,500 (4.8)
Total Solids	5,100 (13)	68,000 (91)
Total Suspended Solids	920 (2.3)	2,200 (2.6)
Total Dissolved Solids	4,200 (11)	66,000 (88)
Total Volatile Solids	3,000 (8)	--[2]
COD	7,700 (19)	113,000 (150)
TOC	7,300 (18)	26,000 (34)
Oil and Grease	33 (0.083)	1,700 (2.7)
Average Flow (gpd)	300	164

[1] Average of data obtained from three day verification sampling.
[2] Not analyzed.

SECTION VI

CONTROL AND TREATMENT TECHNOLOGY

INTRODUCTION

In this section the technologies used for the control and treatment of wastewater pollutants at printing and publishing plants visited during the screening and verification program are discussed. As discussed in previous sections the Agency determined that six of the eight subcategories of the printing and publishing point source category would be excluded from regulation pursuant to Paragraph 8 (a)(iv) of the Settlement Agreement. Therefore, the technical study of the art and copy preparation and composition, finishing and binding, photoprocessing, nonmetallic platemaking, pressroom (nonwater-based inks), and pressroom (water-based inks) subcategories was terminated after completion of the screening and verification sampling programs. Also, because gravure cylinder preparation and metallic platemaking will be addressed as part of the metal finishing point source category, treatment system data for plants in these subcategories are not included in this document. Wastewater control and treatment or pretreatment technologies used at plants visited and sampled during this study have been emphasized in this document. One should not assume that the control and treatment technologies discussed in this report are the only technologies applicable to treating printing and publishing wastewaters.

SUMMARY OF AVAILABLE DATA

General

Table VI-1 lists the types of processes and treatment systems employed at the sampled plants. The major operations at these plants fall into the photoprocessing, nonmetallic platemaking, and pressroom subcategories. Two plants were direct dischargers; the others were indirect dischargers (i.e., discharge to municipal sewers).

Wastewater flows at plants in the industry where wastewater is discharged were generally not continuous and ranged from 95 liters/day (25 gpd) to more than 76,000 liters/day (20,000 gpd). Many of the wastes, especially those containing heavy metals, are generated and treated on a batch basis. At most of the plants visited, all or part of the pressroom effluents are contract hauled. Some form of treatment was employed at only 418 of the 5,004 plants whose representatives responded to the Data Request

TABLE VI-1

SUMMARY OF PLANTS WITH TREATMENT SYSTEMS SAMPLED

Plant Code	Products/Processes	Subcategories Covered[1]	Type of Treatment	Wastewater Flow, gpd	Type of Discharge	Remarks
5478	Packaging supplies—flexographic, lithographic, letterpress printing	1,2,4,6,7,8	Chemical Biological	30,000	Direct	Wastewater from photoprocessing, nonmetallic platemaking, and cleanup of water-based ink printing presses.
8190	Magazines, comic books—lithographic and letterpress commercial printing	2,4,6,8	Physical Chemical	39,000	Direct	Wastewater from photoprocessing, platemaking, plant cleanup, and cooling tower blowdown.
6653 & 9012	Newspapers—offset lithographic printing	1,2,4,6	Physical	11,500	Indirect	Wastewater from photoprocessing and nonmetallic platemaking.
5430	Books—lithographic and letterpress printing	2,4,6,8	Physical Chemical	<20,000	Indirect	Wastewater from photoprocessing, nonmetallic platemaking, rag laundering, and ink blending.

[1] Subcategories:
1—Art and copy preparation and composition
2—Photoprocessing
3—Nonmetallic platemaking
4—Metallic platemaking
5—Gravure cylinder preparation
6—Pressroom, nonwater-based inks
7—Pressroom, water-based inks
8—Finishing and binding operations

