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A PRINTED CIRCUIT BOARD MANUFACTURER'S COMPLIANCE WITH PRETREATMENT REQUIREMENTS: CASE STUDY

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(ABSTRACT)

Cirtek Incorporated of Owings Mills, Maryland, is a printed circuit board manufacturer that discharges approximately 100,000 gallons per day of process wastewater to the Baltimore County Sewage System. The principal objectives of the study were to assess Cirtek's compliance with applicable pretreatment standards and requirements and to evaluate the Company's approach for achieving compliance with the pretreatment requirements.

Detailed inspections of the facility and review of over five years of records, including results of over 100 sampling events were used to determine Cirtek's compliance. Numerous technologies were considered by Cirtek; the chosen alternative (ion exchange and electrolytic recovery) and its application to Cirtek and the printed circuit board industry at large are discussed. The full range of compliance options are also presented.

Considering Cirtek's longstanding noncompliance and other factors, it is believed that the chosen technology was the ideal choice. However, failure to consider appropriate in-plant controls and basic engineering considerations during treatment plant design, led to prolonged noncompliance and continued enforcement liability.

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1. INTRODUCTION

Municipal wastewater treatment systems collect wastewater from a variety of sources, including domestic residences, schools, offices, stores and industry. At the treatment plant, pollutants are removed and the treated effluent is discharged, usually to a surface water such as a river, lake or ocean. The residue from treatment, or sewage sludge, has beneficial value and may be used as a soil conditioner. Wastes from industrial and commercial sources often contain toxic pollutants which may be harmful to the treatment plant. Further, these pollutants are not always intended to be treated by the treatment plant and may pass through to the receiving stream or contaminate the sewage sludge, thus limiting its use or increasing disposal costs.

Concern about the potentially deleterious effects of industrial and other nondomestic wastes upon these wastewater treatment plants, has resulted in the establishment of the National Pretreatment Program. Authorized by federal law, this national program establishes discharge standards and other requirements for certain industries that discharge toxic pollutants to municipal sewer systems.

This case study evaluates the efforts of Cirtek, a printed circuit board manufacturer to achieve compliance with the relevant federal and local pretreatment standards. The case study includes a review of the printed circuit board industry in general, the specific nature of Cirtek, its processes and wastes, a review of the applicable pretreatment standards, a historical review of Cirtek's compliance status, and an evaluation of Cirtek's efforts to install suitable treatment of its wastes and comply with the pretreatment standards.

2. INDUSTRY CHARACTERIZATION

2.1 OVERVIEW OF THE PRINTED CIRCUIT BOARD INDUSTRY

Printed circuit boards have widespread use in applications such as computers, communications, and home entertainment equipment. In the mid to late 1970s, the total market for printed circuit boards was about one billion dollars domestically and about two billion dollars worldwide; total annual production in this country was about 150 million square feet of printed boards (1). By 1985, the world market had grown to 10 billion dollars with production in the U.S. responsible for 40 percent of the sales and more than 475 million square feet of rigid printed circuit boards (2). This need is brought about by a free world demand for electronic systems and equipment that exceeded 356 billion dollars in 1986. Consumption of electronic systems in the U.S. alone is forecast to reach 370 billion dollars by 1991, up from 210 billion dollars in 1986 and steadily increasing at a rate of 12 percent per year (3). The basic markets for printed circuit board sales in the U.S. in 1985 is shown in Table 1.

The industry as a whole, however, is considered remarkably fragile and fragmented. There are more than 900 independent printed circuit board manufacturers nationwide. Over 750 are small shops with less than 5 million dollars in annual sales; about 400 of which had less than 1 million dollars in sales in 1985 (5).

There are four major types of printed circuit boards:

- Single-Sided Boards: printed circuitry laid out on one side only. These are the easiest and cheapest to manufacture, but are limited to applications in low-price category items such as televisions and radios. They form the smallest portion of printed circuit board production in the U.S.

TABLE 1

MARKETS FOR PRINTED CIRCUIT BOARDS IN 1985 DOLLARS
after Pritchard (4)

BASIC MARKETS		VALUE OF PRODUCTION INDEPENDENTS	VALUE OF PRODUCTION CAPTIVES	TOTAL MARKET
	%	Million Dollars	Million Dollars	Million Dollars
Business	2.1	$ 45	$ 75	$ 120
Communications	18.9	402	281	683
Consumer	11.5	245	95	340
Computer	43.2	919	746	1,665
Government	12.2	260	315	575
Industrial	5.1	108	62	170
Instruments	7.0	149	71	220
TOTAL	100.0%	$2,128	$1,645	$3,773

o Double-Sided Boards: printed circuitry laid out on both sides of the board. These form the major portion of printed circuit board production. They are found in personal computers, communication equipment, and process control systems.

o Multilayer Boards: printed circuitry laid out on two or more pieces of dielectric material stacked up and bonded together. They form the second largest portion of the printed circuit board production and are found in sophisticated applications such as mainframe computers and military equipment.

o Flexible Circuits: printed circuitry formed on a thin, flexible dielectric substrate. These are found in applications requiring the circuitry to bend or shape to conform to nonflat surfaces such as in telephone receivers, automobiles, or missiles.

Early printed boards were produced by brushing a specially formulated silver paint on a ceramic plate in the desired circuit pattern. Heating at high temperatures removed the paint vehicle and binder, leaving behind the electrically conductive silver. Boards today are typically manufactured by applying a nonconductive resist layer to copper foil, which in turn is bonded to a substrate.

Photographic, machining, and chemical processing activities consume water for cleaning, cooling, lubricating, and chemical processing. The resulting wastewaters may become contaminated with copper, tin, lead, nickel, fluorides, and organics. The major sources of waste deriving from printed circuit board manufacturing are shown in Table 2. The principle source of pollutants from the process, primarily copper, is the result of "drag-out" where process (i.e., plating, etching, cleaning, etc.) solution inadvertently clings to the working parts and is removed in the rinse water. A typical square foot of printed circuit board can result in the "drag-out" or loss of as much as 10 mL of process solution. Other sources of pollutants include batch discharges, spills, leaks, etc. Waste copper and the resulting sludge from treatment have been estimated for typical small and large printed circuit board manufacturers and are shown in Table 3.

TABLE 2

MAJOR WASTE SOURCES IN PRINTED CIRCUIT BOARD PRODUCTIONS
after EPA (6)

POLLUTANT	SOURCE
<u>Copper</u>	
	Acid copper electroplate (copper sulfate/sulfuric acid) Copper etches (alkaline ammonia or sulfuric acid/hydrogen peroxide) Electroless copper plating (copper/EDTA/formaldehyde) Acid dips/cleaners
<u>Tin/Lead</u>	
	Tin/lead (solder) plate (tin/lead fluoroborate) Tin plate (tin fluoroborate or tin sulfate)
<u>Nickel</u>	
	Nickel tab or contact finger plate (nickel borate or sulfamate)
<u>Fluoride</u>	
	Tin/lead electroplate (tin/lead fluoroborate) Tin electroplate (tin fluoroborate) Glass etches
<u>Halogenated Organic Solvents</u>	
	Dry film developer Resist strip Cleaners

The environmental challenges for the printed circuit board industry include:

- o Reducing water usage
- o Maximizing the reuse and recycle of raw materials
- o Minimizing the generation of hazardous sludges
- o Reducing the costs of raw materials and sludge disposal
- o Achieving and maintaining compliance with applicable environmental laws and regulations.

2.2 OVERVIEW OF CIRTEK

Cirtek Incorporated is a manufacturer and fabricator of printed circuit boards located in Owings Mills, Maryland. The company located at its current address in 1975 and was previously known as Bar Gale Industries until May of 1983 when ownership changed to Cirtek. The facility employs approximately 150 employees, operating in two shifts. Cirtek generates about 130,000 gallons per day (gpd) of process and nonprocess wastewater that is discharged to the Baltimore County sewage system.

Cirtek principally manufactures double sided and multilayer printed circuit boards for use in specific applications, hence, Cirtek is considered a job shop in that they produce the boards on an order basis. The customer will usually provide the specifications for the desired boards although Cirtek does offer board design and layout services.

2.2.1 Manufacturing Processes

The sequence of the overall process employed by Cirtek in the manufacture of printed circuit boards is shown in Figure 1. Since this case study focuses on Cirtek's compliance with wastewater discharge

TABLE 3

ESTIMATED WASTE GENERATION LEVELS OF COPPER FOR
TYPICAL PRINTED CIRCUIT BOARD MANUFACTURING OPERATIONS
after California DHS (3)

OPERATION	SMALL	LARGE
PC Board Production Volume (sq.ft./day)	250	4,000
Water Usage (and discharged), gal/day	12,500	200,000
Acid copper plating tank		
Volume drag-out (liter/day)	3	48
Copper metal produced (Kg/day)	0.075	1.2
Equivalent to (Kg/year)	18.75	300
Contribution from this stream to total acid copper wastes	10%	10%
Total Copper Sources		
Metal produced, Kg/day	0.75	12
Metal produced, Kg/year	187	3,000
Total copper level in untreated waste (ppm)	15	15
Sludge generation (tons/year) estimated 3% copper	6	100

requirements, the following discussion of each process step highlights waste generation.

- Board Shearing - The laminate boards, from which printed circuit boards are made, consist of glass epoxy material with about 0.0007 in. copper coated on both surfaces. They come in standard 3 x 4 ft sheets, which are cut to a customer's specifications. The board shearing operation is dry, involving the use of no cutting oils or lubricants.

- Computer Drilling - After the boards are cut, the holes for the attachment of various components are drilled. The drill presses which perform the operation are controlled by computer, programmed with the appropriate bit size and hole location, corresponding to the printed circuit board to be produced. The presses can drill numerous boards concurrently. The drilling process is a dry operation except the presses are cleaned occasionally using rags wet with methyl ethyl ketone (MEK). The rags are washed by an industrial laundry.

- Deburring and Scrubbing - Cirtek uses two scrubber units and one deburring unit. The scrubbers operate using water and brushes, and the rinses go to the sanitary sewer. The deburring unit uses about 20 gallons per minute (gpm) of water and the scrubber about 12 gpm. Copper burrs are collected, stored in 55 gallon drums, and sold as scrap copper. After deburring and scrubbing, the boards go to one of two processes: the multilayer line batch (MLB) or plating through hole (PTH).

- Multilayer Line Batch (MLB) - The board is conditioned in an alkaline conditioner followed by two water rinses. It is dipped in potassium permanganate ($KMnO_4$) etch solution, followed again by two water rinses, then dipped in a neutralizer solution. It is again water rinsed. After rinsing, it is dipped in a glass etching solution (containing ammonium bifluoride), then sent to the final rinse. All the rinses go to the sewer. A flow diagram of all the steps in this process is shown in Figure A-1.

- Plating Through Hole - Because printed circuit boards are only clad with copper on the surfaces and the major portion of the board consists of a nonconductive material (glass epoxy) continuity of conductance from one surface to the other is lost when the boards are drilled. Therefore, to assure continuity between the two surfaces of the board, the surfaces of the drilled holes must be replated with copper. Also, because

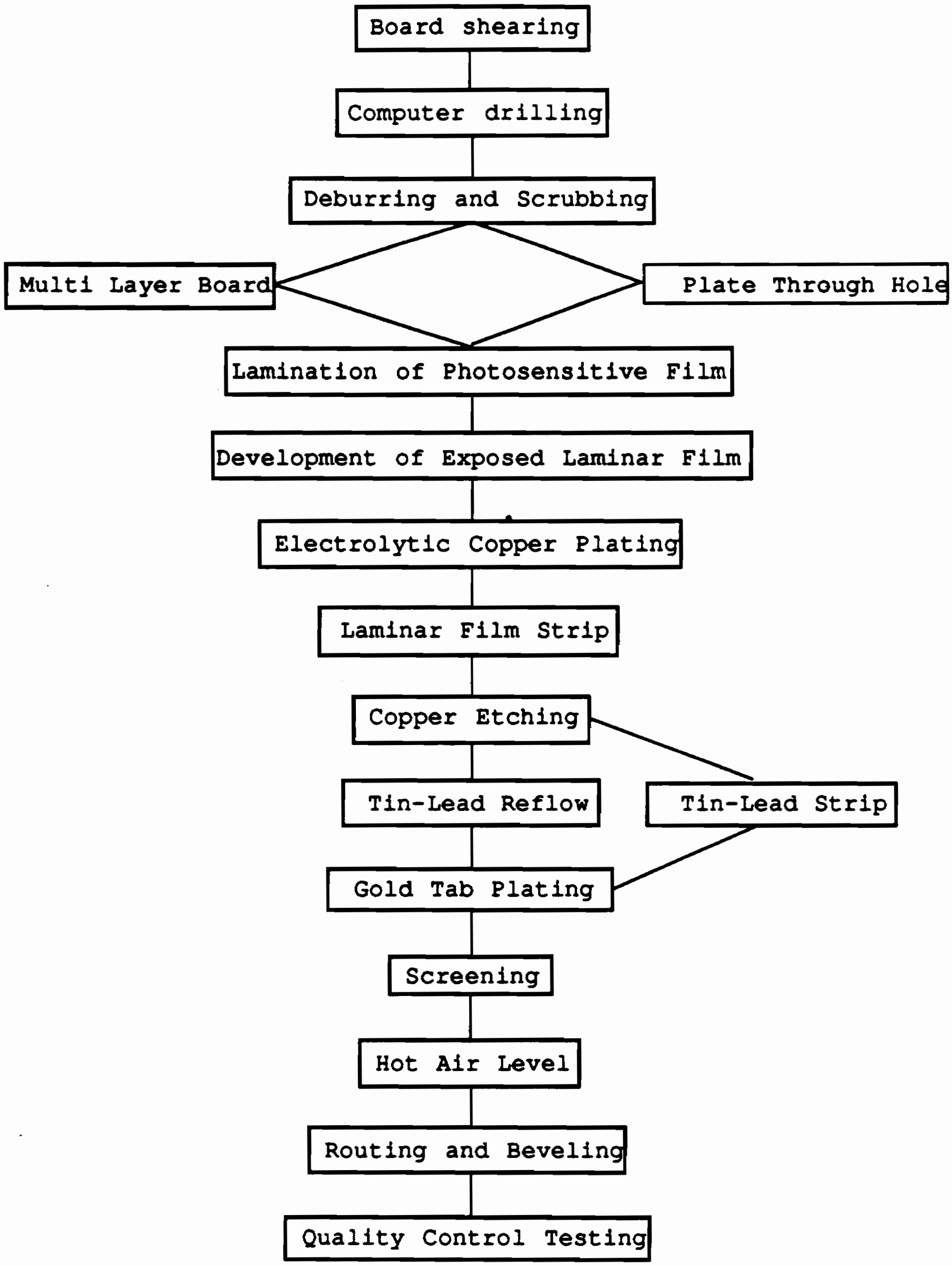

FIGURE 1 CIRTEK'S PRINTED CIRCUT BOARD MANUFACTURING PROCESS

electrolytic plating cannot be done on a nonmetallic surface, plating of the thru-holes must be done by the electroless method. Electroless copper plating involves a series of preparatory solutions which include surface activators and catalysts and an alkaline solution of copper sulfate ($CuSO_4$) which serves as the copper source. The steps in the PTH line are shown in Figure A-2.

- o Lamination of Photosensitive Film - To receive the circuit pattern, a photosensitive film (called "blue laminar") is applied to the boards via a heat process. To transfer the desired circuit pattern onto the photosensitive "blue laminar," a photonegative of the circuit is overlaid onto the board and then exposed to light. This is a dry process.

- o Development of Exposed Laminar Film - After the circuit pattern has been exposed onto the photosensitive film, the film must be developed. The "blue laminar" film used by Cirtek is a diazo-type film which does not require the reduction of silver halide crystals to silver for developing and, thus, does not generate any waste silver salts as a part of the spent developing solutions. The chemistry used for developing the "blue laminar" film is manufactured by Kodak; chemistry is batch discharged (approximately 26 gallons total) to the sanitary sewer at the end of every working day. Developing the exposed film results in removing the "blue laminar" film in the areas of the circuit pattern, and exposing the underlying copper; the laminated film still remains as a covering over the copper in all the boundary regions of the board.

- o Electrolytic Copper Plating - The entire circuit pattern, including the thru-holes, is now exposed and already has a thin covering of copper, either from the original copper clad board or as a result of the electroless plating of the thru-holes. Although this existing copper covering is not sufficient to produce good quality circuitry, it will permit additional deposition of copper via electrolytic plating, whereas copper cannot be deposited on those areas of the board still covered by the laminar film. The electrolytic plating process actually consists of two separate plating operations -- 1) copper and 2) tin-lead (solder) -- each with their own preparation lines. These process lines are depicted in Figure A-3.

  - Copper is plated on the circuit pattern to produce the final thickness of copper specified by the customer. The copper plating portion of the electrolytic plating process consists of 3 prep solutions, 3 running rinses, and one static rinse, and 3 - 325 gallon copper plating tanks.

- Tin-lead (solder) is plated over the copper to protect it during the subsequent stripping of the laminar film and the thin copper cladding from the noncircuit regions of the board. The tin-lead plating portion of the electrolytic plating process consists of 2 prep solutions and 3 running rinses, and 1 - 325 gallon tin-lead plating tank.

o Laminar Film Strip - After the copper circuitry has been protected by the tin-lead coating, the laminar film and then the copper cladding in the noncircuit regions of the board need to be removed. The laminar film is stripped in a machine which contains sodium hydroxide (25 percent NaOH). The contents of the 50 gallon reservoir are discharged to the sanitary sewer once every 2 weeks. The machine also discharges rinsewater to the sanitary sewer at a rate of 5-10 gpm during operation.

o Copper Etching - The thin copper cladding which now covers the noncircuit regions of the boards is removed by an etching machine to produce a discrete circuit pattern. The copper circuit will not be affected by the etchant solution which primarily consists of sodium hydroxide (NaOH) and ammonium chloride (NH_4CL) because it is protected by the tin-lead solder layer which covers it. Spent etchant, which contains relatively high concentrations of copper, is continuously pumped from the etching machine to 55 gallon drums while new solution is continuously pumped in to replenish the reservoir. Spent etchant is generated at a rate of approximately 55 gallons per day and is removed on an as-needed basis by a local waste hauler. The boards are then placed in a solder bright neutralizer to neutralize any residual etchant solution not removed by the rinse. The acid neutralizer is batch discharged weekly. Following the acid bath is another running rinse which goes to the sanitary sewer. The boards are then dried.

o Tin-Lead (Sn-Pb) Reflow - The board is now functionally operative. However, to improve the oxidation resistance of the tin-lead coating, the board is passed through a "solder reflow" machine. This machine is merely an oven which heats the solder to a temperature where it becomes molten. Flux is used in the machine to enhance the flow characteristics of the solder; this is recirculated within the machine, however, approximately 5 gallons is replenished every 2 weeks to make up for losses due to evaporation, spills, and residual carryover on the boards. The machine also contains an alkaline tin-lead activator solution (55 gallon tank) which is batch discharged every 2 weeks. Immediately following the tin-lead activator tank is a 75-100 gallon overflow rinse tank which discharges rinse water continuously to the sanitary sewer.

- Tin-Lead Strip - To prevent oxidation of the tin-lead coating and to improve the appearance of the board, some customers require that the Sn-Pb coating be stripped. When required, the boards are immersed in a solder strip solution which consists of ammonium hydrofluoride (NH_4HF_2) and hydrogen peroxide (H_2O_2). The spent solution is drummed and sent back to the manufacturer for recovery. The board is allowed to drip over the tank before going to the running rinse. After the rinsing, the board is placed in a 10 percent fluorobic acid (HBF_4) solution which is batch discharged to the sewer. The board is then returned to the rinse tank for final rinsing.

