ALTERNATIVE SOLVENTS/TECHNOLOGIES FOR PAINT STRIPPING: PHASE I

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13. ABSTRACT *(Maximum 200 words)*

This report presents the results of an extensive investigation of possible alternative solvents and technologies that may be safely applied to some Air Force paint-stripping operations. The objective of the Alternative Solvents/Technologies Program is to minimize hazardous waste by eliminating toxic chemicals in the maintenance and repair processes. Three phases of study are defined: Phase I, identify alternate solvents/strippers and screen them; Phase II, field test solvent/strippers; and Phase III, implement alternate solvents and technologies as approved. A list of potential alternate solvents and paint systems were identified and carried into Phase II. Both immersion and spray/brush-on application methods were studied.

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PREFACE

This report was prepared by the EG&G Idaho, Inc, P.O. Box 1625, Idaho Falls, ID 83415 under DOE Idaho Field Office Contract DE-AC07-76ID01570 for the Air Force Civil Engineering Support Agency, 139 Barnes Drive, Tyndall AFB, FL 32403-5319.

This Phase I final report summarizes efforts to identify alternative non-toxic paint strippers for possible use at Air Force maintenance and repair facilities. The work was performed between March 1991 and September 1992. The Air Force project officer was Lieutenant Phillip P. Brown.

This report has been reviewed by the Public Affairs Officer (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for public release.

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EXECUTIVE SUMMARY

A. OBJECTIVE

The objective of the Alternative Solvents/Technologies for Paint-stripping Program is to minimize hazardous waste by eliminating the use of toxic chemicals in the U.S. Air Force's paint-stripping facilities. The objectives of Phase I were to gather baseline information, to conduct screening tests of possible commercially available, alternative paint-stripping formulations, and to select the most promising paint strippers for further testing.

B. BACKGROUND

Paint must be stripped from aircraft parts and equipment as part of maintenance at the five U.S. Air Force's Air Logistics Centers (ALCs) for corrosion inspection, damage repair, and repainting. Wastes generated by these paint-stripping operations contain toxic chemicals, which require costly handling and disposal as hazardous waste. The discharge of paint-stripping waste is now regulated by the U.S. Environmental Protection Agency (USEPA), who can impose fines on individuals or organizations whose wastes exceed the established limits.

C. SCOPE

Paint-stripping baseline information was gathered through a literature search and a questionnaire, which was sent to the five ALCs. This information was used to establish requirements for current paint-stripping operations and for potential paint-stripping replacements.

The literature search produced a compilation of reports, journal articles, papers, patents, procedures, and standards relating to paint-stripping. Several mechanical paint-stripping methods were discovered as a result of the literature search that warrant further investigation. They include wheat starch blasting, CO_2 pellet blasting, flash lamp stripping, laser stripping, and ice blasting.

The paint-stripping information obtained from the questionnaire has been compiled into a data base for easy retrieval. Several aerospace companies were contacted in an effort to encourage cooperation in developing low-toxicity paint strippers. Boeing Aerospace, Pacific Northwest Laboratories (PNL), and the Idaho National Engineering Laboratory (INEL) have established a collaborative agreement to exchange technical information and to prevent duplication of research efforts.

Several commercially available solvents samples were obtained for testing. Low toxicity chemical paint strippers were screened for biodegradability, stripping efficiency, and corrosion.

D. METHODOLOGY

The test method used for the biodegradability screening was a modified ASTM standard test for Biodegradability of Alkylbenzene Sulfonates. The bacterial culture used for this test was taken from the activated sludge system at Tinker Air Force Base's Industrial Waste Treatment Plant (IWTP).

The test method used for the stripping efficiency test was derived from several federal and military standards and from the questionnaire sent to the five ALCs.

The test method used for the immersion corrosion analysis was the Total Immersion Corrosion Test for Aircraft Maintenance Chemicals, ASTM F483-77.

E. TEST DESCRIPTION

Changes were made to the protocol for the biodegradability test to simulate actual conditions at the IWTP. The microbes were exposed to the paint-stripper solution for 6 hours during which chemical oxygen demand (COD) and adenosine triphosphate (ATP) were monitored.

A preliminary stripping efficiency test was conducted, which narrowed the number of paint strippers from 63 to 24. The 24 candidates were then subjected to a more stringent test to remove six paint systems from aluminum and steel coupons. A paint stripper currently being used at the ALCs was used as a control to compare stripping results. Ten paint strippers were identified that passed this test and can be used for the hot immersion method in a dip tank. These paint strippers were then subjected to the immersion corrosion test.

The immersion corrosion test procedures for precleaning test specimens, conditioning, testing, and data analysis closely followed the ASTM standard. Seven types of metal substrates were used for this test and nine paint strippers passed on at least one metal. The nine paint strippers will go on to Phase II testing, which includes extended performance tests, hydrogen embrittlement tests, and treatability tests.

F. RESULTS

Phase I established the baseline from which more research can be accomplished by identifying requirements, criteria, and test methods for paint-stripping. The stripping efficiency test narrowed the list of commercially available paint strippers to 10 for the immersion methods, and the corrosion test identified several paint strippers that performed well on aluminum and steel substrates.

G. CONCLUSION

The results of the testing show that the amount of hazardous waste generated by paint-stripping operations can be reduced. By applying new technologies, the Air Force and private industry will be able to comply with USEPA guidelines for hazardous waste.

H. RECOMMENDATIONS

Pilot-scale verification studies for the solvents selected in Phase I will be conducted in Phase II. Phase III of this project will implement alternative paint strippers at Tinker Air Force Base's Air Logistic Center.

New technologies for mechanical stripping should be developed. Government and private industry should continue to cooperate in developing new paint-stripping technology.

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LIST OF ABBREVIATIONS

AFESC	Air Force Engineering and Services Center
ALC	Air Logistics Center
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ATP	Adenosine Triphosphate
CARC	Chemical Agent Resistant Coating
CFC	Chlorofluorocarbons
COD	Chemical Oxygen Demand
FAA	Federal Aviation Administration
HILDS	High Intensity Light Depainting System
INEL	Idaho National Engineering Laboratory
InTA	International Technical Associates
IRC	INEL Research Center
IWTP	Industrial Waste Treatment Plant
MIL-SPECS	Military Specifications
MOU	Memorandum of Understanding
MSDS	Material Safety Data Sheet
NADEP	Naval Aviation Depot
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PMB	Plastic Media Blasting
PNL	Pacific Northwest Laboratory
PPM	Parts Per Million
TLV	Threshold Limit Value
TOC	Total Organic Carbons
TTO	Total Toxic Organics
USEPA	United States Environmental Protection Agency
UV	Ultraviolet
VOC	Volatile Organic Compounds

SECTION I
INTRODUCTION

Paint-stripping is a necessary part of maintenance at U.S. Air Force Air Logistics Centers (ALCs). The waste from Air Force paint-stripping operations contains toxic chemicals that require special handling and must be disposed of as hazardous waste at considerable cost. Emissions from these solvents into the atmosphere as volatile organic compounds (VOCs) are another source of pollution. These wastes are hazardous to the environment and to operating personnel. The paint-stripping wastes are regulated by the U.S. Environmental Protection Agency (USEPA), who can impose fines on those whose wastes exceed the established limits.

This report describes the research program titled Alternative Solvents/ Technologies for Paint-stripping being conducted by the Idaho National Engineering Laboratory (INEL) for the Air Force Engineering and Services Center (AFESC) at Tyndall Air Force Base. This report also includes the results obtained in Phase I.

A. OBJECTIVE

The objective of this program is to minimize hazardous waste by eliminating the use of toxic chemicals in military and industrial paint-stripping facilities. The paint strippers now used will be replaced with one or a combination of the following: (a) nontoxic chemical formulations, (b) new process development, and (c) new coating reformulations. This program consists of three phases. The Phase I objectives are to gather baseline information, to conduct screening tests of possible alternative paint-stripping solvents, and to select the most promising solvents for further testing. In addition, this phase will identify mechanical methods of paint-stripping and address specific problems associated with each. The Phase II objective is to verify, through extended laboratory studies, the feasibility of alternative solvents determined in Phase I. Concurrently, work will be done to solve waste problems resulting from mechanical stripping and to establish contact with the paint and chemical industries. This contact will enable the timely evaluation of new paint stripper formulations and new paint coatings that have low toxicity and low VOC content. In addition, the paint industry will be made aware of the need to formulate paints that can be readily removed without harsh chemicals. The Phase III objectives are to implement the alternative paint strippers at Tinker ALC, to pursue new technologies in mechanical stripping methods, and to continue interactions with the paint and chemical industries.

B. BACKGROUND

Paint is removed to inspect for corrosion, repair damage, remove weathered paint, and change the paint system. Toxic chemicals are currently being used to strip high-performance paints from aircraft, missiles, ships, tanks, and equipment. The paint-stripping formulations contain various combinations of methylene chloride, phenol, formic acid, chromate, and other additives. These chemicals are hazardous to the environment and to the workers in paint-stripping facilities.

The USEPA has enacted new wastewater discharge limits on total toxic organics (TTO), which is the summation of all quantifiable amounts greater than 0.01 mg/L and includes the 109 organic compounds listed in Appendix A (Reference 1). The maximum allowable TTO for facilities discharging more than 10,000 gallons of process wastewater per day is 2.13 mg/L. Methylene chloride and phenol are major contributors to the TTO released into wastewater at military refinishing installations.

Another significant source of pollution is VOC discharged into the atmosphere. These VOC emissions have recently become regulated by the USEPA and by most state or local agencies. A separate program will be initiated by the Air Force regarding low VOC solvents.

In addition, worker safety and health are jeopardized by constant exposure to large doses of these toxic chemicals. As a result, full-body protective garments and respirators are necessary to prevent exposure through skin absorption and inhalation. The following toxicity data were taken from References 2 and 3. The threshold limit values (TLV) were taken from Threshold Limit Values and Biological Exposure Indices for 1989-1990 established by the American Conference of Governmental Industrial Hygienists.

- Methylene Chloride
  Exposure: Inhalation; skin absorption
  Toxicology: Mild central nervous system depressant and an eye, skin, and respiratory tract irritant; carcinogenic in experimental animals; concentrations in excess of 50,000 parts per million (PPM) are thought to be immediately life-threatening.
  TLV: 50 mg/L

- Phenol
  Exposure: Skin absorption; inhalation; ingestion
  Toxicology: Irritant of the eyes, mucous membranes, and skin; systemic absorption can cause convulsions and liver and kidney damage; direct contact with solid or liquid can produce chemical burns.
  TLV: 5 mg/L

- Formic Acid
  Exposure: Inhalation
  Toxicology: Vapor is a severe irritant of the eyes, mucous membranes, and skin; direct contact causes burns with blisters; inhibits cellular respiration.
  TLV: 5 mg/L

- Chromate
  Exposure: Inhalation
  Toxicology: Severe irritant of the nasopharynx, larynx, lungs, and skin; increased incidence of bronchogenic carcinoma is found in workers exposed to certain chromate dusts.
  TLV: 0.05 mg/L

1. Paint-Stripping Considerations

Several factors determine the ease or difficulty of the paint-stripping process: (a) type of paint system, (b) type of substrate, (c) type of surface preparation and pretreatment, (d) method of curing and baking, and (e) age of the paint system. These factors are described below.

a. Type of Paint System

The paint system refers to the combined layers of primer, topcoat, and other protective coatings. Generally, it includes one primer coat and two topcoats. New paint systems have been developed that are highly polymerized and crosslinked to reduce permeability and to resist attack from alkalies, acids, and solvents. Epoxies, polyurethanes, and polyamides are commonly used in both the primer and topcoat, which has increased the difficulty of paint-stripping to the point that chemicals alone are not effective.

b. Type of Substrate

The type of substrate painted is an important factor in the stripping process. Damage due to corrosion or fatigue can compromise the safety and performance of costly hardware. Among metal substrates, the most commonly painted parts are aluminum, steel, magnesium, and titanium. Both industry and the military are increasing their use of composites such as fiber glass, carbon graphite, epoxy resins, thermoplastics, and hybrids of these composites to build aircraft parts. Currently, aluminum is of prime concern for two reasons: (1) it is the major substrate on most aircraft and, (2) is very susceptible to damage from high heat, mechanical blasting, and alkaline strippers. Composite materials will be of prime concern in the future as they increasingly replace aluminum on aircraft. Composites present a major problem because of their varied composition and vulnerability to mechanical and chemical stripping processes.

c. Surface Preparation and Pretreatment

The type of surface preparation and pretreatment can greatly influence the degree of difficulty in paint-stripping. Various surface preparation techniques required for proper adhesion and maximum coating performance are being used before painting to remove soil, grease, and oxides. The substrate surface can be prepared by mechanical or chemical methods.

Mechanical pretreatment methods include hand cleaning with brushes or scrapers, power cleaning with rotary tools or high-pressure water, and blasting with high-velocity abrasives. Of these, abrasive blasting is the most effective in prolonging the life of the coating by increasing surface area for proper adhesion.

Chemical methods include acid pickling, alkali cleaning, acid cleaning, emulsion cleaning, and solvent cleaning. These procedures may be used in conjunction with or in place of mechanical cleaning. The surface must be thoroughly cleaned without damaging the substrate.

After the surface has been cleaned, a conversion coating is usually applied to improve paint adhesion and prevent corrosion. A conversion coating is defined as a uniform crystalline or amorphous deposit formed on a properly prepared surface by a chemical reaction with the base metal (Reference 4). Various phosphoric acid, chromic acid, and proprietary treatments are used in the coatings on nearly every metal before painting. Alodining is a widely used chemical conversion coating for aluminum in which the coating is applied by spraying or brushing. Anodizing is another form of pretreatment in which a protective film is formed on a metal part by an electrochemical process. Aluminum is coated with a layer of aluminum oxide by an anodic process in a suitable electrolyte such as chromic acid. Magnesium is coated with electrolytes such as fluorides, phosphates, or chromates.

d. Method of Curing and Baking

The method of curing determines the extent of crosslinking and polymerization. The temperature and length of time the paint is allowed to bake is important to a strong paint film. Within limits, the higher the temperature and the longer the baking time, the more difficult it is to remove the paint.

e. Age of the Paint System

The age of the paint system is a crucial factor in paint-stripping. Older paint films that have been weathered by environmental conditions are much harder to remove than freshly painted films.

2. Chemical Paint Strippers

The two primary types of paint strippers are either alkaline-based or solvent-based. Alkaline-based strippers consist of caustic soda and additives such as wetting agents, emulsifiers, and detergents. These ingredients quickly penetrate the paint film, cleave chemical links, and emulsify the plasticizer or other components.

Solvent-based organic paint strippers have been widely used to remove most paint systems.[*] They consist of several components, each with its own purpose and function. Understanding these functions will help in selecting new and less toxic replacements.

a. Primary Solvents

The main function of the primary solvent is to penetrate, swell, and lift the paint film rapidly. It should also be an intermediate solvent which only partially dissolves the paint. This prevents redeposition of the paint onto the substrate. Methylene chloride is widely used because it is an intermediate solvent, is nonflammable, and has a small molecular size which enables it to permeate the paint film more effectively than other solvents.

b. Cosolvents

The function of the cosolvent is to increase stripping efficiency by removing coatings that are resistant to the primary solvent and to limit or increase the solubility of other additives. Methanol and phenol are often used as cosolvents.

c. Activators

Activators increase the rate of stripping by inducing greater lifting of the surface coating. Activators are usually polar solvents, acids, alkalies, and amines. Organic acids such as formic acid hydrolyze ether linkages in the paint film and destroy crosslinking to allow rapid penetration of the primary solvent.

d. Evaporation Retarders

Paraffin wax is added to form a continuous surface film which slows down the evaporation rate. A seal cap of high-boiling oil may be added to organic strippers that are used hot.

e. Thickeners

Thickeners are needed when the stripper is used on vertical surfaces. The thickened film maximizes contact time and allows more solvent to be drawn into the paint film. A common thickener is hydroxypropyl methyl cellulose.

f. Corrosion Inhibitors

Corrosion inhibitors such as sodium chromate or benzoate are included because of the presence of corrosive ingredients such as water, acids, and amines in the paint strippers.

g. Surfactants

Surfactants assist in the removal of the softened paint and stripper residues.

3. Current Methods of Chemical Paint-stripping

a: Immersion Method

The immersion method is used for smaller parts that can be easily disassembled and requires the use of large dip tanks. Three types of immersion methods are used, depending on the makeup of the chemicals in the dip tanks.

(1) Cold Acidic Stripper. A typical metal refinishing process uses a cold acidic stripper with a hot alkaline dip and a cold water rinse. The acid stripper commonly used contains 85 percent methylene chloride, 10 percent phenol, and 5 percent formic acid. In this process, the disassembled parts are lowered into a tank of stripper using large dipping baskets or conveyorized hooks. The

parts remain submerged for approximately 20 minutes or until the paint is completely loosened. The basket is raised and excess stripper is allowed to drain and evaporate. Next, the basket is lowered into a hot caustic dip to neutralize any remaining stripper. It is again raised, allowed to drain, and submerged in a rinse tank of fresh water. The parts are further cleaned with a pressurized hot water/steam lance before the surface is prepared, pretreated, and repainted.

The TTO discharged into the wastewater comes from the rinse tank because of the carryover of stripper or "dragout" from the two previous tanks. Figure 1 illustrates this process (Reference 5).

(2) <u>Cold Caustic Stripper</u>. This method uses a cold caustic stripper followed by a hot water rinse.

(3) <u>Hot Tank Stripper</u>. The hot stripper uses various organic solvents or mildly alkaline solutions at an elevated temperature. The temperature varies from approximately 100 - 200°F (38 - 93°C) depending on the kind of paint being stripped. In this method, there is only one heated, temperature-controlled tank. Mechanical agitation is often incorporated in the tank design to enhance stripping efficiency. Dipping baskets or conveyorized hooks are used to dip the parts in the hot stripper. The parts are drained and then rinsed with a pressurized hot water/steam lance. Surface preparation, pretreatments, and repainting follow. Dragout and paint waste enter the effluent during rinsing, which contributes to total toxic organic (TTO) discharges.

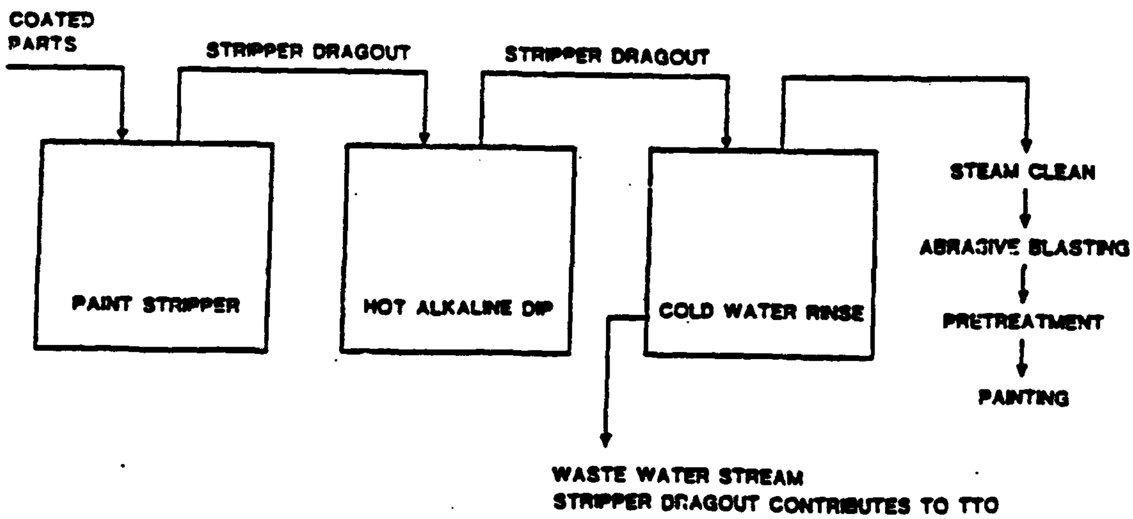

Figure 1. Metal Refinishing Process - Immersion Method.

b. Spray/Brush Method

The spray/brush method is used for large parts such as aircraft fuselage and wings. A viscous paint stripper is brushed or sprayed on the part and allowed to penetrate, swell, or wrinkle the paint. The dwell time varies, but is generally 20 to 30 minutes. The surface is then manually scrubbed by workers using soft bristle pads. If necessary, the process is repeated until all the paint is removed. A pressurized hot water/steam lance is used to rinse away excess paint and stripper. Surface preparation and pretreatment are used as needed before repainting. The rinse water containing paint and stripper wastes is drained away through floor grills to large collection tanks.

Regardless of the method of paint-stripping, the effluent contains large amounts of paint and stripper wastes that contribute to TTO discharges. Paint chips and debris can be filtered out and discarded in drums, but paint-stripper waste goes through the Industrial Waste Treatment Plant (IWTP) where it is either released to the atmosphere as a VOC (methylene chloride), released in streams because it cannot be chemically or biologically treated, drummed and hauled to a hazardous material landfill, or incinerated.

C. SCOPE

1. Phase I: Data Gathering and Preliminary Screening

Phase I had two main goals. The first goal was to identify and test commercially available alternative chemical paint strippers. These strippers were evaluated according to biodegradability, stripping efficiency, and corrosivity. The second goal was to investigate mechanical methods of paint-stripping to determine the extent of work already done and identify specific areas of concern that have not been addressed. Seven tasks were chosen to accomplish these goals.

a. Task 1: Conduct a Literature Search

An extensive literature search was conducted to compile relevant information. Information was gathered to identify current and developing paint-stripping technologies.

b. Task 2: Compile Military Specifications and ASTM Standards

Military specifications (MIL-SPECS) and federal standards pertaining to metal substrates, paint systems, and paint-stripping parameters were obtained, reviewed, and compiled into a bibliography to establish requirements for a reliable test plan to evaluate stripping efficiency. As a result, the metal coupons used and the paint systems applied closely represented the actual painted parts to be stripped. MIL-SPECS were also referred to for guidelines in the selection of alternative paint strippers, which must meet performance criteria as defined by the military. Corrosion tests were done according to ANSI/ASTM standards on Total Immersion Corrosion Test for Aircraft Maintenance Chemicals (Reference 6). Future corrosion evaluations will be done per American National Standards Institute ANSI/ASTM standard on Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Chemicals (Reference 7). Other corrosion tests will be conducted as required by the military. If necessary, the sandwich corrosion test can be performed according to ASTM 1110-88 Standard Test Method for Sandwich Corrosion Test (Reference 8).

c. Task 3: Conduct a Survey of Paint-Stripping Procedures

A detailed knowledge of the paint-stripping operations at the five Air Logistics Centers (ALCs) is imperative to give direction to this program and to focus on the needs of each facility. A questionnaire was used to obtain specific information on current procedures, the kinds of paints and substrates involved, and the amount of waste generated.

d. Task 4: Encourage Industry Collaboration

In an effort to encourage collaboration with industry, several aerospace companies were contacted by INEL to establish a working relationship. Reformulation of paint coatings by the paint industry will also be encouraged. Chemical companies were asked to develop new formulations of paint strippers.

e. Task 5: Acquire Samples for Laboratory Analysis

Commercially available nonchlorinated, nonphenolic strippers that can remove epoxy paint from aluminum and steel were obtained for screening. Additional criteria for selecting paint strippers were biodegradability and low toxicity.

f. Task 6: Evaluate Samples for Toxicity/Safety

A major concern of this project is to identify alternative chemical paint strippers that do not endanger humans or the environment. Each sample was evaluated for toxicity and safety. The Material Safety Data Sheets (MSDS) were used to determine the hazardous ingredients as defined by Occupational Safety and Health Administration (OSHA's) "Hazard Communication" (Reference 9). The permissible exposure limit (PEL) and/or the threshold limit value (TLV) in milligrams per liter (mg/L) for each known ingredient was noted, if available, from the manufacturer and compared to that of methylene chloride, phenol, formic acid, and chromates. The alternative strippers were initially required to have a flash point greater than 140°F (60°C). This requirement has since been changed by the program sponsor to 200°F (93°C) to avoid dangers due to combustibility.

g. Task 7: Perform Laboratory Screening of Alternative Paint Strippers

The alternative strippers were evaluated in the laboratories of the Idaho National Engineering Laboratory's Idaho Research Center (IRC) for: (a) biodegradability, (b) stripping efficiency, and (c) corrosivity. All samples were subjected to biodegradability and stripping efficiency tests; those that performed adequately in both of these evaluations were tested for corrosion effects. Figure 2 summarizes the screening criteria.

(1) Biodegradability. For this program, solvents or toxic compounds that could be biologically degraded by the activated sludge system at Tinker ALC's Industrial Waste Treatment Plant (IWTP) were considered biodegradable. The method used was a modified ASTM standard test for Biodegradability of Alkylbenzene Sulfonates (Reference 10). The protocol was changed to achieve a more direct correlation of test conditions to actual conditions at the IWTP at Tinker AFB.

The bacterial culture used for this test was from the activated sludge system at Tinker's IWTP. Phenol was selected as the control compound since this is the organic constituent currently treated at the plant. A 1:600 dilution of the paint stripper solvents was used because it represents the concentration of the influent as it enters the IWTP. A 6-hour test period was specified because this was the normal retention time of the solvents in the activated sludge system. Biodegradability was determined by a decrease in soluble chemical oxygen demand (COD), which is a measure of the material concentration in the wastewater that can be chemically oxidized. The test criterion for this project was the degradation of organic wastes from paint-stripping operations by the activated sludge system to below the National Pollutant Discharge Elimination System (NPDES) limits. The NPDES discharge limit for COD is 75 mg/L at Tinker Air Force Base's IWTP (Reference 11). Since the initial COD values for the paint strippers were extremely high (approx. 1,000,000 mg/L), a 50 percent decrease in COD after 6 hours from the original 1:600 dilution would also be considered acceptable.

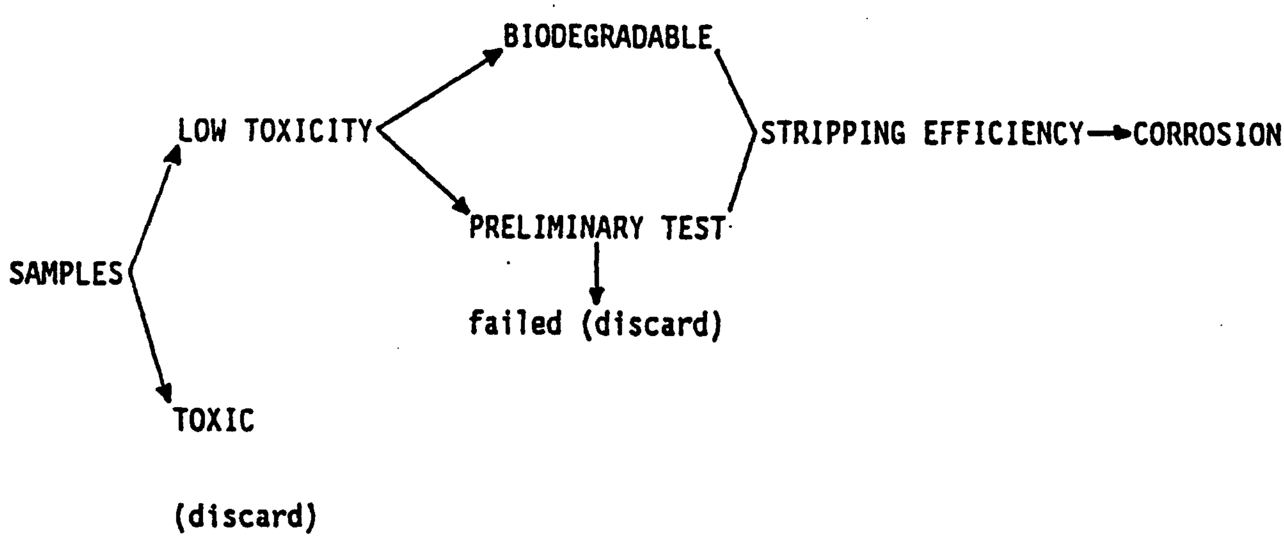

Figure 2. Phase I Summary Chart.

(2) Stripping Efficiency. Stripping efficiency was evaluated by determining the ability of the stripper to remove various types of paint systems from metal coupons. The test methods were developed from military and federal specifications for paint-stripping. A preliminary test was conducted on all samples to eliminate those that cannot remove paint under moderate conditions. The effects of each stripper on the paint system was determined by visual observations. For the preliminary test, aluminum Alloy 2024 and an epoxy paint system were chosen as the representative metal substrate and high-performance paint. The best strippers were subjected to a more stringent test to provide accurate stripping performance data. This test used aluminum and steel coupons painted with six different paint systems, typical of the traditional and high-performance paints. The paint systems are described in Table 3, Section II. Both tests had a 1-hour time limit by which stripping efficiency was evaluated. A paint stripper containing methylene chloride, phenol, and formic acid was used as a baseline control.

(3) Corrosion Testing. Samples that performed well in the biodegradability and stripping efficiency tests were subjected to the Total Immersion Corrosion Test for Aircraft Maintenance Chemicals, ANSI/ASTM F483-77 (Reference 6).

2. Phase II: Extended Laboratory Studies and Pilot Scale Testing

The paint strippers that passed Phase I laboratory screening for biodegradability, stripping efficiency, and corrosivity will be subjected to extended laboratory studies. The following are tasks for Phase II:

Extended performance tests should include stripping efficiency and rinsability of the candidate paint strippers on unique fabricated parts that represent various types of configurations encountered in the paint-stripping operation. Actual aircraft parts, if available, should also be used to simulate the stripping process. Parts should be repainted to determine the refinishing properties of the stripped surface. A tack-free film with undiminished adhesion would be considered acceptable. The capacity and life expectancy (shelf life) of the strippers should also be determined. Agitation, ultrasonics, and other process enhancement methods to improve stripping efficiency should be evaluated.

Corrosion testing should include hydrogen embrittlement corrosion tests to determine the effects of the paint strippers on steel substrates. The sandwich corrosion test and dissimilar metals corrosion test may be incorporated, if warranted, before final implementation.

Economic and environmental factors require that available technologies to recover and recycle the spent paint-stripping solvents be identified and tested. Current solvent recovery techniques, of which distillation is the most common, apply to single component solvents such as methyl ethyl ketone (MEK) and 1,1,1 trichloroethane (TCA). However, many of the potential solvent replacements are multicomponent mixtures, and therefore may not be conducive to typical distillation techniques. A separate project entitled Solvent Recycle/Recovery will investigate several existing and emerging technologies to accomplish maximum recovery and recycling of paint-stripping and cleaning solvents.

The release of volatile organic compounds (VOC) into the atmosphere from the replacement solvents may still pose environmental problems. Therefore, methods to identify and measure the potential VOC emissions should be investigated. Identification and quantification of the specific volatile compound will be useful in designing the required VOC containment. A separate project entitled Volatile Organic Compounds will achieve this goal.

Biological treatment of the spent solvents in an IWTP using the activated sludge system should be studied in greater detail. A 72-hour acclimation period as recommended by the standard test method for Biodegradability of Alkylbenzene Sulfonates (Reference 10) would allow the microbes to acclimate to the new paint stripper solvents before the biodegration tests. Gas chromatography should be used to analyze the biodegradation products and to determine the fate of the organic constituents. Based on this information, the feasibility of using chemical oxidation with hydrogen peroxide or ozone before biodegradation should be evaluated. If results of the Solvent Recycle/Recovery Project indicate that it is technically and economically feasible to recover parts of the paint stripper formulation, then the remainder of the waste may be biodegraded by the activated sludge system without additional efforts. If necessary, a new bacterial seed culture should be produced to degrade the specific components.

Point source treatment should also be established for facilities that do not have biological treatment. This would involve chemical or physical treatment schemes at the source of the waste generation point. Methods such as resin adsorption, hydrogen peroxide/ferrous sulfate oxidation, hydrogen peroxide/ozone/UV oxidation, and wet air oxidation should be studied. If results of the Solvent Recycle/Recovery Project indicate that it is technically and economically feasible to recover parts of the paint stripper formulation, then the remainder of the waste may be easier to treat.

Following extended laboratory studies, the paint strippers that meet the requirements for toxicity, stripping efficiency, corrosion, and treatability as established by the Air Force, should be tested at the pilot plant facility at Tinker ALC or Kelly ALC. Large 100-gallon immersion tanks equipped with heaters and the optimum enhancement features should be used to remove paint from aircraft parts. Other parameters, such as corrosion effects, rinsing requirements, and capacity can also be determined at this time. The waste should then be treated accordingly in the pilot plant based on the results of the previous tests on biological, chemical or physical treatment methods.

For situations in which chemical stripping is neither technically nor environmentally feasible, new process technologies should be tested on a pilot scale. Actual aircraft parts should be used to determine refinishing properties, corrosion and fatigue effects, volume of waste generated, and economic feasibility. Waste treatment schemes and media recovery methods would also be necessary to reduce the volume of waste generated. Some of the new technologies include wheat starch blasting, CO_2 pellet blasting, laser stripping, flashlamp stripping, and ice blasting. Validation studies on these technologies are imperative to the success of this project.

Combined chemical and mechanical processes should be considered to achieve maximum performance if no suitable alternative chemical paint stripper can be found. A chemical solvent may be used to soften, age, or make brittle the paint film so a mechanical process, such as bead or dry ice (CO_2) blasting, can completely remove the paint.

The information obtained from these studies should be entered into the Solvent Utilization Handbook, which will be addressed under a separate project. The handbook is a data base that will incorporate all information pertinent to solvent substitution for the Department of Energy, Department of Defense, and industry. The handbook data base generated from this project will include stripping efficiency, corrosion, treatability, recycle/recovery techniques, volatile organic compound (VOC) emissions and control, flashpoint, toxicity, test methodology, and test conditions.

Close contact should be maintained with chemical and paint companies to keep current with the latest paint strippers and paint formulations. If a paint system is particularly difficult to remove, the chemical companies could be asked to formulate a specific stripper. Low VOC and low toxicity paints may be a requirement of the future, as well as the ability to remove the high-performance paints without harsh chemicals.

3. Phase III: Implementation of Alternative Paint Strippers

In this phase, full-scale implementation of the alternative paint strippers should be completed at Tinker ALC or Kelly ALC. In addition, efforts to implement new technologies in mechanical stripping should be pursued. Efforts should be made to maintain contact with the chemical and paint industries. At this point in the program, it is too early to predict specific tasks.

SECTION II
TEST PROCEDURES

A. BIODEGRADABILITY

A culture of bacteria from Tinker ALC's activated sludge system was maintained in a bench-scale sludge column located at the IRC. This culture was used in biodegradability tests of new products proposed for replacing currently used strippers. Six small columns (Figure 3) were fabricated to evaluate biodegradability of the paint-stripping solvents. These columns use air diffusion to suspend solids and to provide sufficient oxygen to the microorganisms. Sample ports were designed that closely represent those of the actual treatment system. Samples of each stripper were mixed to concentrations recommended by the manufacturer and diluted 1/600 with the nutrient medium described in Appendix B. This dilution represents the concentrations expected at the IWTP. The test columns were filled to a total volume of 250 milliliters; 225 milliliters of sample basic nutrient medium and 25 milliliters of culture column microorganisms. To ensure a consistent correlation of biomass to sample ratio, the dry weight of

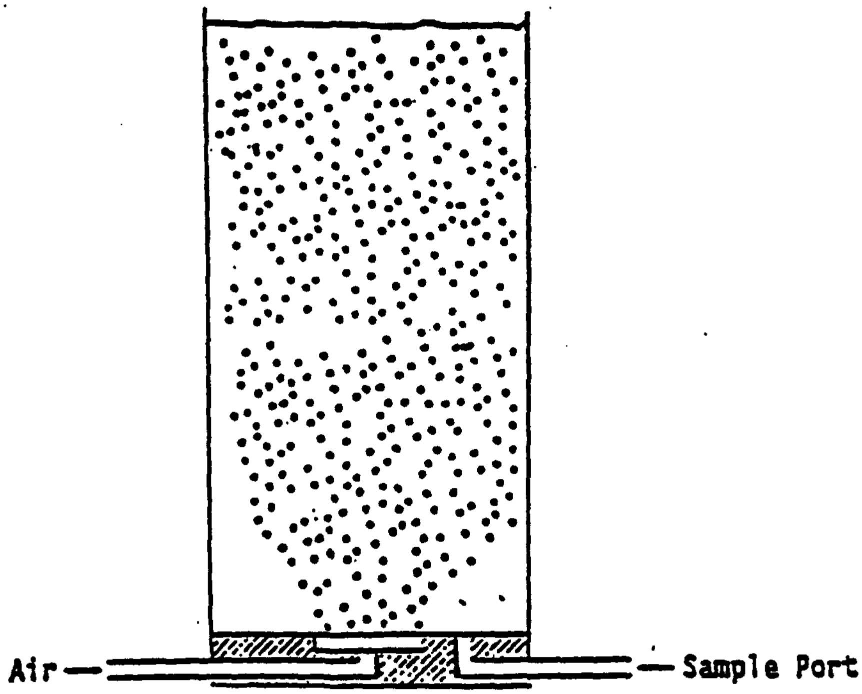

Figure 3. The Biodegradability Test Columns

the activated sludge was determined for each set of tests. A control was used to compare the chemical oxygen demand (COD) of the stripper to that of phenol on which the culture was maintained.

COD analyses were done on two samples taken every hour for 6 hours from each test column. The COD was determined on each sample and plotted against time. An adenosine triphosphate (ATP) measure of each column was also taken at the beginning and end of each test to determine the effect of the strippers on the biomass. An increase in ATP would indicate that the microorganisms were growing and a decrease would indicate that they were adversely affected by the paint stripper. ATP analysis was performed with a Turner Design ATP Photometer using an internal standard procedure for the photometer.

Before the biodegradability test, the paint stripper samples were analyzed for initial COD. Total organic carbons (TOC) were also analyzed as a measure of comparison to indicate the proportion of the COD that can be attributed to the organic carbons present in the strippers. COD was measured using the HACH Company COD reactors and the HACH Company prepackaged COD reagents. The concentrations were read with the HACH DR3000 spectrophotometer. TOC was analyzed using the O.I. Corporation's Total Carbon Analyzer and the direct injection procedure provided with the analyzer.

B. PAINT-STRIPPING EFFICIENCY

The paint-stripping samples were categorized according to the manufacturer's recommended method of application, which is either spray/brush-on or immersion. Two test methods were used to accommodate both types of applications. A preliminary test was conducted on all samples before the actual stripping efficiency test. Important factors chosen for these tests included the metal substrate, paint system, accelerated aging, time, and temperature. In every test, time was the limiting factor in order to stay within reasonable production line schedules. Paint strippers containing methylene chloride, phenol, and formic acid were used as controls. The following specifications were referenced to establish the test requirements:

Military	Federal
MIL-R-81903 A	TT-R-230 B
MIL-R-81294 C	TT-R-248 B
MIL-R-25134 B	TT-R-251 J
MIL-R-83936 B	
MIL-R-81835	
MIL-R-87978	

1. Preliminary Test

A preliminary stripping efficiency test was conducted on all samples to eliminate those that cannot remove paint under moderate conditions and to determine the effects of each stripper. Table 1 lists the paint system, substrate, and chemical preparation on the test coupons.

TABLE 1. SUBSTRATES AND PAINTS USED IN PRELIMINARY TESTS.

Color	Substrate	Chem Prep	Paint System	Specification
White	Aluminum	Alodined	Epoxy water-borne primer Polyurethane topcoat	MIL-P-85582 MIL-C-83286
Grey	Aluminum	Anodized	Epoxy water-borne primer Polyurethane topcoat	MIL-P-85582 MIL-C-83286
Black	Steel	Alodined	Epoxy polyamide primer Polyurethane topcoat	MIL-P-23377 MIL-C-83286

The preliminary test included the following test conditions:

- Metal substrates (aluminum - alodined or anodized) (steel - only analyzed when specified by manufacturer)
- One paint system composed of one coat epoxy, waterborne primer (MIL-P-85582), and two coats aliphatic isocyanate urethane topcoat (MIL-C-83286)
- No accelerated aging
- One exposure time period (1 hour)
- One temperature (ambient or maximum recommended by manufacturer)

- No replicates
- 50 percent of the topcoat and primer had to be removed to pass this test.

2. Stripping Efficiency Test

The paint strippers that passed the preliminary test were subjected to the actual stripping efficiency test, which included the following conditions:

- Two metal substrates (aluminum and steel; see Table 2)
- Six paint systems (see Table 3)
- Accelerated simulated aging
- Three exposure time periods (15 minutes, 30 minutes, 1 hour)
- One temperature (ambient or maximum recommended by manufacturer)
- Two replicates
- 90 percent of the topcoat and primer had to be removed to pass this test.

3. Metal Substrates

Aluminum and steel coupons were prepared as specified in Table 2. The coupons measured 2 x 3 x 1/16 inches with a 1/8-inch hole drilled in the top center of the 3-inch end. Each coupon was inscribed with an "A" for aluminum or an "S" for steel followed by an identifying number.

Steel and aluminum were chosen for testing because they best represent the types of substrates usually encountered in paint-stripping facilities. The substrate metal is an important parameter in stripping efficiency because it helps determine the degree of coating adhesion. Surface preparation, pretreatment, and conversion coating also affect adhesion of the paint system to the metal substrate as described earlier.

4. Paint System

The paint system includes the primer, topcoat, and other layers such as adhesives or sealants. Hundreds of paint systems are used for various purposes.

TABLE 2. METAL COUPONS.

Substrate Designation	Metal Coupons	Specification	Surface Pretreatment
A	Aluminum Alloy 2024, plate and sheet	QQ-A-250/4	Chemical conversion coating (MIL-C-81706)
S	Steel, Carbon, 1010 sheet and strip, dull matte finish	QQ-S-698	No conversion coating

NOTE: All coupons were cleaned by boiling in isopropanol for 5 minutes, rinsed with methanol, and air dried before pretreatment and painting.

Military and federal specifications were consulted to choose six paint systems that represent the traditional and the high-performance types most often used. Other paint systems can be used as needed in Phase II of extended performance testing.

Table 3 lists the paint systems chosen to evaluate the stripping efficiency of the alternative chemical paint strippers. Systems 1 and 2 are high-performance paints used on Air Force aircraft. System 3 consists of a new water-thinned epoxy primer that complies with emission regulations for volatile organic compounds (VOC) and a urethane topcoat that is a chemical agent resistant coating (CARC). This type of paint system is applied to many Army vehicles. System 4 is a traditional alkyd type coat that is widely used throughout the military. System 5 includes polysulfide sealants under the primer and topcoat, which is also very difficult to remove. System 6 is a high-performance paint on Navy ships used because of its outstanding performance in fresh and salt water immersion.

After the paint systems were applied and cured, the coupons were baked for 96 hours at 210 ± 10°F (98.9°C), then cooled to ambient temperature and subjected to an aging process by immersion in hydrogen peroxide.

TABLE 3. PAINT SYSTEMS.

Paint System Designation	Primer/Topcoat	No.of Coats	Dry Film Thickness	Specification
1	Epoxy polyamide primer	1	0.6 - 0.9 mil	MIL-P-23377
	Epoxy polyamide topcoat	2	2.0 - 3.0 mil	MIL-C-22750
2	Elastomeric polysulfide primer	1	0.6 - 0.9 mil	MIL-P-87112
	Urethane topcoat	2	2.0 - 3.0 mil	MIL-C-83286
3	Water-thinned epoxy primer	1	0.6 - 0.9 mil	MIL-P-53030
	CARC urethane topcoat	2	2.0 - 3.0 mil	MIL-C-53039
4	Zinc chromate primer	1	0.6 - 0.9 mil	TT-P-1757
	Alkyd topcoat	2	2.0 - 3.0 mil	TT-E-489G
5	Epoxy polyamide primer	1	0.6 -0.9 mil	MIL-P-23377
	Polysulfide sealant	3	2 mil each coat	MIL-S-81733
	Epoxy polyamide primer	1	0.6 - 0.9 mil	MIL-P-23377
	Urethane topcoat	2	2.0 - 3.0 mil	MIL-C-83286
6	Epoxy polyamide primer	1	0.6 - 0.9 mil	MIL-P-24441 Formula 150
	Epoxy polyamide topcoat	2	2.0 - 3.0 mil	MIL-P-24441 Formula 152

Allow each coat to dry at room temperature for the following amount of time:

Primer coat: 1 hour
Topcoat: 4 hours between coats and 48 hours after last coat
Sealant: 15 minutes between each coat

5. Accelerated Aging

The painted coupons were exposed to an accelerated aging process by immersion in 2 percent hydrogen peroxide for 18 hours. This accelerates oxidation, which normally occurs with ultraviolet (UV) light and time. Coupons for the preliminary test were not aged before testing.

6. Exposure Time

One hour was chosen as the maximum exposure time to prevent a bottleneck in the production line. In the preliminary test, the painted coupons were exposed to each alternative paint stripper for 1 hour without periodic observations. In the actual stripping efficiency test, coupons were checked after 15 minutes, 30 minutes, and 1 hour to determine how fast the strippers removed the paint.

7. Temperature

The alternative paint strippers were tested at only one temperature, based on the manufacturer's recommendation. When a temperature range was given for hot immersion application, the maximum suggested temperature was used, provided that it was at least 50°F or 28°C below the product's flash point. A heating plate was used to maintain the desired temperature plus or minus 10°F or 5°C.

8. Test Method for Spray/Brush-on Strippers

Before testing, the primer and topcoat thicknesses were determined with a dry film thickness gauge. Each panel was weighed and then placed with the 3-inch edge at a 45-degree angle from the horizontal. Sufficient well-mixed paint remover was then poured along the top edge of the panel to completely wet and cover the entire test area, which allowed the excess to drain off. The stripper remained on the paint surface for a maximum of 1 hour, then rinsed with a pressurized hot water gun in an enclosed spray booth to collect paint and stripper wastes. The panels were air-dried and weighed to determine the amount of paint removed. Visual examination ultimately determined the degree of stripping efficiency because the original amount of paint on each coupon was not known. Therefore, quantitative data for percent of paint removed could not be calculated. Also, responses from the questionnaire sent to the five ALCs indicated that visual examination was the only means of determining stripping efficiency.

9. Test Method for Immersion Strippers

Before testing, the primer and topcoat thicknesses were measured with a dry film thickness gauge. Each panel was weighed and then immersed in a glass beaker containing the paint stripper sample at the manufacturer's recommended temperature. After 1 hour, the panels were raised from the beaker, allowed to drain, then rinsed with a pressurized hot water gun in an enclosed booth to collect paint and stripper wastes. The panels were air-dried and weighed to determine the amount of paint removed. Visual examination ultimately determined the degree of stripping efficiency because the original amount of paint on each coupon was not known. Therefore, quantitative data for percent of paint removed could not be calculated. Also, responses from the questionnaire sent to the five ALCs indicated that visual examination was the only means of determining stripping efficiency.

C. CORROSION TESTING

Only paint strippers that met the stripping efficiency criteria were subjected to the Total Immersion Corrosion Test For Aircraft Maintenance Chemicals, ANSI/ASTM F483 -77 (Reference 6).

1. Test Specimen Coupons

Test specimen coupons for the total immersion corrosion tests measured 1 x 2 x 0.06 inches with a 0.125-inch diameter mounting hole at the long end. A list of the metal substrates chosen for this test are given in Table 4.

2. Test Procedures

The test procedures for precleaning test specimens, conditioning, methods, and data reporting followed ANSI/ASTM F483 - 77. The calculations for corrosion rates in mil/year were taken from ASTM G31-72 Standard Practice for Laboratory Immersion Corrosion Testing of Metals (Reference 12). According to this standard, a corrosion rate of less than or equal to 0.30 mil/year was considered acceptable.

TABLE 4. METAL SUBSTRATES USED IN IMMERSION CORROSION TEST.

Metal	Specification
Aluminum alloy (Alclad 2024)	QQ-A-250/5
Aluminum alloy (Alclad 7075)	QQ-A-250/13
Aluminum alloy (2024) Anodized (Type I or II)	QQ-A-250/4 MIL-A-8625
Steel, polished 65 RMS	MIL-S-7952
Steel Cadmium plated (Type I, Class 3)	MIL-S-7952 QQ-P-416
Magnesium alloy (Condition H) Chrome pickled (Type I)	QQ-M-44 MIL-M-3171
Titanium alloy (6Al-4V)	MIL-T-9046

SECTION III
PHASE I RESULTS

This section presents the achievements and results obtained for each task in Phase I.

A. TASK 1: LITERATURE SEARCH

An intensive literature search was conducted to compile information relevant to the program objectives. Documents, reports, journals, and conference papers were reviewed and abstracts were entered into a bibliography, which is included in Appendix C. Appendix D includes a list of patents pertaining to paint-stripping, solvent recovery, and paint waste separation. The literature search revealed some mechanical alternatives to chemical paint-stripping that may reduce the generation of hazardous waste. These methods are described in the following paragraphs.

1. Plastic Media Blasting

Plastic Media Blasting (PMB) uses small, rough plastic beads dispersed at high velocity through a nozzle at a painted surface. The technique has been successfully demonstrated at Hill ALC, Pensacola Naval Aviation Depot (NADEP), Republic Airlines, United Airlines, and Boeing Vertol. Many other industrial facilities have installed a PMB unit because it eliminates or reduces the need for chemical paint strippers.

The PMB blasting system includes a booth, compressors for a clean air supply, a ventilation system, nozzles and hoses, hoppers to store the plastic media, and a media reclamation system. The typical media reclamation system uses a cyclone separator to sort the media by size and a magnetic separator to remove ferrous contaminants. Some also include a fluidized bed system to remove heavy particles through high density separation. In general, the media can be recycled 6-10 times depending on the contaminant level required by the individual military service. The Navy for example, has established a contaminant level of 0.05 percent, therefore a highly efficient reclamation system is critical to the operation of the PMB system. Currently, several suppliers manufacture and install state-of-the-art PBM blasting systems that range in size from a small booth to a large hangar for an entire aircraft.

PMB completely eliminates wet hazardous waste (solvent and paint sludge in water). However, the spent plastic beads and the paint chips are classified as hazardous waste because of the metal content in paint. They are currently being incinerated or buried in hazardous waste landfills. Future regulations may soon ban the disposal of PMB waste in landfills.

The PMB technique has been effective in stripping and removing a variety of coatings from a number of substrate surfaces. Extreme care must be exercised on composite surfaces, thin aluminum, and other fragile materials. In particular, composite fibers have sometimes unraveled when blasting composite surfaces that did not have a resin-rich surface. Often using excessive pressure or holding the nozzle too close to the surface damages the substrate. Even though the PMB process is relatively simple, considerations such as these require that operators receive adequate training (Reference 13).

Questions pertaining to the use of PMB have not been answered and work is needed to completely define the parameters of this technique. Damage due to substrate fatigue caused by PMB is still a concern. Recent research results indicate that fatigue losses do not occur for plastic beads with a hardness of 3.0 Mohs, which is softer than those currently used at Hill ALC, where plastic beads with a hardness of 3.5 Mohs are used. Decreasing bead hardness from 3.5 to 3.0 Mohs approximately halves the stripping rate. In addition, fine PMB particles contribute to crack closure and prevent the detection of potentially damaging cracks.

Another question that needs to be addressed is the number of times an aircraft can be stripped using PMB. A test conducted at Corpus Christi Army Depot indicated aircraft skins can be subjected to five PMB paint removal cycles (Reference 14). The Federal Aviation Administration (FAA) has given approval to Boeing Commercial Air to use PMB only once on aircraft with Alclad airframe skins.

A serious problem associated with PMB is the generation of fine dust particles, which can be explosive. A new type of plastic media made of thermoplastic acrylic creates less dust and therefore reduces the risk of explosions. Nevertheless, a very efficient ventilation system is required to minimize dust in the booth.

More research needs to be conducted on the spent plastic media. Ways of removing heavy metals from the PMB material would allow the spent materials to be treated as a nonhazardous waste, thus reducing the overall cost of the PMB process.

2. Sodium Bicarbonate Wet Medium Blasting

This process uses *granular sodium bicarbonate* ($NaHCO_3$) as the abrasive medium that is mixed in the spray gun with small quantities of water and driven by compressed air to impact the part to be stripped. The potential utility of the process was demonstrated by stripping the outer skin of a TF-102 aircraft at Kelly ALC in San Antonio, Texas. The paint thickness was 3 to 7 mils (approximately six coats of paint) and the blasting time was 19.9 hours. Total processing time was 56 hours, which included blasting time, setup, and cleanup. The average stripping rate was between 1.5 - 2.5 ft^2 per minute.

A preliminary cost evaluation conducted by Kelly ALC indicated that the process would be economically competitive with present chemical paint-stripping processes. Advantages of using the sodium bicarbonate media include a reduction of the hazardous waste volume and substantial economic benefits compared to PMB. The spent sodium bicarbonate could be collected in powdered form or dissolved in water and separated from the paint particles and heavy metals. The alkaline solution remaining (water and $NaHCO_3$) would be useful in treating acidic waste streams generated by other on-base facilities. The spent $NaHCO_3$ could also be recycled for reuse if the process proves to be economically and technically feasible.

A recent report submitted by Warner-Robins ALC in Georgia disclosed the results of the corrosion tests on the sodium bicarbonate media. The potential for corrosion existed because at temperatures over 100°F (38°C), sodium bicarbonate is converted to *sodium carbonate*, a highly alkaline chemical (Reference 15). The media, entrapped in interior compartments that can reach temperatures in excess of

160°F (71°C), would create a very corrosive environment for aluminum aircraft structure. Based on immersion corrosion and sandwich corrosion tests, the report recommended that sodium bicarbonate media should not be used to remove paint from aircraft, aircraft assemblies and subassemblies, or aircraft component parts. This process would still be applicable to parts in which structural integrity was not critical to performance.

3. Wheat Starch Media Blasting

The use of wheat starch as a blasting media is the newest innovation for paint-stripping that was developed by Ogilvie Mills, Inc. The Envirostrip media is a nonpetroleum, nontoxic polymer made from pure starch in the form of clear white grit particles. The media hardness is approximately 2.8 Mohs and the particle size ranges from 12 to 30 U.S. standard mesh. Envirostrip has a breakdown rate of 5 percent per cycle and can be reused several times. Depending on the paint system and thickness, the stripping rate ranges from 0.6 - 1.2 ft^2 per minute using a 1/2-inch nozzle.

Based on information gathered at a depainting demonstration held on September 24-28, 1990 at McClellan ALC, the wheat starch process appears to have several advantages. The following advantages and concerns warrant further studies on this process.

a. Envirostrip can be used in a pre-existing PMB unit with only minor modifications, which would eliminate capital equipment costs. The appropriate compressor and vacuum return system should be used to optimize stripping efficiency. A dry and clean air supply is important to avoid moisture in the media. An auger feed is also necessary to prevent clogging of the media in the hopper.

b. The wheat starch process is less operator sensitive which results in less substrate damage. Two identical radome panels made of epoxy graphite composite and painted with an elastomeric paint were stripped with wheat starch and PMB. The panel stripped with wheat starch experienced much less damage to the composite structure than with PMB. Several additional composite substrates were successfully stripped using the Envirostrip media.

c. The surface finish on Alclad and other metal substrates is excellent. This, in turn, facilitates the ease by which the part can be repainted.

d. Because the media is a carbohydrate, the spent media waste can be degraded through biological processes or it can be used as cement kiln fuel.

Several concerns need to be addressed before considering implementing wheat starch media blasting. The process parameters must be optimized to increase stripping efficiency. As with any abrasive media, fatigue tests must be conducted to ensure substrate integrity. Potential corrosion characteristics must be identified due to the hygroscopic nature of the media and its likely entrapment into cracks and crevices. A treatment and disposal scheme is needed to avoid disruption of the normal processes in an Industrial Waste Treatment Plant (IWTP).

4. CO_2 Pellet Blasting

The Lockheed Company first investigated CO_2 pellet blasting for removing aircraft paint. The attractive aspect of this technology is that the dry ice pellets vaporize, and the only waste product is the dry paint chips. There are, however, questions concerning the potential damage to surfaces, effectiveness of paint removal, and operation costs. One problem is that the carbon dioxide generated displaces oxygen in a room, necessitating the use of a separate air supply while blasting. Fog production from humid air is also a problem when using CO_2 pellet blasting (Reference 13).

The engine shop at Tinker ALC uses a CO_2 blasting unit to clean engine parts of excess carbon and paint residues. The unit works well on heavy steel parts, but not on aluminum. It was used in an attempt to remove paint from aluminum aircraft parts, but was found to dimple materials less than 0.06 inches thick. Another problem experienced with the CO_2 blast system was the slow rate of paint removal (0.02 ft^2 per minute). Elastomeric paints on aircraft composite radomes were not removed by the CO_2 pellets. The development of improved control parameters could eliminate most of these problems.

A presentation by Cold Jet of Cincinnati, Ohio indicated that improvements were made to the CO_2 system. It was able to remove paint from bare skin aluminum and titanium down to 0.025 inches at an average rate of 1.75 ft^2 per minute. They also suggested that a combination of CO_2 and a biodegradable chemical stripper or the flashlamp would increase stripping efficiency. Battelle is conducting feasibility studies on the Cold Jet system regarding flow rate, surface analysis, and system optimization in conjunction with flashlamp stripping. Another manufacturer of a CO_2 blasting unit is Alpheus Cleaning Technologies in California.

5. Ice Blasting

The use of ice crystals for paint-stripping was developed by IXTAL Blast Technology Corporation, of Victoria, B.C., Canada. The original ice blasting unit was designed for the Canadian Navy to remove enamel paint from the inside of ships where ventilation was very poor. The ice blasting system consists of an ice maker, refrigeration unit, air supply, ice handling unit, process controller, and blast nozzle. The current prototype as demonstrated at McClellan ALC on September 24-28, 1990, works well on uncured paints. Its performance in paint removal from aircraft structures, where high-performance paints are used and a variety of substrates are encountered, can be improved with a bigger compressor to exceed the fracture threshold of cured paints and a higher media flow rate to increase the stripping rate.

Ice blasting may be ideal for the decommissioning of nuclear power plants and reactor facilities. It is a very cost effective and simple way to strip paint, dirt, and contamination from the surface of tanks and cooling towers. The wastewater can then be treated to remove radioactive contaminants and heavy metals.

6. High-Pressure Water-Jet Blasting

Both the Navy and the Air Force investigated water-jet blasting for removing paint. This process uses pulsed or continuous water-jet blasting produced by high-pressure pumping. Its technical feasibility has been demonstrated in the automotive industry to remove paint buildup from the floor gratings of paint booths. United Technologies has developed a fully automated robotic system that is used to remove paint from solid rocket boosters at the

Kennedy Space Center. This robotic system has also been used to remove paint from engine components and aircraft wing flaps.

The following questions still need to be resolved about the robotic system: (a) system control and reliability, (b) potential damage to the substrate surface caused by the system, (c) system's ability to remove a wide range of coatings, (d) potential for internal corrosion from water infiltration, and (e) worker safety (Reference 13).

7. Laser Paint-stripping

Research has been directed at developing a technology to remove paint using pulses of high intensity radiant energy. The pulsed CO_2 laser was chosen for two reasons: First, the CO_2 laser is highly efficient which makes production systems economically feasible. Second, the 10.6 micron wavelength of the CO_2 laser is readily absorbed by the paint. Process control is enhanced by the pulsed output, which allows examination of the target before and after each pulse (Reference 16).

International Technical Associates (InTA) have developed a robot-operated pulsed CO_2 laser system (Reference 17). The laser will automatically strip paint and other coatings from metallic or composite aircraft surfaces. Operator safety is not jeopardized because of the remote controls of this system. The power of the laser beam can be precisely controlled to remove one coat of paint or all layers down to the substrate. The laser beam can also be moved through a raster over a large area to allow an individual area to cool between intervals and prevent substrate damage. The aircraft does not need to be masked before laser stripping and the waste generated is vaporized paint in its gaseous form. Tests need to be conducted to quantify the amount of heavy metals in the vaporized paint waste.

InTA is currently contracted by the Navy to build and install two fully automated production laser systems at the Cherry Point Naval Aviation Depot in North Carolina and at the Norfolk Naval Shipyard in Virginia. This system will be used to verify the laser's reliability and efficiency in removing paint from fighter-size aircraft. In addition, the Air Force and Army are in the process of signing a Memorandum of Understanding (MOU) with the Navy to include tests on larger aircraft and other ground support vehicles.

8. Flashlamp Stripping

Flashlamp stripping is similar in theory to laser stripping, except it uses a high-energy Xenon arc lamp to vaporize paint. The flashlamp configuration consists of a power source, umbilical cords, and lamp heads with their respective housings. In this process, concentrated light energy is applied in rapid pulses to heat thin layers of paint. The paint is carbonized rather than melted and all that is left is a fine soot on the substrate surface. The soot contains heavy metals from the paint and would have to be disposed of as hazardous waste. Unresolved questions involve potential damage to various substrates due to high temperatures, generation of toxic air pollutants, economic benefits, and design issues regarding a production unit (Reference 13).

McClellan ALC, California is conducting research and development on this process (Reference 18). Based on the PRAM report published in 1987, the flashlamp can strip paint from metallic and composite structures without damage to the substrate and can selectively strip down to the primer. The surface temperature, measured with an infrared thermometer, was 125°F after exposure to the flashlamp.

A demonstration of the flashlamp was held at McClellan on September 24-28, 1990. A prototype system designed and built by Surfprep in 1985 was used for the demonstration. This system was loud (95 decibels), cumbersome, and had difficulty removing paint from curved surfaces.

A second generation system called High Intensity Light Depainting System (HILDS) is being developed with the following modifications to improve the flashlamp's applicability to aircraft and other component depainting.

a. multiple heads and/or quick disconnect and snap-on heads for corners, curvatures, and recessed areas.

b. mechanically automated system to improve handling.

c. controls to lower pulse width and power into light to minimize thermal damage.

d. controls to vary current intensity and change wavelength for different colored paints.

Another system is being designed by Maxwell Labs to incorporate CO_2 blasting with the flashlamp to remove the soot and excess paint that is left on the surface.

9. Cryogenic Coating Removal

This method operates on the principle that organic coatings become brittle and tend to de-bond from substrate metals because of different thermal contraction of the coating films and the basis material.

A proprietary system uses liquid nitrogen in an enclosed chamber to reduce the surface temperature to -100°F (-73.3°C) and plastic media are mechanically thrown at the surface to break off the frozen paint. This system, at present, is not suitable for large-scale operations (Reference 19).

10. Salt-Bath Paint-stripping

Equipment is commercially available to strip paints in a molten salt bath operating at a temperature of 900°F (482.2°C). This method is used in the automotive and appliance manufacturing industries. In this process, items to be stripped (generally steel) are immersed in the molten salt bath (mixture of sodium hydroxide, sodium or potassium nitrate, sodium chloride, and catalyst) where heat destroys the paint. This process cannot be used on parts or equipment constructed of aluminum, nonmetallics, and alloys because of the effects of heat (Reference 13).

11. Burn-Off Systems

High-temperature flames and ovens and fluidized beds are used commercially to burn paint off; however, this technology is limited to steel parts (Reference 13).

B. TASK 2: COMPILE MILITARY SPECIFICATIONS AND ASTM STANDARDS

All available MIL-SPECS and ASTM Standards were compiled, filed, and reviewed for test procedures on biodegradability, stripping efficiency, and corrosivity. Pertinent specifications are cited in this report.

C. TASK 3: SURVEY PAINT-STRIPPING PROCEDURES

A questionnaire was written to obtain specific information on the current procedures used, the kinds of paints and substrates involved, and the amount of waste generated. A copy of the questionnaire (Appendix E) was sent to a liaison at Tinker ALC who routed copies to the appropriate persons at the five ALCs. A computer data base was developed to organize the responses from the questionnaire and includes the following information:

1. Air Force Base

   a. Aircraft and parts that are stripped
   b. Name and phone number of contact personnel

2. Paint Systems

   a. Types of paints used and their military specifications
   b. Current paint-stripping process
   c. Requirements and concerns with current process
   d. Amount of waste generated from current process

3. Substrates

a. Types of substrates and military specifications
b. Current paint-stripping process
c. Requirements and concerns of current process
d. Amount of waste generated from current process

This data base is on DBASE IV™ and can generate reports on the paint systems, substrates, paint-stripping process, and key words from the memo field for one or all Air Force Bases.

D. TASK 4: ENCOURAGE INDUSTRY COLLABORATION

In April 1989, visits were made to Boeing Aerospace in Seattle, Washington to discuss their efforts to eliminate toxic chemical paint strippers. They have already tested many commercially available paint strippers for stripping efficiency and corrosion characteristics but have not found suitable replacement strippers to date. A collaborative research agreement was signed between Boeing and the INEL to exchange technical information regarding a wide range of hazardous waste minimization programs. The three priority areas of the agreement are as follows: (a) reduction and elimination of solvents and chlorofluorocarbons (CFCs), (b) reduction of chromium emissions and usage, and (c) hazardous waste elimination. Technical task teams were established for each research project and regularly scheduled meetings are planned for technology transfer. The goal is to expand the collaboration effort with other aerospace companies and the paint and chemical industries.

E. TASK 5: ACQUIRE SAMPLES FOR LABORATORY ANALYSIS

Names and phone numbers of chemical companies were obtained from the Thomas Register and the Products Finishing Directory to identify sources of commercially available alternative paint-stripping formulations.

Approximately 250 chemical companies were contacted (see the list in Appendix F). Inquiries focused on nonchlorinated, nonphenolic strippers that could remove epoxy paint from aluminum or steel. Biodegradability and low toxicity were specified as important criteria. Seventy samples were received and the Material Safety Data Sheets (MSDS) were reviewed for proper use, handling, and disposal of wastes. Many were discarded because of low flash point or toxic ingredients. Appendix G contains the company and product names of the 63 samples chosen for evaluation, and Appendix H summarizes important information on their proper use. Table 5 categorizes the samples as either spray/brush-on or immersion type strippers.

F. TASK 6: EVALUATE SAMPLES FOR TOXICITY/SAFETY

Several samples have been eliminated because they contained methylene chloride or had a flash point below 140°F (60°C). In the future, formulations with a flash point below 200°F (93°C) will be eliminated from the screening tests. Other samples were discarded because they contained organic compounds that are on the EPA's list of toxic organics. The Permissible Exposure Limit (PEL) and/or the Threshold Limit Value (TLV) in milligrams/liter (mg/L) for each known ingredient is included in Appendix I and compared to that of methylene chloride, phenol, and formic acid.

G. TASK 7: PERFORM LABORATORY SCREENING OF ALTERNATIVE STRIPPERS

1. Biodegradability

To establish a basis for comparison, the biodegradability tests were run with appropriate controls and standards. Phenol was used as the standard solvent, since this is the solvent currently treated at Tinker ALC IWTP. Therefore, changes in the biological activity (ATP) and chemical oxygen demand (COD) were compared to the controls in which phenol was added. Initial COD analysis was performed on each paint stripper before the biodegradability test. This information is presented in Appendix J.

TABLE 5. PAINT STRIPPERS CATEGORIZED ACCORDING TO METHOD.

IMMERSION	SPRAY/BRUSH-ON
Ambion, Insulstrip S	3M, Safest Stripper
Broco, Broco 300	Brulin, Safety Strip 2000
Brulin, Safety Strip 1000	Brulin, Safety Strip 4000
Brulin, Exp. 2187	Chemco, CSP-2015
Chemical Methods, CM-500	Chemical Methods, CM-550
Chemical Methods, CM-3321	Chemical Methods, CM-552X
Chemical Methods, CM-3707	Du Pont, DBE (E60988-37)
Chemical Methods, CM-3707A	Envirosolv, Re-Entry ES*
Chemical Solvents, SP-822	Fine Organics, FO 2115A
Chemical Solvents, SP-823	Hurri-Kleen, Paint Remover
Chemical Solvents, SP-824	Hurri-Kleen, Stay Put
Chemical Solvents, SP-800	Rochester Midland, PSS601
Chemical Systems, PS-589X/590	Texo, Texo LP 1582
Eldorado, HT-2230	Turco, Turco 6088A
Elgene, Fabulene	Turco, Turco 6744
Elgene, 22 Skidoo	Turco, Turco 6776
Enthone, Endox L-76	
Enthone, Endox Q-576	
Envirosolv, Re-Entry ES*	
Exxon, Exp.#1	
Exxon, Exp.#2	
Exxon, Exp.#3	
Exxon, Exp.#4	
Exxon, Norpar 13	
Exxon, Norpar 15	
Fine Organics, FO 606	
Fine Organics, FO 621	
Fine Organics, FO 623	
Frederick Gumm, Clepo Envirostrip 222	
Fremont, F-289	
GAF, M-Pyrol	
Indust. Chem. Prod. of Detroit, Enamel Stripper 77	
Key Chemicals, Key Chem 0457OH	
Man-Gill, Power Strip 5163/0846	
McGean-Rohco, Cee-Bee A-245	
McGean-Rohco, Cee-Bee A-477	
Oakite, Oakite Stripper ALM	
Patclin, 103B	
Patclin, 104C	
Patclin, 106Q	
Patclin, 126	
Pavco, Decoater 3400/3400-AX	
Rochester Midland, PSS 600	
Super Wash Intl., Super-Wash	
Turco, Turco 5668	
U.S. Polychemical, PXP Salome M	
Witco, Stripper MCR	

* Can be used for either method

The biodegradability tests were run on all 63 samples and on the paint strippers currently being used at the ALCs. The biodegradability of each sample was determined by a decrease in COD and an increase in ATP over a 6-hour period that was comparable to phenol. Appendix K contains the actual readings from the ATP and COD analyses for each test and the graphs generated from the data. The paint strippers are listed according to the date they were tested. Graphs cannot be generated for samples in which the COD readings were above the range of the DR3000 spectrophotometer. These samples were not biodegradable to below NPDES limits and therefore would not require further testing during Phase I.

Most of the samples tested were not biodegradable according to the definition stated in Section II - Test Procedures. Many of the COD values were above 3,000 mg/L at the 1/600 concentration and did not show a significant decrease during the 6-hour test. The few that were biodegradable, did not pass the preliminary stripping efficiency test. The laboratory screening indicates that N-methyl-pyrrolidone, a primary solvent in many of the alternative strippers was not biodegradable to below NPDES limits (75 mg/L) because it had a very high COD reading which increased slightly with time. This could have been due to desorption of the solvent from the biomass and/or column during the test period, which was then measured as an increase in COD if the solvent was not biodegradable to any great extent. Based on the ATP data, N-methyl-pyrrolidone was not toxic to the microorganisms since there was an increase in biological activity by the end of the test. Other paint strippers were alkaline based (inorganic) and the possible degradation of small quantities of organics was negligible to the overall change in COD. Acclimation of the microorganisms before this test may be necessary to obtain a true indication of the biodegradability of these paint strippers. The standard test method for Biodegradability of Alkylbenzene Sulfonates (Reference 11) recommends a 72-hour acclimation period before the biodegradation tests. Other methods are needed to treat alkaline paint strippers before exposure to the activated sludge system.

2. Paint-Stripping Efficiency

General Dynamics in Fort Worth, Texas provided the aluminum coupons with an epoxy paint system for the preliminary stripping efficiency test. Boeing Aerospace in Seattle, Washington was contracted to supply the aluminum and steel coupons with six paint systems for the more stringent stripping efficiency test. An enclosed spray booth was built and a high-pressure hot water gun was purchased to rinse the coupons. The dry film thickness gauges for aluminum and steel were also purchased.

The preliminary test was completed on all 63 samples. Turco 5351 was used as the control to compare the results of this test. Aluminum coupons were used for the preliminary screening and steel coupons were used only if the stripper sample was not suitable for aluminum substrates. The samples were tested according to the manufacturer's recommended method of application (spray/brush-on or immersion), concentration, and temperature. Visual examination was used to determine the samples' stripping efficiency and to choose those which would go on to further testing. The anodized aluminum coupons were the most difficult to remove paint from, therefore, not many samples did well on these coupons. Even Turco 5351 was unable to remove the primer from the anodized aluminum. Appendix L contains the results of the preliminary test.

Twenty-four samples were chosen that removed at least 50 percent of the topcoat and primer. Table 6 lists the company and product names of each sample. All 24 samples were for hot immersion applications only, and none of the spray/brush on paint strippers at room temperature passed. Chemical Methods, CM-500 and Enthone, Endox L-76 were used for steel substrates only.

The 24 samples were then subjected to a more stringent stripping efficiency test with six paint systems on aluminum and steel coupons. For this test McGean Rohco, Cee Bee A-227D, Cee Bee A-458, and Cee Bee J-59 were used as controls.

The paint strippers varied in their stripping efficiency based on the types of paint systems encountered. They all had more difficulty removing paint from the aluminum coupons than the steel coupons because of the alodined surface treatment which increased adhesion. The paint strippers, including the controls, had great difficulty removing the epoxy polyamide primer and topcoat (paint system 6 in Table 3).

TABLE 6. PAINT STRIPPERS THAT PASSED THE PRELIMINARY STRIPPING TEST.

	COMPANY NAME	PRODUCT NAME
1.	AMBION CORP.	INSULSTRIP S
2.	CHEMICAL METHODS	CM-500
3.	CHEMICAL METHOD	CM-3707
4.	CHEMICAL METHODS	CM 3707A
5.	CHEMICAL SOLVENTS	SP-800
6.	CHEMICAL SOLVENTS	SP-823
7.	CHEMICAL SYSTEMS	PS 589X/590
8.	ELDORADO	HT-2230
9.	ENTHONE	ENDOX L-76
10.	FINE ORGANICS	FO 606
11.	FINE ORGANICS	FO 623
12.	FREDERICK GUMM	CLEPO ENVIROSTRIP 222
13.	GAF	M-PYROL
14.	INDUSTRIAL CHEM. PRODUCTS	ENAMEL STRIPPER 77
15.	KEY CHEMICAL	KEY CHEM 04570H
16.	MAN-GIL	POWER STRIP 5163
17.	McGEAN-ROHCO	CEE-BEE A477
18.	McGEAN-ROHCO	CEE-BEE A245
19.	PATCLIN CHEMICAL	PATCLIN 126 HOT DIP
20.	PAVCO	DECOATER 3400
21.	ROCHESTER MIDLAND	PSS 600
22.	TURCO	T-5668
23.	U.S. POLYCHEM	PXP SALOME "M"
24.	WITCO	STRIPPER MCR

Ten paint strippers passed this test because they removed 90 percent of both the topcoat and primer from at least 7 of the 12 painted coupons. The company and product names are listed in Table 7. The detailed information regarding stripping efficiency at 15, 30, and 60 minutes for each paint system is included in Appendix M. Chemical Solvents SP-800 was run at the wrong temperature and will have to be tested again at 150°F (65.6°C) rather than 200°F (93.3°C) during Phase II. The operating temperature had to be 50°F (10°C) below the paint stripper's flash point.

3. Corrosion Testing

The metal coupons for the total immersion corrosion test included three types of aluminum, and two types of steel, one type of magnesium, and one type of titanium as described in Table 4. The acceptable corrosion results ($\leq$ 0.3 mil/year) for each of the 10 paint strippers are given in Table 8. Appendix N provides a detailed description of the corrosive effects on the metal coupons. Chemical Methods' CM 3707 was the least corrosive, passing on five of the seven metals, and Patclin 126 was the most corrosive, failing on every metal. The nine paint strippers that passed on at least one metal will go on to further testing in Phase II.

TABLE 7. PAINT STRIPPERS THAT PASSED THE STRIPPING EFFICIENCY TEST.

	COMPANY NAME	PRODUCT NAME
1.	CHEMICAL METHODS	CM-3707
2.	CHEMICAL SOLVENTS	SP-800
3.	FINE ORGANICS	FO 606
4.	FREDERICK GUMM	CLEPO ENVIROSTRIP 222
5.	GAF	M-PYROL
6.	MCGEAN-ROHCO	CEE BEE A245
7.	MCGEAN-ROHCO	CEE BEE A477
8.	PATCLIN	126 HOT STRIPPER
9.	ROCHESTER MIDLAND	PSS 600
10.	TURCO	T-5668

TABLE 8. IMMERSION CORROSION TEST RESULTS.