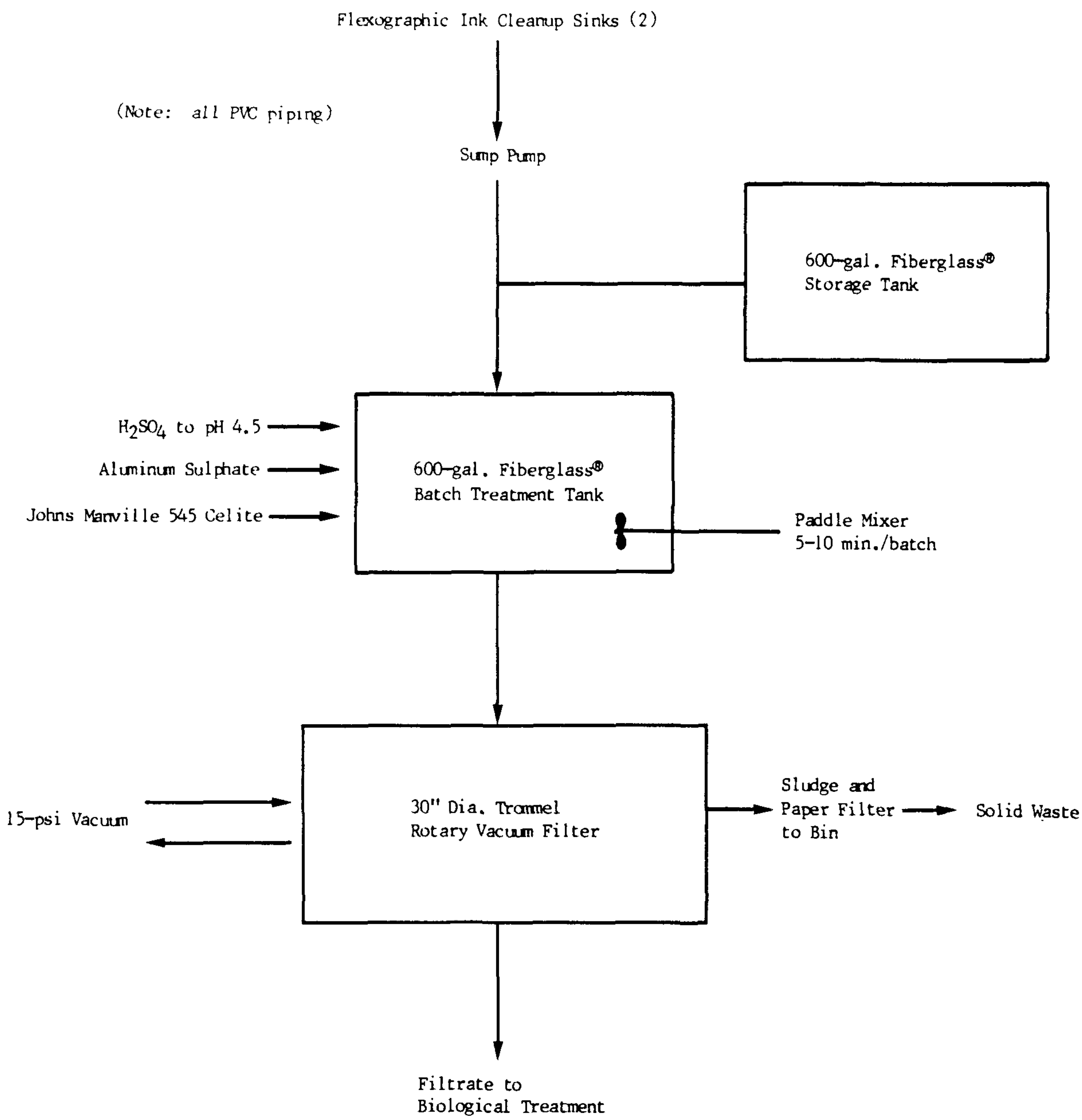

FIGURE VI-1. METALS TREATMENT SYSTEM AT PLANT 5478

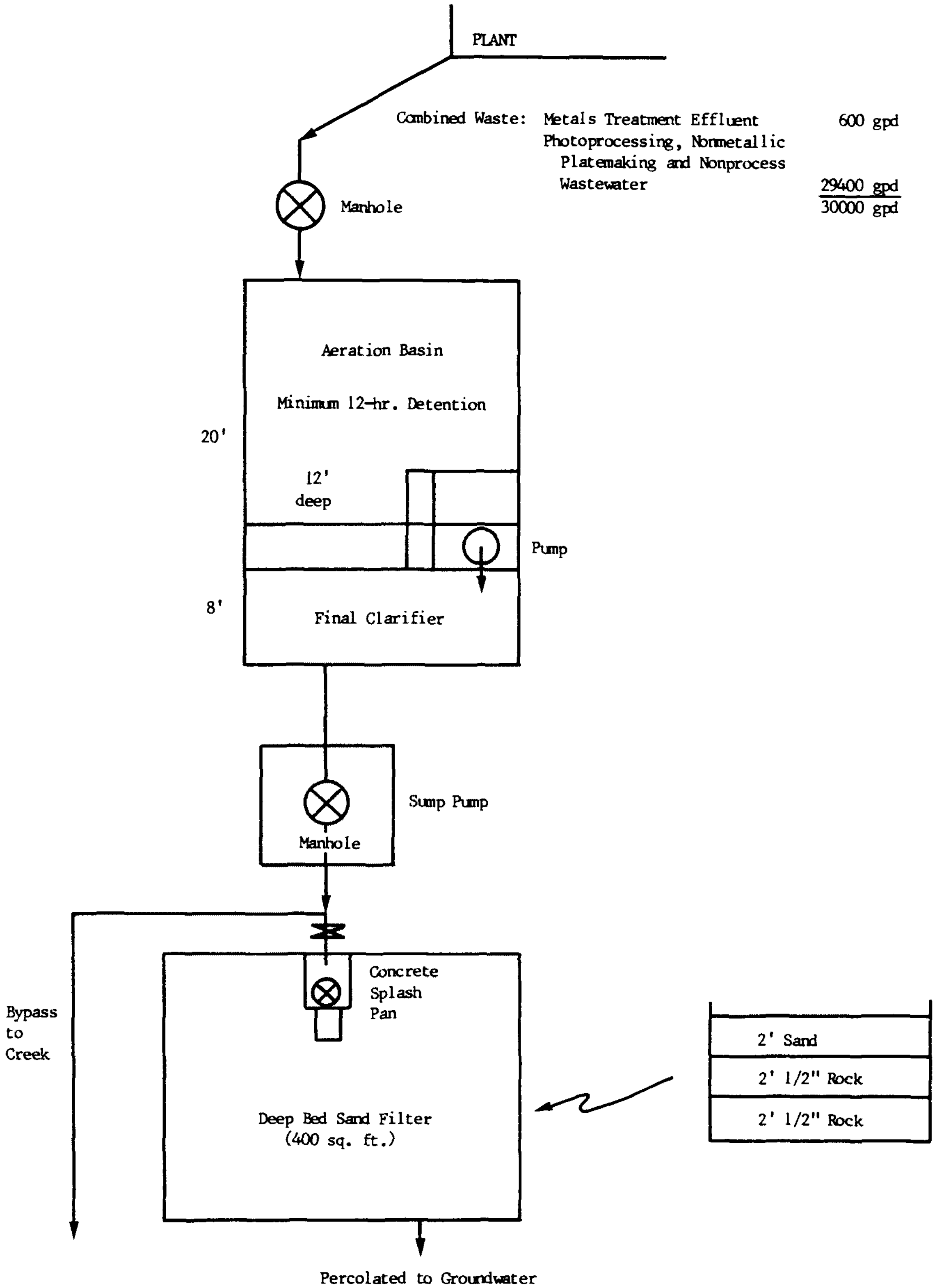

FIGURE VI-2. BIOLOGICAL TREATMENT SYSTEM AT PLANT 5478

TABLE VI-2

TOXIC POLLUTANT REMOVAL IN BATCH METALS TREATMENT SYSTEM AT PLANT 5478[1]

Parameter	Influent to Treatment (ug/l)	Effluent From Treatment (ug/l)	Percent Removal
Chromium	109,000	1,690	98
Copper	4,610	771	83
Lead	482,000	3,830	99
Nickel	74	71	4
Zinc	10,700	14,300	
Ethylbenzene	1,780	80	96
Benzene	190	10	95
Chloroform	900	5	99
Arsenic	33	6	82

[1] Flow = 600 gpd from water-based ink press cleaning.

TABLE VI-3

TOXIC POLLUTANT REMOVAL IN BIOLOGICAL TREATMENT SYSTEM AT PLANT 5478[1]

	2/14/79			2/15/79			2/16/79		
Parameter (mg/l)	Influent	Effluent	Percent Removed	Influent	Effluent	Percent Removed	Influent	Effluent	Percent Removed
Lead	190	9.5	95	150	13	91	240	13	95
Chromium	44	7.1	84	38	6.3	83	51	5.9	88
Copper	8.5	1.0	88	8.5	1.2	86	9.1	0.92	90
Nickel	0.13	0.08	38	0.062	<0.1		0.084	0.055	35
Zinc	2.1	8.1		2.2	5.0		3.7	6.0	
Toluene	1.3	0.16	88	4.3	0.49	89	3.6	0.46	87

[1] Flow 30,000 gpd; 29,400 gpd sanitary, cooling, photoprocessing and nonmetallic platemaking process wastewater combined with 600 gpd effluent from batch metals pretreatment system.

TABLE VI-4

CONVENTIONAL AND NONCONVENTIONAL POLLUTANT REMOVAL IN BIOLOGICAL TREATMENT SYSTEM AT PLANT 5478[1]

Parameter (mg/l)	Influent to Biological System	Effluent From Biological System	Percent Removal
COD	270	35	87
BOD_5	130	<6.0	>95
TOC	84	9.0	89
NH_3 as N	21	2.6	88
TKN as N	50	3.4	93
NO_3, NO_2 as N	0.06	5.7	
Total Suspended Solids	160	3.0	98
Total Volatile Solids	300	170	43

1 Flow 30,000 gpd; 29,400 gpd sanitary, cooling, photoprocessing and nonmetallic platemaking process wastewater and 600 gpd metals pretreatment effluent.

Survey. In many instances, respondents who reported treatment were referring to silver recovery of photoprocessing wastes for economic purposes. As reported in Section III, process wastewater was discharged directly at less than 54 plants nationwide.

Wastewater treatment systems are not employed at many small plants. The data presented here were obtained from screening or verification sampling at large plants. Sampling and analysis procedures followed the Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants.(7) Data are reported only for toxic pollutants which were detected in raw or treated effluent samples and for conventional pollutants which were analyzed.

Plant 5478

At Plant 5478, gummed labels, pricing stickers, paper bags, plastic bags, sales slips, and boxes are printed by the lithographic, flexographic, and letterpress processes. Water-based inks are used in flexographic printing. Sources of wastewater are the flexographic press cleanup, film processing, and the lithographic and flexographic platemaking operations. A metals treatment system and a package-type biological system are employed at the plant. Schematics of these treatment systems are shown in Figures VI-1 and VI-2.

Wastewater generated from cleanup of the flexographic printing presses is batch treated for metals removal in a 2,300 liter (600 gal) fiberglass tank equipped with a paddle mixer. After the pH is adjusted to 4.5 with sulfuric acid; alum and a filter aid are added. (The pH adjustment is necessary to achieve optimum coagulation and flocculation). The treated wastewater flows through a 76-cm (30-inch) diameter vacuum filter. The filtrate (2,300 liters/day (600 gpd)) combines with 111,000 liters/day (29,400 gpd) of photoprocessing, platemaking, and nonprocess wastewater to form the influent to the biological treatment system. The biological system consists of an aeration tank and a clarifier. The clarifier sludge is partially recycled; the portion which is wasted is contract hauled to a landfill. The effluent from the biological system percolates to groundwater through a multimedia filter consisting of a 61-cm (2 foot) top layer of sand over a 122-cm (4 foot) bed of rock. The sand filter can be bypassed, in which case the biological treatment system effluent flows directly to a creek.

The reductions of toxic pollutants in the metals treatment system and in the biological system are shown in Tables VI-2 and VI-3.

The reductions of conventional and nonconventional pollutants in the biological system are shown in Table VI-4.

Plant 8190

Magazines, comic books, and commercial publications are printed and bound at plant 8190. Photoprocessing and platemaking operations are performed in conjunction with letterpress and lithographic printing. Products are bound with hot melt glues by the "perfect binding" process. Water is not used in the binding process.

Pressroom effluents, including cleanup and waste ink are stored in a 5,700 liter (1,500 gal) tank. Twice a month, the tank is emptied and its contents are hauled from the plant by a licensed scavenger. Sanitary and cooling wastewaters are segregated from process wastewater and discharged to a municipal sewer.

Approximately 148,000 liters/day (39,000 gpd) of wastewater from photoprocessing, platemaking, press roller washing, truck washing, battery washing[2], and cooling tower blowdown is pumped to the treatment system illustrated in Figure VI-3. Fix solution used in photoprocessing operations flows through a three-stage silver recovery unit prior to entering the treatment system. The cooling water contains the following additives: a phosphate ester or hydrochloric acid, sodium nitrate, and biocides. Phosphate esters and hydrochloric acid are used to prevent scaling; sodium nitrate prevents corrosion; and biocides control algae.

Flocculants are added to the wastewater in the combination flash mix and flocculation tank. The next step in the treatment process is a flotation-clarifier unit which provides both settling and flotation of floc. Flotation is assisted by bubble aeration. The sludge from the clarifier is pumped to one of two interconnected settling basins, each of which is approximately 0.506 hectares (1.25 acres) in area and has a volume of approximately 4.9 million liters (1.3 million gal). Supernatant from the settling ponds may be recirculated to the flash-mix and flocculation tank. Sludge is periodically removed by dredging and deposited in a landfill (at the time of the visit, the east pond had recently been cleaned and was not in operation). The clarifier effluent flows through a garnet filter bed followed by an alumina filter bed, and then enters an aerated tank. Filter backwash, which occurs for 15 minutes at the rate of 150

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[2]Batteries are used as a direct current source in electroplating operations.

liters/minute (40 gpm) once every 6 hours, is pumped to the settling basin. The final treatment step consists of an activated carbon system which receives a flow of approximately 76 liters/minute (20 gpm). Carbon is thermally regenerated on site about twice monthly. Treated effluent is discharged into a creek. Wastewater characteristics and treatment efficiencies are shown in Table VI-5.

Plants 6653 and 9012

The same newspaper is printed by the offset lithographic process at plants 6653 and 9012. These establishments are two manufacturing locations of a large newspaper publishing company. Process wastewater is generated from photoprocessing operations and from platemaking operations in which automatic plant processors are employed. Wastewater is handled in the same manner at both plants. Effluents are filtered through 61-cm (2-foot) diameter, 91-cm (3-foot) deep limestone filters prior to discharge to a municipal sewer. The filters are used for pH adjustment. The influent and effluent characteristics for the filter at each plant are presented in Tables VI-6 and VI-7.

Plant 5430

Textbooks, encyclopedias, and other books are printed at plant 5430. Photoprocessing, nonmetallic platemaking, ink blending, finishing, and binding operations are performed in conjunction with lithographic and letterpress printing. Spent solvents, waste glues, varnishes, laquers, and oils are drummed and contract hauled from the premises to a landfill. Hot water, steam, and a biodegradable detergent are used to launder 182-kg (400 pound) batches of ink rags. As much as 1,140 kg (2,500 pounds) of rags are washed during one shift. Wastewaters from photoprocessing, nonmetallic platemaking, and rag laundering are treated in the system illustrated in Figure VI-4.