- Gold Tab Plating - Although it increases the cost of the board, customers frequently require the plating of the circuit connections (tabs) with gold, which significantly improves their durability. To plate gold over the circuit connections, boards which have not had the tin-lead solder stripped must have it removed from those areas to be plated. Therefore, the first step in the tab plating process is to manually apply a masking tape on the boards to separate the connections from the remainder of the circuit. The boards are then dipped into the tin-lead stripping tank, which contains hydrogen peroxide (H_2O_2) and fluorobic acid (HBF_4). This solution is periodically drummed and stored for removal by a waste hauler. After the tin-lead coating has been removed from the connections, they are ready to be plated. To plate gold over copper, a thin layer of nickel must first be deposited. The individual elements of the gold plating process are shown in Figure A-4.

- Screening (Solder Masking) - Epoxy resin is applied over the entire surface of the boards which forms a protective surface providing mechanical and electrical protection and corrosion resistance. The resins come in different colors to meet customer specifications and are applied by a screening process similar to silkscreening. After application, the resin is cured in ultraviolet ovens. Waste resin is placed with municipal waste for disposal. Cleaning the screens, which occurs at the end of the working day or between runs of different colors, requires the use of solvents, either methyl ethyl ketone or toluene. The solvents are applied with rags and a cumulative usage rate of approximately 10 gallons per month was estimated. Soiled rags are laundered by a local industrial laundry.

- Routing and Beveling - To reduce the size and weight of the finished boards, borders and unnecessary sections are cut away by computer controlled routing machines. In addition, the connections which have just been plated with gold are beveled to produce smoother fits. These two processes are completely dry. The waste that is generated (i.e., scrap board sections and dust) is collected and sold to a metals reclamation company for gold recovery.

- Quality Control Testing - Before printed circuit boards leave the plant, they are electrically tested to assure that the circuitry is correct. In addition, many boards are examined with a microscope to check cross-section dimensions. Customers may request specific thicknesses of copper and gold deposits and these must be met. However, if the deposits are thicker than they need to be, valuable raw materials are wasted. Both types of quality control testing are completely dry activities.

2.2.2 Wastewater Generation

Cirtek's wastewater falls into two common categories, sanitary and process. Sanitary wastes from the approximately 100 employees is collected through the on-site sewer system separate from the process wastes. Process wastes from the plating area (wet room), scrubber and deburring machines, and the gold plating room are collected in a wastewater collection sump. Process wastes from the sump flow to the sanitary sewer in a dedicated on-site sewer. Cirtek officials consistently cited historical process flow figures at about 70,000 gallons per day (gpd) or at a rate of 50 gallons per minute(gpm) based on a twenty four hour work day. Cirtek officials also expressed the desire to reduce process flow to about 30 gpm or about 43,000 gpd. Cirtek had no specific information on existing flows nor specific plans for flow reduction.

On October 6, 1988, two flow estimation techniques were used to evaluate Cirtek's existing process flows. First, Cirtek's master water meter was read at two different times during the day. Second, a five gallon bucket and stop watch were used to estimate the discharge volume from each rinse tank, deburring and scrubber machines and all other significant source of process flow.

The master water meter provided an indication of total water usage at a single point in time. The flow rate on the water meter was read at

10:00 a.m. and at 11:30 a.m., during normal plant operation, with respective flow rates of 89.8 and 97.2 gpm. Assuming this water usage rate was maintained for a twenty four hour period, water use would range from 130,000 to 140,000 gpd. A crude estimation of sanitary flow can be made assuming 100 gpd per employee, resulting in less than 10,000 gpd or 7 gpm of sanitary flow. This flow estimation suggests that Cirtek's water use and subsequent process flow is 120,000 to 130,000 gpd or nearly twice that estimated by company officials.

The second approach used to estimate Cirtek's process wastewater flow was direct measurement of individual wastestreams with a bucket and stopwatch. Nearly every process discharge was accessible. Each of thirteen rinse tanks and seven machines (e.g., scrubbers, deburrers and presses) were estimated. The sum of all measured discharges was 139.7 gpm or a daily estimated flow of over 200,000 gpd. This estimated flow rate is best observed as a "peak" flow rate since it assumes simultaneous operation of all scrubbers, deburrers and presses, a likely occurrence only during the first shift. Nonetheless, flows from the rinse tanks alone, which are operated consistently through the three shifts was over 75 gpm or about 108,000 gallons per day. An undated schematic of the plating room, located in company files, estimated flow from this area at 34 gpm or less than half of the measured flows.

3. PRETREATMENT STANDARDS AND REQUIREMENTS

3.1 FEDERAL WATER POLLUTION CONTROL LEGISLATION

The Federal Water Pollution Control Act established a national strategy for controlling water pollution based on clean-up requirements for the desired uses of effluent-receiving waters (drinking water, body-contact recreation, fishing, navigation, etc.) as determined by State governments, and the water quality conditions necessary to support those uses. The Federal Water Pollution Control Act, amended in 1972 by passage of Public Law 92-500, established a national goal of eliminating pollutant discharges by 1985, and directed "that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983" (7).

The 1972 Amendments to the Act were complex laws covering a wide range of water pollution control regulations. Both the municipal and industrial communities were impacted significantly. Mandatory secondary treatment for POTWs and a base level of pollution control, Best Practicable Control Technology Currently Available (BPT) installed by direct industrial discharges to waterways by July 1, 1977, highlighted the requirements (8). Public Law (PL) 92-500 also required EPA to establish levels of pollution reduction achievable by industry using Best Available Technology Economically Achievable (BAT) by 1983 (9). In addition, a new source standard calling for the use of advanced technology was required. In 1976 and 1979, in settlement of a suit with the Natural Resources Defense Council (NRDC), EPA agreed to concentrate attention on potentially toxic substances using technology based standards (10). Toxic substances were to be included in the Best Available Control Technology (BAT) Standards for direct and indirect dischargers to be issued for the 34 industrial categories listed in Table 4.

TABLE 4

NRDC CONSENT DECREE - 34 INDUSTRY CATEGORIES
NATURAL RESOURCES DEFENSE COUNCIL (NRDC)
after NRDC (10)

1.	Adhesives	18.	Pulp & Paper
2.	Leather Tanning & Finishing	19.	Textile Mills
3.	Soaps & Detergents	20.	Timber
4.	Aluminum Forming	21.	Coal Mining
5.	Battery Manufacturing	22.	Ore Mining
6.	Coil Coating	23.	Petroleum Refining
7.	Copper Forming	24.	Steam Electric
8.	Electroplating	25.	Organic Chemicals
9.	Foundries	26.	Pesticides
10.	Iron & Steel	27.	Pharmaceuticals
11.	Nonferrous Metals	28.	Plastics & Synthetic Materials
12.	Photographic Supplies	29.	Rubber
13.	Plastics Processing	30.	Auto & Other Laundries
14.	Porcelain Enameling	31.	Mechanical Products
15.	Gum & Wood Chemicals	32.	Electric & Electronic Components
16.	Paint and Ink	33.	Explosives Manufacturing
17.	Printing & Publishing	34.	Inorganic Chemicals

Further amendments to the Federal Water Pollution Control Act, subsequently known as the Clean Water Act of 1977 (PL 95-217), incorporated substantial portions of the NRDC consent decree and brought about other changes in the direction of improved water quality (11). On February 4, 1987, despite two previous presidential vetoes, Congress passed the Water Quality Act of 1987. The Act basically fine tuned EPA's existing programs, yet initiates new efforts to control toxic pollutants to achieve the goals of the Act.

3.2 NATIONAL PRETREATMENT STANDARDS AND REQUIREMENTS

On June 26, 1978, the Environmental Protection Agency published a rule [Title 40 Code of Federal Regulations (CFR), Part 403] which established a national strategy for controlling the introduction of wastes from nondomestic sources into Publicly Owned Treatment Works (POTWs) (12). These General Pretreatment Regulations for Existing and New Sources of Pollution establish objectives to:

- o Prevent the introduction of pollutants into POTWs which will interfere with treatment operations and/or the use or disposal of municipal sludge
- o Prevent the introduction of pollutants into the POTW which will pass through the treatment works or otherwise be incompatible
- o Improve the feasibility of recycling and reclaiming municipal and industrial wastewaters and sludges.

The General Pretreatment Regulations laid out the responsibilities and requirements for over 200,000 industrial users (30,000 of which are considered as significant industrial users), 1,500 POTWs, States, and EPA to achieve these program objectives.

The General Pretreatment Regulations established prohibited discharge standards and incorporated categorical pretreatment standards as the effluent limitations industries must meet in order to control pollutant discharges into POTWs. In addition, POTWs were required to establish and impose more stringent local limits on industrial users, where necessary, to protect the environment or the municipal sewage system.

Prohibited discharge standards applied to all industrial and commercial establishments connected to POTWs. The prohibited standards control the discharge of pollutants that:

- o Create a fire or explosion hazard
- o Cause corrosion or substances with a pH lower than 5.0
- o Obstruct flow in the sewer system or interfere with operation of the treatment works
- o Upset the treatment processes or cause a violation of the POTW's NPDES permit
- o Increase the temperature of wastewater entering the treatment plant to above 104°F (40°C) (12).

Categorical pretreatment standards are technology based standards that apply to users in specific industrial categories. Each categorical pretreatment standard is developed as a separate regulation in EPA's effluent guidelines process. The standard contains limitations for pollutants commonly discharged by the specific industrial category. All firms regulated by a particular category are required to comply with these standards, no matter where they are located in the U.S. As many as 126 toxic pollutants were considered for regulation during development of these categorical pretreatment standards.

3.3 LOCAL PRETREATMENT REQUIREMENTS

The Baltimore County Department of Public Works received EPA approval of its local pretreatment program in August 1985 and, as such, became responsible for applying and enforcing pretreatment standards and requirements upon industrial users within its service area. In accordance with the General Pretreatment Regulations and its approved pretreatment program, Baltimore County was required to:

- o Operate under adequate legal authority
- o Issue control mechanisms (permits) to its industrial users
- o Conduct monitoring (sampling and inspections) to verify industrial user compliance
- o Initiate appropriate enforcement action in the event of industrial user noncompliance
- o Maintain adequate resources and funding to carry out all program responsibilities.

Cirtek was among the over 120 significant industrial users discharging wastes to the County sewerage system and regulated under the local pretreatment program.

3.4 PRETREATMENT STANDARDS APPLICABLE TO CIRTEK

3.4.1 Standards

Three different types of pretreatment standards are applicable to Cirtek: categorical pretreatment standards, prohibited discharge standards, and local limits.

Categorical Pretreatment Standards

On September 7, 1979, EPA promulgated 40 CFR Part 413, Effluent Guideline Limitations for the Electroplating Point Source Category, which established pretreatment standards for existing sources (13). While most electroplating and metal finishing operations are now subject to the more stringent metal finishing categorical standard (40 CFR Part 433), existing job shop electroplaters and independent printed circuit board manufacturers remain subject to the electroplating category (14).

A new source is defined as a facility that began construction after publication of the proposed rule. For purposes of determining whether Cirtek is an existing source (subject to electroplating standards - 40 CFR Part 413) or a new source (subject to the metal finishing standards - 40 CFR Part 433), the key date was August 31, 1982, the publication date of the proposed metal finishing rule. Despite the change of ownership from Bar Gale to Cirtek in 1983, the facility existed prior to August 31, 1982 and, therefore, was determined to be an existing source. Simply changing ownership had no bearing on the facility's characterization of existing or new source.

Pretreatment standards applicable to Cirtek are contained in Subpart H - Printed Circuit Board Subcategory of 40 CFR Part 413 (13). The provisions of Subpart H apply to the manufacture of printed circuit boards, including all manufacturing operations required or used to convert an insulating substrate to a finished printed circuit board. Limitations for printed circuit board facilities discharging 38,000 liters or more per day (10,000 gallons per day) are shown in Table 5 (13). The compliance deadline for the metals and cyanide limitations was April 27, 1984. The compliance deadline for total toxic organics (TTO) was July 15, 1986. TTO is the summation of all values greater than 0.01 mg/L for each of the toxic pollutants listed in 40 CFR 413.02.

Prohibited Discharge Standards

Baltimore County is required at a minimum to apply and enforce the prohibited discharge standards contained in 40 CFR 403.5. The Baltimore County Code Section incorporates these standards as well as many others. Table 6 contains those prohibitions that are appropriate to Cirtek given the nature of its discharge. Compliance with the Section 403.5 prohibitions had to be attained by August 25, 1981. Compliance with Baltimore County prohibitions was assumed to be a precondition before discharge. Baltimore County's prohibitions are shown in Table 7.

TABLE 5

SUBPART H - PRINTED CIRCUIT BOARD FACILITIES DISCHARGING 38,000 LITERS (10,000 gpd) OR MORE PER DAY - PRETREATMENT STANDARDS FOR EXISTING SOURCES (PSES) LIMITATIONS
after EPA (13)

POLLUTANT OR POLLUTANT PROPERTY	MAXIMUM FOR ANY 1 DAY (mg/l)	AVERAGE OF DAILY VALUES FOR 4 CONSECUTIVE MONITORING DAYS SHALL NOT EXCEED (mg/l)
Cyanide, Total (CN,T)	1.9	1.0
Copper, Total (Cu)	4.5	2.7
Nickel, Total (Ni)	4.1	2.6
Chromium, Total (Cr)	7.0	4.0
Zinc, Total (Zn)	4.2	2.6
Lead, Total (Pb)	0.6	0.4
Cadmium, Total (Cd)	1.2	0.7
Total metals[1]	10.5	6.8
Total Toxic Organics[2]	2.13	--

[1]Total Metals - the sum of the concentrations of Copper (Cu), Nickel (Ni), Chromium (Cr) and Zinc (Zn).

[2]Total Toxic Organics - the summation of all quantifiable values greater than 0.01 mg/l for the toxic organics listed in 40 CFR 413.02.

TABLE 6

SPECIFIC DISCHARGE PROHIBITIONS
40 CFR SECTION 403.5
after EPA (12)

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(1) Pollutants which create a fire or explosion hazard in the POTW;

(2) Pollutants which will cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, unless the works is specifically designed to accommodate such discharges;

(3) Solid or viscous pollutants in amounts which will cause obstruction to the flow in the POTW resulting in Interference;

(4) Any pollutant, including oxygen demanding pollutants (BOD, etc.) released in a discharge at a flow rate and/or pollutant concentration which will cause Interference with the POTW.

(5) Heat in amounts which will inhibit biological activity in the POTW resulting in Interference, but in no case heat in such quantities that the temperature at the POTW Treatment Plant exceeds 40°C (104°F) unless the Approval Authority, upon request of the POTW, approves alternate temperature limits.

TABLE 7

BALTIMORE COUNTY PROHIBITED WASTES
after Baltimore County (15)

Uncontaminated water in areas of separated sewers
Flammable or explosive substances
Wastes outside pH range of 6.0 to 10.0
Substances which may obstruct sewage flow or interfering with the operation of pumping stations or treatment facilities
Wastes with temperatures over 150°F
Improperly shredded garbage
Radioactive materials in certain concentrations
Substances causing excessive discoloration
Slug flows - i.e., short-term, high volume or high strength discharges
Wastes which contain or result in the production of toxic, corrosive, poisonous, or malodorous gases

Local Limits

Section 403.5 of the General Pretreatment Regulations (13) require Control Authorities to establish local limits that are capable of protecting the POTW against pass through or interference. Other than existing ordinance values for some conventional and nonconventional pollutants, Baltimore County has not adopted local limits for any toxic pollutants.

3.5 REPORTING REQUIREMENTS

The General Pretreatment Regulations (13) as well as the Baltimore County Code (15) establish specific reporting requirements that apply to Cirtek. Following is an overview of each of the reports, required contents, and the date the reports are required to be submitted by Cirtek to Baltimore County.

- o Baseline Monitoring Report [403.12(b)].

  Within 180 days after the effective date of a categorical standard (September 13, 1981, in the case of the Electroplating Standard) or 180 days after a final decision on a category determination submission, which is later, an industrial user subject to the standard must submit to Baltimore County a report that indicates whether the industrial user meets the standard. The specific elements of the report are contained in 40 CFR 403.12(b)(1-7) and summarized below:

  - Name and address of the facility, including names of operator(s) and owner(s).
  - List of all environmental control permits held by or for the facility.
  - Brief description of the nature, average production rate and Standard Industrial Classification (SIC) code for each of the operation(s) conducted, including a schematic process diagram which indicates points of discharge from the regulated processes to the POTW.
  - Flow measurement information for regulated process streams discharged to the municipal system.

- Identification of the pretreatment standards applicable to each regulated process and results of measurements of pollutant concentrations and/or mass.

- Statement of certification concerning compliance and noncompliance with pretreatment standards.

- If not in compliance, a compliance schedule must be submitted with the baseline monitoring report that describes the actions the user will take and a timetable for completing those actions to achieve compliance with the standard. The compliance schedule must contain specific increments of progress in the form of dates for the commencement and completion of major events, however, no increment of the schedule shall exceed nine months.

o Report on Progress in Meeting Compliance Schedules [403.12(c)].

Categorical industrial users who are required to submit compliance schedules in conjunction with their baseline monitoring reports must report their progress to the Control Authority within 14 days of each date in their schedule.

o Report on Compliance with Categorical Pretreatment Standards [403.12(d)].

Within 90 days following the date for final compliance with the applicable categorical standard, the industrial user must submit to Baltimore County a report indicating the nature and concentration of all limited pollutants in the regulated discharges and the average and maximum daily flow for these discharges. The report also must indicate whether the pretreatment standards are being met consistently. This report was due to Baltimore County by July 25, 1984.

o Periodic Report on Continued Compliance [403.12(e)].

Categorical industrial users are required to report on their regulated waste discharges to the Control Authority at least semiannually. The regulations [Section 403.12(e)(1)] state that the reports are to contain information "indicating the nature and concentration of pollutants in the effluent which are limited by such categorical pretreatment standards." This report is due to Baltimore County by July 1 and December 31 of each year.

- o Notice of Slug Loading [403.12(f)].

  All industrial users must notify the Control Authority immediately of any slug loading. Slug loading is defined as any pollutant [including Biochemical Oxygen Demand (BOD)] released in a discharge at a flow rate or concentration which will cause interference with the operation of the treatment works.

3.6 DISCHARGE PERMIT REQUIREMENTS

Baltimore County issues Wastewater Discharge Permits as a form of control mechanism. The permit serves several functions including:

- o Formal notification of the dischargers' obligations
- o Clear delineation of specific pretreatment standards and requirements
- o Consequences for noncompliance
- o Citation to the basis of legal authority.

On August 1, 1986, Baltimore County issued Wastewater Discharge Permit No. 1325 to Cirtek Incorporated (See Appendix B). The permit contains the applicable electroplating categorical standards as well as local limits for selected conventional and nonconventional pollutants. The permit also establishes a self-monitoring schedule for Cirtek that requires biannual sampling for 4 consecutive, 24-hour periods. Eleven parameters are required to be sampled for and the results must be reported by July 1 and December 31 of each year.

3.7 ASSESSMENT OF CIRTEK'S COMPLIANCE STATUS

3.7.1 Overview

In an effort to assist Control Authorities, like Baltimore County, with an evaluation of an industrial user's compliance with applicable pretreatment standards and guidance, EPA established a recommended definition of significant noncompliance (SNC) (16). The definition is intended to identify violations or patterns of violations that warrant priority attention for enforcement action. In June 1988, EPA made available a tool, Pretreatment Compliance Monitoring and Enforcement (PCME) Software, to assist Control Authorities in determining and tracking the compliance status of industrial users (17). The PCME software is a user-friendly, IBM compatible, menu-driven system that allows data entry and tracking of SNC. EPA's definition of SNC and the software has been used to assess Cirtek's compliance status from 1985 through 1988. This time period was chosen because of the availability of monitoring data on Cirtek's discharge. Cirtek's compliance has also been evaluated based upon a review of correspondence between Cirtek and the regulating authorities during the same time period.