COMPANY	PRODUCT	ACCEPTABLE CORROSION RESULTS	MIL-SPEC
Chemical Methods	CM-3707	Aluminum Alloy (Alclad 7075)	QQ-A-250/13
		Aluminum Alloy (Alclad 2024)	QQ-A-250/5
		Aluminum Alloy (2024,Anodized)	QQ-A-250/4
		Steel, polished 65 RMS	MIL-S-7952
		Titanium Alloy (6Al-4V)	MIL-T-9046
Chemical Solvents	SP-800	Aluminum Alloy (Alclad 7075)	QQ-A-250/13
		Aluminum Alloy (Alclad 2024)	QQ-A-250/5
		Steel, polished 65 RMS	MIL-S-7952
		Titanium Alloy (6Al-4V)	MIL-T-9046
Fine Organics	FO 606	Steel, polished 65 RMS	MIL-S-7952
		Titanium Alloy (6Al-4V)	MIL-T-9046
Frederick Gumm	Clepo Enviro-strip 222	Titanium Alloy (6Al-4V)	MIL-T-9046
GAF	M-Pyrol	Aluminum Alloy (Alclad 7075)	QQ-A-250/13
		Aluminum Alloy (Alclad 2024)	QQ-A-250/5
		Aluminum Alloy (2024,Anodized)	QQ-A-250/4
		Titanium Alloy (6Al-4V)	MIL-T-9046
McGean-Rohco	Cee-Bee A477	Titanium Alloy (6Al-4V)	MIL-T-9046
McGean-Rohco	Cee-Bee A245	Steel, polished 65 RMS	MIL-S-7952
		Steel, cadmium plated	MIL-S-7952
		Titanium Alloy (6Al-4V)	MIL-T-9046
Patclin Chemical	Patclin 126 Hot	Not acceptable	
Rochester Midland	PSS 600	Aluminum Alloy (Alclad 7075)	QQ-A-250/13
		Aluminum Alloy (Alclad 2024)	QQ-A-250/5
		Aluminum Alloy (2024,Anodized)	QQ-A-250/4
		Titanium Alloy (6Al-4V)	MIL-T-9046
Turco	Turco 5668	Steel, polished 65 RMS	MIL-S-7952
		Titanium Alloy (6Al-4V)	MIL-T-9046

SECTION IV
CONCLUSIONS

As a result of gathering baseline information, military specifications and ASTM standards, test plans were developed for the laboratory screening of biodegradability, stripping efficiency, and corrosion. The responses to the questionnaire also provided valuable information on current paint-stripping procedures and on the needs of each facility. The data base developed can be accessed as a reference point from which new paint strippers can be verified and selected. Several new process technologies such as media blasting were identified for further studies. Each had advantages to a potential application but required pilot-scale studies before full-scale implementation.

A joint program has been established between Boeing Aerospace and the INEL on collaborative research efforts to reduce and eliminate toxic and hazardous chemical from processes used in the fabrication and maintenance of aerospace hardware. This will facilitate technology transfer to both government and private sectors.

Based on the 6-hour biodegradability screening tests, most of the paint strippers were not biodegradable to within NPDES limits of 75 mg/L for chemical oxygen demand (COD). Of the ten paint strippers that passed the stripping efficiency test, none passed the biodegradability test. Acclimation studies and other approaches such as chemical oxidation may be necessary to aid the activated sludge system in breaking down the organic constituents. Solvent recovery and recycling would also reduce the amount of waste entering the IWTP.

The stripping efficiency test revealed several potential substitutes for the immersion method at an elevated temperature. These paint strippers are applicable to parts that can be immersed in a dip tank but not for large aircraft fuselage and wings. New formulations for the spray/brush-on method at room temperature are being developed by the chemical companies and will also be tested. If this proves unsuccessful, mechanical paint-stripping methods may be necessary to compliment chemical stripping.

The immersion corrosion tests were performed to determine the corrosion characteristics of the ten paint strippers. The results indicate that the use of these new paint strippers is limited to certain metal substrates and does not have a wide range of applications. Therefore, several chemical alternatives may be necessary to achieve stripping efficiency while preserving substrate integrity.

These tests provide baseline information that can be used to identify the best alternatives to toxic chemical paint strippers. Further studies are needed to verify these results. The criteria were based on Air Force requirements but can be modified to be applicable to the Army, Navy, and other services.

SECTION V
RECOMMENDATIONS

The recommendations for Phase II of this project are summarized in Section I. The verification studies should be conducted on the nine paint strippers listed in Table 9 that passed the corrosion tests on at least one metal. The emphasis should be placed on extended performance tests along with process enhancements to improve stripping efficiency. In addition, new formulations for spray/brush on paint strippers should also be tested during Phase II. Waste treatment through biological, chemical, or physical methods is also critical to the success of implementing new chemical paint strippers. New process technologies should be closely evaluated to be used for applications in which low toxicity chemicals cannot be identified or is not cost effective. Wheat starch blasting appears to have most potential as a viable near-term alternative technology. The information acquired during Phase II should be continuously added to the Solvent Utilization Handbook (data base), which in turn will facilitate technology transfer.

TABLE 9. PAINT STRIPPERS FOR PHASE II TESTING.

	COMPANY NAME	PRODUCT NAME
1.	CHEMICAL METHODS	CM-3707
2.	CHEMICAL SOLVENTS	SP-800
3.	FINE ORGANICS	FO 606
4.	FREDERICK GUMM	CLEPO ENVIROSTRIP 222
5.	GAF	M-PYROL
6.	MCGEAN-ROHCO	CEE BEE A245
7.	MCGEAN-ROHCO	CEE BEE A477
8.	ROCHESTER MIDLAND	PSS 600
9.	TURCO	T-5668

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APPENDIX A

ORGANIC COMPOUNDS CITED BY USEPA*

Acenaphthene
Acrolein
Acrylonitrile
Benzene
Benzidine
Carbon tetrachloride
(tetrachloromethane)
Chlorobenzene
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane
Hexachloroethane
1,1-Dichloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
Chloroethane
Bis (2-chloroethyl) ether
2-Chloroethyl vinyl ether (mixed)
2-Chloronaphthalene
2,4,6-Trichlorophenol
Parachlorometa cresol
Chloroform (trichloromethane)
2-Chlorophenol
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3-Dichlorobenzidine
1,1-Dichloroethylene
2,4-Dichlorophenol
1,2-Dichloropropane
1,3-Dichloropropylene
(1,3-Dichloropropene)
2,4-Dimethylphenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
1,2-Diphenylhydrazine
Ethylbenzene
Fluoranthene
4-Chlorophenyl phenyl ether
4-Bromophenyl phenyl ether
Bis-(2-chloroisopropyl) ether
Bis-(2-chloroethoxy) methane
Methyl chloride (dichloromethane)
Methyl bromide (bromomethane)
Bromoform (tribromomethane)
Dichlorobromomethane
Chlorodibromomethane
Hexachlorobutadiene
Hexachlorocyclopentadiene
Isophrone
Naphthalene
Nitrobenzene
2-Nitrophenol
4-Nitrophenol
2,4-Dinitrophenol
4,6-Dinitro-o-cresol
N-Nitrosodimethylamine
N-Nitrosodiphenylamine
N-nitrosodi-n-propylamine
Pentachlorophenol
Phenol
Bis (2-ethylhexyl) phthalate

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* Source: 40 CFR, Chapter 1, 7-1-87 Ed. (1987).

Butyl benzyl phthalate
Di-n-butyl phthalate
Di-n-octyl phthalate
Diethyl phthalate
Dimethyl phthlate
1,2-Benzanthracene
(benzo(a)anthracene)
Benzo(a)pyrene(3,4-benzopyrene)
3,4-Benzofluoranthane
(benzo(b)fluoranthene)
11,12-Benzofluoranthene
(benzo(k)fluoranthene)
Chrysene
Acenaphthylene
Anthracene
1,12-Benzoperylene
(benzo(ghi) perylene)
Fluorene
Phenanthrene
1,2,5,6-Dibenzanthracene
(dibenzo(a,h)anthracene)
Indeno (1,2,3-cd) pyrene)
(2,3-o-phenylene pyrene)
Pyrene
Tetrachloroethylene
Toluene
Trichloroethylene
Vinyl chloride (chloroethylene)
Aldrin
Dieldrin
Chlordane (technical mixture and
metabolites)
4,4-DDT
4,4-DDE(p,p-DDX)
4,4-DDD(p,p-TDE)
Alpha-endosulfan
Beta-endosulfan
Endosulfan sulfate
Endrin
Endrin aldehyde
Heptachlor
Heptachlor epoxide
(BHC-hexachlorocyclohexane)
Alpha-BHC
Beta-BHC
Gamma-BHC
Delta-BHC
(PCB-polychlorinated biphenyls)
PCB-1242 (Arochlor 1242)
PCB-1254 (Arochlor 1254)
PCB-1221 (Arochlor 1221)
PCB-1248 (Arochlor 1248)
PCB 1260 (Arochlor 1260)
PCB-1016 (Arochlor 1016)
Toxaphene
2,3,7,8-Tetrachlorodibenzo-p-
dioxin (TCDD)

APPENDIX B

BIODEGRADABILITY PROTOCOL

A. TEST CONFIGURATION

The activated sludge from Tinker AFB is maintained in a culture column with air circulation, siphon-activated maximum volume overflow wasting, and constant nutrient additions. Solids are maintained at approximately 2.5 grams/liter.

Time (hours)	Test Columns 1	2	3	4	5	6 (Phenol)
0	2F* 2ATP	2F 2ATP	2F 2ATP	2F 2ATP	2F 2ATP	2F 2ATP
1	2F 2UF	2F	2F	2F	2F	2F
2	2F	2F	2F	2F	2F	2F
3	2F	2F	2F	2F	2F	2F
4	2F	2F	2F	2F	2F	2F
5	2F 2UF	2F	2F	2F	2F	2F
6	2F 2ATP	2F 2ATP	2F 2ATP	2F 2ATP	2F 2ATP	2F 2ATP

* 2F 2 filtered (2-milliliter) samples for COD analysis
ATP 2 unfiltered (1-milliliter) samples for adenosine triphosphate (ATP) analysis
2UF 2 unfiltered (2-milliliter) samples for COD analysis

B. SOLIDS

Activated sludge, brought to this laboratory from Tinker AFB's IWTP, is concentrated by centrifugation at 5°C and 5000 rpm. The elutrient is discarded and the pellet is collected in a container, which is stored in a refrigerator at 5°C. The moisture content of the concentrated sludge is determined by adding 1.0 grams of wet concentrated sludge to a preweighed pan and dried to a constant weight at 105°C in a drying oven. The percent solids is determined by:

$$\frac{\text{Dry weight}}{\text{Wet weight}} \times 100 = \text{\% solids}$$

This value is used to determine the amount of concentrated sludge added to the column.

$$\frac{\text{2.5 grams solids/liter}}{\text{\% Solids}} \times \text{4 liters of column} = \text{amount of wet solids added to the column}$$

C. COLUMN SETUP

1. Add 4 liters of dilution medium to the column and turn on the air agitation in the column.

2. Allow the column to mix for 5 minutes to permit solution mixing and oxygenation before adding solids.

3. Add the preweighed solids to the column.

4. Start nutrient feed to the column.

5. After a 1/2-hour mixing period, add a 50-milliliter sample to a glass beaker, add a magnet bar, and place on a stirring plate. Measure the solution pH with a calibrated pH probe. Discard this solution after the pH determination.

6. Add a 25-milliliter sample of the culture column material to a preweighed drying tin, place the sample in a 105°C drying oven and dry to a constant weight.

Comments:

The air flow in the column should be adjusted to prevent excessive bumping, but adequate mixing.

Check all feed and waste discharge lines for proper flow.

Prepare a slide for microscopic observation of the column material.

D. ACTIVATED SLUDGE MEDIUM

The medium used for maintaining the activated sludge will be made of the following materials (*):

1 liter deionized water (DIW)
1 milliliter solution I
1 milliliter solution II
1 milliliter solution III

Solution	Compound	g/L
I	NH_4Cl	35
	KNO_3	15
	$K_2HPO_4 \cdot 3H_2O$	75
	$NaH_2PO_4 \cdot H_2O$	25
II	KCl	10
	$MgSO_4$	20
	$FeSO_4 \cdot 7H_2O$	1
	(adjust pH to 3.0)	
III	$CaCl_2$	5
	$ZnCl_2$	0.05
	$MnCl_2 \cdot 4H_2O$	0.5
	$CuCl_2$	0.05
	$CoCl_2$	0.001
	H_3BO_3	0.001
	MoO_3	0.0004

*Federal Register (September 27, 1985), volume 50, number 188, page 39279. Refrigerate the solutions.

E. NUTRIENT SUPPLEMENT PREPARATION

The following addresses the nutrient feed concentration of phenol, nitrogen, and phosphorus added daily. The ratio of 10:5:1 (C:N:P) is the operating premise. Iron is added as an additional supplement for good floc growth.

The average phenol feed is assumed to be 100 ppm (similar to pilot plant maintenance feed requirements). The feed rate of 16 liters per day would offer a 4.0 turnover rate of the column (4-liter volume), similar to the pilot plant and IWTP at Tinker AFB.

100 ppm carbon (100 milligrams/liter)(16 liters) = 1.60 grams C/day
50 ppm nitrogen (50 milligrams/liter)(16 liters) = 0.80 grams N/day
10 ppm phosphorus (10 milligrams/liter)(16liters) = 0.16 grams P/day
5 ppm iron (5 milligrams/liter)(16liters) = 0.08 grams Fe/day

For the source of carbon, phenol will be added at a rate of <u>1.60 grams of phenol</u> daily.

Ammonium chloride (NH_4Cl) is used as the source of nitrogen. The nitrogen in ammonium chloride represents approximately 26 percent of the formula weight; therefore, (0.8 gram N/day)/(26% N/NH_4Cl) = <u>3.077 grams NH_4Cl/day</u> is required in the nutrient feed.

Potassium phosphate (KPO_4) is used as the source of phosphorus, which represents approximately 13 percent of the formula weight; therefore,

$(0.16 \text{ gram } P/\text{day})/(13\% \ P/KPO_4)$ = 1.231 grams KPO_4/day required in the nutrient feed.

Ferric chloride ($FeCl_3$) is used as the source of iron, which represents approximately 34.5% of the formula weight; therefore, $(0.08 \text{ gram/day})/(34.5\% \ Fe/FeCl_3)$ = 0.232 g $FeCl_3$ required in the nutrient feed.

F. FEED/FLOW RATE CALCULATIONS

Based on a feed flow rate of 0.75 milliliters/minute, the amount of materials needed to be in a liter of the biodegradation solution can be calculated by:

(0.75 milliliter/minute)(60 minutes/hour)(24 hours/day) = 1080 milliliters/day, or 1.08 liters/day. Therefore, in making up the nutrient feed for the columns, the following compounds must be added in the amounts indicated:

$$\frac{(1.60 \text{ grams phenol/day})}{(1.08 \text{ L/day})} = 1.481 \text{ grams/liter}$$

$$\frac{(3.077 \text{ grams ammonium chloride/day})}{(1.08 \text{ liters/day})} = 2.849 \text{ grams/liter}$$

$$\frac{(1.231 \text{ grams potassium phosphate/day})}{(1.08 \text{ liters/day})} = 1.140 \text{ grams/liter}$$

$$\frac{(0.232 \text{ grams ferric chloride/day})}{(1.08 \text{ liters/day})} = 0.215 \text{ grams/liter}$$

Volume Prepared (Liters)	Phenol (grams)	Ammonium Chloride (grams)	Potassium Phosphate (grams)	Ferric Chloride (grams)
1	1.481	2.849	1.140	0.215
2	2.962	5.698	2.280	0.430
3	4.443	8.547	3.420	0.645

1. Add the ammonium chloride, potassium phosphate (monobasic), and ferric chloride to the basic nutrient medium.

2. Sterilize the solution, 121°C, 20psi, 20 minutes.

3. Cool the solution to room temperature.

4. To prepare the phenol additive:
   a. Dissolve phenol in 50 milliliters deionized water
   b. Filter sterilize

5. Add the phenol to the medium.

6. Attach the nutrient medium, aseptically, to the nutrient feed pump.

G. TEST SETUP PROCEDURES

During the biodegradation test, the basic EPA medium will be used to dilute the solvent and culture material in the test columns. All test columns will be filled to a total final volume of 250 milliliters. The solvent test columns will be filled as follows:

- o 225 milliliters basic EPA medium.
- o 0.417 milliliter of most concentrated manufacturer's recommended mix of solvent (based on a 1:600 dilution, which is a typical IWTP dilution ratio at Tinker AFB)
- o 25 milliliters of culture column microorganisms

The phenol test column will be filled as follows:

- o 200 milliliters of basic EPA medium.
- o 25 milliliters of a 1000-ppm phenol solution (0.1000 grams of phenol added to a 100-milliliter volumetric flask and filled to the mark with nanopure water).
- o 25 milliliters of culture column microorganisms

CODs will be run according to HACH Chemical procedures:

- o Filtered: 2-milliliter samples will be filtered using a syringe-filter system equipped with a 0.45-micron pore size filter.
- o Unfiltered: 2-milliliter samples, collected from one column at the first and fifth hours of testing, will be measured for total COD.

ATPs will be run according to the internal standard method of Turner Instruments, Inc.

Dry weights will be collected on the culture column and initial samples at the beginning and end of the test runs. Twenty-five milliliters of material will be placed in a preweighed drying pan and heated in a drying oven (at 103°C) until dry. The pan will be reweighed and the difference between the initial and final pan weights divided by the volume placed in the pan will give solid dry weights per unit volume.

COD will be compared to a control phenol column run simultaneously during each test period. Also, CODs will be compared to each other based on solid dry weights, ATP, and relative phenol degradations.

H. ATP PROCEDURE

Set ATP photometer: 3-second delay, 10-second integration period.

1. Reading Unknown (RU)

   - Place 50 microliters sample in an 8 X 50 millimolar polypropylene tube.
   - Add 50 microliters releasing agent, mix, and let stand 30 seconds.
   - Add 50 microliters HEPES buffer.
   - Place in photometer.
   - Inject 100 microliters Luciferin-Luciferase (L&L).
   - Record full integral.

2. Reading Internal Standard (RIS)

   - Place 50 microliters sample in an 8 X 50 millimolar polypropylene tube.
   - Add 50 microliters releasing agent, mix, and let stand 30 seconds.
   - Add 50 microliters ATP Standard, 0.0025 micrograms/milliliter ATP.
   - Place in photometer.
   - Inject 100 microliters Luciferin-Luciferase (L&L).
   - Record full integral.

3. Reading the Blank (RB)

   - 50 microliters distilled water in an 8 X 50 millimolar polypropylene tube.
   - Add 50 microliters releasing agent, mix, and let stand 30 seconds.
   - Add 50 microliters HEPES buffer.
   - Place in photometer.
   - Injects 100 microliters Luciferin-Luciferase (L&L).
   - Record full integral.

4. Reagents

Releasing Agent - purchased ready-to-go from Turner Designs, Inc.

HEPES buffer - purchased ready-to-go from Turner Designs, Inc.

ATP Standard - purchased as a concentrated, sterile liquid from Turner Designs, Inc. (see below for preparation details).

Luciferin-Luciferase - purchased as a sterile, dry powder (5.5 milliliter preparation volume) from Turner Designs, Inc. (see below for preparation details).

KEEP ALL REAGENTS REFRIGERATED AND COOLED.
ATP STANDARD SHOULD BE FROZEN BETWEEN TESTING PERIODS.
DISCARD ANY THAWED L&L FOLLOWING THE DAILY TEST PERIOD.

5. ATP Standards Preparation

- o Fill Dewar with liquid nitrogen.
- o Calibrate 100-microliter pipette (Eppendorf) to deliver 25 microliters by weight using the microbalance, 0.2500 grams/10 deliveries.
- o Use a 10-milliliter volumetric pipette to deliver 10 milliliters of sterile HEPES buffer into five clean plastic tubes.
- o Pipette 25 microliters of ATP Standard (5-milliliter bottle, blue label, liquid, Turner Designs) into each 10-milliliter tube.
- o Vortex-mix each tube after adding the ATP standard.
- o Pipette 2 milliliters of the diluted standard into blue, snap-cap tubes.
- o Place the 2-milliliter ATP standards in the liquid nitrogen.
- o Continue transferring ATP standard until the 5 test tubes of HEPES buffer have been used.
- o Remove the prepared standards from the liquid nitrogen and place them in a labelled beaker (indicating the date of preparation and the person who prepared them) and place the beaker in the freezer.

6. Luciferin-Luciferase Preparation

- Remove 5 or 6 bottles of L&L (green labels, Turner Designs) from the refrigerator.

- Using a 10-milliliter syringe (calibrated to 0.2-milliliter volume), add 5.5 milliliters of sterile HEPES buffer to 3 of the bottles of L&L.

- Using a 1-milliliter pipette, transfer 1 milliliter of the L&L into a blue, snap-cap, conical plastic tube.

- Close the cap and place the tube in *liquid nitrogen*.

- After all the bottles have been made up, remove the prepared L&L tubes from the liquid nitrogen and place them in a labelled beaker (indicating the date of preparation and the person who prepared them) and place the beaker in the freezer.

I. COD STANDARD PREPARATION

Do not add dry chemical or strong acid/base to a dry volumetric flask; therefore, add approximately 10 milliliters of nanopure water to 3-100-milliliter volumetric flasks.

Mark one of the three volumetric flasks as number "1." This is the initial solution flask. Mark the other two flasks as "A" and "B." These will be the two standards, actually measured.

1. Initial Solution

- Weigh out 9.800 grams of ferrous ammonium sulfate (FAS), and add to the volumetric flask.

- Using a 2-milliliter volumetric pipette, transfer 2 milliliters of concentrated sulfuric acid to the volumetric flask.

- Bring the volume in the flask to about 3/4 total volume, and swirl the flask until all of the FAS crystals have dissolved.

- Bring the flask volume to the mark with nanopure water and seal with parafilm.

- Invert the volumetric flask at least 13 times, allowing the neck to fill and empty completely each time (also rotate the flask slightly each inversion).

2. Standard Solution A

- Using Solution 1, fill a 10-milliliter volumetric pipette to just above the mark.

- o Empty the pipette into a large-volume waste beaker.

- o Draw a second volume of the solution to the mark and transfer this volume to the volumetric flask labelled "A."

- o Fill the volumetric to the mark with nanopure water, seal with parafilm, and invert at least 13 times (same as making the initial solution).

- o Rinse a small, clean, plastic weigh boat with this solution and discard the rinse into the waste beaker.

- o Fill the weigh boat again with this solution and transfer 2 milliliters of this solution to two separate COD analysis tubes.

- o Vortex the tubes and place them in the COD incubator.

2. Standard Solution B

- o Using Solution 1, fill a 25-milliliter volumetric pipette to just above the mark.

- o Empty the pipette into a large-volume waste beaker.

- o Draw a second volume of a solution to the mark and transfer this volume to the volumetric flask labelled "B."

- o Fill the volumetric flask to the mark with nanopure water, seal with parafilm, and invert at least 13 times (same as making the initial solution).

- o Rinse a small, clean, plastic weigh boat with this solution and discard the rinse into the waste beaker.

- o Fill the weigh boat again with this solution and transfer 2 milliliters of this solution to 2 separate COD analysis tubes.

- o Vortex the tubes and place them in the COD incubator.

Notes: When you are through with the solutions prepared for COD analysis:

a. Discard remaining solutions into the waste solution beaker.

b. Add an equal amount of water to dilute the acidic solution.

c. Neutralize and discard this solution (it is only an iron precipitate).

d. Wash the outside of the volumetric flasks with soap and hot water.

e. Rinse the volumetric flasks (fill and dump) three times with tap water, three times with a 5 percent HNO_3 acid solution, three times with deionized water, and three times with nanopure water.

f. Invert the volumetric flasks on a drying rack and allow to air dry.

g. Rinse the volumetric pipettes (fill and dump) three times in the 5 percent HNO_3 solution and three times with deionized water, and place them on the drying rack.

Note: Check the volumetric pipettes for completely wetted surfaces. If droplets form on the inside of the glass bulb, repeat step "g."

J. BASIC CALCULATIONS

ATP in sample (grams/milliliter):

$$\frac{(RU - RB)}{(RIS - RU)} \text{ X ATP in standard}^{*}\text{(grams/milliliter)}$$

Solids in sample (grams/milliliter):

$$\frac{\text{pan dry weight (final-initial, grams)}}{\text{volume of sample (milliliters)}}$$

ATP per gram solids gram/gram:

$$\frac{\text{ATP in sample}}{\text{Solids in sample}}$$

* $2.5 \text{ X } 10^{-8}$ grams ATP/milliliter (standard concentration currently prepared)

APPENDIX C

ABSTRACTS OF LITERATURE SEARCH

ABRASIVE BLASTING

Walnut Hulls Clean Aluminum: Hulls Inflict Minimal Substrate Damage, NTN84-0780, October 1984, 1 page.

This citation summarizes a one-page announcement of technology available for use. Walnut hulls were found to be the best abrasive for cleaning aluminum surfaces before painting. Samples blasted with walnut hulls showed no surface compressive stress. Samples blasted with abrasives such as silicon carbide, silica sand, or garnet showed average compressive stresses of 23.6 to 33.1 psi. Walnut-hull blasting resulted in the least amount of warpage and produced the smoothest surface. The quality of the repainted surfaces was very similar to a first-time painted surface. When purchased in quantity, walnut hulls were the least expensive abrasive.

Nitterhouse, J.; Kalabokes, S. NEO Robotic Application Development at Letterkenny Army Depot: The Application of Robotics to Agricultural Blast Cleaning, DOD Robotics Application Workshop Proceedings, Sacramento, CA, October 1983, pp. 358-362.

M109 and M110 Howitzer hulls and turrets must be blast cleaned to remove old paint and rust from metal surfaces before preparation and final painting. Walnut shells are blasted against the vehicle surface with forces ranging from 110 to 150 PSI. Because of the varying tenacity of the old paint at different areas along the vehicle, the removal rate differs at any given point on the vehicle surface until bare metal is visible; we then move the nozzle to the next area to continue the process. The decision to robotize the agricultural blast cleaning operation at Letterkenny is founded on the inefficiency of the current process and hazards to the human operator. The worker is subjected to excessive heat, as high as 120°F in the summer, humidity as high as 90 percent saturation, high noise levels, and poor ventilation. Moreover, the aerosols generated create an atmosphere conducive to explosion. The authors conclude that the robotic approach should be a viable replacement to the manual operation pending proper design and installation. It will offer improved conditions over the current method in terms of cost, safety, and readiness.

ALTERNATIVE CHEMICAL PAINT STRIPPERS

Grant, A. R.; Morimoto, Y., Advanced Paint Stripper Used by Leading Japanese Motor Manufacturer, Industrial Finishing and Surface Coatings, Vol. 26, March 1974, pp. 26-27.

A method is described for removing paint from items contaminated in spray booths. The parts are passed through a tank on a conveyor; the chemical used consists of a mixture of alkali and nontoxic additives with no detrimental or poisonous effect on the environment. It provides the most economic means of paint stripping, consistent with very high speed for unstoved paints and most stoved finishes.

Race, T. D., Alternative Chemical Paint Strippers for Army Installations, Volume I: Identification and Laboratory Analysis, AMXTH-TE-CR-88017, USATHAMA, May 1988, 149 pages.

The U. S. Environmental Protection Agency (USEPA) has established discharge criteria regulating the amount of total toxic organics (TTO) released from metals finishing facilities. The Army conducts metals finishing operations at several of its installations and is responsible for meeting these criteria. At these facilities, it is known that the chemical paint stripping step contributes 90 percent of the TTO discharged into the waste stream. Clearly, reducing the TTO from chemical stripping could greatly lower the overall TTO concentration discharged at an installation.

The TTO from chemical stripping is due mainly to the methylene chloride and phenol contained in the standard military-issue paint stripper (MIL-R-46116). It is possible that alternative products would achieve the same level of performance with no TTO contribution.

APG Develops Paint Remover Considered Nontoxic to Wildlife, Army Research & Development, Vol. 13, No. 6, September 1972, p. 14

An improved alkaline paint remover has been developed for use in separating paint from aluminum. It is nontoxic to animals because it contains certain inorganic stannates instead of the commonly used chromates for protecting the aluminum from corrosion. The stannates permit paint strippers to be formulated for use at higher pH ranges and higher efficiencies and are more effective than chromates in preventing corrosion.

Hahn, Wilfred J.; Werschulz, P. O., Evaluation of Alternatives to Toxic Organic Paint Strippers, EPA/600/S2-86/063, September 1986.

A study was undertaken to survey commercially available paint stripping formulations and identify those whose use would result in lower total toxic organics (TTO) loading in stripping operation wastewaters without decreasing the effectiveness or efficiency of the stripping operation. Data were gathered by means of a literature review, a survey of potential suppliers, and bench scale tests of alternative striping formulations identified as having potential for reducing the level of released TTO. The chemical composition of an epoxy stripper (MS-111) used extensively in military installations was compared with commercially available alternatives having the potential to reduce TTO in stripping wastewaters. The paint striping operation at the Sacramento Army Depot (SAAD) was studied to establish a basis for designing bench-scale tests that would compare the performance characteristics.

The bench-scale tests of SAAD-supplied samples and the selected alternative formulations identified three stripping formulations that met the performance standards experienced by MS-111 and that were expected to significantly reduce TTO levels in stripping operation wastewaters.

Werschulz, P., Reduction of Total Toxic Organics in Metal Finishing Wastewater - Alternative Paint Strippers, Toxic and Hazardous Wastes, Proceedings of the Eighteenth Mid-Atlantic Industrial Waste Conference, Blacksburg, VA, June 1986.

The most common major ingredient in cold paint strippers is methylene chloride, which is a suspected carcinogen and it is not biodegradable. It is undergoing current regulatory scrutiny by FDA and EPA and has been branded a hazardous chemical by the Consumer Product Safety Commission. This study of alternative paint strippers was part of a large pollution abatement program initiated by the U. S. Army. CARLTECH used the metal finishing operations at an Army depot as the baseline for evaluation of TTO reduction potential and performance of alternative cold organic strippers.

Boardman, G. D.; Werschulz, P., Reduction of Total Toxic Organics in Metal Finishing Wastewater - Alternative Paint Strippers, Mid-Atlantic Industrial Waste Conference, Blacksburg, VA, June 1986, pp. 348-356.

The metal finishing industry must frequently remove paint as part of routine operations. Stripper chemicals enter metal finishing wastewater through dragout and rinsing operations. The most common major ingredient in cold paint strippers is methylene chloride. It is a suspected carcinogen and it is not biodegradable. Methylene chloride is included in the list of materials to be monitored and reported as part of a facility's TTO (Total Toxic Organics) included in their discharge permit. There are several strategies for reducing methylene chloride in discharge streams, but the least expensive and simplest is to find a substitute stripper that is more environmentally acceptable. CARLTECH tested ten paint strippers that either were reduced or free of methylene chloride on various paint samples. This paper presents the results of their testing program.

BIODEGRADATION

Baburao, K.; Linfield, W. M., Biocompatible Paint Strippers and Aircraft Cleaners, Report No. IITRI-C6134-6, December 1968, 43 pages.

A number of commercially available solvents, various combinations of solvent mixtures, some synthesized organic compounds, and different kinds of surfactants were screened for incorporation into new biocompatible paint strippers and aircraft cleaners. To facilitate these studies, methods were developed to rate the various ingredients of paint strippers. A tentative formula for a moderately efficient biocompatible paint stripper was developed.

Kroop, Ronald H.; Jambor, Richard L., Biodegradability Investigation of a Nonphenolic Aircraft Paint Stripper, Report No. AFWL-TR-74-19, May 1974, 32 pages.

Paint stripping of aircraft and ground equipment is conducted periodically to prevent intergranular corrosion of the metallic surfaces. Wastewater occurs when the viscous paint stripper is rinsed from the aircraft or ground equipment surface with a high-pressure water system. The necessity and cost of on-site treatment of phenolic aircraft paint stripping wastewater have generated an urgent need to develop a nonphenolic paint stripper that is effective for removing polyurethane and epoxy paint. A nonphenolic paint stripper is effective in removing at least some polyurethane and epoxy paints. Thus, a study was made by the Air Force Weapons Laboratory (AFWL) to determine if existing biological treatment processes were effective in treating the resulting nonphenolic paint stripping wastewater. The results of laboratory-scale investigations indicate that biological treatment processes are satisfactory if (1) the methylene chloride concentration is previously reduced and, (2) the chemical oxygen demand contribution from the paint stripper does not exceed 200 mg/L.

Mueller, James A.; Heinemann, Jack M., Biological Treatment of T-38 Paint Stripping Wastes, Report No. REHL (K)-66-7, May 1967, 45 pages.

The waste resulting from paint stripping T-38 aircraft can cause stream pollution if not properly treated. To determine the feasibility of biological treatment of this waste, the paint stripping waste from Vance Air Force Base, Oklahoma, was tested in laboratory activated sludge units. The results indicated that the waste could be treated biologically at a COD concentration below 3000 mg/L. The effluent from these units was not lethal to fish during a 96-hour exploratory bioassay if diluted in a 1:2 ratio with tap water. Based on the laboratory results, the waste was fed at a controlled rate to the Vance Air Force Base sewage treatment plant. Adequate treatment was obtained and no deleterious effects have occurred at the treatment plant or in the receiving water.

Cobb, H. D. Jr., , Egan, J. W., Olive, W. E. Jr., and Hansen, D. J., Biodegradation of Phenolic Paint Stripping Waste: Laboratory Evaluation of a Fixed Film Batch Reactor, Report No. ESL-TR-79-11, May 1979, 119 pages.

USAF aircraft and ground support equipment require the protection of durable epoxy-polyurethane surface coatings. Maintenance of such painted surfaces using phenol and chromium-containing strippers has created a waste disposal problem that is aggravated by the centralization of large aircraft depainting operations. The present investigation studied performance of a selectively-seeded, dedicated-function, trickling filter biodegradation unit built at Trinity University, San Antonio, TX. The specific waste target was the concentrated phenolic wastewater produced at the Kelly AFB-ALC depaint operation. Experiments were run examining solid support media choice, bed length and volume, ventilation requirements, hydraulic surface loading, phenol concentration and loading, rate kinetics, chromium tolerance, starvation response, and temperature effects. It was theorized that the batch process, with its alternating starvation/loading cycles, selects for a microbial community better able to cope with occasional wider swings in this cycle. A thin-film reactor conserves the genes of its adapted community more efficiently than other reactor types. The data summarized in this report suggest that a batch fixed-film process may have advantages over other biological unit processes for some phenolic waste streams.

Burns, F. A.; Dyke, Jr., R. A., Study of Austenitic Stainless Steel Welded with Low Alloy Steel Filler Metal, Report No. NASA-TP-1460, June 1979, 32 pages.

The tensile and impact strength properties of 316L stainless steel plate welded with low alloy steel filler metal were determined. Tests were conducted at room temperature and -100°F on standard test specimens machined from as-welded panels of various chemical compositions. No percentage chemical composition on the impact and tensile test results. The weldments containing lower chromium and nickel as the result of dilution of parent metal from the use 1 ft. The use of a protective finish, i.e., a nitrile-based paint containing aluminum powder, prevented the corrosive attack.

Allsopp, H. J.; Doble, J. B.; McLoughlin, V. C. R., The Corrosion Resistance and Paint Adhesion Properties of Chromate Conversion Coatings on Aluminum and Its Alloys, Report No. RAE-TR-76063; DRIC-BR-53655, May 1976, 55 pages.

A nonproprietary process for the chromate conversion coating (chromate filming) of aluminum and its alloys has been evaluated with respect to both corrosion resistance of, and paint adhesion to, the chromate films. The process involves immersion of the metal in an aqueous chromic acid/sodium dichromate/sodium fluoride solution for three minutes at 30°C. Iridescent, yellow-colored films result. Alternative times and temperatures of immersion, metal pretreatments, washing and drying of chromate-filmed test pieces, and modes of application were examined. The chromate film thicknesses were measured and their corrosion resistance compared. Except for thin films (less than 50 nm) corrosion resistance did not vary markedly with thickness. Comparisons were also made with two proprietary processes and no major differences were found in corrosion resistance or paint-adhesion properties of the different chromate films. Of four methods used for assessing corrosion resistance, exposure to continuous 5 percent neutral salt fog was the best, and paint adhesion was evaluated by using two British Standards Institution test methods. The findings in this report will be used as the basis for a Defense Standard for chromate conversion coatings for aluminum and aluminum alloys.

Diener, S. L. Development of Improved Electrodeposited Corrosion Inhibiting Primers, Report No. NOR-79-34; AFML-TR-79-4073, June 1979, 117 pages.

This program was conducted to develop a cathodically applied electroprimer for adhesive bonding of aircraft structural components. This program is an extension of the effort performed under Contract F33615-76-C-5301, which evolved a modified epoxy electroprimer curing at 325°F, which provided high adhesive bonding strengths except that the -65°F bonding strengths were somewhat lower than desired. The current program was established to develop a 250°F curing corrosion resistant electroprimer with enhanced -65°F adhesive bonding properties. Two electroprimers, SA-6411 and SA-6412, have been developed which meet the goals of the program. The electropriming system is unique in that it is a self-limiting electroplating process that easily coats, to a uniform thickness, all areas of parts including those difficult to coat by other conventional priming methods.

Flinn, D. R.; Cramer, S. D.; Carter, J. P.; Lee, P. K.; Sherwood, S. I., Acidic Deposition and the Corrosion and Deterioration of Materials in the Atmosphere: A Bibliography, 1880-1982, EPA/600/3-83-059, July 1983, 564 pages.

The bibliography contains more than 1300 article citations and abstracts on the effects of acidic deposition, air pollutants, and biological and meteorological factors on the corrosion and deterioration of materials in the atmosphere. The listing includes citations for the years 1950 to 1982, with selected citations for the years 1880 to 1949. The citations are catalogued by year in six sections for metallic materials--ferrous material, aluminum, copper, nickel, zinc, galvanized steel, and other metals--and six sections for nonmetallic materials--masonry, stone, and ceramics, elastomers, fabrics, paints, plastics, and other nonmetals. An author index and an index of chemical, biological, and meteorological variables are provided.

Metallized Coatings for Corrosion Control of Naval Ship Structures and Components, Report No. NMAB-409, February 1983, 115 pages.

In attempting to improve corrosion control, the U. S. Navy has undertaken a program of coating corrosion-susceptible shipboard components with thermally sprayed aluminum. In this report, the program is reviewed in depth, including examination of processes, process controls, the nature and properties of the coatings, nondestructive examination, and possible hazards to personnel. The performance of alternative metallic coating materials is also discussed. It is concluded that thermally sprayed aluminum can provide effective long-term protection against corrosion, thereby obviating the need for chipping of rust and repainting by ship personnel. Such coatings are providing excellent protection to below-deck components such as steam valves, but improvements are needed to realize the full potential of coatings for above-deck service. Several recommendations are made regarding processes, materials, and research and development aimed at upgrading further the performance of these coatings.

Treadway, D. G., Corrosion Control at Graphite/Epoxy-Aluminum and Titanium Interfaces, Report No. AFML-TR-74-150, July 1974, 60 pages.

A test program was conducted to develop and evaluate corrosion protection systems for use on graphite/epoxy-aluminum and graphite/epoxy-titanium joints. The joint specimens were prepared in duplicate and protected with several corrosion protection systems including epoxy polyamide primer, inhibited polysulfide sealant, and a linear polyurethane topcoat.

Jankowsky, E. J., Shipboard Exposure Testing - USS America, Report No. NADC 82101-60, August 1982, 31 pages.

Results of corrosion tests of various inorganic coatings on 17-4 pH and 4130 steel specimens exposed on the flight deck of an aircraft carrier are given in the report. Also described are the results of exposure on EMI seals, water displacing paint, cadmium and aluminum coated steel fasteners in aluminum alloy plate, and boron/aluminum composite material.

Hack, H. P., Galvanic Corrosion of Coated HY-130 Steel Coupled to 5456 Aluminum, Report No. NSRDC-28-939, March 1974, 21 pages.

Specimens of HY-130 steel were galvanically coupled to 5456-H117 aluminum in natural sea water at velocities of 0 to 30 feet per second. The steel was coated, coated with defect, partially coated, and uncoated. Corrosion rates of both materials increased with increasing seawater velocity. Corrosion of the HY-130 was reduced and that of the aluminum was increased with increasing amounts of uncoated steel area.

Wegman, R. F., Ross, M. C., Russell, W., and Garnis, E. A., Evaluation of New Bonding Systems for Depot-Level Maintenance of Aircraft Honeycomb Panels, Report No. ARLCD-TR-78019, December 1978, 54 pages.

Four adhesive systems, EA 9628, ADX 656.2, PL 717B, and M1113, are evaluated and reported to be improvements over adhesives presently used for bonding honeycomb structures in army helicopters. These systems have increased durability and fatigue properties, but do not change the stiffness of the panel. Using corrosion-inhibiting primers can increase the life expectancy of the structure provided the application of the primer is very stringently controlled. An investigation into fracture analysis of failed joints indicates that the origin of failure, the mechanism of crack propagation, and an estimate of the load the joint experienced at the time of failure can be detected by a careful analysis of the joint. A nondestructive technique has been evaluated by which the degradation in a bonded panel can be followed using the Harmonic Bond Tester. The technique detects changes in the adhesive, the onset of corrosion in the bond line, and the presence of voids.

CRYOGENIC PAINT STRIPPING

Welch, R. A., Cryogenic Paint Stripping, Chemical Coaters Assoc., May 1982, Book.

A new process and equipment technology is presented that uses liquid nitrogen to remove industrial coatings from paint hangers and fixtures. The theory, experimental results, equipment, and estimated economics of the process are surveyed. Notable advantages of the process include speed, safety, low energy requirements, cleaning effectiveness, and economy.

Ottinger, R. S., Blumenthal, J. L., Dal Porto, D. F., Gruber, G. I., and Santy, M. J., Recommended Methods of Reduction, Neutralization, Recovery, or Disposal of Hazardous Waste, Report No. TRW-21485-6013-RU-00 Vol. 14, EPA/670/2/73/053/N, August 1973, 160 pages.

This volume provides information on the origins, forms, and quantities of 13 groups of hazardous waste stream constituents including pesticides, mercury and mercury compounds, arsenic and arsenic compounds, cadmium and cadmium compounds, lead compounds, soluble copper compounds, selenium and selenium compounds, boron hydrides, chromium compounds, inorganic cyanides, hydrofluoric and fluoroboric acids, specific organic chemicals, explosive propellant and chemical warfare material, and radioactive material. Separate reports on paint wastes and wastes from battery manufacture and the electroplating industry are also presented.

Higgins, T, E., Fergus, R. B., and Desher, D. P., "Evaluation of Industrial Process Modifications to Reduce Hazardous Wastes in the Armed Services, Proceedings of the 40th Industrial Waste Conference, West Lafayette, IN, May 1985, pp. 14-16

Since 1980 the Department of Defense (DOD) policy has been to limit the generation of hazardous waste through alternative procurement policies and operational procedures that are environmentally attractive and economically competitive. DOD operates industrial facilities to repair, recondition aircraft, helicopters, ships, tanks, and other vehicles and equipment. Metal finishing operations, which are performed at over 100 DOD industrial facilities, produce most of the DOD's hazardous wastes. Metal finishing operations include paint stripping, solvent cleaning (i.e., removal of dirt, oils, grease, and corrosion products), metal plating, and painting. This paper examines process modification case studies from each of these four metal finishing categories.

Installation Restoration Program Records Search for Tyndall Air Force Base, Florida, Supersedes AD-A110-369, June 1982, 229 pages.

The major industrial operations at Tyndall AFB involving hazardous chemicals and wastes have been in existence since the 1960s, and include aircraft washing, stripping and painting, pneudraulics repair, engine and bearing cleaning, AGE maintenance, and the NDI lab activities. Since no large-scale industrial operations have been conducted at Tyndall AFB, the quantities of waste oils, solvents, paint residues, and thinners generated have been small. The standard procedure for disposing of waste oils and solvents has been to send the wastes to designated POL waste storage tanks. No direct evidence indicates migration of hazardous contamination beyond Tyndall AFB properties. In the past, small quantities of hazardous wastes, primarily waste solvents, have been disposed of in landfills.

Copeland, L. G.; York, R. J., Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, MD, Cor. Source Codes: 060995000; 411386, March 1984, 17 pages.

One of the primary missions of the Anniston Army Depot (ANAD) is the repair of combat vehicles. Industrial processes used in this activity led to the production of a large amount of wastes, mainly degreasing, paint stripping, and metals processing sludges. Many of the chemicals contained in the wastes are classified as hazardous under both Federal and State of

Alabama hazardous waste regulations. The potential for localized groundwater contamination led to the decision to exhume, remove, and dispose of the contaminated material in the seven disposal trenches. As part of this contract, the hazardous sludges in the old lagoon sludge pile were to be removed, although groundwater contamination was not associated with this site. Through the use of ground penetrating radar (FRR), magnetometry, metal detection, and electromagnetics, the exact boundaries of the chemical sludge disposal trenches were determined. A total of 62,119 tons of contaminated material and soils from the chemical sludge disposal trenches, old lagoon sludge pile, and chemical sump at Building 130 were exhumed, transported, and disposed of.

Saunders, F. M., Chian, E. S. K., Harmon, C. B., Kratz, K. L., and Medero, J. M., Evaluation of Process Systems for Effective Management of Aluminum Finishing Wastewaters and Sludges, Report No. EPA-600/2-84-077, March 1984, 157 pages.

Innovative processes for use in treating wastewaters and sludges produced in anodizing, etching, and painting extruded aluminum were investigated. Results of the research can be immediately implemented at many aluminum-finishing plants where sludge disposal restrictions and costs are increasing. Segregated neutralization and recovery of spent caustic etching solutions can be used to increase the net solids content of dewatered sludge available for disposal. Reclamation of dewatered sludge solids using acid eliminated the need for sludge disposal while producing a net income from this sludge reclamation process.

Higgins, T. E., Industrial Processes to Reduce Generation of Hazardous Waste at DOD Facilities, Phase I Report, Evaluation of 40 Case Studies, Report No. WDR-93/02, February 1985, 121 pages.

Many studies of DOD facilities have recommended industrial process modification that would reduce wastes at the source, rather than concentrating efforts on end-of-pipe treatment facilities. Some of these studies, which included many featuring excellent cost/benefit ratios, have been successfully implemented. Some, however, have not. Therefore, the methods, such as incentives and management practices used to successfully implement a given modification, are important factors in the evaluations of case studies examined in this report.

Higgins, E.; Higgins, B. P. J., Industrial Processes to Reduce Generation of Hazardous Waste at DOD Facilities, Phase III Report, Summary of Projects of Excellence Workshops, Report No. 059137000, 415705, December 1985, 49 pages.

This report, the third for this waste reduction project, summarizes the results of the project, presents workshop reviews, and, in the appendices, provides a source of materials prepared for the workshops. This report concentrates on the three cases selected as projects of excellence: Plastic Media Paint Stripping at Hill Air Force Base, Ogden, Utah; Innovative Hard Chrome Plating at Pensacola Naval Air Rework Facility, Pensacola, Florida; and Centralized Vehicle Washracks and Scheduled Maintenance Facilities at Fort Lewis Army Post, Tacoma, Washington.

Schultz, D. and Black, D., "Land Disposal of Hazardous Waste," Proceedings of the Eighth Annual SHWRD Research Symposium on Land Disposal of Municipal Solid Waste and Industrial Solid Waste and Resource Recovery of Municipal Solid Waste, Ft. Mitchell, KY, March 1982.

The purpose of the symposium was to (a) provide a forum for a state-of-the-art review and discussion of ongoing and recently completed research projects dealing with the management of solid and industrial wastes, (b) bring together people concerned with municipal solid waste management who can benefit from an exchange of ideas and information, and (c) provide an arena for the peer review of SHWRD's overall research program. These proceedings are a compilation of papers presented by the symposium speakers. The technical areas covered in the Land Disposal of Municipal Solid Waste, are gas and leachate production, treatment and control technologies, and economics. The areas covered in Land Disposal of Hazardous Wastes are landfill design and operation, pollutant movement, and control technology - linear system, control technology - waste modification, land treatment, uncontrolled sites/remedial action, and economics.

HEALTH HAZARDS

Hervin, R. L., Cormer, J, W., Butler, G. J., Health Hazard Evaluation/Toxicity Determination Report, NIOSH-TR-HHE-74-2/28-164, December 1974, 19 pages.

NIOSH evaluated workers' exposure to welding fumes, gases, and particulates in a vending machine company's welding department. It was determined that employees were exposed to potentially toxic concentrations of dust, iron oxide, zinc oxide, copper ozone, carbon monoxide, and carbon dioxide. The exposure of workers to trichloroethylene in degreasing operations was also evaluated and it was determined that these employees may occasionally be exposed to toxic concentrations of trichloroethylene. Concentrations of methyl cellosolve and methylene chloride were not found to be hazardous in the paint-stripping departments.

Love, J. R., Donohue, M. T., Health Hazard Evaluation Report No. HETA 78-135-1333, International Brotherhood of Painters and Allied Trades Electric Boat Division of General Dynamics Corp., Groton, Connecticut, Report No. HETA-78-135-1333, August 1983, 34 pages.

To investigate reports of rashes, dizziness, fainting, and nausea, environmental sampling and medical evaluations found employees engaged in grit blasting operations were potentially overexposed to metal fumes: iron (range of values - 5 to 474 mg/m^3), lead (0.05 to 11 mg/m^3), copper (1 to 15 mg/m^3), nickel (0.04 to 0.4 mg/m^3), chromium III (0.18 to 2.5 mg/m^3), beryllium (0.006 to 0.134 mg/m^3), aluminum 45 mg/m^3), and magnesium (1.0 to 5.5 mg/m^3). Exposures ranges up to 268 times the recommended exposure limits. Employees engaged in painting operations were potentially overexposed to solvents: methyl isobutyl ketone (230 mg/m^3), methyl cellosolve (108 mg/m^3), and cellosolve (27 to 475 mg/m^3). Exposures ranged up to 25 times the recommended exposure limits. The potential for significant exposure of workers to metal fumes and solvent vapors exists unless a more conscientious respiratory protection program is maintained. Health effects were consistent with reported solvent exposure. Recommendations for health promotion, better health surveillance, and environmental control are presented in the report.

Okawa, M. T. and Keith, W., Health Hazard Evaluation Determination Report Number 75-195-396, United Airlines Maintenance Base, San Francisco International Airport, Burlingame, California, Report No. NIOSH-TR-HHE-75-195-396, May 1977, 34 pages.

A health hazard evaluation was conducted by NIOSH at the working hangars of the United Airlines Maintenance Base, Burlingame, California, for worker exposure to solvents and other substances used in stripping, priming, and painting jet aircraft. Medical studies on a representative sample of workers and environmental measurements revealed that during paint stripping, employees without respiratory protection are exposed to potentially toxic concentrations of methylene chloride, a fact also confirmed by the high rate of complaints of occasional eye and throat irritation, and head congestion when in close proximity to the paint stripping operation. Employees in contact with other solvents, including toluene, isopropyl alcohol, methyl ethyl ketone, n-butyl acetate, n-butyl alcohol, ethyl acetate, chylohexanone, methyl isobutyl ketone, xylene, cellosolve acetate, and phenol, are not exposed to toxic levels of these agents. Employees who spray paint aircraft with paint containing hexamethylene diisocyanate may be exposed to potentially toxic levels of this agent, although this fact could not be conclusively established. Control measures are recommended.

Mallets, T., "Laser Paint Removal," DOD Robotics Application Workshop Proceedings, Sacramento, CA, October 1983, 4 pages.

The Laser Paint Stripper program is a three-phase effort which includes feasibility demonstration, prototype optimization, and implementation at Air Logistic Centers (depots) by FY-88. Major technical areas that make up the automated system include (a) laser device with power and uptime to handle the number and size of aircraft (F-16 vs C-5A), (b) the beam transport and manipulation system, (c) controls for beam/aircraft safety, alignment, and surface condition sensors, (d) integration software, and (e) cleanup of residue.

METHYLENE CHLORIDE

Cohen, J. M., Dawson, R., and Koketsu, M., Extent-of-Exposure Survey of Methylene Chloride, DHHS (NIOSH) Publ. (U.S.), No. 80-131, 1980, 53 pages.

Survey results are reported of occupational health hazards as a result of exposure to methylene chloride from paint stripping operations, acetate fiber manufacturing, and coffee decaffeination.

Koketsu, M, Methylene Chloride Survey Report, Robins Air Force Base, Warner Robins, Georgia, Final Task III, Report No. NIOSH-210-76-0158(9), May 1979, 42 pages.

Occupational exposure to methylene chloride was studied. An industrial hygiene survey was conducted at Robins Air Force Base, Warner Robbins, Georgia, to determine methylene chloride concentrations. Area samples of ammonia were also collected. The authors conclude that although measurable amounts of methylene chloride exist in the paint stripping facility, the time-weighted average exposure of workers was below the OSHA standard of 500 ppm. A sample taken from an aircraft's wheel well exceeded 200 ppm, but was due to inadequate ventilation in the wheel well.

PAINTS/COATINGS

Grabler, R. V., "Air Force, Robotic Painting," DOD Robotics Application Workshop Proceedings, Sacramento, California, October 1983, AD-A145 867, pp. 307-314

This paper briefly reviews Ogden ALC's proposed applications of robotics in an aerospace industrial facility. Specifically, the paper presents experience with the Devilbiss/Trallfa TR-3500 robot that is used for stripping and painting U. S. Air Force Sidewinder missiles at the Ogden depot.

Self-Priming Topcoat Produced, Domestic Technology Transfer Fact Sheet, September 1988, Vol. 13, No. 9.

Scientists at the Naval Air Development Center, Warminster, Pennsylvania, have produced a self-priming topcoat. The new product is undergoing tests using the F-14 Tomcat fighter aircraft and Navy H-3 helicopters. The specially formulated corrosion-preventive organic coating provides the same or better protection with a single coat as the present two coats, and annual cost savings to the Navy have been estimated at nearly $1.3 million.

The new self-priming topcoat meets or exceeds all the critical performance requirements of Navy's current aircraft paint system, which is a two-coat method--an epoxy primer and a polyurethane topcoat. In addition to the obvious savings in manpower, material, and painting time, the single coating contains no chromates or leads (toxic substances) and has reduced volatile organic compounds (solvents) released into the atmosphere.

Drisko, R. W., Matsui, E. S., Schwab, L. K., Effects of Steel Profile and Cleanliness on Coating Performance, Report No. NCEL-TN-1741, January 1986, 33 pages.

A 5-year study was conducted in cooperation with the Steel Structure Painting Council (SSPC) to determine a surface profile and cleanliness requirements for long-term performance of generic coating system currently used on Navy shore facilities. The experimental design included two levels of cleaning (white metal finish and commercial finish), four levels of profile height (low, medium, high, and very high), eight levels of abrasive (eight different abrasives), and six levels of generic coating system (Alkyd, acrylic latex, vinyl, epoxy, coal tar epoxy, and inorganic zinc/vinyl). Replicate sets of the different variations were exposed in a salt fog chamber and at test exposure sites in a tropical marina atmospheric environment at Kwajalein Atoll in the Marshall Islands; in an industrial environment at Pittsburgh, PA; and in a relatively mild marine atmospheric environment at Kure Beach, N.C. After 15 months of exposure at Kwajalein, relatively little change had occurred in the overall loss in bonding strength. Significantly different variations occurred between the different coating systems, and the range of values was greatly reduced. For the periods measured, salt fog exposure had a much greater effect on loss of adhesion than did natural exposure for 57 months. Levels of statistical significance for performance at Kwajalein varied greatly with time and were much greater on scribed than unscribed specimens. Coating system was the most significant variable, followed by abrasive and profile weight, and lastly by level of cleaning. Thus, profile was more important than cleanliness in field performance as well as in the laboratory salt fog testing and the adhesion study.

Plastics and Elastomers as Protective Coatings, February 1985-April 1988, Citations From the Rubber and Plastics Research Association Database, April 1988, 107 pages.

This bibliography contains citations concerning thermoplastics, thermosets, and elastomers as protective coatings and paints. Epoxies, polyurethanes, teflons, and polyesters are examined. Applications to aircraft, marine, building, commercial, and industrial products are included. Performance evaluations of selected materials are also included. (This updated bibliography contains 191 citations, 34 of which are new entries to the previous edition).

Burnett, R. D., Diamond, P., Industrial Hygiene Evaluation of Spray of Polyurethane Coatings, Report No. EHL-M-73M-10, Nov. 1973, 69 pages.

The report presents the results of the industrial hygiene evaluations conducted in the aircraft painting facility (Bldg. 692) at McClellan AFB, California. The building is a large hangar-type structure specifically designed for spray painting aircraft. The building has a downdraft ventilation system; air is supplied through numerous ceiling diffusers and exhausted through floor grills. Painters' exposures and potential exposures to airborne concentrations of organic solvent vapors, hexamethylene diisocyanate (HMDI), toluene diisocyanate, and particulates were determined. The highest exposures to solvent vapors occurred during aircraft surface cleaning with solvent-soaked rags. HMDI was the only contaminant generated in excessive concentrations during the spray painting operations. The adequacy of protective clothing and building ventilation was also studied.

Moore, J. C., O'Leary, J. R., Evaluation of Structural Steel Coatings in Relation to Industrial Atmospheric Conditions, Report No. WVDOH-23, January 1975, 78 pages.

Project No. 23 has supplied added technical information on the durability of coatings applied to structural steel and exposed to the atmosphere plus chemical fumes from nearby industrial plants. The amount and nature of those chemical fumes were recorded and averages establsished for later use in the accelerated testing program. The coating system was designated as failing when the degree of rusting of the steel had reached 10% on the ASTM D-610 pictorial standards. Sets of steel panels were blast-cleaned to metal to commercial standards and one set was pre-rusted and then cleaned by wire brushing. Paints were applied by brush and spray. The general types of available primers and some recommended top coats were included. The most important result of this project is the economy of blast-cleaning the structural steel to at least the commercial standard before coating. Vinyl top coats showed some checking. Aluminum top coats were satisfactory.

Featherston, A. B., Kelly, G. W., Optimization of Processing Variables Which Affect Adhesion of Organic Coatings, Report No. 2-37100/7R-3390, June 1977, 51 pages.

This report describes the results obtained in a study program to optimize surface preparation and application of organic coatings on non-metallic composites and to develop adhesion data on additional aluminum alloys following an optimized anodizing process. This study also describes development of adhesion data on additional aluminum alloys following an optimized chemical conversion coating processes. The Blister Test Method was used for generating all adhesion data obtained in this study. The concluding segment of this study describes optimization of chemical characteristics within practical processing tolerances. The investigation of more rapid test methods of measuring resistance of aluminum alloys to corrosion is also described.

Gehring, Jr., George A.; Behmke, Doreen L., Further Evaluation of Selected Protective Coatings Applied Under Adverse Conditions, Report No. NAEC-ENG-7936, December 1977, 35 pages
ABSTRACT:
Effective protective coatings are required to prevent corrosion of hardware components around the launch area of aircraft carriers. The uniquely severe environment characteristic of the launch area, as well as the adverse conditions under which coating maintenance must be accomplished, has made selection of an optimum coating doubtful. The results of 1 year simulated exposure tests indicate that a mil spec epoxy coating applied in 2 or 3 coats to achieve an 8 mil build is equal to any

of the maintenance-type coatings presently available and should have an adequate service life. The results also suggest that, when complete rust removal is not possible, a zinc chromate primer available within the Navy Supply System is equal to the proprietary rust-stabilizing primers currently on the market.

Newnham, J., Sing, K., and Curley, L., Applied Research Program on Lubrication of Titanium Bolts. Report on IVD Aluminum, Report No. SPS-5229-4, ESA-CR(P)-1020, October 1977, 31 pages.

Work is reported on the identification of a coating/lubricant combination for titanium alloy fasteners to give predictable frictional conditions on repeated installations and to be compatible with environmental conditions, both in space and on the ground. Ion vapor deposited (IVD) aluminum coatings were evaluated. The coatings examined were of the conventional or soft type, and the hard type, where diffusion into the titanium substrate is allowed. Coating thickness was evaluated, and torque-tension tests conducted under lubricated and unlubricated conditions. Neither of the IVD coatings evaluated appeared to offer any advantages over the aluminum paint coating examined previously.

Carson, K. A., Isocyanate Monitoring Using N-p-Nitrobenzyl N Propylamine Glass Fiber Sampling Tube, Report No. OEHL-82-022EH163HAE, August 1982, 24 pages.

N-p-nitrobenzyl-N-propylamine glass fiber sampling tubes were evaluated in the field for detecting hexamethylene diisocyanate (HDI) during aircraft spray painting and MDI during foam-in-place operations. The tubes, prepared and analyzed according to NIOSH Method P&CAM 326, were satisfactory for HDI monitoring during spray painting, but were inadequate for MDI monitoring under the conditions of the survey.

O'Brian, D. M., Hurley, D. E, An Evaluation of Engineering Control Technology for Spray Painting, Report No. DHHS/PUB/NIOSH-81-121, June 1981, 186 pages.

A NIOSH survey for the evaluation of control technology for spray painting and coating process is reviewed. Walk-through surveys of 19 facilities were conducted, with 11 spray finishing processes, including coating type and toxicity, application techniques, engineering controls and work practices, personal protection equipment, product size and shape, substrate materials, and required finish and appearance. Tabulated data is presented for the use of resins, pigments, and solvents from 1973 to 1977 and for each industry. Also discussed are the hazards due to aluminum (5429905), barite (61026413), calcium (7440702), chromium (440473), lead (7439921), silica (7631869), silicates, titanium dioxide (13463677), zinc (7440666), zinc oxide (1314132), organic pigments, acetylic resins, alkyds, amino-resins, cellulose-resins, epoxy-resins, urethane (51796), vinyl resins, alcohols, esters, glycols, ketones, petroleum distillates, toluene (108883), xylene (1330207), paint driers, and plastizers. Control of health hazards by substitution of materials or equipment or by isolation or changes in ventilation also is described.

The authors recommend the use of paints that contain relatively nontoxic materials and a minimum amount of solvent, spray booths with proper ventilation, and application equipment that will minimize the amount of spray mist generated. They also recommended further studies on health and respiratory protection and the improvement of material safety data sheets provided with the coating.

Anderton, W. A., High-Build Vinyl Coatings for Use on the Cathodically Protected Bottoms of Ships, Report No. DREP-79-C, December 1979, 19 pages.

A number of high-build vinyl anti-fouling shipbottom coatings, formulated for airless hot spray and conventional spray application, were evaluated in the laboratory and on service vessels. The main objective of the investigation was to find an underwater coating system with performance equivalent to the Maritime Force's specified vinyl system, but one requiring fewer coats of paint and therefore lower labor costs and a shorter application time. In this evaluation, the formulations for hot spray and airless hot-spray application proved better than those formulated for high-build application with conventional spray equipment. A four-coat system consisting of one coat of vinyl was primer-applied by conventional spray, followed by a high-build aluminum-vinyl primer, an intermediate high-build vinyl-aluminum anti-corrosive coat, and a coat of 1-GP-123 vinyl cuprous oxide anti-fouling, all applied by hot spray, achieved the required 10-mil minimum total thickness and, on the basis of the laboratory and ship trial performance, can be considered for general use.

Zaebst, D. D., Walk Through Survey Report of General Dynamics, Report No. IWS-134.15, August 1986, 23 pages.

A walk-through survey was conducted to evaluate painters' exposures to glycol ethers at the General Dynamics military aircraft manufacturing facility (3721), Fort Worth, Texas. Personal breathing zone exposures to airborne 2-ethoxyethyl-acetate (111159) (2-EEA) averaged 1.30 parts per million (ppm). The highest individual exposure was 6 ppm. The current OSHA standard is 100 ppm. Results of two surveys of major painting areas indicated that painters' exposures to 2-EEA ranged from 0.48 to 2.8 ppm, from 0.1 to 7.49 ppm, and from 1.5 to 12.1 ppm in the three areas. Due to the use of respiratory protection by many of the painters, actual inhalation exposures were undoubtedly much lower than the breathing zone measurements. Some exposure may have been incurred through skin absorption. The authors recommended that an additional industrial hygiene survey, including urine monitoring and air monitoring should be carried out in order to obtain a better estimate of total exposure to 2-EEA.

Reinbold, K. A. and Hangeland, E., Proceedings: Workshop on Environmental Consideration in the Life-Cycle of Paints and Coatings, USA-CERL, CP N-88/08, July 1988, 145 pages.

This workshop was jointly organized by the U. S. Environmental Protection Agency and the Department of the Army. It was hosted by the U. S. Army Construction Engineering Research Laboratory during September 9-10, 1986 in Champaign, IL. The purpose of the workshop was to exchange information on research and development (R&D) needs and ongoing R&D for solving environmental problems related to paints and coatings and their operations. Included were environmental aspects of (a) paint formulation and manufacture, (b) paint strippers and solvents and their use and disposal, (c) disposal of sludges from paint removal, and (d) health hazards associated with paints, strippers, solvents, and sludges.

PHENOLIC WASTES

Keating, E. J., Brown, R. A., and Greenberg, E. S., "Phenolic Problems Solved with Hydrogen Peroxide Oxidation," Industrial Water Engineering, Vol. 15, December 1978, p. 22

The authors report that major industrial sources of phenolic waste discharges are: insulation fiberglass manufacturing, petroleum refineries, smelting and slag operations, organic products manufacture, synthetic resin manufacture, textile mills, steelmaking, paint stripping, plywood, hardboard, and wood preserving. Phenolic discharges create problems in three areas: Toxicity to marine life, taste and odor disturbances, and oxygen depletion of the receiving water. Methods for analyzing phenols are described. Metal catalyzed hydrogen peroxide is evaluated as an oxidant for the destruction of phenols. H_2O_2 treatment of phenols is shown to be commercially useful in batch treatment of phenolic wastes, for emergency backup to other phenolic treatment systems, and for polishing when discharge requirements are particularly stringent.

Kroop, R. H., "Ozonation of Phenolic Aircraft Paint Stripping Wastewater," International Symposium on Ozone for Water and Wastewater Treatment, 1st Proc., Washington, DC, December 1973, pp. 660-673

Phenols are used in aircraft paint strippers for removing polyurethane and epoxy paints, which is a periodic maintenance function for preventing intergranular corrosion to the aircraft surface. The resulting wastewater varies in concentration, but not composition, depending on the specific paint stripper used and the amount of rinsewater. Treatment of the paint stripping wastewater or any phenolic wastewater is necessary for compliance with discharge standards based primarily on the protection of water used for domestic consumption. Various treatment processes have been used for treating phenolic wastewaters. These processes can be categorized into chemical oxidation, biological, and adsorption. This paper describes the ozone oxidation process and presents results of an experimental investigation into phenol removal from wastewater through oxidation. It is demonstrated that ozonation of phenolic aircraft paint stripping wastewater is effective at elevated pH values, but phenol oxidation is incomplete and the ozone requirements are high, especially to reduce phenol concentration to below 20 mg/L.

Kroop, R. H., Treatment of Phenolic Aircraft Paint Stripping Wastewater, Report No. AFWL-TR-72-181, January 1973, 108 pages.

A laboratory investigation was conducted to determine the optimum economic and technological treatment process to use for treating large amounts of wastewater. Three candidate unit processes were selected and tested to determine their effectiveness for removing the major contaminants in the wastewater. These processes were oxidation with ozone, oxidation with potassium permanganate, and adsorption with granular activated carbon. Granular activated carbon adsorption removed the most organic contaminants and was also the least expensive. Phenol concentration was reduced from 3000 mg/L to less than 2 mg/L in 60 minutes of contact time.

Perrotti, A. E., Activated Carbon Treatment of Phenolic Paint Stripping Wastewater, Report No. AFCEC-TR-75-14, August 1975, 132 pages.

The use of activated carbon for removal of phenol from wastewater is a well-demonstrated and generally accepted treatment method. The Air Force operates a number of facilities for depainting aircraft and related equipment, and the wastewater generated sometimes contains high concentrations of phenol. A study was conducted to ascertain the economical and technical practicality of using a granular carbon system for treating large volumes of this type of phenol-bearing wastewater. Basically, this work involved two phases. The initial phase was performed in the laboratory and involved an in-depth characterization of the wastewater and the evaluation of different activated carbons for treating this wastewater. The second phase was performed on-site at Kelly Air Force Base and involved operating a pilot plant for treating phenol wastewater. The carbon was exhausted five times and thermally regenerated four times. The pilot plant was operated intermittently and was on-site for six months. The technical feasibility of using activated carbon on the specific wastewater was demonstrated and the cost of constructing and operating full-size plants was determined. Color illustrations reproduced in black and white.

PLASTIC BEAD BLASTING

Higgins, T. E. and Higgins, B. P. J., Industrial Processes to Reduce Generation of Hazardous Waste at DOD Facilities. Phase 3 Report Appendix A. Workshop Manual Plastic Media Paint Stripping. Hill Air Force Base. Ogden. Utah, December 1985, 280 pages.

This appendix is the Workshop Manual for the waste reduction project pertaining to Plastic Media Paint Stripping at Hill Air Force Base, Ogden, Utah.

Wolbach, C. D. and Mcdonald, C., Reduction of Total Toxic Organic Discharges and VOC (Volatile Organic Compounds) Emissions from Paint Stripping Operations Using Plastic Media Blasting, Report No. ER-86-109/ESD, EPA/600/2-87/014, February 1987, 106 pages.

The U. S. Army Toxic and Hazardous Materials Agency and the U. S. EPA Water Engineering Research Laboratory cooperated to investigate the feasibility of plastic media blasting (PMB) as a technique for removing paint from aluminum military shelters. The PMB process was compared in a field test with sandblasting and with chemical stripping to determine relative cost, effectiveness, efficiency, and environmental consequences. The PMB process was judged superior to the chemical stripping process and marginally better than sandblasting, based on the evaluation criteria.

Plastic Media Blasting Recycling Equipment Study, Report No. CR 89.001, October 1988, 90 pages.

Different systems for recycling plastic media were evaluated for operational performance, losses, efficiency, and metal removal. An optimum recycling system was selected which included a cyclone for gross air/media separation, a vibrating screen to remove extra large and extra small particles, and a self-cleaning magnetic separator for ferrous particle removal.

Darvin, C. H., and Wilmoth, R. C., Technical, Environmental, and Economic Evaluation of Plastic Media Blasting for Paint Stripping, Report No. EPA/600-RD-87/028, January 1987, 16 pages.

The U. S. Army Toxic and Hazardous Materials Agency and the U. S. EPA Water Engineering Research Laboratory cooperated to investigate the feasibility of plastic media blasting (PMB) as a technique for removing paint from aluminum military shelters. The PMB process was compared in field tests with sandblasting and with chemical stripping to determine relative cost, effectiveness, efficiency, and environmental consequences. The PMB process was judged superior to the chemical stripping process and marginally better than sandblasting, based on the evaluation criteria.

Tapscott, R. E., Blahut, G. A., and Kellog, S. H., Plastic Media Blasting Waste Treatment, Report No. NMERI-WA4-10; AFESC/ESL-TR-88-12, July 1988, 130 pages.

Plastic media blasting (PMB) of aircraft and aircraft parts is replacing paint removal by chemicals at many Air Force installations. Plastic media blasting has several advantages over chemical stripping, including waste and cost reductions, and reduction of environmental problems and health hazards. The use of plastic media may result in generation of a hazardous waste, however, as evidenced by plastic media stripping of F-4 aircraft at Hill AFB. The waste is hazardous due primarily to metal contaminant levels exceeding EPA's Extraction Procedure (EP) Toxicity limits for chromium and, occasionally, cadmium. Potential methods to reduce or eliminate the hazardous waste volume were evaluated in an HQ AFESC research project. Laboratory investigations of incineration were demonstrated to provide at least a 90 percent reduction in hazardous waste volume. Laboratory evaluation resulted in identification of an encapsulation method that can make the waste nonhazardous. Fire prevention in plastic media blasting facilities was also evaluated.

Childers, S., Watson, D. C., Stumpff, P., and Tirpak, J., Evaluation of the Effects of a Plastic Bead Paint Removal Process on Properties of Aircraft Structural Materials, Report No. AFWAL-TR-85-4138, December 1985, 151 pages.

An abrasive blasting process using plastic beads is proposed for removing organic coatings from aircraft surfaces and component parts. During prototype development of the plastic bead blasting process for paint removal, many concerns surfaced relative to the potential effects of the process on metal and composite aircraft structural materials. This evaluation of the plastic bead blasting paint removal showed that it removed protective metal coatings such as aluminum cladding and anodize coatings from aluminum alloys and cadmium plating from steel structure. Surface roughness resulted on clad aluminum alloys. Warpage as a result of surface cold working occurred on unsupported thin skin metal materials. The bond strength of thin-skin adhesive-bonded structure was not affected. The process is less damaging in fatigue to 7075-T6 aluminum structure blasted at 60 psi nozzle pressure than at 38 psi nozzle pressure. Epoxy/graphite composite structure that was plastic bead blasted showed statistically significant losses in matrix-dominated properties. No significant reductions occurred in the fiber-dominated mechanical properties.

Cashdollar, K. L.; Hertzberg, M.; Zlochower, I. A.; Conti, R. S., Explosibility and Ignitability of Plastic Abrasive Media, Report No. NCEL-CR-87-.001, June 1987, 44 pages.

At the request of the U. S. Navy, the Bureau of Mines investigated the explosibility hazards of plastic abrasive media used for removing paint from aircraft surfaces. The tests included both original and recycled media. Four types of plastic media were tested and compared with Pittsburgh bituminous coal and polyethylene. The tests were performed in a 20-L explosibility test chamber and a 1.2-L ignitibility furnace. The original coarse media used for abrasive blasting of aircraft components could not be ignited when dispersed as a dust cloud, but the fines generated during the blasting process were capable of generating strong explosions.

Plastic Media Blasting for Paint Stripping: Technique Surpasses Sandblasting and Chemical Stripping In Many Cases, Report No. NTIS PB87-146353/NAC, October 1987, 1 page
ABSTRACT:
This citation summarizes a one-page announcement of technology available for utilization.. Paint removal operations can be major generators of air, water, and solid waste pollution. There are two traditional methods used for industrial paint removal operations--sandblasting and chemical stripping. Over 60,000 tons per year of methylene chloride is used as a chemical striping agent resulting in air, water, and solid waste pollution. In addition, countless tons of toxic material-contaminated

sand from sandblast stripping must also be disposed of in an environmentally safe manner. Therefore, the unique method of plastic media blasting (PMB) for paint removal promises to significantly reduce air, water, and solid waste pollution from paint stripping operations. A study evaluated the technical, economic, and environmental factors of the three paint removal processes. It addressed three areas; the quality of the finished product the speed of removal, and the environmental impact of each process. More importantly, it showed that, when cost of pollution control is taken into account, total production cost can be significantly reduced when using PMB. PMB is a unique variation of the sandblasting process that uses plastic beads rather than silica sand. Similar to sandblasting, the media impacts upon the surface and attacks the paint covering the substrate. However, due to the hardness of the plastic beads, approximately 3 to 5 Mohs, it is nonabrasive to metal substrates, which typically have a surface hardness greater than 6 Mohs. A disadvantage, however, is that PMB will not remove rust since the beads are softer than rust.

SOLVENT RECOVERY

Hazelwood, D. L. and Burgher, B. J., "Solvent Waste Reduction and Recovery, Toxic and Hazardous Wastes," Proceedings of the Seventeenth Mid-Atlantic Industrial Waste Conference, Lewisburg, PA. June 1985.

Numerous industrial operations generate waste solvents. Some of the most common operations include parts cleaning and degreasing, general plant cleanup and maintenance, painting, paint stripping, fuel tank cleaning, and printing. One of the largest sources of waste solvents is preparation of metal surfaces for further processing by solvent and degreasing. In light of the large quantities of waste solvents from this source and the renewed interest in solvent recovery, this paper explores the available technology, economics, and applications/limitations of waste stream reduction techniques as well as on-site and off-site recovery systems.

THERMAL DEGRADATION OF WASTE

LSW-500 Disposal of Air Force Liquid Wastes, Report No. AFWL-TR-74-70, April 1975, 143 pages.

Presented are the results of a feasibility investigation on thermal degradation of selected USAF liquid wastes in a fluidized bed incineration system. Aircraft washrack wastes; paint stripping wastes; herbicide orange; petroleum, oil, and lubricant wastes (POL); municipal garbage; and sewage sludge were used for testing in Combustion Power Company's 3-foot-diameter (LSW-500) fluid bed combustor. Results show that with proper liquid waste injection locations and procedures, POL wastes or air-classified and shredded municipal garbage can be used as fuel to dispose of non-fuel liquid wastes without requiring supplemental fuel. When using solid waste as fuel to dispose of liquid waste or when using limestone to control HCl, an additional particulate emission control device downstream of the first and second stage inertial system will be required. Combustion Power Company is presently developing a dry scrubber for this purpose.

Sims, A. F. E., "Industrial Effluent Treatment with Hydrogen Peroxide," Chem. Ind. Vol. 14, July 1983, pp. 555-558.

Treating industrial wastes with hydrogen peroxide is discussed, including treatment of tar distillery, oil refinery, paint stripping, and steel plating effluents; effluents from food, pharmaceutical, cellophane, and acrylonitrile manufacture; tip leachate; and phenol- and cyanide-containing wastes. The safe handling of hydrogen peroxide is also discussed.

Mishack, E., Taylor, D. R., Telles R., and Lubowitz, H., Encapsulation/Fixation (E/F). Mechanisms, Report No. DRXTH-TE-CR-84298, June 1984, 239 pages.

The objective of this project was to examine the chemical and/or physical bonds created in the process of encapsulating/fixing AAP-type sludges. Typical sludge compositions were selected for detailed study on review of sludges generated by wastewater treatment and related operations at 22 Army facilities.

Candidate fixatives included polysilicates, amine-cured polyepoxides and polysulfides. A limited study was also conducted using ion-exchange resins of the non-ionic type for sludges containing TNT and RDX; and cationic exchangers with specific chemically reactive groups for sludges containing heavy metals. The measure of effectiveness of the AAP sludge-fixative combination was EPA's EP Toxicity Test Instrumentation characterization methods included optical microscopy, infrared spectroscopy, scanning electron microscopy, energy dispersive x-ray analysis, and x-ray diffraction.