Acidic wastewater (pH 2-4) from ink blending, photoprocessing, and nonmetallic platemaking and alkaline wastewater (pH 9-11) from rag laundering are segregated and stored in 38,000 liter (10,000 gal) holding tanks. When sufficient volumes are accumulated, 3,800 liters (1,000 gal) of the acidic wastewater are combined with 7,600 liters (2,000 gal) of the alkaline wastewater in a 13,000 liter (3,500 gal) reactor equipped with a two-speed paddle mixer. Hexavalent chromium is reduced with sodium metabisulfite. The progress of this reaction is monitored with an oxidation reduction potential meter. Metals precipitation is accomplished by adding sufficient caustic soda to raise the pH to 10. Jar tests are performed to determine optimum conditions for flocculation, and cationic or anionic polymer flocculants are added as appropriate. The reduction, precipitation, and flocculation reactions may be controlled manually or automatically. The reactions take from 1 to 2 hours but settling time may vary from 4 to 20 hours.

After settling, sludge and supernatant are pumped to further treatment. Sludge (two to three precent solids) is collected in a holding tank and then concentrated by centrifuging. The sludge cake (13 to 20 percent solids) is hauled to a landfill and the centrate is discharged to the sewer, or recycled to the sludge holding tank. Reactor supernatant is filtered by a fabric filter and then metered to the sewer from a 19,000-liter (5,000-gal) holding tank. Batches which contain unsatisfactory levels of suspended solids are recycled to the reactor. Filtered solids are hauled to a landfill. The reduction of toxic pollutants in the reactor is shown in Table VI-8.

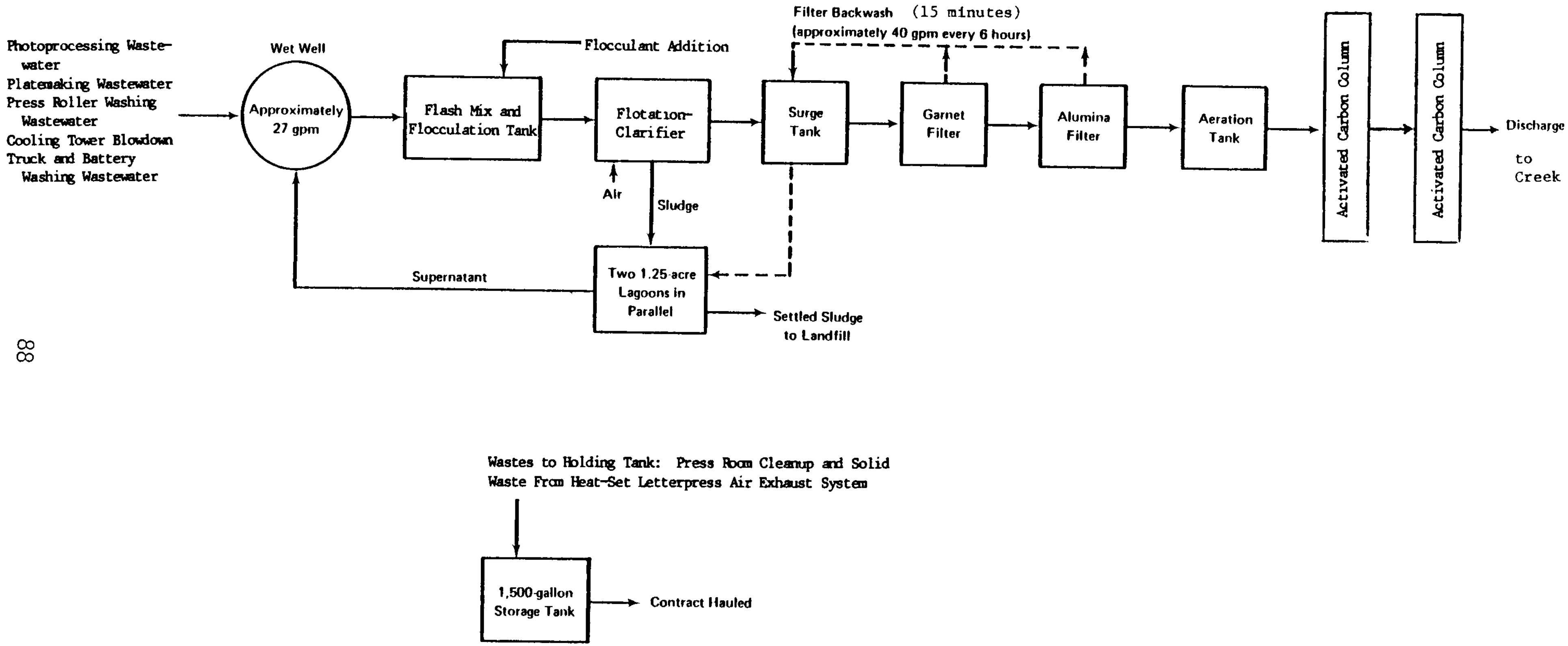

FIGURE VI-3. PHYSICAL/CHEMICAL TREATMENT SYSTEM AT PLANT 8190

TABLE VI-5

REDUCTION OF TOXIC, CONVENTIONAL, AND NONCONVENTIONAL POLLUTANTS IN PHYSICAL/CHEMICAL TREATMENT SYSTEM AT PLANT 8190[1]

Pollutant	Raw Wastewater	Treated Effluent	Percent Removal
Chromium (ug/l)	1,190	75	94
Copper (ug/l)	52	12	77
Lead (ug/l)	46.1	7.5	84
Silver (ug/l)	8.5	0.5	94
Zinc (ug/l)	395	28	93
BOD_5 (mg/l)	570	<6.0	>98
COD (mg/l)	2,700	31	99
TOC (mg/l)	560	9.0	98
NH_3 as N (mg/l)	8.4	0.4	95
TKN as N (mg/l)	1.2	0.7	42
Total Suspended Solids (mg/l)	40	4.0	90
Total Volatile Solids (mg/l)	360	50	86

[1]Flow approximately 39,000 gpd. Chromium is added as part of cooling water treatment program. Raw wastewater does not include contract hauled pressroom effluent.

TABLE VI-6

REDUCTION OF TOXIC POLLUTANTS IN LIMESTONE FILTER AT PLANT 6653[1,2]

Parameter	Influent (ug/l)	Effluent (ug/l)	Percent Removal
pH[3]	8.4	9.1	
Cadmium	70.5	1.25	98
Chromium	281	11	96
Copper	180	39	78
Lead	22.4	0.6	97
Silver	51.3	29.8	42
Zinc	553	--	
Mercury	11	2.1	81

[1] Wastewater flow is estimated to be 11,500 gpd.
[2] No toxic organic pollutants were detected in either of the screening samples collected.
[3] pH readings from grab samples collected October 13, 1977.

--: Not analyzed.

TABLE VI-7

REDUCTION OF TOXIC POLLUTANTS
IN LIMESTONE FILTER AT PLANT 9012[1,2]

Parameter	Influent (ug/l)	Effluent (ug/l)	Percent Removal
pH[3]	8.8	9.3	
Cadmium	319	8.52	97
Cyanide	560	120	79
Zinc	35.4	40	
Mercury	3.3	1.7	48

1 No flow data available.
2 No toxic organic pollutants were detected in either of the screening samples collected.
3 pH reading from grab samples collected October 13, 1977.