3.7.2 SNC Definition

EPA's definition of SNC is patterned after similar criteria used in the National Pollutant Discharge Elimination System (NPDES) Program at 40 CFR 123.45 (18). The definition, which is applied to monitoring data at six month intervals, was finalized in a 1990 rulemaking and consists of five criteria (12):

1. Violations of wastewater discharge limits.

    a. Chronic violations. Sixty-six percent or more of the measurements exceed the same daily maximum limit or the same average limit in a six month period (any magnitude of exceedance).

    b. Technical Review Criteria (TRC) violations. Thirty-three percent or more of the measurements exceed the same daily maximum limit or the same average limit by more than the TRC in a six month period.

    There are two groups of TRCs:

Group I for conventional pollutants (BOD, TSS, and fats, oil and grease)	TRC = 1.4
Group II for all other pollutants	TRC = 1.2

c. Any other violation(s) of an effluent limit (average or daily maximum) that the Control Authority believes has caused, alone or in combination with other discharges, interference (e.g., slug loads) or pass through; or endangered the health of the sewage treatment personnel or the public.

d. Any discharge of a pollutant that has caused imminent endangerment to human health/welfare or to the environment and has resulted in the POTW's (Baltimore County in this case) exercise of its emergency authority to halt or prevent such a discharge.

2. Violations of compliance schedule milestones, contained in an industrial user permit or enforcement order, for starting construction, completing construction, and attaining final compliance by 90 days or more after the schedule date.

3. Failure to provide reports for compliance schedules, self-monitoring data, or categorical standards (baseline monitoring reports, 90-day compliance reports, or periodic reports) within 30 days from the due date.

4. Failure to accurately report noncompliance.

5. Any other violation or group of violations that the Control Authority considered to be significant.

3.7.3 Evaluation of Monitoring Results

During the period from July 1985 through September 1988, a total of 101 days of effluent monitoring was conducted by Cirtek or by Baltimore County. Samples usually were 24-hour, time composite samples for the following parameters:

pH	Chromium
BOD	Copper
COD	Lead
TSS	Nickel
Phosphate	Zinc
Cadmium	Silver

Appendix C presents the monitoring results during the time period from mid 1985 through 1988 collected by Baltimore County and Cirtek. The data are organized and presented using EPA's PCME software. This data summary provides the limits as well as the actual sample results for each monitoring event. A distinction is provided between monitoring results obtained by Baltimore County (indicated as "scheduled") and monitoring conducted by Cirtek itself (indicated as "self" for self-monitoring). The PCME system presents the raw data, calculates a 4-day average, where appropriate, and identifies all the individual violations with an asterisk. The limits entered into the PCME software are those contained in Cirtek's discharge permit. As indicated in Section 3.4.1, these discharge limits are a combination of electroplating categorical pretreatment standards and local limits.

3.7.4 Summary of Limit Violations

During the nearly three year period, 104 limit violations were recorded. By far, the most common violations were of the pH, copper, and lead limits. When determining whether a violation or series of violations is significant, the SNC definition takes into account not only the number of violations (chronic violation criteria) but also the magnitude of the violations (technical review violations) within a six-month period. Table 8 summaries the compliance status of Cirtek for the three-year period in which monitoring data was collected. Using the EPA definition of SNC, Cirtek's compliance status is evaluated in six-month intervals. Table 8 represents, in part, a summary of the limit violations as calculated EPA's PCME software and shown in Appendix D.

3.7.5 Other Violations

EPA's definition of SNC also includes criteria for failure to meet compliance schedule milestones, failure to provide reports, failure to accurately report noncompliance and other significant violations. During the three-year period for which monitoring results were available, substantial correspondence, monitoring and inspection reports, and other documentation was available and evaluated.

Appendix D provides a chronological summary of over fifty pieces of correspondence, notices of violations, and any other significant activities affecting Cirtek or necessary for the evaluation of Cirtek's compliance status. All available documentation, including the eight notices of violation issued by Baltimore County were evaluated against EPA's SNC criteria. The results of this analysis are also shown on Table 8.

3.8 COMPLIANCE STATUS SUMMARY

EPA's definition of SNC allows for an objective evaluation of an industrial user's compliance status with applicable pretreatment standards and requirements. For the three and one half years for which data were evaluated, Cirtek was in significant noncompliance the entire time. Insufficient data exists to assess compliance between April 27, 1984 (the compliance deadline for the electroplating standards) and July 1, 1985.

TABLE 8

SUMMARY OF CIRTEK COMPLIANCE STATUS
JANUARY 1985 THROUGH DECEMBER 1988

NATURE OF VIOLATION	1985 7/1-12/31	1986 1/1-6/30	1986 7/1-12/31	1987 1/1-6/30	1987 7/1-12/31	1988 1/1-6/30	1988 7/1-12/31
1. <u>Discharge Limits</u>							
BOD5	C	C	C	C	I	C	I
Cadmium	C	C	C	C	C	C	C
Chromium	C	C	C	C	C	C	C
Copper	C	C	**SNC**	**SNC**	**SNC**	**SNC**	**SNC**
Lead	**SNC**	**SNC**	**SNC**	**SNC**	I	I	**SNC**
Nickel	C	C	C	C	C	C	C
Zinc	C	C	C	C	C	C	C
Total Metals (Cu, Cr, Ni, Zn)	C	C	C	C	C	C	C
pH	C	I	I	I	I	I	I
TTO							
2. <u>Compliance Schedule Milestones</u>	*	*	*	*	*	**SNC**	**SNC**
3. <u>Failure to Provide Reports</u>	*	*	*	**SNC**	**SNC**	*	**SNC**
4. <u>Failure to Accurately Report Noncompliance</u>	*	*	*	*	*	*	*
5. <u>Other Significant Violations</u>	*	*	*	*	*	*	*

KEY: C - Constant Compliance; **SNC** - Significant Noncompliance
I - Infrequent Noncompliance; * - Insufficient documentation for evaluation of status

4. PRETREATMENT ALTERNATIVES

The General Pretreatment Regulations [Section 403.3(q)] broadly define pretreatment as:

> "the reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in wastewater prior to or in lieu of discharging or otherwise introducing such pollutants into a POTW. The reduction or alteration may be obtained by physical, chemical or biological processes, process changes or by other means ..." (12)

Cirtek's options for achieving compliance with the electroplating categorical standards fall into three broad categories:

- o Process modifications/in-plant controls
- o Metal treatment and recovery processes
- o Offsite treatment and disposal.

The distinctions between these general groups as well as specific applications of these measures and technologies comprising these groups are described in this section. First, however, a brief overview is given of the technology basis the categorical pretreatment standards (electroplating point source category) that Cirtek is obligated to meet.

4.1 TECHNOLOGY BASIS OF THE ELECTROPLATING STANDARDS

The effluent guideline limitations contained in the electroplating pretreatment standards (40 CFR Part 413) represent pollutant reductions that may be achieved through application of the "best available treatment economically available" (BAT) (13). During development of these national "technology based" effluent limitations, EPA evaluated the full range of control and treatment technologies within the electroplating category including factors such as cost in relation to the pollutant reduction benefits, age of existing equipment and facilities, the current processes employed, the engineering aspects of various control techniques, process changes, and nonwater quality impacts. The overall end-of-pipe treatment system upon which the electroplating pretreatment standards are developed involves precipitation followed by clarification and ranges from treatment of all process wastes combined or segregation of process wastes and subsequent individual treatment.

While precipitation and clarification may represent the technology basis for the electroplating standards, a full range of controls, technologies, and other options exist for Cirtek to achieve compliance with the numeric limitations. Cirtek is in no way bound to install the BAT technology, only to comply with limitations, within certain restrictions.

4.2 IN-PLANT CONTROLS

Effective utilization of in-plant controls can not only reduce chemical and water use, but also lower wastewater treatment needs and disposal costs. If not at least driven by savings in raw material costs, institution of in-plant controls, and modifications should be a prerequisite to and the basis for pollution system design. In-plant control techniques that may be used in the metal finishing industry and applicable to Cirtek include:

- Flow reduction
- Process bath conservation
- Process bath segregation
- Process modification
- Good housekeeping.

4.2.1 Flow Reduction

Water use reduction will lower the cost for rinse water and raw materials (i.e., chemical costs) and reduce the size and cost of wastewater treatment. Flow reduction can be achieved through:

- o Drag-out control
- o Efficient rinsing techniques
- o Application of rinsing systems
- o Rinse water control methods.

Drag-Out Control

Drag out is the inadvertent carryover of a plating bath on a workpiece (19). Since one of the purposes of rinsing is to remove process solution from the surface of the workpiece, the first method of control is to reduce the dragout. Dragout can be a function of several factors including the geometry of the workpiece, the kinematic viscosity and surface tension of the process solution, withdrawal and drainage time, and racking techniques.(20) Control of dragout may also be enhanced by additional techniques such as air knives or use of compressed air to help strip process solution from the workpiece(s).

Rinsing Techniques

Rinsing techniques commonly used throughout the metal finishing industry include the single running rinse, countercurrent rinse, series rinse, spray rinse, and still rinse. Different rinse types can result in wide variations in water use. Table 9 shows the theoretical flow arrangements for several different rinse types to maintain a 1,000 to 1 reduction in concentration.

Rinsing Systems

Different rinse techniques may be combined to establish

TABLE 9

THEORETICAL RINSE WATER FLOWS REQUIRED TO MAINTAIN A 1,000 TO 1 CONCENTRATION REDUCTION
after EPA (20)

Type of Rinse	Single	Series	Countercurrent	
Number of Rinses	1	2	2	3
Required Flow (gpm)	10	0.61	0.31	0.1

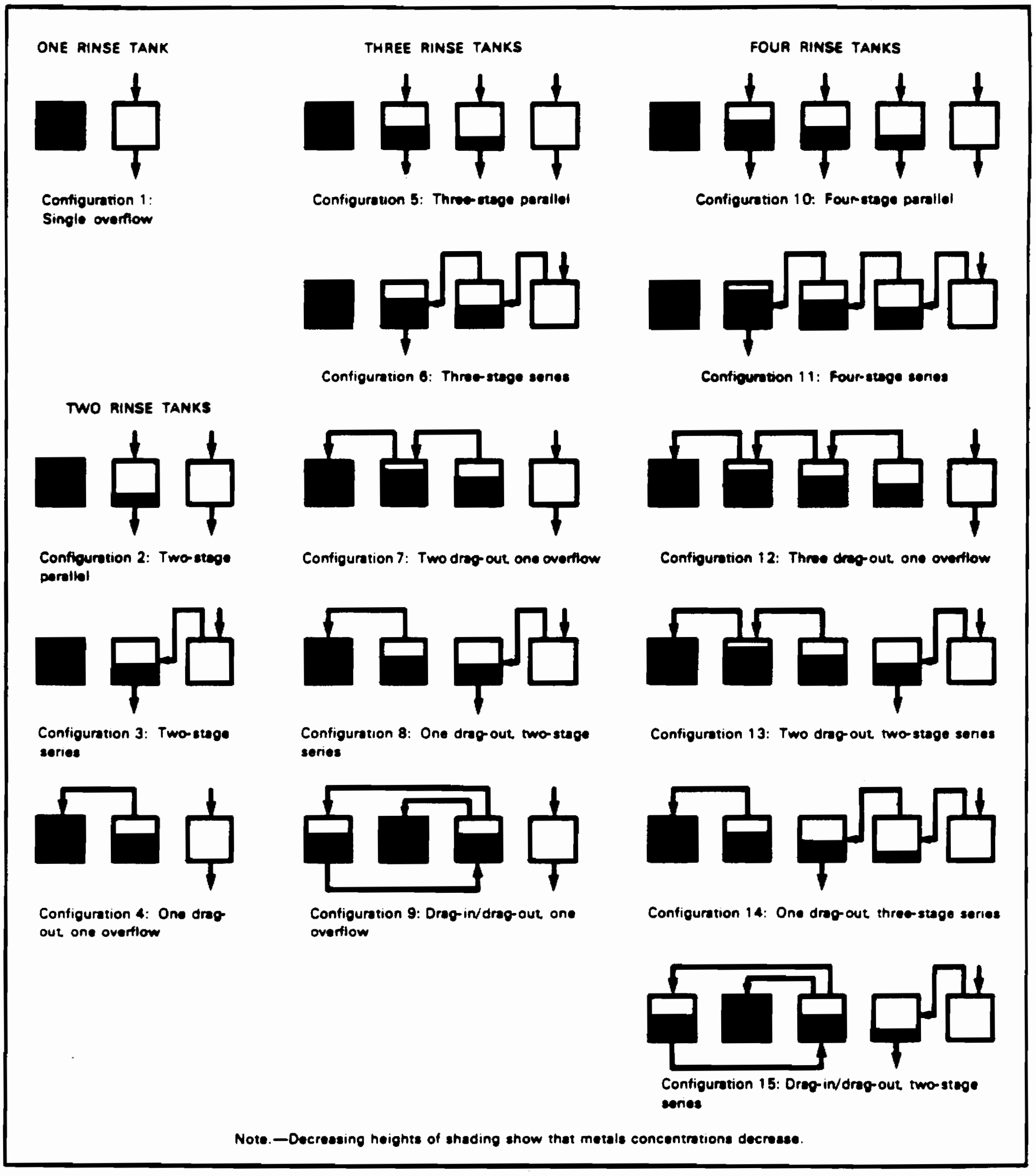


FIGURE 2. RINSING CONFIGURATIONS after EPA (21)

specialized rinsing arrangements. Figure 2 provides examples of the many combinations of rinsing techniques that may be applied.

Rinsewater Control

The flow of feed water entering rinse tanks or rinse systems may be controlled by conductivity controllers, liquid level controllers, flow restrictors, timers, and/or manual operated valves.

4.2.2 Process Bath Conservation

Several techniques are utilized in the metal finishing industry to recover or reuse process solutions. Some examples that may be applicable are reuse of spent etchants, recovery of metal from spent process baths, regeneration of etchants and dragout recovery.

4.2.3 Process Bath Segregation

Similar to the need to segregate raw wastestreams, process baths which are sent to waste treatment should be segregated from one another and appropriately batch treated. Mixing of process solutions may form compounds that are difficult to treat or create larger volumes of water or sludge.

4.2.4 Process Modifications

The plating process itself can be modified to reduce the amount of water required for rinsing or to reduce or eliminate the presence of a particular pollutant. An increasingly number of substitute bath solutions and plating processes are becoming available such as non-cyanide copper plating and etch recovery and recirculating systems (21).

4.2.5 Good Housekeeping

Sound operating practices in the plating area, treatment system area, and throughout the facility can reduce, prevent, or eliminate premature or unnecessary dumps of process solutions, spills, or other accidental releases of process solutions and wastes, and otherwise promote a safe working environment. Examples of good housekeeping practices include:

- o Frequent inspection and maintenance and repair of all tanks, fittings, and other equipment
- o Chemical storage areas isolated from floor drains and high hazard fire areas
- o Periodic review of the plumbing system for cross connections and adequate backflow prevention.

4.3 AVAILABLE TREATMENT TECHNOLOGIES

A wide array of treatment techniques are used or available to remove or recover wastewater pollutants normally generated by electroplating facilities, depending on the nature of waste intended for treatment. Table 10 lists the available technologies and their potential application to electroplating/metal finishing wastes (20). Table 11 indicates more specifically, the potential applicability of these treatment technologies to the raw wastes generated by Cirtek.

4.4 OFF-SITE DISPOSAL AND TREATMENT

An emerging option for electroplaters and other industrial facilities is to transport wastes off-site to a "centralized waste treatment" facility. EPA has sponsored case studies to demonstrate the feasibility and projected savings based on the existence of a centralized treatment facility (23). Of course, the savings available to any electroplater will depend on the volume of wastewater generated and the distance it must be shipped to the centralized facility.

TABLE 10
APPLICATION OF TREATMENT TECHNOLOGIES TO ELECTROPLATING AND METAL FINISHING WASTES
after EPA (20)

Technology	Application
Aerobic Decomposition	Oil breakdown and organics removal
Carbon Adsorption	Removal of trace metals and organics
Centrifugation	Sludge dewatering, oil removal
Chemical Reduction	Treatment of chromic acid and chromates
Chemical Reduction-Precipitation/Sedimentation	Removal of complexed metals
Coalescing	Oil removal
Diatomaceous Earth Filtration	Metal hydroxides and suspended solids removal
Electrochemical Oxidation	Destruction of free cyanide and cyanates
Electrochemical Reduction	Reduction of chromium from metal finishing and cooling tower blowdown
Electrochemical Regeneration	Conversion of trivalent chromium to hexavalent valence
Electrolytic Recovery	Recovery of precious and common metals
Emulsion Breaking	Breakdown of emulsified oil mixtures
Evaporation	Concentration and recovery of process chemicals
Ferrous Sulfate ($FeSO_4$)-Precipitation/Sedimentation	Removal of complexed metals and cyanides
Flotation	Suspended solids and oil removal
Granular Bed Filtration	Solids polishing of settling tank effluent

TABLE 10
APPLICATION OF TREATMENT TECHNOLOGIES TO ELECTROPLATING AND METAL FINISHING WASTES (Continued)
after EPA (20)

Technology	Application
High pH Precipitation/ Sedimentation	Removal of complexed metals
Hydroxide Precipitation	Dissolved metals removal
Insoluble Starch Xanthate	Dissolved metals removal
Integrated Adsorption	Emulsified oils and paints removal
Ion Exchange	Recovery or removal of dissolved metals
Membrane Filtration	Dissolved metals and suspended solids removal
Oxidation by Chlorine	Destruction of cyanides and cyanates
Oxidation by Hydrogen Peroxide	Cyanide destruction and metals removal
Oxidation by Ozone	Destruction of cyanides and cyanates
Oxidation by Ozone with UV Radiation	Destruction of cyanides and cyanates
Peat Adsorption	Dissolved metals removal
Pressure Filtration	Sludge dewatering or suspended solids removal
Resin Adsorption	Removal of organics
Reverse Osmosis	Removal of dissolved salts for water reuse
Sedimentation	Suspended solids and metals removal
Skimming	Free oil removal
Sludge Bed Drying	Sludge dewatering

TABLE 10

APPLICATION OF TREATMENT TECHNOLOGIES TO ELECTROPLATING AND METAL FINISHING WASTES (Continued)
after EPA (20)

Technology	Application
Sulfide Precipitation	Dissolved metals removal
Ultrafiltration	Oil and suspended solids removal and paint purification
Vacuum Filtration	Sludge dewatering

Source: Development Document for Effluent Limitations Guidelines and Standards for the Metal Finishing Point Source Category, U.S. EPA, June 1983, EPA 440/1-83/091.

TABLE 11
GENERAL APPLICABILITY OF TREATMENT TECHNOLOGIES TO CIRTEK RAW WASTE TYPES
after EPA (1,20)

Technology	Common Metals	Complexed Metals	Toxic Organics	Sludge
Aerobic Decomposition			X	
Carbon Adsorption	X	X	X	
Centrifugation				X
Chemical Reduction				
Coalescing				
Diatomaceous Earth Filtration	X	X	X	
Electrochemical Oxidation				
Electrochemical Reduction				
Electrochemical Regeneration				
Electrodialysis				
Electrolytic Recovery	X			
Emulsion Breaking				
Evaporation	X	X		
Flotation	X	X		
Granular Bed Filtration	X	X		
Gravity Sludge Thickening				X
High pH Precipitation		X		
Hydroxide Precipitation	X	X		
Insoluble Starch Xanthate	X	X		
Ion Exchange	X	X		
Membrane Filtration	X	X		
Oxidation by Chlorine				
Oxidation by Hydrogen Peroxide				
Oxidation by Ozone				
Oxidation by Ozone with UV Radiation				
Peat Adsorption	X	X		
Pressure Filtration	X	X		
Resin Adsorption			X	
Reverse Osmosis	X	X	X	
Sedimentation	X	X		
Skimming				
Sludge Bed Drying				
Sulfide Precipitation	X	X	X	X
Ultrafiltration	X	X		
Vacuum Filtration				X

5. SELECTION OF PRETREATMENT CONTROLS

5.1 VENDER PROPOSALS

Cirtek elicited proposals from seven different vendors over nearly a two year period. Table 12 provides a summary of the vendors and brief descriptions of the technologies offered. Five of the seven proposals rely on "conventional" treatment of metal finishing wastes using metals precipitation. Four of the five rely on clarification; one enhanced with dual media filtration; the fifth uses membrane filtration. The two remaining proposals rely upon metal recovery technologies (ion exchange and electrolytic recover). The most significant difference between the metals treatment and recovery technologies, besides a noticeable difference in capital cost, is in the volume of sludge that would expected to be generated.