Polysilicates were found to fix heavy metals as a consequence of the highly alkaline-buffered media they provide. Nitrocellulose was observed to react with epoxy ingredients with the possible removal of nitrate groups. Studies with polysulfides and ion-exchange resins were encouraging, resulting in chemically fixed sludges of high contaminant density and resistance to leaching.

APPENDIX D

PATENTS

The following list contains numbers, titles, and inventors' names of patents pertaining to paint stripping.

NUMBER	TITLE	INVENTORS
3,625,907	CORROSION INHIBITED PAINT REMOVING COMPOSITION	MYER ROSENFELD, TROY R. NICHOLS
4,120,820	PAINT REMOVER WITH IMPROVED SAFETY CHARACTERISTICS	DAVID PALMER
4,269,724	COMPOSITION FOR PAINT STRIPPER	JAMES HODSON
4,666,626	PAINT STRIPPER COMPOSITIONS	ROLAND FRANCISCO
4,680,133	STRIPPING COMPOSITION CONTAINING AN AMIDE AND A CARBONATE AND USE THEREOF	IRL WARD
4,711,729	PROCESS FOR THE RECOVERY OF VALUABLE SUBSTANCES FROM LACQUER SLUDGE	WOLF-DIETRICH RUDROFF
4,711,936	CURING AGENT FOR EPOXY RESIN AND METHOD FOR CURING EPOXY	ICHIRO SHIBANSI, NAKAMURA OSAKA
4,713,181	METHOD AND APPARATUS FOR HANDLING SLUDGE	FREDERICKRUSSEL
4,717,620	DECORATIVE COATINGS PROVIDING A MULTICOLOR, TEXTURED SURFACE	THOMAS BOWEN, W. GREEN JON GRAYSTONE, ANDREW HOBBS

NUMBER	TITLE	INVENTORS
4,726,848	CHLORINATED HYDROCARBON PROTECTIVE AND/OR DECORATIVE COATING STRIPPING COMPOSITION AND METHOD	DONALD MURPHY
4,729,797	PROCESS FOR REMOVAL OF CURED EPOXY	HAROLD LINDE, ELIZABETH MURPHY, DENNIS POLEY
4,732,695	PAINT STRIPPER COMPOSITIONS HAVING REDUCED TOXICITY	ROLAND FRANCISCO
4,737,195	ACTIVATOR-ACCELERATOR MIXTURES FOR ALKALINE PAINT STRIPPER COMPOSITIONS	ROBERT KOCH, CARMEN CARANDANG
4,749,510	PAINT STRIPPING COMPOSITION AND METHOD OF MAKING AND USING THE SAME	HENRY NELSON
4,750,919	PAINT REMOVAL USING OIL-IN-WATER EMULSIONS	ROBERT PATZELT, EDWIN AUERNER, MICHAEL DWYER
4,783,257	PAINT WASTE SEPARATOR-COLLECTOR APPARATUS	KOJI MORIOKA, MAKOTO WATANABE

APPENDIX E

SURVEY OF PAINT STRIPPING PROCEDURES

NOTE: The word "paint" will be used generically and also refers to the primer and protective coatings.

Background

1. What specific types of aircraft or equipment are being stripped at your facility?

2. What kinds of paints, primers and protective coatings are used and on which parts of the aircraft or equipment? MIL-SPEC? Which are the most difficult to remove?

3. What kinds of substrates are painted? Which are you most concerned with in terms of corrosion and stress due to the stripping process?

4. Approximately how often is an aircraft or equipment stripped? How is it determined when stripping is required?

5. What process is being used to strip the paint? Chemical, mechanical or both?

6. Is there a written protocol for the stripping process? If yes, please send a copy.

Chemical Paint Stripping

1. Which chemical stripper is predominantly used? MIL-SPEC? What does it contain and in what percentage? Are other strippers used?

2. How is the stripper used to remove the paint? Sprayed, brushed or in a dip tank?

NOTE: If the spray/brush method is used, continue to #3. If the dip tank method is used go to #23.

Spray/Brush Method

3. Are parts of the aircraft or equipment disassembled and sorted before stripping? Do the various sizes and geometries of the parts require different procedures or different strippers? How is paint removed from cracks and crevices?

4. What kind of spray or brush equipment is used to apply the paint stripper?

5. How long does the stripper remain on the paint surface? How many times is it applied? What is the maximum dwell time allowable to prevent a bottleneck in the production line.

6. Are enhancement processes such as manual scrubbing used to increase stripping efficiency?

7. Is a hot water/steam lance used in the final step to remove the paint and stripper?

8. Does this process remove all the paint?

9. Would you be able to tolerate a slightly less efficient stripper?

10. Can epoxy polyamide be recoated after incomplete stripping?

11. Is quality control for stripping efficiency based only on visual examination? Is there a MIL-SPEC?

12. Is corrosion testing based on the Hydrogen Embrittlement Test (ANSI/ASTM F519-77) and Total Immersion Corrosion Test (ANSI/ASTM F483-77)? Are there other preferred corrosion testing procedures?

13. What volume of each kind of paint stripper is currently used per year?

14. How much do existing strippers cost?

15. Approximately how many gallons of wastewater is generated per day from your stripping process?

16. What happens to the waste water after stripping? How is it disposed of and at what cost per year?

17. Are paint chips and debris removed from the waste water and disposed of separately? If so, how is it separated, how much paint waste is generated per year, and how much does it cost to dispose of it?

18. What percentage do the organic strippers contribute to TTO? What are TTO limits in the effluent for your facility?

19. Do the existing strippers pose potential dangers to the environment via air pollution?

20. What safety precautions are taken when stripping the paint? Are operators required to wear safety garments and equipment? If so, what kind?

21. If necessary, could the plant be modified to accommodate changes in the process?

22. What are the major concerns or problems you have with this process?

<u>Dip Tank Method</u>

23. Are parts of the aircraft and equipment disassembled and sorted before stripping? Do the various sizes and geometries of the

parts require different procedures or different strippers? How is paint removed from cracks and crevices?

24. What kinds of equipment are used in the dip tank method?

25. Are parts dipped in tanks in an assembly line procedure? Is it controlled remotely? How many parts are processed daily (routinely)?

26. How many different tanks is each part dipped into? What chemicals are used in the tanks? (i.e., chemical rinse)

27. What is the length of immersion time based on the kinds of paint to be stripped?

28. What is the maximum immersion time allowable to prevent a bottleneck in the production line?

29. What are the various sizes of the dip tanks to accommodate part sizes? What volume of stripper is used in each?

30. What temperature is the stripper? What is the maximum hot tank temperature that can be tolerated in terms of worker safety and or parts integrity?

31. How often is the stripper changed? How is it decided when to change it?

32. Is more solvent added to strengthen the stripper?

33. Are enhancement processes such as stirring used to increase stripping efficiency?

34. Are mechanical procedures such as sanding or abrasive blasting used in the final step to completely remove the paint?

35. Does this process remove all the paint?

36. Would you be able to tolerate a slightly less efficient stripper?

37. Can epoxy polyamide be recoated after incomplete stripping?

38. Is quality control for stripping efficiency based only on visual examination? Is there a MIL-SPEC or ASTM Standard?

39. Is corrosion testing based on the Hydrogen Embrittlement Test (ANSI/ASTM F519-77) and Total Immersion Corrosion Test (ANSI/ASTM F 483-77)? Are there other preferred corrosion testing procedures?

40. Approximately how many gallons of waste water is generated per day from your stripping process?

41. What happens to the waste water after stripping? How is it disposed of and at what cost per year?

42. Are paint chips and debris removed from the waste water and disposed of separately? If so, how is it separated, how much paint waste is generated per year, and how much does it cost to dispose of it?

43. What percentage do the organic strippers contribute to TTO?

44. Do the existing strippers pose potential dangers to the environment via air pollution?

45. What volume of each kind of paint stripper is currently used per year?

46. How much do existing strippers cost?

47. What safety precautions are taken when stripping the paint? Are operators required to wear safety garments and equipment? If so, what kind?

48. If necessary could the plant be modified to accommodate changes in the process?

49. What are the major concerns or problems you have with this process?

Mechanical Paint Stripping

If bead blasting, abrasive blasting or other means of mechanical stripping is used, please give a detailed account of the process in terms of:

1) Equipment used
2) Procedure used
3) Efficiency of stripping
4) Cost
5) Advantages
6) Problems
7) Needs

APPENDIX F

CHEMICAL COMPANIES CONTACTED

3D INC.
3M CENTER
ACME CLEANING EQUIPMENT
ADVANCE AEROSOL & CHEMICAL CO.
AIR PRODUCTS & CHEMICALS, INC.
ATLANTIC RICHFIELD CO.
ALEXANDER CHEMICAL CO.
ALLIED SIGNAL INC.
ALLIED-KELITE
ALVIN PRODUCTS
AMBRON
AMERICAN NIAGARA
AMREP INC.
ANGLER CHEMICAL CO.
APEX ALKALI PRODUCTS, CO.
ARCAL CHEMICALS, INC.
ARCO CHEMICAL CO.
ARDROX COMPANY
ASHLAND CHEMICAL CO.
ASHLAND OIL, INC.
ATOMERGIC CHEMETALS, INC.
AURIC CORP.
BARON BLASKESLEE INC.
BARTLETT CHEMICALS, INC.
BASF CORP.
BEACON CHEMICAL CO.
BEAM CHEMICAL CO.
BEAVER ALKALI PRODUCTS
BECK CHEMICALS
BETTER ENGINEERING
BIOTEK
BISON CORP.
BIX PROCESS SYSTEM, INC.
BROWNING-FERRIS INDUSTRIES
BRULIN & CO.
BUILD-ALL CORP.
BURMAK TECHNICAL SERVICES
B & B CHEMICAL CORP.
CALGON COMMERCIAL DIV.
CALIFORNIA CHEMICAL CO.
CERTIFIED COATING PRODUCTS
CHEM POWER MFG.
CHEMCO MANUFACTURING CO.
CHEMDET INC.
CHEMICAL DYNAMICS CORP.
CHEMICAL METHODS
CHEMICAL PRODUCTS
CHEMICAL SOLVENTS INC.
CHEMICAL SYSTEMS
CHEMICAL WAYS CORP.

CHEMICAL COMPANIES CONTACTED

CHEMIX CORP.
CHEMTRONICS INC.
CHESTERTON CO.
CHEVRON
CHRYSLER CORP.
CIRCUIT CHEMISTRY CORP.
CLEMCO IND.
CORAL CHEMICAL CO.
CRAIN CHEMICALS CO., INC.
CRC DIST./TWIN SPECIALTIES
CREST INDUSTRIAL CHEMISTRY
CROWLEY CHEMICAL CO.
CRYSTAL REFINING CO.
CUSTOM CHEMICAL CO.
DALCO INDUSTRIES LTD.
DARMEX
DAY, JAMES B & CO.
DELTA FOREMOST CHEMICAL CORP.
DIAMOND SHAMROCK CORP.
DIVERSEY WYANDOTTE CORP.
DOBER CHEMICAL CORP.
DOW CHEMICAL CO.
DUBOIS CHEMICALS
DUNBAR SALES & MFG
DUPONT DE NEMOURS
ELDORADO CHEMICAL CO.
ELGENE DIVISION CHARGER CORP.
ENEQUIST CHEMICAL CO.
ENTERPRISE CO.
ENTHONE INC.
ENVIROSOLV, INC.
ETHYL CORP.
EUREKA CHEMICAL CO.
EXXON CHEMICAL CO.
FIDELITY CHEMICAL PRODUCTS, CO.
FINE ORGANICS CORP.
FREDERICK GUMM CHEMICAL CO.
FREMONT INDUSTRIES
FULLER O'BRIEN
GAF
GIVANDEN CORP.
GOODRICH PRODUCT DIV.
GRAYMILLS CORP.
GROW GROUP INC.
HAAS, CHARLES, INC.
HACHET PETROLEUM CO.
HAVILAND PRODUCTS CO.
HEATBATH CORP.
HIGLEY CHEMICAL CO.
HOMESTEAD INDUSTRY, INC.
HOOKER CHEMICAL
HORIZON CHEMICALS, INC.

CHEMICAL COMPANIES CONTACTED

HUKILL CHEMICAL CORP.
HUNTINGTON LABORATORIES
HYDRITE CHEMICAL CO.
HYDROTEX INC.
HY-KO ENVIRO-MAINTENANCE PRODUCTS
INDUSTRIAL CHEMICAL CO., INC.
INDUSTRIAL CHEMICAL PRODUCTS OF DETROIT
INDUSTRIAL CHEM. LABS
INDUSTRIAL SOLVENTS CORP.
INLAND SPECIALTY CHEMICAL CORP.
INTERNATIONAL CHEMICAL CO.
K & S ALL PURPOSE PRODUCTS
KANO LABORATORIES
KCI CHEMICAL CO.
KELLOGG, E.H. & CO.
KEY CHEMICALS
KIESOW INTERNATIONAL CORP.
KLEER-FLOR CO.
KLEM CHEMICAL CORP.
KOLENE CORP.
KUTOL PRODUCTS CO.
KWICK KLEEN INDUSTRIAL SOLVENTS
LAKE PRODUCTS CO., INC.
LEA MFG. CO.
LOCTITE CORP.
LONDON CHEMICAL CO.
LPS CHEMICAL PRODUCTS
LUSTER-ON PRODUCTS
MACDERMID CORP.
MADISON BIONICS
MAGIE BROS. OIL CO.
MAGNA IND. CO. LTD.
MAGNUSON PRODUCTS
MAN-GILL CHEMICAL CO.
MCGEAN-RHOCO
MEGGEM DIV., BEROL CHEMICAL INC.
MICHIGAN INDUSTRIAL FINISHES CORP.
MIDLAND LABORATORIES
MITCHELL-BRADFORD INTERNATIONAL
MOLINE PAINT MFG. CO.
MONTGOMERY CHEMICAL CO.
MORGAN CHEMICALS INC.
MULTI-CLEAN
NALCO CHEMICAL CO.
NATIONAL CHEMICAL INDUSTRIES, INC.
NORTON PETROLEUM CORP.
NOVOCOL CHEMICAL CO.
NUVITE CHEMICAL COMPOUNDS CORP.
PACE NATIONAL CORP.
PANTHER CHEMICAL CO.
PARK CHEMICAL CO.
PARKER AMCHEM

CHEMICAL COMPANIES CONTACTED

PARKER CHEMICAL CO.
PATCLIN CHEMICAL CO.
PAVCO
PENETONE CORP.
PETROCON MARINE & INDUSTRIAL CHEMICAL CORP.
PHILLIPS MANUFACTURING CO.
PIERCE CHEMICAL CO.
PM CHEMICALS, INC.
PPG INDUSTRIES INC.
PRECISIONAIRE INC.
PRODUCT-SOL INC.
PROFESSIONAL COATINGS LABORATORIES
PROGRESS CHEMICAL INC.
PUREX CORP.
QUAKER CHEMICAL CO.
RADIATOR SPECIALTY CO.
RAP PRODUCTS, INC.
RAWN CO.
REICHOLD CHEMICALS, INC.
RELIABLE PASTE & CHEMICAL CO.RESEARCH CHEMICALS
RHONE POULENE INC.
ROBBISH INDUSTRIAL PRODUCTS
ROCHESTER MIDLAND
ROLY INTERNATIONAL
SAVOGRAN CO.
SAX CORP.
SECO CHEMICALS INC.
SEMCO DIVISION, PRODUCTS RESEARCH & CHEMICAL
SHELL CHEMICAL CO.
SPECIALTY CHEMICALS & SERVICES, INC.
SPECTRON INC.
SPEREX/VHT CORP.
SPRAYON PRODUCTS
STANDARD OIL CO.
STARKEY CHEMICAL PROCESS CO.
STA-LUBE, INC.
STEPAN CO.
STERLING-CLARK-LURTON CORP.
STRIP-TECH
SUN REFINING & MARKETING CO.
SURFACE DYNAMICS USA, INC.
SWI INTERNATION INC.
TEXACO
TEXO
THERMO-COTE, INC.
TOWER CHEMICAL CORP.
TRUESDALE CO.
TURCO PRODUCTS
UNION CHEMICALS
UNIQUE INDUSTRIES INC.
UNITED LABORATORIES INC.
UNOCOL CORP.

CHEMICAL COMPANIES CONTACTED

U. S. POLYCHEMICAL CORP.
U.S.I. CHEMICALS
VALESKA SOLVENTS INC.
VALUE LINE LABORATORIES
VAN STRAATEN CHEMICAL CO.
VIRGINIA CHEMICALS, INC.
VISTA CHEMICAL CO.
VI-PANN CHEMICALS, INC.
WARNER-GRAHAM CO.
WASTE RESEARCH & RECLAMATION
WATERLAC INDUSTRIES, INC.
WESTERN CHEMICAL CO.
WHITTAKER, BATAVIA COATINGS DIVISION
WILLIAM BARR & CO.
WITCO CORP.
WORLD LABORATORIES
ZEP MFG. CO.

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APPENDIX G

PAINT STRIPPERS CHOSEN FOR EVALUATION

COMPANY NAME	PRODUCT NAME
3M	SAFEST STRIPPER
AMBION	INSULSTRIP S
BROCO	BROCO 300
BRULIN	SAFETY STRIP 1000
BRULIN	SAFETY STRIP 2000
BRULIN	SAFETY STRIP 4000
BRULIN	EXPERIMENTAL 2187
CHEMCO	CSP-2015
CHEMICAL METHODS	CM-500
CHEMICAL METHODS	CM-550
CHEMICAL METHODS	CM-552X
CHEMICAL METHODS	CM-3321
CHEMICAL METHODS	CM-3707
CHEMICAL METHODS	CM-3707A
CHEMICAL SOLVENTS	SP-800
CHEMICAL SOLVENTS	SP-822
CHEMICAL SOLVENTS	SP-823
CHEMICAL SOLVENTS	SP-824
CHEMICAL SYSTEMS	PS-589X/590
DU PONT	DBE (E60988-37)
ELDORADO	HT-2230
ELGENE	22 SKIDOO
ELGENE	FABULENE
ENTHONE	ENDOX L-76
ENTHONE	ENDOX Q-576
ENVIROSOLV	RE-ENTRY ES
ENVIROSOLV	RE-ENTRY RFS
EXXON	EXPERIMENTAL #1
EXXON	EXPERIMENTAL #2
EXXON	EXPERIMENTAL #3
EXXON	EXPERIMENTAL #4

COMPANY NAME	PRODUCT NAME
EXXON	NORPAR 13
EXXON	NORPAR 15
FINE ORGANICS	FO 606
FINE ORGANICS	FO 621
FINE ORGANICS	FO 623
FINE ORGANICS	FO 2115A
FREDRICK GUMM	CLEPO ENVIROSTRIP 222
FREMONT	F-289
GAF	M-PYROL
HURRI-KLEEN	HURRI-SAFE PAINT REMOVER
HURRI-KLEEN	HURRI-SAFE STAY PUT
INDUSTRIAL CHEM. PROD. OF DETROIT	ENAMEL STRIPPER 77
KEY CHEMICALS	KEY CHEMICALS 0457OH
MAN GILL	POWER STRIP 5163/0846
McGEAN-ROHCO	CEE-BEE A-245
McGEAN-ROHCO	CEE-BEE A-477
OAKITE	OAKITE STRIPPER ALM
PATCLIN	103B
PATCLIN	104C
PATCLIN	106 Q
PATCLIN	126 HOT DIP
PAVCO	DECOATER 3400
ROCHESTER MIDLAND	PSS 600
ROCHESTER MIDLAND	PSS 601
SUPER WASH INTL.	SUPER WASH
TEXO CORP.	TEXO LP 1582
TURCO	TURCO 5668
TURCO	TURCO 6088A
TURCO	TURCO 6744
TURCO	TURCO 6776
U.S. POLYCHEMICAL	PXP SALOME "M"
WITCO	STRIPPER MCR

APPENDIX H
PAINT STRIPPER INFORMATION

COMPANY	PRODUCT	METALS	CONCENTRATION	METHOD	TEMP.	FLASH POINT
3M	SAFEST STRIPPER	ALUMINUM, STEEL	NEAT	SPRAY OR BRUSH	AMBIENT	N/A
AMBION CORPORATION	INSULSTRIP S	ALUMINUM, STEEL	NEAT	HOT DIP TANK	116-121 C	90.5 C
BROCO PRODUCTS, INC.	BROCO 300	ALUMINUM, STEEL, NOT MAGNESIUM	NEAT	DIP TANK	AMBIENT	>62.8 C
BRULIN & COMPANY, INC.	EXP 2187	ALL METALS	NEAT	HOT DIP TANK	79-85 C	104.4 C
BRULIN & COMPANY, INC.	SAFETY STRIP 1000	ALL METALS	NEAT	COLD-HOT DIP TANK	COLD-60 C	>93.3 C
BRULIN & COMPANY, INC.	SAFETY STRIP 2000	ALL METALS	NEAT	SPRAY ON	COLD-60 C	>93.3 C
BRULIN & COMPANY, INC.	SAFETY STRIP 4000	ALL METALS	NEAT	BRUSH ON	COLD-60 C	>93.3 C
CHEMCO MFG. CO., INC.	CSP-2015	ALUMINUM, STEEL	NEAT	SPRAY ON	AMBIENT	60 C
CHEMICAL METHODS INC.	CM-500	FERROUS METALS, NOT FOR ALUMINUM, ZINC	50-100% BY VOLUME	HOT DIP TANK	93-110 C	121.1 C
CHEMICAL METHODS INC.	CM-550	STEEL, ALUMINUM, COPPER, BRASS	NEAT	BRUSH ON	AMBIENT	73.9 C
CHEMICAL METHODS INC.	CM-552X	STEEL, ALUMINUM, COPPER, BRASS	NEAT	BRUSH ON	AMBIENT	73.9 C
CHEMICAL METHODS INC.	CM-3321	ZINC, ALUMINUM	NEAT	HOT DIP W/3321-AX	77-121 C	132.3 C
CHEMICAL METHODS INC.	CM-3707	FERROUS/NON-FERROUS	NEAT	HOT DIP TANK	65-104 C	118.3 C
CHEMICAL METHODS INC.	CM-3707A	FERROUS/NON-FERROUS	NEAT	HOT DIP TANK	66-88 C	96.1 C
CHEMICAL SOLVENTS INC.	SP-800	ALUMINUM & STEEL	NEAT	HOT DIP TANK	71-93 C	96.1 C
CHEMICAL SOLVENTS INC.	SP-822	ALUMINUM & STEEL	NEAT	HOT DIP TANK	71-93 C	93.3 C
CHEMICAL SOLVENTS INC.	SP-823	STEEL	NEAT	HOT DIP TANK	71-93 C	93.3 C
CHEMICAL SOLVENTS INC.	SP-824	STEEL	NEAT	REJUV SP-823 2.5% V.	71-93 C	NONE
CHEMICAL SYSTEMS INC.	PS-589X	FERROUS/NON-FERROUS	NEAT	HOT DIP TANK	71-79 C	87.8-107.2 C
CHEMICAL SYSTEMS INC.	PS-590 (SEAL)	FERROUS/NON-FERROUS	2"-4" SEAL	HOT DIP TANK	71-79 C	107.2 C
DU PONT	DBE (E60988-37)	ALUMINUM, STEEL	NEAT	BRUSH ON	AMBIENT	100 C
ELDORADO	HT-2230	STEEL, ALUM., TITANIUM, MAGNESIUM, STRUCT. METALS	NEAT	HOT DIP TANK	66-82 C	104.4 C
ELGENE	22 SK1000	STEEL ONLY	1:5	HOT DIP TANK	AMB.-BOIL	NONE
ELGENE	FABULENE	STEEL, FERROUS METALS, ALUM. MAG. COPPER	NEAT	SPRAY OR DIP TANK	AMB./HOT	NONE
ENTHONE	ENDOX L-76	STEEL, COPPER, BRASS, MAGNESIUM	NEAT	HOT DIP TANK	77-115 C	NONE

APPENDIX H
PAINT STRIPPER INFORMATION

COMPANY	PRODUCT	METALS	CONCENTRATION	METHOD	TEMP.	FLASH POINT
ENTHONE	ENDOX-Q-576	FERROUS METALS, COPPER & COPPER ALLOYS	90-150 G/L	HOT DIP TANK	82-93 C	N/A
ENVIROSOLV INC.	RE-ENTRY ES	ALL METALS	NEAT	SPRAY OR DIP TANK	AMBIENT	62.8 C
ENVIROSOLV INC.	RE-ENTRY RFS	ALUMINUM & STEEL	NEAT	DIP TANK	AMBIENT	
EXXON COMPANY	EXPERIMENTAL #1	ALL METALS	NEAT	NOT AVAILABLE	N/A	N/A
EXXON COMPANY	EXPERIMENTAL #2	ALL METALS	NEAT	NOT AVAILABLE	N/A	N/A
EXXON COMPANY	EXPERIMENTAL #3	ALL METALS	NEAT	NOT AVAILABLE	N/A	N/A
EXXON COMPANY	EXPERIMENTAL #4	ALL METALS	NEAT	NOT AVAILABLE	N/A	N/A
EXXON COMPANY	NOPAR 13	ALUMINUM, STEEL	NEAT	SPRAY OR DIP TANK	AMBIENT	93.3 C
EXXON COMPANY	NOPAR 15	ALUMINUM, STEEL	NEAT	SPRAY OR DIP TANK	AMBIENT	93.3 C
FINE ORGANICS CORP.	FO 2115A	COMPOSITES & OTHER METALS	NEAT	BRUSH OR FLOW ON	AMBIENT	93.3 C
FINE ORGANICS CORP.	FO 606 W/SEAL	ALUMINUM & MAGNESIUM	NEAT	HOT DIP TANK	71-82 C	98.9 C
FINE ORGANICS CORP.	FO 621 W/SEAL	ALUMINIUM & MAGNESIUM	NEAT	HOT DIP TANK	71-82 C	98.9 C
FINE ORGANICS CORP.	FO 623 W/SEAL	ALUMINUM & MAGNESIUM	NEAT	HOT DIP TANK W/SEAL	71-82 C	98.8 C
FREDERICK GUMM	CLEPO ENVIROSTRIP 222	ALUMINUM, ZINC, BRASS BASE METALS	80% BY VOLUME	HOT DIP TANK	82-88 C	>126.6 C
FREMONT INDUSTRIES, INC.	F-289	FERROUS/NON-FERROUS	NEAT	HOT DIP TANK	66-93 C	96.1 C
GAF CHEMICALS CORP.	M-PYROL	ALL METALS	NEAT	HOT DIP TANK	66-93 C	90.5 C
HURRI-KLEEN CORP.	HURRI-SAFE PAINT REMOVER	ALUMINUM, STEEL	NEAT	BRUSH ON	AMBIENT	N/A
HURRI-KLEEN CORP.	HURRI-SAFE STAY PUT	ALUMINUM, STEEL	NEAT	BRUSH ON	AMBIENT	N/A
IND. CHEM. PROD. OF DETROIT	ENAMEL STRIPPER 77	ALUMINUM, STEEL, ZINC & GALVANIZED COPPER	NEAT	HOT DIP TANK	88-93 C	<93.3 C
KEY CHEMICALS	KEY CHEM 0457OH	ALUMINUM, ZINC, GALVANIZED & FERROUS SURFACES	NEAT	HOT DIP TANK	121-141 C	>148.9 C
MAN-GILL CHEMICAL CO.	POWER STRIP 5163	MILD STEEL, ALUMINIUM & ZINC	NEAT	DIP TANK	AMBIENT	>93.3 C
MAN-GILL CHEMICAL CO.	ADDITIVE 0846	MILD STEEL, ALUMINUM & ZINC	NEAT	OIL SEAL LAYER	AMBIENT	>93.3 C
MCGEAN ROHCO	CEE BEE A-227D (CONTROL)	ALUMINUM & STEEL	NEAT	DIP TANK	AMBIENT	N/A
MCGEAN-ROHCO	CEE-BEE A-245	HIGH,MILD,STAINLESS STEEL, ALUM & MAGNESIUM	NEAT	HOT DIP TANK	110-121 C	157.2 C

APPENDIX H
PAINT STRIPPER INFORMATION

COMPANY	PRODUCT	METALS	CONCENTRATION	METHOD	TEMP.	FLASH POINT
MCGEAN ROHCO	CEE BEE A-458 (CONTROL)		NEAT	BRUSH ON	AMBIENT	NONE
MCGEAN-ROHCO	CEE-BEE A-477	HIGH,MILD,STAINLESS STEEL, ALUM. & MAGNESIUM	NEAT	HOT DIP TANK	71-100 C	N/A
MCGEAN ROHCO	CEE BEE J-59 (CONTROL)	MAGNESIUM & STEEL	NEAT	HOT DIP TANK	88-99 C	N/A
OAKITE PRODUCTS, INC.	OAKITE STRIPPER ALM	ALUMINUM, STEEL	25-50%	HOT DIP TANK	71 C	>93.3 C
PATCLIN CHEMICAL CO., INC.	103B HOT PAINT STRIPPER	STEEL, ALUMINUM, ZINC, COPPER, BRASS	NEAT	HOT DIP TANK	71-88 C	NONE
PATCLIN CHEMICAL CO., INC.	104C HOT PAINT STRIPPER	STEEL, ALUMINUM, COPPER, BRASS	NEAT	HOT DIP TANK	71-88 C	96.1 C
PATCLIN CHEMICAL CO., INC.	106Q HOT PAINT STRIPPER	ALUMINUM, STEEL, ZINC, COPPER, BRASS	NEAT	HOT DIP TANK	71-88 C	96.1 C
PATCLIN CHEMICAL CO., INC.	126 HOT PAINT STRIPPER	ALUMINUM, STEEL, COPPER, BRASS	NEAT	HOT DIP TANK	71-88 C	NONE
PAVCO	DECOATER 3400	STEEL, ALUMINUM, ZINC, CADMIUM	NEAT	HOT DIP W/3400-AX	82-110 C	121.1 C
ROCHESTER MIDLAND	PSS 600	ALL METALS	NEAT	DIP TANK	AMB-65 C	93.3 C
ROCHESTER MIDLAND	PSS 601	ALL METALS	NEAT	BRUSH OR FLOW ON	AMB-65 C	93.3 C
SUPER WASH INTL. INC.	SUPER-WASH	STEEL - NOT ALUMINUM	NEAT	SPRAY	AMBIENT	NONE
TEXO CORP.	TEXO LP 1582	ALL METALS	NEAT	SPRAY OR BRUSH	AMBIENT	63.3 C
TURCO PRODUCTS INC.	TURCO 5351	ALL METALS	NEAT	SPRAY, BRUSH OR DIP	AMBIENT	NONE TO BOIL
TURCO PRODUCTS INC.	TURCO 5668	ALUM. TIT. MAG. CAD. FER. ALLOYS NO HI-STRENGTHS	NEAT	HOT DIP TANK	71-82 C	>93.3 C
TURCO PRODUCTS INC.	TURCO 6088A	ALUMINUM, MILD STEEL, CAST IRON, TITANIUM	NEAT	SPRAY OR BRUSH	AMBIENT	>93.3 C
TURCO PRODUCTS INC.	TURCO 6744	ALUMINUM & STEEL	NEAT	BRUSH ON	AMBIENT	62.8 C
TURCO PRODUCTS INC.	TURCO 6776	ALUMINUM & STEEL	NEAT	BRUSH ON	AMBIENT	NONE
U.S. POLY CHEMICAL CORP.	PXP SALOME "M"	ALL NORMAL METALS/ALLOYS	NEAT	HOT DIP W/ AGITATOR	AMB.-60 C	>93.3 C
WITCO	STRIPPER MCR		80-100% W/ WATER	HOT DIP TANK	88-93 C	98.9 C

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APPENDIX I

TOXICITY DATA ON PAINT STRIPPERS

COMPANY NAME:PRODUCT NAME	PERCENTAGE	PEL	TLV
PRESENT STRIPPERS			
Turco: Turco 5351			
Methylene Chloride	50		50 mg/L
Phenol (skin)	25	5 mg/L	5 mg/L
Sodium Chromate	1		50 ug/L
McGean Rohco: Cee-Bee A-227D			
Methylene Chloride	25-50		50 mg/L
Xylene	3-8	100 mg/L	100 mg/L
Toluene	3-8		100 mg/L
Formic Acid	15		5 mg/L
Phenol (skin)	18-25	5 mg/L	5 mg/L
Hydroflouric Acid	<2		3 mg/L *

* As Flouride

COMPANY NAME:PRODUCT NAME	PERCENTAGE	PEL	TLV
McGean Rohco: Cee-Bee A-458			
Methylene Chloride	80		50 mg/L
Ethanol	<15		1000 mg/L
McGean Rohco: Cee-Bee J-59			
Sodium Hydroxide	20-40		2 mg/m^3
Cresol (skin)	10-20		5 mg/L
POSSIBLE REPLACEMENTS			
Chemical Methods: CM-3707			
2-Aminoethanol	20	3 mg/L	3 mg/L
Chemical Solvents: SP-800			
Tetrahydro Furfuryl Alcohol			
Diethanolamine	20-40		3 mg/L
Fine Organics: FO 606 w/ Seal			
Ethanolamine	<18		3 mg/L
N-Methylpyrrolidone	70		100 mg/L
Frederick Gumm Chem: Clepo Envirostrip 222			
Dodecyl Benzene Sulfonic Acid	21.3		
Sulfuric Acid	0.220		1 mg/m^3

TOXICITY DATA ON PAINT STRIPPERS

COMPANY NAME:PRODUCT NAME	PERCENTAGE	PEL	TLV
GAF: M-Pyrol			
N-Methylpyrrolidone	100		100 mg/L
McGean-Rohco: Cee-Bee A-245			
Benzyl Alcohol	5		
Butylene Glycol	50		
McGean-Rohco: Cee-Bee A-477			
Ethanolamine	<50	3 mg/L	3 mg/L
Mineral Oil	8		5 mg/m^3
Patclin: 126 Hot Stripper			
Alkane Sulfonic Acid	10		
Blends of Glycol Ethers	75		
2-Butoxyethanol (skin)		50 mg/L	25 mg/L
Rochester Midland: PSS 600			
N-Methylpyrrolidone	>50		100 mg/L
Turco: Turco 5668			
Hydrotreated Napthenic Distillate	15		5 mg/m^3
Monoethanol Amine	30		3 mg/L
N-Methylpyrrolidone	45		100 mg/L
Potassium Hydroxide	<5		2 mg/m^3

NOTE: Explanation of Units for TLV and PEL:

Milligrams per liter (mg/L) - Vapors and gases

Milligrams per liter (mg/m^3) - Particulates in the air

APPENDIX J

INITIAL COD ANALYSIS

COMPANY	PRODUCT	INITIAL COD
3M	SAFEST STRIPPER	439000
AMBION CORPORATION	INSULSTRIP S	1645000
BROCO PRODUCTS, INC.	BROCO 300	2865000
BRULIN & COMPANY, INC.	SAFETY STRIP 1000	2180000
BRULIN & COMPANY, INC.	SAFETY STRIP 2000	2320000
BRULIN & COMPANY, INC.	SAFETY STRIP 4000	1705000
BRULIN & COMPANY, INC.	EXP 2187	2055000
CHEMCO MFG. CO., INC.	CSP-2015	5420000
CHEMICAL METHODS INC.	CM-500	539000
CHEMICAL METHODS INC.	CM-550	4940000
CHEMICAL METHODS INC.	CM-552X	2375000
CHEMICAL METHODS INC.	CM-3321	318000
CHEMICAL METHODS INC.	CM-3707	2790000
CHEMICAL METHODS INC.	CM-3707A	3555000
CHEMICAL SOLVENTS INC.	SP-822	2735000
CHEMICAL SOLVENTS INC.	SP-823	1880000
CHEMICAL SOLVENTS INC.	SP-824	350000
CHEMICAL SOLVENTS, INC.	SP-800	2585000
CHEMICAL SYSTEMS INC.	PS-589X	1720000
CHEMICAL SYSTEMS INC.	PS-590 (SEAL)	NA
DU PONT	DBE (E60988-37)	2935000
ELDORADO	HT-2230	2625000
ELGENE	22 SKIDOO	118000
ELGENE	FABULENE	68500
ENTHONE	ENDOX L-76	262000
ENTHONE	ENDOX-Q-576	10500
ENVIROSOLV INC.	RE-ENTRY ES	5145000
ENVIROSOLV INC.	RE-ENTRY RFS	1225000
EXXON COMPANY	EXPERIMENTAL #1	1200000
EXXON COMPANY	EXPERIMENTAL #2	1535000
EXXON COMPANY	EXPERIMENTAL #3	1575000

INITIAL COD ANALYSIS

COMPANY	PRODUCT	INITIAL COD
EXXON COMPANY	EXPERIMENTAL #4	1025000
EXXON COMPANY	NOPAR 13	1349500
EXXON COMPANY	NOPAR 15	78500
FINE ORGANICS CORP.	FO 2115A	2865000
FINE ORGANICS CORP.	FO 606 W/SEAL	574500
FINE ORGANICS CORP.	FO 621 W/SEAL	2505000
FINE ORGANICS CORP.	FO 623 W/SEAL	2795000
FREDERICK GUMM	CLEPO ENVIROSTRIP 222	5980000
FREMONT INDUSTRIES, INC.	F-289	2400000
GAF CHEMICALS CORP.	M-PYROL	1335000
HURRI-KLEEN CORP.	HURRI-SAFE PAINT REMOVER	401500
HURRI-KLEEN CORP.	HURRI-SAFE STAY PUT	805500
IND. CHEM. PROD. OF DETROIT	ENAMEL STRIPPER 77	1475000
KEY CHEMICALS	KEY CHEM 04570H	12330000
MAN-GILL CHEMICAL CO.	POWER STRIP 5163	1275000
MAN-GILL CHEMICAL CO.	ADDITIVE 0846	1210000
MCGEAN ROHCO	CEE BEE A-458 (CONTROL)	461500
MCGEAN ROHCO	CEE BEE J-59 (CONTROL)	523500
MCGEAN ROHCO	CEE BEE A-227D (CONTROL)	1110000
MCGEAN ROHCO	CEE-BEE A-245	5080000
MCGEAN ROHCO	CEE-BEE A-477	1141500
OAKITE PRODUCTS, INC.	OAKITE STRIPPER ALM	2285000
PATCLIN CHEMICAL CO., INC.	103B HOT PAINT STRIPPER	3085000
PATCLIN CHEMICAL CO., INC.	104C HOT PAINT STRIPPER	3390000
PATCLIN CHEMICAL CO., INC.	106Q HOT PAINT STRIPPER	4195000
PATCLIN CHEMICAL CO., INC.	126 HOT PAINT STRIPPER	1392000
PAVCO	DECOATER 3400	2035000
ROCHESTER MIDLAND	PSS 600	2350000
ROCHESTER MIDLAND	PSS 601	2505000
SUPER WASH INTL. INC.	SUPER-WASH	209500
TEXO CORP.	TEXO LP 1582	1790000

INITIAL COD ANALYSIS

COMPANY	PRODUCT	INITIAL COD
TURCO PRODUCTS INC.	TURCO 5668	1950000
TURCO PRODUCTS INC.	TURCO 6088A	498000
TURCO PRODUCTS INC.	TURCO 5351	NA
TURCO PRODUCTS INC.	TURCO 6776	440500
TURCO PRODUCTS INC.	TURCO 6744	1208000
U.S. POLY CHEMICAL CORP.	PXP SALOME "M"	2410000
WITCO	STRIPPER MCR	2540000

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APPENDIX K

BIODEGRADABLITY DATA

COMPANY NAME	PRODUCT NAME	DATE RUN
3M	SAFEST STRIPPER	9/6/89
AMBION	INSULSTRIP S	9/5/89
BROCO	BROCO 300	9/6/89
BRULIN	SAFETY STRIP 1000	9/5/89
BRULIN	SAFETY STRIP 2000	9/5/89
BRULIN	SAFETY STRIP 4000	9/5/89
BRULIN	EXPERIMENTAL 2187	9/5/89
CHEMCO	CSP-2015	9/6/89
CHEMICAL METHODS	CM-500	9/6/89
CHEMICAL METHODS	CM-550	9/6/89
CHEMICAL METHODS	CM-552X	3/5/90
CHEMICAL METHODS	CM-3321	3/6/90
CHEMICAL METHODS	CM-3707	3/1/90
CHEMICAL METHODS	CM-3707A	3/1/90
CHEMICAL SOLVENTS	SP-800	8/9/89
CHEMICAL SOLVENTS	SP-822	3/6/90
CHEMICAL SOLVENTS	SP-823	3/1/90
CHEMICAL SOLVENTS	SP-824	8/9/89
CHEMICAL SYSTEMS	FS-589X/590	8/9/89
DU PONT	DBE (E60988-37)	9/20/89
ELDORADO	HT-2230	9/19/89
ELGENE	22 SKIDOO	9/12/89
ELGENE	FABULENE	SEE FOOTNOTE 1
ENTHONE	ENDOX L-76	9/20/89
ENTHONE	ENDOX Q-576	9/20/89
ENVIROSOLV	RE-ENTRY ES	9/20/89
ENVIROSOLV	RE-ENTRY RFS	3/5/90

COMPANY NAME	PRODUCT NAME	DATE RUN
XXON	EXPERIMENTAL #1	9/13/89
EXXON	EXPERIMENTAL #2	9/13/89
EXXON	EXPERIMENTAL #3	9/13/89
EXXON	EXPERIMENTAL #4	9/13/89
EXXON	NORPAR 13	SEE FOOTNOTE 1
EXXON	NORPAR 15	SEE FOOTNOTE 1
FINE ORGANICS	FO 606	7/20/89
FINE ORGANICS	FO 621	7/20/89
FINE ORGANICS	FO 623	7/20/89
FINE ORGANICS	FO 2115A	7/20/89
FREDRICK GUMM	CLEPO ENVIROSTRIP 222	9/19/89
FREMONT	F-289	9/19/89
GAF	M-PYROL	7/20/89
HURRI-KLEEN	HURRI-SAFE PAINT REMOVER	3/22/90
HURRI-KLEEN	HURRI-SAFE STAY PUT	3/22/90
INDUSTRIAL CHEM. PRODUCTS OF DETROIT	ENAMEL STRIPPER 77	2/27/90
KEY CHEMICALS	KEY CHEMICALS 04570H	9/19/89
MAN GILL	POWER STRIP 5163/0846	9/26/89
McGEAN-ROHCO	CEE-BEE A-245	3/5/90
McGEAN-ROHCO	CEE-BEE A-477	2/28/90
McGEAN-ROHCO	CEE-BEE A-227D (CONTROL)	3/5/90
McGEAN-ROHCO	CEE-BEE A-458 (CONTROL)	3/5/90
McGEAN-ROHCO	CEE-BEE J-59 (CONTROL)	3/5/90
OAKITE	OAKITE STRIPPER ALM	9/20/89
PATCLIN	103B	9/26/89
PATCLIN	104C	9/26/89
PATCLIN	106 Q	9/26/89
PATCLIN	126 HOT DIP	2/27/90
PAVCO	DECOATER 3400	9/26/89
ROCHESTER MIDLAND	PSS 600	3/1/90
ROCHESTER MIDLAND	PSS 601	3/1/90
SUPER WASH INTL.	SUPER WASH	3/22/90

COMPANY NAME	PRODUCT NAME	DATE RUN
TEXO CORP.	TEXO LP 1582	9/27/89
TURCO	TURCO 5668	9/27/89
TURCO	TURCO 6088A	9/27/89
U.S. POLYCHEMICAL	PXP SALOME "M"	9/27/89
WITCO	STRIPPER MCR	9/27/89

1. Chavez, A.A., Ugaki, S.M., Wikoff, P.M., et al., Substitution of Cleaners with Biodegradable Solvents, Phase II, Extended Performance Testing, Final Report, ESL-TR Air Force Engineering & Services Center, Tyndall AFB, Florida, November 1989.

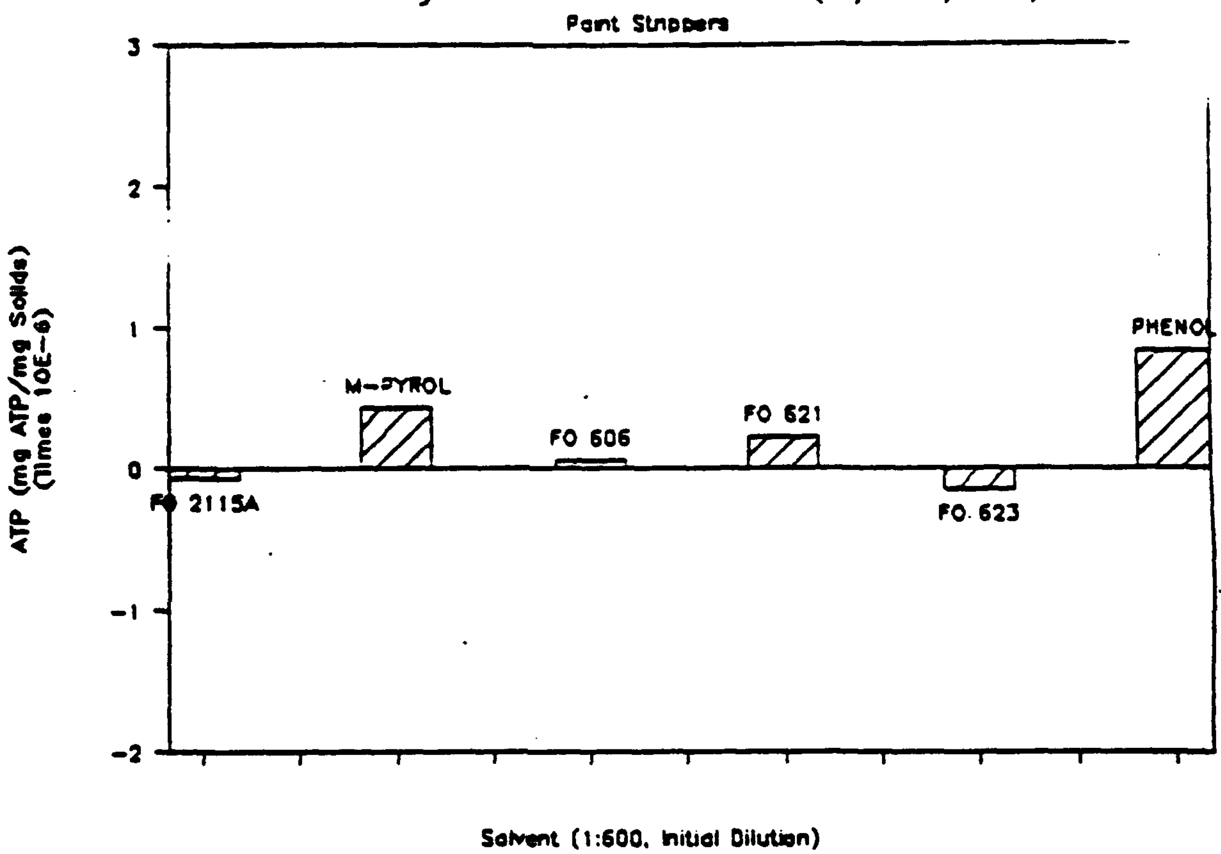
ATP DATA

Date: 7/20/89 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	0.445	183.8	0.452	187.350	0.86417	0.00430	
	0	0.459	190.9					
Bugs	0	52.34	298.3	51.830	314.650	0.1939	1.120E-06	
	0	51.32	331					
FO 2115A	0	58.92	283.6	65.325	264.650	0.3234	1.867E-06	
	0	71.73	245.7					
N-PYROL	0	48.96	347.3	59.410	357.250	0.1966	1.135E-06	
	0	69.86	367.2					
FO 606	0	77.18	328.1	73.455	338.100	0.2743	1.584E-06	
	0	69.73	348.1					
FO 621	0	63.81	345.4	74.185	339.900	0.2759	1.593E-06	
	0	84.56	334.4					
FO 623	0	84.27	280.6	74.585	289.600	0.3429	1.980E-06	
	0	64.9	298.6					
PHENOL	0	53.22	269.3	56.200	271.950	0.2565	1.481E-06	
	0	59.18	274.6					
Blank	5	0.782	224.7	0.877	223.200			
	5	0.971	221.7					
FO 2115A	6	79.3	360.6	89.150	371.550	0.3126	1.805E-06	-6.2E-08
	6	99	382.5					
N-PYROL	6	61.96	322.5	69.170	321.400	0.2708	1.564E-06	4.3E-07
	6	76.38	320.3					
FO 606	6	78.88	341.8	79.075	353.650	0.2848	1.645E-06	6.1E-08
	6	79.27	365.5					
FO 621	6	79.58	339.7	83.755	346.700	0.3152	1.820E-06	2.3E-07
	6	87.93	353.7					
FO 623	6	81.81	347.8	84.970	348.850	0.3187	1.840E-06	-1.4E-07
	6	88.13	349.9					
PHENOL	6	90.24	309.2	93.515	324.300	0.4015	2.318E-06	8.4E-07
	6	96.79	339.4					
Blank	6	1.099	229.3	1.264	227.950			
	6	1.429	226.6					

Solids dry wt. (g)	g/mL
0.10816	0.0043

Average	Blank	
Without	Standard	0.864
With	Standard	212.833

Thursday's Columns ATP (7/20/89)



COD DATA

Date: 7/20/89

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	245	257.0	FO 2115A	1	1560.0	1543.5
Bugs 0.1	0	269		FO 2115A	1	1527	
Bugs 0.01	0	51	37.0	FO 2115A	5	3126.0	3021.0
Bugs 0.01	0	23		FO 2115A	5	2916	
FO 2115A	0	2844	2830.0	FO 621	0	>1650	>1650
FO 2115A	0	2816		FO 621	0	>1650	
FO 2115A	1	2750	2742.0	FO 621	1	2576	2559.0
FO 2115A	1	2734		FO 621	1	2542	
FO 2115A	2	2902	2924.0	FO 621	2	2692	2685.0
FO 2115A	2	2946		FO 621	2	2678	
FO 2115A	3	2632	2707.0	FO 621	3	2538	2591.0
FO 2115A	3	2782		FO 621	3	2644	
FO 2115A	4		ERR	FO 621	4	2674	2683.0
FO 2115A	4			FO 621	4	2692	
FO 2115A	5	3012	3068.0	FO 621	5	2586	2585.0
FO 2115A	5	3124		FO 621	5	2584	
FO 2115A	6	2752	2661.0	FO 621	6	2634	2684.0
FO 2115A	6	2570		FO 621	6	2734	
M-PYROL	0	2444	2612.0	FO 623	0	2718	2653.0
M-PYROL	0	2780		FO 623	0	2588	
M-PYROL	1	2576	2555.0	FO 623	1	2726	2633.0
M-PYROL	1	2534		FO 623	1	2540	
M-PYROL	2	2724	2770.0	FO 623	2	2784	2692.0
M-PYROL	2	2816		FO 623	2	2600	
M-PYROL	3	2830	2873.0	FO 623	3	2810	2705.0
M-PYROL	3	2916		FO 623	3	2600	
M-PYROL	4	3090	3038.0	FO 623	4	2734	2747.0
M-PYROL	4	2986		FO 623	4	2760	
M-PYROL	5	3002	2883.0	FO 623	5	2694	2730.0
M-PYROL	5	2764		FO 623	5	2766	
M-PYROL	6	3082	2850.0	FO 623	6	2702	2835.0
M-PYROL	6	2681		FO 623	6	2968	
FO 606	0	>1650	>1650	PHENOL	0	193	194.5
FO 606	0	>1650		PHENOL	0	196	
FO 606	1	2722	2652.0	PHENOL	1	251	250.5
FO 606	1	2582		PHENOL	1	250	
FO 606	2	2460	2532.0	PHENOL	2	242	230.5
FO 606	2	2604		PHENOL	2	219	
FO 606	3	2480	2577.0	PHENOL	3	184	174.0
FO 606	3	2674		PHENOL	3	164	
FO 606	4	2536	2458.0	PHENOL	4	162	191.5
FO 606	4	2380		PHENOL	4	221	
FO 606	5	2622	2579.0	PHENOL	5	71	53.0
FO 606	5	2536		PHENOL	5	35	
FO 606	6	2558	2598.0	PHENOL	6	26	35.0
FO 606	6	2638		PHENOL	6	44	
Standard							
0.10			223				
0.10							
0.25			250.5				
0.25							
Phenol			2317				
Phenol							

REGRESSION DATA

Date: 7/20/89

Sample	Hour	Average
FO 2115A	0	2830.0
FO 2115A	1	2742.0
FO 2115A	2	2924.0
FO 2115A	3	2707.0
FO 2115A	5	3068.0
FO 2115A	6	2661.0

Regression Output:	
Constant	2817.459
Std Err of Y Est	170.6319
R Squared	0.000591
No. of Observations	6
Degrees of Freedom	4
X Coefficient(s)	1.602484
Std Err of Coef.	32.93996

Sample	Hour	Average
N-PYROL	0	2612.0
N-PYROL	1	2555.0
N-PYROL	2	2770.0
N-PYROL	3	2873.0
N-PYROL	4	3038.0
N-PYROL	5	2883.0
N-PYROL	6	2850.0

Regression Output:	
Constant	2621.785
Std Err of Y Est	119.7968
R Squared	0.571806
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	58.5
Std Err of Coef.	22.63947

Sample	Hour	Average
FO 606	0	>1650
FO 606	1	2652.0
FO 606	2	2532.0
FO 606	3	2577.0
FO 606	4	2458.0
FO 606	5	2579.0
FO 606	6	2598.0

Regression Output:	
Constant	2590.8
Std Err of Y Est	71.85292
R Squared	0.040809
No. of Observations	6
Degrees of Freedom	4
X Coefficient(s)	-7.08571
Std Err of Coef.	17.17613

Sample	Hour	Average
FO 621	0	>1650
FO 621	1	2559.0
FO 621	2	2685.0
FO 621	3	2591.0
FO 621	4	2683.0
FO 621	5	2585.0
FO 621	6	2684.0

Regression Output:	
Constant	2589.466
Std Err of Y Est	60.91942
R Squared	0.143352
No. of Observations	6
Degrees of Freedom	4
X Coefficient(s)	11.91428
Std Err of Coef.	14.56252

Sample	Hour	Average
FO 623	0	2653.0
FO 623	1	2633.0
FO 623	2	2692.0
FO 623	3	2705.0
FO 623	4	2747.0
FO 623	5	2730.0
FO 623	6	2835.0

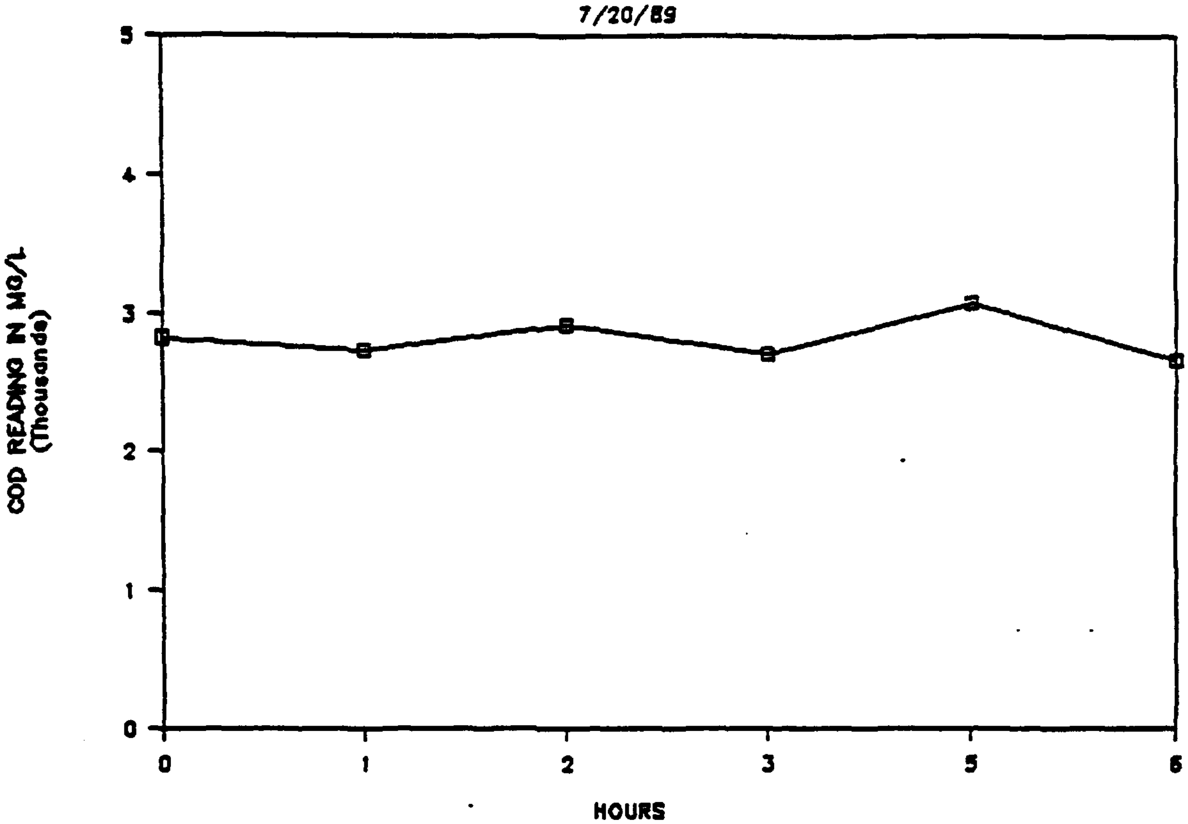
Regression Output:	
Constant	2628.392
Std Err of Y Est	29.18695
R Squared	0.841255
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	28.39285
Std Err of Coef.	5.515816

Sample	Hour	Average
Phenol	0	194.5
Phenol	1	250.5
Phenol	2	230.5
Phenol	3	174.0
Phenol	4	191.5
Phenol	5	53.0
Phenol	6	35.0

Regression Output:	
Constant	259.0535
Std Err of Y Est	50.72219
R Squared	0.698045
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-32.5892
Std Err of Coef.	9.585593

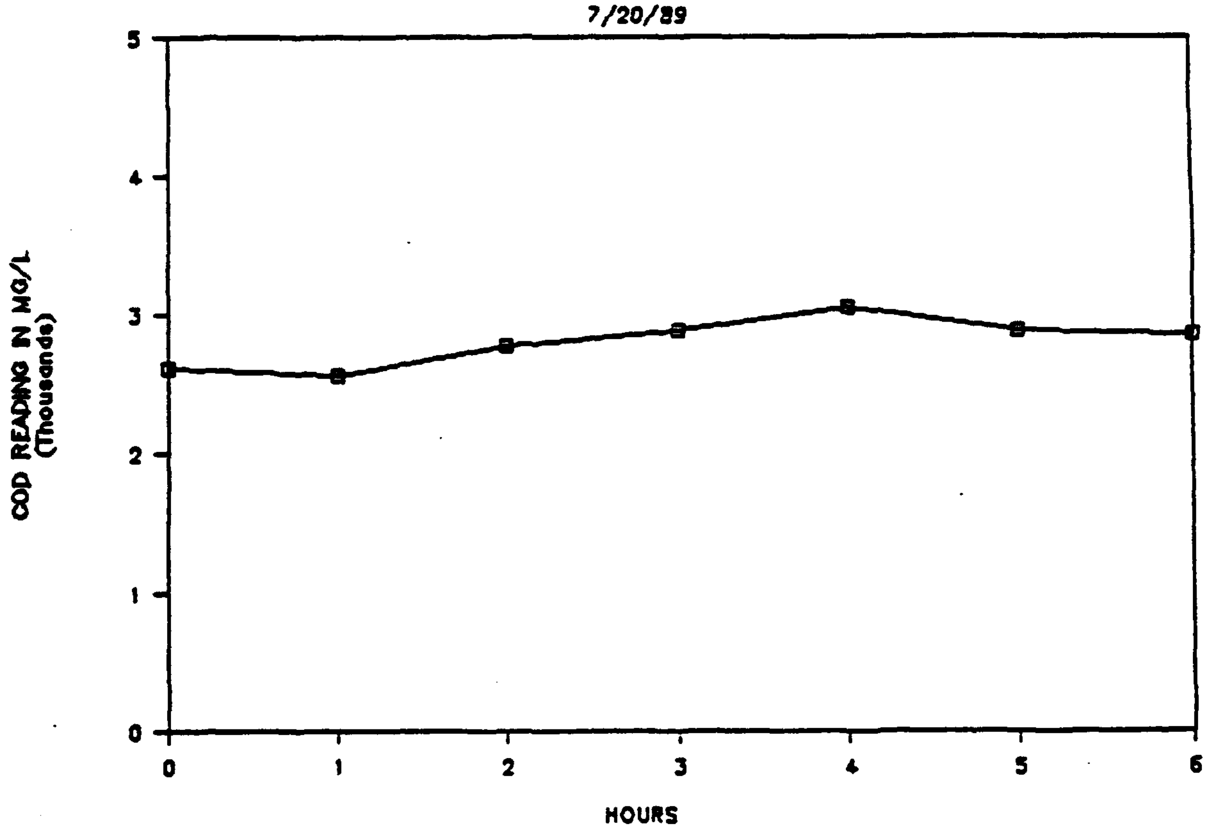
FO 2115A, FINE ORGANICS

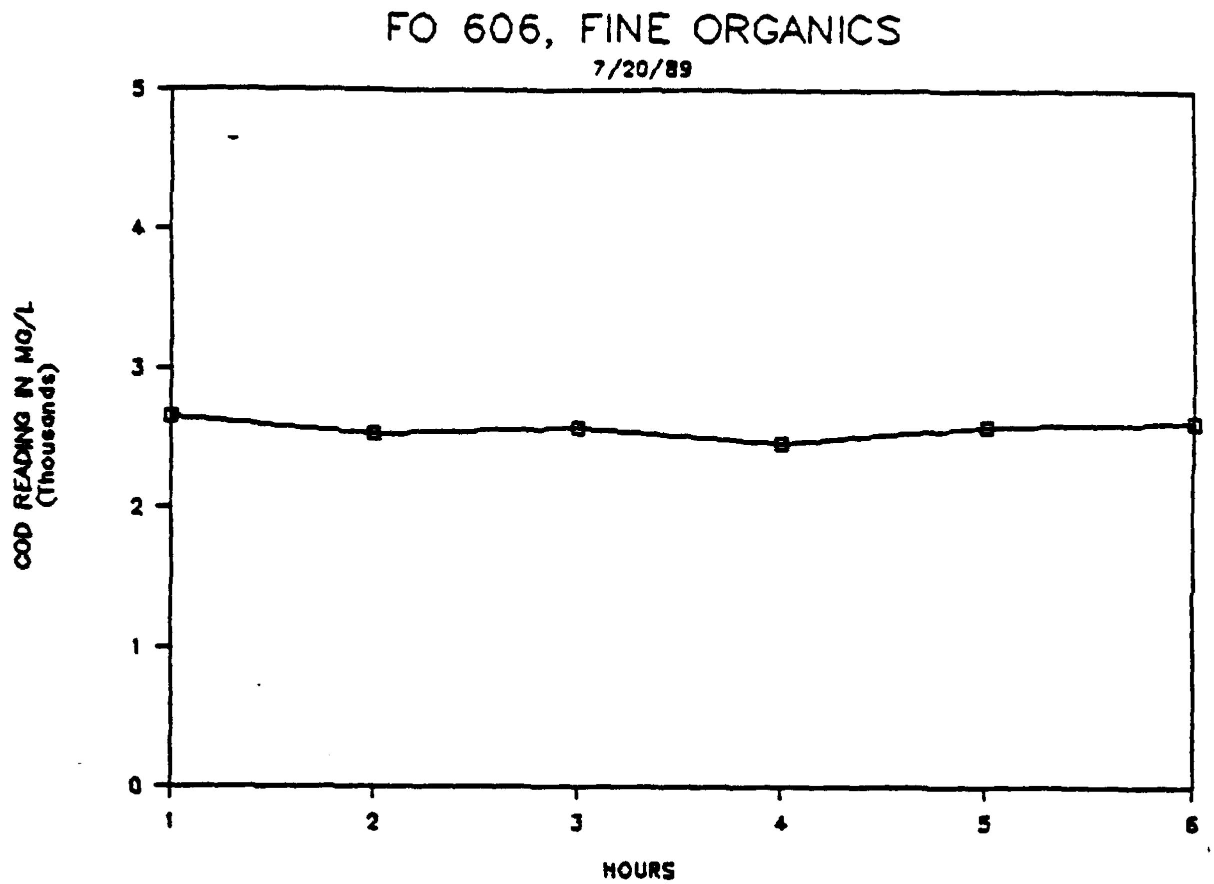
7/20/89

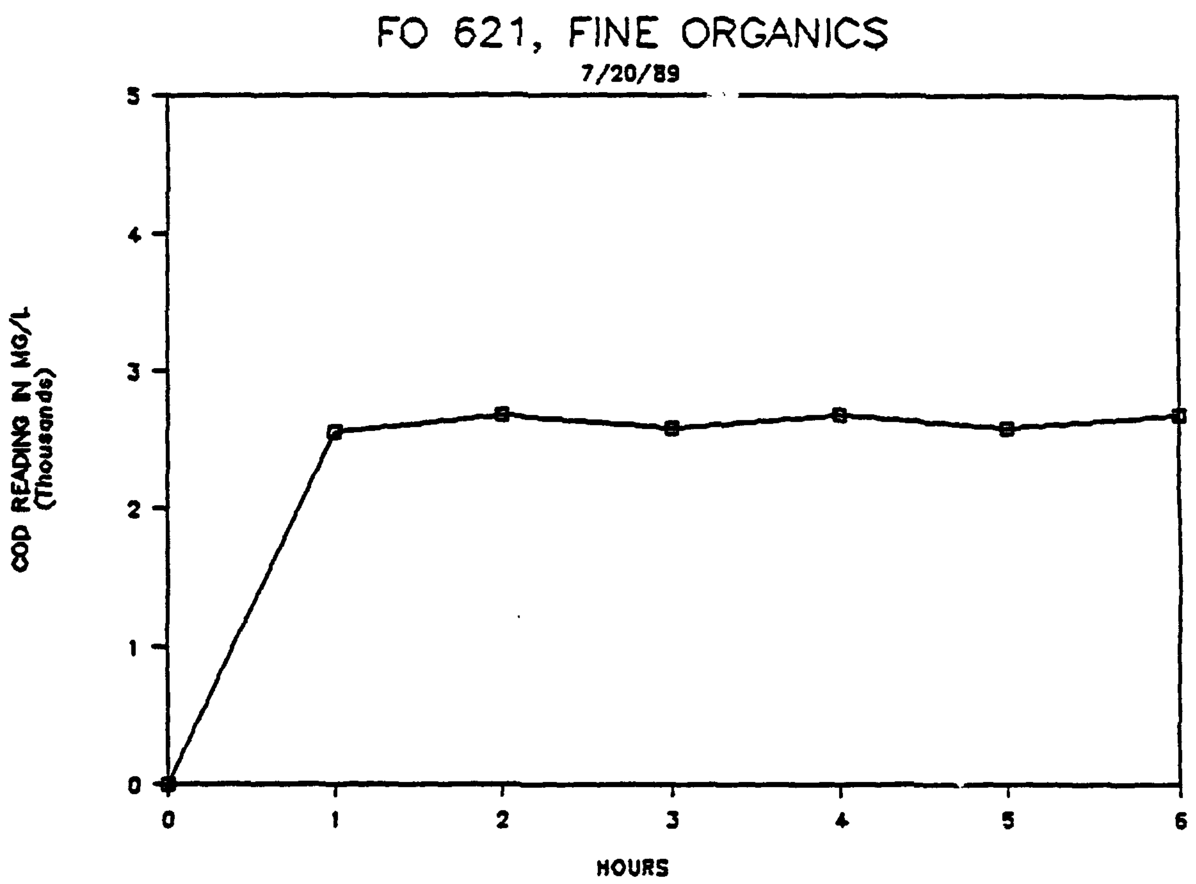


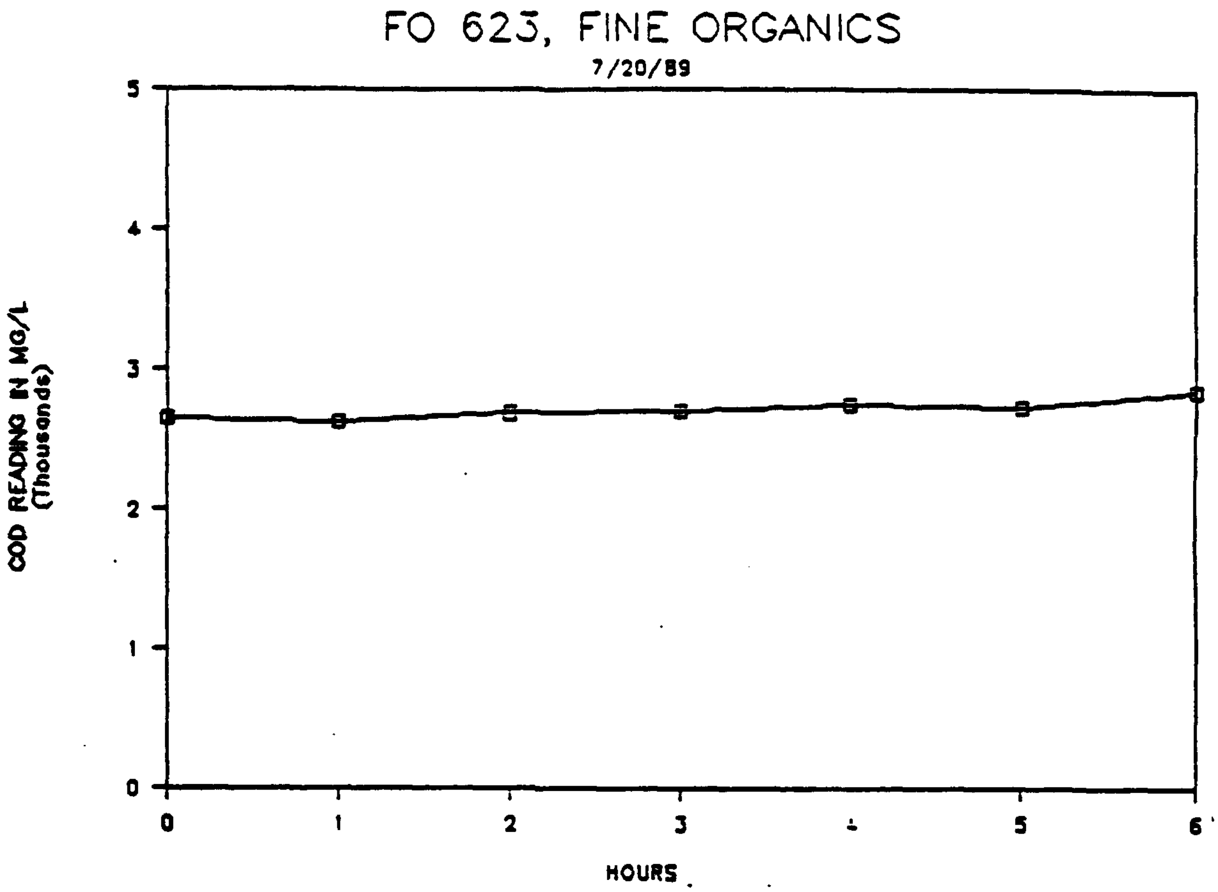
M-PYROL, GAF

7/20/89

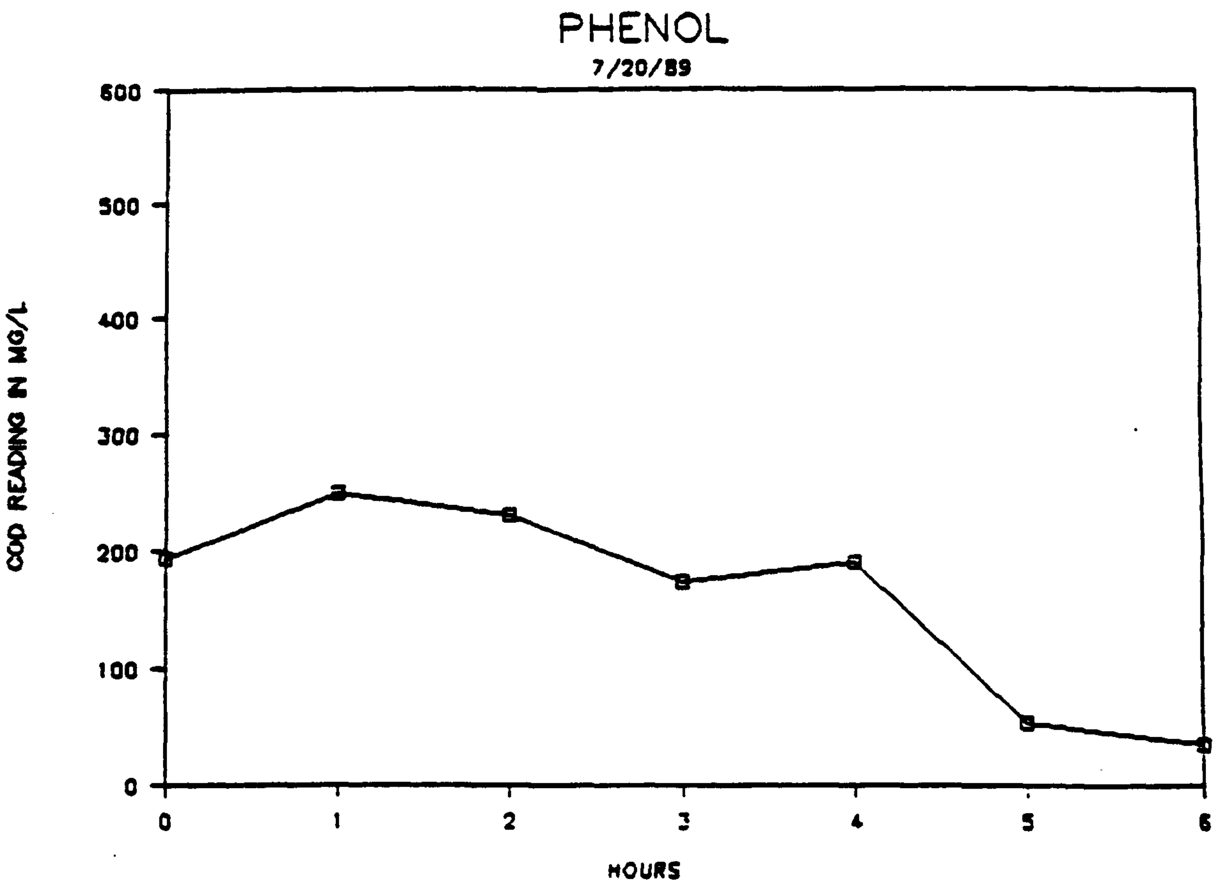



FO 606, FINE ORGANICS
7/20/89
COD READING IN MG/L
(Thousands)
0
1
2
3
4
5
1
2
3
4
5
6
HOURS


FO 621, FINE ORGANICS
7/20/89
COD READING IN MG/L
(Thousands)
0
1
2
3
4
5
0
1
2
3
4
5
6
HOURS



FO 623, FINE ORGANICS
7/20/89
COD READING IN MG/L
(Thousands)
0
1
2
3
4
5
6
HOURS



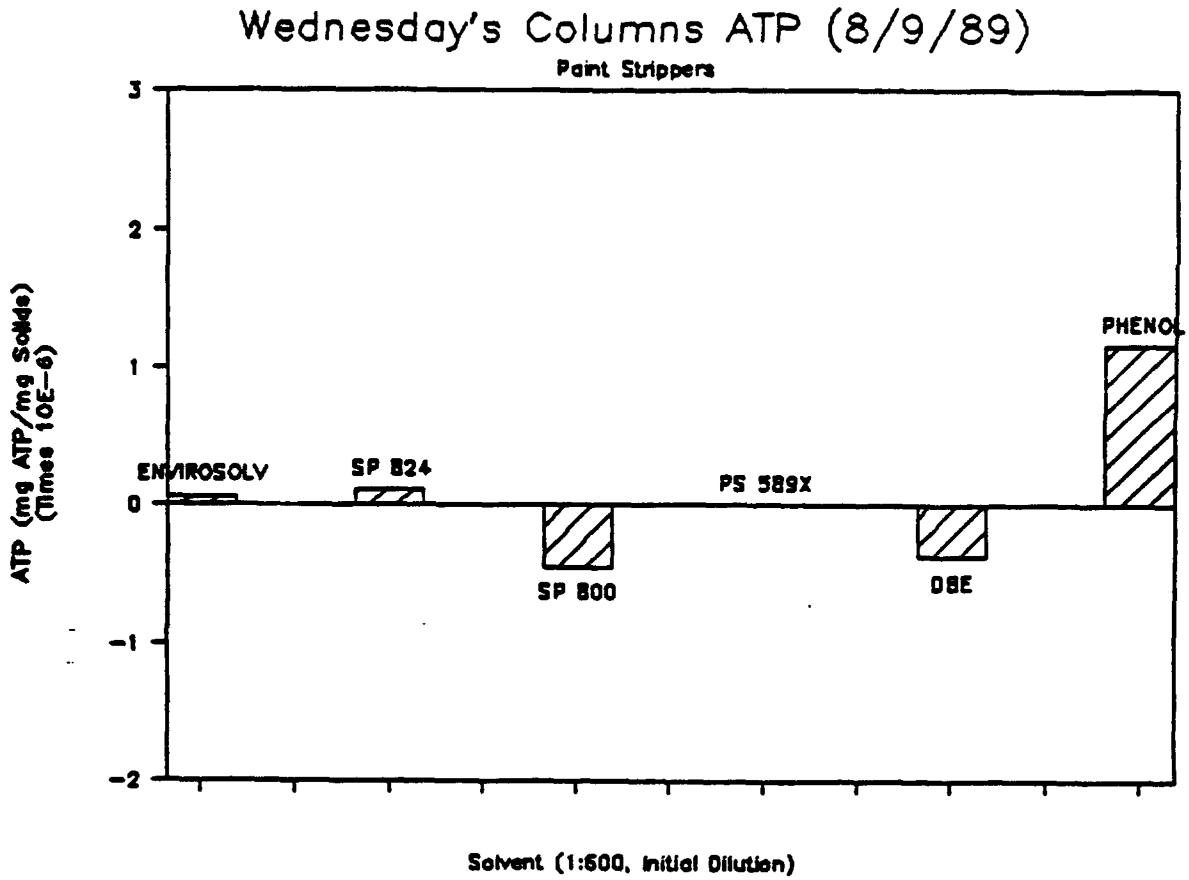
PHENOL
7/20/89
COD READING IN MG/L
0
100
200
300
400
500
600
HOURS