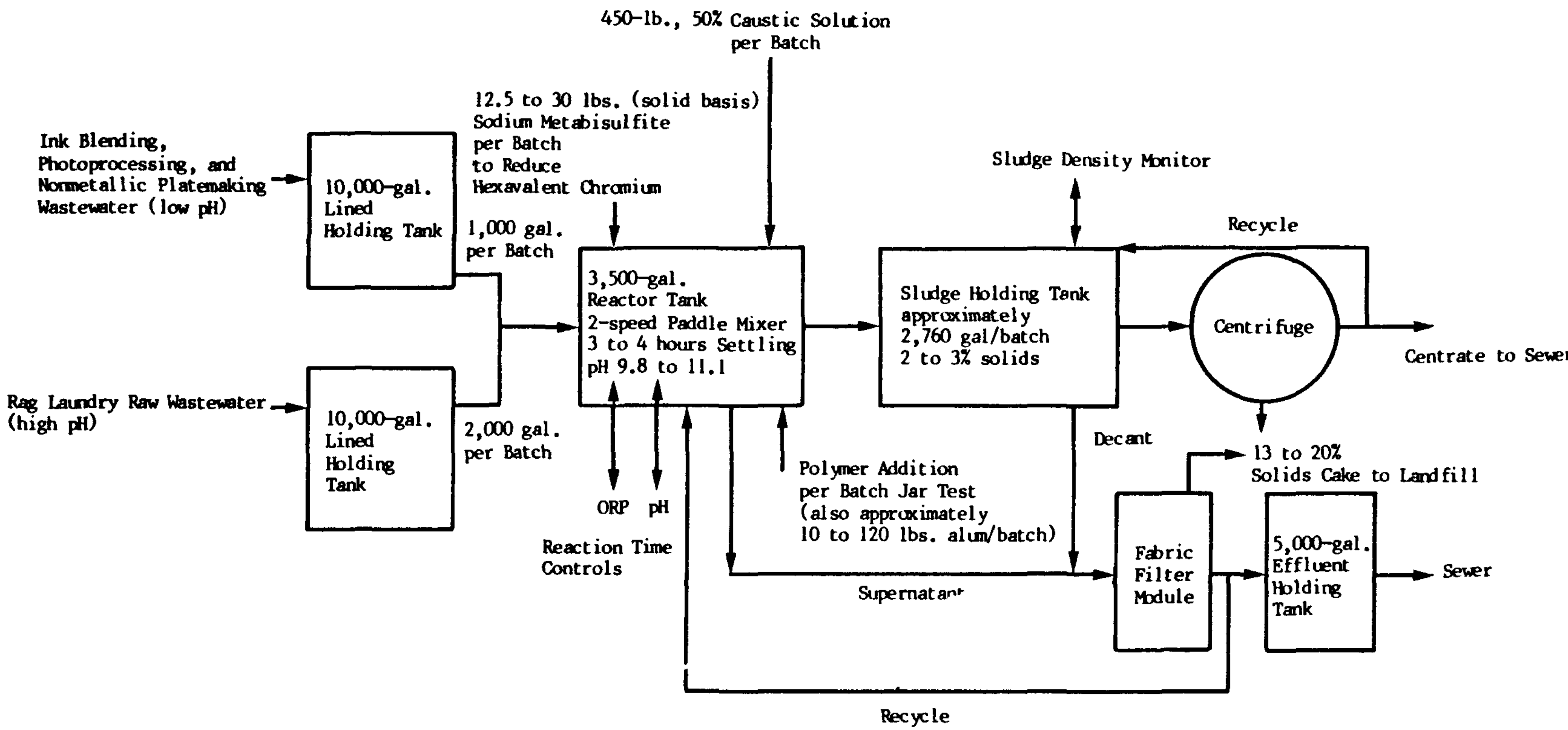

FIGURE VI-4. METALS TREATMENT SYSTEM AT PLANT 5430

TABLE VI-8

REDUCTION OF TOXIC POLLUTANTS IN
METALS TREATMENT SYSTEM AT PLANT 5430

Parameter	Blended Raw Wastewater (ug/l)	Reactor Effluent (ug/l)	Percent Removal
Bis(2-ethylhexyl)phthalate	9,800	<10	>99
Phenol	500	500	0
Butyl benzyl phthalate	200	<10	>95
Di-n-butyl phthalate	800	<10	>99
Diethyl phthalate	89	<10	>89
Cadmium	50	13	74
Chromium	13,755	3,413	75
Copper	20,950	692	97
Lead	4,200	36	99
Zinc	220,000	685	>99

A maximum of four 3,500 gallon batches are treated per day.

SECTION VII

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BAT), NEW SOURCE PERFORMANCE STANDARDS (NSPS), AND PRETREATMENT STANDARDS FOR NEW AND EXISTING SOURCES (PSNS AND PSES)

INTRODUCTION

The Agency has excluded the six printing and publishing subcategories which are the main subject of this document from national regulations under the provisions of Paragraph 8 (a)(iv) of the Settlement Agreement. (1)(2) This section summarizes information and data which support the Agency's decision.

Art and copy preparation and composition operations do not involve the use of water and finishing and binding operations are essentially dry processes. Total toxic pollutant raw waste loads from plants in the remaining four subcategories are less than 1.2 pounds per day per plant. EPA estimates that there are 56,000 printing and publishing manufacturing establishments at which at least one, but usually several, process operations are employed. The results of the data request survey indicate that the median wastewater discharge volume at these plants is between 98 and 190 liters per day (26 and 50 gallons per day). Based on NPDES permit information, there are less than 54 printing and publishing plants nationwide where process wastewater is discharged directly to navigable waters. At all other plants, wastewaters are either not discharged or are discharged to publicly owned treatment works.

ART AND COPY PREPARATION AND COMPOSITION SUBCATEGORY

Decision Not to Establish National Regulations

Based on an extrapolation of the results of the data request survey, there are approximately 32,000 plants where art and copy preparation and composition operations are performed. No water is used in these operations. Therefore, BAT, NSPS, PSNS, and PSES regulations will not be established for this subcategory, under the authority of Paragraph 8 (a)(iv) of the Settlement Agreement.

PHOTOPROCESSING (PRINTING AND/OR PUBLISHING FACILITIES ENGAGED IN INTERNAL PHOTOPROCESSING OPERATIONS) AND NONMETALLIC PLATEMAKING SUBCATEGORIES

Decision Not to Establish National Regulations

Discharge of heavy metals and other toxic pollutants may occur from plants in the photoprocessing and nonmetallic platemaking subcategories. While potential exists for discharge, the amount and toxicity of the pollutants contained in the raw wastewater discharges do not justify developing national regulations. Therefore, BAT, NSPS, PSNS, and PSES regulations will not be established for these subcategories, under the authority of Paragraph 8 (a)(iv) of the Settlement Agreement.

Data Evaluation

Except in two instances, it was not possible to segregate photoprocessing and nonmetallic platemaking waste streams in the screening sampling program; therefore, the decision not to regulate these subcategories is based on the combined raw waste loads from both processes.

Table VII-1 summarizes the screening sampling data obtained at seven large facilities where photoprocessing and nonmetallic platemaking operations are performed. The discharge volumes at these seven large plants ranged between 11,000 and 100,000 liters (3,000 and 27,000 gallons) per day. The pollutant loadings at these plants are expected to be significantly greater than at smaller facilities which make up the majority of the plants in these subcategories. The greatest total discharge of toxic pollutants from any individual plant was less than 0.150 kilograms (0.329 pounds) per day.

Photoprocessing Subcategory Plant Profile

Based on an extrapolation of the results of the data request survey, there are approximately 41,000 plants where photoprocesssing operations are performed. At over 99 percent of these facilities process wastewater is either discharged to publicly owned treatment works or not discharged.

Nonmetallic Platemaking Subcategory Plant Profile

Based on an extrapolation of the results of the data request survey, there are approximately 43,000 plants where nonmetallic platemaking operations are performed. At over 99 percent of

TABLE VII-1

TOXIC POLLUTANT RAW WASTE LOADS FROM PHOTOPROCESSING AND NONMETALLIC PLATEMAKING OPERATIONS

	Plant Code						
	9011	8190[1]	6653	9012	1303	5478	2382
Pesticides[2] (lb/day)	ND[3]	0.005	ND	ND	<0.001	ND	<0.002
Organics (lb/day)	<0.108	<0.222	<0.059	<0.037	<0.092	ND	NR[4]
Metals and Cyanide (lb/day)	<0.201	<0.102	0.116	<0.126	<0.097	<0.260	<0.017
Total Toxic Pollutants (lb/day)	<0.310	<0.329	<0.175	<0.163	<0.190	<0.260	<0.020

1 Chromium added as part of cooling tower water treatment program at Plant 8190 and is not used in photoprocessing or nonmetallic platemaking. Data for chromium were not included in the raw waste load for this plant.
2 Pesticides tentatively identified by gas chromatography (electron capture) but not confirmed by gas chromatography/mass spectroscopy.
3 ND means not detected.
4 NR means not reported.

these facilities process wastewater is either discharged to publicly owned treatment works or not discharged.

PRESSROOM (NONWATER-BASED INKS) SUBCATEGORY

Decision Not to Establish National Regulations

Discharge of heavy metals and other toxic pollutants may occur from plants in the pressroom (nonwater-based inks) subcategory. While the potential exists for discharge, the amount and toxicity of the pollutants contained in the raw wastewater discharges do not justify developing national regulations. Therefore, BAT, NSPS, PSNS, and PSES regulations will not be established for this subcategory, under the authority of Paragraph 8 (a)(iv) of the Settlement Agreement.

Data Evaluation

Table VII-2 summarizes screening sampling data obtained at two large facilities where pressroom (nonwater-based inks) operations are performed. The discharge volumes at these plants were 400 and 800 liters (100 and 200 gallons) per day. The total discharge of toxic pollutants from each plant was less than 0.0054 kilograms (0.012 pounds) per day. Because of the value of solvents used in nonwater-based inks, waste inks are drummed and collected by waste scavengers at the majority of the plants in this subcategory.

Pressroom (Nonwater-Based Inks) Subcategory Plant Profile

Based on an extrapolation of the results of the data request survey, there are approximately 46,000 plants where pressroom (nonwater-based inks) operations are performed. At over 99 percent of these facilities process wastewater is either discharged to publicly owned treatment works or not discharged.

PRESSROOM (WATER-BASED INKS) SUBCATEGORY

Decision Not to Establish National Regulations

Discharge of heavy metals and other toxic pollutants may occur from plants in the pressroom (water-based inks) subcategory. While the potential exists for discharge, the amount and toxicity of the pollutants contained in the raw wastewater discharges does not justify developing national regulations. Therefore, BAT, NSPS, PSNS, and PSES regulations will not be established for this subcategory, under the authority of Paragraph 8(a)(iv) of the Settlement Agreement.

TABLE VII-2

TOXIC POLLUTANT RAW WASTE LOADS FROM PRESSROOM (NONWATER-BASED INKS) OPERATIONS

	Plant Code	
	1303	9002
Pesticides (lb/day)[1]	ND[2]	<0.000002
Organics (lb/day)	<0.0070	<0.0013
Metals and Cyanide (lb/day)	<0.0050	<0.00070
Total Toxic Pollutants (lb/day)	<0.0120	<0.0021

[1] Pesticides tentatively identified by gas chromatography (electron capture) but not confirmed by gas chromatography/mass spectroscopy.
[2] ND means not detected.

Data Evaluation

Table VII-3 summarizes the verification sampling data obtained at two large facilities where pressroom (water-based inks) operations are performed. Discharge volumes at these large plants ranged between 621 and 1900 liters per day (164 and 500 gallons per day). The typical discharge volume at pressroom (water-based inks) plants where wastewater is discharged is less than 200 liters (50 gallons) per day. Therefore, the pollutant loadings at the sampled plants are expected to be significantly greater than at smaller establishments which make up the vast majority of the plants in this subcategory. The average discharge of total toxic pollutants determined from screening and verification sampling at the two facilities was less than 0.545 kilograms (1.2 pounds) per day per plant.