5.2 SELECTED TECHNOLOGY

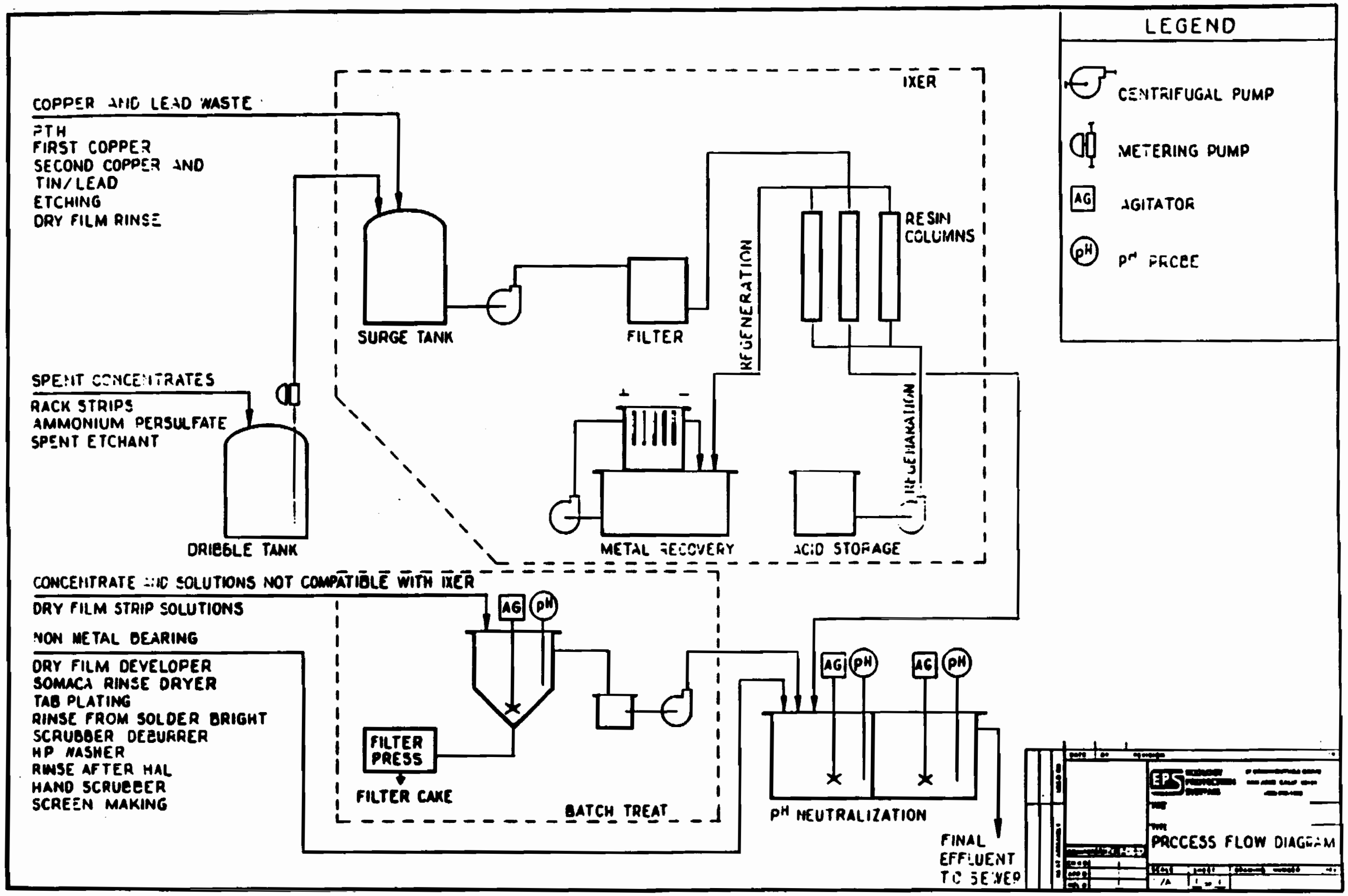
5.2.1 <u>Overview</u>

Cirtek chose to purchase and install Environmental Protection System's IXER (Ion Exchange Electrolytic Recovery) System (22). The IXER system relies upon ion exchange and electrolytic recovery to remove copper, lead, and tin from the wastewater discharge. Figure 3 shows the process flow diagram for the IXER System and Figure 4 shows the actual layout of the equipment as installed. Selected design criteria are summarized in Table 13.

The IXER System is designed to remove copper, tin, and lead from Cirtek's wastestream and recover the metals as a metallic plate. The pH of the final effluent is adjusted prior to discharge to the sewer. Spent concentrates that are not compatible with the IXER and, therefore, cannot be slowly metered in, are batch treated. Precipitates are allowed to settle and dewatered in a filter press.

TABLE 12
SUMMARY OF VENDOR PROPOSALS

VENDOR/MANUFACTURER	PROPOSAL	PROP DATE	TREATMENT TRAIN OVERVIEW	FLOW (gpm)	COST ($)
Camac Industries 18 Commerce Road Fairfield NJ 07006 J Gesumaria (201) 575-1831	C-11185	3-14-86	•metals precipitation •inclined plate clarifier •bag filters	30	59,460
DMP Corporation 4049 Point Clear Drive Fort Mill, SC 29715 Peter DeSee (201) 567-9339	4109	10-20-87	•metals precipitation •Lamella clarifier •sludge filter press	30	99,600
Durco, The Durion Company 9542 Hardpan Road Angola, NY 14006 K.Schmitz (716) 549-2500	6487	9-25-87	•metals precipitation •Lamella clarifier •batch treatment •sludge filter press	65	107,920
Memtek Corporation 520 Stokes Road Medford, NJ 08055 Eugene Tinus(609) 953-1788	ER-87-101-01-L	11-2-87	•metals precipitation •membrane filtration •sludge filter press	30	137,985
NCA Systems Inc. 7207 114th Ave North Largo, FL 33543 Bobby Capel (813) 541-1550	20/1837/A	12-23-87	•ion exchange •electrolytic recovery •batch tretment •sludge filter press	40	167,742
Treatment Technologies Inc RD 4 Poplar Road Honey Brook, PA 19344 D Zimmerman (215) 273-2977	Q88-1002	1-5-87	•metals precipitation •slant tube clarifier •mixed media filtration •sludge filter press	54	112,712
Env. Protection Systems 27 Bonaventure Drive San Jose, CA 95134 David Woods(403) 432-1595	88-2434	1-24-88	•ion exchange •electrolytic recovery •batch treatment •sludge filter press	45	150,266



<u>NOTE:</u> The carbon columns, neutralization system, ~~dribble~~ one tank and sampler are not shown on the flow diagram.

FIGURE 3. PROCESS FLOW DIAGRAM FOR IXER TREATMENT SYSTEM after Environmental Protection Systems (22)

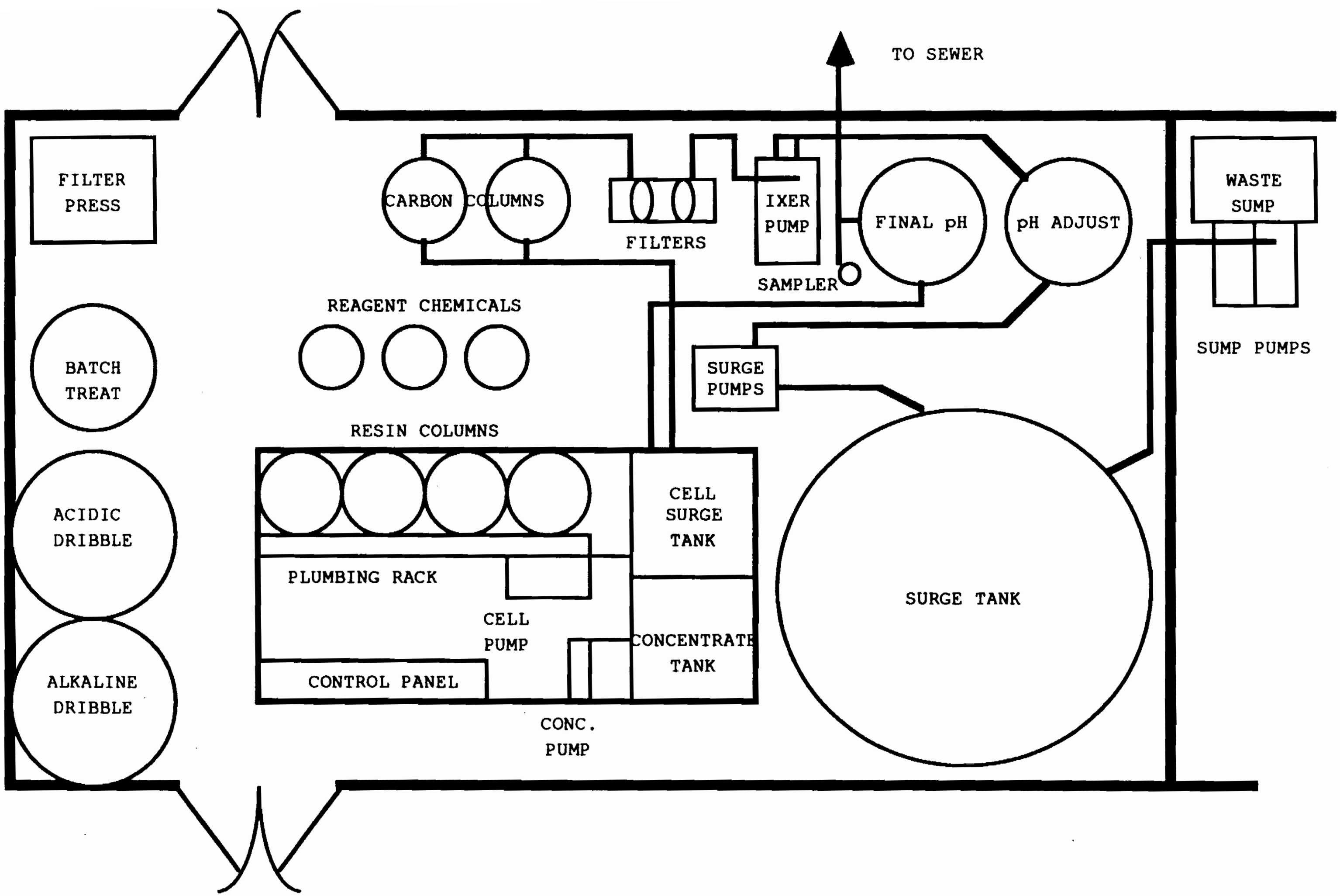


Figure 4. Cirtek Treatment System Layout

TABLE 13

DESIGN CRITERIA FOR THE EPS IXER SYSTEM

Design Flow Rate	45 gallons per minute
Heavy Metals Removed	copper, tin, lead
Metal Loading Capacity	19 lbs/day
Operating Time	24 hours/day
Surge Tank Volume	8,000 gallons
Carbon Column Volume (2)	unknown
Filter Type (2)	10 inch paper discs
Resin Column Volume (4)	10 cubic feet/column
Resin Form	hydrogen
Electrolytic Recovery Cell	
Tank Volume	100 gallons
Anodes	19 plutinized titanium
Cathodes	20 stainless steel
Batch Treatment System Volume	200 gallons
Filter Press	one half cubic foot

5.2.2 Major System Components

The system components of the EPS IXER system are discussed below.

Sump

Process wastewaters are collected in an existing (2'6" x 2'6" x 3') sump. Level sensors and pumps lift wastewaters to the treatment area. An open "T" connection remains in the sump that allows process wastes to overflow to the sewer in the event that the pumps fail to deliver the process wastes or if flows exceed the capacity of the treatment system.

Flow Equalization Tank

The 8,000 gallon surge tank collects incoming process wastewater and backwash from the ion exchange columns. The purposes of the surge tank are to collect and hold the wastewater, provide equalization, and allow for reserve capacity in the event of system breakdown or scheduled maintenance. Process wastes entering the surge tank are those containing copper and lead, including plating rinses, etching rinses and dry film rinse.

pH Adjustment

The pH of the incoming waste is adjusted to within 4.0 and 6.0 to ensure that the metals remain in dissolved form.

Dribble Tanks

Two tanks (800 and 500 gallons) collect spent alkaline and acidic concentrates (rack strips, ammonium persulfate, and spent etchants) which are slowly introduced into the surge tank. Only those concentrates amenable to ion exchange and electrolytic recovery are allowed into the IXER System.

Filters

Two paper disc filter units remove insoluble debris and other particulate matter from the wastestream before it passes through the carbon and resin columns.

Carbon Columns

Two 42" x 72" carbon columns were installed at the request of Cirtek. These normally optional items are intended to remove organic compounds that may foul the ion exchange resins. The equipment supplier did not require the carbon columns as part of the system design, and in fact, recommended that they not be included.

Resin Columns-Ion Exchange

Four resin columns are operated as pairs in series. When the primary columns are saturated to the extent that they no longer achieve the desired degree of metal removal, this pair of columns is regenerated with acid. The wastewater flow is redirected to the other pair of columns to maintain continuous treatment. When the primary columns are regenerated, they are returned to service as the secondary pair during the next cycle. During regeneration, the strong acid removes the metals from the resins as dissolved ions. The acid regeneration wash is collected in the electrolytic cell surge tank (100 gallons).

Electrolytic Recovery Cell

The regenerant is reactivated in the plate out cell where the dissolved metal is electrolytically deposited on reusable stainless steel cathodes. When the metal reaches a thickness of about 1/8" or more, it is stripped off as plates or sheets for reclamation or disposal.

Batch Treatment

Some printed circuit board wastes are not compatible with the ion exchange process, in particular, the dry film strip solutions. A 200 gallon reaction tank is equipped for chemical addition (acid or caustic) for precipitation and clarification.

Filter Press

A 1/4 cubic foot filter press is used to dewater the sludge produced from the batch treatment system.

pH Neutralization

Final pH adjustment is provided immediately prior to discharge to the sanitary sewer.

5.3 SIMILAR APPLICATIONS

Several factors are responsible for the improved viability and application of metal recovery technologies to the treatment of metal finishing wastes. Use of ion exchange and electrolytic recovery in the printed circuit board industry is being considered for the same reasons:

- o While ion exchange has been used in various forms for waste recovery for more than 20 years, only in recent years has it become economically viable with the developments in low-cost process control technology (3).
- o Advances in electrochemical engineering occurring over the past two decades have resulted in the development of a spectrum of electrochemical reactor designs that can handle a wide-range of pollution problems (3).
- o The Hazardous and Solid Waste Amendments of 1984 crystallize a philosophy that had been emerging in Congress and at EPA for a period of years; the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible (24).

- The rising costs of metal sludge disposal have created a strong economic incentive for conservation and recovery. It is not uncommon to see costs for disposal of plating waste sludges of $200 to $300 per ton compared to $30 to $50 per ton a few years ago (25).

- Rising costs and availability of raw materials and chemicals offer an economic incentive for recovery of metals from waste. By the year 2000 it has been projected that more than 63 percent of copper, 67 percent of cadmium, 78 percent of nickel and all chromium will need to be imported into the United States (26).

A review of the literature finds several case study presentations on the successful application of ion exchange and electrolytic recovery to printed circuit board manufacturing operations.

- Electronic Precision Circuitry (EPC) of Providence, Rhode Island, is a small printed circuit job shop that produces about 1000 square feet of primary single and double-sided boards daily (27). Because of concerns with the cost and liability of disposal of metal sludges, conventional metals precipitation was not considered a viable long-term solution. EPC commissioned a three phase engineering approach which consisted of on-site assessment, laboratory analysis and pilot feasibility design and equipment selection. The onsite assessment consisted of:

    - A complete plant survey

    - Identification of all wet processes, chemical makeup, and operating volume of each process tank and dumping frequencies

    - Measurement of flows from all rinsing stations and recommendations of total flow reduction

    - Sampling and analysis of pollutants

    - Examination of facility layout

    - Review of applicable local, State, and Federal pretreatment standards and requirements.

An example of the necessity of this comprehensive evaluation was the detected presence of fluorides in the wastestream which necessitated the use of fluoride-impervious anodes in the ultimate operating system. The technology of choice for EPC was high-mass-transfer electrowinning, which utilized the high surface area, carbon fiber electrode. The system is designed to treat dilute process rinsewater on a continuous batch basis during production hours and the concentrated process dumps on a periodic basis during off production hours. All metal is removed during the electrowinning process and, therefore, generation of metal sludge and the liability associated with hazardous waste are eliminated (27).

- Hewlett Packard (HP) in Boise, Idaho, includes operations which produce multilayer printed circuit boards and disc drives. Treatment of rinsewaters and batch dumps previously consisted of ferrous sulfate precipitation followed by solid/liquids separation. While consistently meeting Federal and local discharge requirements, this approach generated a high volume of hazardous metal hydroxide sludge which was shipped out of State for disposal. Escalating costs and long-term liabilities associated with transportation and disposal of the sludge motivated HP to investigate alternatives. The system installed uses ion exchange and electrowinning for the removal and recovery of copper and nickel. HP reports that the cost of operation is lower than that of the more traditional treatment system previously used (28).

- Tingstol Company of Chicago has been manufacturing printed circuit boards since 1954. In 1986, Tingstol installed a 40 gpm Environmental Protection System IXER unit, to remove copper, tin, and lead in a mixed wastestream. Commenting on the boldness of his decision to abort conventional metals precipitation, company president John Zopp said in 1988, "I thought the real gamble would have been to continue to produce sludge. Sludge disposal was difficult then. Its far more difficult and costly now. We made the right move at the right time" (29).

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The following conclusions are drawn from the results of this case study:

- Significant potential hazards exist within Cirtek's manufacturing facility. Potable water supplies are directly connected to rinse tanks and process baths resulting in cross connections. No containment provisions exist to prevent entry of process chemicals to the sewer in the event of a spill.

- Cirtek failed to install any controls to achieve compliance with the federal Categorical Pretreatment Standards (Electroplating Category) by the April 27, 1984 deadline. Based on data collected by Cirtek and the Control Authority, the company was in significant noncompliance with the Electroplating Standards and the conditions of its permit continuously from 1985 through 1988. Because of the lack of any control technology prior to 1989, there is no reason to believe that the facility was in compliance between April 27, 1984 and 1985.

- After review and consideration of several treatment technologies and suppliers, Cirtek installed an emerging technology that would not only achieve compliance with applicable standards but would also provide significant resource recovery benefits and reduce Cirtek's cost and future liability for hazardous waste disposal.

- Cirtek's lack of consideration of design parameters and in-plant controls contributed to constant hydraulic overloading of the treatment system, resulting in continuous bypassing of untreated effluent. Despite the high quality effluent from the treatment system, when combined with the untreated bypass, the discharge remained in violation of the Electroplating standards.

- The ion exchange/electrolytic recovery technology is considered superior to the model technology (metals precipitation) used as the basis for developing the Electroplating Standards. Despite a higher capital cost, the IXER unit can achieve equal or better effluent quality with significantly less generation of sludge to be disposed of as hazardous waste. With only minor additional equipment, Cirtek could reuse the effluent for cooling water, rinse water or process makeup.

- The overwhelming majority of the records and correspondence evaluated for this study were obtained from Baltimore County and could not be found at Cirtek. Record keeping and correspondence tracking was so poor that Cirtek failed to respond to one notice of violation.

6.2 RECOMMENDATIONS

The following recommendations are offered considering the findings and conclusions of this case study:

- Immediate steps must be taken to correct the potential hazards within the facility. Cross connections should be eliminated by removing water hoses from all rinse and process tanks. Fill pipes should be mounted not less than two inches from the top of each tank to provide for an adequate air gap. Process water supplies should be segregated from the potable supply, and a suitable backflow prevention device installed on the water service to the building.