ATP DATA

DATE: 8/9/89 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	0.701	310.8	0.765	313.000	1.08167	0.00368	
	0	0.829	315.2					
Bugs	0	26.63	318.1	23.040	330.750	0.0714	4.848E-07	
	0	19.45	343.4					
ENVIROSOLV	0	31.37	350	31.265	363.350	0.0909	6.175E-07	
	0	31.16	376.7					
SP 824	0	36.26	235.2	38.050	237.450	0.1854	1.259E-06	
	0	39.84	239.7					
SP 800	0	16.63	222.2	18.945	217.500	0.0900	6.112E-07	
	0	21.26	212.8					
PS 589X	0	14.49	241.1	17.825	242.500	0.0745	5.063E-07	
	0	21.16	243.9					
DBE	0	16.28	221.9	13.580	211.250	0.0632	4.295E-07	
	0	10.88	200.6					
PHENOL	0	25.57	288.1	25.450	271.850	0.0989	6.719E-07	
	0	25.33	255.6					
Blank	5	1.126	285.9	1.184	273.350			
	5	1.241	260.8					
ENVIROSOLV	6	24.18	257.1	24.020	251.750	0.1007	6.843E-07	6.7E-08
	6	23.86	246.4					
SP 824	6	41.45	216.6	39.295	227.900	0.2026	1.376E-06	1.2E-07
	6	37.14	239.2					
SP 800	6	6.145	211.6	6.032	214.250	0.0238	1.615E-07	-4.5E-07
	6	5.919	216.9					
PS 589X	6	23.79	335.5	24.560	334.150	0.0768	5.152E-07	8.9E-09
	6	25.33	332.8					
DBE	6	3.549	286.2	3.341	274.950	0.0083	5.651E-08	-3.7E-07
	6	3.133	263.7					
PHENOL	6	95.6	405.3	83.970	390.450	0.2705	1.837E-06	1.2E-06
	6	72.34	375.6					
Blank	6	1.211	282	1.297	268.000			
	6	1.382	254					

Solid dry wt.(g)	g/mL
0.09212	0.0037

Average	Blank	
Without	Standard	1.082
With	Standard	284.783


Wednesday's Columns ATP (8/9/89)
Paint Strippers
ATP (mg ATP/mg Solids)
(Times 10E-6)
3
2
1
0
-1
-2
ENVIROSOLV
SP 824
SP 800
PS 589X
DBE
PHENOL
Solvent (1:600, Initial Dilution)

COD DATA

Date: 8/9/89

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	235	231.5	ENVIROSOLV	1	1074.0	1014.5
Bugs 0.1	0	228		ENVIROSOLV	1	955	
Bugs 0.01	0	22	18.0	ENVIROSOLV	5	609.0	607.5
Bugs 0.01	0	14		ENVIROSOLV	5	606	
ENVIROSOLV	0	386	385.5	PS 589X	0	2506	2569.0
ENVIROSOLV	0	385		PS 589X	0	2632	
ENVIROSOLV	1	354	360.0	PS 589X	1	2680	2650.0
ENVIROSOLV	1	366		PS 589X	1	2620	
ENVIROSOLV	2	389	394.0	PS 589X	2	2578	2598.0
ENVIROSOLV	2	399		PS 589X	2	2618	
ENVIROSOLV	3	410	416.5	PS 589X	3	2704	2677.0
ENVIROSOLV	3	423		PS 589X	3	2650	
ENVIROSOLV	4	366	364.5	PS 589X	4	2564	2616.0
ENVIROSOLV	4	363		PS 589X	4	2668	
ENVIROSOLV	5	409	402.0	PS 589X	5	2854	2841.0
ENVIROSOLV	5	395		PS 589X	5	2828	
ENVIROSOLV	6	389	388.5	PS 589X	6	2778	2676.0
ENVIROSOLV	6	388		PS 589X	6	2574	
SP 824	0	57	53.5	DBE	0	1762	1758.0
SP 824	0	50		DBE	0	1754	
SP 824	1	64	52.5	DBE	1	1866	1847.0
SP 824	1	41		DBE	1	1828	
SP 824	2	66	58.0	DBE	2	1838	1838.0
SP 824	2	50		DBE	2	1838	
SP 824	3	53	49.5	DBE	3	1882	1898.0
SP 824	3	46		DBE	3	1914	
SP 824	4	45	47.5	DBE	4	1920	1891.0
SP 824	4	50		DBE	4	1862	
SP 824	5	63	59.0	DBE	5	1902	1882.0
SP 824	5	55		DBE	5	1862	
SP 824	6	64	67.0	DBE	6	1842	1832.0
SP 824	6	70		DBE	6	1822	
SP 800	0	3022	3087.0	Phenol	0	279	270.0
SP 800	0	3152		Phenol	0	261	
SP 800	1	3258	3177.0	Phenol	1	194	233.0
SP 800	1	3096		Phenol	1	272	
SP 800	2	3080	3000.0	Phenol	2	166	162.0
SP 800	2	2920		Phenol	2	158	
SP 800	3	2980	2971.0	Phenol	3	21	30.5
SP 800	3	2962		Phenol	3	40	
SP 800	4	3066	3069.0	Phenol	4	-3	5.0
SP 800	4	3072		Phenol	4	13	
SP 800	5	3090	3085.0	Phenol	5	33	29.0
SP 800	5	3080		Phenol	5	25	
SP 800	6	3094	3149.0	Phenol	6	16	19.5
SP 800	6	3204		Phenol	6	23	
Standard							
0.10			196.50				
0.10							
0.25			515.00				
0.25							
Phenol			1195.00				
Phenol							

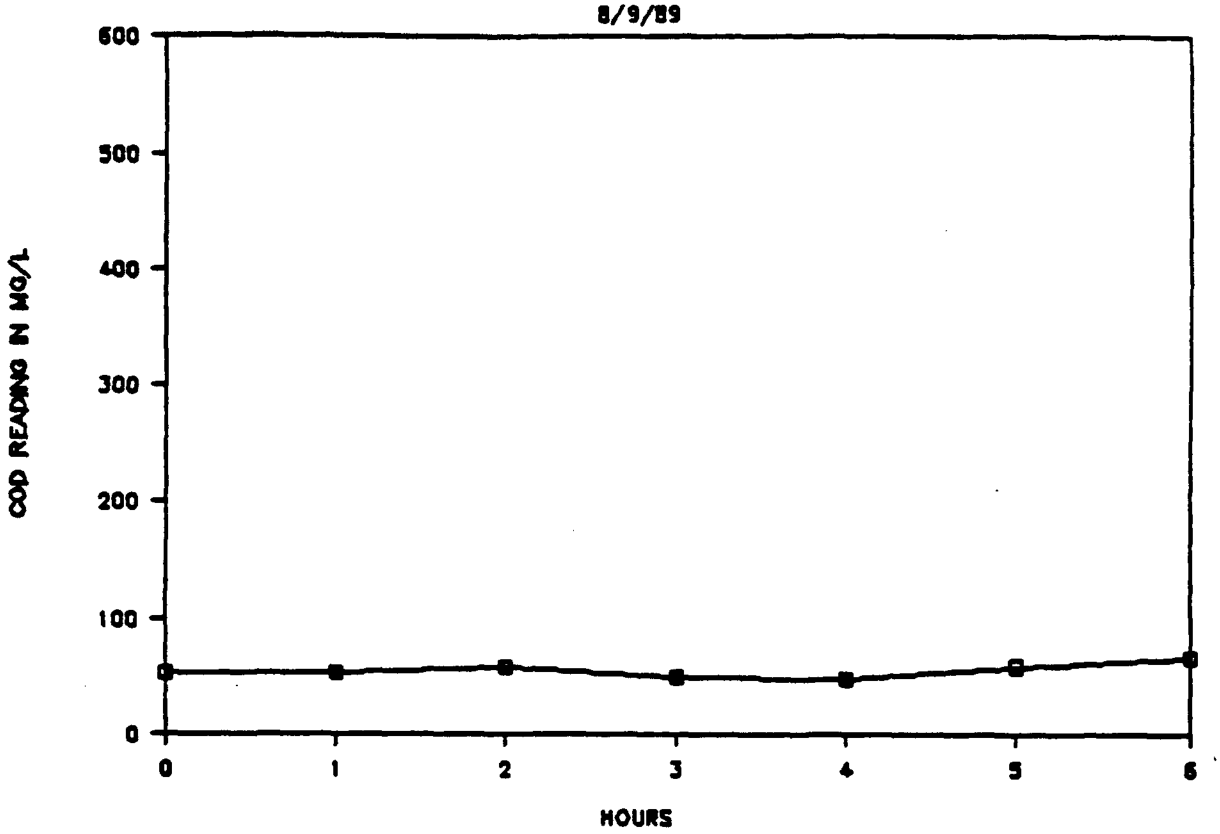
REGRESSION DATA

DATE: 8/9/89

Sample	Hour	Average		
			Regression Output:	
ENVIROSOLV	0	385.5	Constant	380.4821
ENVIROSOLV	1	360.0	Std Err of Y Est	21.16326
ENVIROSOLV	2	394.0	R Squared	0.060420
ENVIROSOLV	3	416.5	No. of Observations	7
ENVIROSOLV	4	364.5	Degrees of Freedom	5
ENVIROSOLV	5	402.0		
ENVIROSOLV	6	388.5	X Coefficient(s)	2.267857
			Std Err of Coef.	3.999481
			Regression Output:	
SP 824	0	53.5	Constant	50.67857
SP 824	1	52.5	Std Err of Y Est	6.283197
SP 824	2	58.0	R Squared	0.250677
SP 824	3	49.5	No. of Observations	7
SP 824	4	47.5	Degrees of Freedom	5
SP 824	5	59.0		
SP 824	6	67.0	X Coefficient(s)	1.535714
			Std Err of Coef.	1.187412
			Regression Output:	
SP 800	0	3087.0	Constant	3069.25
SP 800	1	3177.0	Std Err of Y Est	80.49449
SP 800	2	3000.0	R Squared	0.005526
SP 800	3	2971.0	No. of Observations	7
SP 800	4	3069.0	Degrees of Freedom	5
SP 800	5	3085.0		
SP 800	6	3149.0	X Coefficient(s)	2.535714
			Std Err of Coef.	15.21203
			Regression Output:	
PS 589X	0	2569.0	Constant	2583.75
PS 589X	1	2650.0	Std Err of Y Est	76.01874
PS 589X	2	2598.0	R Squared	0.391187
PS 589X	3	2677.0	No. of Observations	7
PS 589X	4	2616.0	Degrees of Freedom	5
PS 589X	5	2841.0		
PS 589X	6	2676.0	X Coefficient(s)	25.75
			Std Err of Coef.	14.36619
			Regression Output:	
DBE	0	1758.0	Constant	1812.464
DBE	1	1847.0	Std Err of Y Est	44.03821
DBE	2	1838.0	R Squared	0.304773
DBE	3	1898.0	No. of Observations	7
DBE	4	1891.0	Degrees of Freedom	5
DBE	5	1882.0		
DBE	6	1832.0	X Coefficient(s)	12.32142
			Std Err of Coef.	8.322440
			Regression Output:	
Phenol	0	270.0	Constant	248.0535
Phenol	1	233.0	Std Err of Y Est	52.09124
Phenol	2	162.0	R Squared	0.820218
Phenol	3	30.5	No. of Observations	7
Phenol	4	5.0	Degrees of Freedom	5
Phenol	5	29.0		
Phenol	6	19.5	X Coefficient(s)	-47.0178
			Std Err of Coef.	9.844320

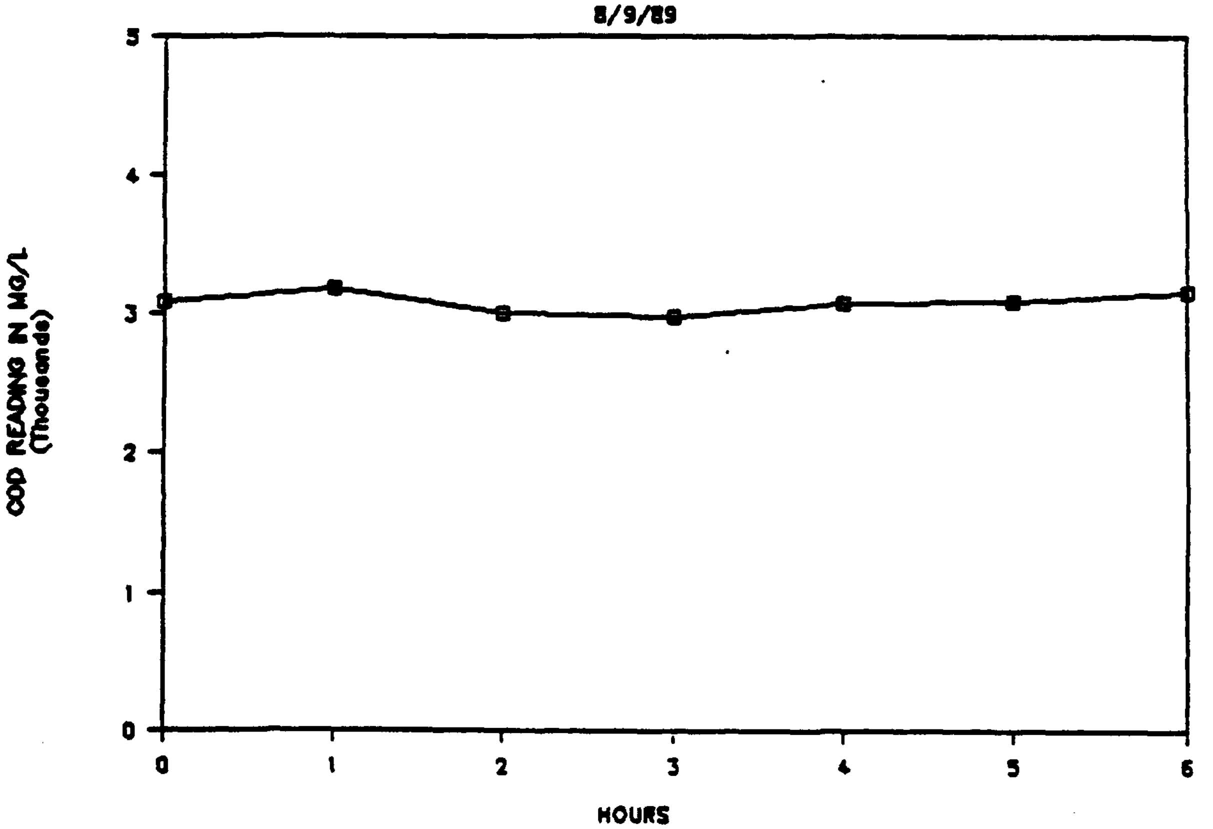
SP-824, CHEMICAL SOLVENTS

8/9/89



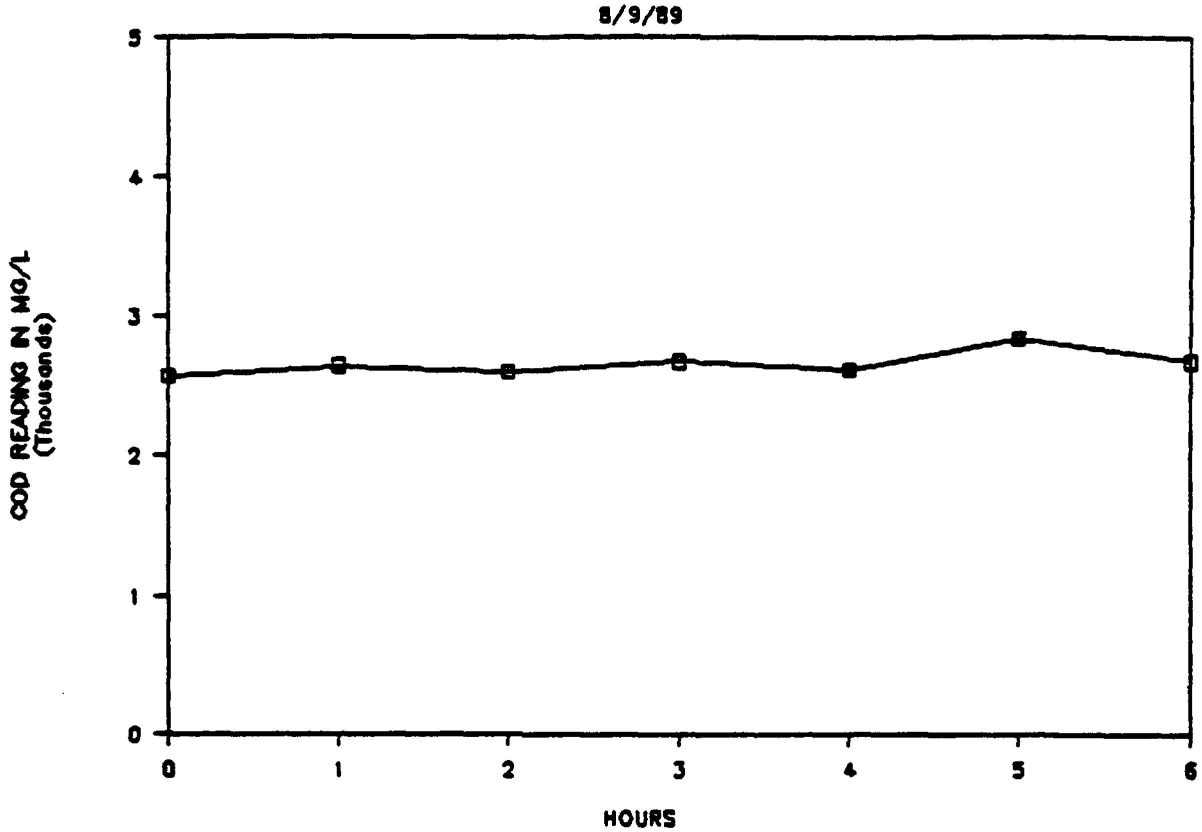
SP-800, CHEMICAL SOLVENTS

8/9/89



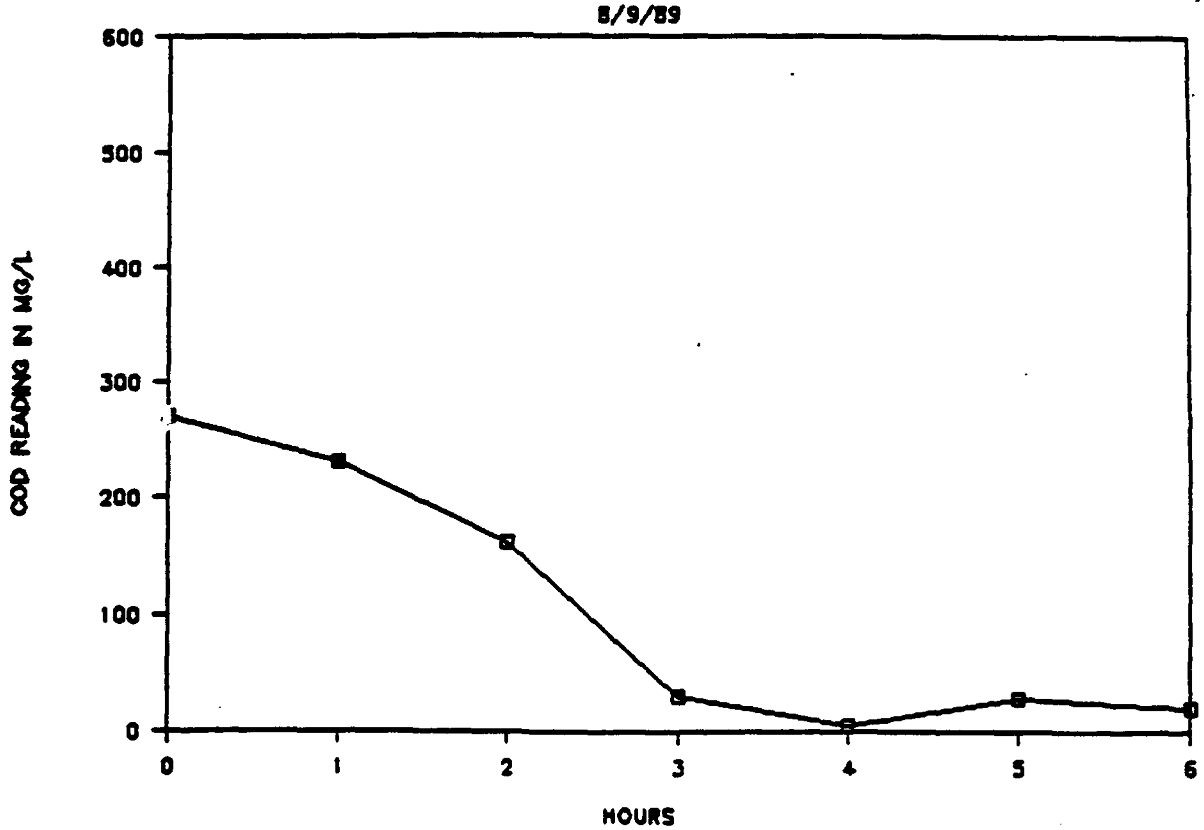
PS 589X, CHEMICAL SYSTEMS

8/9/89



PHENOL

8/9/89

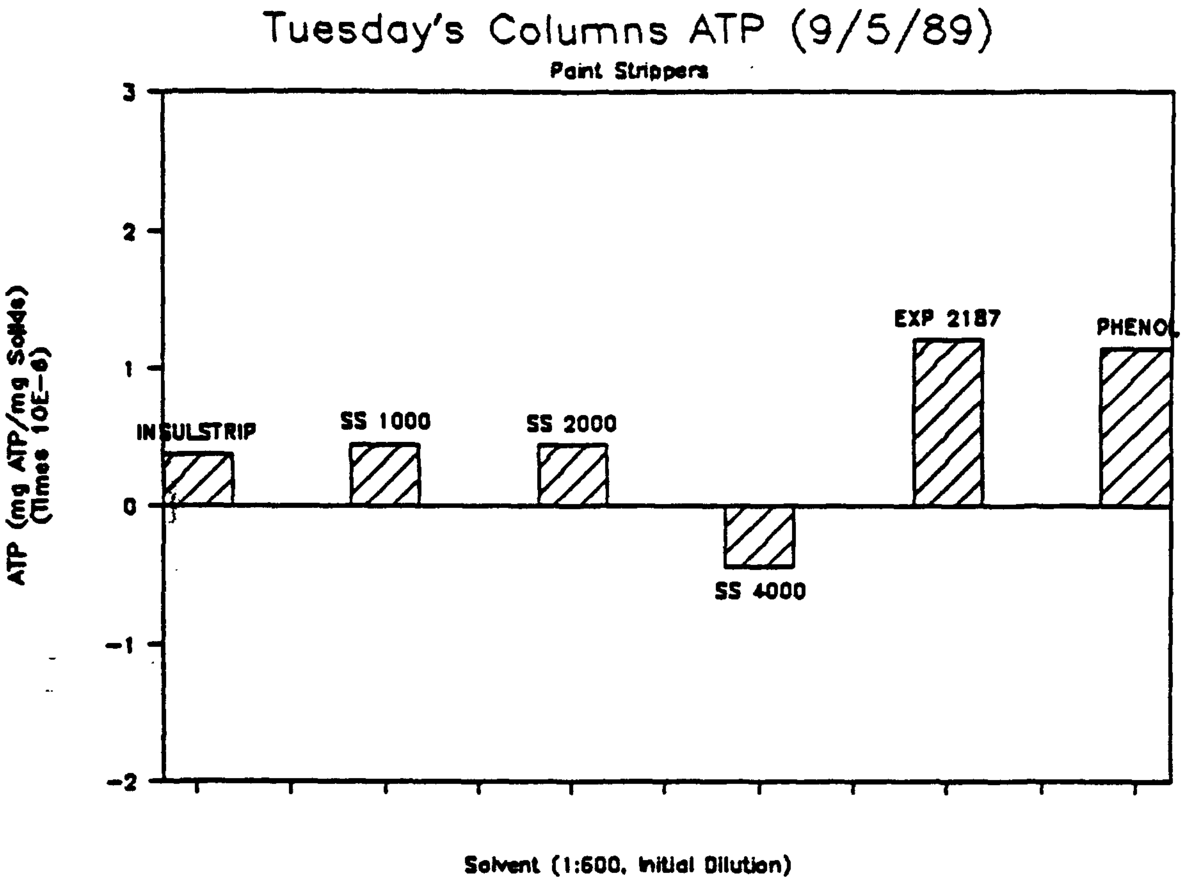


ATP DATA

Date: 9/5/89 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank) (RIS-RU)	mg ATP mg Solids	Change in ATP
Blank	0	0.724	248.9	0.681	240.900	0.38033	0.00210	
	0	0.637	232.9					
Bugs	0	11.36	258.3	11.045	257.700	0.0432	5.075E-07	
	0	10.73	257.1					
INSULSTRIP	0	10.52	214.9	11.840	213.350	0.0569	6.675E-07	
	0	13.16	211.8					
SS 1000	0	9.54	217.7	10.100	210.700	0.0485	5.687E-07	
	0	10.66	203.7					
SS 2000	0	11.25	205	11.235	208.600	0.0550	6.455E-07	
	0	11.22	212.2					
SS 4000	0	14.94	202	14.195	200.050	0.0743	8.724E-07	
	0	13.45	198.1					
EXP 2187	0	14.3	224.5	13.730	219.250	0.0650	7.624E-07	
	0	13.16	214					
PHENOL	0	20.05	191.5	20.230	191.050	0.1162	1.364E-06	
	0	20.41	190.6					
Blank	5	0.19	214.7	0.171	201.250			
	5	0.152	187.8					
INSULSTRIP	6	8.81	129	9.640	113.900	0.0888	1.042E-06	3.7E-07
	6	10.47	98.8					
SS 1000	6	4.41	63.21	5.508	64.255	0.0873	1.024E-06	4.6E-07
	6	6.606	65.3					
SS 2000	6	7.583	78	6.976	77.950	0.0929	1.091E-06	4.5E-07
	6	6.369	77.9					
SS 4000	6	3.217	135.5	5.294	138.500	0.0369	4.329E-07	-4.4E-07
	6	7.37	141.5					
EXP 2187	6	28.15	142.8	22.160	152.350	0.1673	1.964E-06	1.2E-06
	6	16.17	161.9					
PHENOL	6	11.66	68.1	12.965	72.050	0.2130	2.500E-06	1.1E-06
	6	14.27	76					
Blank	6	0.265	60.1	0.290	55.350			
	6	0.314	50.6					

Solids dry wt. (g)	g/mL
0.0532	0.0021

Average	Blank	
Without	Standard	0.380
With	Standard	165.833


Tuesday's Columns ATP (9/5/89)
Paint Strippers
ATP (mg ATP/mg Solids)
(Times 10E-6)
3
2
1
0
-1
-2
INSULSTRIP
SS 1000
SS 2000
SS 4000
EXP 2187
PHENOL
Solvent (1:600, Initial Dilution)

COD DATA

Date: 9/5/89

Sample	Hour	Reading	Average
Bugs 0.1	0	250	220.0
Bugs 0.1	0	190	
Bugs 0.01	0	59	54.0
Bugs 0.01	0	49	
INSULSTRIP	0	>1650	>1650
INSULSTRIP	0	>1650	
INSULSTRIP	1	3272	3269.0
INSULSTRIP	1	3266	
INSULSTRIP	2	3236	3232.0
INSULSTRIP	2	3228	
INSULSTRIP	3	3248	3235.0
INSULSTRIP	3	3222	
INSULSTRIP	4	3156	3165.0
INSULSTRIP	4	3174	
INSULSTRIP	5	>3300	>3300
INSULSTRIP	5	>3300	
INSULSTRIP	6	>1650	>1650
INSULSTRIP	6	>1650	
SS 1000	0	>1650	>1650
SS 1000	0	>1650	
SS 1000	1	2694	2662.0
SS 1000	1	2630	
SS 1000	2	2678	2630.0
SS 1000	2	2582	
SS 1000	3	2606	2619.0
SS 1000	3	2632	
SS 1000	4	2516	2498.0
SS 1000	4	2480	
SS 1000	5	2378	2462.0
SS 1000	5	2546	
SS 1000	6	2528	2510.0
SS 1000	6	2492	
SS 2000	0	>1650	>1650
SS 2000	0	>1650	
SS 2000	1	2726	2666.0
SS 2000	1	2606	
SS 2000	2	2636	2637.0
SS 2000	2	2638	
SS 2000	3	2496	2498.0
SS 2000	3	2500	
SS 2000	4	2430	2413.0
SS 2000	4	2396	
SS 2000	5	2462	2463.0
SS 2000	5	2464	
SS 2000	6	2436	2418.0
SS 2000	6	2400	
Standard			
0.10			210.00
0.10			
0.25			530.00
0.25			
Phenol			1189.50
Phenol			

Sample	Hour	Reading	Average
INSULSTRIP	1	>3300	>3300
INSULSTRIP	1	>3300	
INSULSTRIP	5	>3300	>3300
INSULSTRIP	5	>3300	
SS 4000	0	>1650	>1650
SS 4000	0	>1650	
SS 4000	1	2652	2601.0
SS 4000	1	2550	
SS 4000	2	2558	2570.0
SS 4000	2	2582	
SS 4000	3	2530	2582.0
SS 4000	3	2634	
SS 4000	4	2396	2441.0
SS 4000	4	2486	
SS 4000	5	2556	2584.0
SS 4000	5	2612	
SS 4000	6	2626	2577.0
SS 4000	6	2528	
EXP.2187	0	>1650	>1650
EXP.2187	0	>1650	
EXP.2187	1	>3300	>3300
EXP.2187	1	>3300	
EXP.2187	2	>3300	>3300
EXP.2187	2	>3300	
EXP.2187	3	>3300	>3300
EXP.2187	3	>3300	
EXP.2187	4	>3300	>3300
EXP.2187	4	>3300	
EXP.2187	5	>3300	>3300
EXP.2187	5	>3300	
EXP.2187	6	>3300	>3300
EXP.2187	6	>3300	
PHENOL	0	259	254.5
PHENOL	0	250	
PHENOL	1	246	248.0
PHENOL	1	250	
PHENOL	2	224	233.0
PHENOL	2	242	
PHENOL	3	221	211.0
PHENOL	3	201	
PHENOL	4	183	177.5
PHENOL	4	172	
PHENOL	5	186	180.5
PHENOL	5	175	
PHENOL	6	121	122.5
PHENOL	6	124	

REGRESSION DATA

Date: 9/5/89

Sample	Hour	Average
INSULSTRIP	0	>1650
INSULSTRIP	1	3269.0
INSULSTRIP	2	3232.0
INSULSTRIP	3	3235.0
INSULSTRIP	4	3165.0
INSULSTRIP	5	>3300
INSULSTRIP	6	>1650

Sample	Hour	Average
SS 1000	0	>1650
SS 1000	1	2662.0
SS 1000	2	2630.0
SS 1000	3	2619.0
SS 1000	4	2498.0
SS 1000	5	2462.0
SS 1000	6	2510.0

Regression Output:

Constant		2702
Std Err of Y Est		42.59191
R Squared		0.790640
No. of Observations		6
Degrees of Freedom		4
X Coefficient(s)	-39.5714	
Std Err of Coef.	10.18141	

Sample	Hour	Average
SS 2000	0	>1650
SS 2000	1	2666.0
SS 2000	2	2637.0
SS 2000	3	2498.0
SS 2000	4	2413.0
SS 2000	5	2463.0
SS 2000	6	2418.0

Regression Output:

Constant		2700.533
Std Err of Y Est		54.20428
R Squared		0.805702
No. of Observations		6
Degrees of Freedom		4
X Coefficient(s)	-52.7714	
Std Err of Coef.	12.95730	

Sample	Hour	Average
SS 4000	0	>1650
SS 4000	1	2601.0
SS 4000	2	2570.0
SS 4000	3	2582.0
SS 4000	4	2441.0
SS 4000	5	2584.0
SS 4000	6	2577.0

Regression Output:

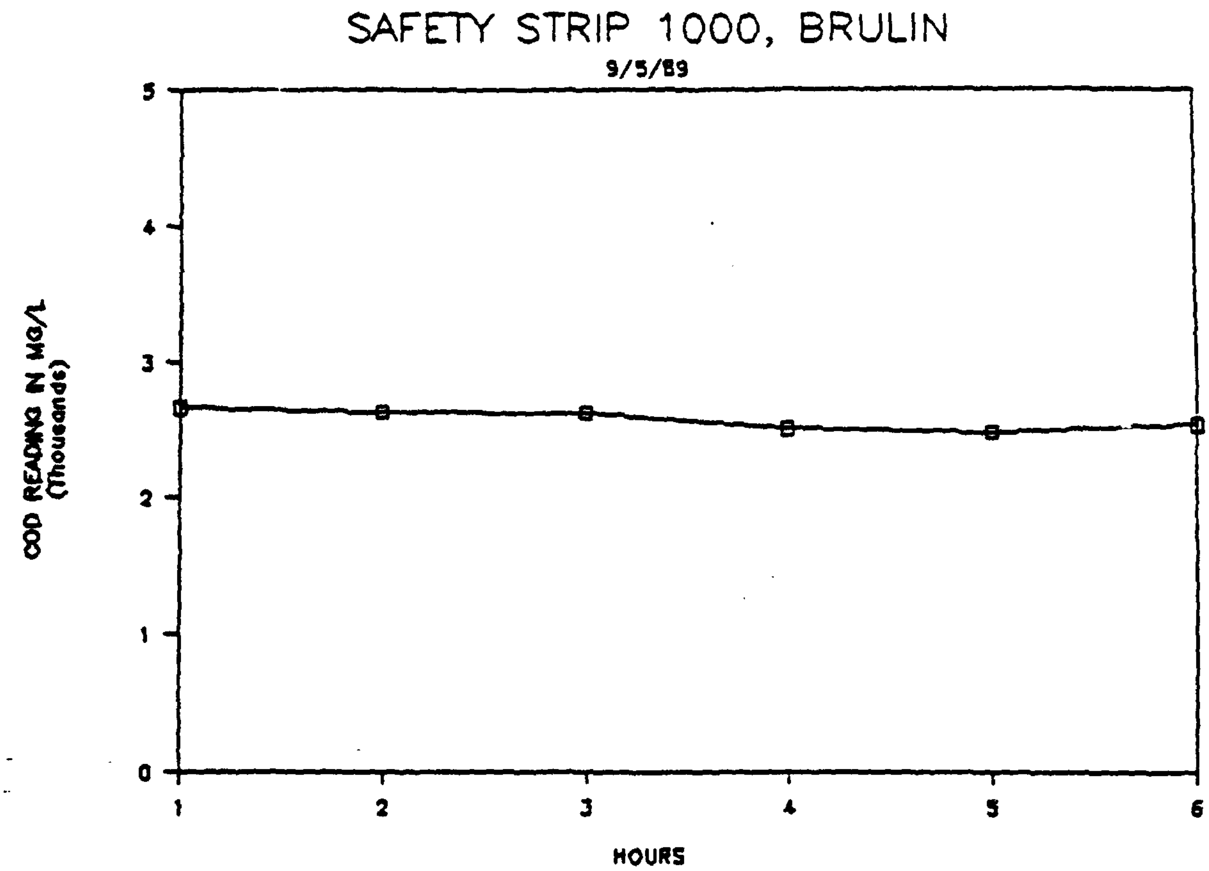
Constant		2581.066
Std Err of Y Est		64.42374
R Squared		0.039634
No. of Observations		6
Degrees of Freedom		4
X Coefficient(s)	-6.25714	
Std Err of Coef.	15.40022	

Sample	Hour	Average
EXP.2187	0	>1650
EXP.2187	1	>3300
EXP.2187	2	>3300
EXP.2187	3	>3300
EXP.2187	4	>3300
EXP.2187	5	>3300
EXP.2187	6	>3300

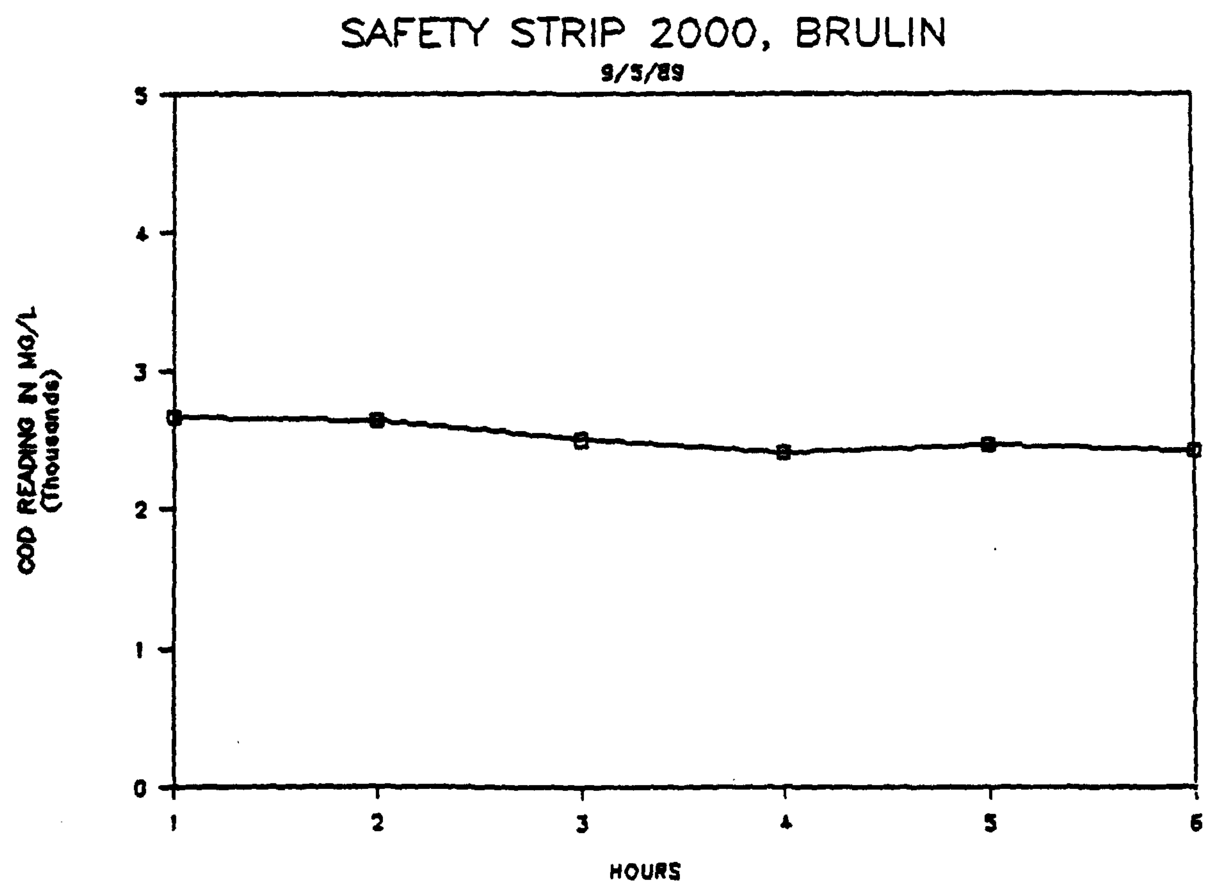
Sample	Hour	Average
PHENOL	0	254.5
PHENOL	1	248.0
PHENOL	2	233.0
PHENOL	3	211.0
PHENOL	4	177.5
PHENOL	5	180.5
PHENOL	6	122.5

Regression Output:

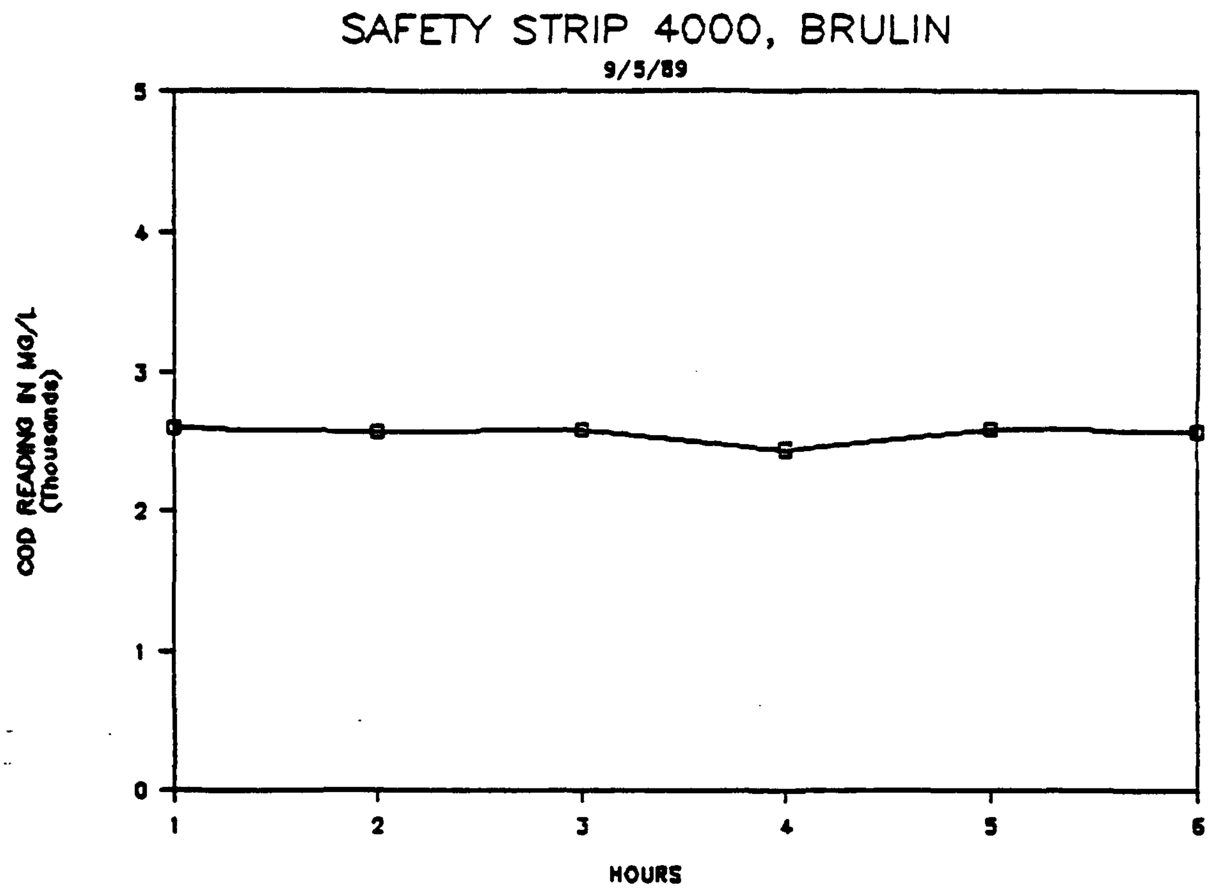
Constant		266.6964
Std Err of Y Est		14.05543
R Squared		0.925579
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-20.9464	
Std Err of Coef.	2.656228	

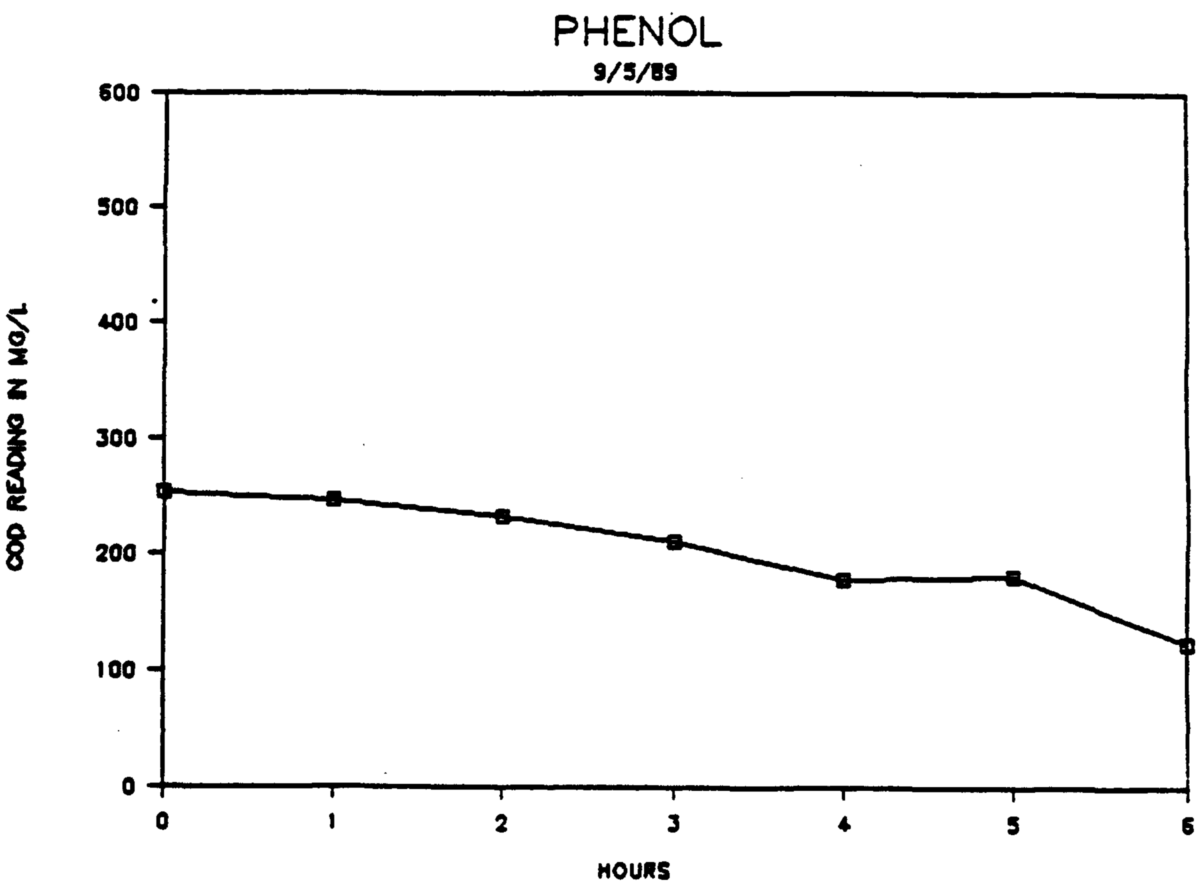


SAFETY STRIP 1000, BRULIN
9/5/89
COD READING IN MG/L
(Thousands)
0
1
2
3
4
5
1
2
3
4
5
6
HOURS



SAFETY STRIP 2000, BRULIN
9/5/89
COD READING IN MG/L
(Thousands)
0
1
2
3
4
5
1
2
3
4
5
6
HOURS


SAFETY STRIP 4000, BRULIN
9/5/89
COD READING IN MG/L
(Thousands)
HOURS
0
1
2
3
4
5
6

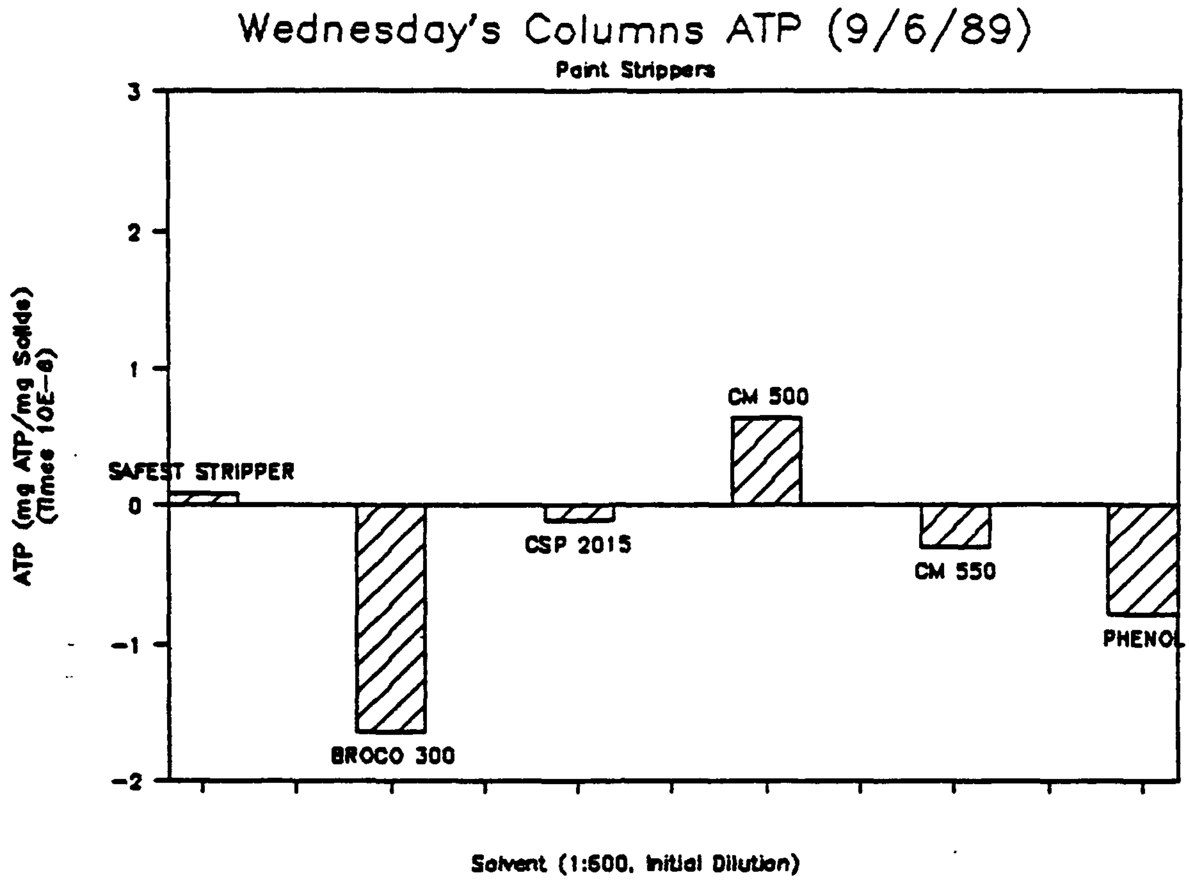

PHENOL
9/5/89
COD READING IN MG/L
HOURS
0
100
200
300
400
500
600
1
2
3
4
5
6

ATP DATA

Date: 9/6/89 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	0.276	200.2	0.336	192.950	0.25867	0.00210	
	0	0.396	185.7					
Bugs	0	10.13	173.7	10.320	173.100	0.0618	7.393E-07	
	0	10.51	172.5					
SAFEST STRIP	0	21.16	211.8	18.350	198.050	0.1007	1.204E-06	
	0	15.54	184.3					
BROCO 300	0	43.01	210.3	42.250	203.550	0.2603	3.114E-06	
	0	41.49	196.8					
CSP 2015	0	17.66	197.2	16.595	192.150	0.0931	1.113E-06	
	0	15.53	187.1					
CM 500	0	29.39	231.3	29.180	224.250	0.1483	1.773E-06	
	0	28.97	217.2					
CM 550	0	9.12	182.3	8.720	176.700	0.0504	6.025E-07	
	0	8.32	171.1					
PHENOL	0	24.25	142.1	21.240	145.000	0.1695	2.028E-06	
	0	18.23	147.9					
Blank	5	0.19	102.6	0.206	104.700			
	5	0.221	106.8					
SAFEST STRIP	6	11.78	115.2	11.730	118.150	0.1078	1.289E-06	8.5E-08
	6	11.68	121.1					
BROCO 300	6	16.8	170.2	17.625	158.500	0.1233	1.475E-06	-1.6E-06
	6	18.45	146.8					
CSP 2015	6	8.085	90.7	7.992	100.250	0.0838	1.003E-06	-1.1E-07
	6	7.898	109.8					
CM 500	6	16.68	99.6	16.430	96.500	0.2020	2.416E-06	6.4E-07
	6	16.18	93.4					
CM 550	6	1.831	61.82	1.903	65.105	0.0260	3.111E-07	-2.9E-07
	6	1.974	68.39					
PHENOL	6	30.01	299.2	26.420	278.200	0.1039	1.243E-06	-7.9E-07
	6	22.83	257.2					
Blank	6	0.229	160.3	0.235	172.100			
	6	0.24	183.9					

Solids dry wt. (g)	g/mL
0.0523	0.0021

Average	Blank	
Without	Standard	0.259
With	Standard	156.583


Wednesday's Columns ATP (9/6/89)
Paint Strippers
3
2
1
0
-1
-2
ATP (mg ATP/mg Solids)
(Times 10E-8)
SAFEST STRIPPER
BROCO 300
CSP 2015
CM 500
CM 550
PHENOL
Solvent (1:500, Initial Dilution)

COD DATA

Date: 9/6/89

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	209	200.5	SAFEST STRIP	1	831.0	835.5
Bugs 0.1	0	192		SAFEST STRIP	1	840	
Bugs 0.01	0	29	20.5	SAFEST STRIP	5	845.0	841.0
Bugs 0.01	0	12		SAFEST STRIP	5	837	
SAFEST STRIP	0	603	616.5	CM 500	0	850	848.5
SAFEST STRIP	0	630		CM 500	0	847	
SAFEST STRIP	1	629	627.5	CM 500	1	874	877.5
SAFEST STRIP	1	626		CM 500	1	881	
SAFEST STRIP	2	620	619.0	CM 500	2	880	874.5
SAFEST STRIP	2	618		CM 500	2	869	
SAFEST STRIP	3	621	622.5	CM 500	3	868	872.5
SAFEST STRIP	3	624		CM 500	3	877	
SAFEST STRIP	4	623	625.0	CM 500	4	886	898.5
SAFEST STRIP	4	627		CM 500	4	911	
SAFEST STRIP	5	611	618.0	CM 500	5	885	886.0
SAFEST STRIP	5	625		CM 500	5	887	
SAFEST STRIP	6	621	618.5	CM 500	6	898	902.5
SAFEST STRIP	6	616		CM 500	6	907	
BROCO 300	0	2108	2046.0	CM 550	0	1628	1714.0
BROCO 300	0	1984		CM 550	0	1800	
BROCO 300	1	1812	1808.0	CM 550	1	2004	2140.0
BROCO 300	1	1804		CM 550	1	2276	
BROCO 300	2	1804	1772.0	CM 550	2	2456	2654.0
BROCO 300	2	1740		CM 550	2	2852	
BROCO 300	3	1722	1736.0	CM 550	3	2404	2416.0
BROCO 300	3	1750		CM 550	3	2428	
BROCO 300	4	1760	1744.0	CM 550	4	2574	2607.0
BROCO 300	4	1728		CM 550	4	2640	
BROCO 300	5	1748	1750.0	CM 550	5	2430	2444.0
BROCO 300	5	1752		CM 550	5	2458	
BROCO 300	6	1740	1738.0	CM 550	6	2348	2390.0
BROCO 300	6	1736		CM 550	6	2432	
CSP 2015	0	3460	3398.0	PHENOL	0	246	243.5
CSP 2015	0	3336		PHENOL	0	241	
CSP 2015	1	3536	3518.0	PHENOL	1	205	197.0
CSP 2015	1	3500		PHENOL	1	189	
CSP 2015	2	3356	3348.0	PHENOL	2	189	187.5
CSP 2015	2	3340		PHENOL	2	186	
CSP 2015	3	3504	3426.0	PHENOL	3	152	153.0
CSP 2015	3	3348		PHENOL	3	154	
CSP 2015	4	3544	3458.0	PHENOL	4	140	143.0
CSP 2015	4	3372		PHENOL	4	146	
CSP 2015	5	3528	3448.0	PHENOL	5	94	96.5
CSP 2015	5	3368		PHENOL	5	99	
CSP 2015	6	2372	2388.0	PHENOL	6	34	32.0
CSP 2015	6	2404		PHENOL	6	30	

Standard	Average
0.10	233.00
0.10	
0.25	531.00
0.25	
Phenol	1121.00
Phenol	

REGRESSION DATA

Date: 9/6/89

Sample	Hour	Average
SAFEST STRIPPER	0	616.5
SAFEST STRIPPER	1	627.5
SAFEST STRIPPER	2	619.0
SAFEST STRIPPER	3	622.5
SAFEST STRIPPER	4	625.0
SAFEST STRIPPER	5	618.0
SAFEST STRIPPER	6	618.5

Regression Output:

Constant		621.75
Std Err of Y Est		4.432832
R Squared		0.0175
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-0.25	
Std Err of Coef.	0.837726	

Sample	Hour	Average
BROCO 300	0	2046.0
BROCO 300	1	1808.0
BROCO 300	2	1772.0
BROCO 300	3	1736.0
BRCCO 300	4	1744.0
BROCO 300	5	1750.0
BROCO 300	6	1738.0

Regression Output:

Constant		1913.571
Std Err of Y Est		82.70221
R Squared		0.543626
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-38.1428	
Std Err of Coef.	15.62925	

Sample	Hour	Average
CSP 2015	0	3398.0
CSP 2015	1	3518.0
CSP 2015	2	3348.0
CSP 2015	3	3426.0
CSP 2015	4	3458.0
CSP 2015	5	3448.0
CSP 2015	6	2388.0

Regression Output:

Constant		3611.285
Std Err of Y Est		351.4494
R Squared		0.351276
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-109.285	
Std Err of Coef.	66.41769	

Sample	Hour	Average
CM 500	0	848.5
CM 500	1	877.5
CM 500	2	874.5
CM 500	3	872.5
CM 500	4	898.5
CM 500	5	886.0
CM 500	6	902.5

Regression Output:

Constant		858.25
Std Err of Y Est		9.977474
R Squared		0.747270
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	7.25	
Std Err of Coef.	1.885565	

Sample	Hour	Average
CM 550	0	1714.0
CM 550	1	2140.0
CM 550	2	2654.0
CM 550	3	2416.0
CM 550	4	2607.0
CM 550	5	2444.0
CM 550	6	2390.0

Regression Output:

Constant		2060.464
Std Err of Y Est		276.1995
R Squared		0.385602
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	92.46428	
Std Err of Coef.	52.19679	

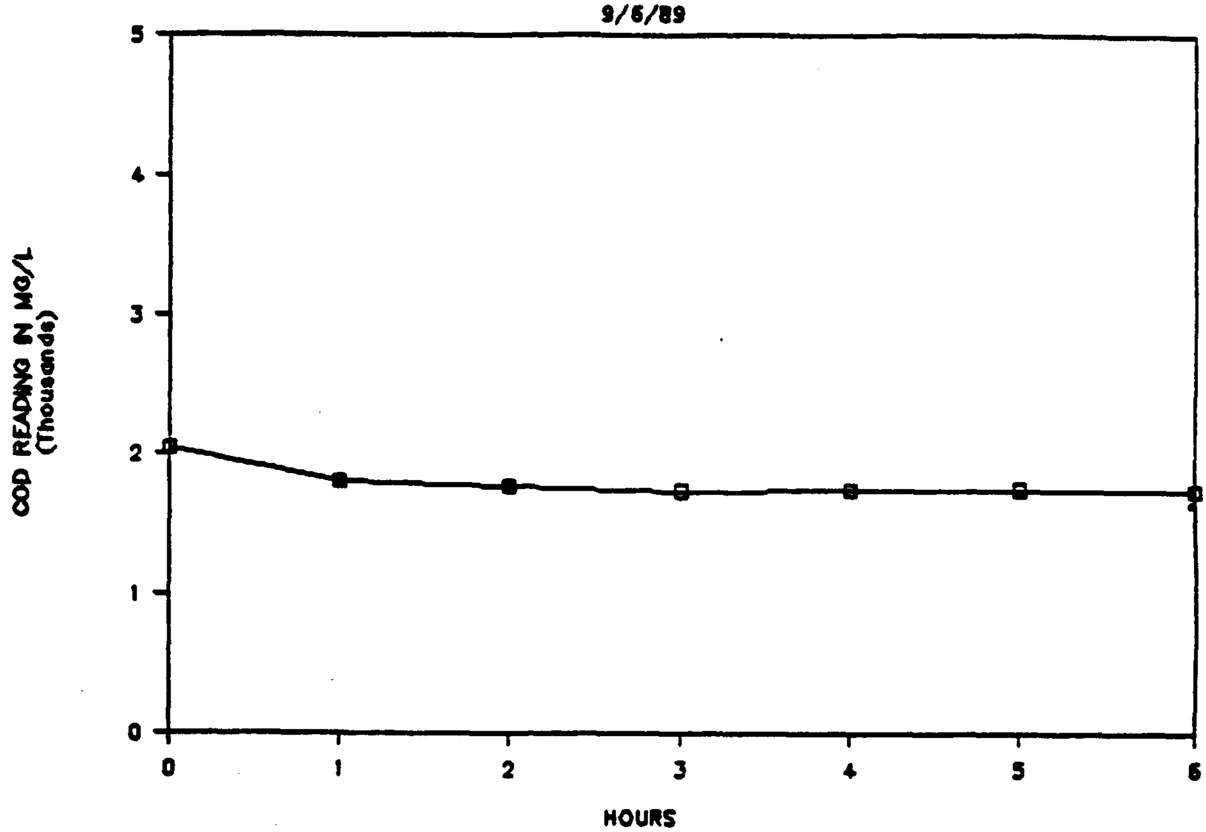
Sample	Hour	Average
PHENOL	0	243.5
PHENOL	1	197.0
PHENOL	2	187.5
PHENOL	3	153.0
PHENOL	4	143.0
PHENOL	5	96.5
PHENOL	6	32.0

Regression Output:

Constant		244.6428
Std Err of Y Est		17.57108
R Squared		0.947134
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-31.4285	
Std Err of Coef.	3.320622	

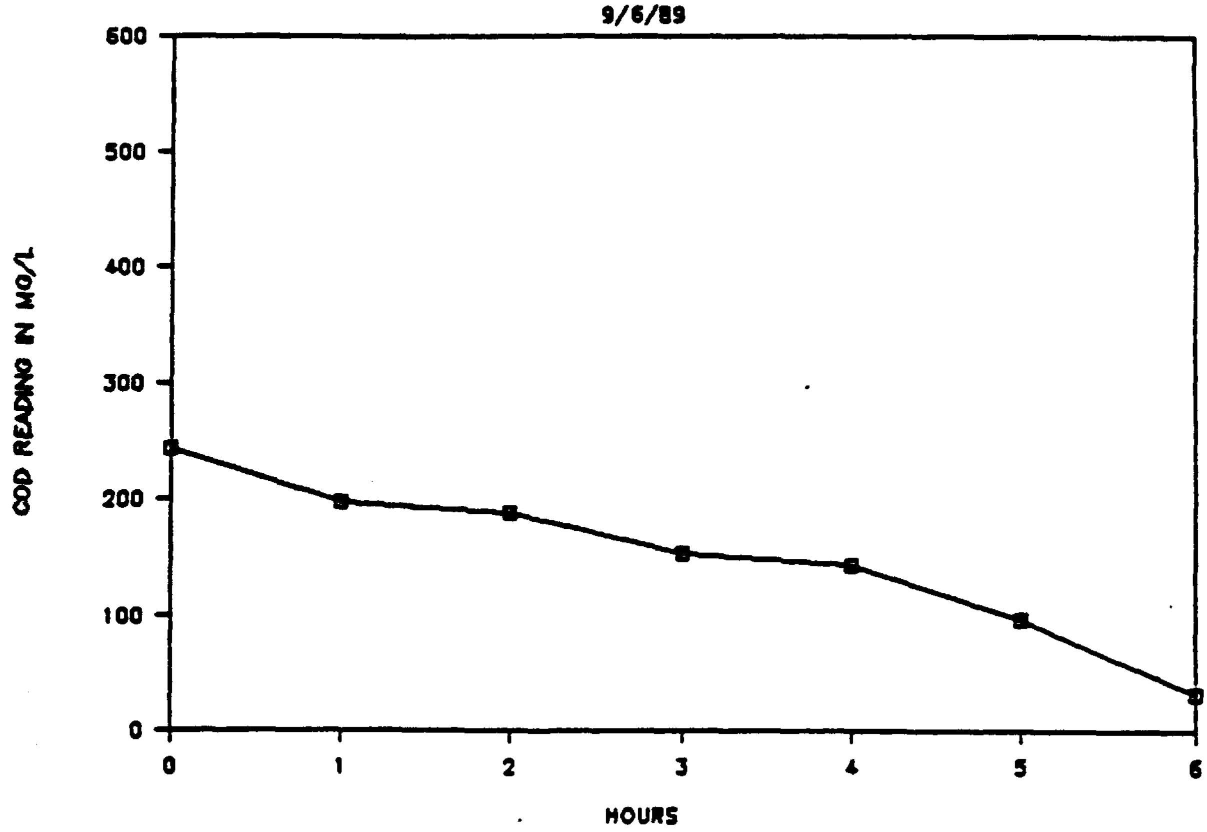
BROCO 300, BROCO PRODUCTS

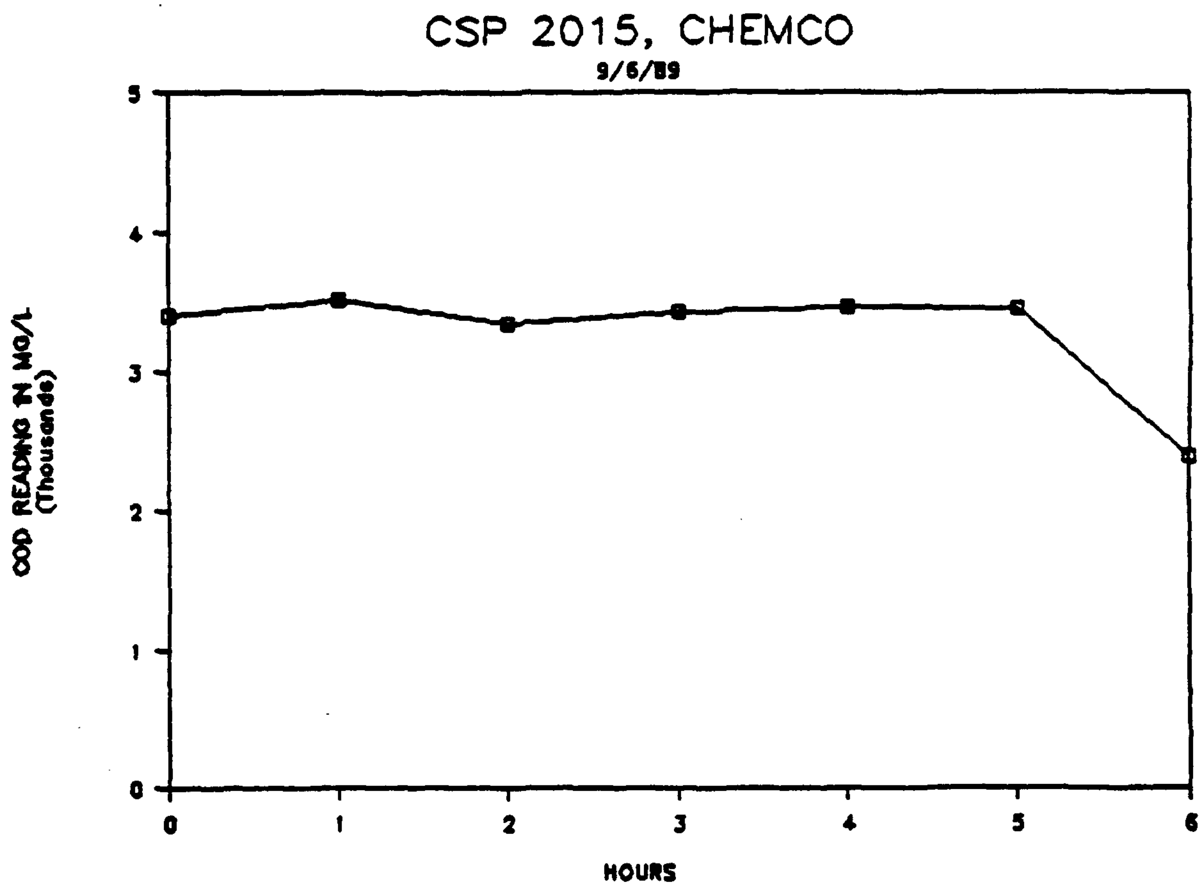
9/6/89



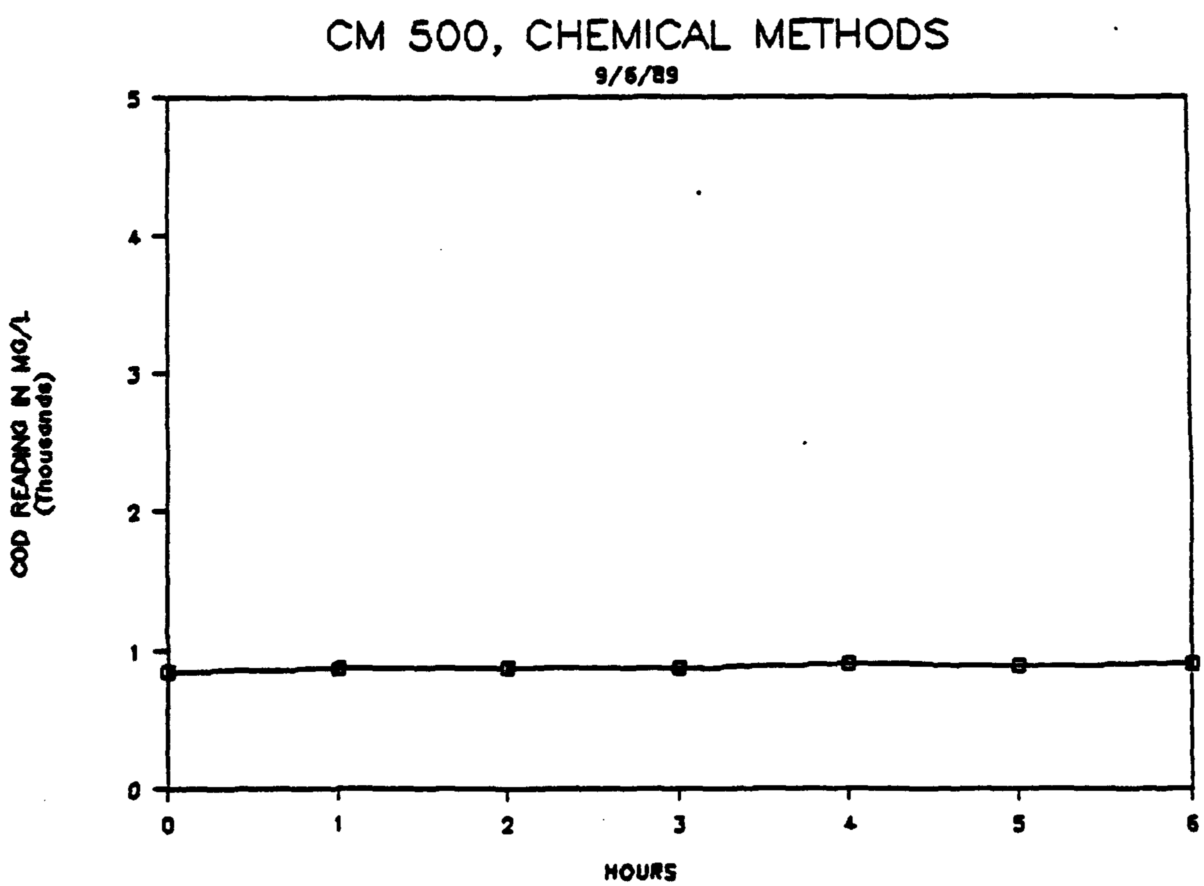
PHENOL

9/6/89

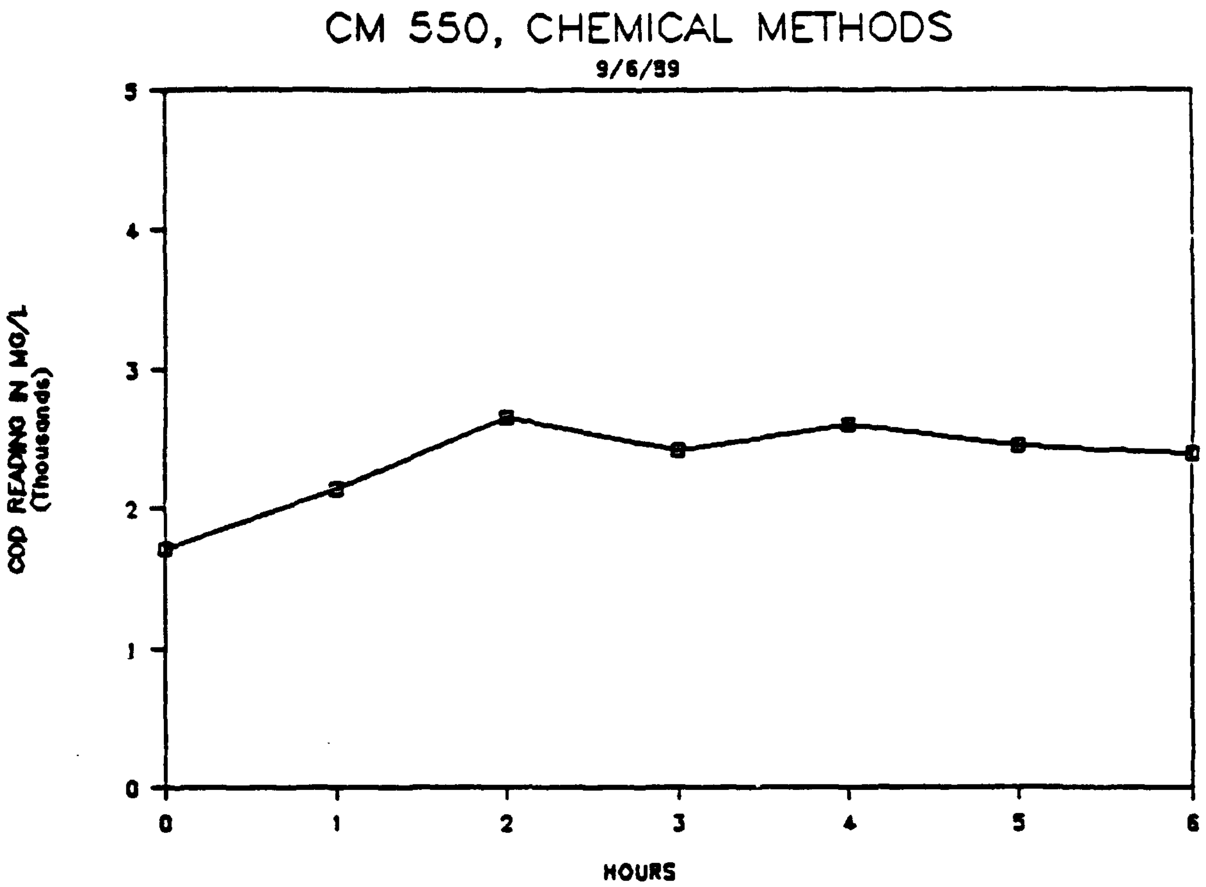




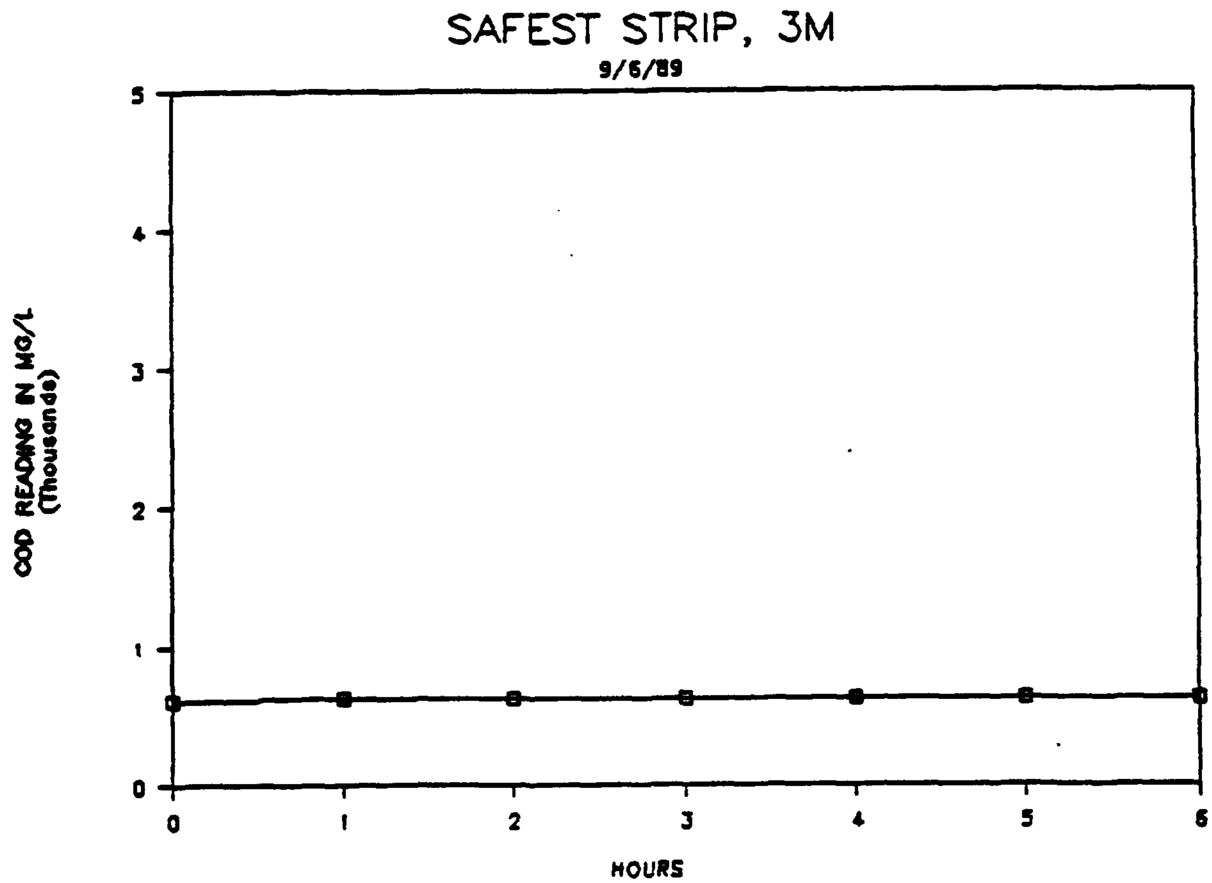
CSP 2015, CHEMCO
9/6/89
COD READING IN MG/L (Thousands)
0
1
2
3
4
5
0
1
2
3
4
5
6
HOURS