Pressroom (Water-Based Inks) Subcategory Plant Profile

Based on an extrapolation of the results of our data request survey, there are approximately 600 plants where pressroom (water-based inks) operations are performed. EPA estimates that process wastewater is generated at only half of these plants and that more than 95 percent of the generated wastewater is not discharged or is discharged to publicly owned treatment works.

FINISHING AND BINDING OPERATIONS SUBCATEGORY

Decision Not to Establish National Regulations

Based on an extrapolation of the results of the data request survey, there are approximately 6,000 plants where finishing and binding operations are performed. Finishing and binding operations are dry processes, with the possible exception of small amounts of wastewater generated from infrequent cleanup operations. However, in most cases, this waste is hauled away. Because these are essentially dry operations, BAT, NSPS, PSNS, and PSES regulations will not be established for this subcategory, under the authority of Paragraph 8 (a)(iv) of the Settlement Agreement.

TABLE VII-3

TOXIC POLLUTANT RAW WASTE LOADS FROM PRESSROOM (WATER-BASED INKS) OPERATIONS

	Plant Code		
	5478 Screening[1,2]	5478 Verification[3]	9018 Verification[3]
Pesticides (lb/day)[4]	0.000004	ND[5]	ND
Organics (lb/day)	0.017	0.018	0.004
Metals and Cyanide (lb/day)	<2.58	<0.620	<0.910
Total Toxic Pollutants (lb/day)	<2.60[6]	<0.638[6]	<0.914

1 Data from one day screening sampling.
2 Total toxic pollutant raw waste load at Plant 5478 was 0.085 lb/day (during screening) if chromium and lead are not included in the total. Both chromium and lead were found at substantially lower levels during subsequent verification sampling at this plant.
3 Average of data from three day verification sampling.
4 Pesticides tentatively identified by gas chromatography (electron capture) but not confirmed by gas chromatography/mass spectrometry.
5 ND means not detected.
6 The average total toxic pollutant raw waste load from Plant 5478 is <1.2 lb/day. This loading was determined by averaging the data from the one day of screening sampling and the three days of verification sampling.

SECTION VIII

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SECTION X

GLOSSARY

Art and Copy - Material to be reproduced in quantity. Manuscripts are examples of line copy. Photographs and full color artwork are termed continuous tone.

Binder - The film forming component of an ink.

Carbon Tissue - A light-sensitive emulsion on a paper backing used in gravure cylinder preparation. (see resist)

Cellosolve - Union Carbide Corporation Trademark for mono and dialkyl ethers of ethylene glycol and their derivatives.

Composition - The process of preparing original type or manuscripts for platemaking operations.

Continuous Tone - An image which is composed of a continuous range of overlapping tones.

Deep-Etch Plate - A type of lithographic printing plate on which the image areas are slightly below the surface of the plate.

Diazonium Resin - A light-sensitive coating used on short-run lithographic printing plates.

Direct Discharger - A plant where treated or untreated process wastewater is released from its site or property, generally into a receiving water, but not into a publicly owned treatment works.

Dot Etching - Chemically reducing the size of the dots on a halftone image to increase or reduce (depending on whether the respective image is a positive or a negative) local color.

Drier - A salt of cobalt, manganese, lead, or another metal used to catalyze the oxidation of the binding vehicle in certain inks.

Etch - The process of forming an image on a printing plate or cylinder by the action of an acid or an electrolyte. Also a chemical used in lithographic fountain solutions to prevent corrosion of the aluminum backings on printing plates.

Evaporation of Wastewater - A disposal method in which natural or induced head causes evaporation of wastewater.

Expose - To submit a photographic emulsion to light.

Fixing - Chemical action which renders photographic images permanent and insensitive to further exposure.

Fountain Solution - See Lithographic Fountain Solution.

Gelatin - A medium which serves to hold light-sensitive materials in suspension.

Gum Arabic - An exudation of the acacia plant. When applied to lithographic printing plates, gum arabic makes the non-image areas repel greasy inks.

Halftone - An image, composed of a series of minute dots, produced by exposing a photographic emulsion to the subject through a fine screen. This is the type of image on lithographic, letterpress, flexographic, and halftone gravure cylinders. The ink density on these printing plates and cylinders is constant; tonal variations in the products are the result of varing dot sizes on the plates.

Indirect Discharger - A plant where treated or untreated process wastewater is released from its site or property to a publicly owned treatment works.

In-house Printing - A printing operation which produces goods or services solely for a parent organization (or one or more of its divisions) primarily engaged in a business other than printing or publishing.

Intaglio - An engraved image.

Lacquer - In platemaking, an ink receptive coating. Also a clear glossy protective coating applied to printed products.

Layout - A model of the finished printed product.

Landfill - A solid waste land disposal technique in which waste is placed in an excavation and covered with earth. Wastewaters and sludges may also be disposed of by this method.

Land Disposal - A wastewater disposal technique such as spray irrigation or evaporation ponds.

Light-Sensitive Material - A material which reacts to form a latent image upon exposure to light.

Lithographic Fountain Solution - An aqueous solution used on lighographic printing plates to keep the non-image areas free of ink.

Negative - An image on printing plates or transparencies in which the light and dark values are reversed from the subject. Negatives are used chiefly for making positives.

Noncontact Cooling Water - Water which is used for cooling purposes but which has no direct contact with and is no way contaminated by (temperature change excepted) the manufacturing process or contaminated wastewaters.

Nonprocess Wastewater - Wastewater which is not contaminated by the process or related materials. Examples of nonprocess wastewater include boiler blowdown, noncontact cooling water, sanitary sewage, and storm water.

NPDES (National Pollutant Discharge Elimination System) Permit - A permit issued by EPA or an approved state program to point sources which discharge to public waters. The permit specifies certain conditions which the permittee must attain in order to continue its effluent discharge.

Perfect Binding - A book binding, widely used on paperback books, which consists primarily of a flexible adhesive.

Pigment - A solid with desirable color properties. Colloidal suspensions of such solids in an ink give the ink its characteristic color.

Positive - An image on printed material, printing plates, or transparencies showing the light and dark values as they are in the subject.

Potassium Alum - Aluminum Potassium Sulfate-$Al_2(SO_4)_3 \cdot K_2(SO_4) \cdot 24H_2O$

Presensitized Plate - A lithographic printing plate which is supplied to the printer covered with a light-sensitive coating. (See wipe-on plate)

Process Wastewater - Any used water which results from or has had contact with printing or allied processes, including any water for which there is a reasonable possibility of contamination from the process or from raw material - intermediate product -final product storage and handling, transportation, processing, or cleaning operations. Examples of process wastewater include wastewater generated by photoprocessing, engraving and etching, platemaking, equipment and plant cleanup, etc. Cooling water, sanitary wastewater, storm water and boiler blowdown are not considered process wastewater if they have no contact with the process.

Proof - Printed material which is checked for errors prior to full scale production.

Publicly Owned Treatment Works - Wastewater collection and treatment facilities owned and operated by a public body such as a municipality or county.

Resist - A light-sensitive coating used on printing plates, cylinders, or screens which hardens upon exposure to light and serves to prevent etching of the hardened areas during subsequent processing with etching solutions.

Retouching - Chemically correcting the tone values on finished transparencies.

Sanitary Sewage - Liquid waste resulting from bathrooms, drinking fountains, etc., which is totally independent of the manufacturing process.

Stripping - The positioning of transparencies in platemaking operations.

Spray Irrigation - The transport of wastewater or sludge to a distribution system from which it is sprayed over an area of land. The liquid percolates into the soil or evaporates. None of the sludge or wastewater runs off the irrigated area.

Thermography - A variation of the letterpress or lithographic processes. Printed material is dusted with a proprietary powder and heated as it comes off the printing press. The ink swells as it dries creating a raised image on the product.

Transparency - A partially transparent copy such as a photographic film. In platemaking operations, light is passed through or reflected from the transparency, thereby exposing and forming an image on the light-sensitive coating of a printing plate.

Varnish - A vehicle used in printing inks. Also the term for certain coatings used on printed products for durability and appearance. In addition, an acid resistant coating used in gravure platemaking.

Wastewater - Water for which a facility has no further use and which must be disposed.

Wax - A component of some printing inks and a coating used on printed material which prevents products from sticking together.

Wipe-On Plate - A lithographic printing plate which is covered with a light-sensitive coating by the printer.

APPENDIX - HISTORICAL RAW WASTEWATER DATA

HISTORICAL DATA FROM PLANTS VISITED AND/OR SAMPLED

Representatives of five plants which were visited by Agency representatives during this study provided historical raw wastewater data. The data for Plants 8190 and 5430 are shown in Tables A-1 and A-2. These plants are discussed in Section VI. A brief summary of the processes employed and the sources of wastewater at the remaining three plants is presented below.

Plant 5247

At plant 5247, six film processing machines are used in the production of positive and negative screened transparencies. The transparencies are sold to printing establishments where they are used to manufacture printing plates.

City water is filtered and treated with zeolite water softeners prior to use in photoprocessing operations. This is necessary to avoid damage to the film. Developer consumption ranges between 8 and 45 liters/day (2 and 12 gpd) per machine depending on the size and quantity of transparencies developed. Fixing solution flows continuously at a constant rate of approximately 0.50 liter/minute (0.13 gpm). Used fixing solution flows through a silver recovery unit and the desilvered fixing solution is partially recycled. Rinse water flow is regulated at approximately 8 liters/minute (2 gpm). The rinse water flows only when film is being processed. Waste fix, developer, and rinse water flow through a proportional chlorinator. The chlorinator effluent is combined with sanitary sewage and discharged. The combined sanitary sewage and process wastewater volume ranges between 19,000 and 26,000 liters/day (5,000 to 7,000 gpd). Available raw wastewater data are presented in Table A-3.