- Plans should be prepared, and submitted to the County for approval, for the installation of measures to prevent loss of process chemicals to the sewer system in the event of a spill.

- Immediate in-plant controls must be implemented to reduce the current wastewater flow from the over 90 gpm to within the 45 gpm design flow rate of the treatment unit. In-plant controls may include flow restriction devices, timers and alternative rinse systems. Analysis of individual process streams may reveal that some do not require treatment. Once flow volumes are reduced, the open T connection that allows the bypass must be eliminated.

- Immediately upon reducing the hydraulic load to the treatment system, Cirtek should conduct comprehensive monitoring over an extended period to demonstrate consistent compliance with all pretreatment standards.

- Cirtek should institute a well documented monitoring, maintenance and record keeping system.

- Cirtek should initiate collection of data to evaluate the performance of the IXER system against the manufacturer specifications and claims.

6.3 POSTSCRIPT

Sometime during Memorial Day weekend in 1989, a fire of unknown origin completely destroyed the Cirtek facility (30). Ultimately, Cirtek's quest to achieve environmental compliance ends in irony and as a small environmental disaster. Over the course of nearly six years, with capital expenditures in excess of $150,000 and pending administrative penalties of $400,000 (31), Cirtek came close to its objective. However, the fire not only eliminated the existence of the company, but it resulted in the release of the very pollutants Cirtek was trying to reclaim and prevent from being discharged to the sanitary sewer system.

Initially it was unclear to local officials what may have happened to the thousands of gallons of process wastewater, plating and cleaning baths, chemicals, and hazardous wastes that were stored in the facility. Unfortunately, several characteristics about Cirtek's facility suggest that virtually all these materials went to the sewer. All the plating baths, bulk chemicals and accumulated hazardous waste were stored in various forms of plastic tanks, drums or other containers. These were likely to have melted during the fire. The building was constructed with a poured concrete floor and about an eight inch high threshold around the perimeter of the floor. Any liquid material spilled within the building would flow to one of many floor drains or the sump, which had a gravity overflow to the sewer. This situation was not realized until several weeks after the fire. The effects of these materials, if any, on the municipal wastewater treatment plant were not investigated.

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APPENDIX A

CIRTEK PROCESS SCHEMATICS

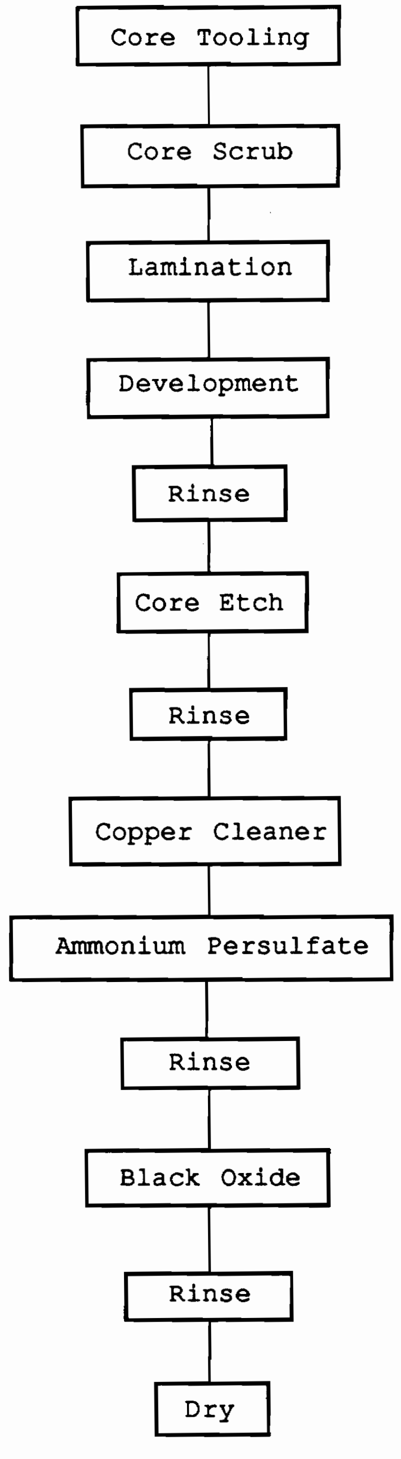

FIGURE A - 1 MULTILAYER BATCH LINE PROCESS FLOW DIAGRAM

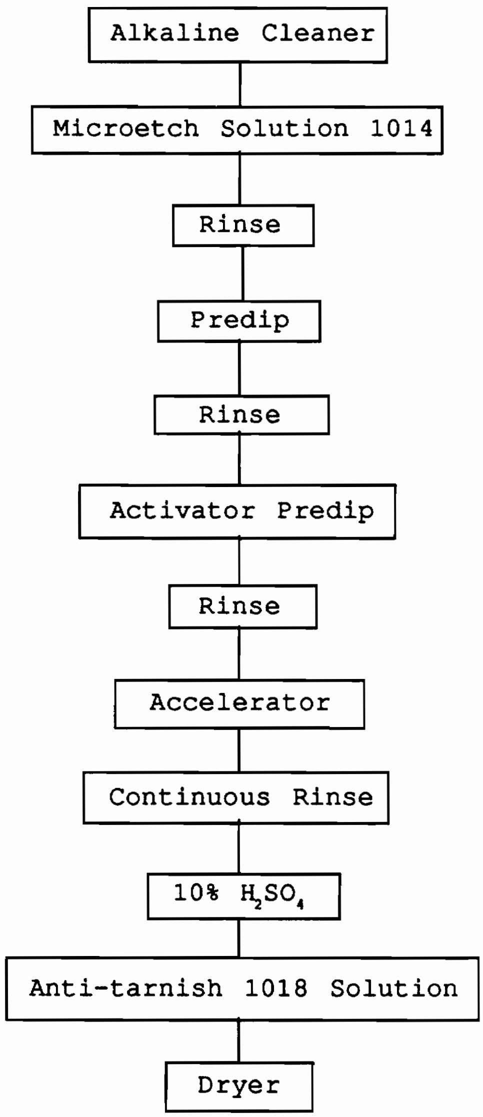

Figure A - 2 PLATING THROUGH HOLE (PTH) LINE ELECTROLYSIS COPPER PROCESS FLOW DIAGRAM

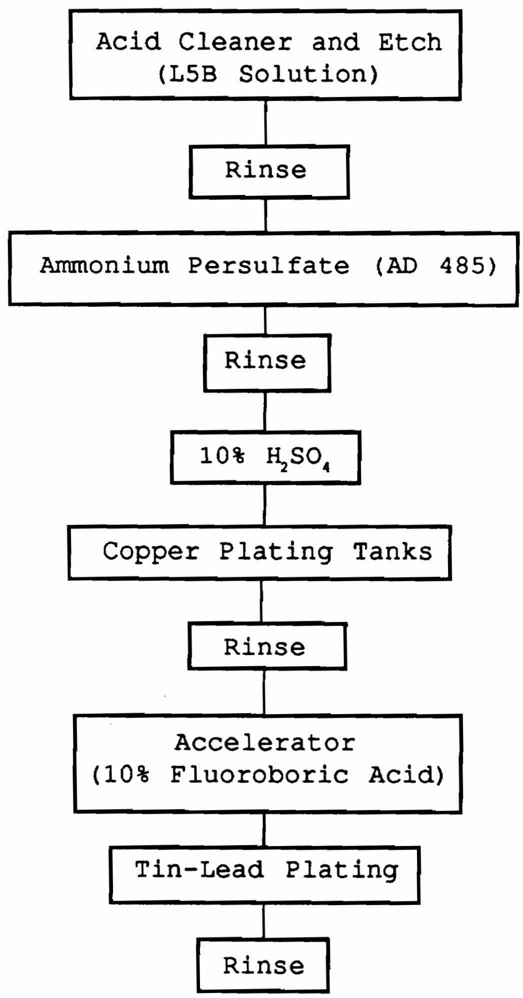

FIGURE A - 3 ELECTROLYTIC COPPER PLATING PROCESS FLOW DIAGRAM

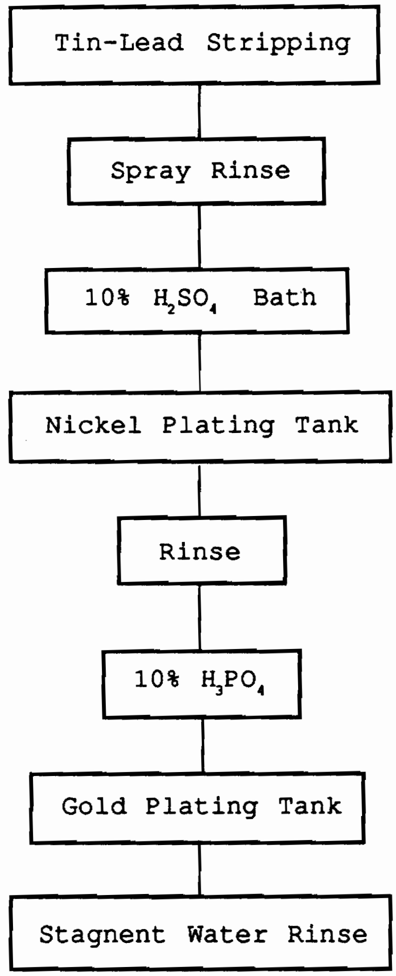

FIGURE A - 4 GOLD TAB PLATING LINE PROCESS FLOW DIAGRAM

APPENDIX B

CIRTEK'S WASTEWATER DISCHARGE PERMIT

BALTIMORE COUNTY, MARYLAND

DEPARTMENT OF PERMITS AND LICENSES

TOWSON, MARYLAND 21204

LICENSING YEAR: AUGUST 1986 THROUGH JULY 1987

PERMIT Nº 1325 **FACILITY NO.** 03361

WASTEWATER DISCHARGE PERMIT

PERMISSION IS HEREBY GRANTED TO: CIRTEK/MD, Inc.

FOR THE CONTRIBUTION OF INDUSTRIAL WASTEWATER INTO THE BALTIMORE COUNTY SEWER LINES AT 25 New Plant Road, P.O. Box 406

Owings Mills, MD 21117

EFFECTIVE THIS 1st DAY OF August, 19 86

APPROVED: ____________________

Director, Permits & Licenses

RECEIVED DEC 11 19[illegible]

BALTIMORE COUNTY
DEPARTMENT OF PERMITS & LICENSES
TOWSON, MARYLAND 21204
494-3610

TED ZALESKI, JR.
DIRECTOR

■ 1 ■

NAM: 1-C3361

CIRTEK/MC. INC
25 NEW PLANT RD, P.O. BOX 406
OWINGS MILLS MD 21117

Enclosed are a Wastewater Discharge Permit and Wastewater Discharge Permit Conditions form for the discharge of wastewater by your establishment.

The Wastewater Discharge Permit shall be posted in a prominent place visible to the public. Wastewater Discharge Permits are to be renewed annually. An annual permit fee shall be payable to the County upon receipt of notice. The permit will become effective on August 1st of each calendar year and will expire on July 31st of the following year.

Unless the discharge conditions for a user change substantially, only the permit to discharge is renewed. Existing discharge conditions shall remain in force until specifically revised or altered by the County.

Failure to fulfill any of the conditions specified may be cause for revocation of the Wastewater Discharge Permit and loss of sewer use benefits.

If you have any questions concerning the Wastewater Discharge Industrial Waste Program, the Wastewater Discharge Permit, or the Wastewater Discharge Permit Conditions form, please contact the Baltimore County Bureau of Utilities, Pollution Control Division at 668 7530, between the hours of 7:30 A.M. and 3:30 P.M.

Sincerely,

Eugene A. Freeman, Chief
Administration and Processing

EAF:kel

Enclosure

Facilty No. 03361

Baltimore County

Department of Permits and Licenses

WASTEWATER DISCHARGE PERMIT CONDITIONS

In accordance with all terms and conditions of the Baltimore County Code, Article III, Division 5, Section 34-79 to 34-111, et seq., and also with any applicable provisions of Federal or state law or regulation; Permission is Hereby Granted to Cirtek/Maryland, Inc.

Classified by SIC No. 3679

for the contribution of Industrial/Commercial wastewater to the Baltimore County sewer lines at 25 New Plant Court

Baltimore, Md. 21117

This supercedes any previous wastewater discharge permit conditions and is effective August 1, 1986

1988

FACILITY NO. 2-03361

ADDENDUM I

Monitoring Schedule

You are hereby required to sample for the following checked parameters:

CADMIUM (Cd)	X	Phenols	
CHROMIUM-TOTAL (Cr)	X	Oil and Grease	X
CHROMIUM-HEXAVALENT (Cr^{+6})		pH	X
COPPER (Cu)	X	Biochemical Oxygen Demand	
CYANIDE (Cn)	X	Chemical Oxygen Demand	
LEAD (Pb)	X	Suspended Solids	X
NICKEL (Ni)	X	Flow (MGD)	
ZINC (Zn)	X	Total Phosphorus	
Total Toxic Organics (TTO)	X		

At The Following Frequency:

[] No Sampling [] Quarterly (four times per year)

[] Annual [] Bi-Monthly

[X] Bi-Annual (twice per year) [] Other (see below)

TYPES OF SAMPLES:

[] Single (1) 24-Hour Composite

[] Three (3) Consecutive 24-Hour Composite (Report as 3 sampling incidents)

[X] Four (4) Consecutive 24-Hour Composite (Report as 4 sampling incidents)

[] Ten (10) Consecutive 24-Hour Composite (Report as 10 sampling incidents)

REPORT DUE: The report must be composed of the analytical results for each sampling day in the period.

July 1 []

July 1 [X]
December 31 [X]

March 31 []
June 30 []
September 30 []
December 31 []

February 1 []
April 1 []
June 1 []
August 1 []
October 1 []
December 1 []

In consideration of the granting of this permit, the permittee has agreed:

1. To furnish any additional information relating to the installation or use of the industrial sewer for which this permit is sought as may be requested by the County.
2. To accept and abide by all provisions of the Baltimore County Sewer Use Ordinance, and of all other pertinent ordinances or regulations that may be adopted in the future.
3. To operate and maintain any waste pretreatment facilities, as may be required as a condition of the acceptance into the wastewater treatment system of the industrial wastes involved, in an efficient manner at all times, and at no expense to the County.
4. To cooperate at all times with the County and its representatives in their inspecting, sampling and study of the industrial wastes, and any facilities provided for pretreatment.
5. To notify the County immediately in the event of any accident, or other occurrence that causes the contribution of any wastewater or substances to the sewer system which are prohibited or not covered by this permit.

IN THE EVENT OF AN ACCIDENTAL SPILL TO THE SANITARY SEWER SYSTEM, CONTACT THE POLLUTION CONTROL DIVISION DURING THE HOURS OF 7:30 AM TO 3:30 PM AT (301) 668-7530. IF THE SPILL OCCURS DURING THE HOURS OF 3:30 PM TO 7:30 AM, CONTACT THE BUREAU OF UTILITIES AT 666-0522.

Additionally, the permittee is advised that:

Sludges generated by pretreatment facilities must be disposed of in accordance with the requirements contained in 42-USC-80901 (U.S. Public Health Code) and COMAR 10.51 (State of Maryland Hazardous Waste Regulations);

The discharge of segregated and treatable wastewaters, containing hazardous or toxic substances, to the sanitary sewer may constitute a violation of COMAR 10.51;

As a clarification of the purpose of the pretreatment program, the disposal or dumping of wastewaters or sludges containing hazardous or toxic substances into the sanitary sewer in quantities that pose a threat to the wastewater treatment plant, conveyance facilities, operations personnel, or the environment is prohibited and punishable by the maximum penalty under the law and immediate loss of sewer use privileges upon conviction.

DOCUMENTATION OF SAMPLE

Location of sample collection ________________________________

Start of sampling period ______________ ______________

End of sampling period ________________________________

Collection method ________________________________

Sample received by Laboratory ________________________________

Type of preservative added to sample ________________________________

Wastewater discharged to public sewer during sampling period ________________________________ Gallons

*Indicate origin of seeding material and date obtained ________________________________

*Sample must be seeded with fresh sewage organisms preparatory to performing Biochemical Oxygen Demand Analysis.

CHARACTERISTICS OF COMPOSITE WASTEWATER SAMPLE

Indicate the characteristics of the representative composite wastewater sample in terms of the following parameters.

Parameter	Value
pH	______________
Phosphorus	______________
Copper	______________
Cyanide	______________
Lead	______________
Nickel	______________

DISCHARGE STANDARDS

Special Conditions to be Applied:

For non-categorical users, Electroplating categorical standards shall apply.

See Addendum I for monitoring requirements

PARAMETERS (mg/l)	Limitations on Waste-water Strength: Maximum Conc. (mg/l) - 24-Hr. Composite Sample (Operational Day)	Limitations on Waste-water Strength: Average Daily Maximum (mg/l) (Four consecutive sampling days)
Arsenic (As)	*	*
Cadmium (Cd)	1.2	0.7
Chromium - total (Cr)	7.0	4.0
Chromium - hexavalent (Cr +)	*	
Copper (Cu)	4.5	2.7
Cyanide (CN)	1.9	1
Lead (Pb)	0.6	0.4
Manganese (Mn)	*	*
Mercury (Hg)	*	*
Nickel (Ni)	4.1	2.6
Phenols	*	*
Silver (Ag)	1.2	0.7
Zinc (Zn)	4.2	2.6
Total Metals	10.5	6.8
Oil & Grease	100 Ω	100
TTO (Total Toxic Organics)	2.13 Ω	N/A
pH Range (pH Units)	6.0 - 10.0 Ω	N/A
Biochemical Oxygen Demand - (Surcharge Level)	>300	
Chemical Oxygen Demand	*	*
Suspended Solids - (Surcharge Level)	>300	
Flow - (MGD)	*	*
Lower Explosive Limit - (%)	10% Ω	N/A
Ω Limit applicable at any time		
*Limits to be set on a case by case basis		
N/A Not applicable		

INDUSTRIAL WASTEWATER SURVEY

Complete and return this form together with a copy of the laboratory results to:

Gary L. Sipes
Pollution Control Section
Bureau of Utilities
9901 York Road
Cockeysville, Maryland #21030

FOR COUNTY USE ONLY
CATEGORY: 1☒ 2☐ 3☐ 4☐ 5☐ 6☐
Facility No: 03361
Tax Account No:

Company Name ______________________

Mailing Address ______________________

____

Facility Address ______________________

Telephone No.: ______________________

Person to contact concerning information provided herein:

____

Name Title

Telephone No.: ( ) ______________________

Standard Industrial Classification (SIC) Number ______________________

Specify either the principal product or the principal raw material and the quantity per day produced or consumed in units of measurement normally used by this industry.

PRODUCT	AMOUNT	UNITS OF MEASUREMENT

Wastewater Quantity

Indicate the quantity of wastewater in gallons per working day discharged to the public sewer and whether this discharge is intermittent or continuous.

Flow in gallons per working day ______________________

Intermittent ______________________ Continuous ______________________

Pretreatment Provided

Indicate if pretreatment is provided prior to discharge to the public sewer system.

Yes ______________________ No ______________________

WASTEWATER MONITORING GUIDELINES

Your company is hereby directed to begin collecting representative samples of the wastewater discharged from your facility to the sanitary sewer system. The following guidelines must be adhered to in conducting this sampling:

1. A representative composite sampling of the total effluent from your plant operations must be accomplished at the frequency indicated in the Monitoring Schedule (Addendum I) of your Wastewater Discharge Permit.

2. The sampling is to be done at least once every hour during a normal work day. This includes all shifts (i.e. day, evening and night), any any clean-up activities. Non-working hours should be excluded. Under no circumstances should a sampling period exceed 24 hours.

   For example: Company A has two (2) shifts. The day shift is from 8:00 A.M. to 4:00 P.M. and the evening shift is from 4:00 P.M. to 11:00 P.M.. Therefore, their sampling period must be from 8:00 A.M. to 11:00 P.M.

3. Samples may be collected manually i.e. hand-grabs taken at specified time intervals and composited, or be use of automatic sampling devices.