CM 500, CHEMICAL METHODS
9/6/89
COD READING IN MG/L (Thousands)
0
1
2
3
4
5
0
1
2
3
4
5
6
HOURS



CM 550, CHEMICAL METHODS
9/6/89
COD READING IN MG/L
(Thousands)
0
1
2
3
4
5
0
1
2
3
4
5
6
HOURS



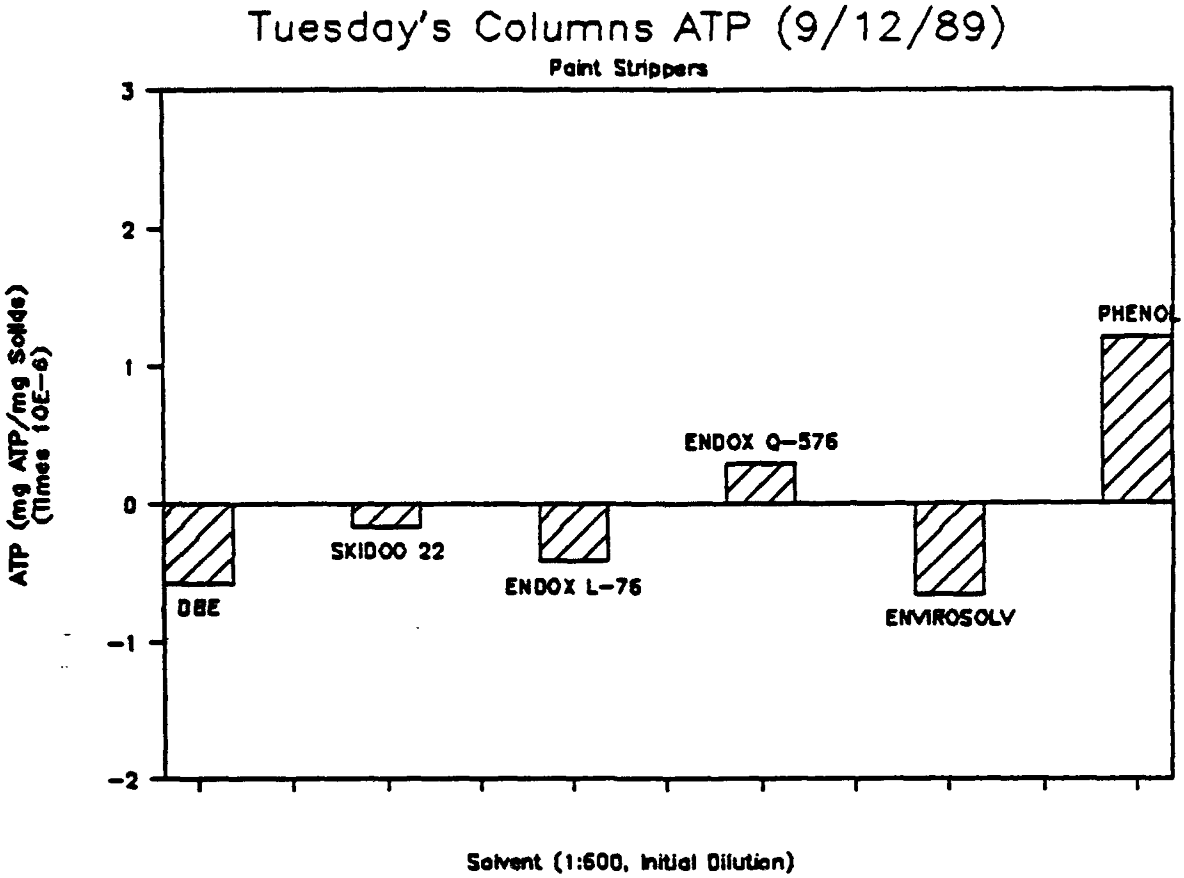
SAFEST STRIP, 3M
9/6/89
COD READING IN MG/L
(Thousands)
0
1
2
3
4
5
0
1
2
3
4
5
6
HOURS

ATP DATA

Date: 9/12/89 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	0.618	307.6	0.592	324.600	0.62950	0.00280	
	0	0.566	341.6					
Bugs	0	50.28	355.3	46.125	363.400	0.1434	1.271E-06	
	0	41.97	371.5					
DBE	0	27.35	292.7	26.390	307.600	0.0916	8.121E-07	
	0	25.43	322.5					
SKIDOO 22	0	35.76	321.5	38.900	320.400	0.1360	1.205E-06	
	0	42.04	319.3					
ENDOX L-76	0	48.98	287.8	45.345	291.500	0.1817	1.610E-06	
	0	41.71	295.2					
ENDOX Q-576	0	39.26	379.8	43.695	368.750	0.1325	1.175E-06	
	0	48.13	357.7					
ENVIROSOLV	0	43.78	319.4	41.270	311.750	0.1503	1.332E-06	
	0	38.76	304.1					
PHENOL	0	47.89	417	51.135	408.050	0.1415	1.254E-06	
	0	54.38	399.1					
Blank	5	0.6	252.5	0.586	252.800			
	5	0.571	253.1					
DBE	6	6.88	233	6.514	228.500	0.0265	2.350E-07	-5.8E-07
	6	6.148	224					
SKIDOO 22	6	18.31	175.7	19.470	179.385	0.1178	1.044E-06	-1.6E-07
	6	20.63	183.07					
ENDOX L-76	6	29.67	258.8	31.445	260.050	0.1348	1.195E-06	-4.2E-07
	6	33.22	261.3					
ENDOX Q-576	6	43.08	301.5	42.105	291.750	0.1661	1.473E-06	3.0E-07
	6	41.13	282					
ENVIROSOLV	6	34.62	486.6	33.910	473.000	0.0758	6.719E-07	-6.6E-07
	6	33.2	459.4					
PHENOL	6	33.2	151.6	34.950	158.700	0.2773	2.459E-06	1.2E-06
	6	36.7	165.8					
Blank	6	0.813	300.8	0.711	304.250			
	6	0.609	307.7					

Solids dry wt. (g)	g/mL
0.0704	0.0028

Average	Blank	
Without	Standard	0.630
With	Standard	293.883



Tuesday's Columns ATP (9/12/89)
Paint Strippers
ATP (mg ATP/mg Solids)
(Times 10E-6)
3
2
1
0
-1
-2
DBE
SKIDOO 22
ENDOX L-76
ENDOX Q-576
ENVIROSOLV
PHENOL
Solvent (1:600, Initial Dilution)

COD DATA

Date: 9/12/89

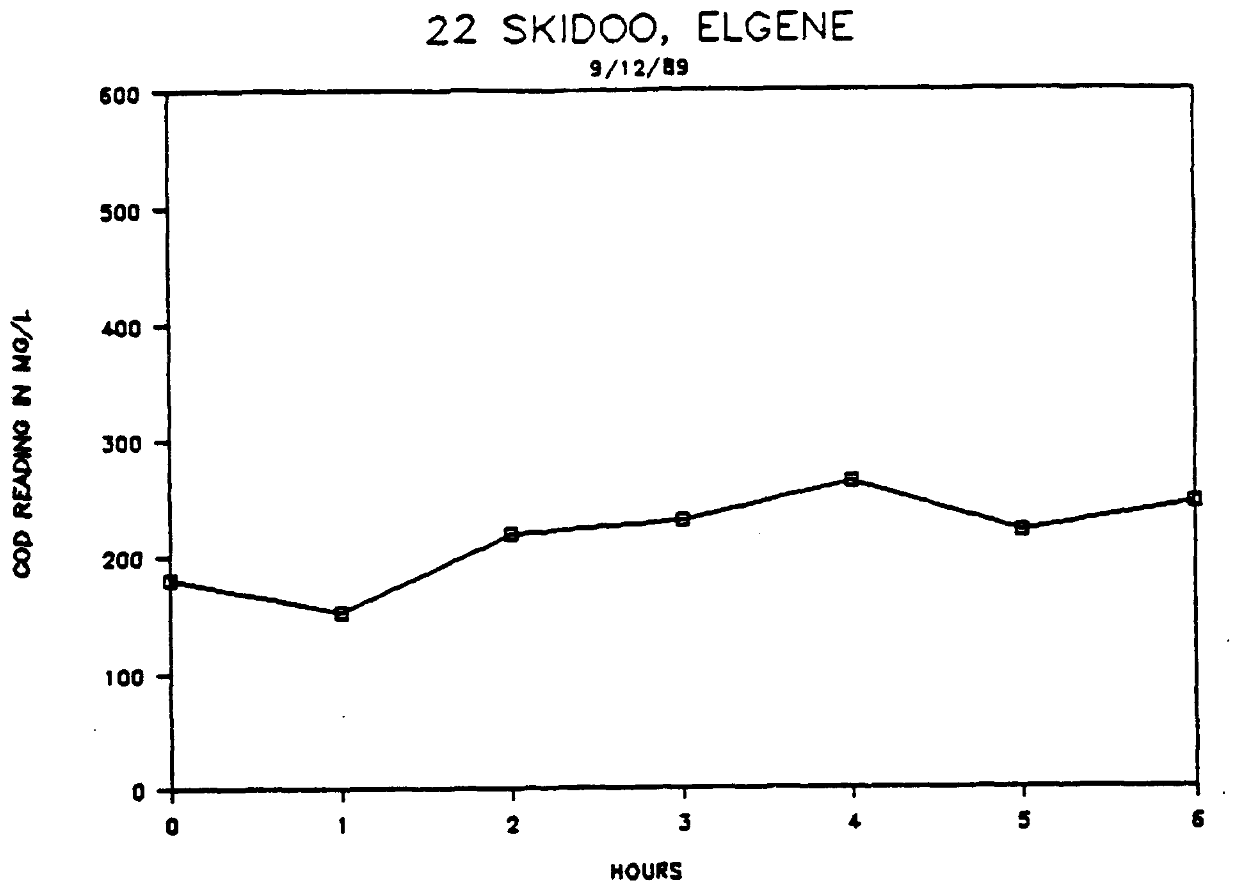
Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	298	288.0	DBE (UF)	1	3392.0	3296.0
Bugs 0.1	0	278		DBE (UF)	1	3200	
Bugs 0.01	0	35	30.0	DBE (UF)	5	2652.0	2674.0
Bugs 0.01	0	25		DBE (UF)	5	2696	
DBE	0	1708	1708.0	Endox Q-576	0	80	74.0
DBE	0	1708		Endox Q-576	0	68	
DBE	1	1632	1582.0	Endox Q-576	1	27	31.0
DBE	1	1532		Endox Q-576	1	35	
DBE	2	1804	1798.0	Endox Q-576	2	70	79.0
DBE	2	1792		Endox Q-576	2	88	
DBE	3	1820	1780.0	Endox Q-576	3	66	68.0
DBE	3	1740		Endox Q-576	3	70	
DBE	4	1948	1976.0	Endox Q-576	4	67	73.0
DBE	4	2004		Endox Q-576	4	79	
DBE	5	1848	1832.0	Endox Q-576	5	42	42.0
DBE	5	1816		Endox Q-576	5	42	
DBE	6	1884	1910.0	Endox Q-576	6	59	59.0
DBE	6	1936		Endox Q-576	6	59	
22 Skidoo	0	183	181.5	Envirosolv	0	452	446.0
22 Skidoo	0	180		Envirosolv	0	440	
22 Skidoo	1	154	153.0	Envirosolv	1	280	282.0
22 Skidoo	1	152		Envirosolv	1	284	
22 Skidoo	2	219	219.0	Envirosolv	2	452	460.0
22 Skidoo	2	219		Envirosolv	2	468	
22 Skidoo	3	232	230.5	Envirosolv	3	460	452.0
22 Skidoo	3	229		Envirosolv	3	444	
22 Skidoo	4	275	264.0	Envirosolv	4	460	472.0
22 Skidoo	4	253		Envirosolv	4	484	
22 Skidoo	5	221	220.5	Envirosolv	5	508	492.0
22 Skidoo	5	220		Envirosolv	5	476	
22 Skidoo	6	247	245.5	Envirosolv	6	448	452.0
22 Skidoo	6	244		Envirosolv	6	456	
Endox L-76	0	471	471.5	Phenol	0	186	193.0
Endox L-76	0	472		Phenol	0	200	
Endox L-76	1	445	449.0	Phenol	1	220	221.0
Endox L-76	1	453		Phenol	1	222	
Endox L-76	2		ERR	Phenol	2	214	200.0
Endox L-76	2			Phenol	2	186	
Endox L-76	3	511	500.0	Phenol	3	157	157.0
Endox L-76	3	489		Phenol	3	157	
Endox L-76	4	584	564.0	Phenol	4	139	144.5
Endox L-76	4	544		Phenol	4	150	
Endox L-76	5	544	530.5	Phenol	5	76	73.0
Endox L-76	5	517		Phenol	5	70	
Endox L-76	6	517	533.0	Phenol	6	31	25.5
Endox L-76	6	549		Phenol	6	20	

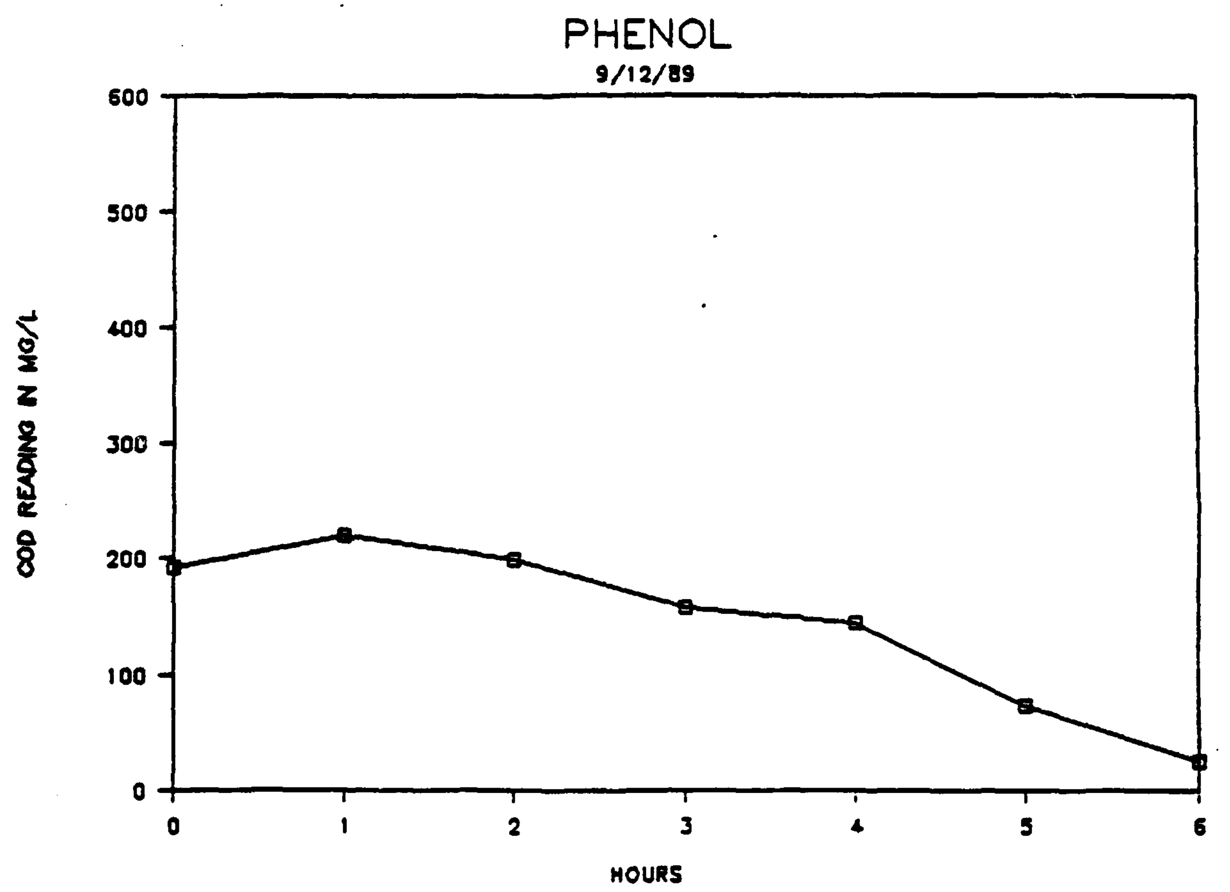
Standard		
0.10		310.50
0.10		
0.25		535.50
0.25		
Phenol		2181.00
Phenol		

REGRESSION DATA

Date: 9/12/89

Sample	Hour	Average		
			Regression Output:	
DBE	0	1708.0	Constant	1660.428
DBE	1	1582.0	Std Err of Y Est	91.19586
DBE	2	1798.0	R Squared	0.586086
DBE	3	1780.0	No. of Observations	7
DBE	4	1976.0	Degrees of Freedom	5
DBE	5	1832.0		
DBE	6	1910.0	X Coefficient(s)	45.85714
			Std Err of Coef.	17.23439
			Regression Output:	
22 Skidoo	0	181.5	Constant	176.4285
22 Skidoo	1	153.0	Std Err of Y Est	26.94491
22 Skidoo	2	219.0	R Squared	0.576532
22 Skidoo	3	230.5	No. of Observations	7
22 Skidoo	4	264.0	Degrees of Freedom	5
22 Skidoo	5	220.5		
22 Skidoo	6	245.5	X Coefficient(s)	13.28571
			Std Err of Coef.	5.092110
			Regression Output:	
Endox L-76	0	471.5	Constant	460.3819
Endox L-76	1	449.0	Std Err of Y Est	27.73518
Endox L-76	3	500.0	R Squared	0.663517
Endox L-76	4	564.0	No. of Observations	6
Endox L-76	5	530.5	Degrees of Freedom	4
Endox L-76	6	533.0		
			X Coefficient(s)	15.03726
			Std Err of Coef.	5.354190
			Regression Output:	
Endox Q-576	0	74.0	Constant	63.96428
Endox Q-576	1	31.0	Std Err of Y Est	19.60010
Endox Q-576	2	79.0	R Squared	0.015396
Endox Q-576	3	68.0	No. of Observations	7
Endox Q-576	4	73.0	Degrees of Freedom	5
Endox Q-576	5	42.0		
Endox Q-576	6	59.0	X Coefficient(s)	-1.03571
			Std Err of Coef.	3.704072
			Regression Output:	
Envirosolv	0	446.0	Constant	388.3571
Envirosolv	1	282.0	Std Err of Y Est	66.48544
Envirosolv	2	460.0	R Squared	0.246547
Envirosolv	3	452.0	No. of Observations	7
Envirosolv	4	472.0	Degrees of Freedom	5
Envirosolv	5	492.0		
Envirosolv	6	452.0	X Coefficient(s)	16.07142
			Std Err of Coef.	12.56456
			Regression Output:	
Phenol	0	193.0	Constant	236.3571
Phenol	1	221.0	Std Err of Y Est	30.54949
Phenol	2	200.0	R Squared	0.848067
Phenol	3	157.0	No. of Observations	7
Phenol	4	144.5	Degrees of Freedom	5
Phenol	5	73.0		
Phenol	6	25.5	X Coefficient(s)	-30.5
			Std Err of Coef.	5.773311


22 SKIDOO, ELGENE
9/12/89
COD READING IN MG/L
600
500
400
300
200
100
0
0
1
2
3
4
5
6
HOURS

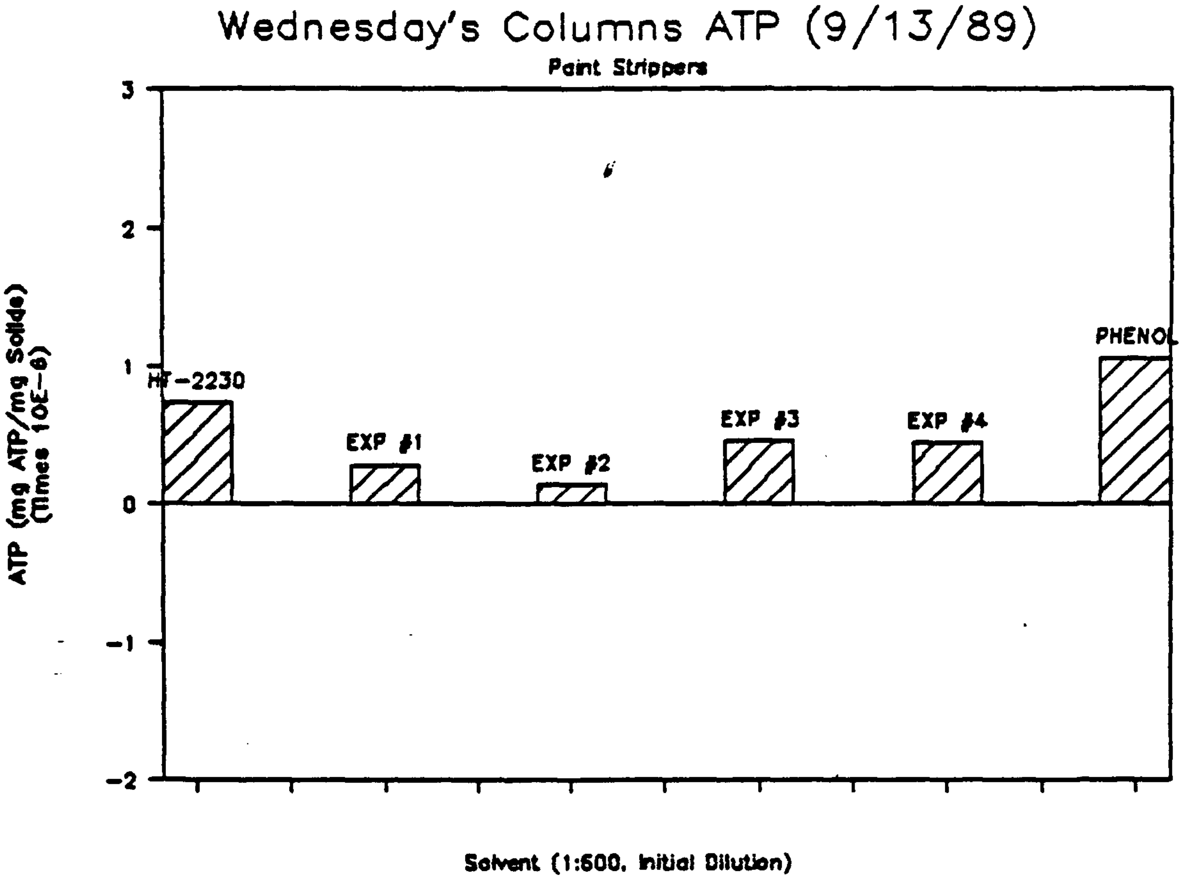

PHENOL
9/12/89
COD READING IN MG/L
600
500
400
300
200
100
0
0
1
2
3
4
5
6
HOURS

ATP DATA

Date: 9/13/89 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	0.496	301.2	0.517	307.450	0.51433		
	0	0.537	313.7					
Bugs	0	30.68	363.4	28.245	349.000	0.0865	5.614E-07	
	0	25.81	334.6					
HT-2230	0	38.62	411.8	40.535	404.650	0.1099	7.137E-07	
HT-2230	0	42.45	397.5					
EXP #1	0	46.63	378.8	43.425	371.600	0.1308	8.491E-07	
EXP #1	0	40.22	364.4					
EXP #2	0	36.37	307.1	35.655	318.950	0.1240	8.055E-07	
EXP #2	0	34.94	330.8					
EXP #3	0	32.63	314.6	33.115	327.150	0.1109	7.200E-07	
EXP #3	0	33.6	339.7					
EXP #4	0	24.42	317	23.985	313.100	0.0812	5.271E-07	
EXP #4	0	23.55	309.2					
PHENOL	0	46.74	321.2	44.860	343.700	0.1484	9.636E-07	
PHENOL	0	42.98	366.2					
Blank	5	0.542	297.7	0.514	301.350			
	5	0.485	305					
HT-2230	6	70.87	345.6	67.170	364.400	0.2243	1.456E-06	7.4E-07
HT-2230	6	63.47	383.2					
EXP #1	6	46.2	299.2	44.935	298.150	0.1754	1.139E-06	2.9E-07
EXP #1	6	43.67	297.1					
EXP #2	6	41.08	292.3	38.550	300.050	0.1455	9.445E-07	1.4E-07
EXP #2	6	36.02	307.8					
EXP #3	6	52.75	329.1	52.620	338.250	0.1824	1.185E-06	4.6E-07
EXP #3	6	52.49	347.4					
EXP #4	6	39.18	313.2	40.985	310.800	0.1500	9.740E-07	4.5E-07
EXP #4	6	42.79	308.4					
PHENOL	6	89.6	361.3	85.705	358.900	0.3118	2.025E-06	1.1E-06
PHENOL	6	81.81	356.5					
Blank	6	0.54	295.1	0.513	313.250			
	6	0.486	331.4					

Solids dry wt. (g)	g/mL
0.0963	0.0039

Average	Blank	
Without	Standard	0.514
With	Standard	307.350



Wednesday's Columns ATP (9/13/89)
Paint Strippers
ATP (mg ATP/mg Solids)
(Times 10E-6)
3
2
1
0
-1
-2
HT-2230
EXP #1
EXP #2
EXP #3
EXP #4
PHENOL
Solvent (1:600, Initial Dilution)

COD DATA

Date: 9/13/89

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	167	173.0	HT-2230	1	2096.0	1674.0
Bugs 0.1	0	179		HT-2230	1	1252	
Bugs 0.01	0	0	0.0	HT-2230	5	1288.0	1096.0
Bugs 0.01	0	0		HT-2230	5	904	
HT-2230	0	96	56.0	Exp. #3	0	2010	2055.0
HT-2230	0	16		Exp. #3	0	2100	
HT-2230	1	412	346.0	Exp. #3	1	1878	1869.0
HT-2230	1	280		Exp. #3	1	1860	
HT-2230	2	484	332.0	Exp. #3	2	1864	1945.0
HT-2230	2	180		Exp. #3	2	2026	
HT-2230	3	248	238.0	Exp. #3	3	1846	1848.0
HT-2230	3	228		Exp. #3	3	1850	
HT-2230	4	24	16.0	Exp. #3	4	1844	1825.0
HT-2230	4	8		Exp. #3	4	1806	
HT-2230	5	80	76.0	Exp. #3	5	1620	1630.0
HT-2230	5	72		Exp. #3	5	1640	
HT-2230	6	56	28.0	Exp. #3	6	1762	1793.0
HT-2230	6	0		Exp. #3	6	1824	
Exp. #1	0	2286	2320.0	Exp. #4	0	2726	2647.0
Exp. #1	0	2354		Exp. #4	0	2568	
Exp. #1	1	2130	2185.0	Exp. #4	1	2200	2282.0
Exp. #1	1	2240		Exp. #4	1	2364	
Exp. #1	2	2254	2201.0	Exp. #4	2	2608	2473.0
Exp. #1	2	2148		Exp. #4	2	2338	
Exp. #1	3	2128	2199.0	Exp. #4	3	2420	2386.0
Exp. #1	3	2270		Exp. #4	3	2352	
Exp. #1	4	2074	2051.0	Exp. #4	4	2440	2460.0
Exp. #1	4	2028		Exp. #4	4	2480	
Exp. #1	5	1948	1974.0	Exp. #4	5	2142	2155.0
Exp. #1	5	2000		Exp. #4	5	2168	
Exp. #1	6	1928	1933.0	Exp. #4	6	2558	2435.0
Exp. #1	6	1938		Exp. #4	6	2312	
Exp. #2	0	1990	1932.0	Phenol	0	347	315.5
Exp. #2	0	1874		Phenol	0	284	
Exp. #2	1	1764	1877.0	Phenol	1	261	320.0
Exp. #2	1	1990		Phenol	1	379	
Exp. #2	2	1792	1803.0	Phenol	2	228	239.5
Exp. #2	2	1814		Phenol	2	251	
Exp. #2	3	1770	1786.0	Phenol	3	210	210.0
Exp. #2	3	1802		Phenol	3	210	
Exp. #2	4	1628	1657.0	Phenol	4	147	147.5
Exp. #2	4	1686		Phenol	4	148	
Exp. #2	5	1846	1718.0	Phenol	5	25	23.5
Exp. #2	5	1590		Phenol	5	22	
Exp. #2	6	1664	1690.0	Phenol	6	10	10.0
Exp. #2	6	1716		Phenol	6	10	
Standard							
0.10			256.50				
0.10							
0.25			523.50				
0.25							
Phenol			2430.00				
Phenol							

REGRESSION DATA

Date: 9/13/89

Sample	Hour	Average
HT-2230	0	56.0
HT-2230	1	346.0
HT-2230	2	332.0
HT-2230	3	238.0
HT-2230	4	16.0
HT-2230	5	76.0
HT-2230	6	28.0

Regression Output:

Constant	256.7142
Std Err of Y Est	137.5695
R Squared	0.250088
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-33.5714
Std Err of Coef.	25.99819

Sample	Hour	Average
Exp. #1	0	2320.0
Exp. #1	1	2185.0
Exp. #1	2	2201.0
Exp. #1	3	2199.0
Exp. #1	4	2051.0
Exp. #1	5	1974.0
Exp. #1	6	1933.0

Regression Output:

Constant	2308.964
Std Err of Y Est	46.34027
R Squared	0.909005
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-61.8928
Std Err of Coef.	8.757489

Sample	Hour	Average
Exp. #2	0	1932.0
Exp. #2	1	1877.0
Exp. #2	2	1803.0
Exp. #2	3	1786.0
Exp. #2	4	1657.0
Exp. #2	5	1718.0
Exp. #2	6	1690.0

Regression Output:

Constant	1907.928
Std Err of Y Est	43.76006
R Squared	0.840818
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-42.5
Std Err of Coef.	8.269874

Sample	Hour	Average
Exp. #3	0	2055.0
Exp. #3	1	1869.0
Exp. #3	2	1945.0
Exp. #3	3	1848.0
Exp. #3	4	1825.0
Exp. #3	5	1630.0
Exp. #3	6	1793.0

Regression Output:

Constant	2000.428
Std Err of Y Est	83.96155
R Squared	0.659957
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-49.4285
Std Err of Coef.	15.86724

Sample	Hour	Average
Exp. #4	0	2647.0
Exp. #4	1	2282.0
Exp. #4	2	2473.0
Exp. #4	3	2386.0
Exp. #4	4	2460.0
Exp. #4	5	2155.0
Exp. #4	6	2435.0

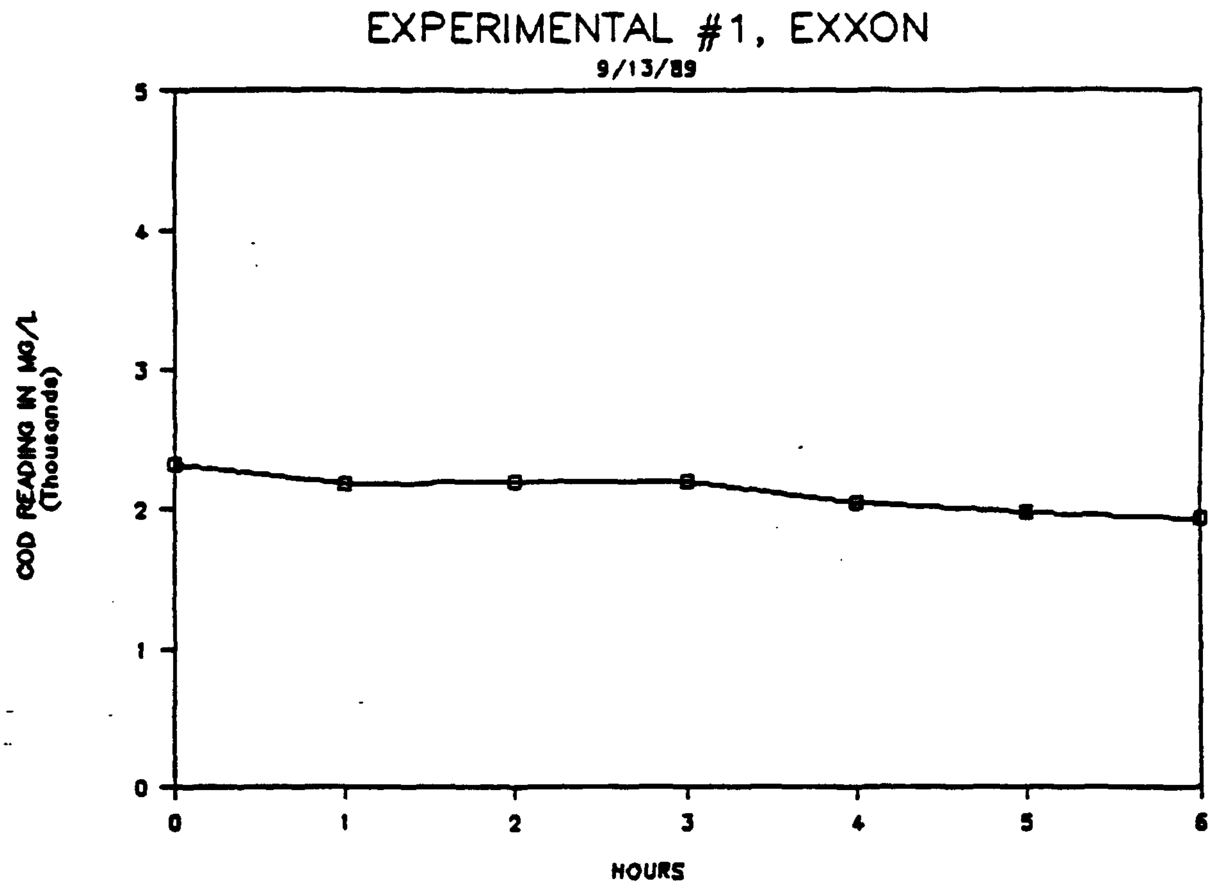
Regression Output:

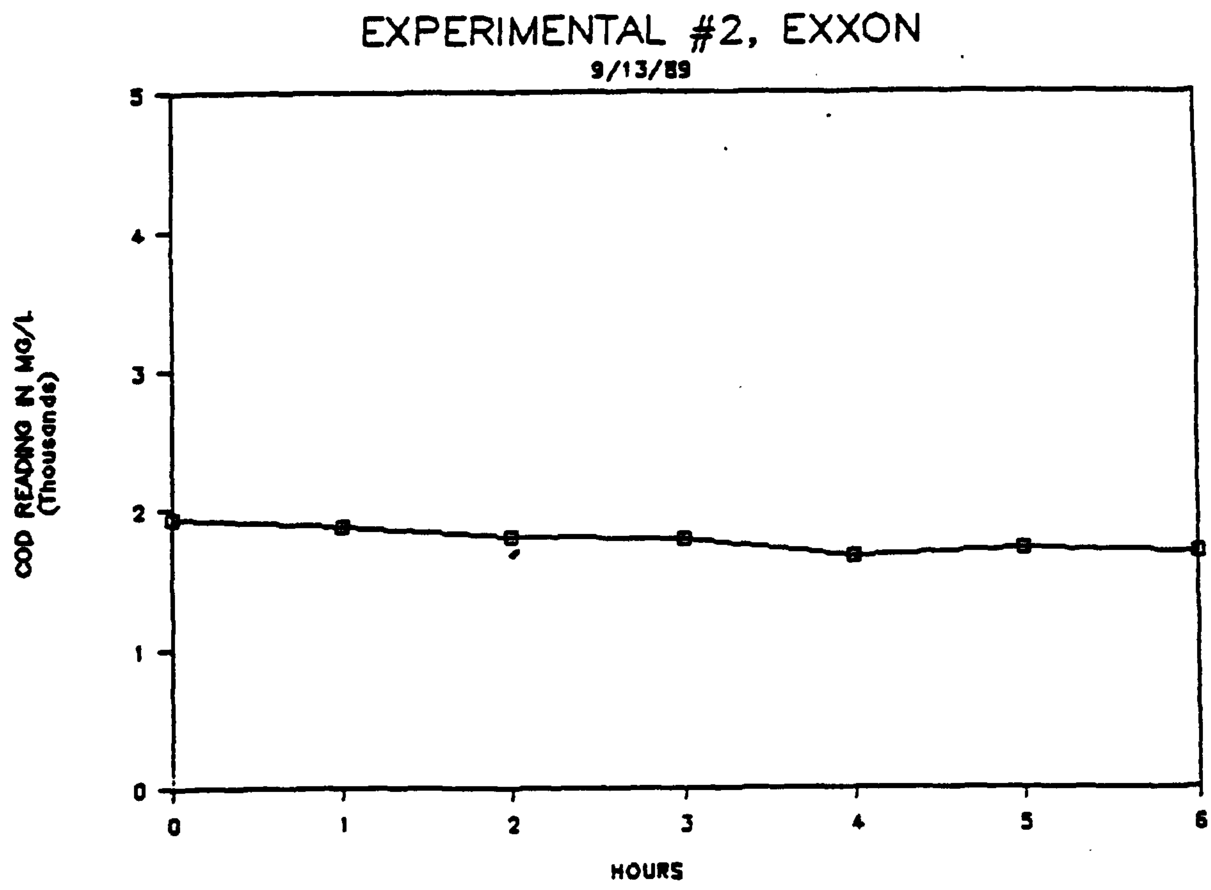
Constant	2502.178
Std Err of Y Est	152.3023
R Squared	0.200698
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-32.25
Std Err of Coef.	28.78243

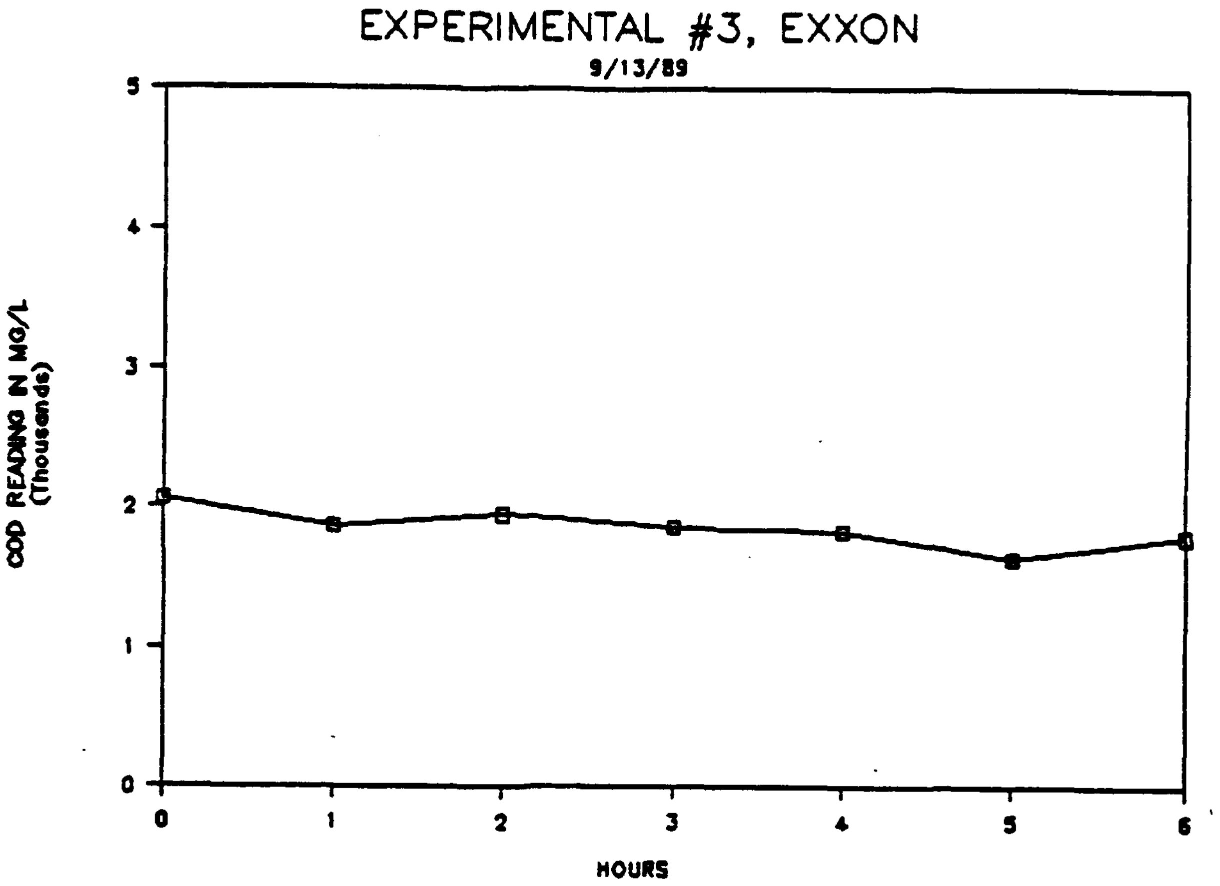
Sample	Hour	Average
Phenol	0	315.5
Phenol	1	320.0
Phenol	2	239.5
Phenol	3	210.0
Phenol	4	147.5
Phenol	5	23.5
Phenol	6	10.0

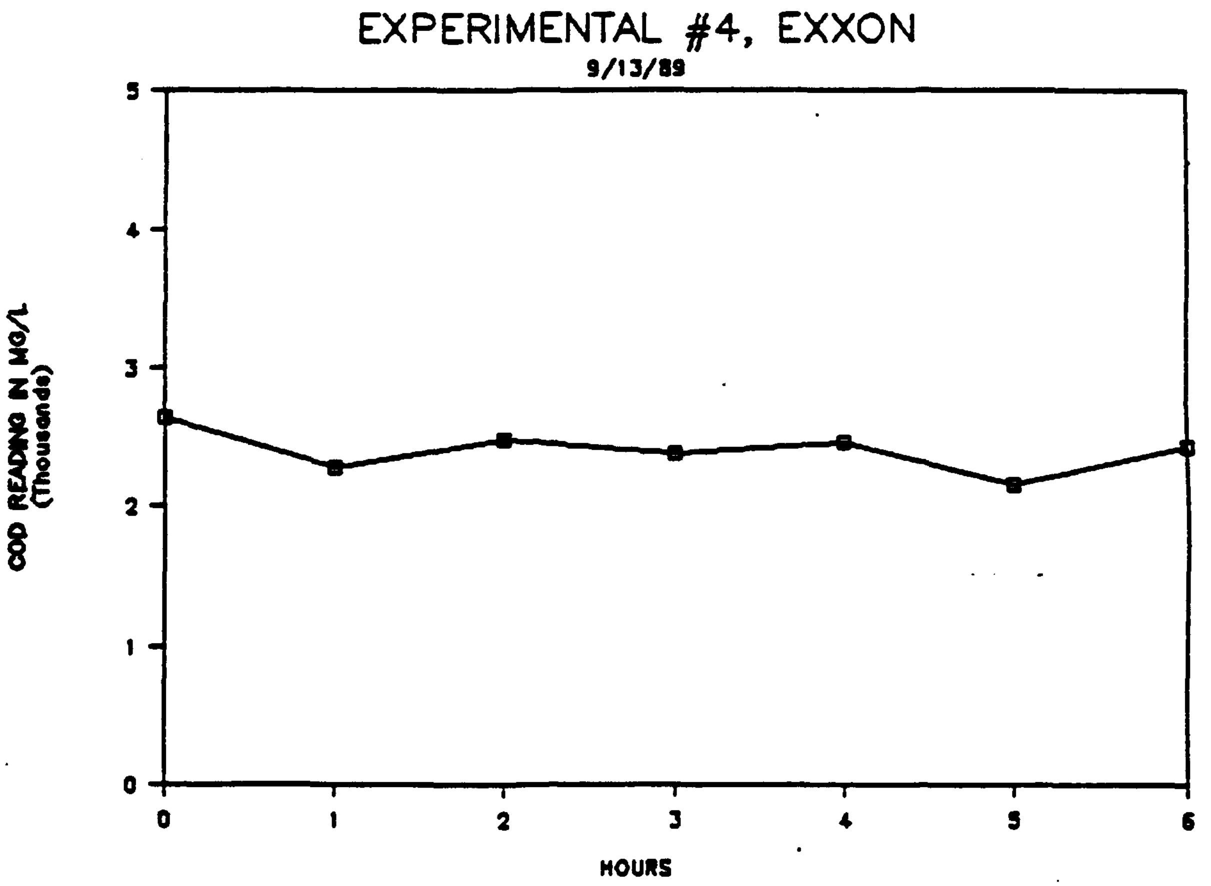
Regression Output:

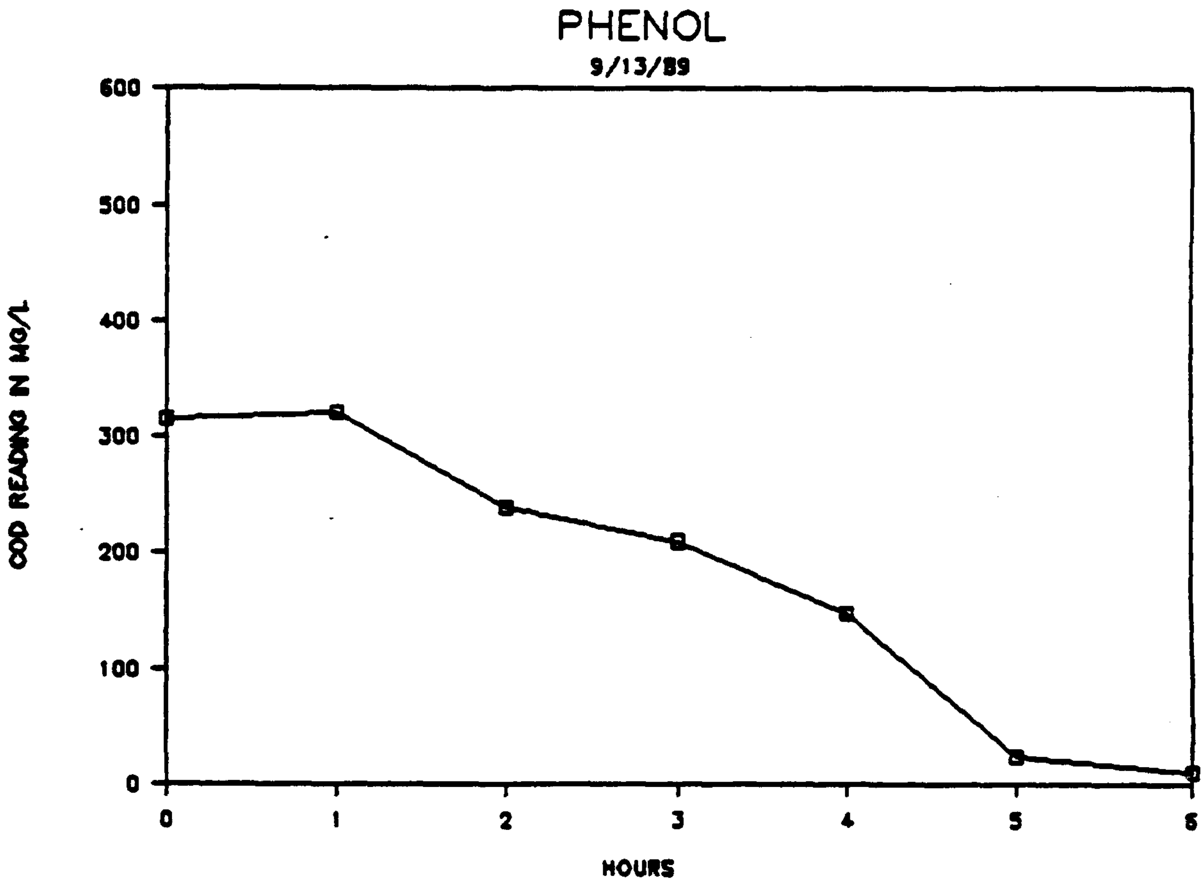
Constant	352.4464
Std Err of Y Est	32.38449
R Squared	0.945853
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-57.1964
Std Err of Coef.	6.120093


EXPERIMENTAL #1, EXXON
9/13/89
COD READING IN MG/L
(Thousands)
HOURS
0
1
2
3
4
5
6
0
1
2
3
4
5


EXPERIMENTAL #2, EXXON
9/13/89
COD READING IN MG/L
(Thousands)
HOURS
0
1
2
3
4
5
6
0
1
2
3
4
5


EXPERIMENTAL #3, EXXON
9/13/89
COD READING IN MG/L
(Thousands)
0
1
2
3
4
5
0
1
2
3
4
5
6
HOURS


EXPERIMENTAL #4, EXXON
9/13/89
COD READING IN MG/L
(Thousands)
0
1
2
3
4
5
0
1
2
3
4
5
6
HOURS

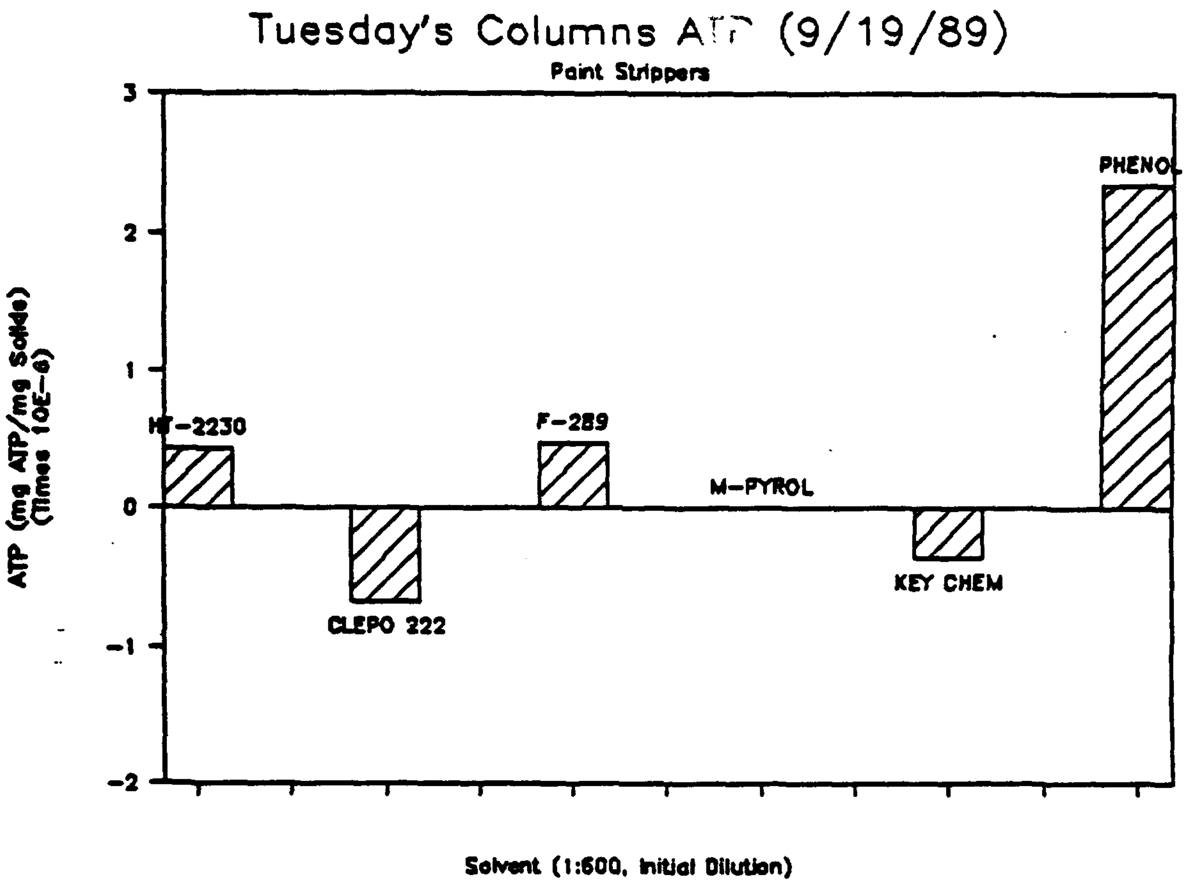

PHENOL
9/13/89
600
500
400
300
200
100
0
COD READING IN MG/L
0
1
2
3
4
5
6
HOURS

ATP DATA

DATE: 9/19/89 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	0.708	345.5	0.640	362.850	0.84050	0.00320	
	0	0.571	380.2					
Bugs	0	88.95	458.7	71.660	445.600	0.1894	1.498E-06	
	0	54.37	432.5					
HT-2230	0	51.38	375.3	44.720	357.750	0.1402	1.109E-06	
	0	38.06	340.2					
CLEPO 222	0	144.2	488	133.800	496.050	0.3670	2.904E-06	
	0	123.4	504.1					
F-289	0	68.67	314.6	69.450	324.300	0.2692	2.130E-06	
	0	70.23	334					
N-PYROL	0	72.2	441.6	67.340	437.200	0.1798	1.422E-06	
	0	62.48	432.8					
KEY CHEM	0	61.43	447.2	57.120	427.500	0.1520	1.202E-06	
	0	52.81	407.8					
PHENOL	0	62.29	385.8	64.810	372.200	0.2081	1.646E-06	
	0	67.33	358.6					
Blank	5	0.761	348.5	0.731	360.200			
	5	0.701	371.9					
HT-2230	6	49.19	370.7	63.145	382.000	0.1954	1.546E-06	4.4E-07
	6	77.1	393.3					
CLEPO 222	6	84.69	414	90.545	409.250	0.2815	2.227E-06	-6.8E-07
	6	96.4	404.5					
F-289	6	73.67	268	70.120	280.100	0.3299	2.610E-06	4.8E-07
	6	66.57	292.2					
N-PYROL	6	38.79	296	44.065	283.750	0.1803	1.427E-06	4.3E-09
	6	49.34	271.5					
KEY CHEM	6	30.4	329.7	30.660	309.800	0.1068	8.451E-07	-3.6E-07
	6	30.92	289.9					
PHENOL	6	133.8	411.3	133.650	397.100	0.5041	3.988E-06	2.3E-06
	6	133.5	382.9					
Blank	6	1.05	256.8	1.151	259.100			
	6	1.252	261.4					

Solids dry wt. (g)	g/mL
0.079	0.0032

Average	Blank	
Without	Standard	0.841
With	Standard	327.383



Tuesday's Columns ATP (9/19/89)
Paint Strippers
ATP (mg ATP/mg Solids)
(Times 10E-6)
3
2
1
0
-1
-2
HT-2230
CLEPO 222
F-289
M-PYROL
KEY CHEM
PHENOL
Solvent (1:600, Initial Dilution)

COD DATA

Date: 9/19/89

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	279	280.5	HT-2230	1	3512.0	3506.0
Bugs 0.1	0	282		HT-2230	1	3500	
Bugs 0.01	0	33	31.0	HT-2230	5	3556.0	3492.0
Bugs 0.01	0	29		HT-2230	5	3428	
HT-2230	0	3260	3226.0	N-PYROL	0	>1650	>1650
HT-2230	0	3192		N-PYROL	0	>1650	
HT-2230	1	3102	3118.0	N-PYROL	1	>1650	>1650
HT-2230	1	3134		N-PYROL	1	>1650	
HT-2230	2	3120	3118.0	N-PYROL	2	>1650	>1650
HT-2230	2	3116		N-PYROL	2	>1650	
HT-2230	3	3096	3103.0	N-PYROL	3	3282	>3300
HT-2230	3	3110		N-PYROL	3	>3300	
HT-2230	4	3186	3162.0	N-PYROL	4	>3300	>3300
HT-2230	4	3138		N-PYROL	4	>3300	
HT-2230	5	2936	3058.0	N-PYROL	5	>3300	>3300
HT-2230	5	3180		N-PYROL	5	>3300	
HT-2230	6	3100	3095.0	N-PYROL	6	>3300	>3300
HT-2230	6	3090		N-PYROL	6	>3300	
CLEPO 222	0	3612	3756.0	KEY CHEM	0	1892	1898.0
CLEPO 222	0	3900		KEY CHEM	0	1904	
CLEPO 222	1	3800	3550.0	KEY CHEM	1	1852	1866.0
CLEPO 222	1	3300		KEY CHEM	1	1880	
CLEPO 222	2	3756	3662.0	KEY CHEM	2	2124	2064.0
CLEPO 222	2	3568		KEY CHEM	2	2004	
CLEPO 222	3	3428	3454.0	KEY CHEM	3	1876	1900.0
CLEPO 222	3	3480		KEY CHEM	3	1924	
CLEPO 222	4	3788	3688.0	KEY CHEM	4	1656	1740.0
CLEPO 222	4	3588		KEY CHEM	4	1824	
CLEPO 222	5	3372	3432.0	KEY CHEM	5	1744	1776
CLEPO 222	5	3492		KEY CHEM	5	1808	
CLEPO 222	6	3504	3520.0	KEY CHEM	6	2116	2026.0
CLEPO 222	6	3536		KEY CHEM	6	1936	
F-289	0	>1650	>1650	PHENOL	0	285	280.0
F-289	0	>1650		PHENOL	0	275	
F-289	1	3780	3732.0	PHENOL	1	272	265.0
F-289	1	3684		PHENOL	1	258	
F-289	2	3548	3666.0	PHENOL	2	256	255.0
F-289	2	3784		PHENOL	2	254	
F-289	3	3732	3774.0	PHENOL	3	220	217.5
F-289	3	3816		PHENOL	3	215	
F-289	4	4000	3932.0	PHENOL	4	257	222.5
F-289	4	3864		PHENOL	4	188	
F-289	5	4284	4042.0	PHENOL	5	146	161.0
F-289	5	3800		PHENOL	5	176	
F-289	6	3780	3806.0	PHENOL	6	103	118.5
F-289	6	3832		PHENOL	6	134	
Standard							
0.10			198.00				
0.10							
0.25			507.00				
0.25							
Phenol			1230.00				
Phenol							

REGRESSION DATA

DATE: 9/19/89

Sample	Hour	Average
NT-2230	0	3226.0
NT-2230	1	3118.0
NT-2230	2	3118.0
NT-2230	3	3103.0
NT-2230	4	3162.0
NT-2230	5	3058.0
NT-2230	6	3095.0

Regression Output:

Constant	3175.96
Std Err of Y Est	44.00381
R Squared	0.447941
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-16.75
Std Err of Coef.	8.315939

Sample	Hour	Average
CLEPO 222	0	3756.0
CLEPO 222	1	3550.0
CLEPO 222	2	3662.0
CLEPO 222	3	3454.0
CLEPO 222	4	3688.0
CLEPO 222	5	3432.0
CLEPO 222	6	3520.0

Regression Output:

Constant	3678.642
Std Err of Y Est	110.9469
R Squared	0.328417
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-32.7857
Std Err of Coef.	20.96700

Sample	Hour	Average
F-289	0	>1650
F-289	1	3732.0
F-289	2	3666.0
F-289	3	3774.0
F-289	4	3932.0
F-289	5	4042.0
F-289	6	3806.0

Regression Output:

Constant	3659.733
Std Err of Y Est	118.5886
R Squared	0.410526
No. of Observations	6
Degrees of Freedom	4
X Coefficient(s)	47.31428
Std Err of Coef.	28.34811

Sample	Hour	Average
N-PYROL	0	>1650
N-PYROL	1	>1650
N-PYROL	2	>1650
N-PYROL	3	>3300
N-PYROL	4	>3300
N-PYROL	5	>3300
N-PYROL	6	>3300

Sample	Hour	Average
KEY CHEM	0	1898.0
KEY CHEM	1	1866.0
KEY CHEM	2	2064.0
KEY CHEM	3	1900.0
KEY CHEM	4	1740.0
KEY CHEM	5	1776
KEY CHEM	6	2026.0

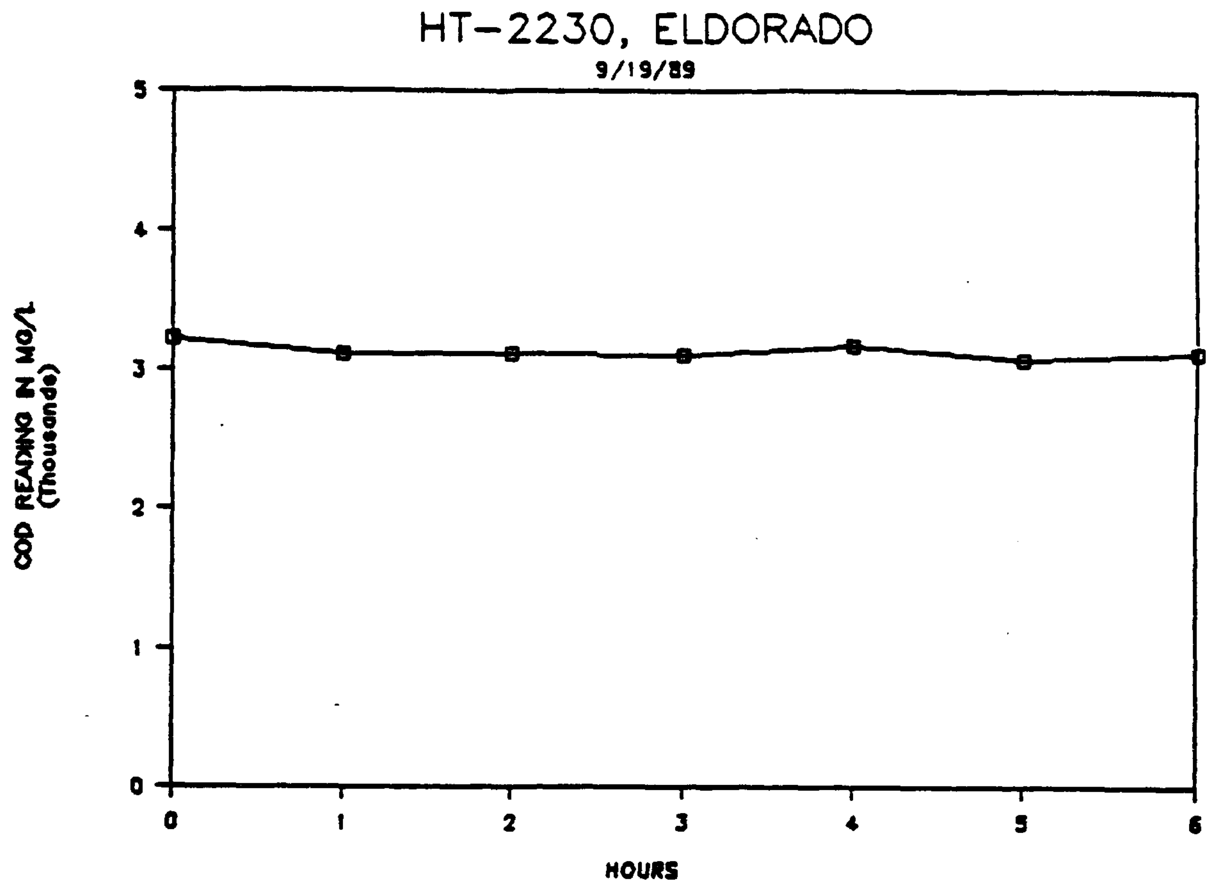
Regression Output:

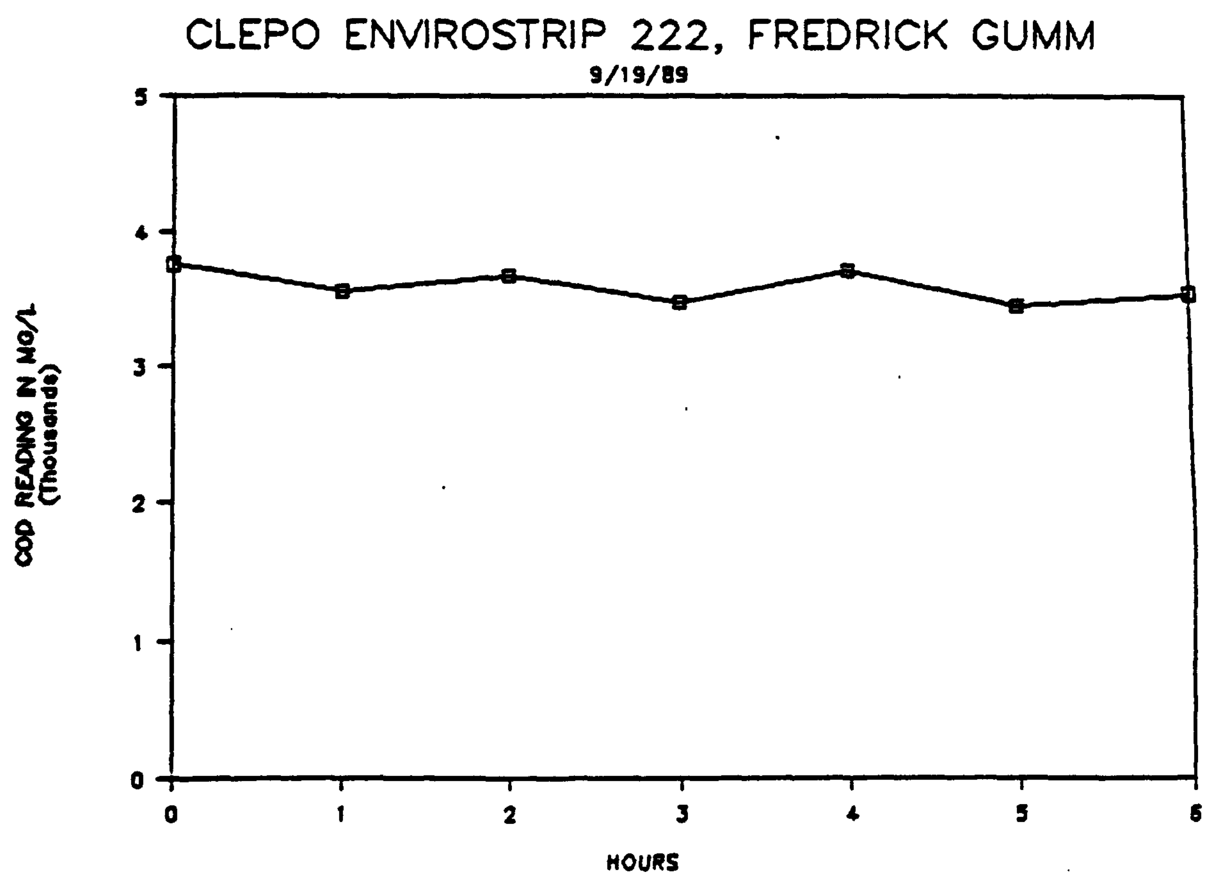
Constant	1908.571
Std Err of Y Est	129.8192
R Squared	0.006066
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-4.28571
Std Err of Coef.	24.53352

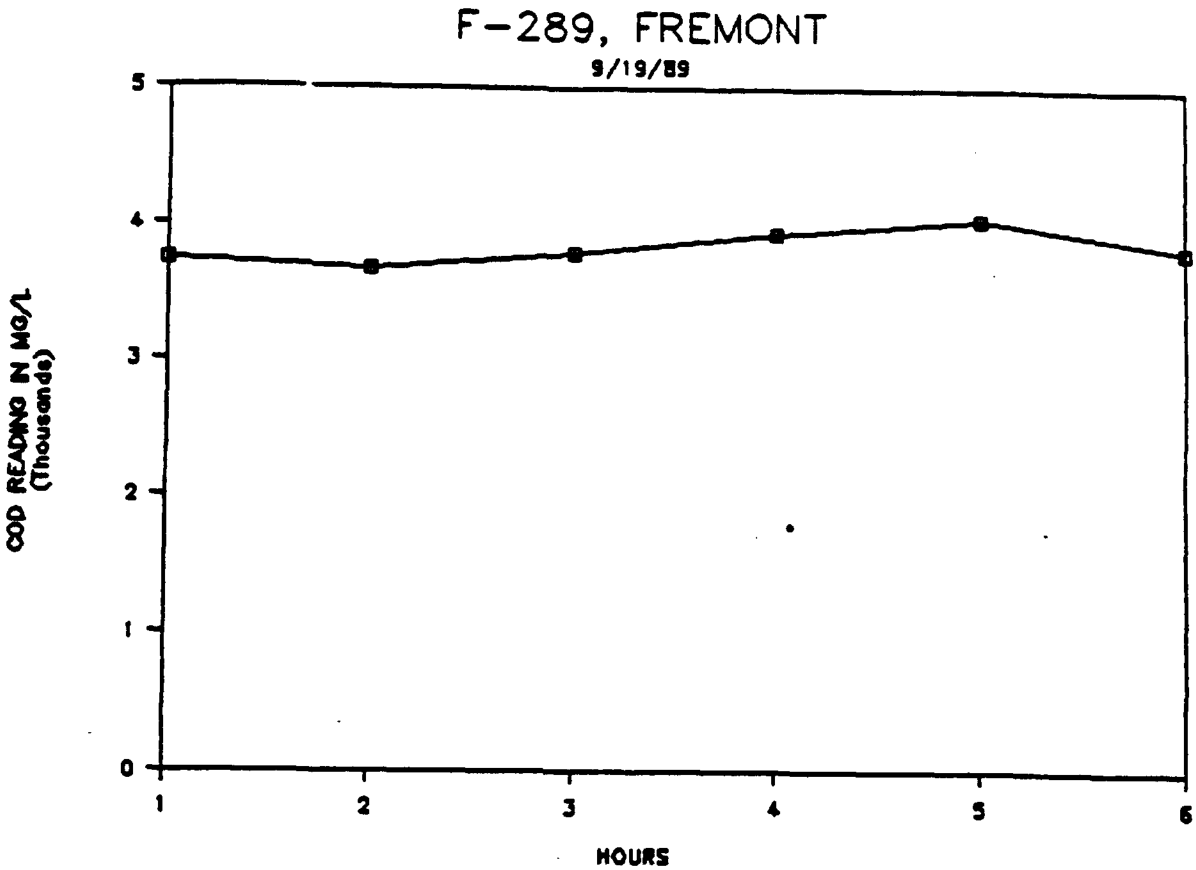
Sample	Hour	Average
PHENOL	0	280.0
PHENOL	1	265.0
PHENOL	2	255.0
PHENOL	3	217.5
PHENOL	4	222.5
PHENOL	5	161.0
PHENOL	6	118.5

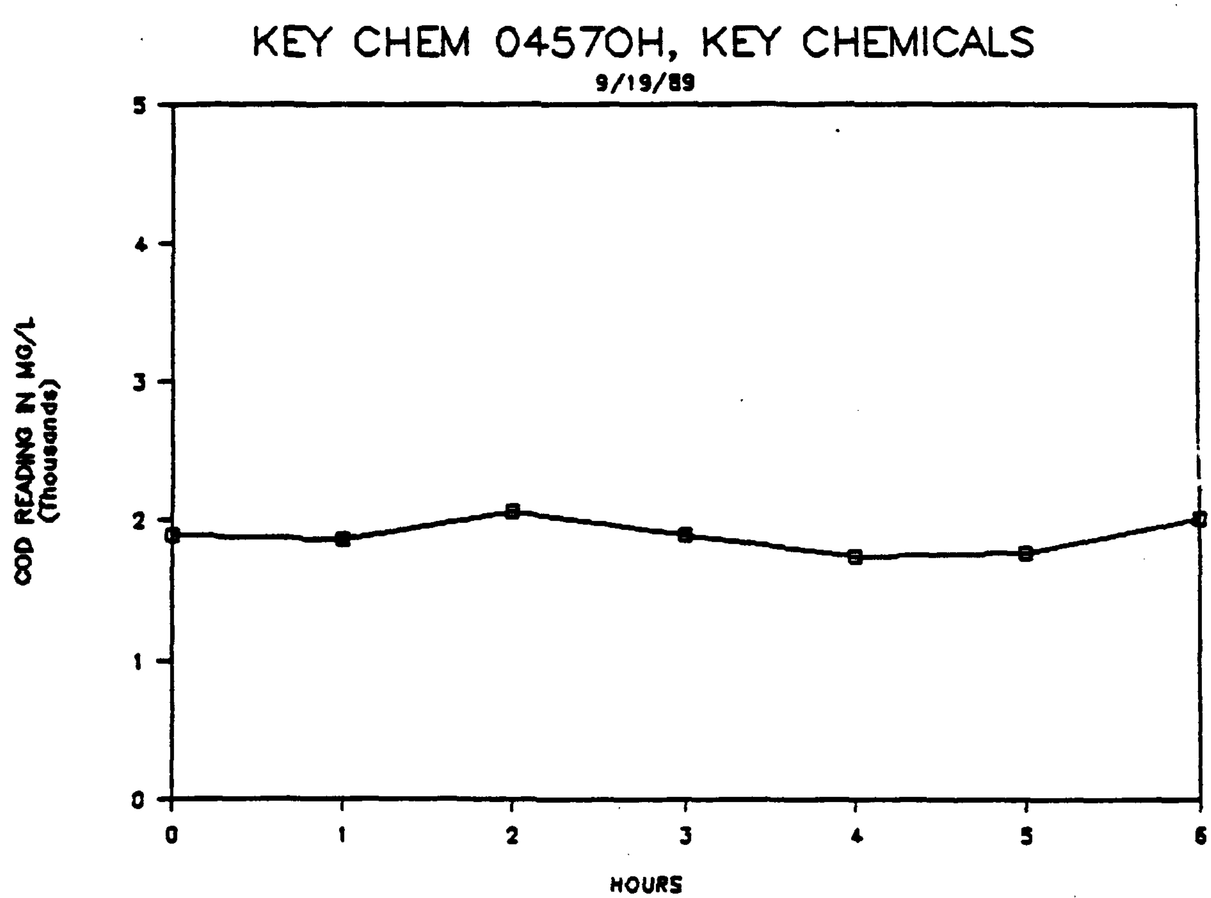
Regression Output:

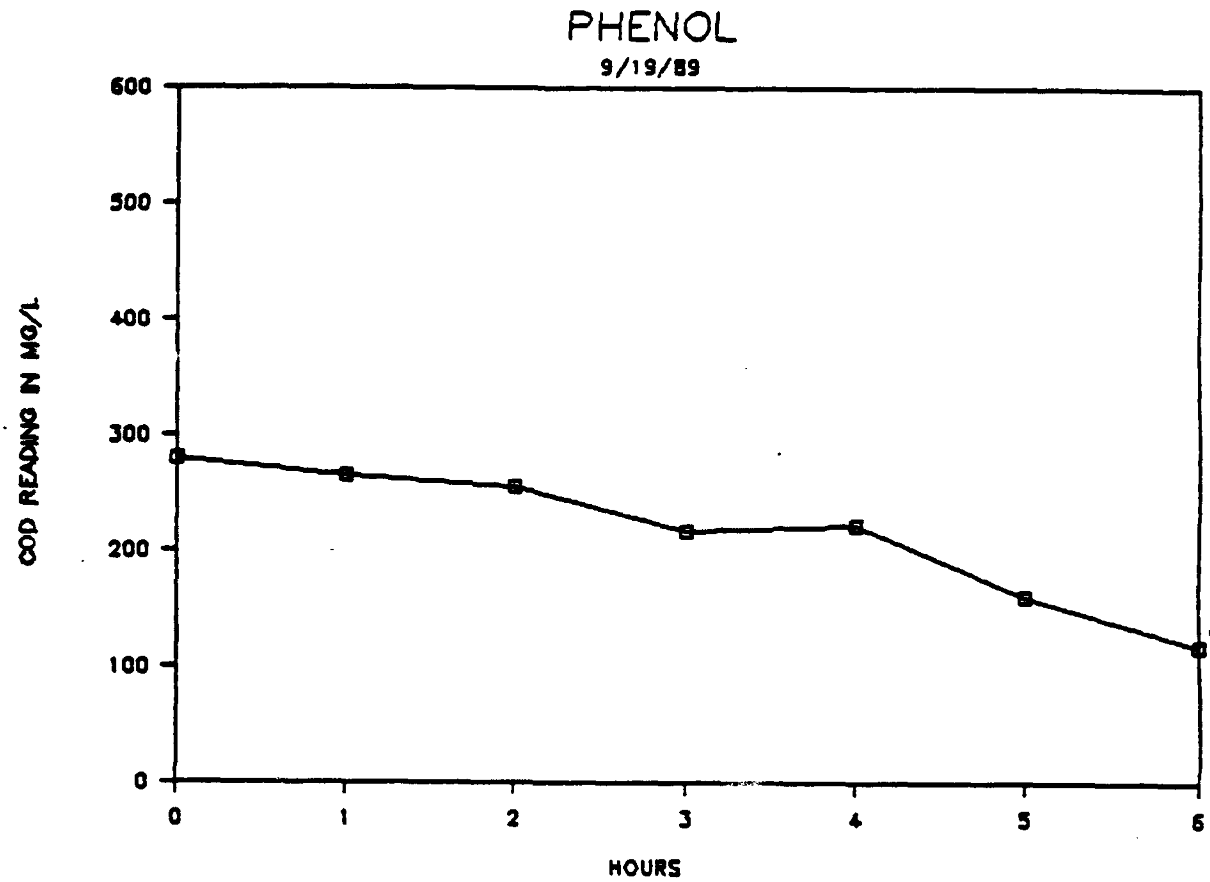
Constant	294.75
Std Err of Y Est	19.04412
R Squared	0.911910
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-25.8928
Std Err of Coef.	3.599000


HT-2230, ELDORADO
9/19/89
COD READING IN MG/L (Thousands)
0
1
2
3
4
5
0
1
2
3
4
5
6
HOURS


CLEPO ENVIROSTRIP 222, FREDRICK GUMM
9/19/89
COD READING IN MG/L (Thousands)
0
1
2
3
4
5
0
1
2
3
4
5
6
HOURS


F-289, FREMONT
9/19/89
COD READING IN MG/L
(Thousands)
HOURS

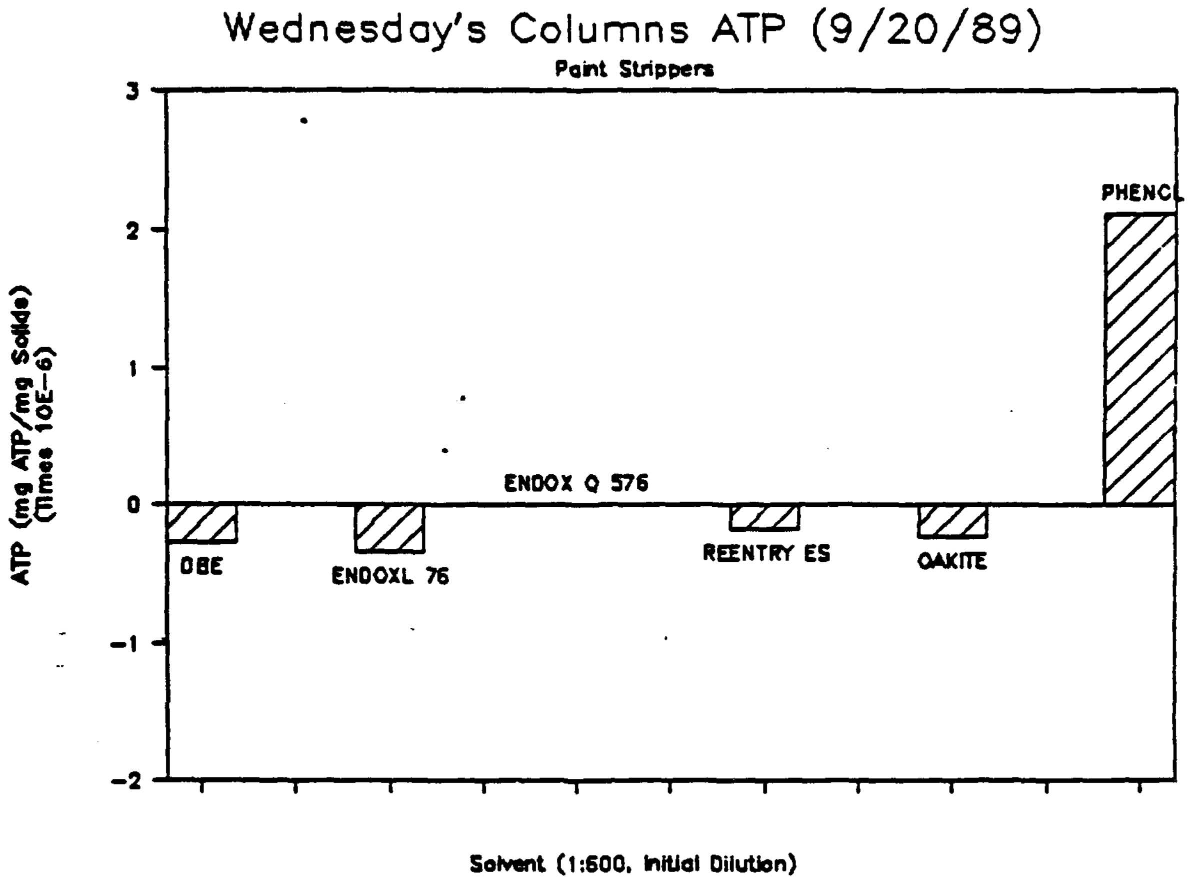

KEY CHEM 04570H, KEY CHEMICALS
9/19/89
COD READING IN MG/L
(Thousands)
HOURS


PHENOL
9/19/89
COD READING IN MG/L
600
500
400
300
200
100
0
0
1
2
3
4
5
6
HOURS

ATP DATA

Date: 9/20/89 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	0.361	384.5	0.417	391.550	0.69800	0.00294	
	0	0.473	398.6					
Bugs	0	43.32	437.1	47.150	443.300	0.1173	9.971E-07	
	0	50.98	449.5					
DBE	0	32.99	448.2	33.615	450.450	0.0790	6.715E-07	
	0	34.24	452.7					
ENDOX L-76	0	92.89	450.6	92.345	455.350	0.2525	2.147E-06	
	0	91.8	460.1					
ENDOX Q-576	0	42.34	444.4	40.070	452.250	0.0955	8.123E-07	
	0	37.8	460.1					
RE-ENTRY ES	0	24.08	389.9	21.815	400.400	0.0558	4.743E-07	
	0	19.55	410.9					
OAKITE	0	18.84	386.3	18.680	386.200	0.0489	4.161E-07	
	0	18.52	386.1					
PHENOL	0	42.21	436.7	44.405	437.250	0.1113	9.461E-07	
	0	46.6	437.8					
Blank	5	0.969	483.7	1.016	474.750			
	5	1.063	465.8					
DBE	6	22.94	469.3	21.810	467.500	0.0474	4.028E-07	-2.7E-07
	6	20.68	465.7					
ENDOX L-76	6	74.06	424.8	74.670	423.500	0.2121	1.803E-06	-3.4E-07
	6	75.28	422.2					
ENDOX Q-576	6	36.51	388.4	34.745	390.000	0.0958	8.150E-07	2.7E-09
	6	32.98	391.6					
RE-ENTRY ES	6	14.2	384.7	14.185	397.700	0.0352	2.990E-07	-1.8E-07
	6	14.17	410.7					
OAKITE	6	8.39	415.4	9.555	418.450	0.0217	1.842E-07	-2.3E-07
	6	10.72	421.5					
PHENOL	6	130.4	450.1	123.150	464.350	0.3589	3.052E-06	2.1E-06
	6	115.9	478.6					
Blank	6	0.685	240.6	0.661	239.550			
	6	0.637	238.5					

Solids dry wt. (g)		g/mL
0.0736		0.0029
Average	Blank	
Without	Standard	0.698
With	Standard	368.617


Wednesday's Columns ATP (9/20/89)
Paint Strippers
ATP (mg ATP/mg Solids)
(Times 10E-6)
3
2
1
0
-1
-2
PHENOL
ENDOX Q 576
DBE
ENDOXL 76
REENTRY ES
OAKITE
Solvent (1:600, Initial Dilution)

COD DATA

Date: 9/20/89

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	220	219.5	DBE (UF)	1	1976.0	1962.0
Bugs 0.1	0	219		DBE (UF)	1	1948	
Bugs 0.01	0	59	53.5	DBE (UF)	5	1960.0	1944.0
Bugs 0.01	0	48		DBE (UF)	5	1928	
DBE	0	1692	1642.0	RE-ENTRY ES	0	1584	1232.0
DBE	0	1592		RE-ENTRY ES	0	880	
DBE	1	1696	1774.0	RE-ENTRY ES	1	924	1022.0
DBE	1	1852		RE-ENTRY ES	1	1120	
DBE	2	1708	1724.0	RE-ENTRY ES	2	796	816.0
DBE	2	1740		RE-ENTRY ES	2	836	
DBE	3	1656	1722.0	RE-ENTRY ES	3	1260	948.0
DBE	3	1788		RE-ENTRY ES	3	636	
DBE	4	1876	1788.0	RE-ENTRY ES	4	700	688.0
DBE	4	1700		RE-ENTRY ES	4	676	
DBE	5	1712	1696.0	RE-ENTRY ES	5	612	634.0
DBE	5	1680		RE-ENTRY ES	5	656	
DBE	6	1812	1744.0	RE-ENTRY ES	6	624	612.0
DBE	6	1676		RE-ENTRY ES	6	600	
ENDOX L-76	0	431	457.0	OAKITE	0	2444	2332.0
ENDOX L-76	0	483		OAKITE	0	2220	
ENDOX L-76	1	519	519.5	OAKITE	1	2094	2095.0
ENDOX L-76	1	520		OAKITE	1	2096	
ENDOX L-76	2	529	533.0	OAKITE	2	2068	2098.0
ENDOX L-76	2	537		OAKITE	2	2128	
ENDOX L-76	3	540	531.5	OAKITE	3	2180	2147.0
ENDOX L-76	3	523		OAKITE	3	2114	
ENDOX L-76	4	530	525.5	OAKITE	4	2136	2166.0
ENDOX L-76	4	521		OAKITE	4	2196	
ENDOX L-76	5	508	509.5	OAKITE	5	2130	2080.0
ENDOX L-76	5	511		OAKITE	5	2030	
ENDOX L-76	6	532	528.0	OAKITE	6	2164	2202.0
ENDOX L-76	6	524		OAKITE	6	2240	
ENDOX Q-576	0	87	81.0	PHENOL	0	270	261.5
ENDOX Q-576	0	75		PHENOL	0	253	
ENDOX Q-576	1	74	74.5	PHENOL	1	256	263.0
ENDOX Q-576	1	75		PHENOL	1	270	
ENDOX Q-576	2	108	95.0	PHENOL	2	242	234.5
ENDOX Q-576	2	82		PHENOL	2	227	
ENDOX Q-576	3	82	81.5	PHENOL	3	185	184.0
ENDOX Q-576	3	81		PHENOL	3	183	
ENDOX Q-576	4	94	89.5	PHENOL	4	108	108.5
ENDOX Q-576	4	85		PHENOL	4	109	
ENDOX Q-576	5	50	46.0	PHENOL	5	14	12.0
ENDOX Q-576	5	42		PHENOL	5	10	
ENDOX Q-576	6	64	57.0	PHENOL	6	15	18.5
ENDOX Q-576	6	50		PHENOL	6	22	

Standard			
0.10			224.00
0.10			
0.25			513.00
0.25			
PHENOL			1278.00
PHENOL			

REGRESSION DATA

Date: 9/20/89

Sample	Hour	Average
DBE	0	1642.0
DBE	1	1774.0
DBE	2	1724.0
DBE	3	1722.0
DBE	4	1788.0
DBE	5	1696.0
DBE	6	1744.0

Regression Output:		
Constant		1704.214
Std Err of Y Est		50.60293
R Squared		0.113275
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	7.642857	
Std Err of Coef.	9.563056	

Sample	Hour	Average
ENDOX L-76	0	457.0
ENDOX L-76	1	519.5
ENDOX L-76	2	533.0
ENDOX L-76	3	531.5
ENDOX L-76	4	525.5
ENDOX L-76	5	509.5
ENDOX L-76	6	528.0

Regression Output:		
Constant		494.9821
Std Err of Y Est		24.74235
R Squared		0.286475
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	6.625	
Std Err of Coef.	4.675864	

Sample	Hour	Average
ENDOX Q-576	0	81.0
ENDOX Q-576	1	74.5
ENDOX Q-576	2	95.0
ENDOX Q-576	3	81.5
ENDOX Q-576	4	89.5
ENDOX Q-576	5	46.0
ENDOX Q-576	6	57.0

Regression Output:		
Constant		89.33928
Std Err of Y Est		15.54113
R Squared		0.348532
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-4.80357	
Std Err of Coef.	2.936997	

Sample	Hour	Average
RE-ENTRY ES	0	1232.0
RE-ENTRY ES	1	1022.0
RE-ENTRY ES	2	816.0
RE-ENTRY ES	3	948.0
RE-ENTRY ES	4	688.0
RE-ENTRY ES	5	634.0
RE-ENTRY ES	6	612.0

Regression Output:		
Constant		1146.428
Std Err of Y Est		92.69858
R Squared		0.863953
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-98.7142	
Std Err of Coef.	17.51838	

Sample	Hour	Average
OAKITE	0	2332.0
OAKITE	1	2095.0
OAKITE	2	2098.0
OAKITE	3	2147.0
OAKITE	4	2166.0
OAKITE	5	2080.0
OAKITE	6	2202.0

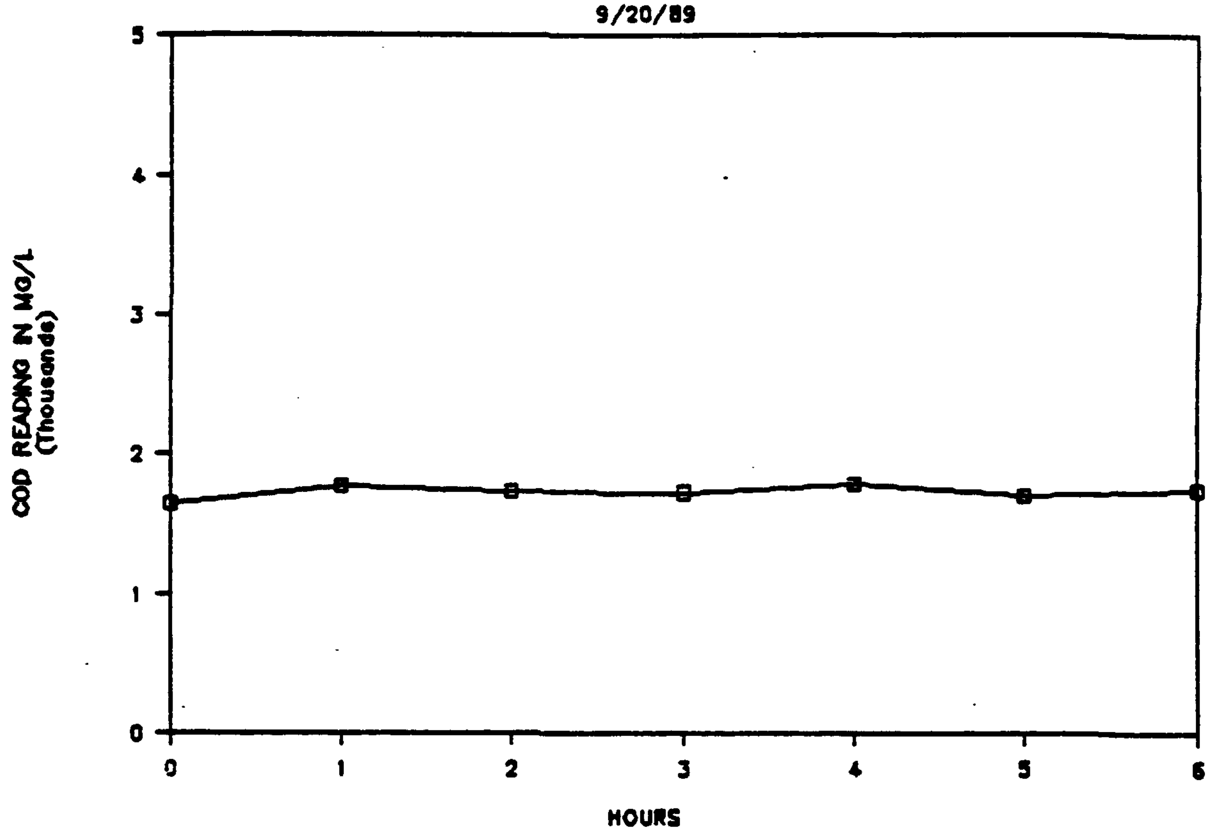
Regression Output:		
Constant		2197.714
Std Err of Y Est		91.21058
R Squared		0.096152
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-12.5714	
Std Err of Coef.	17.23718	

Sample	Hour	Average
PHENOL	0	261.5
PHENOL	1	263.0
PHENOL	2	234.5
PHENOL	3	184.0
PHENOL	4	108.5
PHENOL	5	12.0
PHENOL	6	18.5

Regression Output:		
Constant		299.9642
Std Err of Y Est		33.59666
R Squared		0.920967
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-48.4642	
Std Err of Coef.	6.349172	

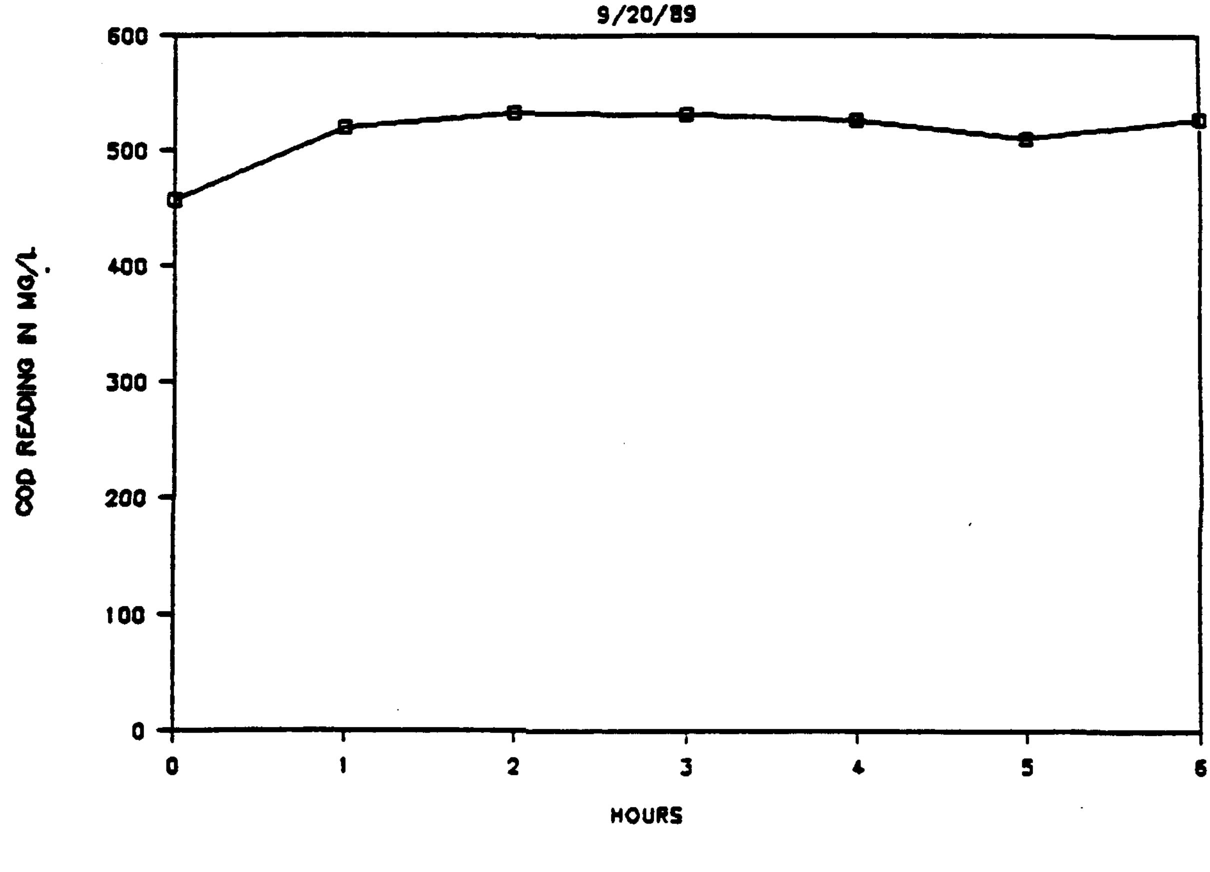
DBE (E60988-37), DU PONT

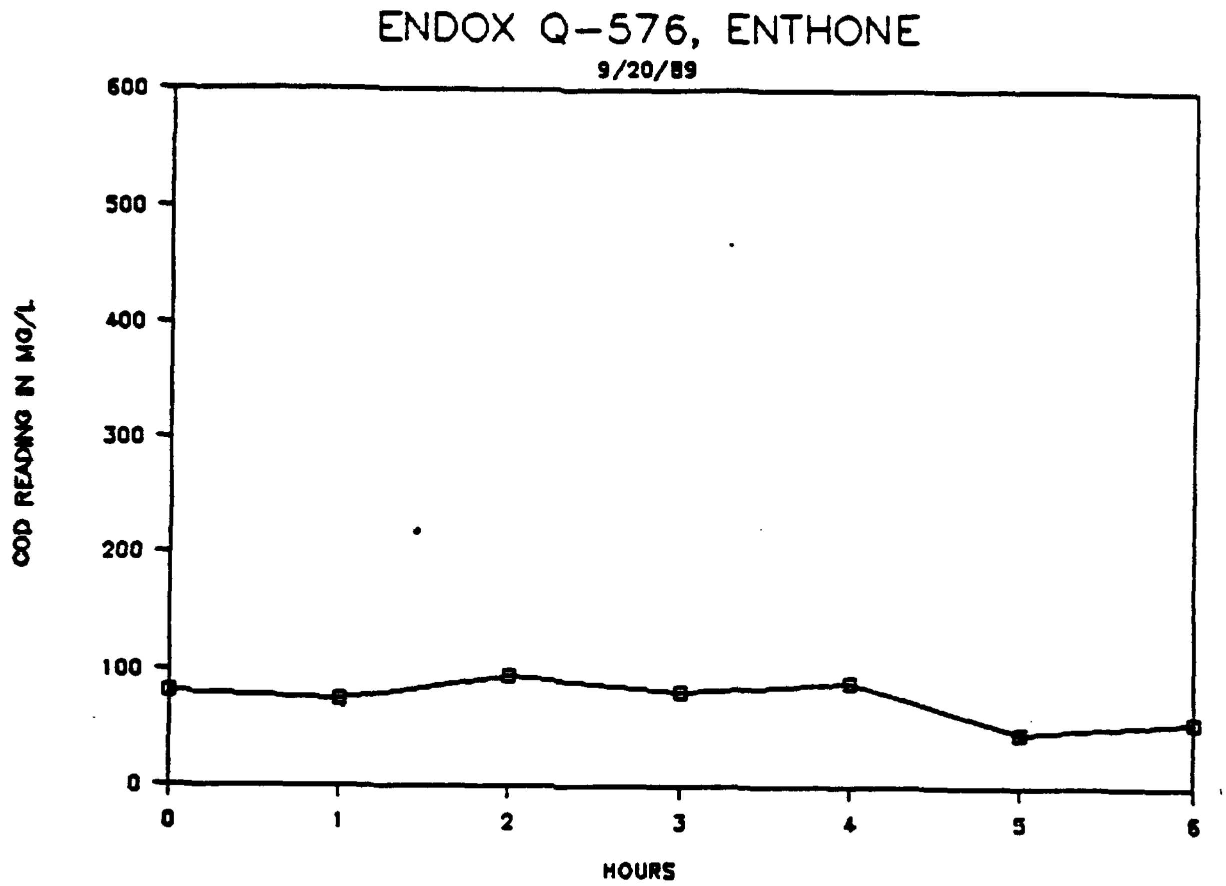
9/20/89

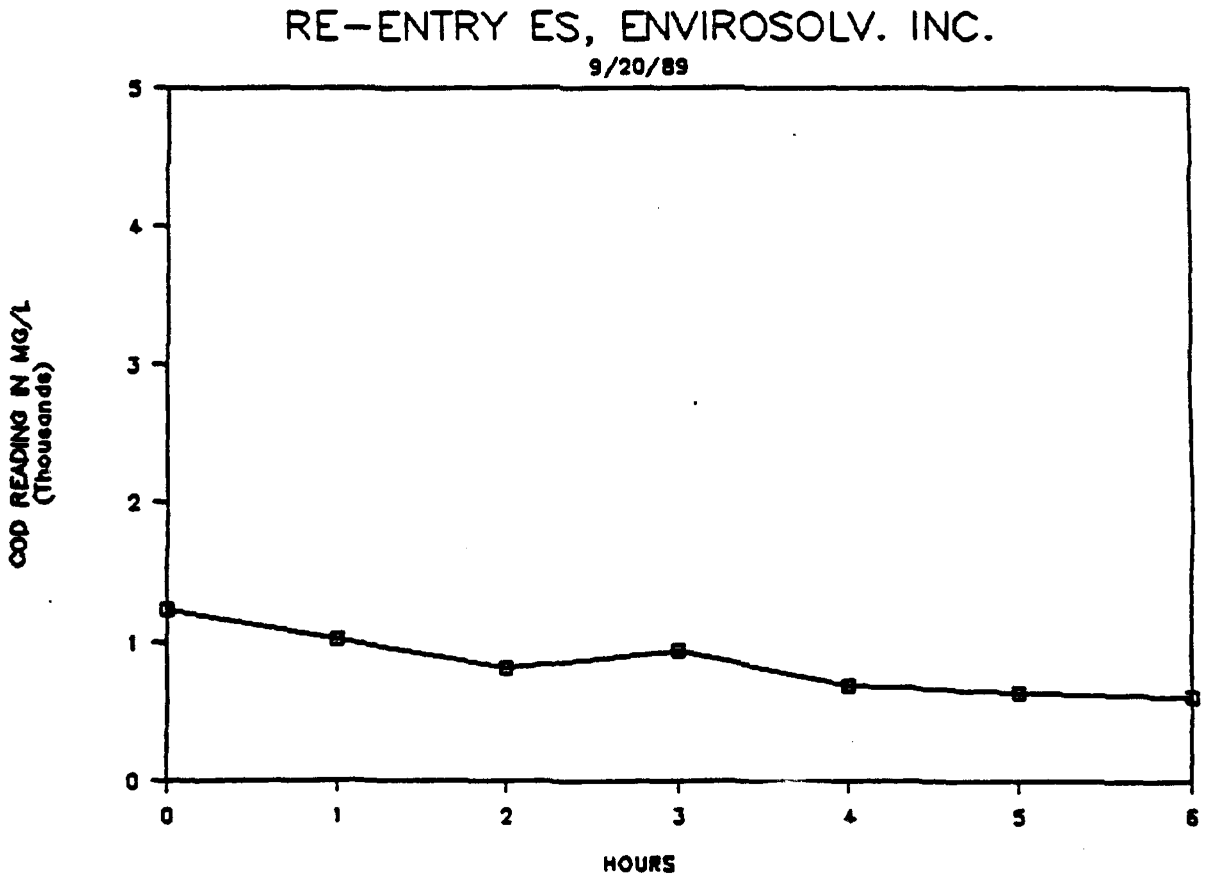


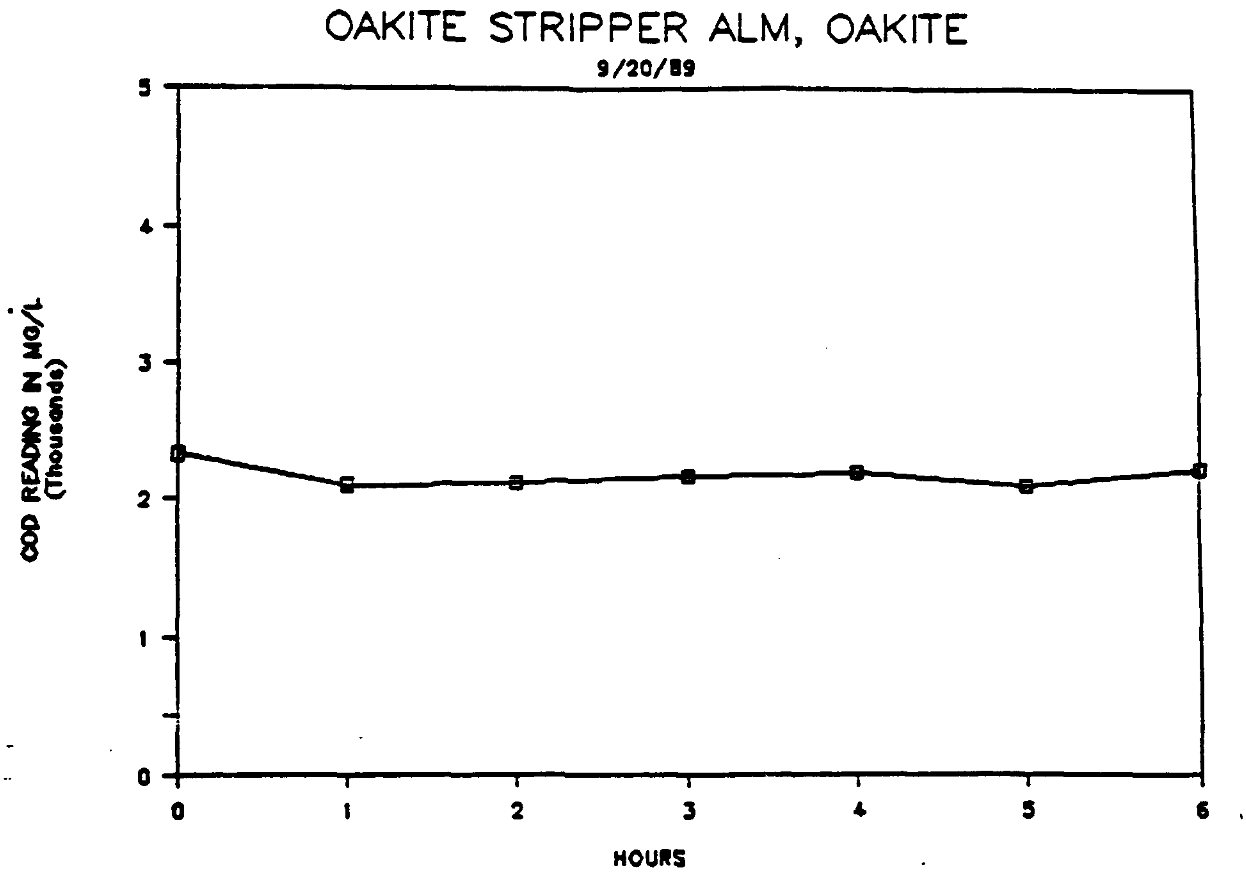
ENDOX L-76, ENTHONE

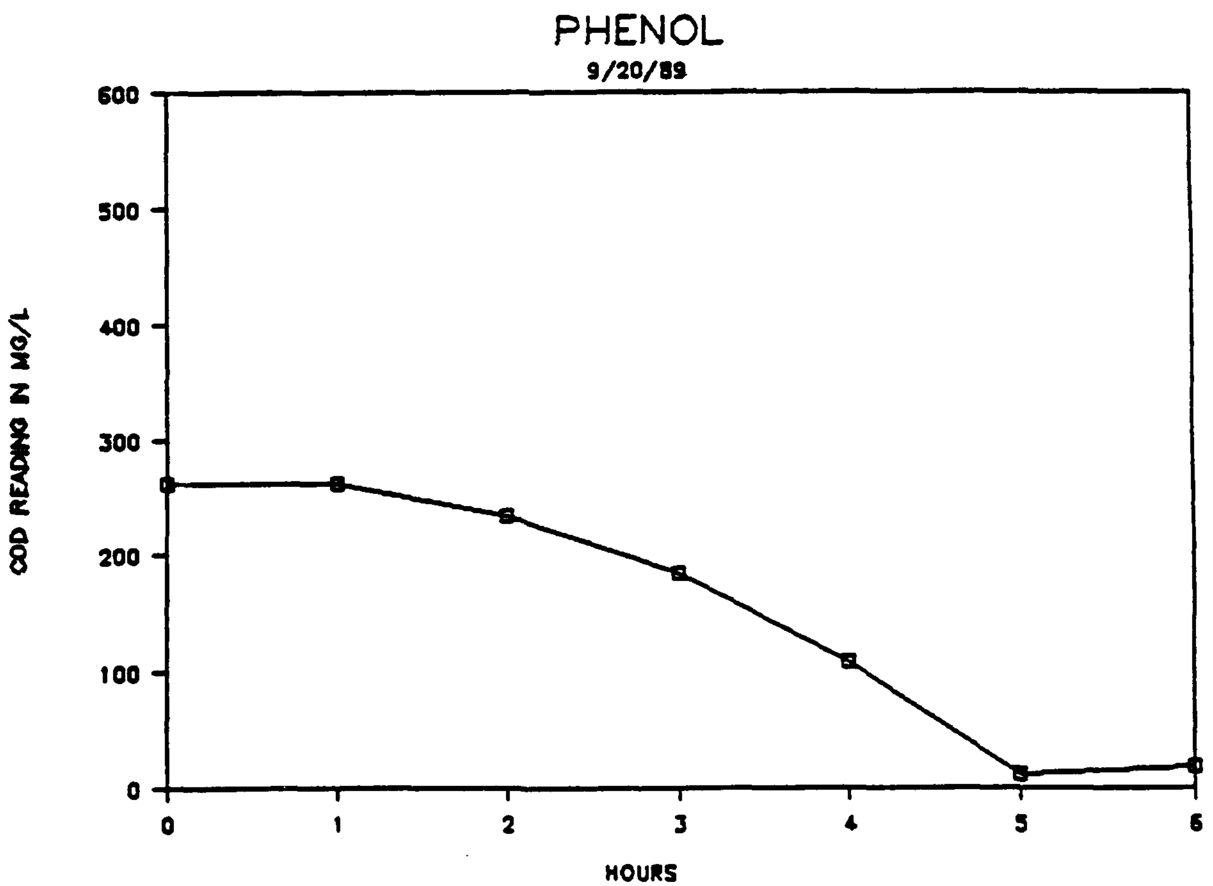
9/20/89




ENDOX Q-576, ENTHONE
9/20/89
COD READING IN MG/L
600
500
400
300
200
100
0
0
1
2
3
4
5
6
HOURS


RE-ENTRY ES, ENVIROSOLV. INC.
9/20/89
COD READING IN MG/L (Thousands)
5
4
3
2
1
0
0
1
2
3
4
5
6
HOURS


OAKITE STRIPPER ALM, OAKITE
9/20/89
COD READING IN MG/L
(Thousands)
0
1
2
3
4
5
0
1
2
3
4
5
6
HOURS

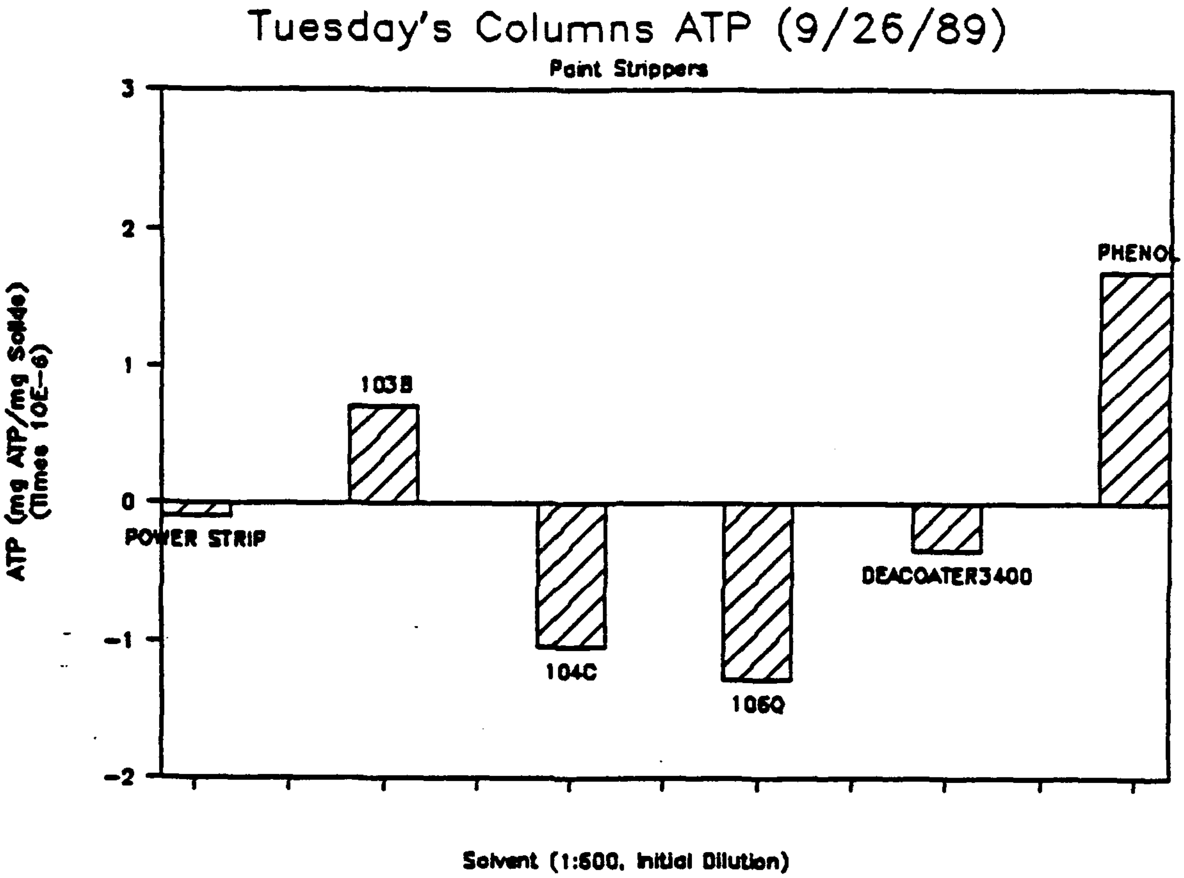

PHENOL
9/20/89
COD READING IN MG/L
0
100
200
300
400
500
600
0
1
2
3
4
5
6
HOURS

ATP DATA

Date:9/26/89 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	0.651	385	0.568	381.150	0.59350	0.00285	
	0	0.485	377.3					
Bugs	0	52.32	385.4	50.890	380.150	0.1528	1.340E-06	
	0	49.46	374.9					
POWER STRIP	0	109.6	495.4	115.400	502.100	0.2969	2.604E-06	
	0	121.2	508.8					
103B	0	34.78	419.2	35.330	420.950	0.0901	7.902E-07	
	0	35.88	422.7					
104C	0	193.2	581.7	195.700	571.650	0.5190	4.552E-06	
	0	198.2	561.6					
106Q	0	168.6	480.1	173.500	488.500	0.5489	4.815E-06	
	0	178.4	496.9					
DECOATER3400	0	59.31	394.9	60.980	395.650	0.1804	1.583E-06	
	0	62.65	396.4					
PHENOL	0	61.34	393.1	60.735	391.550	0.1818	1.595E-06	
	0	60.13	390					
Blank	5	0.637	369	0.617	370.350			
	5	0.596	371.7					
POWER STRIP	6	99.33	434.5	99.065	443.400	0.2860	2.509E-06	-9.6E-08
	6	98.8	452.3					
103B	6	65.69	420.7	62.390	421.950	0.1719	1.508E-06	7.2E-07
	6	59.09	423.2					
104C	6	148.4	503.9	147.250	514.750	0.3991	3.501E-06	-1.1E-06
	6	146.1	525.6					
106Q	6	141.8	482.9	137.600	477.450	0.4031	3.536E-06	-1.3E-06
	6	133.4	472					
DECOATER3400	6	51.09	423.8	52.890	422.850	0.1414	1.240E-06	-3.4E-07
	6	54.69	421.9					
PHENOL	6	74.04	303.9	82.515	302.400	0.3726	3.268E-06	1.7E-06
	6	90.99	300.9					
Blank	6	0.509	250.5	0.596	248.400			
	6	0.683	246.3					

Solids dry wt. (g)		g/mL
0.0712		0.0028

Average	Blank	
Without	Standard	0.594
With	Standard	333.300



Tuesday's Columns ATP (9/26/89)
Paint Strippers
ATP (mg ATP/mg Solids)
(Times 10E-6)
3
2
1
0
-1
-2
POWER STRIP
103B
104C
106Q
DEACOATER3400
PHENOL
Solvent (1:600, Initial Dilution)

COD DATA

DATE: 9/26/89

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	215	215.0	POWER STRIP (UF)	1	1315.0	1314.5
Bugs 0.1	0	215		POWER STRIP (UF)	1	1314	
Bugs 0.01	0	66	44.5	POWER STRIP (UF)	5	1297.0	1288.5
Bugs 0.01	0	23		POWER STRIP (UF)	5	1280	
POWER STRIP	0	1215	1212.5	106 Q	0	3692	3638.0
POWER STRIP	0	1210		106 Q	0	3584	
POWER STRIP	1	1184	1174.5	106 Q	1	3980	3952.0
POWER STRIP	1	1165		106 Q	1	3924	
POWER STRIP	2	1203	1180.0	106 Q	2	3708	3818.0
POWER STRIP	2	1157		106 Q	2	3928	
POWER STRIP	3	1142	1136.5	106 Q	3	4384	4240.0
POWER STRIP	3	1131		106 Q	3	4096	
POWER STRIP	4	1180	1174.0	106 Q	4	3628	3650.0
POWER STRIP	4	1168		106 Q	4	3672	
POWER STRIP	5	1161	1160.5	106 Q	5	3952	4002.0
POWER STRIP	5	1160		106 Q	5	4052	
POWER STRIP	6	1184	1166.0	106 Q	6	3812	4096.0
POWER STRIP	6	1148		106 Q	6	4380	
103 B	0	4276	4222.0	DECOATER	0	>3300	>3300
103 B	0	4168		DECOATER	0	3200	
103 B	1	3656	3442.0	DECOATER	1	>3300	>3300
103 B	1	3228		DECOATER	1	3182	
103 B	2	3232	3136.0	DECOATER	2	3090	3147.0
103 B	2	3040		DECOATER	2	3204	
103 B	3	3332	3064.0	DECOATER	3	3210	3253.0
103 B	3	2796		DECOATER	3	3296	
103 B	4	3084	3024.0	DECOATER	4	>3300	>3300
103 B	4	2964		DECOATER	4	3068	
103 B	5	2880	2978.0	DECOATER	5	>3300	>3300
103 B	5	3076		DECOATER	5	>3300	
103 B	6	2984	3032.0	DECOATER	6	>3300	>3300
103 B	6	3080		DECOATER	6	3290	
104 C	0	3820	3840.0	PHENOL	0	307	285.0
104 C	0	3860		PHENOL	0	263	
104 C	1	3668	3640.0	PHENOL	1	231	230.0
104 C	1	3612		PHENOL	1	229	
104 C	2	3524	3780.0	PHENOL	2	238	229.0
104 C	2	4036		PHENOL	2	220	
104 C	3	3328	3284.0	PHENOL	3	142	142.0
104 C	3	3240		PHENOL	3	142	
104 C	4	3446	3689.0	PHENOL	4	122	117.5
104 C	4	3932		PHENOL	4	113	
104 C	5	3516	3546.0	PHENOL	5	41	39.5
104 C	5	3576		PHENOL	5	36	
104 C	6	3264	3508.0	PHENOL	6	14	25.0
104 C	6	3752		PHENOL	6	36	
Standard							
0.10			237.50				
0.10							
0.25			504.50				
0.25							
PHENOL			1232.50				
PHENOL							

REGRESSION DATA

DATE: 9/26/89

Sample	Hour	Average
POWER STRIP	0	1212.5
POWER STRIP	1	1174.5
POWER STRIP	2	1180.0
POWER STRIP	3	1136.5
POWER STRIP	4	1174.0
POWER STRIP	5	1160.5
POWER STRIP	6	1166.0

Regression Output:

Constant		1190.589
Std Err of Y Est		20.33676
R Squared		0.342055
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-6.19642	
Std Err of Coef.	3.843286	

Sample	Hour	Average
103 B	0	4222.0
103 B	1	3442.0
103 B	2	3136.0
103 B	3	3064.0
103 B	4	3024.0
103 B	5	2978.0
103 B	6	3032.0

Regression Output:

Constant		3765.071
Std Err of Y Est		296.5438
R Squared		0.633191
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-164.642	
Std Err of Coef.	56.04152	

Sample	Hour	Average
104 C	0	3840.0
104 C	1	3640.0
104 C	2	3780.0
104 C	3	3284.0
104 C	4	3689.0
104 C	5	3546.0
104 C	6	3508.0

Regression Output:

Constant		3749.035
Std Err of Y Est		174.1365
R Squared		0.276894
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-45.5357	
Std Err of Coef.	32.90871	

Sample	Hour	Average
106 Q	0	3638.0
106 Q	1	3952.0
106 Q	2	3818.0
106 Q	3	4240.0
106 Q	4	3650.0
106 Q	5	4002.0
106 Q	6	4096.0

Regression Output:

Constant		3773.785
Std Err of Y Est		220.3451
R Squared		0.200594
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	46.64285	
Std Err of Coef.	41.64131	

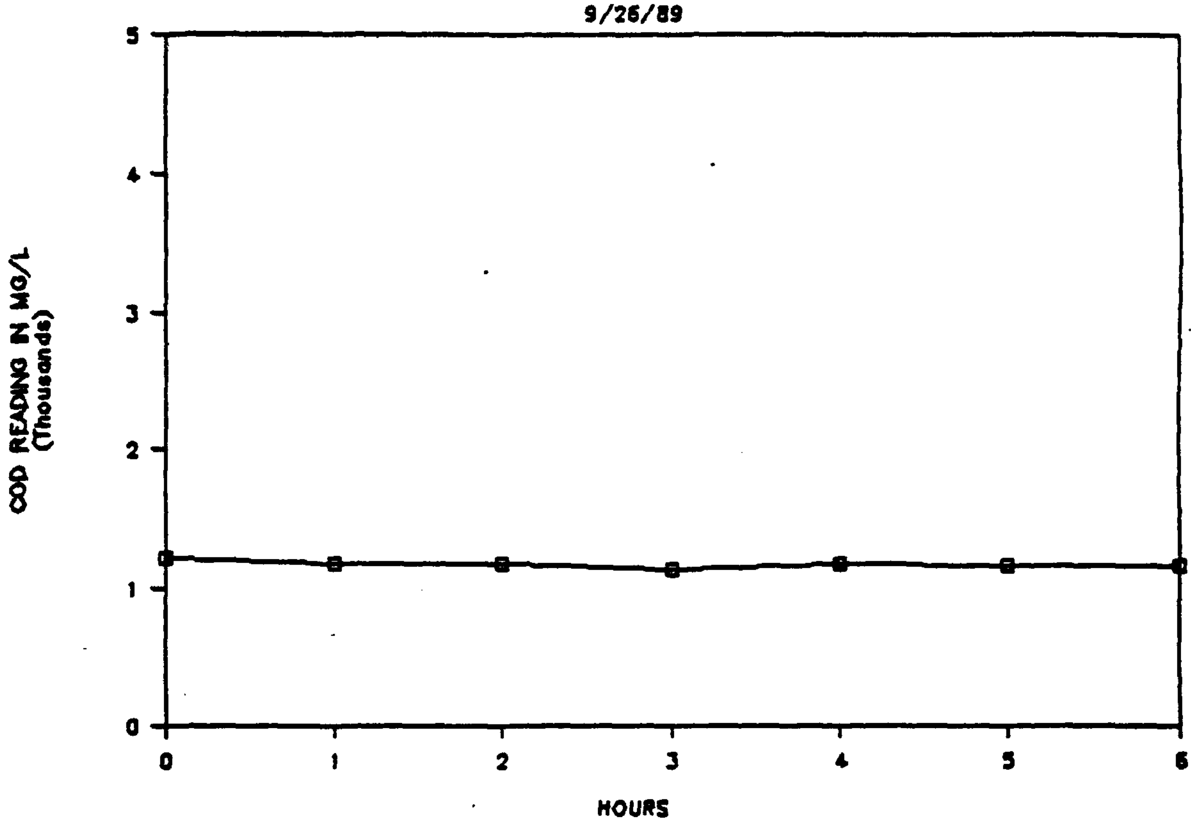
Sample	Hour	Average
DECOATER	0	>3300
DECOATER	1	>3300
DECOATER	2	3147.0
DECOATER	3	3253.0
DECOATER	4	>3300
DECOATER	5	>3300
DECOATER	6	>3300

Sample	Hour	Average
PHENOL	0	285.0
PHENOL	1	230.0
PHENOL	2	229.0
PHENOL	3	142.0
PHENOL	4	117.5
PHENOL	5	39.5
PHENOL	6	25.0

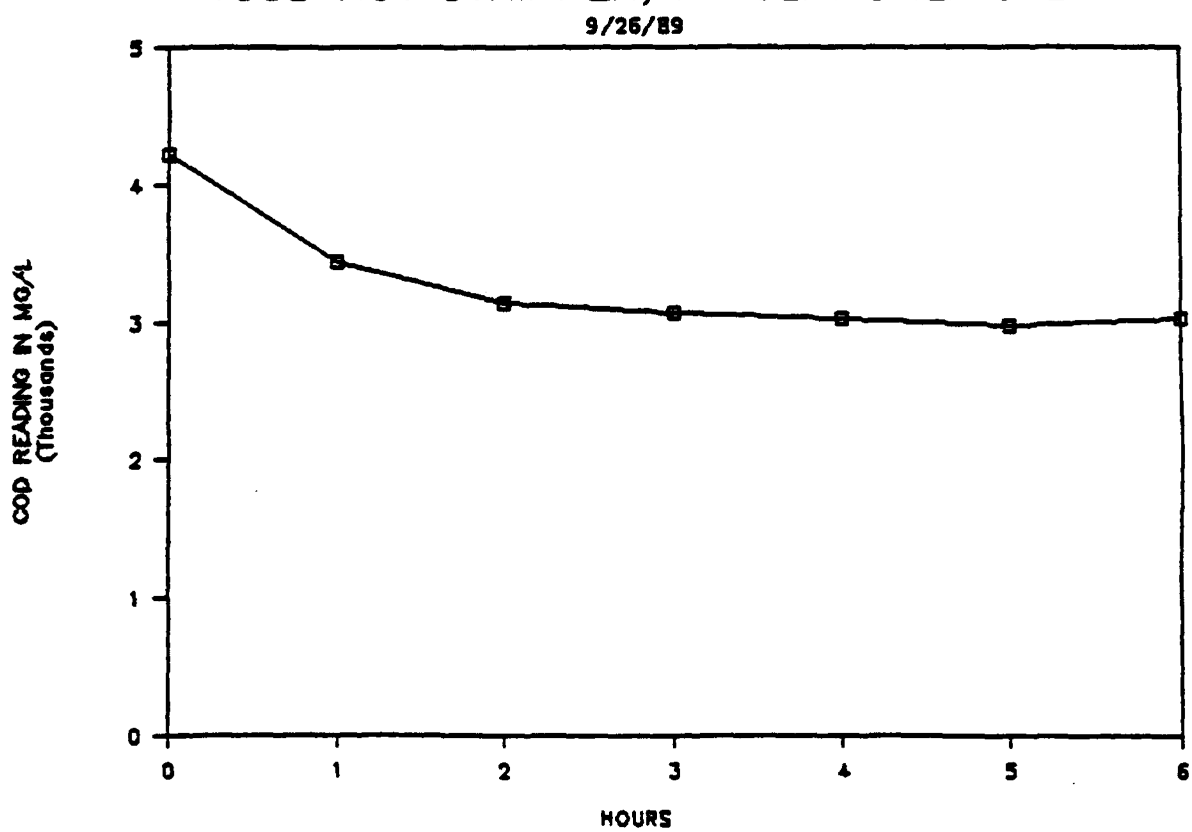
Regression Output:

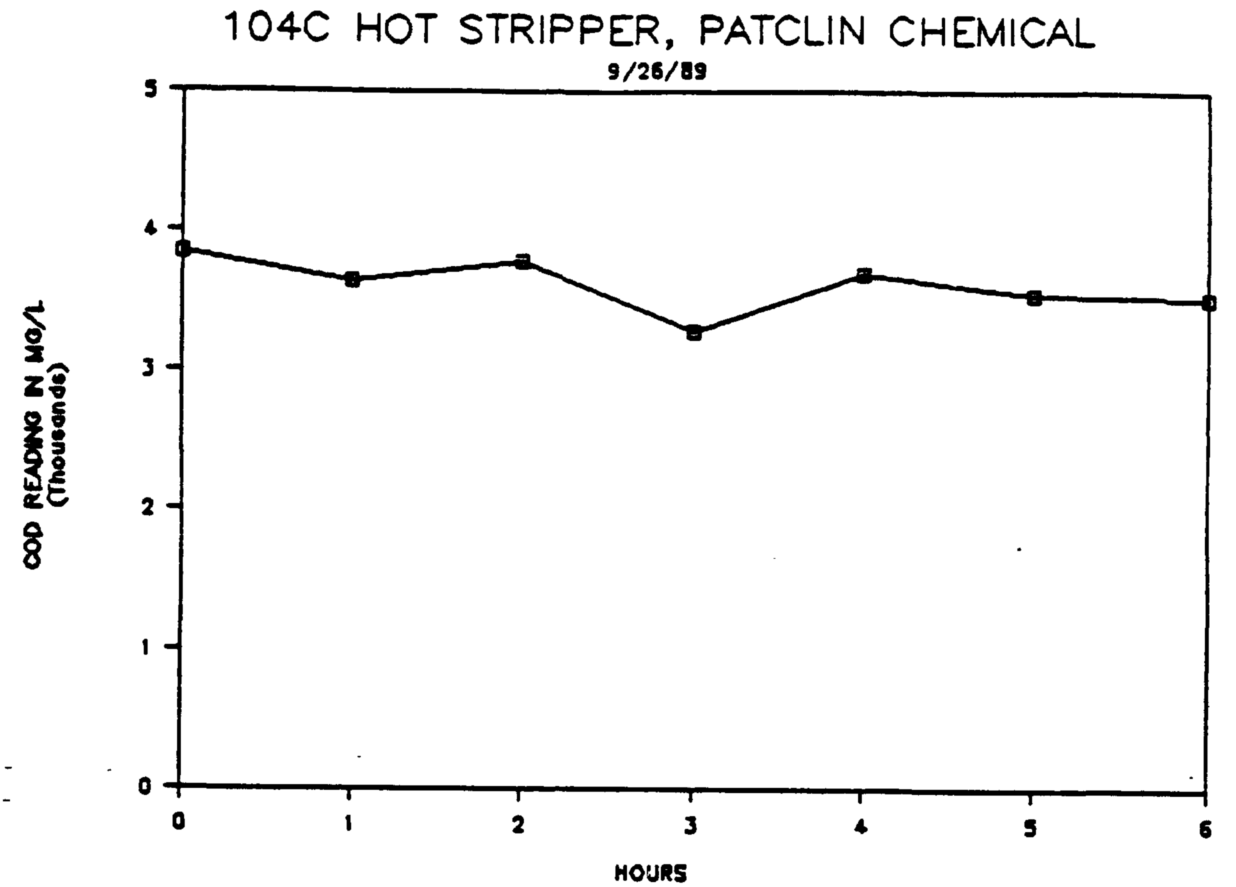
Constant		288.9107
Std Err of Y Est		19.72122
R Squared		0.967467
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-45.4464	
Std Err of Coef.	3.726961	

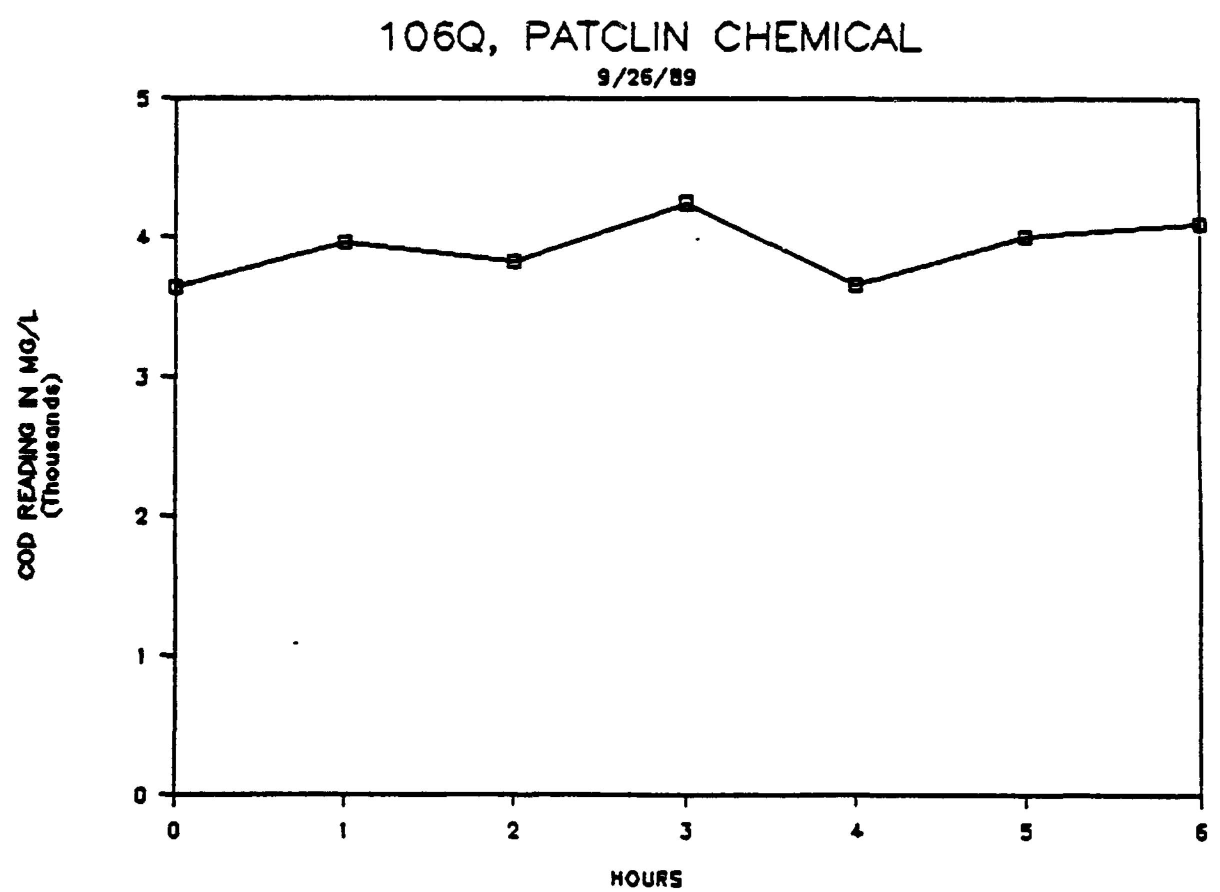
POWER STRIP 5163, MAN-GILL CHEMICAL



103B HOT STRIPPER, PATCLIN CHEMICAL

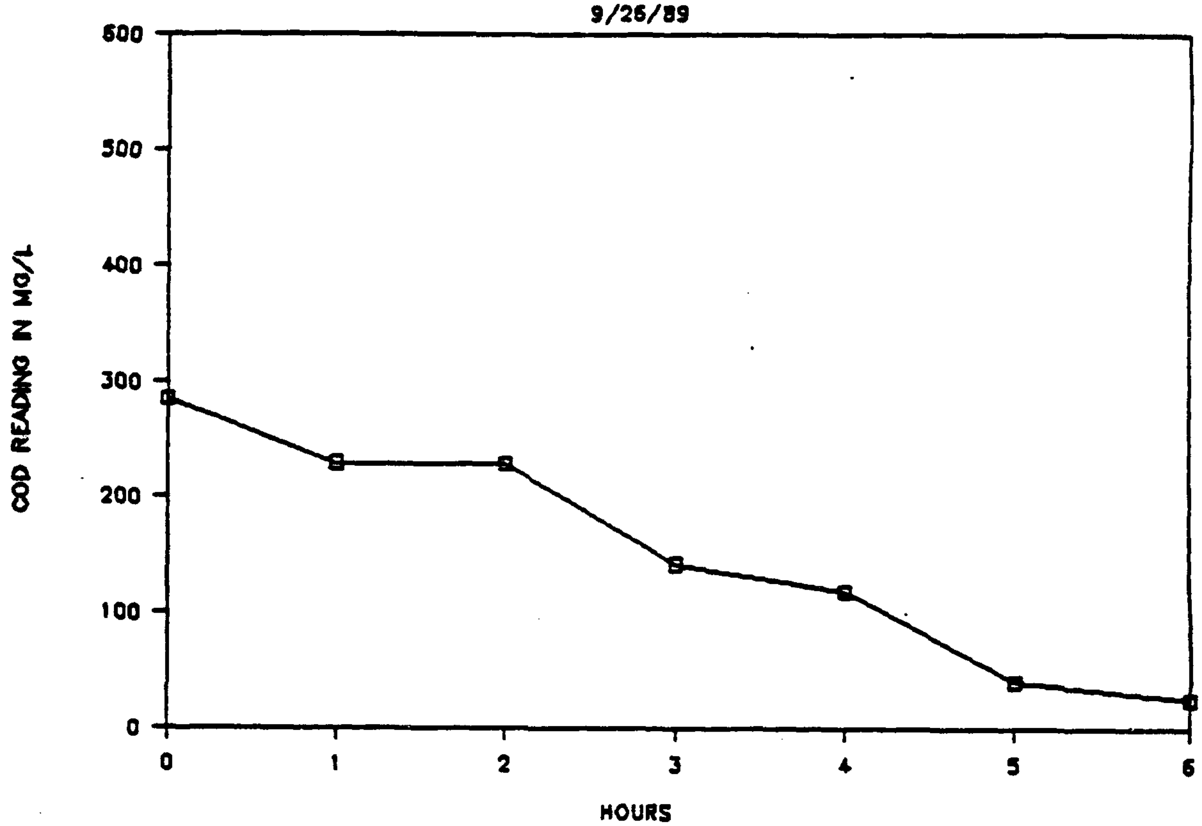



104C HOT STRIPPER, PATCLIN CHEMICAL
9/26/89
COD READING IN MG/L (Thousands)
HOURS
0
1
2
3
4
5
6


106Q, PATCLIN CHEMICAL
9/26/89
COD READING IN MG/L (Thousands)
HOURS
0
1
2
3
4
5
6

PHENOL

9/26/89

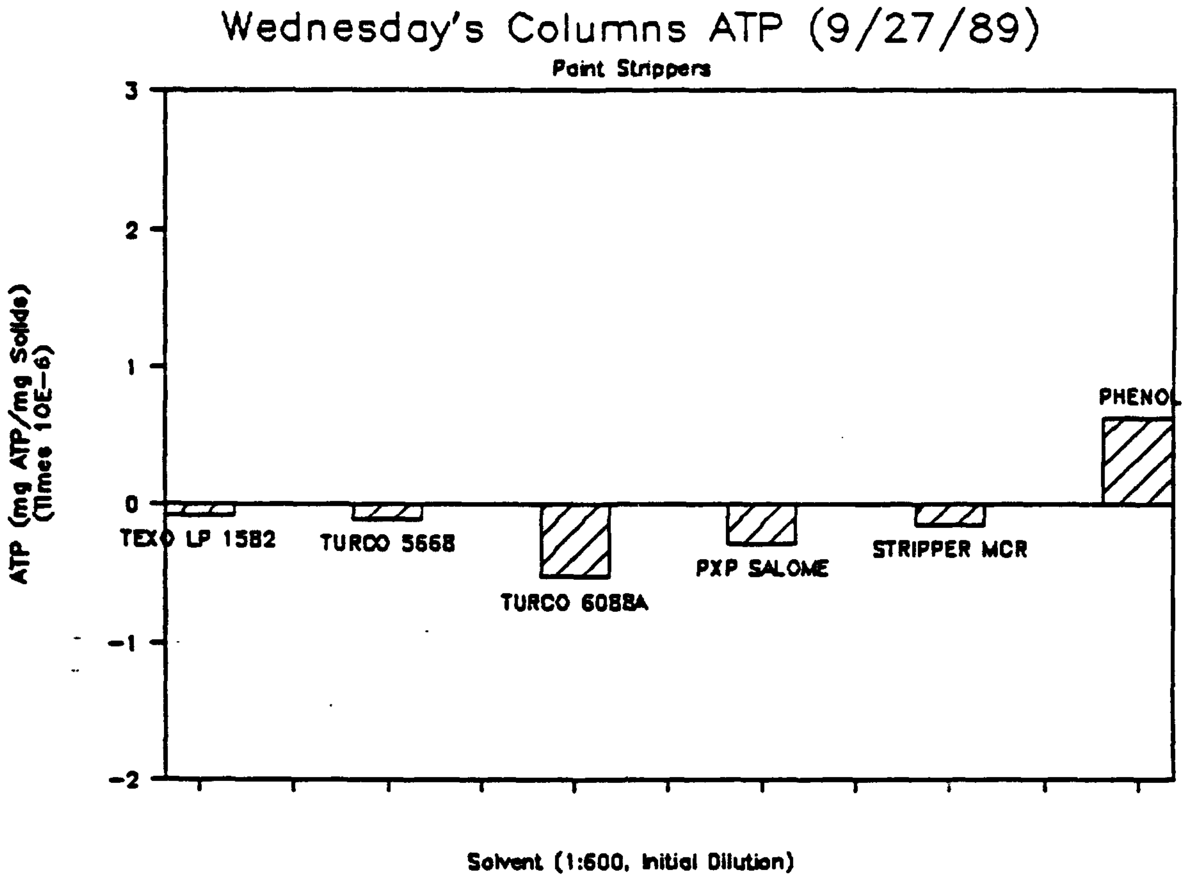


ATP DATA

Date: 9/27/89 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	0.545	226.4	0.650	247.100	0.65617	0.00256	
	0	0.754	267.8					
Bugs	0	19.65	266.5	18.575	265.100	0.0727	7.098E-07	
	0	17.5	263.7					
TEXO LP 1582	0	16.64	369	16.445	374.350	0.0441	4.308E-07	
	0	16.25	379.7					
TURCO 5668	0	11.52	236.8	12.600	244.350	0.0515	5.033E-07	
	0	13.68	251.9					
TURCO 6088A	0	31.35	297.6	27.500	285.600	0.1040	1.016E-06	
	0	23.65	273.6					
PXP SALOME	0	7.708	207.2	8.267	224.700	0.0352	3.434E-07	
	0	8.825	242.2					
STRIPPER MCR	0	26.13	271.2	29.115	282.450	0.1123	1.097E-06	
	0	32.1	293.7					
PHENOL	0	32.24	272.1	31.120	280.600	0.1221	1.192E-06	
	0	30	289.1					
Blank	5	0.813	277.5	0.757	274.200			
	5	0.7	270.9					
TEXO LP 1582	6	8.29	231	8.791	231.150	0.0366	3.573E-07	-7.4E-08
	6	9.292	231.3					
TURCO 5668	6	10.09	221.1	9.313	219.050	0.0413	4.030E-07	-1.0E-07
	6	8.535	217					
TURCO 6088A	6	8.84	200.1	9.240	180.650	0.0501	4.890E-07	-5.3E-07
	6	9.64	161.2					
PXP SALOME	6	1.534	168.1	1.578	171.300	0.0054	5.304E-08	-2.9E-07
	6	1.622	174.5					
STRIPPER MCR	6	10.37	154.4	13.926	151.150	0.0967	9.444E-07	-1.5E-07
	6	17.482	147.9					
PHENOL	6	42.36	253.7	41.800	262.150	0.1867	1.823E-06	6.3E-07
	6	41.24	270.6					
Blank	6	0.519	205.1	0.563	208.150			
	6	0.606	211.2					

Solids dry wt. (g)	g/mL
0.064	0.0026

Average	Blank	
Without	Standard	0.656
With	Standard	243.150


Wednesday's Columns ATP (9/27/89)
Paint Strippers
ATP (mg ATP/mg Solids)
(Times 10E-6)
3
2
1
0
-1
-2
TEXO LP 1582
TURCO 5668
TURCO 6088A
PXP SALOME
STRIPPER MCR
PHENOL
Solvent (1:600, Initial Dilution)

COD DATA

DATE: 9/27/89

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	182	190.0	TEXO (UF)	1	2562.0	2561.0
Bugs 0.1	0	198		TEXO (UF)	1	2560	
Bugs 0.01	0	4	22.5	TEXO (UF)	5	1112.0	1110.0
Bugs 0.01	0	41		TEXO (UF)	5	1108	
TEXO	0	1182	1056.0	PXP SALOME	0	>3300	>3300
TEXO	0	930		PXP SALOME	0	>3300	
TEXO	1	824	825.0	PXP SALOME	1	3254	3262.0
TEXO	1	826		PXP SALOME	1	3270	
TEXO	2	898	878.0	PXP SALOME	2	3276	3298.0
TEXO	2	858		PXP SALOME	2	3320	
TEXO	3	866	882.0	PXP SALOME	3	3380	3222.0
TEXO	3	898		PXP SALOME	3	3064	
TEXO	4	816	862.0	PXP SALOME	4	3408	3450.0
TEXO	4	908		PXP SALOME	4	3492	
TEXO	5	874	868.0	PXP SALOME	5	3268	3242.0
TEXO	5	862		PXP SALOME	5	3216	
TEXO	6	894	916.0	PXP SALOME	6	3388	3590.0
TEXO	6	938		PXP SALOME	6	3792	
TURCO 5668	0	3294	>3300	STRIPPER MCR	0	>3300	>3300
TURCO 5668	0	>3300		STRIPPER MCR	0	>3300	
TURCO 5668	1	3164	3226.0	STRIPPER MCR	1	>3300	>3300
TURCO 5668	1	3288		STRIPPER MCR	1	3146	
TURCO 5668	2	3278	3240.0	STRIPPER MCR	2	3696	3652.0
TURCO 5668	2	3202		STRIPPER MCR	2	3608	
TURCO 5668	3	>3300	>3300	STRIPPER MCR	3	3636	3400.0
TURCO 5668	3	3272		STRIPPER MCR	3	3164	
TURCO 5668	4	3218	>3300	STRIPPER MCR	4	3828	3792.0
TURCO 5668	4	>3300		STRIPPER MCR	4	3756	
TURCO 5668	5	>3300	>3300	STRIPPER MCR	5	3640	3752.0
TURCO 5668	5	>3300		STRIPPER MCR	5	3864	
TURCO 5668	6	3246	3273.0	STRIPPER MCR	6	3464	3712.0
TURCO 5668	6	3300		STRIPPER MCR	6	3960	
TURCO 6088A	0	2314	2380.0	PHENOL	0	265	259.0
TURCO 6088A	0	2446		PHENOL	0	253	
TURCO 6088A	1	1756	1743.0	PHENOL	1	243	254.0
TURCO 6088A	1	1730		PHENOL	1	265	
TURCO 6088A	2	1848	1836.0	PHENOL	2	218	210.0
TURCO 6088A	2	1824		PHENOL	2	202	
TURCO 6088A	3	1792	1792.0	PHENOL	3	175	184.0
TURCO 6088A	3	1792		PHENOL	3	193	
TURCO 6088A	4	1830	1824.0	PHENOL	4	140	142.5
TURCO 6088A	4	1818		PHENOL	4	145	
TURCO 6088A	5	1820	1819.0	PHENOL	5	73	75.5
TURCO 6088A	5	1818		PHENOL	5	78	
TURCO 6088A	6	1790	1811.0	PHENOL	6	36	27.5
TURCO 6088A	6	1832		PHENOL	6	19	

Standard		
0.10	a	199.50
0.10	b	
0.25	a	5[illegible].00
0.25	b	
PHENOL	a	1256.50
PHENOL	b	

REGRESSION DATA

DATE: 9/27/89

Sample	Hour	Average
TEXO	0	1056.0
TEXO	1	825.0
TEXO	2	878.0
TEXO	3	882.0
TEXO	4	862.0
TEXO	5	868.0
TEXO	6	916.0

Regression Output:

Constant		935.6428
Std Err of Y Est		76.28087
R Squared		0.130718
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-12.5	
Std Err of Coef.	14.41572	

Sample	Hour	Average
TURCO 5668	0	>3300
TURCO 5668	1	3226.0
TURCO 5668	2	3240.0
TURCO 5668	3	>3300
TURCO 5668	4	>3300
TURCO 5668	5	>3300
TURCO 5668	6	3273.0
TURCO 6088A	0	2380.0
TURCO 6088A	1	1743.0
TURCO 6088A	2	1836.0
TURCO 6088A	3	1792.0
TURCO 6088A	4	1824.0
TURCO 6088A	5	1819.0
TURCO 6088A	6	1811.0

Regression Output:

Constant		2054.321
Std Err of Y Est		201.0381
R Squared		0.302632
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-55.9642	
Std Err of Coef.	37.99263	

Sample	Hour	Average
PXP SALOME	0	>3300
PXP SALOME	1	3262.0
PXP SALOME	2	3298.0
PXP SALOME	3	3222.0
PXP SALOME	4	3450.0
PXP SALOME	5	3242.0
PXP SALOME	6	3590.0

Regression Output:

Constant		3174
Std Err of Y Est		127.0770
R Squared		0.389929
No. of Observations		6
Degrees of Freedom		4
X Coefficient(s)	48.57142	
Std Err of Coef.	30.37722	

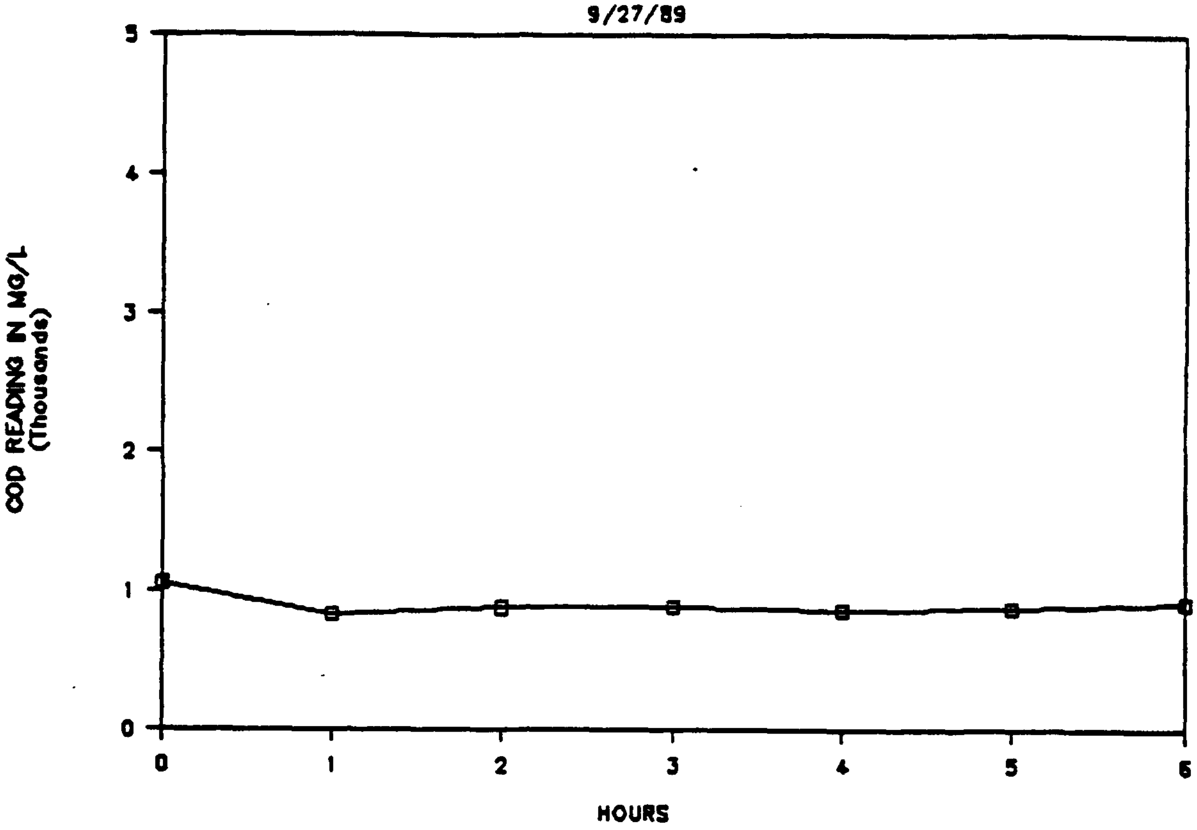
Sample	Hour	Average
STRIPPER MCR	0	>3300
STRIPPER MCR	1	>3300
STRIPPER MCR	2	3652.0
STRIPPER MCR	3	3400.0
STRIPPER MCR	4	3792.0
STRIPPER MCR	5	3752.0
STRIPPER MCR	6	3712.0
PHENOL	0	259.0
PHENOL	1	254.0
PHENOL	2	210.0
PHENOL	3	184.0
PHENOL	4	142.5
PHENOL	5	75.5
PHENOL	6	27.5

Regression Output:

Constant		284.5357
Std Err of Y Est		19.20844
R Squared		0.960381
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-39.9642	
Std Err of Coef.	3.630054	

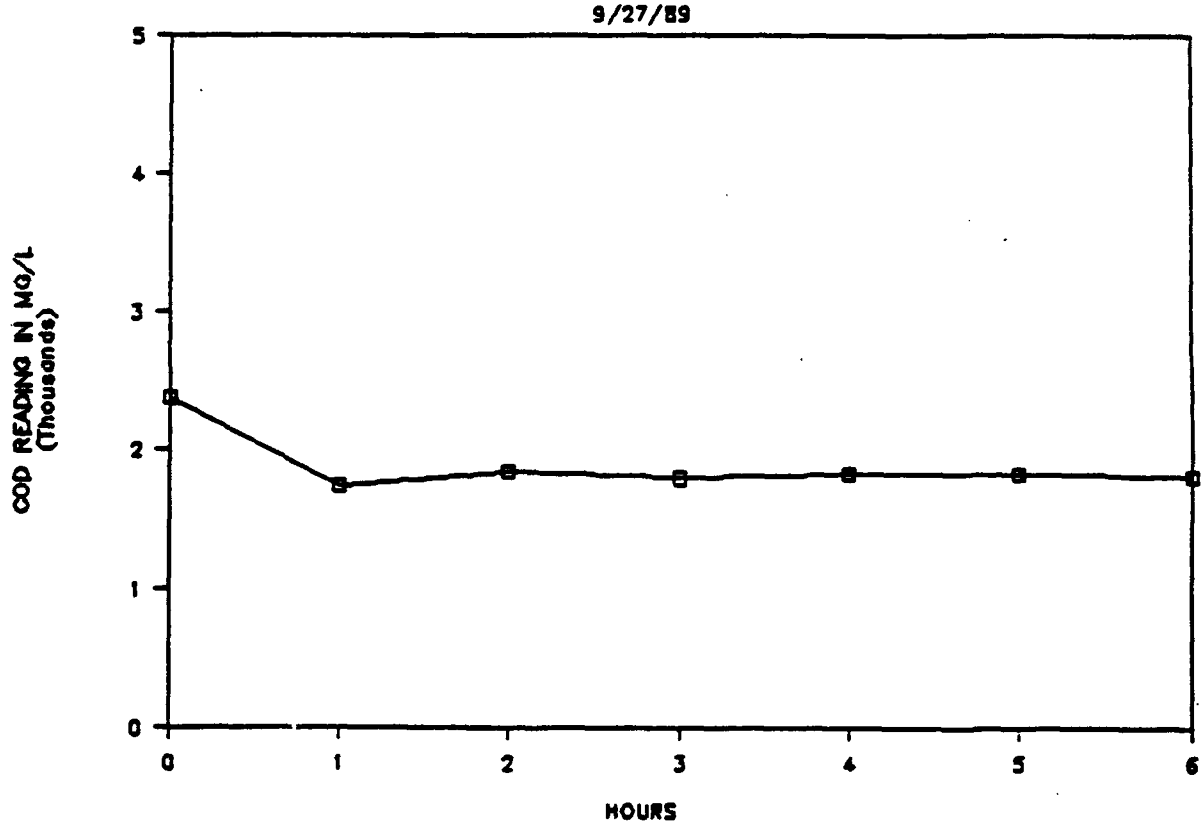
TEXO LP 1582, TEXCO CORP.