Plant 9010

Plant 9010 is a large, fully integrated offset lithographic printing facility where such products as textbooks and

and developed by a deep-etch plate processing machine. Zinc printing plates are also produced by a chemical etching process.

Process wastewater sources include: film processing, deep-etch platemaking, zinc etching wastes, spent fountain solutions, and oily wastes from the printing presses. Total process and nonprocess wastewater volume is estimated to be 151,000 liters/day (40,000 gpd). Raw wastewater data are presented in Table A-4.

Plant 8301

Over 500 people are employed to produce greeting cards at Plant 8301. Finishing and binding are the major plant operations; less than ten percent of the cards produced are actually printed at the plant. These finishing and binding operations include gluing, die cutting, embossing, foil stamping, and other decorative processes. Products are printed by the sheet-fed and web-fed lithographic, thermographic, and flexographic methods.

Process wastewater is generated in platemaking and, to a small extent, in cleanup operations. Process and sanitary wastewaters are combined and discharged to a municipal sewer. Noncontact wastewaters flow directly to a storm sewer. Table A-5 presents pollutant data for combined process and sanitary wastewater.

HISTORICAL DATA FROM PLANTS NOT VISITED AND/OR SAMPLED

Tables A-6 through A-11 present historical raw wastewater data for 44 plants which were not visited. The data were obtained from plant representatives or from local, state, and federal authorities. These tables are organized by printing process rather than by subcategory. Wastewater streams and sample type are documented to the extent that the information was available.

TABLE A-1

HISTORICAL RAW WASTEWATER DATA FOR PLANT 8190[1]

Conventional and Nonconventional Pollutants, Concentration, mg/l

pH	BOD_5	COD	Acidity $CaCO_3$	Alkalinity $CaCO_3$	TSS	Oil and Grease	NH_3	$P(PO_4)$	Sulfate	Total Phenols
6.7-7.6	140	1,209	55	84	179	67	1.6	7.6	129	0.083

Metals, Concentration, mg/l

Ca	Cd	Cr	Cr^{+6}	Cu	Fe	Ni	K	Na	Zn
16.9	0.05	2.7	0.4	3.9	3.7	31.5	8.1	67.9	4.0

1 Average of three 24-hour composite samples, September 1976.

TABLE A-2

HISTORICAL RAW WASTEWATER DATA FOR PLANT 5430[1]

TOXIC AND CONVENTIONAL POLLUTANTS

Wastewater Stream	Flow (gpd)	pH	Concentrations, mg/l					
			Cu	Cr	Zn	TSS	BOD_5	COD
Photographic Department	1,155	2.6	174	100	4,750	29	32,000	64,100
Press Circulators	300	4.1	15.9	400	100	111	70,000	375,000
Rag Laundry	8,000	10.1	3.44	1.60	4.65	737	1,130	5,860
Total Flow	9,455							

[1] Data from consultant report, September 1975. Sample type unknown.

TABLE A-3

HISTORICAL RAW WASTEWATER DATA FOR PLANT 5247[1,2]

Wastewater Stream	Parameter	Concentration mg/l
Fix, Developer, and Rinse Water	Acetate as Acetic Acid	40
	Aluminum	0.04
	Ethylene Diamine	<10
	Ethylene Glycol	< 1.5
	Formaldehyde	< 1.5
	Hydroquinone	<10
	Total Phosphate as PO_4	1.76
	Sulfite as SO_3	365
	Thiosulfate as $Na_2S_2O_3$	2,075
	BOD_5	440
	COD	2,756
	Ammonia as N	159
	Borate as B	<0.10
	Silver	31.746
	Total Phenols	0.168
	Total Suspended Solids	2

[1] Analysis provided by plant consultant, October 1976.
[2] Grab sample taken before silver recovery unit.

TABLE A-4

HISTORICAL RAW WASTEWATER DATA FOR PLANT 9010[1]

Sample	Volume gal/wk	pH	Cr mg/l	Cr^{+6} mg/l	NH_3 mg/l	Cu mg/l	Fe mg/l	Zn mg/l	Free Oil ml/l
1	1,800	6.6	1,000	850	1,900	--	--	--	--
2	400	2.0	7.8	2.1	--	--	--	--	--
3	40	1.3	1,000	450	--	--	--	--	--
4	40	1.0	2.1	--	--	--	3,600	--	--
5	150	4.5	--	--	--	--	1,500	--	--
6	24	1.0	--	--	--	1,200	--	--	--
7	150	3.8	--	--	--	3,600	--	--	--
8	10	4.4	8.0	2.2	--	--	--	--	--
9	200	6.4	1,000	400	200	--	--	--	--
10	21,600	7.2	5.0	1.2	--	--	--	--	--
11	100	1.0	--	--	--	--	1,200	--	--
12	250	--	--	--	--	--	--	--	100

[1] Single grab samples, date unknown.

1. Ammonium dichromate whirler solution
2. Chromic fountain solution
3. $CaCl_2$ developer
4. $FeCl_3$ dip
5. $FeCl_3$ rinse
6. $CuCl_2$ dip
7. $CuCl_2$ rinse
8. Prior hot rinse
9. Hot rinse
10. Cold rinse
11. Zinc etcher waste
12. Oily wastes

--: No data.

TABLE A-5

HISTORICAL RAW WASTEWATER DATA FOR PLANT 8301[1]

Flow (gpd)	pH	Toxic and Conventional Pollutants, Concentrations, mg/l							
		BOD5	COD	TSS	Cr	Pb	Ni	Ag	Cyanide
13,000	6.5-9.3	353	768	176	0.09	0.05	0.04	0.04	0.01

[1] Average of eight plant-collected, 24-hour composite samples taken between November 4, 1975 and May 11, 1977.

TABLE A-6

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED LITHOGRAPHIC PRINTING OPERATIONS

Plant Code	Flow (MGD)	pH	Conventional and Nonconventional Pollutants, Concentrations, mg/l: BOD_5	COD	Oil & Grease	TSS	TOC
463[1]	0.015	--	124	--	--	0.07	--
968[2]	--	--	229	--	--	389	--
405[3]	--	6.6	93	410	--	27	7.3
246[4]	--	--	446	--	27.8	3,024	--
943[5]	--	--	218	--	--	66	--
737[6]	0.015	8.8	144	362	35	81	--

1 Plant 463. Wastewater to municipal sewer. Processing of diazo coated plates; processing of black and white, color, halftone film. Average of four grab samples, January 1974 to December 1976.

2 Plant 968. Wastewater to municipal sewer. Manual processing of presensitized lithographic plates and processing of black and white film. Average of two samples (type unknown), November 1976.

3 Plant 405. Wastewater to municipal sewer. Processing of lithographic plates; processing of black and white, halftone film. 24-hour composite sample, date unknown.

4 Plant 246. Wastewater (includes 15 percent nonprocess wastewater) to municipal sewer. Processing of aluminum lithographic plates; processing of black and white, halftone film. Composite sample taken in 1976 under peak operating conditions.

5 Plant 943. Wastewater to municipal sewer. Processing of lithographic plates; processing of black and white, color, halftone film; lithographic and screen printing. Grab sample, December 1976.

6 Plant 737. Sanitary, process and cooling wastewater to municipal sewer. Processing of photopolymer plates, lithographic and flexographic printing. Eight-hour composite sample, February 1973.

--: No data.

TABLE A-6

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED
LITHOGRAPHIC PRINTING OPERATIONS
(Continued, Page 2 of 3)

Plant Code	Flow (MGD)	pH	Conventional and Nonconventional Pollutants, Concentrations, mg/l				
			BOD_5	COD	Oil & Grease	TSS	TOC
938[7]	--	7.95	--	632.6	17.2	--	--
801[8]	--	6.3	--	2,970	--	337	--
832[9]	--	7.1	217	--	--	49	--
684[10]	--	8	181	531	76	144	--
901[11]	0.008	--	9.8	--	--	106	--
570[12]	--	7.5	29	110	8	47	--

[7] Plant 938. Process and nonprocess wastewater to municipal sewer. Processing of deep-etch plates; processing of black and white, color, halftone film. 24-hour composite sample, January 1973.

[8] Plant 801. Wastewater to municipal sewer. Processing of photopolymer plates; processing of black and white, halftone film. Average of eight samples (type unknown), March 1976 to June 1977.

[9] Plant 832. Wastewater to municipal sewer. Processing of diazo coated and photopolymer plates. Average of 25 samples (type unknown), February 1973 to April 1977.

[10] Plant 684. Wastewater to municipal sewer. Processing of diazo coated plates; processing of black and white, color film. One 24-hour composite sample, November 1975.

[11] Plant 901. Wastewater to municipal sewer. Processing of diazo coated plates; processing of black and white, color film. Average of monthly data for November 1976.

[12] Plant 570. Process and sanitary wastewater (6 to 10 employees). Processing of diazo coated plates and processing of black and white film. Grab sample, August 1975.

--: No data.

TABLE A-6

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED
LITHOGRAPHIC PRINTING OPERATIONS
(Continued, Page 3 of 3)

Plant Code	Flow (MGD)	pH	Conventional and Nonconventional Pollutants, Concentrations, mg/l				
			BOD_5	COD	Oil & Grease	TSS	TOC
880[13]	--	6.7	480	128	--	53	15
333[14]	--	--	29	--	--	42	--
211[15]	--	8.6	12	46	16	2	--
412[16]	0.0008	9.78	9.05	121.6	--	3	15,270
412[17]	0.0002	6.8	33.3	597.2	2.6	11.5	4,080

[13] Plant 880. Wastewater to municipal sewer. Manual processing of presensitized lithographic plates; processing of color, halftone film. One sample, type and date unknown.