4. The volume of the sample obtained should be sufficient to perform all required analyses. The individual portions of a composite should be at least 25 to 100 ml. depending on the frequency of sampling, and the individual sample volume. The total composite sample should be between 2 and 4 liters.

5. Samples should be stored in a manner that insures that the characteristics to be analyzed are not altered. Refrigeration in some instances may be necessary. When the storage of a sample interferes with a particular analysis, it is preferred to take separate samples for such analyses which may require special preservation techniques (See Table I).

6. The sample container and sampling device should be clean and uncontaminated. Before the sample is taken, the container should be rinsed several times with the wastewater.

7. A laboratory analysis of each composite sample must be made for the required parameters indicated in the Monitoring Schedule (Addendum I) of your Wastewater Discharge Permit.

The analysis must be accomplished in accordance with the procedures set forth in the latest edition of "Standard Methods for Examination of Water and Wastewater", published by the American Public Health Association, American Waterworks Association and the Water Pollution Control Federation.

8. The analytical results are to be submitted to:

   Pollution Control Section
   9901 York Road
   Cockeysville, Maryland 21030

   at the frequency indicated in the Monitoring Schedule (Addendum I) of your Wastewater Discharge Permit.

In addition to the characteristics analyzed, the following information must be included:

a. Location of sample collection eg., manhole along Main Street, clean-out downstream of grease-interceptor, etc..

b. Date and time of collection - start time, finish time.

c. Collection method i.e., hand-composited or automatic sampling device.

d. Method of preservation eg., Cool 4°c; H_2SO_4 to $pH < 2$; etc..

e. Date and time sample was submitted to lab for analysis.

f. Origin of BOD seed material
   <u>All samples must be seeded!!</u>

These guidelines are set forth as minimum requirements needed to insure that sampling results are representative of the effluents discharged from your plant. More detailed instructions for sampling are outlined in the "Handbook for Monitoring Industrial Wastewater", published by the U.S. Environmental Protection Agency Technology Transfer.

If you have any questions regarding this format or need further information please contact the Pollution Control Section at 668-7530.

TABLE I

Table I Guidelines for containers, preservatives and maximum holding times for wastewater samples as set forth in the Federal Register 40 CFR Part 136.

Measurement	Container*	Preservation	Maximum Holding Time
Biochemical Oxygen Demand (BOD)	P,G	cool 4°C	48 hours
Chemical Oxygen Demand (COD)	P,G	Cool, 4°C H_2SO_4 to pH $<$ 2	28 days
Cyanide, total	P,G	Cool, 4°C NaOH to pH $>$ 12	14 days
Chromium VI	P,G	Cool, 4°C	48 hours
Metals (except above)	P,G	HNO_3 to pH $<$ 2	6 months
Oil and Grease	G	Cool, 4°C H_2SO_4 to pH $<$ 2	28 days
pH	P,G	Determine on Site	2 hours
Phenols	P,G	Cool, 4°C H_2SO_4 to pH $<$ 2	28 days
Phosphorus, Total	P,G	Cool, 4°C H_2SO_4 to pH $<$ 2	28 days
Residue, non-filterable	P,G	Cool, 4°C	7 days
Temperature	P,G	Determine on Site	Immediately

*Plastic or Glass

APPENDIX C

MONITORING RESULTS

Date: 10/13/88
Page: 1

Industrial User Sample Data
Period 1: 01/01/86 to 06/30/86

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
BOD5	mg/l	300/	SCHEDULED	01/27/86	30
			SELF	03/11/86	262.9
			SELF	03/12/86	27.5
			SELF	03/13/86	6.3
BOD5	mg/l	300/	SCHEDULED	03/24/86	79
			SCHEDULED	03/25/86	24
			SCHEDULED	03/26/86	73
			SCHEDULED	04/14/86	142
Cadmium	mg/l	1.2/1.7	SCHEDULED	01/27/86	0
			SCHEDULED	03/24/86	0.01
			SCHEDULED	03/25/86	0.01
			SCHEDULED	03/26/86	0.01
			Average 4 DAY	01/27/86 03/26/86	0.008
Cadmium	mg/l	1.2/1.7	SCHEDULED	03/27/86	0
			SCHEDULED	04/14/86	0
			SCHEDULED	04/15/86	0
			SCHEDULED	04/16/86	0
Chromium	mg/l	7/4	SCHEDULED	01/27/86	0
			SCHEDULED	03/24/86	0
			SCHEDULED	03/25/86	0
			SCHEDULED	03/26/86	0
Chromium	mg/l	7/4	SCHEDULED	03/27/86	0
			SCHEDULED	04/14/86	0
			SCHEDULED	04/15/86	0
			SCHEDULED	04/16/86	0
Copper	mg/l	4.5/2.7	SCHEDULED	01/27/86	2.42
			SELF	03/11/86	1.25

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/86 to 06/30/86

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Copper	mg/l	4.5/2.7	SELF	03/12/86	0.59
			SELF	03/13/86	1.14
			Average 4 DAY	01/27/86 03/13/86	1.350
Copper	mg/l	4.5/2.7	SCHEDULED	03/24/86	2.7
			SCHEDULED	03/25/86	2.34
			SCHEDULED	03/26/86	2.58
			SCHEDULED	03/27/86	2.95
			Average 4 DAY	03/24/86 03/27/86	2.643
Copper	mg/l	4.5/2.7	SCHEDULED	04/14/86	3.84
			SCHEDULED	04/15/86	1.47
			SCHEDULED	04/16/86	2.67
			SCHEDULED	04/17/86	1.81
			Average 4 DAY	04/14/86 04/17/86	2.448
Lead	mg/l	0.6/0.4	SCHEDULED	01/27/86	0.19
			SELF	03/11/86	0.12
			SELF	03/12/86	0.28
			SELF	03/13/86	0.32
			Average 4 DAY	01/27/86 03/13/86	0.228
Lead	mg/l	0.6/0.4	SCHEDULED	03/24/86	0.3
			SCHEDULED	03/25/86	0.22
			SCHEDULED	03/26/86	0.34
			SCHEDULED	03/27/86	0.58
			Average 4 DAY	03/24/86 03/27/86	0.360
Lead	mg/l	0.6/0.4	*SCHEDULED	04/14/86	1.22
			*SCHEDULED	04/15/86	0.69

*=Samples not in compliance with effluent limits.

Industrial User Sample Data
Period 1: 01/01/86 to 06/30/86

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Lead	mg/l	0.6/0.4	SCHEDULED	04/16/86	0.56
			SCHEDULED	04/17/86	0.5
			Average	04/14/86	
			*4 DAY	04/17/86	0.742
Nickel	mg/l	4.1/2.6	SCHEDULED	01/27/86	0
			SELF	03/11/86	0.04
			SELF	03/12/86	0.01
			SELF	03/13/86	0.01
			Average	01/27/86	
			4 DAY	03/13/86	0.015
Nickel	mg/l	4.1/2.6	SCHEDULED	03/24/86	0
			SCHEDULED	03/25/86	0.11
			SCHEDULED	03/26/86	0.07
			SCHEDULED	03/27/86	0.07
			Average	03/24/86	
			4 DAY	03/27/86	0.063
Nickel	mg/l	4.1/2.6	SCHEDULED	04/14/86	0.06
			SCHEDULED	04/15/86	0
			SCHEDULED	04/16/86	0
			SCHEDULED	04/17/86	0
			Average	04/14/86	
			4 DAY	04/17/86	0.015
Zinc	mg/l	4.2/2.6	SCHEDULED	01/27/86	0.1
			SCHEDULED	03/24/86	0.07
			SCHEDULED	03/25/86	0.05
			SCHEDULED	03/26/86	0.04
			Average	01/27/86	
			4 DAY	03/26/86	0.065
Zinc	mg/l	4.2/2.6	SCHEDULED	03/27/86	0.05
			SCHEDULED	04/14/86	0.06

*=Samples not in compliance with effluent limits.

Industrial User Sample Data
Period 1: 01/01/86 to 06/30/86

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Zinc	mg/l	4.2/2.6	SCHEDULED	04/15/86	0.14
			SCHEDULED	04/16/86	0.19
			Average	03/27/86	
			4 DAY	04/16/86	0.110
pH		10/6	SCHEDULED	01/27/86	6.4
			SELF	03/11/86	6.7
			*SELF	03/12/86	10.1
			SELF	03/13/86	8
pH		10/6	*SCHEDULED	03/24/86	5.5
			SCHEDULED	03/25/86	8.5
			SCHEDULED	03/26/86	8.5
			SCHEDULED	03/27/86	8.4
pH		10/6	SCHEDULED	04/14/86	8.7
			SCHEDULED	04/15/86	7.8
			SCHEDULED	04/16/86	7.4
			SCHEDULED	04/17/86	8.3

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/86 to 12/31/86

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
BOD5	mg/l	300/	SCHEDULED	08/25/86	50
			SCHEDULED	08/26/86	62
			SCHEDULED	08/27/86	44
			SCHEDULED	12/01/86	120
Cadmium	mg/l	1.2/1.7	SCHEDULED	08/25/86	0
			SCHEDULED	08/26/86	0
			SCHEDULED	08/27/86	0
			SCHEDULED	08/28/86	0
Cadmium	mg/l	1.2/1.7	SCHEDULED	12/01/86	0
			SCHEDULED	12/02/86	0.01
			SCHEDULED	12/03/86	0
			SCHEDULED	12/04/86	0.01
			Average 4 DAY	12/01/86 12/04/86	0.005
Chromium	mg/l	7/4	SCHEDULED	08/25/86	0
			SCHEDULED	08/26/86	0
			SCHEDULED	08/27/86	0
			SCHEDULED	08/28/86	0
Chromium	mg/l	7/4	SCHEDULED	12/01/86	0
			SCHEDULED	12/02/86	0
			SCHEDULED	12/03/86	0
			SCHEDULED	12/04/86	0
Copper	mg/l	4.5/2.7	*SCHEDULED	08/25/86	4.8
			SCHEDULED	08/26/86	4.19
			*SCHEDULED	08/27/86	5.7
			*SCHEDULED	08/28/86	8
			Average *4 DAY	08/25/86 08/28/86	5.673

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/86 to 12/31/86

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Copper	mg/l	4.5/2.7	*SCHEDULED	12/01/86	5.8
			SCHEDULED	12/02/86	2.59
			SCHEDULED	12/03/86	4.18
			*SCHEDULED	12/04/86	7.4
			Average *4 DAY	12/01/86 12/04/86	4.993
Lead	mg/l	0.6/0.4	SCHEDULED	08/25/86	0.32
			*SCHEDULED	08/26/86	0.73
			*SCHEDULED	08/27/86	0.83
			SCHEDULED	08/28/86	0.54
			Average *4 DAY	08/25/86 08/28/86	0.605
Lead	mg/l	0.6/0.4	*SCHEDULED	12/01/86	0.99
			SCHEDULED	12/02/86	0.32
			SCHEDULED	12/03/86	0.29
			SCHEDULED	12/04/86	0.24
			Average *4 DAY	12/01/86 12/04/86	0.460
Nickel	mg/l	4.1/2.6	SCHEDULED	08/25/86	0.54
			SCHEDULED	08/26/86	0.19
			SCHEDULED	08/27/86	0.17
			SCHEDULED	08/28/86	0.16
			Average 4 DAY	08/25/86 08/28/86	0.265
Nickel	mg/l	4.1/2.6	SCHEDULED	12/01/86	0.08
			SCHEDULED	12/02/86	0.08
			SCHEDULED	12/03/86	0.12
			SCHEDULED	12/04/86	0.08
			Average 4 DAY	12/01/86 12/04/86	0.090

*=Samples not in compliance with effluent limits.

Industrial User Sample Data
Period 2: 07/01/86 to 12/31/86

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Zinc	mg/l	4.2/2.6	SCHEDULED	08/25/86	0.1
			SCHEDULED	08/26/86	0.08
			SCHEDULED	08/27/86	0.05
			SCHEDULED	08/28/86	0.08
			Average 4 DAY	08/25/86 08/28/86	0.078
Zinc	mg/l	4.2/2.6	SCHEDULED	12/01/86	0.09
			SCHEDULED	12/02/86	0.06
			SCHEDULED	12/03/86	0.04
			SCHEDULED	12/04/86	0.03
			Average 4 DAY	12/01/86 12/04/86	0.055
pH		10/6	SCHEDULED	08/25/86	6
			*SCHEDULED	08/26/86	5.5
			SCHEDULED	08/27/86	6.1
			SCHEDULED	08/28/86	6.4
pH		10/6	*SCHEDULED	12/01/86	3.8
			SCHEDULED	12/02/86	6.9
			SCHEDULED	12/03/86	8.4
			SCHEDULED	12/04/86	9.5

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/87 to 06/30/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
BOD5	mg/l	300/	SCHEDULED	03/23/87	57
			SCHEDULED	03/24/87	8
			SCHEDULED	03/25/87	102
BOD5	mg/l	300/	SELF	04/07/87	0.1
			SELF	04/08/87	0.1
			SELF	04/09/87	0.1
			SCHEDULED	06/08/87	162
Cadmium	mg/l	1.2/1.7	SCHEDULED	03/23/87	0
			SCHEDULED	03/24/87	0
			SCHEDULED	03/25/87	0.03
			SCHEDULED	03/26/87	0.01
			Average 4 DAY	03/23/87 03/26/87	0.010
Cadmium	mg/l	1.2/1.7	SCHEDULED	03/27/87	0
			SELF	04/07/87	0.01
			SELF	04/08/87	0.01
			SELF	04/09/87	0.01
			Average 4 DAY	03/27/87 04/09/87	0.008
Chromium	mg/l	7/4	SCHEDULED	03/23/87	0
			SCHEDULED	03/24/87	0
			SCHEDULED	03/25/87	0
			SCHEDULED	03/26/87	0
Chromium	mg/l	7/4	SCHEDULED	03/27/87	0
			SELF	04/07/87	0.02
			SELF	04/08/87	0.01
			SELF	04/09/87	0.01
			Average 4 DAY	03/27/87 04/09/87	0.010

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/87 to 06/30/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Copper	mg/l	4.5/2.7	*SCHEDULED	03/23/87	18.8
			*SCHEDULED	03/24/87	24.7
			*SCHEDULED	03/25/87	4.8
			*SCHEDULED	03/26/87	5.7
			Average *4 DAY	03/23/87 03/26/87	13.500
Copper	mg/l	4.5/2.7	SCHEDULED	03/27/87	3.3
			SELF	04/07/87	3.62
			SELF	04/08/87	2.21
			SELF	04/09/87	1.87
			Average *4 DAY	03/27/87 04/09/87	2.750
Lead	mg/l	0.6/0.4	*SCHEDULED	03/23/87	1.24
			*SCHEDULED	03/24/87	0.87
			SCHEDULED	03/25/87	0.52
			SCHEDULED	03/26/87	0.45
			Average *4 DAY	03/23/87 03/26/87	0.770
Lead	mg/l	0.6/0.4	SCHEDULED	03/27/87	0.6
			SELF	04/07/87	0.46
			SELF	04/08/87	0.41
			SELF	04/09/87	0.05
			Average 4 DAY	03/27/87 04/09/87	0.380
Nickel	mg/l	4.1/2.6	SCHEDULED	03/23/87	0.13
			SCHEDULED	03/24/87	0.06
			SCHEDULED	03/25/87	0.01
			SCHEDULED	03/26/87	0.05
			Average 4 DAY	03/23/87 03/26/87	0.063

*Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/87 to 06/30/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Nickel	mg/l	4.1/2.6	SCHEDULED	03/27/87	0
			SELF	04/07/87	0.03
			SELF	04/08/87	0.04
			SELF	04/09/87	0.01
			Average 4 DAY	03/27/87 04/09/87	0.020
Zinc	mg/l	4.2/2.6	SCHEDULED	03/23/87	0.08
			SCHEDULED	03/24/87	0.05
			SCHEDULED	03/25/87	0.04
			SCHEDULED	03/26/87	0.05
			Average 4 DAY	03/23/87 03/26/87	0.055
Zinc	mg/l	4.2/2.6	SCHEDULED	03/27/87	0.02
			SELF	04/07/87	0.07
			SELF	04/08/87	0.05
			SELF	04/09/87	0.03
			Average 4 DAY	03/27/87 04/09/87	0.043
pH		10/6	*SCHEDULED	03/23/87	5.9
			*SCHEDULED	03/24/87	3.1
			SCHEDULED	03/25/87	6.8
			SCHEDULED	03/26/87	9.9
pH		10/6	SCHEDULED	03/27/87	6.4
			SELF	04/07/87	6.1
			SELF	04/08/87	8
			SELF	04/09/87	9.7

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/87 to 12/31/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
BOD5	mg/l	300/	SCHEDULED	06/08/87	162
			SCHEDULED	06/09/87	85
			*SCHEDULED	07/06/87	351
			SCHEDULED	07/07/87	146
BOD5	mg/l	300/	SCHEDULED	07/08/87	16
			SCHEDULED	07/27/87	90
			SCHEDULED	07/28/87	240
			SCHEDULED	07/29/87	120
BOD5	mg/l	300/	SCHEDULED	08/31/87	14
			SCHEDULED	09/01/87	50
			SCHEDULED	09/02/87	72
			SELF	09/08/87	0.1
BOD5	mg/l	300/	SELF	09/09/87	0.1
			SELF	09/10/87	0.1
			SELF	09/15/87	0.1
			SELF	09/16/87	0.1
BOD5	mg/l	300/	SELF	09/17/87	0.1
			SCHEDULED	12/07/87	220
			SCHEDULED	12/08/87	18
			SCHEDULED	12/09/87	13
Cadmium	mg/l	1.2/1.7	SCHEDULED	06/08/87	0
			SCHEDULED	06/09/87	0
			SCHEDULED	06/11/87	0
			SCHEDULED	07/06/87	0
Cadmium	mg/l	1.2/1.7	SCHEDULED	07/07/87	0
			SCHEDULED	07/08/87	0
			SCHEDULED	07/09/87	0
			SCHEDULED	07/27/87	0

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/87 to 12/31/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Cadmium	mg/l	1.2/1.7	SCHEDULED	07/28/87	0
			SCHEDULED	07/29/87	0
			SCHEDULED	07/30/87	0
			SCHEDULED	08/31/87	0
Cadmium	mg/l	1.2/1.7	SCHEDULED	09/01/87	0
			SCHEDULED	09/02/87	0
			SCHEDULED	09/03/87	0
			SELF	09/08/87	0.01
			Average	09/01/87	
			4 DAY	09/08/87	0.003
Cadmium	mg/l	1.2/1.7	SELF	09/09/87	0.01
			SELF	09/10/87	0.01
			SELF	09/15/87	0.01
			SELF	09/16/87	0.01
			Average	09/09/87	
			4 DAY	09/16/87	0.010
Cadmium	mg/l	1.2/1.7	SELF	09/17/87	0.01
			SCHEDULED	12/07/87	0.01
			SCHEDULED	12/08/87	0.01
			SCHEDULED	12/09/87	0
			Average	09/17/87	
			4 DAY	12/09/87	0.008
Cadmium	mg/l	1.2/1.7	SCHEDULED	12/10/87	0
			SCHEDULED	12/14/87	0
			SCHEDULED	12/15/87	0
			SCHEDULED	12/16/87	0
Chromium	mg/l	7/4	SCHEDULED	06/08/87	0
			SCHEDULED	06/09/87	0
			SCHEDULED	06/11/87	0
			SCHEDULED	07/06/87	0

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/87 to 12/31/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Chromium	mg/l	7/4	SCHEDULED	07/07/87	0
			SCHEDULED	07/08/87	0
			SCHEDULED	07/09/87	0
			SCHEDULED	07/27/87	0
Chromium	mg/l	7/4	SCHEDULED	07/28/87	0
			SCHEDULED	07/29/87	0
			SCHEDULED	07/30/87	0
			SCHEDULED	08/31/87	0
Chromium	mg/l	7/4	SCHEDULED	09/01/87	0
			SCHEDULED	09/02/87	0
			SCHEDULED	09/03/87	0
			SELF	09/08/87	0.01
			Average 4 DAY	09/01/87 09/08/87	0.003
Chromium	mg/l	7/4	SELF	09/09/87	0.01
			SELF	09/10/87	0.01
			SELF	09/15/87	0.01
			SELF	09/16/87	0.01
			Average 4 DAY	09/09/87 09/16/87	0.010
Chromium	mg/l	7/4	SELF	09/17/87	0.01
			SCHEDULED	12/07/87	0
			SCHEDULED	12/08/87	0
			SCHEDULED	12/09/87	0
			Average 4 DAY	09/17/87 12/09/87	0.003
Chromium	mg/l	7/4	SCHEDULED	12/10/87	0
			SCHEDULED	12/14/87	0
			SCHEDULED	12/15/87	0
			SCHEDULED	12/16/87	0

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/87 to 12/31/87

IU Code: 3361   Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Copper	mg/l	4.5/2.7	*SCHEDULED	06/08/87	10.4
			*SCHEDULED	06/09/87	7.3
			*SCHEDULED	06/11/87	11.15
			SCHEDULED	07/06/87	3.24
			Average	06/08/87	
			*4 DAY	07/06/87	8.023
Copper	mg/l	4.5/2.7	SCHEDULED	07/07/87	3.62
			SCHEDULED	07/08/87	1.7
			SCHEDULED	07/09/87	3.93
			SCHEDULED	07/27/87	2.19
			Average	07/07/87	
			*4 DAY	07/27/87	2.860
Copper	mg/l	4.5/2.7	SCHEDULED	07/28/87	2.22
			SCHEDULED	07/29/87	3.45
			SCHEDULED	07/30/87	3.06
			SCHEDULED	08/31/87	3.84
			Average	07/28/87	
			*4 DAY	08/31/87	3.143
Copper	mg/l	4.5/2.7	*SCHEDULED	09/01/87	6.15
			SCHEDULED	09/02/87	3.63
			SCHEDULED	09/03/87	3.43
			SELF	09/08/87	3.38
			Average	09/01/87	
			*4 DAY	09/08/87	4.148
Copper	mg/l	4.5/2.7	SELF	09/09/87	3.43
			SELF	09/10/87	1.98
			SELF	09/15/87	3.38
			SELF	09/16/87	3.43
			Average	09/09/87	
			*4 DAY	09/16/87	3.055

*=Samples not in compliance with effluent limits.