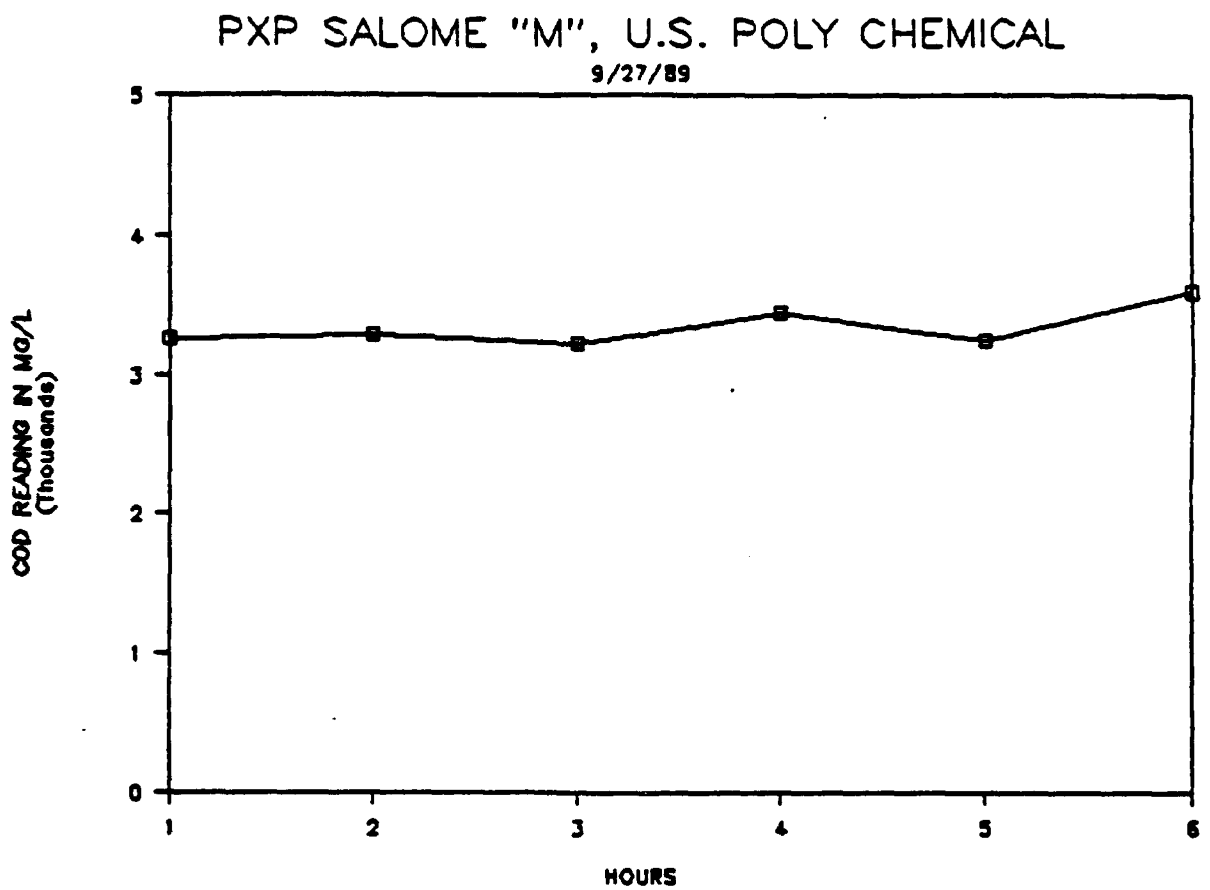
9/27/89

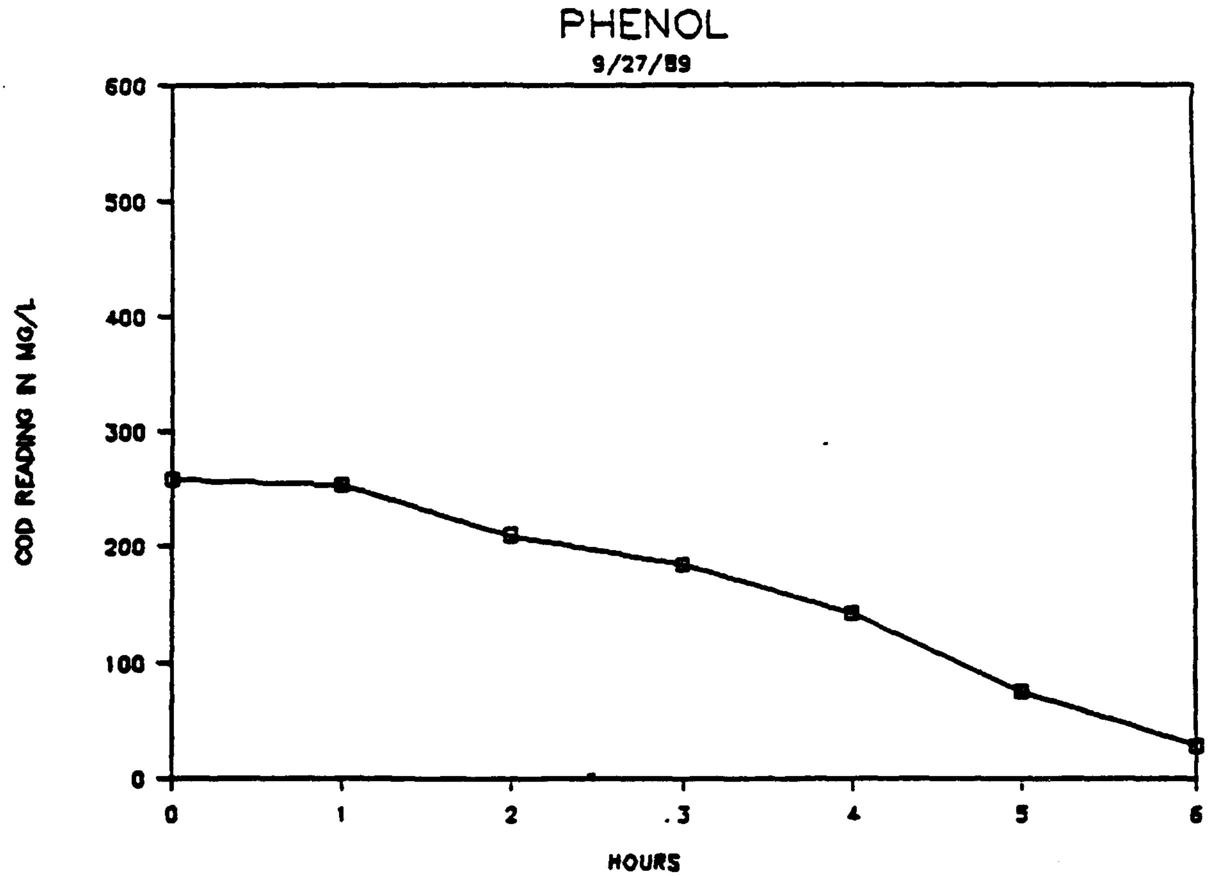


TURCO 6088A, TURCO PRODUCTS

9/27/89




PXP SALOME "M", U.S. POLY CHEMICAL
9/27/89
COD READING IN MG/L (Thousands)
0
1
2
3
4
5
1
2
3
4
5
6
HOURS


PHENOL
9/27/89
COD READING IN MG/L
0
100
200
300
400
500
600
0
1
2
3
4
5
6
HOURS

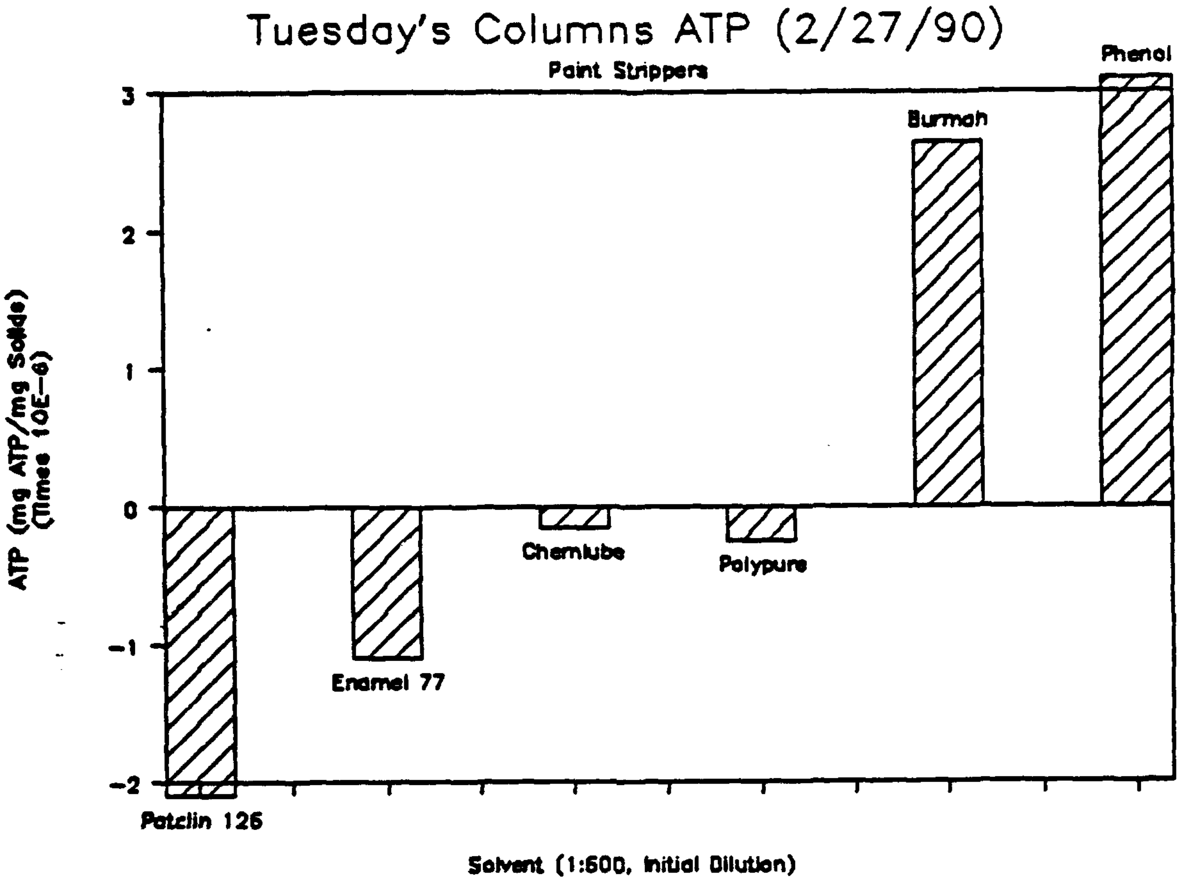
ATP DATA

Date: 2/27/90

Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank) (RIS-RU)	mg ATP mg Solids	Change in ATP
Blank	0	0.58	414	0.570	415.500	0.59167	0.00480	
	0	0.56	417					
Bugs	0	150	565	171.000	560.000	0.4396	2.285E-06	
	0	192	555					
Patclin 126	0	208	559	186.000	551.000	0.5096	2.649E-06	
	0	164	543					
Enamel 77	0	160	559	169.500	543.000	0.4538	2.359E-06	
	0	179	527					
Chemlube	0	179	510	174.500	516.500	0.5102	2.652E-06	
	0	170	523					
Polypure	0	187	559	177.500	570.000	0.4522	2.350E-06	
	0	168	581					
Burmah	0	184	585	180.500	594.500	0.4360	2.266E-06	
	0	177	604					
Phenol	0	195	597	215.000	605.000	0.5513	2.865E-06	
	0	235	613					
Blank	5	0.5	369	0.645	371.500			
	5	0.79	374					
Patclin 126	6	42.8	449	45.000	445.000	0.1125	5.847E-07	-2.1E-06
	6	47.2	441					
Enamel 77	6	108	524	102.500	526.500	0.2417	1.256E-06	-1.1E-06
	6	97	529					
Chemlube	6	261	761	245.000	753.500	0.4818	2.504E-06	-1.5E-07
	6	229	746					
Polypure	6	221	733	205.000	709.500	0.4063	2.112E-06	-2.4E-07
	6	189	686					
Burmah	6	468	890	439.500	905.000	0.9441	4.907E-06	2.6E-06
	6	411	920					
Phenol	6	1370	1830	1370.000	1790.000	3.2619	1.695E-05	1.4E-05
	6	1370	1750					
Blank	6	0.5	429	0.560	438.000			
	6	0.62	447					

Solids dry wt. (g)	g/ml
0.1202	0.0048

Average	Blank	
Without	Standard	0.592
With	Standard	408.333



Tuesday's Columns ATP (2/27/90)
Paint Strippers
ATP (mg ATP/mg Solids)
(Times 10E-6)
3
2
1
0
-1
-2
Phenol
Burmah
Chemlube
Polypure
Enamel 77
Patclin 126
Solvent (1:600, Initial Dilution)

COD DATA

Date: 2/27/90

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	582	584.0	Patclin 126	1	3148.0	3000.0
Bugs 0.1	0	586		Patclin 126	1	2852	
Bugs 0.01	0	59	60.0	Patclin 126	5	3152.0	3168.0
Bugs 0.01	0	61		Patclin 126	5	3184	
Burmah	0	274	273.5	Patclin 126	0	2424	2484.0
Burmah	0	273		Patclin 126	0	2544	
Burmah	1	306	288.5	Patclin 126	1	2372	2536.0
Burmah	1	271		Patclin 126	1	2700	
Burmah	2	180	181.0	Patclin 126	2	2192	2322.0
Burmah	2	182		Patclin 126	2	2452	
Burmah	3	165	156.5	Patclin 126	3	2540	2504.0
Burmah	3	148		Patclin 126	3	2468	
Burmah	4	45	55.0	Patclin 126	4	2424	2452.0
Burmah	4	65		Patclin 126	4	2480	
Burmah	5	11	8.0	Patclin 126	5	2640	2676.0
Burmah	5	5		Patclin 126	5	2712	
Burmah	6	29	31.5	Patclin 126	6	2568	2518.0
Burmah	6	34		Patclin 126	6	2468	
Chem-lube	0	274	274.0	Polypure	0	281	278.0
Chem-lube	0	274		Polypure	0	275	
Chem-lube	1	253	249.5	Polypure	1	239	235.0
Chem-lube	1	246		Polypure	1	231	
Chem-lube	2	186	180.5	Polypure	2	179	176.5
Chem-lube	2	175		Polypure	2	174	
Chem-lube	3	135	147.5	Polypure	3	141	140.5
Chem-lube	3	160		Polypure	3	140	
Chem-lube	4	47	62.5	Polypure	4	59	59.5
Chem-lube	4	78		Polypure	4	60	
Chem-lube	5	11	6.5	Polypure	5	23	24.0
Chem-lube	5	2		Polypure	5	25	
Chem-lube	6	34	37.5	Polypure	6	27	24.5
Chem-lube	6	41		Polypure	6	22	
Enamel 77	0	2008	1936.0	Phenol	0	274	274.0
Enamel 77	0	1864		Phenol	0	274	
Enamel 77	1	2024	1946.0	Phenol	1	229	226.0
Enamel 77	1	1868		Phenol	1	223	
Enamel 77	2	1664	1766.0	Phenol	2	211	204.0
Enamel 77	2	1868		Phenol	2	197	
Enamel 77	3	1908	1896.0	Phenol	3	166	171.5
Enamel 77	3	1884		Phenol	3	177	
Enamel 77	4	2124	2072.0	Phenol	4	68	64.0
Enamel 77	4	2020		Phenol	4	60	
Enamel 77	5	1664	1714.0	Phenol	5	19	17.0
Enamel 77	5	1764		Phenol	5	15	
Enamel 77	6	1716	1774.0	Phenol	6	37	36.0
Enamel 77	6	1832		Phenol	6	35	
Standard							
0.10			225				
0.10							
0.25			515.5				
0.25							
Phenol			0				
Phenol							

REGRESSION DATA

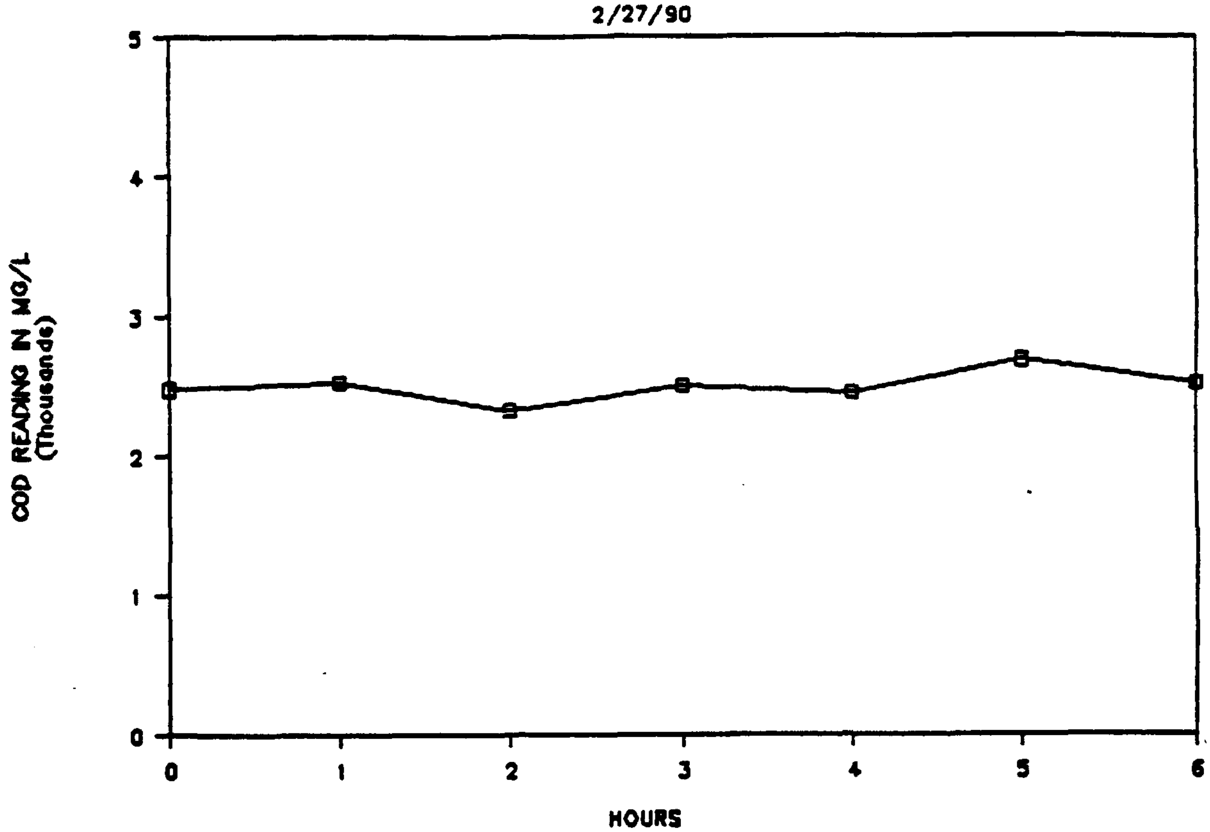
Date: 2/27/90

Sample	Hour	Average
Burmah	0	273.5
Burmah	1	288.5
Burmah	2	181.0
Burmah	3	156.5
Burmah	4	55.0
Burmah	5	8.0
Burmah	6	31.5
Chem-lube	0	274.0
Chem-lube	1	249.5
Chem-lube	2	180.5
Chem-lube	3	147.5
Chem-lube	4	62.5
Chem-lube	5	6.5
Chem-lube	6	37.5
Enamel 77	0	1936.0
Enamel 77	1	1946.0
Enamel 77	2	1766.0
Enamel 77	3	1896.0
Enamel 77	4	2072.0
Enamel 77	5	1714.0
Enamel 77	6	1774.0
Patclin 126	0	2484.0
Patclin 126	1	2536.0
Patclin 126	2	2322.0
Patclin 126	3	2504.0
Patclin 126	4	2452.0
Patclin 126	5	2676.0
Patclin 126	6	2518.0
Polypure	0	278.0
Polypure	1	235.0
Polypure	2	176.5
Polypure	3	140.5
Polypure	4	59.5
Polypure	5	24.0
Polypure	6	24.5
Phenol	0	274.0
Phenol	1	226.0
Phenol	2	204.0
Phenol	3	171.5
Phenol	4	64.0
Phenol	5	17.0
Phenol	6	36.0

Regression Output:	Burmah	Chem-lube	Enamel 77	Patclin 126	Polypure	Phenol
Constant	293.3928	277.5892	1941	2444	273.2321	278.0714
Std Err of Y Est	37.18861	29.29550	127.3891	107.2236	20.56830	29.50859
R Squared	0.911597	0.934892	0.154368	0.140055	0.966115	0.929934
No. of Observations	7	7	7	7	7	7
Degrees of Freedom	5	5	5	5	5	5
X Coefficient(s)	-50.4642	-46.9107	-23	18.28571	-46.4107	-45.4285
Std Err of Coef.	7.027987	5.536330	24.07428	20.26336	3.887045	5.576600

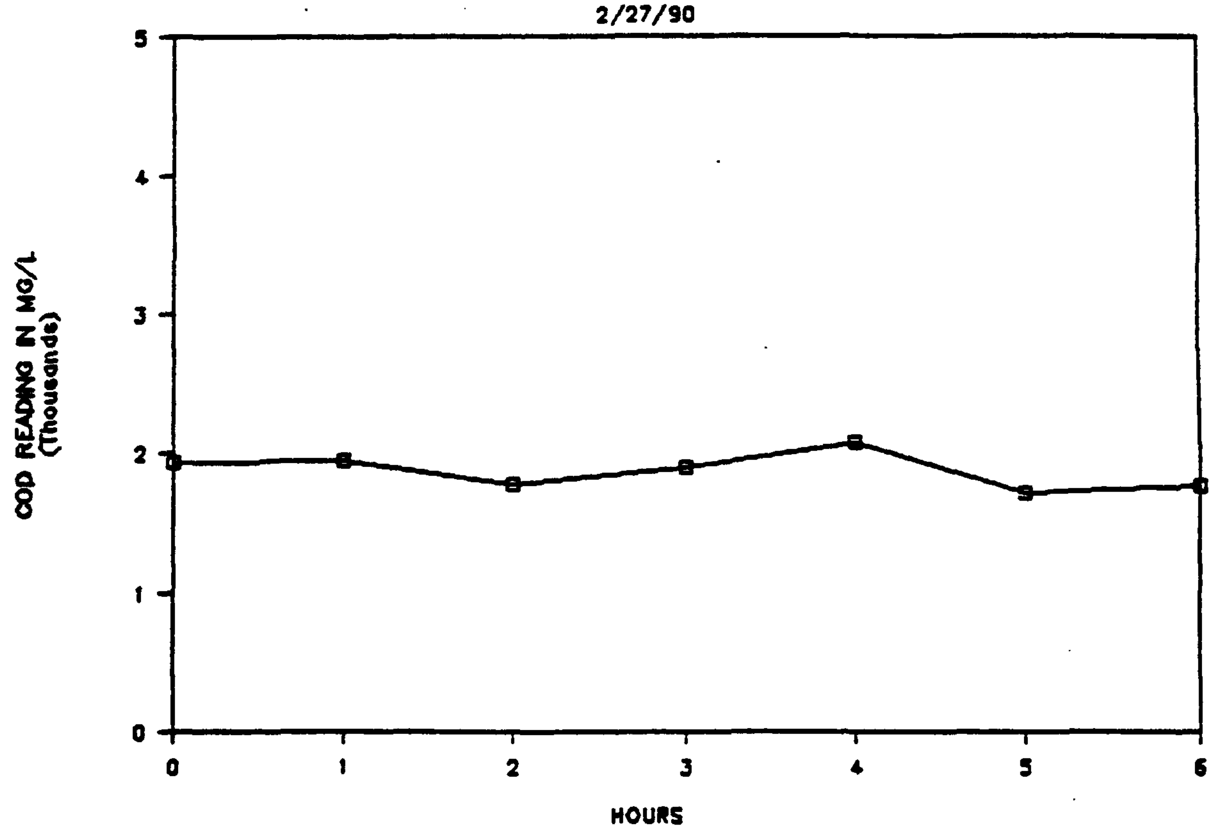
PATCLIN 126 HOT DIP, PATCLIN CHEMICAL

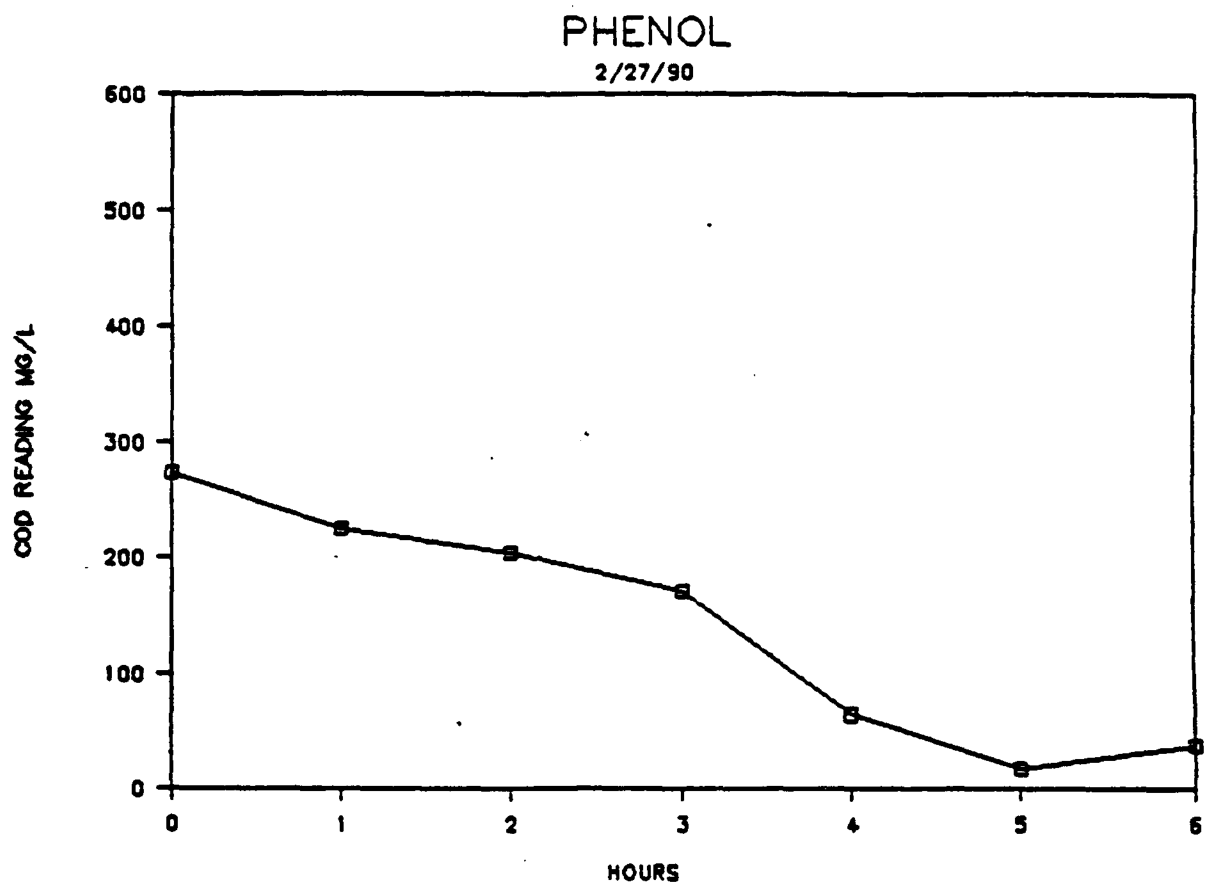
2/27/90



ENAMEL STRIPPER 77, INDUSTRIAL CHEMICAL

2/27/90




PHENOL
2/27/90
600
500
400
300
200
100
0
COD READING MG/L
0
1
2
3
4
5
6
HOURS

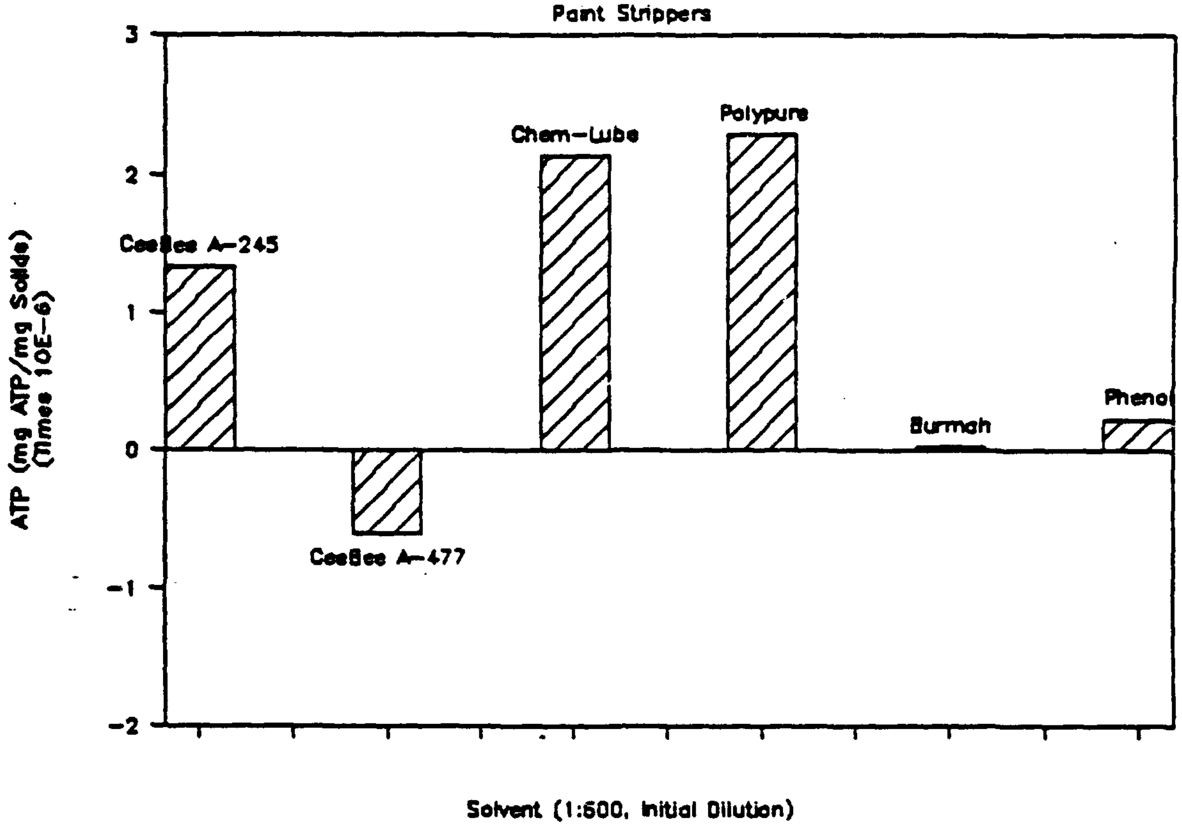
ATP DATA

Date: 2/28/90 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	0.9	421	0.925	422.500	3.41667	0.00440	
	0	0.95	424					
Bugs	0	161	567	166.500	576.500	0.4061	2.307E-06	
	0	172	586					
CeeBee A-245	0	173	553	157.500	556.000	0.3952	2.246E-06	
	0	142	559					
CeeBee A-477	0	158	545	154.500	556.500	0.3843	2.184E-06	
	0	151	568					
Chem-Lube	0	163	542	151.500	534.500	0.3956	2.248E-06	
	0	140	527					
Polypure	0	170	523	157.000	528.000	0.4232	2.404E-06	
	0	144	533					
Burmah	0	161	522	164.000	538.500	0.4379	2.488E-06	
	0	167	555					
Phenol	0	160	567	162.000	556.500	0.4106	2.333E-06	
	0	164	546					
Blank	5	2.61	465	2.415	456.500			
	5	2.22	448					
CeeBee A-245	6	275	681	265.500	686.500	0.6306	3.583E-06	1.3E-06
	6	256	692					
CeeBee A-477	6	106	537	113.000	519.000	0.2783	1.581E-06	-6.0E-07
	6	120	501					
Chem-Lube	6	291	641	280.000	643.000	0.7713	4.383E-06	2.1E-06
	6	26[illegible]	645					
Polypure	6	329	691	307.000	678.500	0.8264	4.695E-06	2.3E-06
	6	285	666					
Burmah	6	177	581	177.000	576.500	0.4431	2.517E-06	2.9E-08
	6	177	572					
Phenol	6	164	554	179.000	575.500	0.4514	2.565E-06	2.3E-07
	6	194	597					
Blank	6	7.04	401	6.910	411.500			
	6	6.78	422					

Solids dry wt. (g)	g/ml
0.1099	0.0044

Average	Blank	
Without	Standard	3.417
With	Standard	430.167

Wednesday's Columns ATP (2/28/90)



COD DATA

Date: 2/28/90

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	554	535.0	CeeBee A-245 (UF)	1	4904.0	4686.0
Bugs 0.1	0	516		CeeBee A-245 (UF)	1	4468	
Bugs 0.01	0	45	49.5	CeeBee A-245 (UF)	5	4852.0	4966.0
Bugs 0.01	0	54		CeeBee A-245 (UF)	5	5080	
CeeBee A-245	0	4124	4310.0	Chem-Lube	0	261	258.5
CeeBee A-245	0	4496		Chem-Lube	0	256	
CeeBee A-245	1	4020	4272.0	Chem-Lube	1	250	246.5
CeeBee A-245	1	4524		Chem-Lube	1	243	
CeeBee A-245	2	4132	4364.0	Chem-Lube	2	217	223.0
CeeBee A-245	2	4596		Chem-Lube	2	229	
CeeBee A-245	3	4156	4156.0	Chem-Lube	3	180	173.5
CeeBee A-245	3	4156		Chem-Lube	3	167	
CeeBee A-245	4	4328	4212.0	Chem-Lube	4	100	108.0
CeeBee A-245	4	4096		Chem-Lube	4	116	
CeeBee A-245	5	4592	4538.0	Chem-Lube	5	91	91.0
CeeBee A-245	5	4484		Chem-Lube	5	91	
CeeBee A-245	6	4820	4588.0	Chem-Lube	6	39	34.5
CeeBee A-245	6	4356		Chem-Lube	6	30	
CeeBee A-477	0	3204	3270.0	Polypure	0	265	260.0
CeeBee A-477	0	3336		Polypure	0	255	
CeeBee A-477	1	3092	3156.0	Polypure	1	250	259.0
CeeBee A-477	1	3220		Polypure	1	268	
CeeBee A-477	2	3228	3186.0	Polypure	2	223	220.0
CeeBee A-477	2	3144		Polypure	2	217	
CeeBee A-477	3	3128	3118.0	Polypure	3	169	171.5
CeeBee A-477	3	3108		Polypure	3	174	
CeeBee A-477	4	3168	3262.0	Polypure	4	112	102.5
CeeBee A-477	4	3356		Polypure	4	93	
CeeBee A-477	5	3412	3248.0	Polypure	5	63	40.0
CeeBee A-477	5	3084		Polypure	5	17	
CeeBee A-477	6	3384	3450.0	Polypure	6	54	57.5
CeeBee A-477	6	3516		Polypure	6	61	
Burmah	0	257	266.5	Phenol	0	269	274.0
Burmah	0	276		Phenol	0	279	
Burmah	1	257	258.5	Phenol	1	264	264.5
Burmah	1	260		Phenol	1	265	
Burmah	2	222	223.0	Phenol	2	228	227.5
Burmah	2	224		Phenol	2	227	
Burmah	3	188	194.5	Phenol	3	174	173.5
Burmah	3	201		Phenol	3	173	
Burmah	4	101	108.0	Phenol	4	102	98.0
Burmah	4	115		Phenol	4	94	
Burmah	5	27	36.5	Phenol	5	14	15.0
Burmah	5	46		Phenol	5	16	
Burmah	6	39	39.5	Phenol	6	62	52.5
Burmah	6	40		Phenol	6	43	

Standard	Hour	Reading	Average
0.10			218.50
0.10			
0.25			536.50
0.25			
Phenol			0.00
Phenol			

REGRESSION DATA

Date: 2/28/90

Sample	Hour	Average
CeeBee A-245	0	4310.0
CeeBee A-245	1	4272.0
CeeBee A-245	2	4364.0
CeeBee A-245	3	4156.0
CeeBee A-245	4	4212.0
CeeBee A-245	5	4538.0
CeeBee A-245	6	4588.0
CeeBee A-477	0	3270.0
CeeBee A-477	1	3156.0
CeeBee A-477	2	3186.0
CeeBee A-477	3	3118.0
CeeBee A-477	4	3262.0
CeeBee A-477	5	3248.0
CeeBee A-477	6	3450.0
Burmah	0	266.5
Burmah	1	258.5
Burmah	2	223.0
Burmah	3	194.5
Burmah	4	108.0
Burmah	5	36.5
Burmah	6	39.5
Chem-Lube	0	258.5
Chem-Lube	1	246.5
Chem-Lube	2	223.0
Chem-Lube	3	173.5
Chem-Lube	4	108.0
Chem-Lube	5	91.0
Chem-Lube	6	34.5
Polypure	0	260.0
Polypure	1	259.0
Polypure	2	220.0
Polypure	3	171.5
Polypure	4	102.5
Polypure	5	40.0
Polypure	6	57.5
Phenol	0	274.0
Phenol	1	264.5
Phenol	2	227.5
Phenol	3	173.5
Phenol	4	98.0
Phenol	5	15.0
Phenol	6	52.5

Regression Output: (CeeBee A-245)

Constant		4218.5
Std Err of Y Est		144.1514
R Squared		0.336257
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	43.35714	
Std Err of Coef.	27.24205	

Regression Output: (CeeBee A-477)

Constant		3155.714
Std Err of Y Est		97.50135
R Squared		0.324722
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	28.57142	
Std Err of Coef.	18.42602	

Regression Output: (Burmah)

Constant		293.7857
Std Err of Y Est		27.42235
R Squared		0.935918
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-44.2857	
Std Err of Coef.	5.182338	

Regression Output: (Chem-Lube)

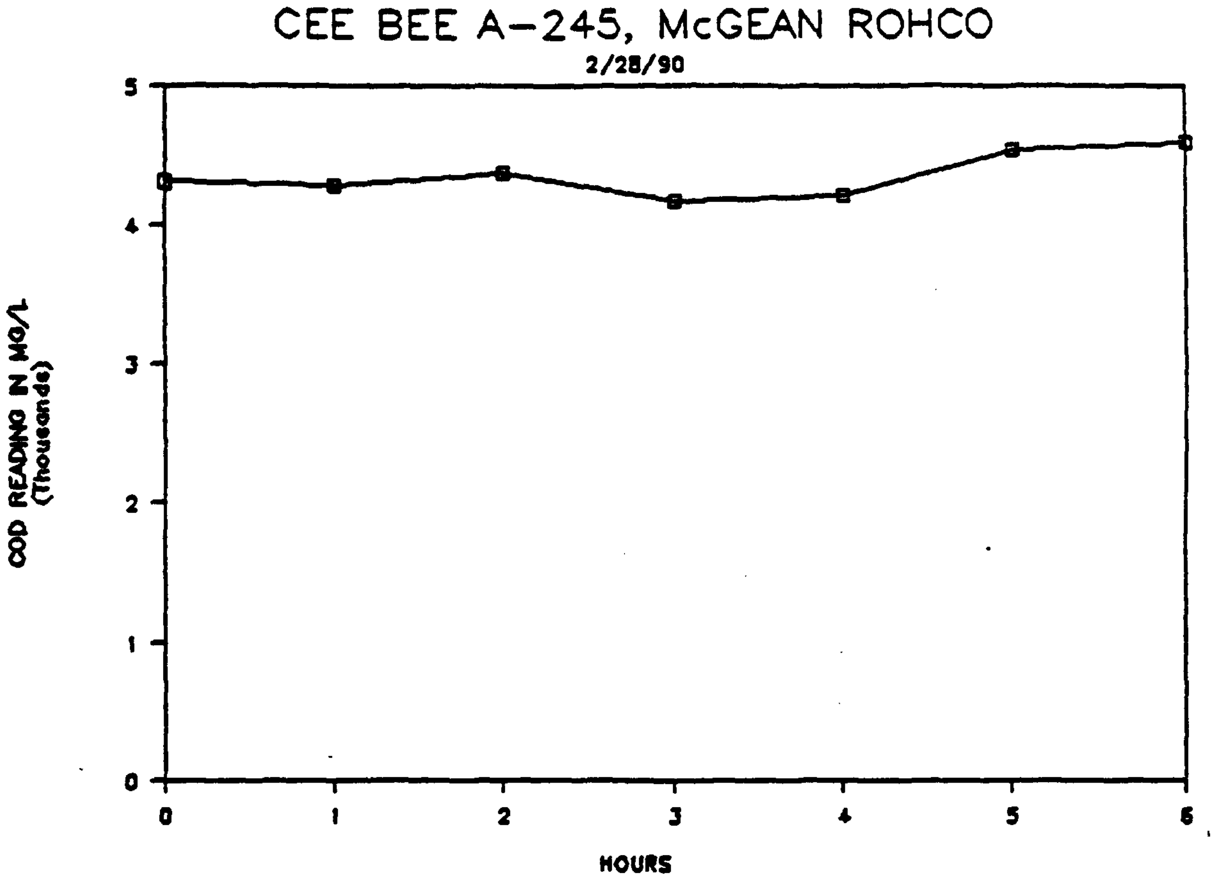
Constant		279.7857
Std Err of Y Est		17.09720
R Squared		0.967169
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-39.2142	
Std Err of Coef.	3.231067	

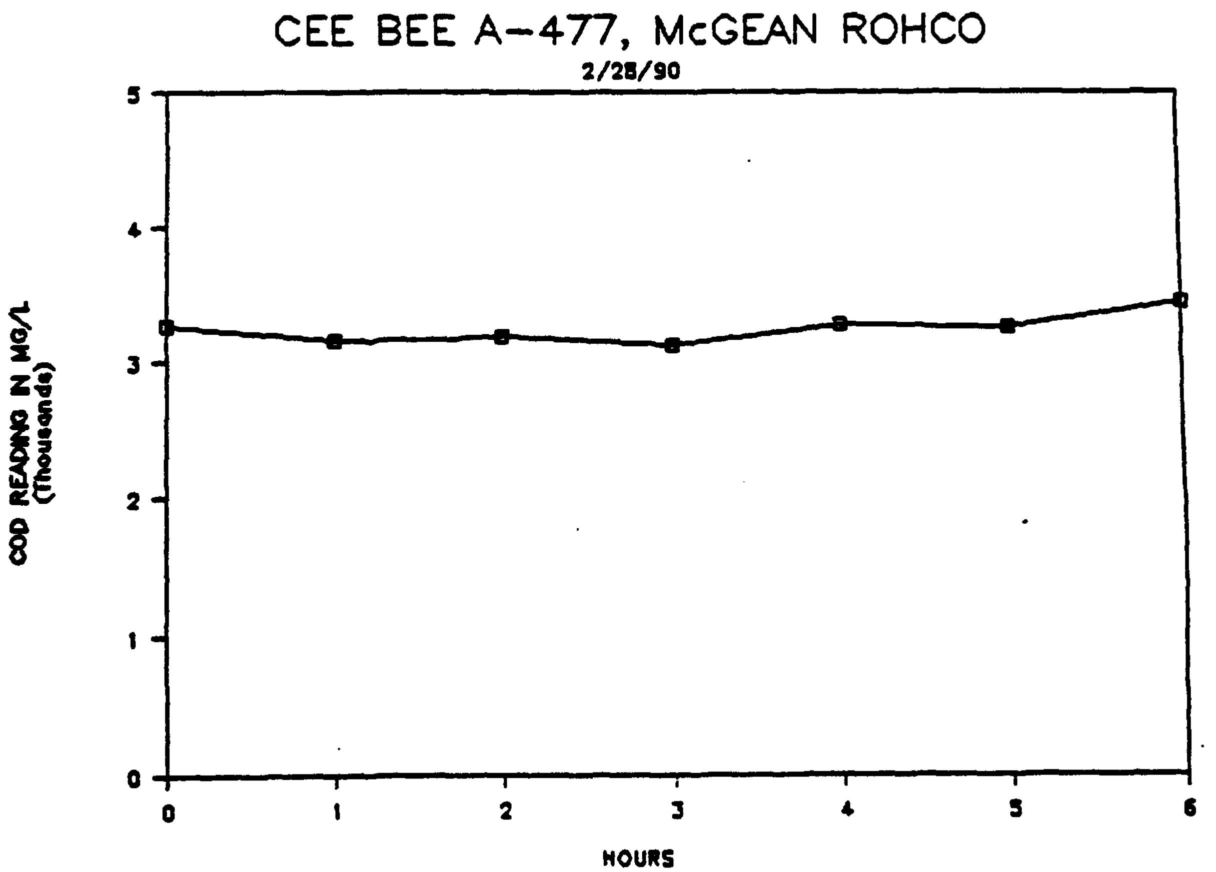
Regression Output: (Polypure)

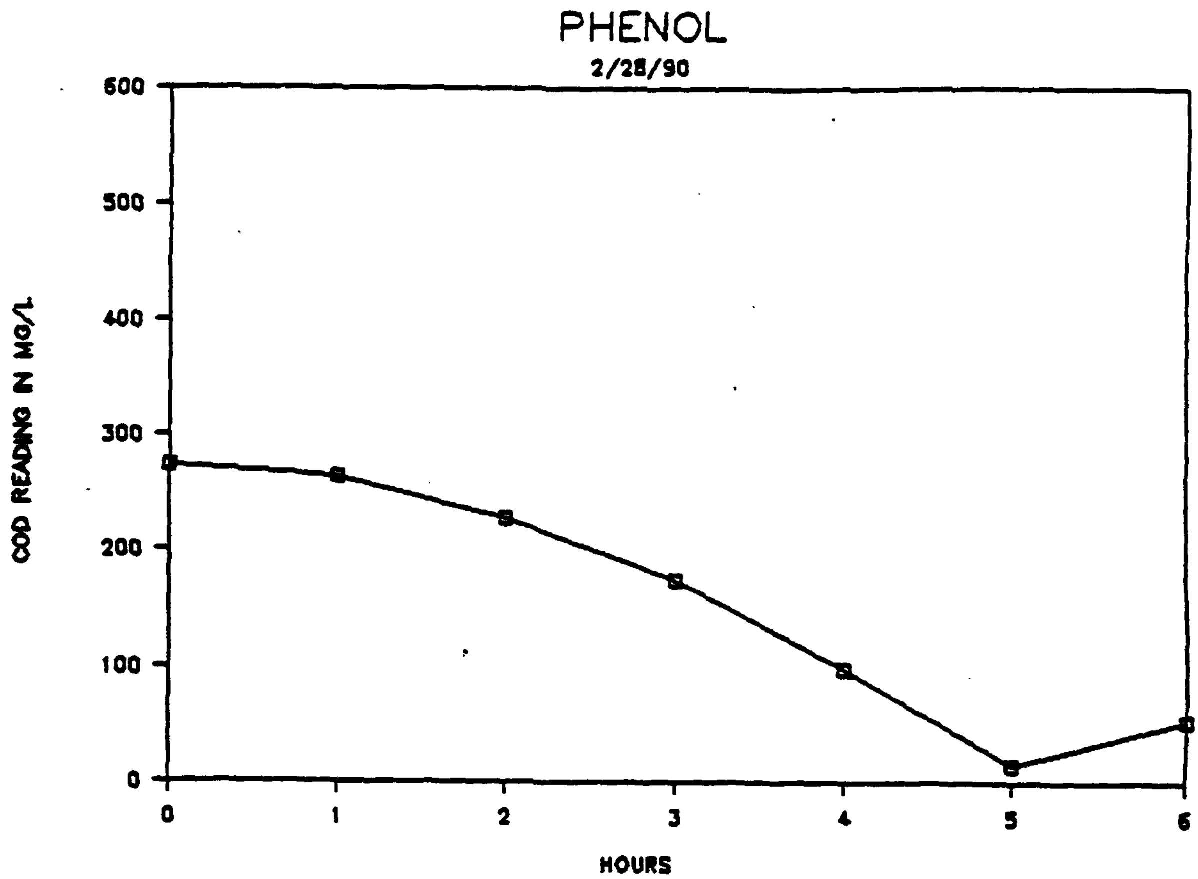
Constant		283.25
Std Err of Y Est		26.17946
R Squared		0.933759
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-41.5357	
Std Err of Coef.	4.947453	

Regression Output: (Phenol)

Constant		296.3928
Std Err of Y Est		32.67709
R Squared		0.917922
No. of Observations		7
Degrees of Freedom		5
X Coefficient(s)	-46.1785	
Std Err of Coef.	6.175391	


CEE BEE A-245, McGEAN ROHCO
2/28/90
COD READING IN MG/L
(Thousands)
HOURS
0
1
2
3
4
5
6


CEE BEE A-477, McGEAN ROHCO
2/28/90
COD READING IN MG/L
(Thousands)
HOURS
0
1
2
3
4
5
6

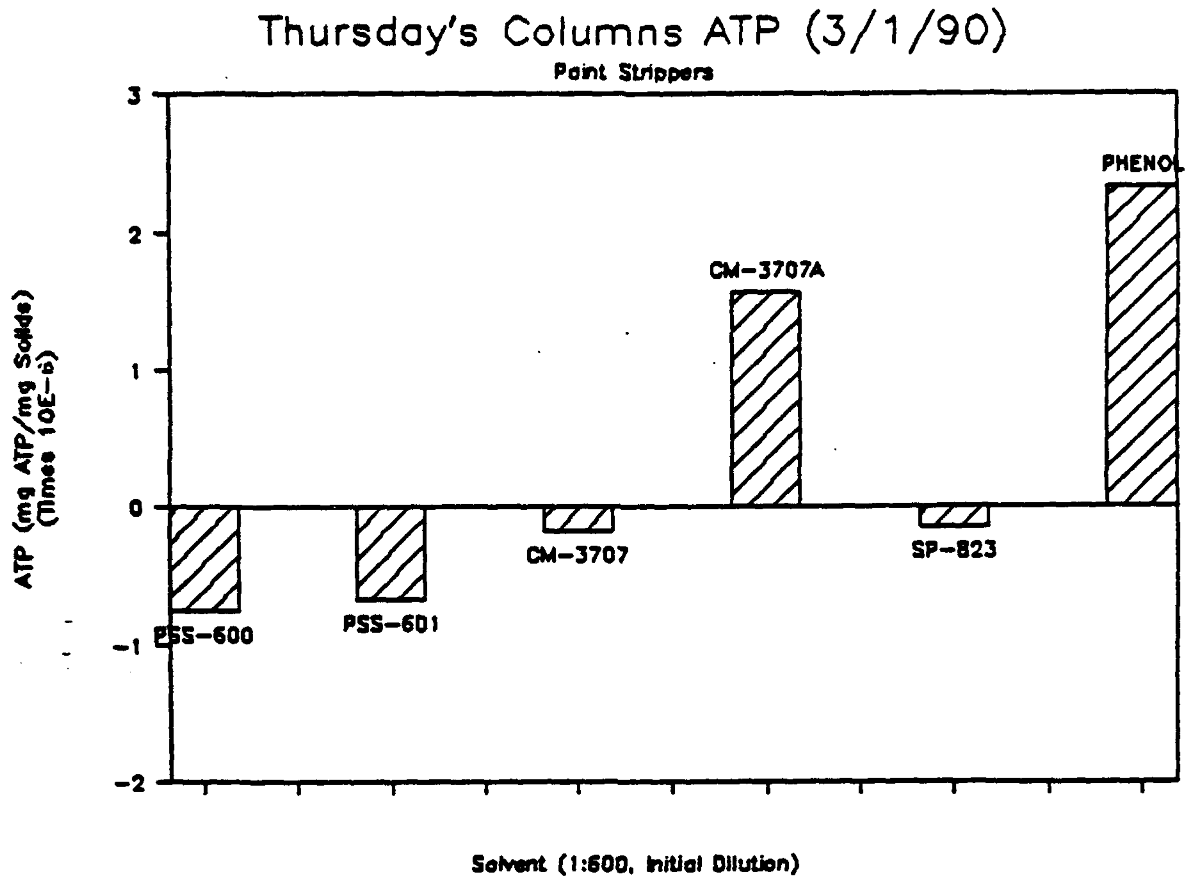

PHENOL
2/28/90
600
500
400
300
200
100
0
COD READING IN MG/L
0
1
2
3
4
5
6
HOURS

ATP DATA

Date: 3/1/90 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	1.56	412	1.515	412.500	1.42833	0.00450	
	0	1.47	413					
Bugs	0	170	563	162.500	571.500	0.3973	2.222E-06	
	0	155	580					
PSS-600	0	154	522	159.000	545.000	0.4119	2.304E-06	
	0	164	568					
PSS-601	0	189	565	167.000	569.000	0.4154	2.323E-06	
	0	145	573					
CN-3707	0	130	559	128.500	556.000	0.3006	1.681E-06	
	0	127	553					
CN-3707A	0	175	565	168.500	579.500	0.4100	2.293E-06	
	0	162	594					
SP-823	0	181	559	183.500	572.000	0.4723	2.642E-06	
	0	186	585					
PHENOL	0	175	541	174.500	530.500	0.4902	2.741E-06	
	0	174	520					
Blank	5	0.88	426	0.830	425.500			
	5	0.78	425					
PSS-600	6	124	526	119.500	549.500	0.2779	1.554E-06	-7.5E-07
	6	115	573					
PSS-601	6	117	485	114.000	499.500	0.2957	1.654E-06	-6.7E-07
	6	111	514					
CN-3707	6	103	522	110.000	518.000	0.2696	1.508E-06	-1.7E-07
	6	117	514					
CN-3707A	6	256	608	255.500	626.000	0.6896	3.857E-06	1.6E-06
	6	255	644					
SP-823	6	166	553	173.000	561.500	0.4453	2.491E-06	-1.5E-07
	6	180	570					
PHENOL	6	349	679	324.500	682.500	0.9064	5.069E-06	2.3E-06
	6	300	686					
Blank	6	2.09	391	1.940	397.500			
	6	1.79	404					

Solids dry wt.(g)	g/ml
0.1118	0.0045

Average	Blank	
Without	Standard	1.428
With	Standard	411.833



Thursday's Columns ATP (3/1/90)
Paint Strippers
ATP (mg ATP/mg Solids) (Times 10E-6)
3
2
1
0
-1
-2
PSS-600
PSS-601
CM-3707
CM-3707A
SP-823
PHENOL
Solvent (1:600, Initial Dilution)

COD DATA

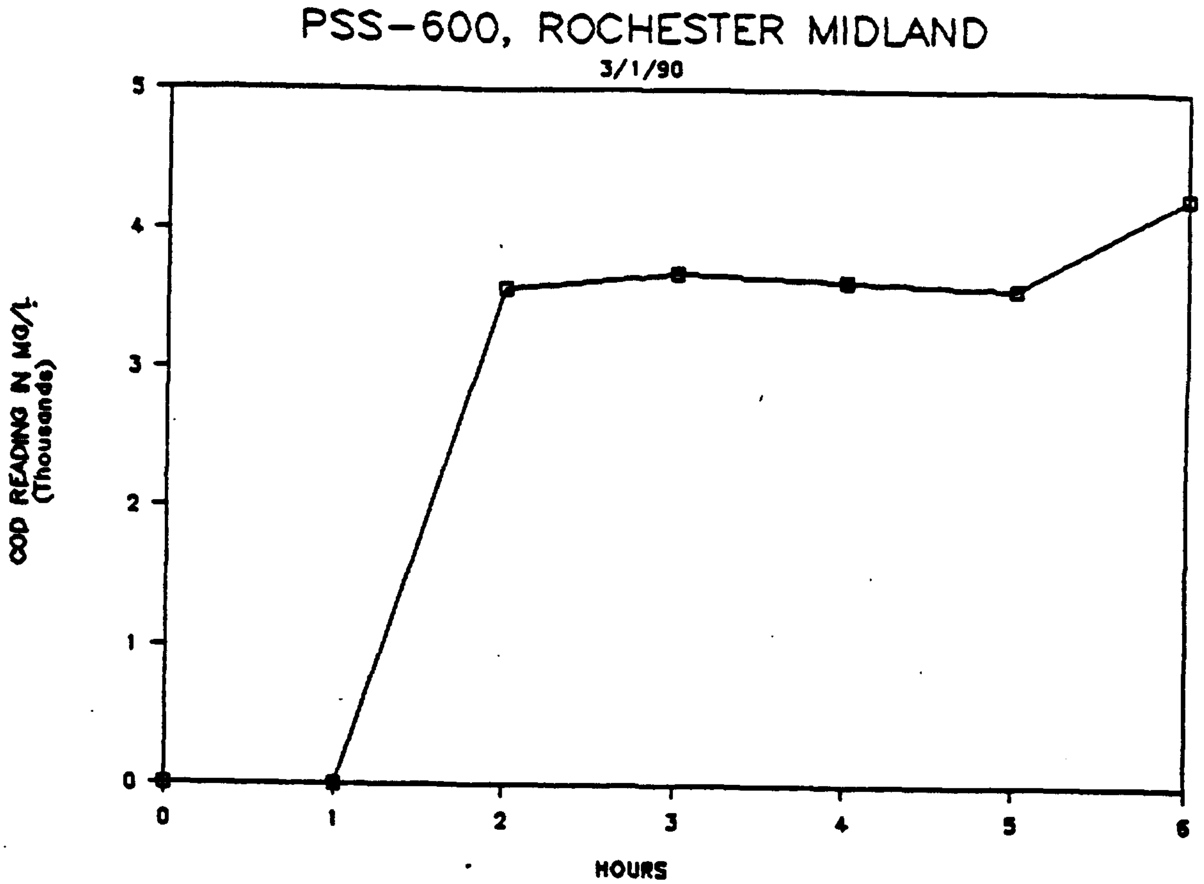
Date: 3/1/90

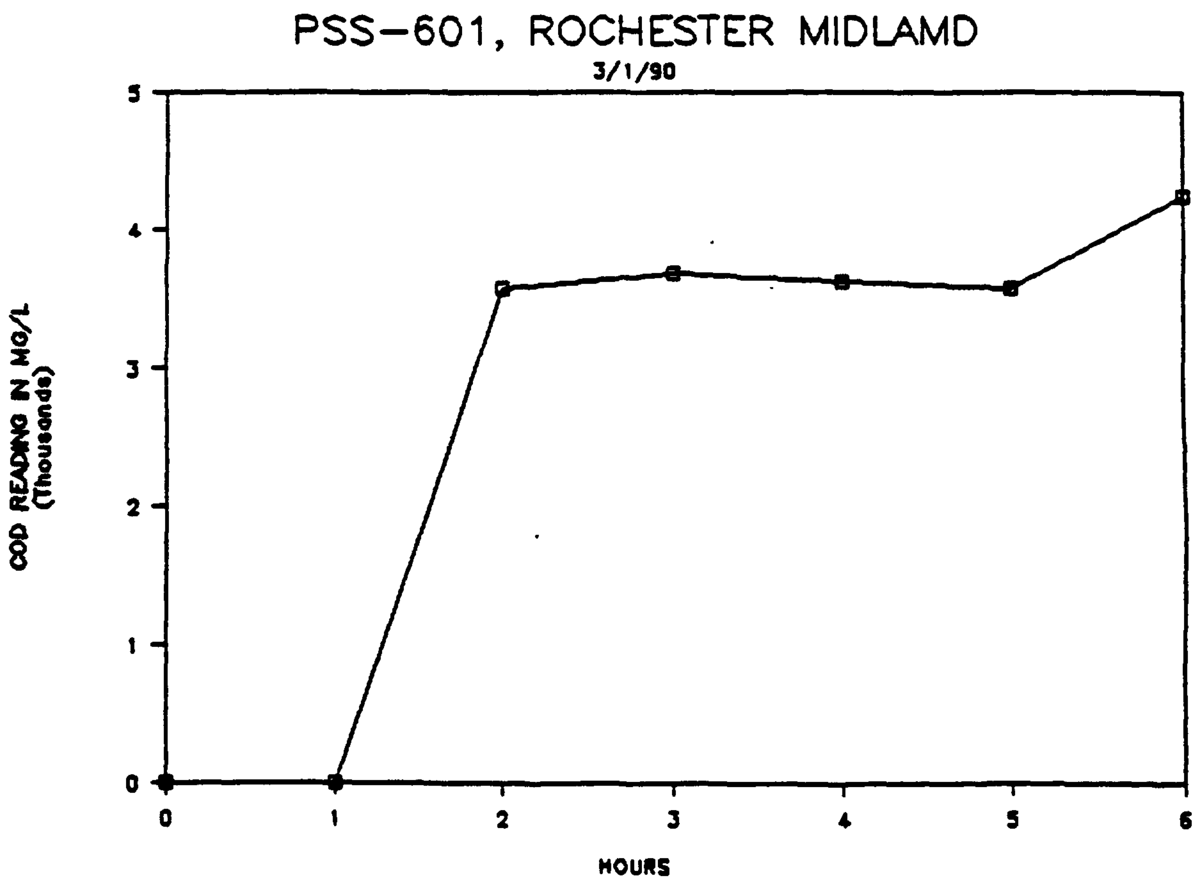
Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	537	535.0	PSS-600 (UF)	1	>1650	>1650
Bugs 0.1	0	533		PSS-600 (UF)	1	>1650	
Bugs 0.01	0	48	61.0	PSS-600 (UF)	5	3712.0	3928.0
Bugs 0.01	0	74		PSS-600 (UF)	5	4144	
CM-3707	0	3400	3416.0	PSS-600	0	>1650	>1650
CM-3707	0	3432		PSS-600	0	>1650	
CM-3707	1	3444	3490.0	PSS-600	1	>1650	>1650
CM-3707	1	3536		PSS-600	1	>1650	
CM-3707	2	3432	3440.0	PSS-600	2	3584	3570.0
CM-3707	2	3448		PSS-600	2	3556	
CM-3707	3	3440	3486.0	PSS-600	3	3760	3684.0
CM-3707	3	3532		PSS-600	3	3608	
CM-3707	4	3428	3464.0	PSS-600	4	3628	3618.0
CM-3707	4	3500		PSS-600	4	3608	
CM-3707	5	3428	3440.0	PSS-600	5	3432	3566.0
CM-3707	5	3452		PSS-600	5	3700	
CM-3707	6	3476	3528.0	PSS-600	6	3624	4242.0
CM-3707	6	3580		PSS-600	6	4860	
CM-3707A	0	4212	3892.0	PSS-601	0	6132	6132.0
CM-3707A	0	3572		PSS-601	0	6132	
CM-3707A	1	3416	3446.0	PSS-601	1	3360	3382.0
CM-3707A	1	3476		PSS-601	1	3404	
CM-3707A	2	3372	3478.0	PSS-601	2	>1650	>1650
CM-3707A	2	3584		PSS-601	2	>1650	
CM-3707A	3	3440	3462.0	PSS-601	3	3472	3468.0
CM-3707A	3	3484		PSS-601	3	3464	
CM-3707A	4	3524	3510.0	PSS-601	4	3468	3474.0
CM-3707A	4	3496		PSS-601	4	3480	
CM-3707A	5	3464	3428.0	PSS-601	5	3324	3274.0
CM-3707A	5	3392		PSS-601	5	3224	
CM-3707A	6	3492	3536.0	PSS-601	6	3224	3260.0
CM-3707A	6	3580		PSS-601	6	3296	
SP-823	0	3764	3566.0	Phenol	0	258	257.5
SP-823	0	3368		Phenol	0	257	
SP-823	1	3520	3436.0	Phenol	1	242	241.5
SP-823	1	3352		Phenol	1	241	
SP-823	2	3132	3214.0	Phenol	2	180	178.0
SP-823	2	3296		Phenol	2	176	
SP-823	3	3416	3370.0	Phenol	3	139	151.5
SP-823	3	3324		Phenol	3	164	
SP-823	4	3428	3424.0	Phenol	4	34	35.0
SP-823	4	3420		Phenol	4	36	
SP-823	5	3276	3306.0	Phenol	5	9	10.5
SP-823	5	3336		Phenol	5	12	
SP-823	6	3440	3456.0	Phenol	6	40	39.0
SP-823	6	3472		Phenol	6	38	
Standard							
0.10		181	198.00				
0.10		215					
0.25		526	522.50				
0.25		519					
Phenol			0.00				
Phenol							

REGRESSION DATA

Date: 3/1/90

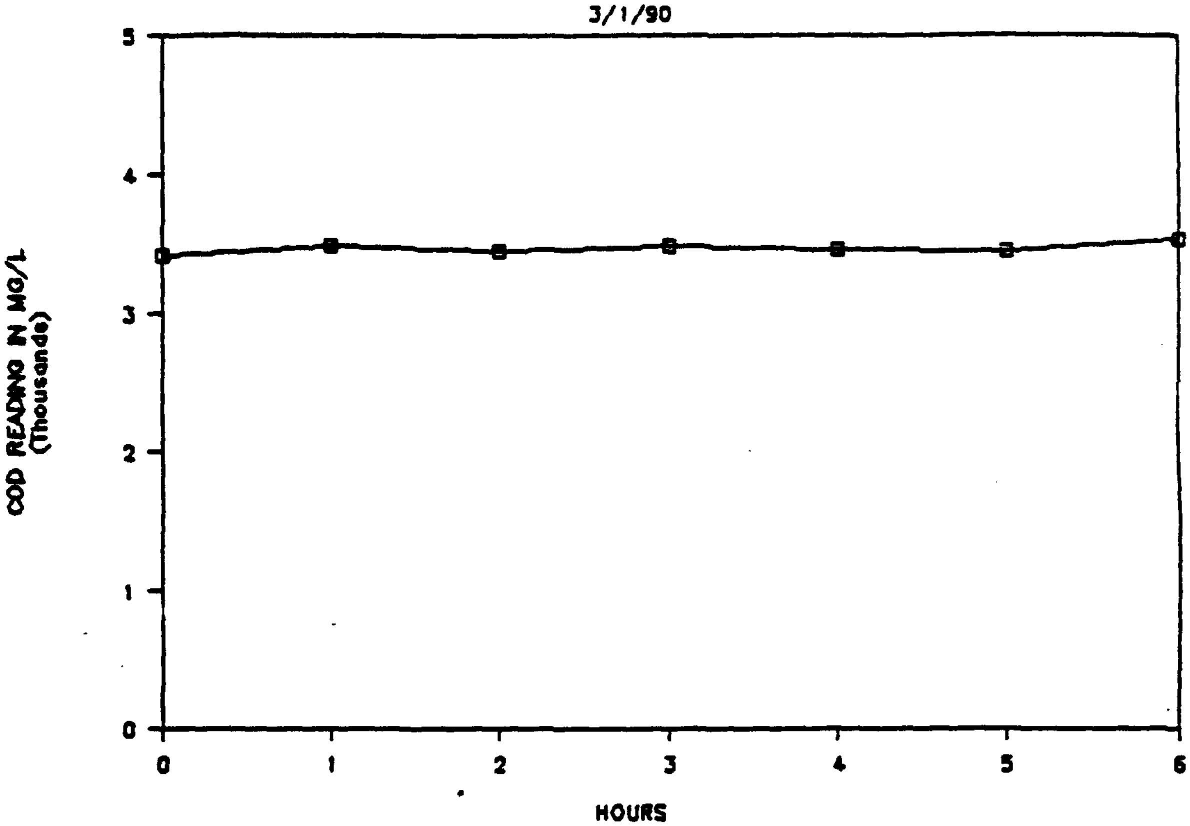
Sample	Hour	Average		
CH-3707	0	3416.0	Regression Output:	
CH-3707	1	3490.0	Constant	3438.428
CH-3707	2	3440.0	Std Err of Y Est	35.38684
CH-3707	3	3486.0	R Squared	0.278290
CH-3707	4	3464.0	No. of Observations	7
CH-3707	5	3440.0	Degrees of Freedom	5
CH-3707	6	3528.0		
			X Coefficient(s) 9.285714	
			Std Err of Coef. 6.687484	
CH-3707A	0	3892.0	Regression Output:	
CH-3707A	1	3446.0	Constant	3650.857
CH-3707A	2	3478.0	Std Err of Y Est	151.6401
CH-3707A	3	3462.0	R Squared	0.263064
CH-3707A	4	3510.0	No. of Observations	7
CH-3707A	5	3428.0	Degrees of Freedom	5
CH-3707A	6	3536.0		
			X Coefficient(s) -38.2857	
			Std Err of Coef. 28.65729	
PSS-600	0	0.0	Regression Output:	
PSS-600	1	0.0	Constant	535.7857
PSS-600	2	3570.0	Std Err of Y Est	1106.068
PSS-600	3	3684.0	R Squared	0.698207
PSS-600	4	3618.0	No. of Observations	7
PSS-600	5	3566.0	Degrees of Freedom	5
PSS-600	6	4242.0		
			X Coefficient(s) 710.9285	
			Std Err of Coef. 209.0273	
PSS-601	0	6132.0	Regression Output:	
PSS-601	1	3382.0	Constant	3858.357
PSS-601	2	0.0	Std Err of Y Est	1894.766
PSS-601	3	3468.0	R Squared	0.054030
PSS-601	4	3474.0	No. of Observations	7
PSS-601	5	3274.0	Degrees of Freedom	5
PSS-601	6	3260.0		
			X Coefficient(s) -191.357	
			Std Err of Coef. 358.0772	
SP-823	0	3566.0	Regression Output:	
SP-823	1	3436.0	Constant	3436.714
SP-823	2	3214.0	Std Err of Y Est	119.6886
SP-823	3	3370.0	R Squared	0.067164
SP-823	4	3424.0	No. of Observations	7
SP-823	5	3306.0	Degrees of Freedom	5
SP-823	6	3456.0		
			X Coefficient(s) -13.5714	
			Std Err of Coef. 22.61902	
Phenol	0	257.5	Regression Output:	
Phenol	1	241.5	Constant	265.4821
Phenol	2	178.0	Std Err of Y Est	35.48155
Phenol	3	151.5	R Squared	0.900146
Phenol	4	35.0	No. of Observations	7
Phenol	5	10.5	Degrees of Freedom	5
Phenol	6	39.0		
			X Coefficient(s) -45.0178	
			Std Err of Coef. 6.705384	