[14] Plant 333. Wastewater to municipal sewer. Processing of presensitized lithographic plates; processing of black and white, halftone film. Grab sample, October 1975.

[15] Plant 211. Wastewater to municipal sewer. Processing of diazo coated plates, processing of black and white film, binding operations. Grab sample, November 1976.

[16] Plant 412. Photoprocessing wastewater. Sample type and date unknown.

[17] Plant 412. Wastewater from processing of photopolymer plates. Sample type and date unknown.

--: No data.

TABLE A-7

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED LITHOGRAPHIC PRINTING OPERATIONS

Plant Code	Flow (MGD)	Metals and Cyanide, Concentrations, mg/1														
		An	As	Be	Cd	Cr	Cr^{+6}	Cu	Cyanide	Pb	Hg	Ni	Se	Ag	Th	Zn
211[1]	-	—	0.01	—	0.12	0.41	—	0.05	0.01	0.46	0.001	0.12	<0.01	0.04	—	0.10
412[2]	-	—	—	—	—	0.27	<0.01	—	—	—	—	—	—	2.21	—	—
412[3]	-	—	—	—	—	<0.005	<0.01	<0.003	—	<0.03	—	—	—	—	—	0.003
570[4]	-	—	<0.001	—	<0.01	<0.1	—	0.4	<0.01	<0.05	<0.001	<0.1	<0.01	<0.05	—	0.06
880[5]	-	—	0.014	<0.05	0.09	0.09	—	—	<2.5	<0.05	<0.0005	—	—	—	—	—
938[6]	-	—	<0.001	<0.01	0.10	0.16	—	0.64	<0.1	<0.001	<0.001	<0.001	<0.01	1.03	—	5.6
801[7]	-	—	—	—	<0.06	22.9	10.4	9.5	—	—	—	<0.08	—	—	—	311
246[8]	-	—	0.0026	0.02	0.48	0.62	—	8.04	0.01	—	0.001	—	—	—	—	—

1 Plant 211. Wastewater to municipal sewer. Processing of diazo coated plates, processing of black and white film, binding operations. Grab sample, November 1976.

2 Plant 412. Photoprocessing wastewater. Sample type and date unknown.

3 Plant 412. Wastewater from processing of photopolymer plates. Sample type and date unknown.

4 Plant 570. Process and sanitary wastewater (6 to 10 employees). Processing of diazo coated plates and processing of black and white film. Grab sample, August 1975.

5 Plant 880. Wastewater to municipal sewer. Manual processing of presensitized lithographic plates; processing of color, halftone film. Sample type and date unknown.

6 Plant 938. Process and nonprocess wastewater to municipal sewer. Processing of deep-etch plates; processing of black and white, color, halftone film. 24-hour composite sample, January 1973.

7 Plant 801. Wastewater to municipal sewer. Processing of photopolymer plates; processing of black and white, halftone film. Average of eight samples (type unknown), March 1976 to June 1977.

8 Plant 246. Wastewater (includes 15 percent nonprocess wastewater) to municipal sewer. Processing of aluminum lithographic plates; processing of black and white, halftone film. Composite sample taken in 1976 under peak operating conditions.

—: No data.

TABLE A-8

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED LETTERPRESS OPERATIONS

Plant Code	Flow (MGD)[1]	Conventional and Nonconventional Pollutants, Concentrations, mg/l					
		pH	BOD_5	COD	Oil & Grease	TSS	TOC
891[2]	106 gpd	0.2-9.3	--	7,970	290	325	--
891[3]	0.087	2.77-8.5	--	--	--	101	--
891[4]	0.087	7.40-8.54	--	--	--	8.25	--
481[5]	0.025	7.29	93.0	512	6.20	22.0	281
510[6]	0.015	6.8-7.0	2.90	111	11.7	130	--
137[7]	0.20	6.3	600	620	152	440	511
411[8]	0.033	8.10-8.20	10.9	87.5	4.76	12.0	--

[1] Unless otherwise noted.
[2] Plant 891. Wastewater from acid etching of zinc plates. Average of two grab samples, December 1972.
[3] Plant 891. Process and sanitary wastewater. Processing of magnesium plates. Average of 12 grab samples, March 1973 to January 1976.
[4] Plant 891. Process and sanitary wastewater. Processing of magnesium and photopolymer plates. Average of 16 grab samples, February 1976 to July 1977.
[5] Plant 481. Process, cooling, and sanitary wastewater. Processing of photopolymer plates. 24-hour composite sample, June 1976.
[6] Plant 510. Process, cooling, and sanitary wastewater. Average of two 24-hour composite samples, November 1973.
[7] Plant 137. Wastewater from processing of stereotype and photopolymer plates. 7-hour composite sample, July 1972.
[8] Plant 411. Process and nonprocess wastewater. Stereotype platemaking. Average of two composite samples, date unknown.

--: No data.

TABLE A-8

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED
LETTERPRESS OPERATIONS
(Continued, Page 2 of 2)

Plant Code	Flow (MGD)[1]	Toxic Pollutant Metals, Concentrations, mg/l											
		As	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Th	Zn
891[2]	106 gpd	--	--	--	--	--	--	--	--	--	--	--	26,000
891[3]	0.087	--	--	--	0.067	--	95.7	--	--	--	--	--	0.63
891[4]	0.087	--	--	--	<0.05	--	30	--	--	--	--	--	0.206
481[5]	0.025	--	--	--	--	--	--	--	--	0.07	--	--	--
510[6]	0.015	--	--	--	0.019	--	--	0.0004	--	--	--	--	0.29
411[7]	0.033	0.002	0.10	<0.001	<0.01	0.015	<0.01	0.0004	<0.01	--	<0.02	<0.01	0.05

1 Unless otherwise noted.
2 Plant 891. Wastewater from acid etching of zinc plates. Average of two grab samples, December 1972.
3 Plant 891. Process and sanitary wastewater. Processing of magnesium plates. Average of 12 grab samples, March 1973 to January 1976.
4 Plant 891. Process and sanitary wastewater. Processing of magnesium and photopolymer plates. Average of 16 grab samples, February 1976 to July 1977.
5 Plant 481. Process, cooling, and sanitary wastewater. Processing of photopolymer plates. 24-hour composite sample, June 1976.
6 Plant 510. Process, cooling, and sanitary wastewater. Average of two 24-hour composite samples, November 1973.
7 Plant 411. Process and nonprocess wastewater. Stereotype platemaking. Average of two composite samples, date unknown.

--: No data.

TABLE A-9

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED LETTERPRESS AND LITHOGRAPHIC PRINTING OPERATIONS

Plant Code	Flow (MGD)	pH	Conventional and Nonconventional Pollutants, Concentrations, mg/l				
			BOD_5	COD	Oil & Grease	TSS	TOC
707[1]	--	7.4	180	57.1	104	68	--
644[2]	--	7.9	302	613	13	46	--
190[3]	--	--	90	--	--	72	--
377[4]	--	--	21	--	--	19	--
774[5]	--	6.4	--	1,500	216	184	--
353[6]	--	6.8	--	314.84	10	81	--

[1] Plant 707. Process and nonprocess wastewater. Processing of diazo coated plates; lithographic, screen, and gravure printing. Sample type unknown, July 1974.

[2] Plant 644. Hot composition, processing of presensitized lithographic plates. Sample type unknown, March 1974.

[3] Plant 190. Sewer water sample. Processing of presensitized lithographic plates. Sample type unknown, July 1977.

[4] Plant 377. Wastewater to municipal sewer. Processing of copper and aluminum bichromated colloid plates, photoengraving. Grab sample, April 1977.

[5] Plant 774. Wastewater from processing of diazo coated plates. Grab sample, November 1977.

[6] Plant 353. Wastewater to municipal sewer. Processing of diazo coated plates and processing of black and white film. 24-hour composite sample, April 1977.

--: No data.

TABLE A-9

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED LETTERPRESS AND LITHOGRAPHIC PRINTING OPERATIONS (Continued, Page 2 of 5)

Plant Code	Flow (MGD)	pH	Conventional and Nonconventional Pollutants, Concentrations, mg/l				
			BOD_5	COD	Oil & Grease	TSS	TOC
584[7]	--	6.1-8.1	3,365	--	20	3,320	--
495[8]	--	--	92.9	--	4.1	125.2	--
772[9]	--	8.4	42	117	196	23	--
425[10]	--	7.5	40	76	13	191	--
222[11]	--	7.8	17	--	--	80	--
422[12]	--	8.8	339	--	55	113	--

[7] Plant 584. Wastewater to municipal sewer. Processing of diazo coated plates, stereotype platemaking, processing of black and white film, color separation. Average of 22 samples, December 1972 to July 1977.

[8] Plant 495. Sanitary, process, and cooling wastewater. Processing of bichromated colloid, photopolymer, and presensitized lithographic plates; stereotype and electrotype platemaking; finishing and binding operations. 24-hour composite sample, date unknown.

[9] Plant 772. Wastewater to municipal sewer. Processing of diazo coated plates and processing of black and white film. Sample type unknown, August 1975.

[10] Plant 425. Wastewater to municipal sewer. Processing of lithographic plates and processing of black and white film. Sample type unknown, September 1975.

[11] Plant 222. Wastewater to municipal sewer. Processing of lithographic plates, processing of black and white film, electroplating. Sample type unknown, October 1975.