Industrial User Sample Data
Period 2: 07/01/87 to 12/31/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Copper	mg/l	4.5/2.7	SELF	09/17/87	1.98
			SCHEDULED	12/07/87	4.28
			*SCHEDULED	12/08/87	9.72
			SCHEDULED	12/09/87	3.64
			Average *4 DAY	09/17/87 12/09/87	4.905
Copper	mg/l	4.5/2.7	*SCHEDULED	12/10/87	5.71
			SCHEDULED	12/14/87	2.73
			SCHEDULED	12/15/87	4.12
			SCHEDULED	12/16/87	2.66
			Average *4 DAY	12/10/87 12/16/87	3.805
Lead	mg/l	0.6/0.4	SCHEDULED	06/08/87	0.49
			SCHEDULED	06/09/87	0.1
			SCHEDULED	06/11/87	0.48
			SCHEDULED	07/06/87	0.41
			Average 4 DAY	06/08/87 07/06/87	0.370
Lead	mg/l	0.6/0.4	SCHEDULED	07/07/87	0.36
			SCHEDULED	07/08/87	0.33
			*SCHEDULED	07/09/87	1.02
			SCHEDULED	07/27/87	0
			Average *4 DAY	07/07/87 07/27/87	0.428
Lead	mg/l	0.6/0.4	SCHEDULED	07/28/87	0
			SCHEDULED	07/29/87	0
			*SCHEDULED	07/30/87	0.66
			SCHEDULED	08/31/87	0.42
			Average 4 DAY	07/28/87 08/31/87	0.270

*=Samples not in compliance with effluent limits.

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Industrial User Sample Data
Period 2: 07/01/87 to 12/31/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Lead	mg/l	0.6/0.4	SCHEDULED	09/01/87	0.35
			SCHEDULED	09/02/87	0.24
			SCHEDULED	09/03/87	0.17
			SELF	09/08/87	0.49
			Average	09/01/87	
			4 DAY	09/08/87	0.313
Lead	mg/l	0.6/0.4	SELF	09/09/87	0.59
			SELF	09/10/87	0.27
			SELF	09/15/87	0.49
			SELF	09/16/87	0.59
			Average	09/09/87	
			*4 DAY	09/16/87	0.485
Lead	mg/l	0.6/0.4	SELF	09/17/87	0.27
			SCHEDULED	12/07/87	0.45
			SCHEDULED	12/08/87	0.52
			SCHEDULED	12/09/87	0.39
			Average	09/17/87	
			*4 DAY	12/09/87	0.408
Lead	mg/l	0.6/0.4	SCHEDULED	12/10/87	0.39
			SCHEDULED	12/14/87	0.31
			SCHEDULED	12/15/87	0.38
			SCHEDULED	12/16/87	0.24
			Average	12/10/87	
			4 DAY	12/16/87	0.330
Nickel	mg/l	4.1/2.6	SCHEDULED	06/08/87	0.06
			SCHEDULED	06/09/87	0.08
			SCHEDULED	06/11/87	0
			SCHEDULED	07/06/87	0
			Average	06/08/87	
			4 DAY	07/06/87	0.035

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/87 to 12/31/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Nickel	mg/l	4.1/2.6	SCHEDULED	07/07/87	0
			SCHEDULED	07/08/87	0.09
			SCHEDULED	07/09/87	0.06
			SCHEDULED	07/27/87	0
			Average 4 DAY	07/07/87 07/27/87	0.038
Nickel	mg/l	4.1/2.6	SCHEDULED	07/28/87	0
			SCHEDULED	07/29/87	0
			SCHEDULED	07/30/87	0
			SCHEDULED	08/31/87	0.09
			Average 4 DAY	07/28/87 08/31/87	0.023
Nickel	mg/l	4.1/2.6	SCHEDULED	09/01/87	0
			SCHEDULED	09/02/87	0
			SCHEDULED	09/03/87	0
			SELF	09/08/87	0.01
			Average 4 DAY	09/01/87 09/08/87	0.003
Nickel	mg/l	4.1/2.6	SELF	09/09/87	0.03
			SELF	09/10/87	0.03
			SELF	09/15/87	0.01
			SELF	09/16/87	0.03
			Average 4 DAY	09/09/87 09/16/87	0.025
Nickel	mg/l	4.1/2.6	SELF	09/17/87	0.03
			SCHEDULED	12/07/87	0
			SCHEDULED	12/08/87	0
			SCHEDULED	12/09/87	0
			Average 4 DAY	09/17/87 12/09/87	0.008

**Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/87 to 12/31/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Nickel	mg/l	4.1/2.6	SCHEDULED	12/10/87	0
			SCHEDULED	12/14/87	0
			SCHEDULED	12/15/87	0
			SCHEDULED	12/16/87	0
Zinc	mg/l	4.2/2.6	SCHEDULED	06/08/87	0.08
			SCHEDULED	06/09/87	0.07
			SCHEDULED	06/11/87	0.09
			SCHEDULED	07/06/87	0.03
			Average 4 DAY	06/08/87 07/06/87	0.068
Zinc	mg/l	4.2/2.6	SCHEDULED	07/07/87	0.03
			SCHEDULED	07/08/87	0.02
			SCHEDULED	07/09/87	0.04
			SCHEDULED	07/27/87	0.05
			Average 4 DAY	07/07/87 07/27/87	0.035
Zinc	mg/l	4.2/2.6	SCHEDULED	07/28/87	0.06
			SCHEDULED	07/29/87	0.07
			SCHEDULED	07/30/87	0.04
			SCHEDULED	08/31/87	0.11
			Average 4 DAY	07/28/87 08/31/87	0.070
Zinc	mg/l	4.2/2.6	SCHEDULED	09/01/87	0.04
			SCHEDULED	09/02/87	0.05
			SCHEDULED	09/03/87	0.04
			SELF	09/08/87	0.01
			Average 4 DAY	09/01/87 09/08/87	0.035
Zinc	mg/l	4.2/2.6	SELF	09/09/87	0.02
			SELF	09/10/87	0.01

*=Samples not in compliance with effluent limits.

Industrial User Sample Data
Period 2: 07/01/87 to 12/31/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Zinc	mg/l	4.2/2.6	SELF	09/15/87	0.01
			SELF	09/16/87	0.02
			Average 4 DAY	09/09/87 09/16/87	0.015
Zinc	mg/l	4.2/2.6	SELF	09/17/87	0.01
			SCHEDULED	12/07/87	0.05
			SCHEDULED	12/08/87	0.04
			SCHEDULED	12/09/87	0.02
			Average 4 DAY	09/17/87 12/09/87	0.030
Zinc	mg/l	4.2/2.6	SCHEDULED	12/10/87	0.02
			SCHEDULED	12/14/87	0.02
			SCHEDULED	12/15/87	0.02
			SCHEDULED	12/16/87	0.03
			Average 4 DAY	12/10/87 12/16/87	0.023
pH		10/6	SCHEDULED	06/08/87	6.6
			SCHEDULED	06/09/87	8.6
			SCHEDULED	06/11/87	8.5
			SCHEDULED	07/06/87	10
pH		10/6	*SCHEDULED	07/07/87	10.8
			*SCHEDULED	07/08/87	11.1
			*SCHEDULED	07/09/87	2.7
			SCHEDULED	07/27/87	7.5
pH		10/6	SCHEDULED	07/28/87	7.9
			*SCHEDULED	07/29/87	3.4
			*SCHEDULED	07/30/87	3.1
			*SCHEDULED	08/31/87	2.8

*=Samples not in compliance with effluent limits.

Industrial User Sample Data
Period 2: 07/01/87 to 12/31/87

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
pH		10/6	SCHEDULED	09/01/87	9.3
			SCHEDULED	09/02/87	8.4
			SCHEDULED	09/03/87	8.8
			SELF	09/08/87	6.3
pH		10/6	SELF	09/09/87	9.1
			SELF	09/10/87	7.9
			SCHEDULED	12/07/87	7.9
			*SCHEDULED	12/08/87	4
pH		10/6	*SCHEDULED	12/09/87	5
			*SCHEDULED	12/10/87	3.5
			SCHEDULED	12/14/87	6.8
			SCHEDULED	12/15/87	6.2

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/88 to 06/30/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
BOD5	mg/l	300/	SCHEDULED	04/27/88	284
			SCHEDULED	05/01/88	6
			SCHEDULED	05/02/88	14
			SCHEDULED	05/03/88	3
BOD5	mg/l	300/	SCHEDULED	05/23/88	12
			SCHEDULED	05/24/88	79
			SCHEDULED	05/25/88	8
			SCHEDULED	06/06/88	1
BOD5	mg/l	300/	SCHEDULED	06/07/88	4
			SCHEDULED	06/08/88	23
			SCHEDULED	06/13/88	3
			SCHEDULED	06/14/88	2
Cadmium	mg/l	1.2/1.7	SCHEDULED	04/22/88	0.01
			SCHEDULED	04/23/88	0
			SCHEDULED	04/24/88	0.01
			SCHEDULED	04/25/88	0
			Average 4 DAY	04/22/88 04/25/88	0.005
Cadmium	mg/l	1.2/1.7	SCHEDULED	04/27/88	0
			SCHEDULED	04/28/88	0
			SCHEDULED	04/29/88	0
			SCHEDULED	04/30/88	0
Cadmium	mg/l	1.2/1.7	SCHEDULED	05/01/88	0
			SCHEDULED	05/02/88	0.01
			SCHEDULED	05/03/88	0
			SCHEDULED	05/04/88	0
			Average 4 DAY	05/01/88 05/04/88	0.003

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/88 to 06/30/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Cadmium	mg/l	1.2/1.7	SCHEDULED	05/23/88	0.01
			SCHEDULED	05/24/88	0
			SCHEDULED	05/25/88	0
			SCHEDULED	05/26/88	0
			Average 4 DAY	05/23/88 05/26/88	0.003
Cadmium	mg/l	1.2/1.7	SCHEDULED	06/06/88	0
			SCHEDULED	06/07/88	0
			SCHEDULED	06/08/88	0
			SCHEDULED	06/09/88	0
Cadmium	mg/l	1.2/1.7	SCHEDULED	06/13/88	0
			SCHEDULED	06/14/88	0
			SCHEDULED	06/16/88	0
			SCHEDULED	06/20/88	0
Chromium	mg/l	7/4	SCHEDULED	04/22/88	0
			SCHEDULED	04/23/88	0
			SCHEDULED	04/24/88	0
			SCHEDULED	04/25/88	0
Chromium	mg/l	7/4	SCHEDULED	04/27/88	0
			SCHEDULED	04/28/88	0
			SCHEDULED	04/29/88	0
			SCHEDULED	04/30/88	0
Chromium	mg/l	7/4	SCHEDULED	05/01/88	0
			SCHEDULED	05/02/88	0
			SCHEDULED	05/03/88	0
			SCHEDULED	05/04/88	0
Chromium	mg/l	7/4	SCHEDULED	05/23/88	0
			SCHEDULED	05/24/88	0

*-Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/88 to 06/30/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Chromium	mg/l	7/4	SCHEDULED	05/25/88	0
			SCHEDULED	05/26/88	0
Chromium	mg/l	7/4	SCHEDULED	06/06/88	0
			SCHEDULED	06/07/88	0
			SCHEDULED	06/08/88	0
			SCHEDULED	06/09/88	0
Chromium	mg/l	7/4	SCHEDULED	06/13/88	0
			SCHEDULED	06/14/88	0
			SCHEDULED	06/16/88	0
			SCHEDULED	06/20/88	0
Copper	mg/l	4.5/2.7	SCHEDULED	04/22/88	2.06
			SCHEDULED	04/23/88	0.63
			SCHEDULED	04/24/88	2.2
			SCHEDULED	04/25/88	3.86
			Average	04/22/88	
			4 DAY	04/25/88	2.188
Copper	mg/l	4.5/2.7	SCHEDULED	04/27/88	3.12
			*SCHEDULED	04/28/88	23.1
			SCHEDULED	04/29/88	2.76
			*SCHEDULED	04/30/88	10.28
			Average	04/27/88	
			*4 DAY	04/30/88	9.815
Copper	mg/l	4.5/2.7	SCHEDULED	05/01/88	2.48
			SCHEDULED	05/02/88	2.43
			*SCHEDULED	05/03/88	6.28
			SCHEDULED	05/04/88	4.05
			Average	05/01/88	
			*4 DAY	05/04/88	3.810

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/88 to 06/30/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Copper	mg/l	4.5/2.7	*SCHEDULED	05/23/88	6.01
			SCHEDULED	05/24/88	2.21
			SCHEDULED	05/25/88	2.56
			SCHEDULED	05/26/88	1.95
			Average *4 DAY	05/23/88 05/26/88	3.183
Copper	mg/l	4.5/2.7	SCHEDULED	06/06/88	1.81
			SCHEDULED	06/07/88	2
			SCHEDULED	06/08/88	4.11
			SCHEDULED	06/09/88	2.79
			Average 4 DAY	06/06/88 06/09/88	2.678
Copper	mg/l	4.5/2.7	SCHEDULED	06/13/88	4.31
			SCHEDULED	06/14/88	4.48
			*SCHEDULED	06/16/88	4.73
			SCHEDULED	06/20/88	2.93
			Average *4 DAY	06/13/88 06/20/88	4.113
Lead	mg/l	0.6/0.4	SCHEDULED	04/22/88	0.2
			SCHEDULED	04/23/88	0
			SCHEDULED	04/24/88	0.16
			SCHEDULED	04/25/88	0.26
			Average 4 DAY	04/22/88 04/25/88	0.155
Lead	mg/l	0.6/0.4	*SCHEDULED	04/27/88	0.62
			SCHEDULED	04/28/88	0.45
			SCHEDULED	04/29/88	0.11
			SCHEDULED	04/30/88	0.15
			Average 4 DAY	04/27/88 04/30/88	0.333

***=Samples not in compliance with effluent limits.**

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/88 to 06/30/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Lead	mg/l	0.6/0.4	SCHEDULED	05/01/88	0.19
			SCHEDULED	05/02/88	0.22
			SCHEDULED	05/03/88	0.5
			SCHEDULED	05/04/88	0.16
			Average 4 DAY	05/01/88 05/04/88	0.268
Lead	mg/l	0.6/0.4	SCHEDULED	05/23/88	0.37
			SCHEDULED	05/24/88	0.21
			SCHEDULED	05/25/88	0.25
			SCHEDULED	05/26/88	0.25
			Average 4 DAY	05/23/88 05/26/88	0.270
Lead	mg/l	0.6/0.4	SCHEDULED	06/06/88	0.44
			SCHEDULED	06/07/88	0.25
			SCHEDULED	06/08/88	0.42
			SCHEDULED	06/09/88	0.44
			Average 4 DAY	06/06/88 06/09/88	0.388
Lead	mg/l	0.6/0.4	SCHEDULED	06/13/88	0.34
			SCHEDULED	06/14/88	0.37
			*SCHEDULED	06/16/88	0.77
			SCHEDULED	06/20/88	0.37
			Average *4 DAY	06/13/88 06/20/88	0.463
Nickel	mg/l	4.1/2.6	SCHEDULED	04/22/88	0
			SCHEDULED	04/23/88	0
			SCHEDULED	04/24/88	0
			SCHEDULED	04/25/88	0
Nickel	mg/l	4.1/2.6	SCHEDULED	04/27/88	0
			SCHEDULED	04/28/88	0

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/88 to 06/30/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Nickel	mg/l	4.1/2.6	SCHEDULED	04/29/88	0
			SCHEDULED	04/30/88	0
Nickel	mg/l	4.1/2.6	SCHEDULED	05/01/88	0
			SCHEDULED	05/02/88	0
			SCHEDULED	05/03/88	0
			SCHEDULED	05/04/88	0
Nickel	mg/l	4.1/2.6	SCHEDULED	05/23/88	0
			SCHEDULED	05/24/88	0
			SCHEDULED	05/25/88	0
			SCHEDULED	05/26/88	0
Nickel	mg/l	4.1/2.6	SCHEDULED	06/06/88	1.01
			SCHEDULED	06/07/88	0.12
			SCHEDULED	06/08/88	0.2
			SCHEDULED	06/09/88	0.06
			Average 4 DAY	06/06/88 06/09/88	0.348
Nickel	mg/l	4.1/2.6	SCHEDULED	06/13/88	0.06
			SCHEDULED	06/14/88	0
			SCHEDULED	06/16/88	0.14
			SCHEDULED	06/20/88	0.08
			Average 4 DAY	06/13/88 06/20/88	0.070
Zinc	mg/l	4.2/2.6	SCHEDULED	04/22/88	0.04
			SCHEDULED	04/23/88	0.4
			SCHEDULED	04/24/88	0.07
			SCHEDULED	04/25/88	0.04
			Average 4 DAY	04/22/88 04/25/88	0.138

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/88 to 06/30/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Zinc	mg/l	4.2/2.6	SCHEDULED	04/27/88	0.03
			SCHEDULED	04/28/88	0.05
			SCHEDULED	04/29/88	0.02
			SCHEDULED	04/30/88	0.03
			Average 4 DAY	04/27/88 04/30/88	0.033
Zinc	mg/l	4.2/2.6	SCHEDULED	05/01/88	0.02
			SCHEDULED	05/02/88	0.03
			SCHEDULED	05/03/88	0.03
			SCHEDULED	05/04/88	0
			Average 4 DAY	05/01/88 05/04/88	0.020
Zinc	mg/l	4.2/2.6	SCHEDULED	05/23/88	0.04
			SCHEDULED	05/24/88	0.05
			SCHEDULED	05/25/88	0.02
			SCHEDULED	05/26/88	0.04
			Average 4 DAY	05/23/88 05/26/88	0.038
Zinc	mg/l	4.2/2.6	SCHEDULED	06/06/88	0.04
			SCHEDULED	06/07/88	0.03
			SCHEDULED	06/08/88	0.04
			SCHEDULED	06/09/88	0.04
			Average 4 DAY	06/06/88 06/09/88	0.038
Zinc	mg/l	4.2/2.6	SCHEDULED	06/13/88	0.04
			SCHEDULED	06/14/88	0.03
			SCHEDULED	06/16/88	0.03
			SCHEDULED	06/20/88	0.02
			Average 4 DAY	06/13/88 06/20/88	0.030