[12] Plant 422. Wastewater to municipal sewer. Processing of lithographic plates and processing of black and white film. Average of two 24-hour composite samples, August 1974.

--: No data.

TABLE A-9

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED
LETTERPRESS AND LITHOGRAPHIC PRINTING OPERATIONS
(Continued, Page 3 of 5)

Plant Code	Flow (MGD)	pH	Conventional and Nonconventional Pollutants, Concentrations, mg/l				
			BOD_5	COD	Oil & Grease	TSS	TOC
135[13]	0.00022	7.1	--	--	<2	--	--
731[14]	--	7.0	60.7	--	9.2	72.5	--
731[14]	--	7.0	802.2	399	27.3	1,101	--
881[15]	--	9.5	1,050	3,100	10	8	--
145[16]	0.00042	7.9	710	2,800	1.4	1	--
893[17]	0.079	6.1	--	1,434	83	185	--

[13] Plant 135. Process, sanitary, and cooling wastewater. Processing of diazo and silver halide coated plates, photoengraving, processing of black and white film, color separation. 24-hour composite sample, October 1976.

[14] Plant 731. Two process wastewater discharge points to municipal sewer. Processing of diazo coated and photopolymer plates; processing of black and white, color, halftone film. Average of unknown number of 24-hour composite samples, 1973 to 1974.

[15] Plant 881. Wastewater to municipal sewer. Processing of diazo coated plates; processing of black and white, halftone film. Grab sample, April 1977.

[16] Plant 145. Process and nonprocess wastewater to municipal sewer. Manual processing of aluminum lithographic plates; processing of black and white, color, halftone film. Composite sample, April 1977.

[17] Plant 893. Wastewater to municipal sewer. Processing of diazo coated and photopolymer plates; processing of black and white, halftone film. Average of fourteen 12-hour composite samples, December 1972 to November 1976.

--: No data.

TABLE A-9

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED
LETTERPRESS AND LITHOGRAPHIC PRINTING OPERATIONS
(Continued, Page 4 of 5)

Plant Code	Flow (MGD)	pH	Conventional and Nonconventional Pollutants, Concentrations, mg/l				
			BOD_5	COD	Oil & Grease	TSS	TOC
527[18]	--	7.3	--	--	--	--	--
626[19]	--	--	76.4	--	--	26.0	--
717[20]	--	7.8	--	560	--	77	--
501[21]	--	7.0	360.5	818	21.0	60	260

[18] Plant 527. Wastewater to municipal sewer. Manual processing of presensitized lithographic plates; processing of black and white, halftone film. Seven-hour composite sample, date unknown.

[19] Plant 626. Process and nonprocess wastewater. Processing of diazo coated plates; processing of black and white, halftone film. Two-hour composite sample taken at 20-minute intervals, date unknown.

[20] Plant 717. Process and nonprocess wastewater to municipal sewer. Processing of diazo coated and photopolymer plates; processing of black and white, color, halftone film. Grab sample, March 1977.

[21] Plant 501. Process and sanitary wastewater to municipal sewer. Processing of plastic, photopolymer, and diazo coated plates; processing of black and white, halftone film; binding operations. Average of unknown number of samples taken during 1973.

--: No data.

TABLE A-9

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED LETTERPRESS AND LITHOGRAPHIC PRINTING OPERATIONS
(Continued, Page 5 of 5)

Plant Code	Flow (MGD)	pH	Conventional and Nonconventional Pollutants, Concentrations, mg/l				
			BOD_5	COD	Oil & Grease	TSS	TOC
302[22]	8.5	--	101	197.6	30.35	45.2	--
295[23]	--	6.4	178	530	--	509	--

22 Plant 302. Combined process and nonprocess wastewater to municipal sewer. Processing of halftone film; lithographic, letterpress, flexographic, gravure, and screen printing. Average of five days of 24-hour composite sampling by municipal authorities, August 1974.

23 Plant 295. Wastewater to municipal sewer. Processing of presensitized lithographic plates; photoengraving; processing of black and white, halftone film. Average of three days of 24-hour composite sampling, January 1974.

--: No data.

TABLE A-10

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED LETTERPRESS AND LITHOGRAPHIC PRINTING OPERATIONS

Plant Code	Flow (MGD)	Metals and Cyanide, Concentrations, mg/l														
		An	As	Be	Cd	Cr	Cr^{+6}	Cu	Cyanide	Pb	Hg	Ni	Se	Ag	Th	Zn
707[1]	-	—	0.05	—	<0.02	<0.01	—	0.1	<0.5	<0.01	0.0094	<0.2	<0.005	0.1	—	0.1
644[2]	-	—	<0.01	—	<0.001	—	0.6	0.09	—	0.04	<0.001	0.5	<0.005	0.13	—	0.001
353[3]	-	—	—	—	—	—	—	—	—	0.4	—	—	—	—	—	0.32
584[4]	-	—	—	—	—	1.00	—	—	—	—	—	—	—	—	—	0.28
495[5]	-	—	—	—	—	0.39	—	0.20	—	0.004	—	—	—	—	—	1.29
772[6]	-	—	0.22	—	0.02	0.16	—	<0.10	<0.05	<0.10	<0.002	<0.1	<0.01	0.11	—	0.39
425[7]	-	—	<0.005	—	0.01	<0.1	—	0.2	<0.1	0.09	0.001	0.1	0.002	0.04	—	1
135[8]	-	—	—	—	<0.01	0.05	<0.02	0.05	—	—	—	<0.05	—	—	—	0.07
731[9]	-	—	—	—	—	—	—	—	—	0.01	0.30	—	—	—	—	96
731[9]	-	—	—	—	—	—	—	—	—	0.21	0.66	—	—	—	—	79.88

[1] Plant 707. Process and nonprocess wastewater. Processing of diazo coated plates; lithographic, screen, and gravure printing. Sample type unknown, July 1974.

[2] Plant 644. Hot composition, processing of presensitized lithographic plates. Sample type unknown, March 1974.

[3] Plant 353. Wastewater to municipal sewer. Processing of diazo coated plates and processing of black and white film. 24-hour composite sample, April 1977.

[4] Plant 584. Wastewater to municipal sewer. Processing of diazo coated plates, stereotype platemaking, processing of black and white film, color separation. Average of 22 samples (type unknown), December 1972 to July 1977.

[5] Plant 495. Sanitary, process, and cooling wastewater. Processing of bichromated colloid, photopolymer, and presensitized lithographic plates; stereotype and electrotype platemaking; processing of black and white, color film; finishing and binding operations. 24-hour composite sample, date unknown.

[6] Plant 772. Wastewater to municipal sewer. Processing of diazo coated plates and processing of black and white film. Sample type unknown, August 1975.

[7] Plant 425. Wastewater to municipal sewer. Processing of lithographic plates and processing of black and white film. Sample type unknown, September 1975.

[8] Plant 135. Sanitary, process, and cooling wastewater. Processing of diazo and silver halide coated lithographic plates, photoengraving, processing of black and white film, color separation. 24-hour composite sample, October 1976.

[9] Plant 731. Two process wastewater discharge points to municipal sewer. Processing of diazo coated and photopolymer plates; processing of black and white, color, halftone film. Average of unknown number of 24-hour composite samples, 1973 to 1974.

—: No data.

TABLE A-10

HISTORICAL RAW WASTEWATER CHARACTERISTICS FROM PLANTS NOT VISITED OR SAMPLED
LETTERPRESS AND LITHOGRAPHIC PRINTING OPERATIONS
(Continued, Page 2 of 2)

Plant Code	Flow (MGD)	Metals and Cyanide, Concentrations, mg/l														
		An	As	Be	Cd	CrT	Cr^{+6}	Cu	Cyanide	Pb	Hg	Ni	Se	Ag	Th	Zn
881[10]	-	—	—	—	0.12	0.07	—	0.08	<0.1	0.05	0.001	0.02	0.01	3.75	—	1.44
145[11]	-	—	0.001	—	<0.001	<0.01	0.004	0.031	—	0.013	0.007	0.002	<0.001	0.084	—	0.13
893[12]	-	—	—	—	—	7.7	2.9	1.6	—	0.06	—	—	—	—	—	—
717[13]	-	—	—	—	—	—	—	0.18	—	—	—	—	—	—	—	—
501[14]	-	—	—	—	—	—	—	0.39	—	0.20	0.0052	0.3	—	—	—	0.235
302[15]	-	—	—	—	—	0.384	—	0.29	—	—	—	0.106	—	<0.02	—	0.18

[10] Plant 881. Wastewater to municipal sewer. Processing of diazo coated plates; processing of black and white, halftone film. Grab sample, April 1976.

[11] Plant 145. Process and nonprocess wastewater to municipal sewer. Manual processing of lithographic plates; processing of black and white, color, halftone film. Composite sample, April 1977.

[12] Plant 893. Wastewater to municipal sewer. Processing of diazo coated and photopolymer plates; processing of black and white, halftone film. Average of fourteen 12-hour composite samples, December 1972 to November 1976.

[13] Plant 717. Process and nonprocess wastewater to municipal sewer. Processing of diazo coated and photopolymer plates; processing of black and white, color, halftone film. Sample type unknown, March 1977.

[14] Plant 501. Process and sanitary wastewater to municipal sewer. Processing of plastic, photopolymer, and diazo coated plates; processing of black and white, halftone film; binding operations. Average of unknown number of samples (type unknown) taken during 1973.

[15] Plant 302. Process and nonprocess wastewater to municipal sewer. Processing of halftone film; lithographic, letterpress, flexographic, gravure, and screen printing. Average of five days of 24-hour composite sampling by municipal authorities, August 1974.

—: No data.