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 1: 01/01/88 to 06/30/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
pH		10/6	SCHEDULED	04/22/88	6.2
			SCHEDULED	04/23/88	6.8
			SCHEDULED	04/24/88	7.1
			SCHEDULED	04/25/88	6.2
pH		10/6	SCHEDULED	04/27/88	8.7
			*SCHEDULED	04/28/88	3.2
			*SCHEDULED	04/29/88	5.6
			SCHEDULED	04/30/88	8.1
pH		10/6	SCHEDULED	05/01/88	7.8
			SCHEDULED	05/02/88	6.1
			*SCHEDULED	05/03/88	5.4
			SCHEDULED	05/04/88	9.1
pH		10/6	*SCHEDULED	05/23/88	4.3
			SCHEDULED	05/24/88	8.9
			*SCHEDULED	05/25/88	5.6
			SCHEDULED	05/26/88	6.2
pH		10/6	*SCHEDULED	06/06/88	3.6
			SCHEDULED	06/07/88	6.5
			*SCHEDULED	06/08/88	5.6
			SCHEDULED	06/09/88	9.2
pH		10/6	*SCHEDULED	06/13/88	5.8
			*SCHEDULED	06/14/88	5.8
			*SCHEDULED	06/16/88	2.7
			SCHEDULED	06/20/88	6.6

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/88 to 12/31/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
BOD5	mg/l	300/	SCHEDULED	06/21/88	13
			SCHEDULED	06/22/88	7
			SCHEDULED	07/18/88	48
			SCHEDULED	07/19/88	22
BOD5	mg/l	300/	SCHEDULED	07/20/88	285
			*SCHEDULED	07/25/88	810
			*SCHEDULED	07/26/88	396
			SCHEDULED	07/27/88	84
BOD5	mg/l	300/	SCHEDULED	08/22/88	36
			SCHEDULED	08/23/88	24
			SCHEDULED	08/24/88	31
			SCHEDULED	08/29/88	210
Cadmium	mg/l	1.2/1.7	SCHEDULED	06/21/88	0
			SCHEDULED	06/22/88	0
			SCHEDULED	06/23/88	0
			SCHEDULED	07/18/88	0
Cadmium	mg/l	1.2/1.7	SCHEDULED	07/19/88	0
			SCHEDULED	07/20/88	0
			SCHEDULED	07/21/88	0
			SCHEDULED	07/25/88	0
Cadmium	mg/l	1.2/1.7	SCHEDULED	07/26/88	0
			SCHEDULED	07/27/88	0
			SCHEDULED	07/28/88	0
			SCHEDULED	08/22/88	0
Cadmium	mg/l	1.2/1.7	SCHEDULED	08/23/88	0
			SCHEDULED	08/24/88	0
			SCHEDULED	08/25/88	0
			SCHEDULED	08/29/88	0

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/88 to 12/31/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Chromium	mg/l	7/4	SCHEDULED	06/21/88	0
			SCHEDULED	06/22/88	0
			SCHEDULED	06/23/88	0
			SCHEDULED	07/18/88	0
Chromium	mg/l	7/4	SCHEDULED	07/19/88	0
			SCHEDULED	07/20/88	0
			SCHEDULED	07/21/88	0
			SCHEDULED	07/25/88	0
Chromium	mg/l	7/4	SCHEDULED	07/26/88	0
			SCHEDULED	07/27/88	0
			SCHEDULED	07/28/88	0
			SCHEDULED	08/22/88	0
Chromium	mg/l	7/4	SCHEDULED	08/23/88	0.12
			SCHEDULED	08/24/88	0
			SCHEDULED	08/25/88	0.07
			SCHEDULED	08/29/88	0
			Average 4 DAY	08/23/88 08/29/88	0.048
Copper	mg/l	4.5/2.7	SCHEDULED	06/21/88	4.43
			*SCHEDULED	06/22/88	4.62
			SCHEDULED	06/23/88	2.99
			*SCHEDULED	07/18/88	6.08
			Average *4 DAY	06/21/88 07/18/88	4.530
Copper	mg/l	4.5/2.7	*SCHEDULED	07/19/88	5.02
			SCHEDULED	07/20/88	2.42
			SCHEDULED	07/21/88	2.74
			SCHEDULED	07/25/88	3.17
			Average *4 DAY	07/19/88 07/25/88	3.338

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/88 to 12/31/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Copper	mg/l	4.5/2.7	SCHEDULED	07/26/88	3.87
			SCHEDULED	07/27/88	2.59
			*SCHEDULED	07/28/88	10.09
			SCHEDULED	08/22/88	2.01
			Average *4 DAY	07/26/88 08/22/88	4.640
Copper	mg/l	4.5/2.7	*SCHEDULED	08/23/88	8.18
			SCHEDULED	08/24/88	2.12
			SCHEDULED	08/25/88	1.71
			SCHEDULED	08/29/88	2.89
			Average *4 DAY	08/23/88 08/29/88	3.725
Lead	mg/l	0.6/0.4	SCHEDULED	06/21/88	0.4
			SCHEDULED	06/22/88	0.26
			SCHEDULED	06/23/88	0.35
			SCHEDULED	07/18/88	0.31
			Average 4 DAY	06/21/88 07/18/88	0.330
Lead	mg/l	0.6/0.4	SCHEDULED	07/19/88	0.21
			SCHEDULED	07/20/88	0.3
			SCHEDULED	07/21/88	0.29
			*SCHEDULED	07/25/88	1.08
			Average *4 DAY	07/19/88 07/25/88	0.470
Lead	mg/l	0.6/0.4	SCHEDULED	07/26/88	0.5
			SCHEDULED	07/27/88	0.35
			SCHEDULED	07/28/88	0.41
			*SCHEDULED	08/22/88	1.55
			Average *4 DAY	07/26/88 08/22/88	0.703

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/88 to 12/31/88

IU Code: 3361   Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Lead	mg/l	0.6/0.4	*SCHEDULED	08/23/88	1.2
			SCHEDULED	08/24/88	0.38
			*SCHEDULED	08/25/88	0.72
			*SCHEDULED	08/29/88	0.85
			Average *4 DAY	08/23/88 08/29/88	0.788
Nickel	mg/l	4.1/2.6	SCHEDULED	06/21/88	0.08
			SCHEDULED	06/22/88	0
			SCHEDULED	06/23/88	0
			SCHEDULED	07/18/88	0
			Average 4 DAY	06/21/88 07/18/88	0.020
Nickel	mg/l	4.1/2.6	SCHEDULED	07/19/88	0.08
			SCHEDULED	07/20/88	0.05
			SCHEDULED	07/21/88	0.1
			SCHEDULED	07/25/88	0.08
			Average 4 DAY	07/19/88 07/25/88	0.078
Nickel	mg/l	4.1/2.6	SCHEDULED	07/26/88	0
			SCHEDULED	07/27/88	0
			SCHEDULED	07/28/88	0.06
			SCHEDULED	08/22/88	0.08
			Average 4 DAY	07/26/88 08/22/88	0.035
Nickel	mg/l	4.1/2.6	SCHEDULED	08/23/88	0.46
			SCHEDULED	08/24/88	0.05
			SCHEDULED	08/25/88	0.11
			SCHEDULED	08/29/88	0.12
			Average 4 DAY	08/23/88 08/29/88	0.185

*=Samples not in compliance with effluent limits.

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Industrial User Sample Data
Period 2: 07/01/88 to 12/31/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
Zinc	mg/l	4.2/2.6	SCHEDULED	06/21/88	0.01
			SCHEDULED	06/22/88	0.05
			SCHEDULED	06/23/88	0.1
			SCHEDULED	07/18/88	0.04
			Average 4 DAY	06/21/88 07/18/88	0.050
Zinc	mg/l	4.2/2.6	SCHEDULED	07/19/88	0.12
			SCHEDULED	07/20/88	0.04
			SCHEDULED	07/21/88	0.05
			SCHEDULED	07/25/88	0.07
			Average 4 DAY	07/19/88 07/25/88	0.070
Zinc	mg/l	4.2/2.6	SCHEDULED	07/26/88	0.04
			SCHEDULED	07/27/88	0.1
			SCHEDULED	07/28/88	0.07
			SCHEDULED	08/22/88	0.04
			Average 4 DAY	07/26/88 08/22/88	0.063
Zinc	mg/l	4.2/2.6	SCHEDULED	08/23/88	0.06
			SCHEDULED	08/24/88	0.03
			SCHEDULED	08/25/88	0.03
			SCHEDULED	08/29/88	0.23
			Average 4 DAY	08/23/88 08/29/88	0.087
pH		10/6	*SCHEDULED	06/21/88	5.7
			*SCHEDULED	06/22/88	5.4
			SCHEDULED	06/23/88	8.6
			*SCHEDULED	07/18/88	5.2
pH		10/6	SCHEDULED	07/19/88	8.1
			SCHEDULED	07/20/88	9.2

*=Samples not in compliance with effluent limits.

Date: 10/13/88
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Industrial User Sample Data
Period 2: 07/01/88 to 12/31/88

IU Code: 3361 Outfall: FAC

IU Name : Cirtek
Address : 25 New Plant Court
City : Owings Mills
State : MD

Parameters	Units	Limits Max/Avg	Sample Type	Sample Date	Sample Results
pH		10/6	SCHEDULED	07/21/88	6.1
			SCHEDULED	07/25/88	9.4
pH		10/6	SCHEDULED	07/26/88	8.8
			SCHEDULED	07/27/88	6.7
			*SCHEDULED	07/28/88	5.9
			*SCHEDULED	08/22/88	5.6
pH		10/6	SCHEDULED	08/23/88	7.6
			SCHEDULED	08/24/88	8.2
			SCHEDULED	08/25/88	6.6
			SCHEDULED	08/29/88	8

*=Samples not in compliance with effluent limits.

APPENDIX D

CHRONOLOGICAL ACTIVITY RECORD FOR CIRTEK, INC.

MAY 1983 - SEPTEMBER 28, 1988

APPENDIX D

ACTIVITY RECORD

RECORD NUMBER	DATE	TYPE OF ACTIVITY	DESCRIPTION
	9-28-88	Notice of Violation	Baltimore County issues Citation No. 2612 alleged exceedances of copper and lead pretreatment standards
	9-12-88	Letter	Memtek responds to Cirtek's request for an evaluation of the effects of 1,1,1-Trichloroethane on its waste treatment system
	8-30-88	Notice of Violation	Baltimore County issues Citation No. 2582 alleging exceedances of the applicable copper and lead categorical standards. Cirtek is advised that penalties assessed per Citation No. 2219 continue.
	8-30-88	Notice of Violation	Baltimore County issues Citation No. 2581 for failure to submit a required report by July 1, 1988. Failure to respond by October 23, 1988 may result in assessment of penalties.
	8-1-88	Letter	Baltimore County advises Cirtek of its requirements to submit semiannual reports on the nature of its discharge. The current report is due August 31, 1988.
	6-14-88	Letter	Cirtek advises Baltimore County that is is installing treatment to improve the quality of its discharge.

APPENDIX D (Continued)

RECORD NUMBER	DATE	TYPE OF ACTIVITY	DESCRIPTION
	6-3-88	Letter	State of Maryland advises Baltimore County of its support of enforcement actions taken by the County against Cirtek.
	6-2-88	Letter	Baltimore County advises Cirtek of its determination that the company is in significant noncompliance and, therefore, will be reported as such in the local newspaper.
	5-31-88	Inter-Office Memo	Baltimore County Board of Appeals notifies the Bureau of Utilities of Cirtek's appeal of the civil penalty assessment.
	5-11-88	Letter	Baltimore County advises the State of Maryland of the enforcement actions initiated against Cirtek including $114,000 in penalties through April 23, 1988.
	4-29-88	Letter	Baltimore County advises Cirtek of its repeated violations and formally assesses penalties of $1,000/day beginning January 1, 1988. As of April 23, the penalty amounts to $114,000 and will continue to accrue at $1,000/day until the company satisfactorily demonstrates consistent compliance.
	4-26-88	Letter	State of Maryland transmits an inspection report to Baltimore County with specific recommendations for action by the County.
	4-13-88	Letter	State of Maryland provides Baltimore County with 30 days notice to initiate appropriate enforcement action against Cirtek.

APPENDIX D (Continued)

RECORD NUMBER	DATE	TYPE OF ACTIVITY	DESCRIPTION
	3-22-88	Letter	Cirtek advises Baltimore County of interim measures (stagnant rinses) in an attempt to reduce copper loadings in its discharge.
	1-5-88	Letter	Baltimore County advises Cirtek that is in significant noncompliance and will, therefore, be published as such on or about January 14, 1988.
	12-18-87	Letter	State of Maryland advises Baltimore County that is believes Cirtek has taken an inordinant amount of time and has not acted in "good faith" to achieve compliance. The State provides recommendations for the County to consider.
	11-19-87	Letter	Baltimore County advises Cirtek that compliance with Pretreatment Standards is required by December 31, 1987. If consistent compliance is not attained by March 31, 988, penalties of $1,000/day will be assessed beginning from December 31, 1987.
	10-23-87	Inspection	On-site inspection by Baltimore County documenting operations and waste generating processes at Cirtek.
	10-22-87	Letter	Baltimore County advises Cirtek that it is in significant noncompliance and will be included on a published list of significant violators.
	10-5-87	Telephone Call	Cirtek advises Baltimore County that response to Citation is being prepared.
	10-5-87	Letter	Baltimore County transmits an addendum to Cirtek's permit.

APPENDIX D (Continued)

RECORD NUMBER	DATE	TYPE OF ACTIVITY	DESCRIPTION
	10-4-87	Letter	Cirtek responds to Citation No. 2219 and Baltimore County's letter of September 25, 1987. Cirtek describes its efforts to select a supplier for treatment equipment and unresolved issues (spare, financing, type of treatment). Cirtek request an extension of the December 31, 1987 deadline until March 31, 1987. Attachments to letter: Preliminary Engineering Survey (dated March 1986); Waste Treatment Proposals by Durion, Memtek, and DMP; and a Pre-Application for a Pretreatment Loan or Load Guarantee.
	9-25-87	Letter	Baltimore County advises that the 8-24-87 citation will become a final order on October 6, 1987. Failure to respond within 10 days of October 6, 1987, will result in assessment of $1,000/day penalties.
	9-15-87	Notice of Violation	Baltimore County issues Citation No.2222 for failure to submit a baseline monitoring report by August 3, 1987. Failure to respond by November 9, 1987, will result in $100/day penalty.
	8-24-87	Notice of Violation	Baltimore County issues Citation No. 2219 for exceedance of categorical standard limitations and requires submission of a compliance schedule and final compliance with Electroplating Standards by December 31, 1987. Failure to respond by October 16, 1987, will result in penalty of $1,000/day.

APPENDIX D (Continued)

RECORD NUMBER	DATE	TYPE OF ACTIVITY	DESCRIPTION
	8-11-87	Inspection	Baltimore County and State representatives conduct an inspection of Cirtek. Changes to operations are noted and grab samples from process tanks are taken.
	8-1-87	Discharge Permit Issued	Baltimore County issues a discharge permit to Cirtek. Permit requires Cirtek to conduct monitoring, submit reports and a compliance schedule, and achieve compliance with Electroplating Standards and the Baltimore County Code.
	7-17-87	Letter	Baltimore County advises Cirtek that it may be subject to Electroplating Standards and that a BMR must be submitted by August 3, 1987.
	7-14-87	Letter	Baltimore County provides Cirtek with criteria for significant noncompliance and advises that meeting the criteria will result in being published as a significant violator.
	6-15-87	Permit Application	Cirtek submits an application for a wastewater discharge permit.
	3-9-87	Notice of Violation	Cirtek issues Citation No. 2151 for failure to submit a lab report on wastewater composition by December 1, 1986. Failure to comply by May 2, 1987, will result in a penalty of $100/day.
	1-30-87	Letter	Baltimore County advises Cirtek that its response to Citation No. 2014 is acceptable.

APPENDIX D (Continued)

RECORD NUMBER	DATE	TYPE OF ACTIVITY	DESCRIPTION
	12-15-86	Letter	Cirtek advises Baltimore County that the discharge permit has been received and is posted in a public place.
	12-10-86	Letter	Cirtek responds to Citation No. 2014 and provides corrective action.
	11-14-86	Notice of Violation	Baltimore County issues Citation No. 2014 to Cirtek for violations of pretreatment standards (copper, lead, pH).
	10-1-86	Inspection	Baltimore County conducts an inspection and notes changes such as the name change (BarGale to Cirtek) and minor process changes. This is the first inspection since the previous one conducted on August 2, 1983.
	9-23-86	Letter	Baltimore County advises Cirtek that its response to Citation No. 1704 is acceptable.
	8-1-86	Issuance of Discharge Permit	Baltimore County issues Wastewater Discharge Permit No. 1325 to Cirtek. The permit contains discharge limitations, reporting and monitoring requirements, and other conditions.
	7-25-86	Letter	Cirtek responds to Citation No. 1704 with corrective actions.
	6-20-86	Notice of Violation	Baltimore County issues Citation No. 1704 for lead and pH violations.
	9-12-85	Letter	Baltimore County advises Cirtek that its response to Citation 1096 is acceptable.

APPENDIX D (Continued)

RECORD NUMBER	DATE	TYPE OF ACTIVITY	DESCRIPTION
	8-20-85	Letter	Cirtek responds to Citation No. 1096 and explains reasons for the violations and its efforts to install treatment. Letter indicates "we" have managed and owned this facility since April 1983.
	1-31-85	Letter	Baltimore County notifies BarGale will no longer be required to monitor quarterly for cadmium, chromium, and zinc.
	1-31-85	Letter	BarGale acknowledges receipt of Baltimore County Citation and provides explanations for the violations.
	1-25-85	Letter	Baltimore County notifies BarGale that continuously recording of pH is required for future reports.
	1-22-85	Letter and Notice of Violation	Baltimore County issues a letter and Citation No. 1096 for violations of pH, copper, lead, and total metals.
	1-16-85	Telephone Contact	Baltimore County notifies BarGale of pH violations and intent to issue a citation.
	7-13-84	Letter	Baltimore County notifies BarGale that quarterly monitoring will no longer be required for FOG, COD, BOD, TSS, and Fe.
	1-3-84	Telephone	Baltimore County notifies BarGale of pH exceedance but that no citation will be issued.
	8-2-83	Industrial Inspection	Comprehensive inspection of BarGale performed.

APPENDIX D (Continued)

RECORD NUMBER	DATE	TYPE OF ACTIVITY	DESCRIPTION
	7-12-83	Notice of Violation	Baltimore County advises BarGale of its failure to submit a laboratory report by June 30, 1983. BarGale is advised it must be submitted by July 22, 1983.
	5-5-83	Permit Application	BarGale submits an application for discharge permit.
	5-4-83	Letter	Notice from BarGale President that the company has been sold to Cirtek, Inc.

VITA

Jeffrey L. Lape was born on October 11, 1954 in Glens Falls, New York. He received an A.A.S. degree (Public Health Technology) from Morrisville Agricultural and Technical College, New York, in 1974 and a B.A. degree (Environmental Science) from Plattsburgh State University College, New York in 1976. Rooted in his upbringing in the Adirondack Mountains of New York, his professional career began and has continued in the field of environmental protection. He has held positions in local, state and Federal government as well as seven years of environmental consulting. Presently, he is a Section Chief in the Office of Water Enforcement and Permits, U.S. Environmental Protection Agency, Washington, DC.