PSS-600, ROCHESTER MIDLAND
3/1/90
COD READING IN MG/L
(Thousands)
HOURS
0
1
2
3
4
5
6


PSS-601, ROCHESTER MIDLAMD
3/1/90
COD READING IN MG/L
(Thousands)
HOURS
0
1
2
3
4
5
6

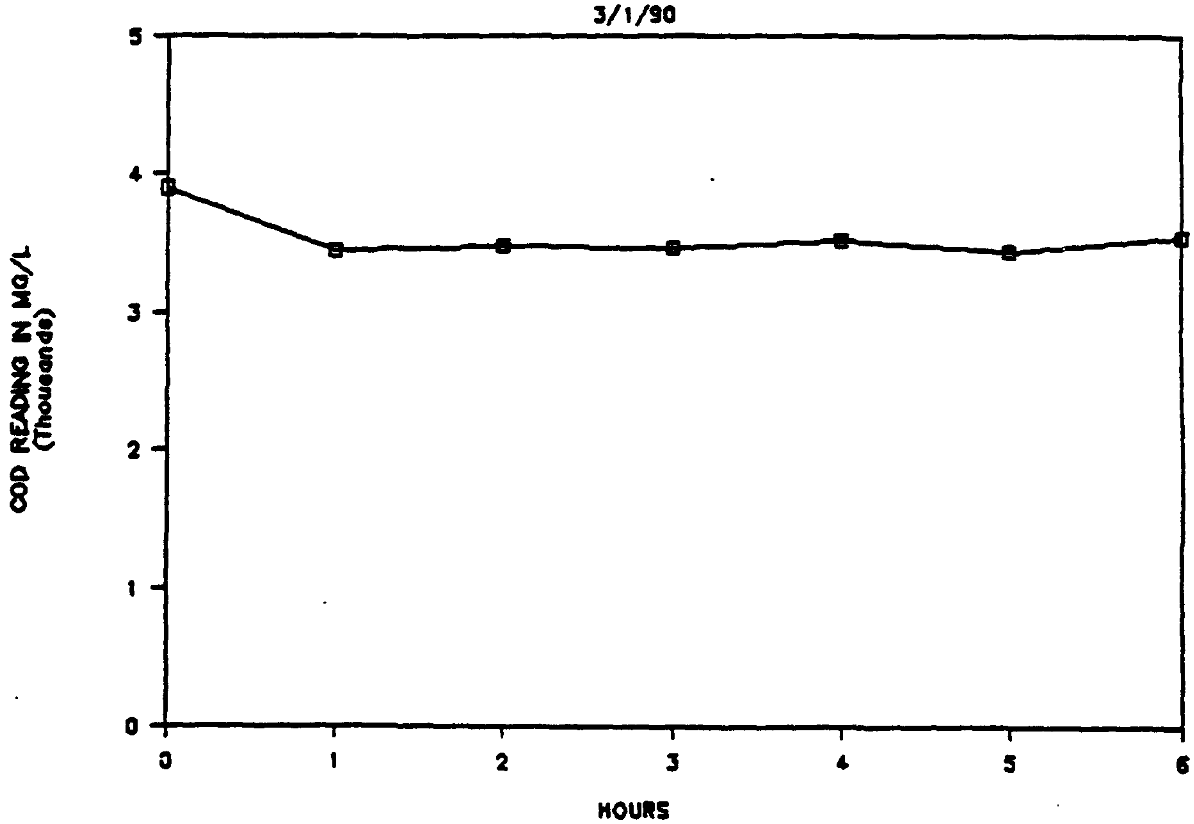
CM-3707, CHEMICAL METHODS

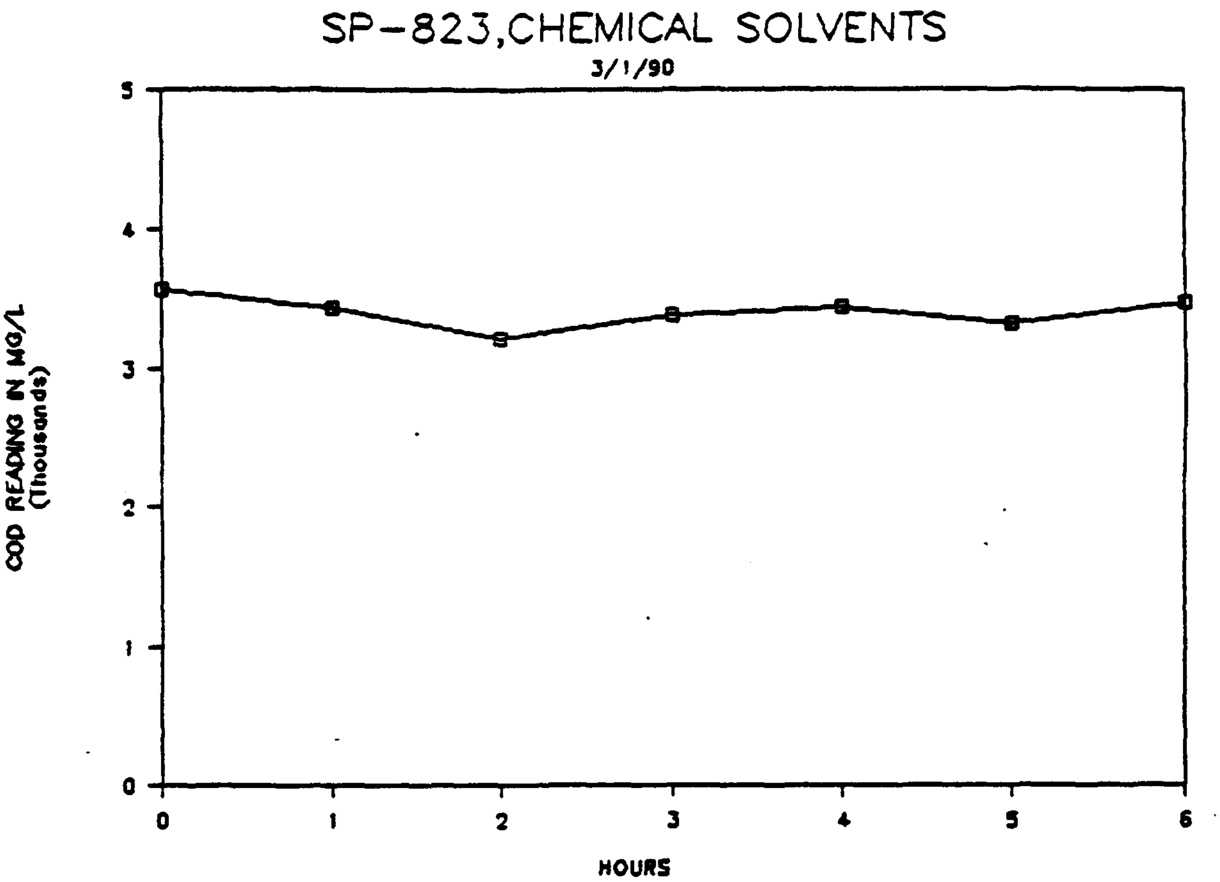
3/1/90

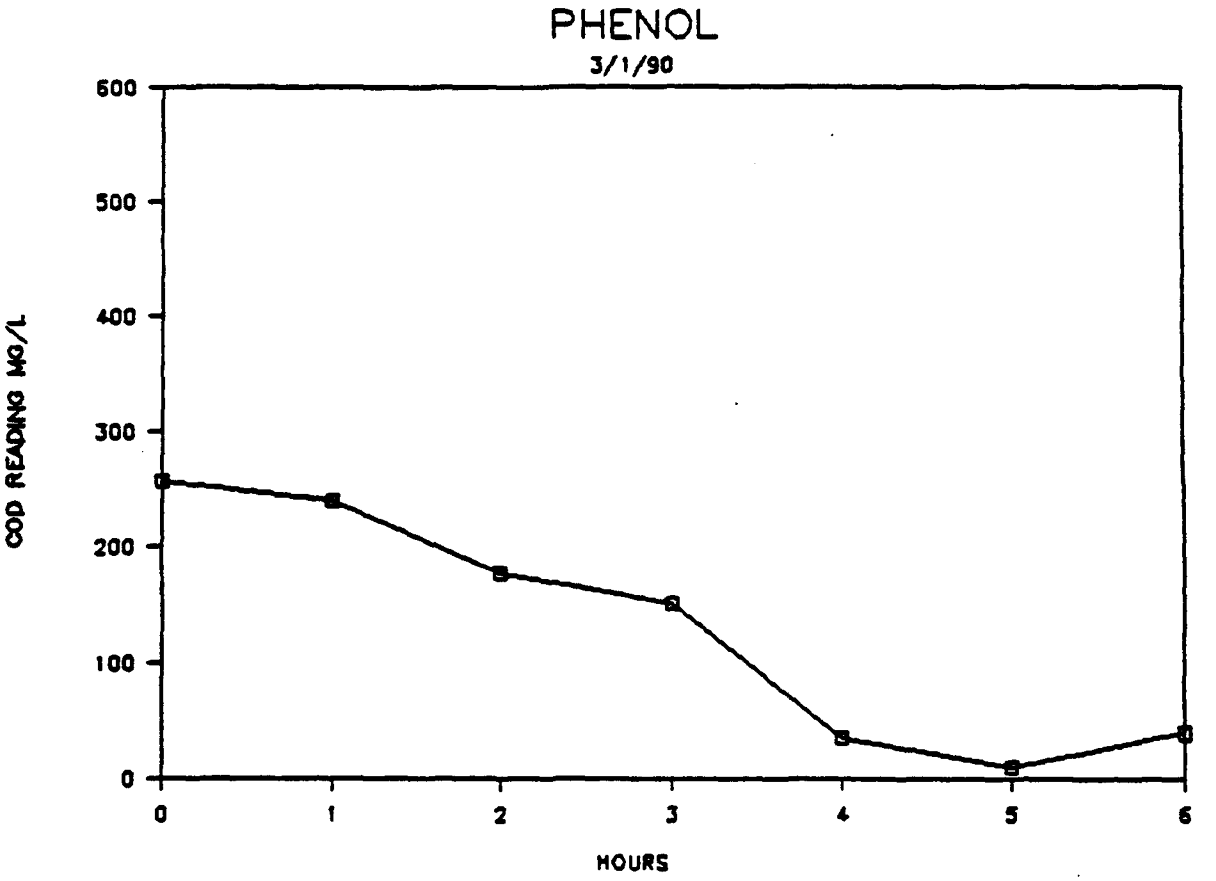


CM-3707A, CHEMICAL METHODS

3/1/90




SP-823,CHEMICAL SOLVENTS
3/1/90
COD READING IN MG/L
(Thousands)
HOURS
0
1
2
3
4
5
6


PHENOL
3/1/90
COD READING MG/L
HOURS
0
100
200
300
400
500
600
1
2
3
4
5
6

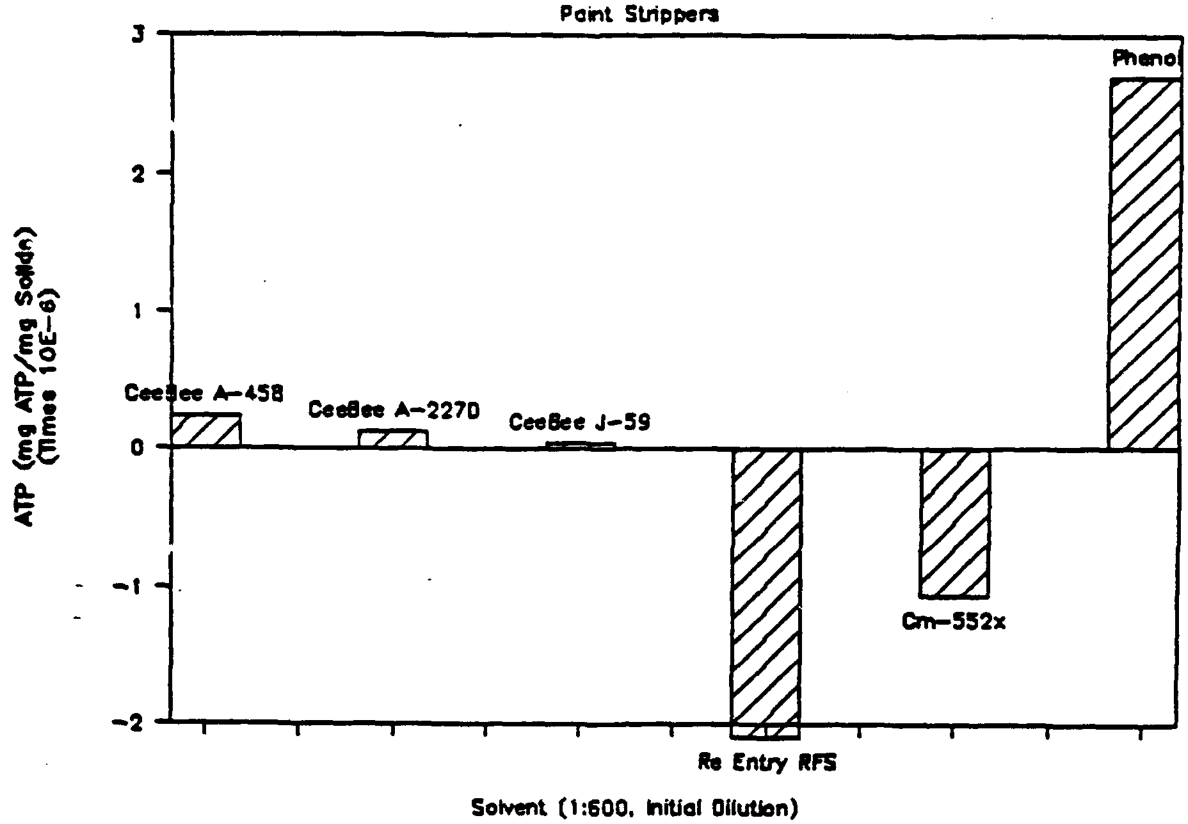
ATP DATA

Date: 3/5/90 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank) (RIS-RU)	mg ATP mg Solids	Change in ATP
Blank	0	5.38	407	5.700	413.500	3.88833	0.00460	
	0	6.02	420					
Bugs	0	147	552	154.500	564.500	0.3768	2.030E-06	
	0	162	577					
CeeBee A-458	0	141	586	157.500	552.500	0.3987	2.148E-06	
	0	174	519					
CeeBee A-227D	0	242	612	215.000	593.500	0.5680	3.060E-06	
	0	188	575					
CEeBee J-59	0	180	516	163.500	497.000	0.4902	2.641E-06	
	0	147	478					
Re Entry RFS	0	143	483	140.500	480.000	0.4138	2.230E-06	
	0	138	477					
CM-552x	0	61.1	367	62.600	358.000	0.2119	1.142E-06	
	0	64.1	349					
Phenol	0	118	439	122.500	451.000	0.3729	2.009E-06	
	0	127	463					
Blank	5	3.93	382	3.850	387.500			
	5	3.77	393					
CeeBee A-458	6	166	589	178.500	582.000	0.4424	2.383E-06	2.4E-07
	6	191	575					
CeeBee A-227D	6	253	696	258.000	694.500	0.5911	3.185E-06	1.2E-07
	6	263	693					
CeeBee J-59	6	200	548	192.500	578.000	0.4993	2.690E-06	4.9E-08
	6	185	608					
Re Entry RFS	6	9.9	384	10.600	379.500	0.0287	1.547E-07	-2.1E-06
	6	11.3	375					
CM-552x	6	4.51	309	4.675	304.500	0.0156	8.393E-08	-1.1E-06
	6	4.84	300					
Phenol	6	380	837	386.000	827.000	0.8753	4.716E-06	2.7E-06
	6	392	817					
Blank	6	2.18	403	2.115	416.000			
	6	2.05	429					

Solids dry wt. (g)	g/ml
0.1159	0.0046

Average	Blank	
Without	Standard	3.888
With	Standard	405.667

Monday's Columns ATP (3/5/90)



COD DATA

Date: 3/5/90

Sample	Hour	Reading	Average
Bugs 0.1	0	591	601.5
Bugs 0.1	0	612	
Bugs 0.01	0	54	60.0
Bugs 0.01	0	66	
CeeBee A-227D	0	2140	2140.0
CeeBee A-227D	0	2140	
CeeBee A-227D	1	1932	1932.0
CeeBee A-227D	1	1932	
CeeBee A-227D	2	1884	1890.0
CeeBee A-227D	2	1896	
CeeBee A-227D	3	2004	1978.0
CeeBee A-227D	3	1952	
CeeBee A-227D	4	2008	1964.0
CeeBee A-227D	4	1920	
CeeBee A-227D	5	1760	1782.0
CeeBee A-227D	5	1804	
CeeBee A-227D	6	1720	1742.0
CeeBee A-227D	6	1764	
CeeBee A-458	0	744	736.0
CeeBee A-458	0	728	
CeeBee A-458	1	668	668.0
CeeBee A-458	1	668	
CeeBee A-458	2	584	568.0
CeeBee A-458	2	552	
CeeBee A-458	3	536	542.0
CeeBee A-458	3	548	
CeeBee A-458	4	524	532.0
CeeBee A-458	4	540	
CeeBee A-458	5	564	518.0
CeeBee A-458	5	472	
CeeBee A-458	6	284	290.0
CeeBee A-458	6	296	
CH-552x	0		ERR
CH-552x	0		
CH-552x	1	2670	2805.0
CH-552x	1	2940	
CH-552x	2	2790	2825.0
CH-552x	2	2860	
CH-552x	3	2810	2827.5
CH-552x	3	2845	
CH-552x	4	3200	3052.5
CH-552x	4	2905	
CH-552x	5	2780	2785.0
CH-552x	5	2790	
CH-552x	6	3080	3052.5
CH-552x	6	3025	
Standard			
0.10			213.50
0.10			
0.25			527.00
0.25			
Phenol			0.00
Phenol			

Sample	Hour	Reading	Average
CeeBee A-458 (UF)	1	1280.0	1256.0
CeeBee A-458 (UF)	1	1232	
CeeBee A-458 (UF)	5	1032.0	928.0
CeeBee A-458 (UF)	5	824	
CeeBee J-59	0	940	956.0
CeeBee J-59	0	972	
CeeBee J-59	1	1088	1118.0
CeeBee J-59	1	1148	
CeeBee J-59	2	1160	1072.0
CeeBee J-59	2	984	
CeeBee J-59	3	1044	1044.0
CeeBee J-59	3	1044	
CeeBee J-59	4	1072	1058.0
CeeBee J-59	4	1044	
CeeBee J-59	5	800	830.0
CeeBee J-59	5	860	
CeeBee J-59	6	1000	1012.0
CeeBee J-59	6	1024	
Re Entry RFS	0	828	830.0
Re Entry RFS	0	832	
Re Entry RFS	1	1810	1780.0
Re Entry RFS	1	1750	
Re Entry RFS	2	1708	1744.0
Re Entry RFS	2	1780	
Re Entry RFS	3	1894	1867.0
Re Entry RFS	3	1840	
Re Entry RFS	4	1862	1804.0
Re Entry RFS	4	1746	
Re Entry RFS	5	1732	1715.0
Re Entry RFS	5	1698	
Re Entry RFS	6	1790	1804.0
Re Entry RFS	6	1818	
Phenol	0	270	265.0
Phenol	0	260	
Phenol	1	234	233.5
Phenol	1	233	
Phenol	2	196	197.0
Phenol	2	198	
Phenol	3	79	79.0
Phenol	3	79	
Phenol	4	38	33.5
Phenol	4	29	
Phenol	5	0	0.0
Phenol	5	0	
Phenol	6	25	26.0
Phenol	6	27	

REGRESSION DATA

Date: 3/5/90

Sample	Hour	Average
CeeBee A-227D	0	2140.0
CeeBee A-227D	1	1932.0
CeeBee A-227D	2	1890.0
CeeBee A-227D	3	1978.0
CeeBee A-227D	4	1964.0
CeeBee A-227D	5	1782.0
CeeBee A-227D	6	1742.0

Regression Output:	
Constant	2070.428
Std Err of Y Est	81.77669
R Squared	0.682914
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-50.7142
Std Err of Coef.	15.45434

Sample	Hour	Average
CeeBee A-458	0	736.0
CeeBee A-458	1	668.0
CeeBee A-458	2	568.0
CeeBee A-458	3	542.0
CeeBee A-458	4	532.0
CeeBee A-458	5	518.0
CeeBee A-458	6	290.0

Regression Output:	
Constant	729.9285
Std Err of Y Est	59.61950
R Squared	0.849199
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-59.7857
Std Err of Coef.	11.26702

Sample	Hour	Average
CH-552x	0	ERR
CH-552x	1	2805.0
CH-552x	2	2825.0
CH-552x	3	2827.5
CH-552x	4	3052.5
CH-552x	5	2785.0
CH-552x	6	3052.5

Regression Output:	
Constant	2757
Std Err of Y Est	115.5823
R Squared	0.325155
No. of Observations	6
Degrees of Freedom	4
X Coefficient(s)	38.35714
Std Err of Coef.	27.62947

Sample	Hour	Average
CeeBee J-59	0	956.0
CeeBee J-59	1	1118.0
CeeBee J-59	2	1072.0
CeeBee J-59	3	1044.0
CeeBee J-59	4	1058.0
CeeBee J-59	5	830.0
CeeBee J-59	6	1012.0

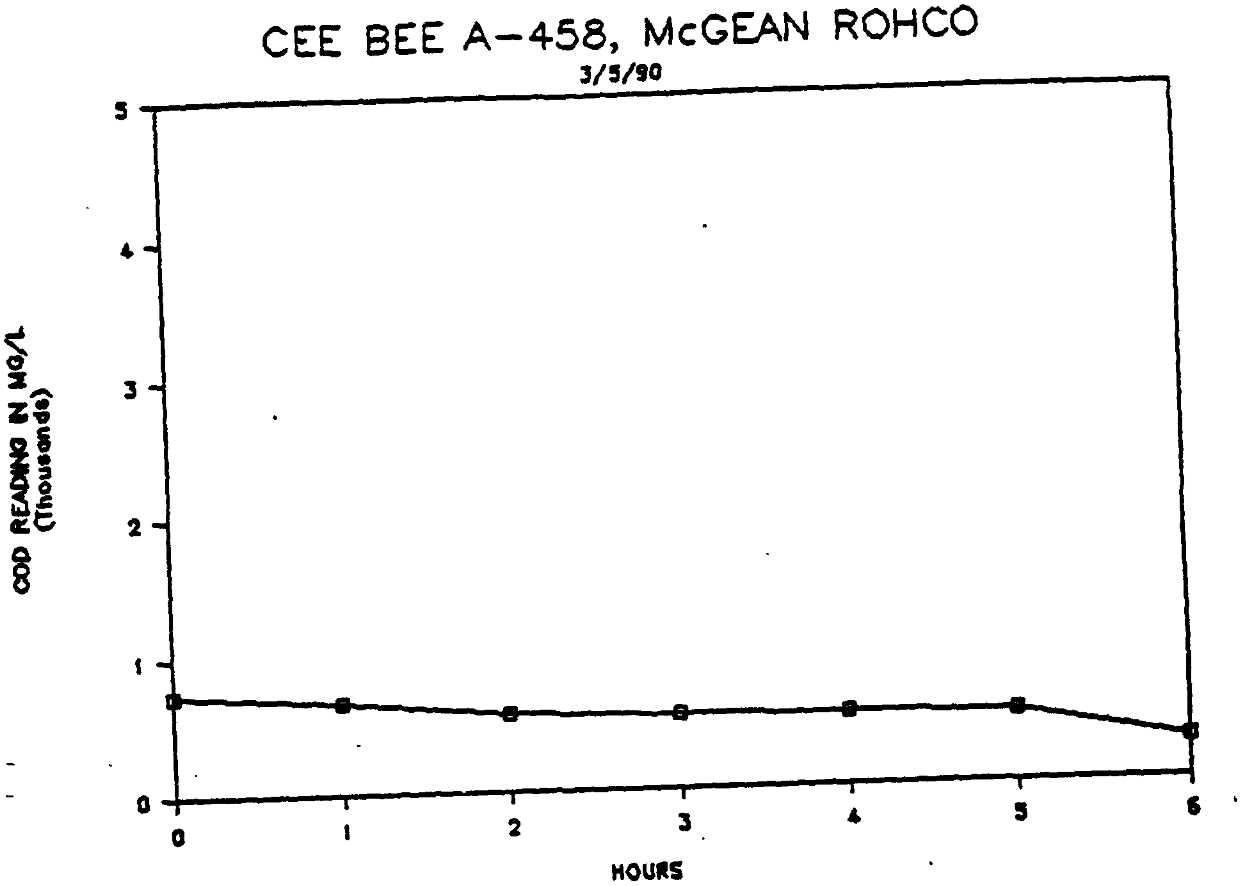
Regression Output:	
Constant	1058.071
Std Err of Y Est	97.84754
R Squared	0.117279
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-15.0714
Std Err of Coef.	18.49144

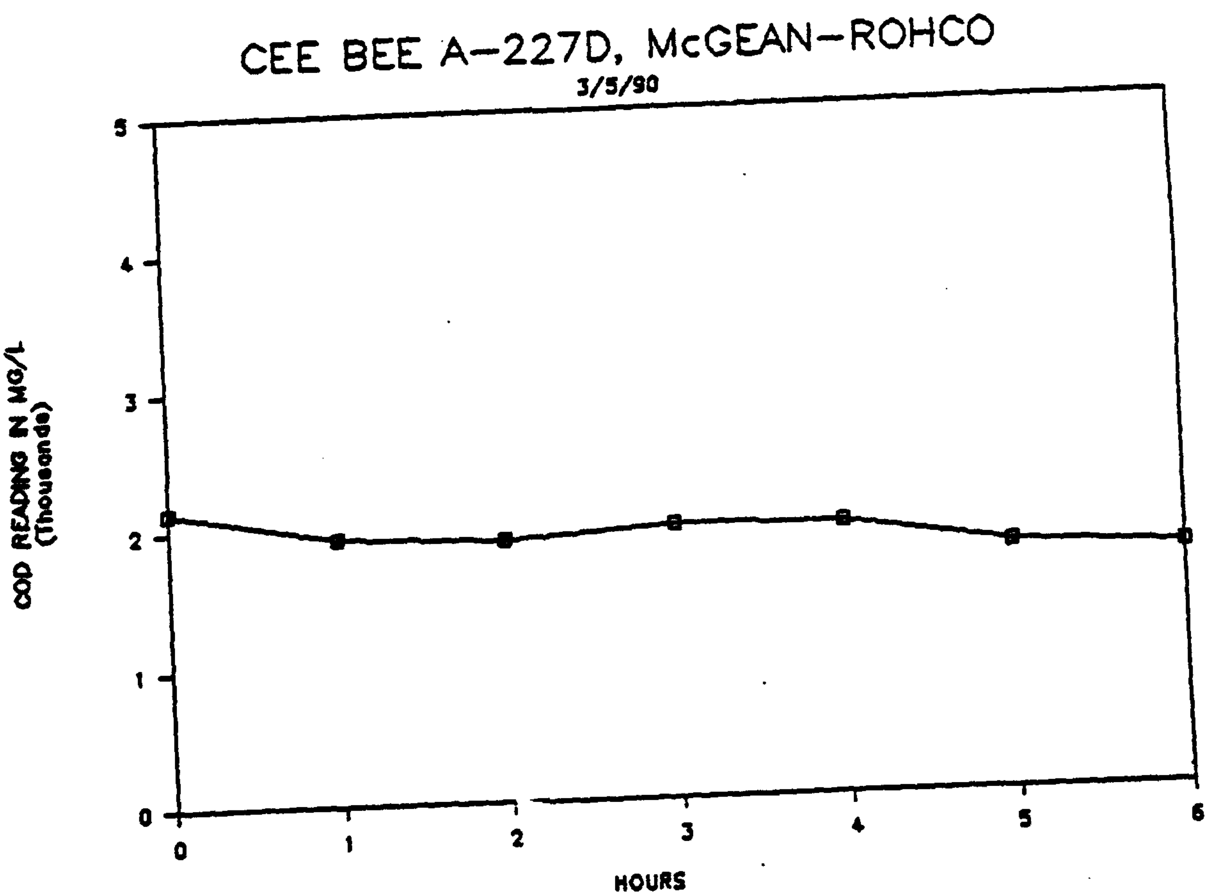
Sample	Hour	Average
Re Entry RFS	0	830.0
Re Entry RFS	1	1780.0
Re Entry RFS	2	1744.0
Re Entry RFS	3	1867.0
Re Entry RFS	4	1804.0
Re Entry RFS	5	1715.0
Re Entry RFS	6	1804.0

Regression Output:	
Constant	1343.571
Std Err of Y Est	318.2389
R Squared	0.364543
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	101.8571
Std Err of Coef.	60.14151

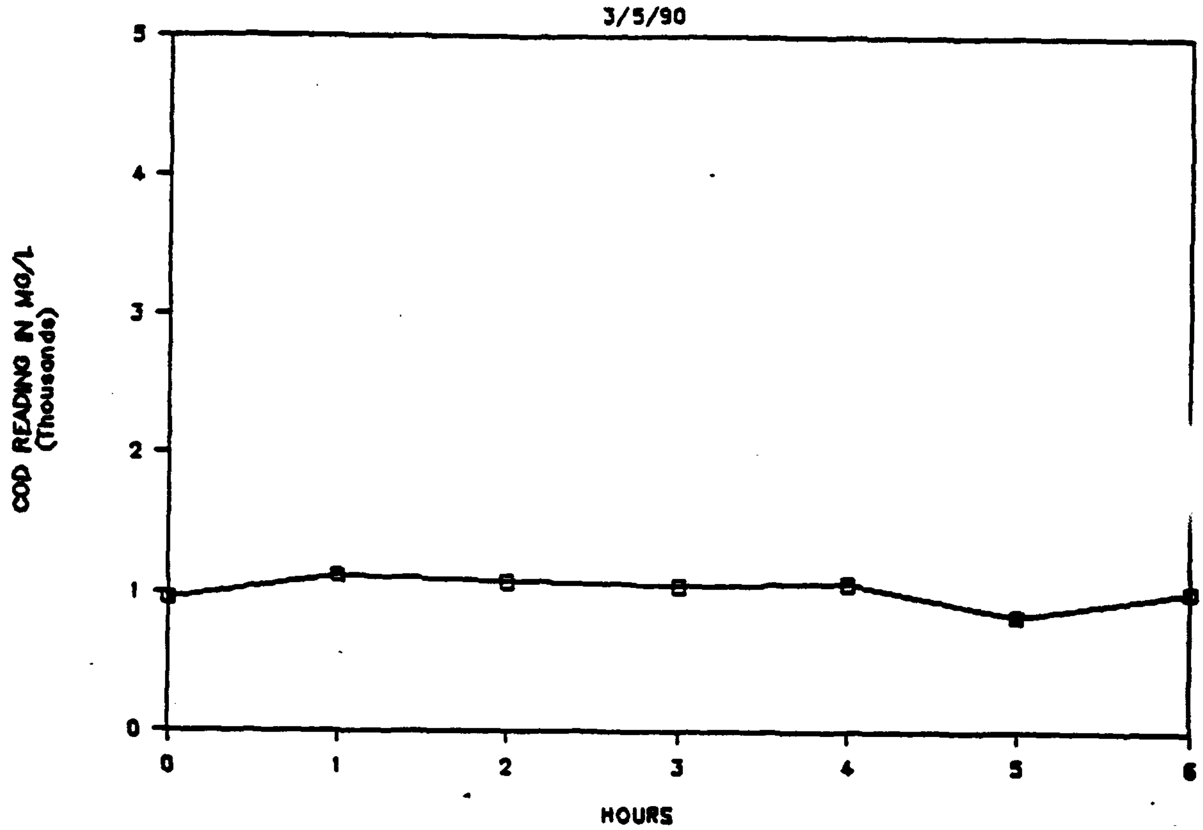
Sample	Hour	Average
Phenol	0	265.0
Phenol	1	233.5
Phenol	2	197.0
Phenol	3	79.0
Phenol	4	33.5
Phenol	5	0.0
Phenol	6	26.0

Regression Output:	
Constant	263.5178
Std Err of Y Est	38.42374
R Squared	0.897800
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-48.125
Std Err of Coef.	7.261404

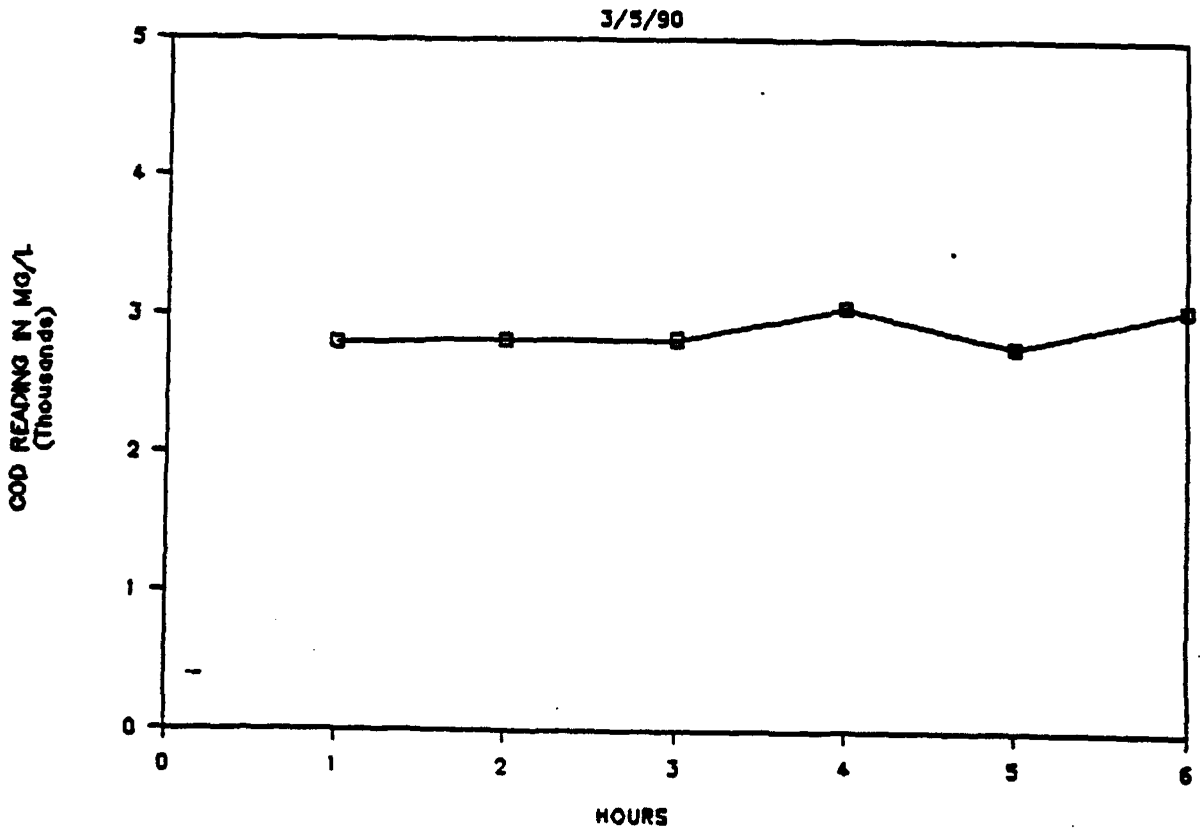

CEE BEE A-458, McGEAN ROHCO
3/5/90
COD READING IN MG/L (Thousands)
0
1
2
3
4
5
HOURS
0
1
2
3
4
5
6

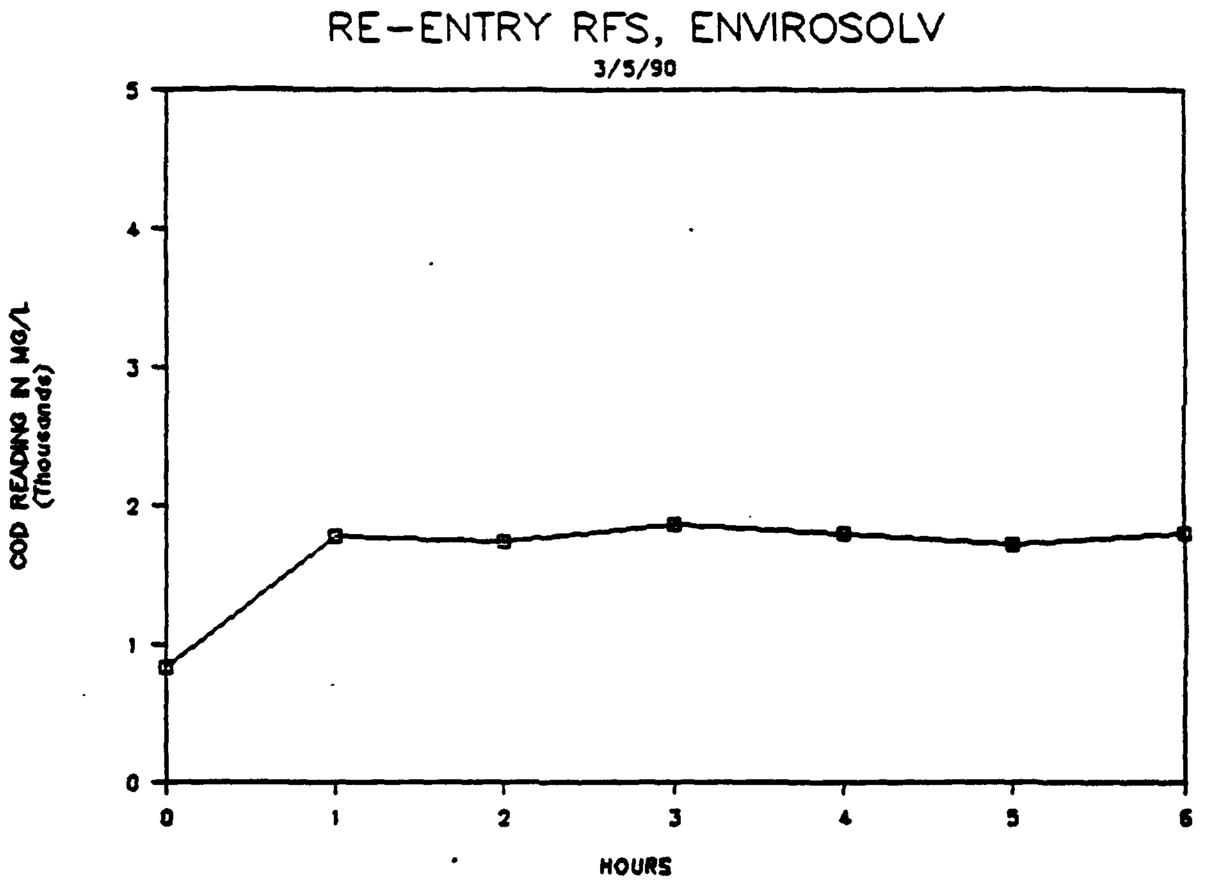

CEE BEE A-227D, McGEAN-ROHCO
3/5/90
COD READING IN MG/L (Thousands)
0
1
2
3
4
5
HOURS
0
1
2
3
4
5
6

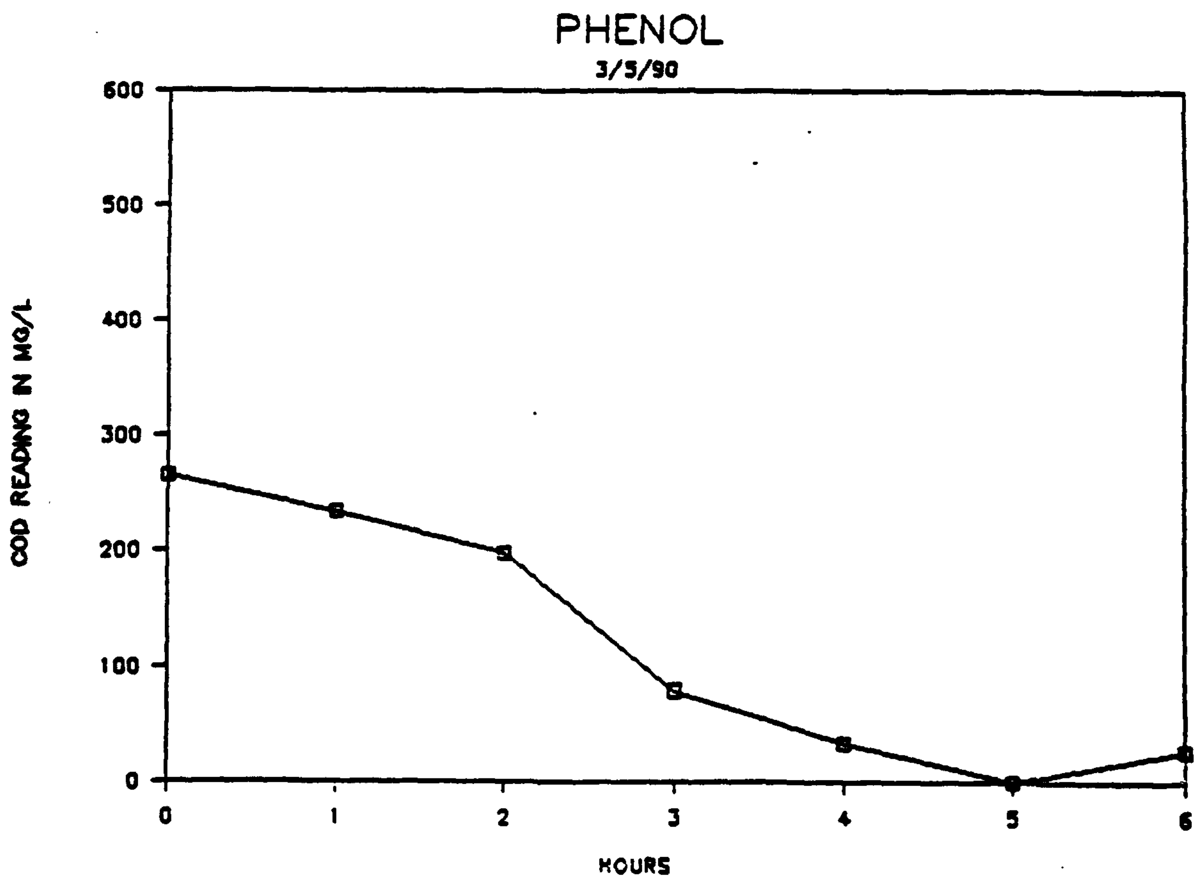
CEE BEE J-59, McGEAN ROHCO



CM-552X, CHEMICAL METHODS




RE-ENTRY RFS, ENVIROSOLV
3/5/90
COD READING IN MG/L
(Thousands)
5
4
3
2
1
0
0
1
2
3
4
5
6
HOURS


PHENOL
3/5/90
COD READING IN MG/L
600
500
400
300
200
100
0
0
1
2
3
4
5
6
HOURS

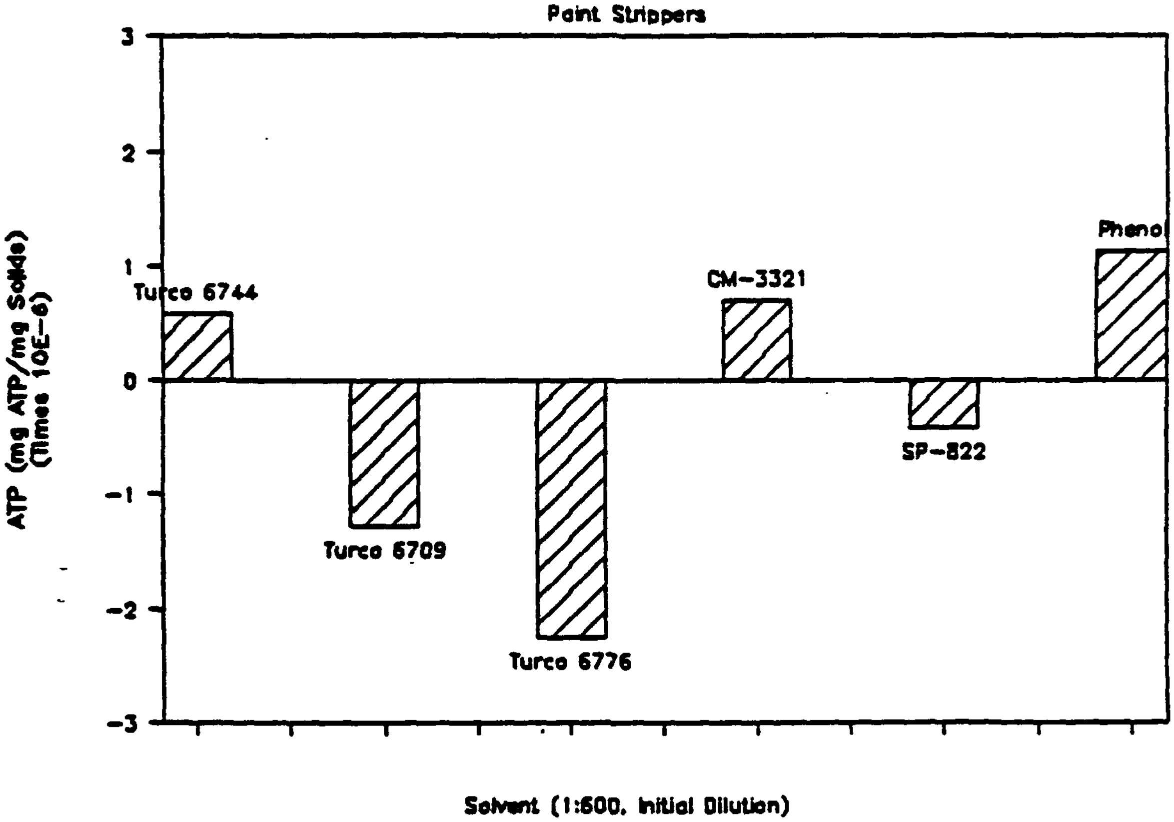
ATP DATA

Date: 3/6/90 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg ATP (RIS-RU) mg Solids		Change in ATP
Blank	0	1.82	460	1.605	459.500	3.14667		
	0	1.39	459					
Bugs	0	182	603	168.500	615.000	0.3774	1.965E-06	
	0	155	627					
Turco 6744	0	166	625	173.500	622.500	0.3864	2.013E-06	
	0	181	620					
Turco 6709	0	182	642	188.000	623.000	0.4322	2.251E-06	
	0	194	604					
Turco 6776	0	161	509	193.000	503.500	0.6216	3.237E-06	
	0	225	498					
CM-3321	0	132	523	134.500	535.500	0.3354	1.747E-06	
	0	137	548					
SP-822	0	156	509	156.000	512.000	0.4382	2.282E-06	
	0	156	515					
Phenol	0	217	564	201.500	554.000	0.5716	2.977E-06	
	0	186	544					
Blank	5	1.97	380	1.650	379.500			
	5	1.33	379					
Turco 6744	6	168	507	168.500	507.000	0.4978	2.593E-06	5.8E-07
	6	169	507					
Turco 6709	6	71.5	449	71.850	452.000	0.1890	9.843E-07	-1.3E-06
	6	72.2	455					
Turco 6776	6	75.2	451	72.200	453.500	0.1893	9.861E-07	-2.3E-06
	6	69.2	456					
CM-3321	6	142	477	154.500	483.000	0.4703	2.450E-06	7.0E-07
	6	167	489					
SP-822	6	145	500	131.500	498.500	0.3583	1.866E-06	-4.2E-07
	6	118	497					
Phenol	6	275	654	277.500	630.000	0.7872	4.100E-06	1.1E-06
	6	280	606					
Blank	6	5.75	359	6.185	353.000			
	6	6.62	347					

Solids dry wt. (g)	g/ml
0.12	0.0048

Average	Blank	
Without	Standard	3.147
With	Standard	397.333

Tuesday's Columns ATP (3/6/90)



COD DATA

Date: 3/6/90

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	583	561.5	Turco 6744 (UF)	1	4000.0	4040.0
Bugs 0.1	0	540		Turco 6744 (UF)	1	4080	
Bugs 0.01	0	53	55.0	Turco 6744 (UF)	5	4152.0	4112.0
Bugs 0.01	0	57		Turco 6744 (UF)	5	4072	
CH-3321	0	3772	3812.0	Turco 6744	0	3488	3366.0
CH-3321	0	3852		Turco 6744	0	3244	
CH-3321	1	4024	3956.0	Turco 6744	1	3168	3276.0
CH-3321	1	3888		Turco 6744	1	3384	
CH-3321	2	3812	3820.0	Turco 6744	2	3464	3486.0
CH-3321	2	3828		Turco 6744	2	3508	
CH-3321	3	3840	3838.0	Turco 6744	3	3040	3056.0
CH-3321	3	3836		Turco 6744	3	3072	
CH-3321	4	3808	3804.0	Turco 6744	4	2716	3060.0
CH-3321	4	3800		Turco 6744	4	3404	
CH-3321	5	3748	3738.5	Turco 6744	5	3420	3406.0
CH-3321	5	3729		Turco 6744	5	3392	
CH-3321	6	3756	3792.0	Turco 6744	6	3676	3608.0
CH-3321	6	3828		Turco 6744	6	3540	
SP-822	0	4020	4004.0	Turco 6776	0	1200	1012.0
SP-822	0	3988		Turco 6776	0	824	
SP-822	1	3564	3504.0	Turco 6776	1	1968	1950.0
SP-822	1	3444		Turco 6776	1	1932	
SP-822	2	3800	3846.0	Turco 6776	2	2024	2038.0
SP-822	2	3892		Turco 6776	2	2052	
SP-822	3	3916	3916.0	Turco 6776	3	2064	2034.0
SP-822	3	3916		Turco 6776	3	2004	
SP-822	4	3816	3860.0	Turco 6776	4	2000	2028.0
SP-822	4	3904		Turco 6776	4	2056	
SP-822	5	3868	3882.0	Turco 6776	5	2012	2016.0
SP-822	5	3896		Turco 6776	5	2020	
SP-822	6	3880	3858.0	Turco 6776	6	2296	2172.0
SP-822	6	3836		Turco 6776	6	2048	
Turco 6709	0	3036	3058.0	Phenol	0	256	254.0
Turco 6709	0	3080		Phenol	0	252	
Turco 6709	1	2908	2948.0	Phenol	1	223	224.0
Turco 6709	1	2988		Phenol	1	225	
Turco 6709	2	2996	2992.0	Phenol	2	153	160.5
Turco 6709	2	2988		Phenol	2	168	
Turco 6709	3	2980	3010.0	Phenol	3	47	45.0
Turco 6709	3	3040		Phenol	3	43	
Turco 6709	4	2932	2960.0	Phenol	4	35	35.5
Turco 6709	4	2988		Phenol	4	36	
Turco 6709	5	2988	3002.0	Phenol	5	37	42.0
Turco 6709	5	3016		Phenol	5	47	
Turco 6709	6	2680	2820.0	Phenol	6	69	78.5
Turco 6709	6	2960		Phenol	6	88	

Standard			
0.10			210.00
0.10			
0.25			529.50
0.25			
Phenol			0.00
Phenol			

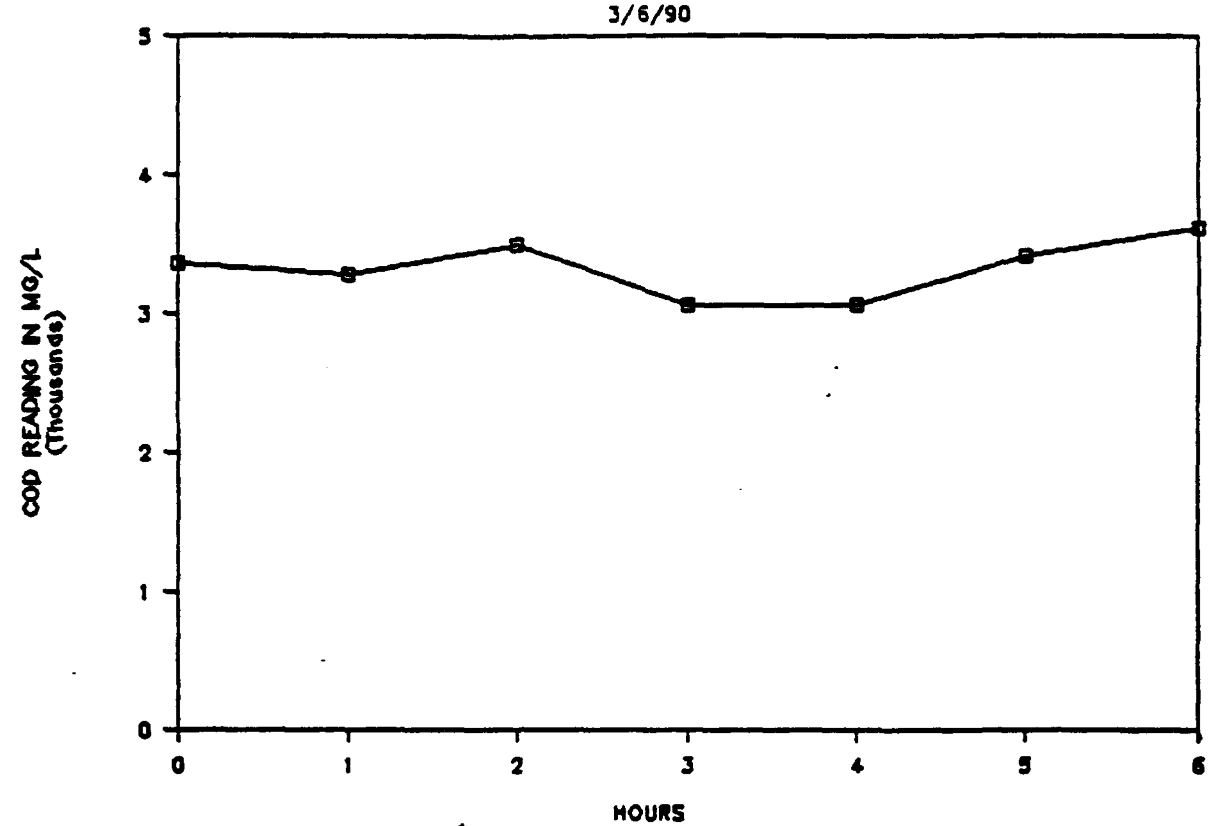
Turco 6776 did not dissolve completely and caused bugs to float.

REGRESSION DATA

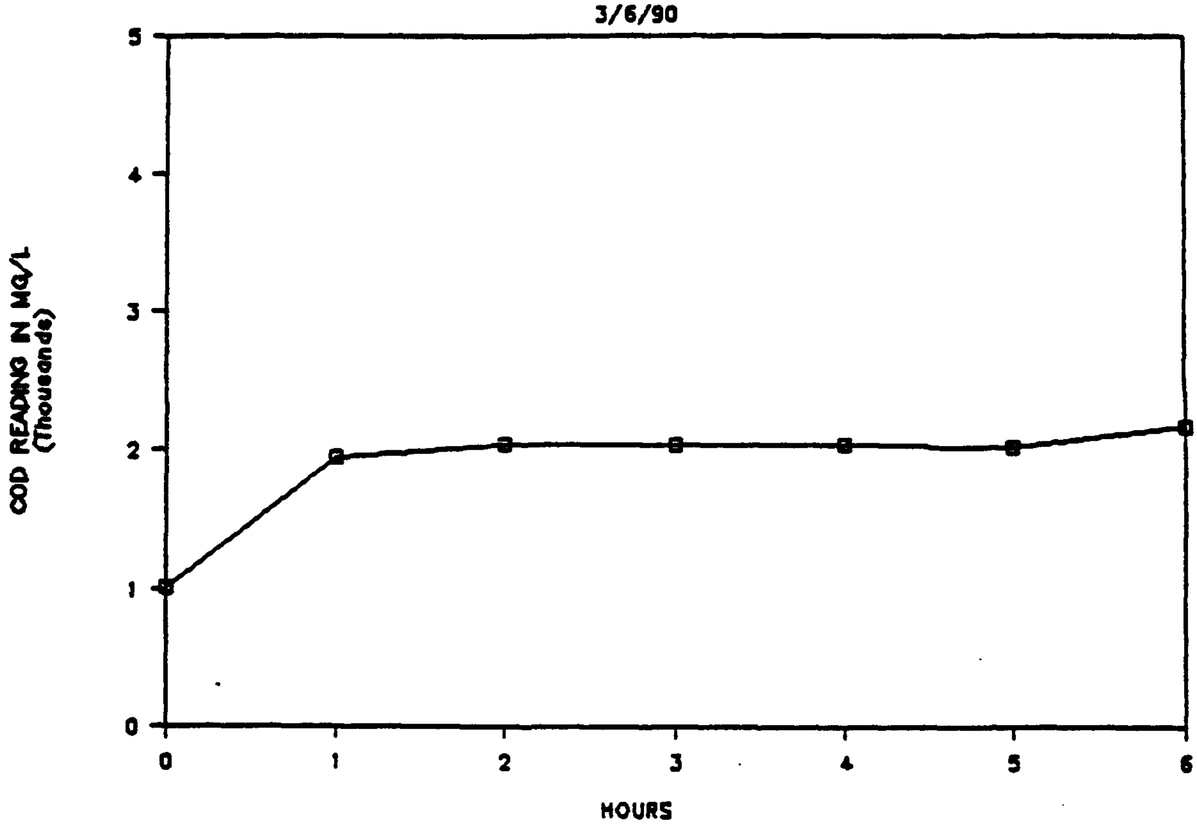
Date: 3/6/90

Sample	Hour	Average			
			Regression Output:		
CH-3321	0	3812.0	Constant		3877.678
CH-3321	1	3956.0	Std Err of Y Est		58.61819
CH-3321	2	3820.0	R Squared		0.351832
CH-3321	3	3838.0	No. of Observations		7
CH-3321	4	3804.0	Degrees of Freedom		5
CH-3321	5	3738.5			
CH-3321	6	3792.0	X Coefficient(s)	-18.25	
			Std Err of Coef.	11.07779	
			Regression Output:		
SP-822	0	4004.0	Constant		3803
SP-822	1	3504.0	Std Err of Y Est		169.7887
SP-822	2	3846.0	R Squared		0.026584
SP-822	3	3916.0	No. of Observations		7
SP-822	4	3860.0	Degrees of Freedom		5
SP-822	5	3882.0			
SP-822	6	3858.0	X Coefficient(s)	11.85714	
			Std Err of Coef.	32.08706	
			Regression Output:		
Turco 6709	0	3058.0	Constant		3038.357
Turco 6709	1	2948.0	Std Err of Y Est		62.28758
Turco 6709	2	2992.0	R Squared		0.428373
Turco 6709	3	3010.0	No. of Observations		7
Turco 6709	4	2960.0	Degrees of Freedom		5
Turco 6709	5	3002.0			
Turco 6709	6	2820.0	X Coefficient(s)	-22.7857	
			Std Err of Coef.	11.77124	
			Regression Output:		
Turco 6744	0	3366.0	Constant		3262.571
Turco 6744	1	3276.0	Std Err of Y Est		222.7095
Turco 6744	2	3486.0	R Squared		0.043210
Turco 6744	3	3056.0	No. of Observations		7
Turco 6744	4	3060.0	Degrees of Freedom		5
Turco 6744	5	3406.0			
Turco 6744	6	3608.0	X Coefficient(s)	20	
			Std Err of Coef.	42.08814	
			Regression Output:		
Turco 6776	0	1012.0	Constant		1506.928
Turco 6776	1	1950.0	Std Err of Y Est		305.9866
Turco 6776	2	2038.0	R Squared		0.497440
Turco 6776	3	2034.0	No. of Observations		7
Turco 6776	4	2028.0	Degrees of Freedom		5
Turco 6776	5	2016.0			
Turco 6776	6	2172.0	X Coefficient(s)	128.6428	
			Std Err of Coef.	57.82604	
			Regression Output:		
Phenol	0	254.0	Constant		228.7321
Phenol	1	224.0	Std Err of Y Est		53.20470
Phenol	2	160.5	R Squared		0.722387
Phenol	3	45.0	No. of Observations		7
Phenol	4	35.5	Degrees of Freedom		5
Phenol	5	42.0			
Phenol	6	78.5	X Coefficient(s)	-36.2678	
			Std Err of Coef.	10.05474	

TURCO 6744, TURCO
3/6/90

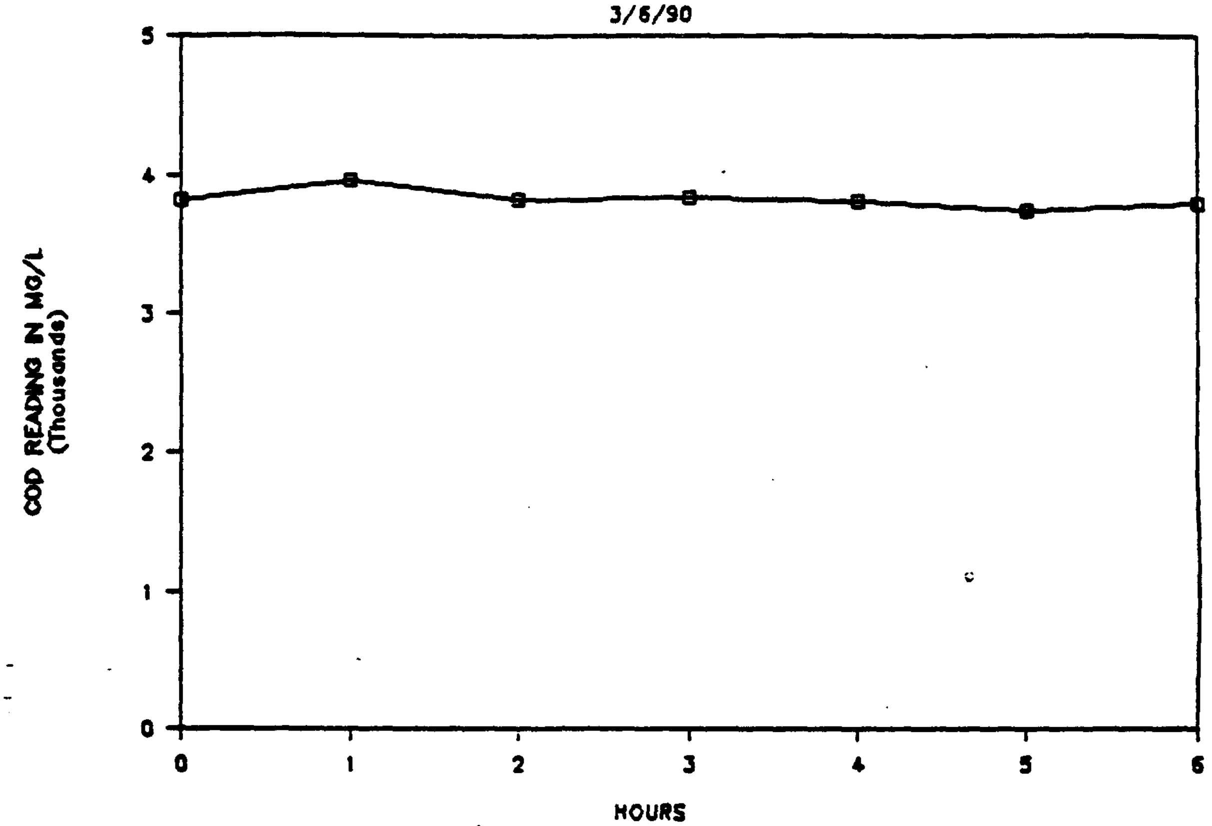


TURCO 6776, TURCO
3/6/90



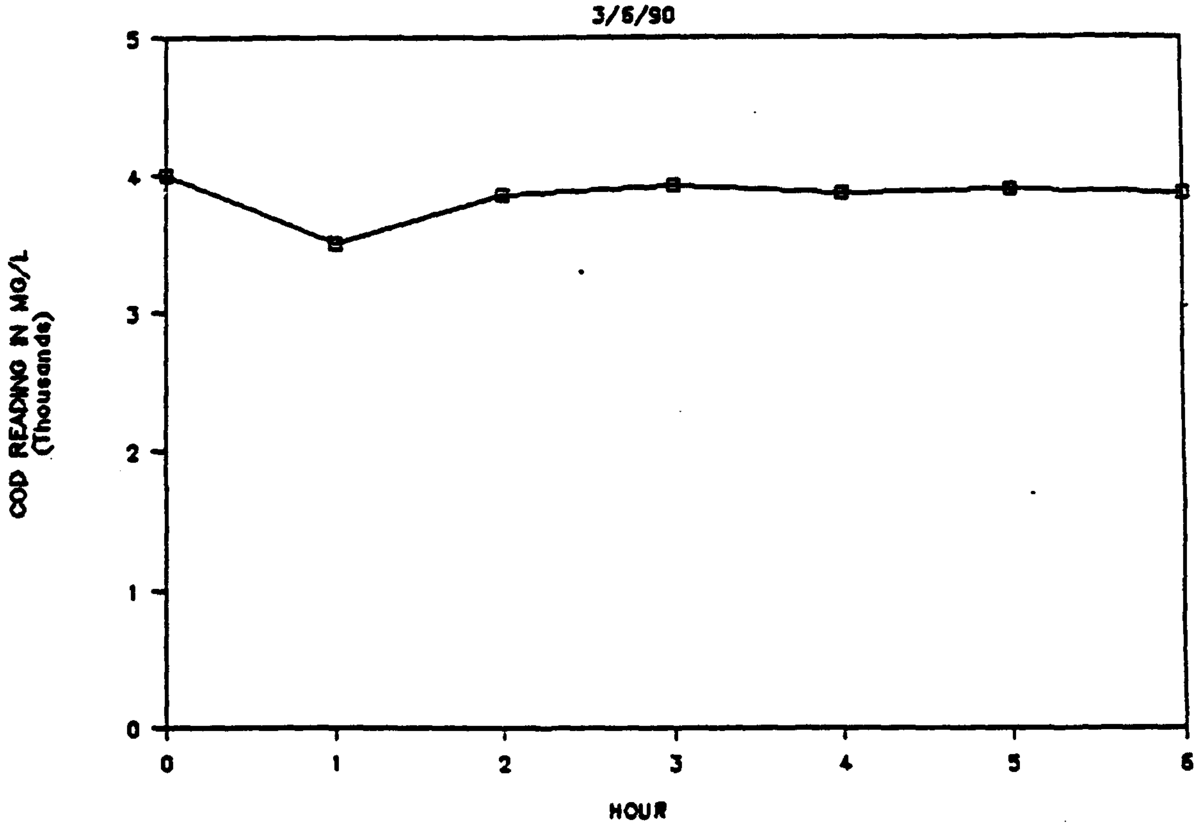
CM-3321, CHEMICAL METHODS

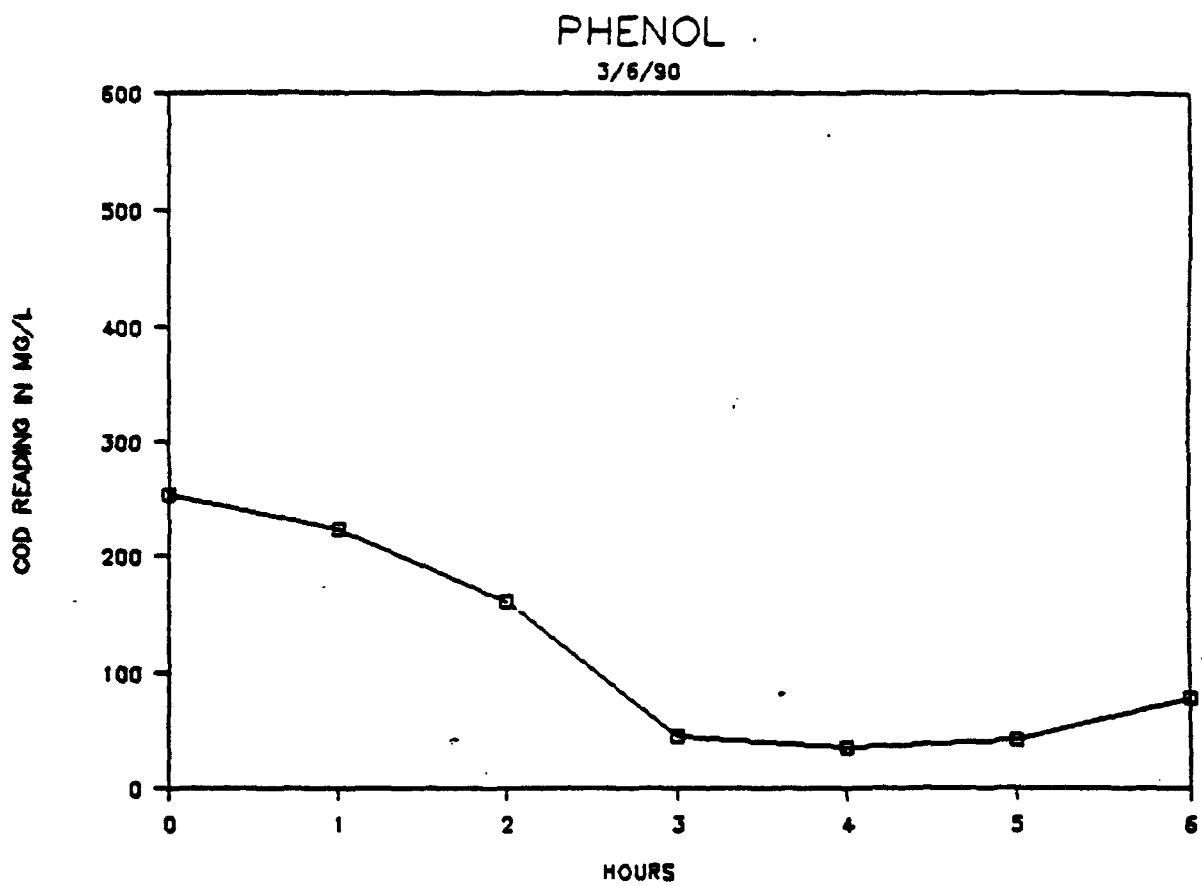
3/6/90



SP-822, CHEMICAL SOLVENTS

3/6/90




PHENOL
3/6/90
COD READING IN MG/L
HOURS
600
500
400
300
200
100
0
0
1
2
3
4
5
6

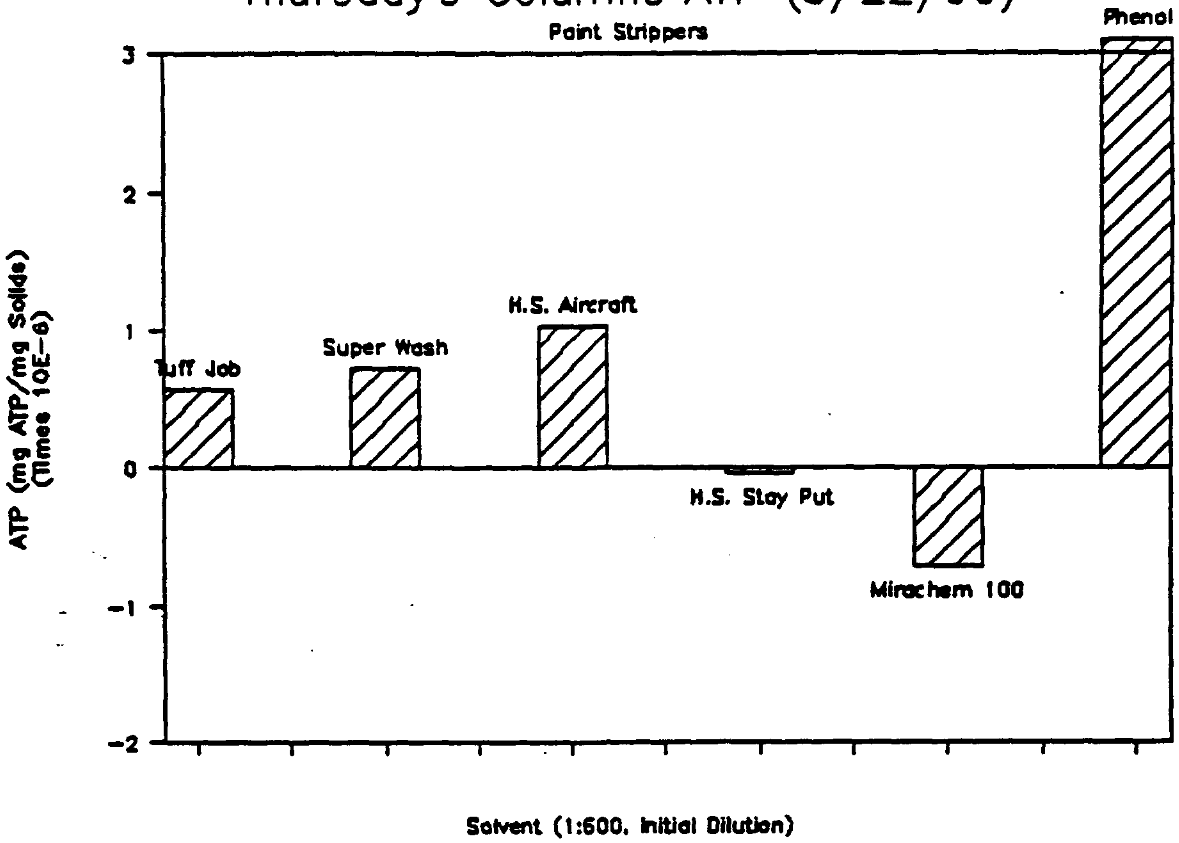
ATP DATA

Date: 3/22/90 Data Point	Hour	RU	RIS	Average RU	Average RIS	(RU-Blank)mg (RIS-RU) mg	ATP Solids	Change in ATP
Blank	0	1.4	379	1.670	377.000	1.81833	0.00380	
	0	1.94	375					
Bugs	0	109	455	100.000	448.000	0.2873	1.900E-06	
	0	91	441					
Tuff Job	0	91	444	93.500	459.000	0.2558	1.692E-06	
	0	96	474					
Super Wash	0	61.8	450	61.300	451.000	0.1573	1.040E-06	
	0	50.8	452					
W.S. Aircraft	0	86	533	74.350	529.500	0.1633	1.080E-06	
	0	62.7	526					
W.S. Stay Put	0	109	545	119.000	553.500	0.2739	1.811E-06	
	0	129	562					
Mirachem 100	0	58.3	496	57.500	487.000	0.1339	8.854E-07	
	0	56.7	478					
Phenol	0	106	500	111.500	503.500	0.2844	1.881E-06	
	0	117	507					
Blank	5	1.73	394	1.715	392.000			
	5	1.7	390					
Tuff Job	6	128	509	129.000	505.500	0.3426	2.266E-06	5.7E-07
	6	130	502					
Super Wash	6	100	480	97.500	461.500	0.2678	1.771E-06	7.3E-07
	6	95	443					
W.S. Aircraft	6	114	445	108.500	449.000	0.3186	2.107E-06	1.0E-06
	6	103	453					
W.S. Stay Put	6	106	456	98.000	462.000	0.2692	1.781E-06	-3.1E-08
	6	90	468					
Mirachem 100	6	9.5	364	9.650	380.500	0.0260	1.720E-07	-7.1E-07
	6	9.8	397					
Phenol	6	285	671	297.500	673.000	0.7923	5.240E-06	3.4E-06
	6	310	675					
Blank	6	2.19	351	2.070	352.500			
	6	1.95	354					

Solids dry wt. (g)	g/ml
0.0946	0.0038

Average	Blank	
Without	Standard	1.818
With	Standard	373.833

Thursday's Columns ATP (3/22/90)



COD DATA

Date: 3/22/90

Sample	Hour	Reading	Average	Sample	Hour	Reading	Average
Bugs 0.1	0	452	427.5	Tuff Job (UF)	1	931.0	922.0
Bugs 0.1	0	403		Tuff Job (UF)	1	913	
Bugs 0.01	0	47	39.5	Tuff Job (UF)	5	892.0	890.0
Bugs 0.01	0	32		Tuff Job (UF)	5	888	
N.S. Aircraft	0	757	761.5	Super Wash	0	282	284.5
N.S. Aircraft	0	766		Super Wash	0	287	
N.S. Aircraft	1	857	871.0	Super Wash	1	356	346.0
N.S. Aircraft	1	885		Super Wash	1	336	
N.S. Aircraft	2	855	857.0	Super Wash	2	313	316.5
N.S. Aircraft	2	859		Super Wash	2	320	
N.S. Aircraft	3	860	850.0	Super Wash	3	325	319.0
N.S. Aircraft	3	840		Super Wash	3	313	
N.S. Aircraft	4	832	833.0	Super Wash	4	306	303.0
N.S. Aircraft	4	834		Super Wash	4	300	
N.S. Aircraft	5	820	825.5	Super Wash	5	316	308.0
N.S. Aircraft	5	831		Super Wash	5	300	
N.S. Aircraft	6	821	816.5	Super Wash	6	284	287.0
N.S. Aircraft	6	812		Super Wash	6	290	
N.S. Stay Put	0	457	455.0	Tuff Job	0	401	395.5
N.S. Stay Put	0	453		Tuff Job	0	390	
N.S. Stay Put	1	1816	1787.0	Tuff Job	1	466	457.5
N.S. Stay Put	1	1758		Tuff Job	1	449	
N.S. Stay Put	2	1682	1682.0	Tuff Job	2	455	459.5
N.S. Stay Put	2	1682		Tuff Job	2	464	
N.S. Stay Put	3	1766	1700.0	Tuff Job	3	435	439.0
N.S. Stay Put	3	1634		Tuff Job	3	443	
N.S. Stay Put	4	1656	1711.0	Tuff Job	4	435	436.5
N.S. Stay Put	4	1766		Tuff Job	4	438	
N.S. Stay Put	5	1710	1708.0	Tuff Job	5	416	419.5
N.S. Stay Put	5	1706		Tuff Job	5	423	
N.S. Stay Put	6	1806	1746.0	Tuff Job	6	464	462.5
N.S. Stay Put	6	1686	-	Tuff Job	6	461	
Mirachem 100	0	868	834.0	Phenol	0	262	258.5
Mirachem 100	0	800		Phenol	0	255	
Mirachem 100	1	726	761.0	Phenol	1	156	138.5
Mirachem 100	1	796		Phenol	1	121	
Mirachem 100	2	702	698.0	Phenol	2	89	90.0
Mirachem 100	2	694		Phenol	2	91	
Mirachem 100	3	722	718.0	Phenol	3	47	55.5
Mirachem 100	3	714		Phenol	3	64	
Mirachem 100	4	702	702.0	Phenol	4	28	24.0
Mirachem 100	4	702		Phenol	4	20	
Mirachem 100	5	720	727.0	Phenol	5	20	17.0
Mirachem 100	5	734		Phenol	5	14	
Mirachem 100	6	684	705.0	Phenol	6	38	28.5
Mirachem 100	6	726		Phenol	6	19	

Standard	Average
0.10	215.50
0.10	
0.25	527.00
0.25	
Phenol	0.00
Phenol	

REGRESSION DATA

Date: 3/22/90

Sample	Hour	Average
N.S. Aircraft	0	761.5
N.S. Aircraft	1	871.0
N.S. Aircraft	2	857.0
N.S. Aircraft	3	850.0
N.S. Aircraft	4	833.0
N.S. Aircraft	5	825.5
N.S. Aircraft	6	816.5

Regression Output:	
Constant	825.2857
Std Err of Y Est	39.04246
R Squared	0.011579
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	1.785714
Std Err of Coef.	7.378332

Sample	Hour	Average
N.S. Stay Put	0	455.0
N.S. Stay Put	1	1787.0
N.S. Stay Put	2	1682.0
N.S. Stay Put	3	1700.0
N.S. Stay Put	4	1711.0
N.S. Stay Put	5	1708.0
N.S. Stay Put	6	1746.0

Regression Output:	
Constant	1140.142
Std Err of Y Est	420.3001
R Squared	0.361753
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	133.7142
Std Err of Coef.	79.42926

Sample	Hour	Average
Mirachem 100	0	834.0
Mirachem 100	1	761.0
Mirachem 100	2	698.0
Mirachem 100	3	718.0
Mirachem 100	4	702.0
Mirachem 100	5	727.0
Mirachem 100	6	705.0

Regression Output:	
Constant	783.3214
Std Err of Y Est	37.21203
R Squared	0.512004
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-16.1071
Std Err of Coef.	7.032414

Sample	Hour	Average
Super Wash	0	284.5
Super Wash	1	346.0
Super Wash	2	316.5
Super Wash	3	319.0
Super Wash	4	303.0
Super Wash	5	308.0
Super Wash	6	287.0

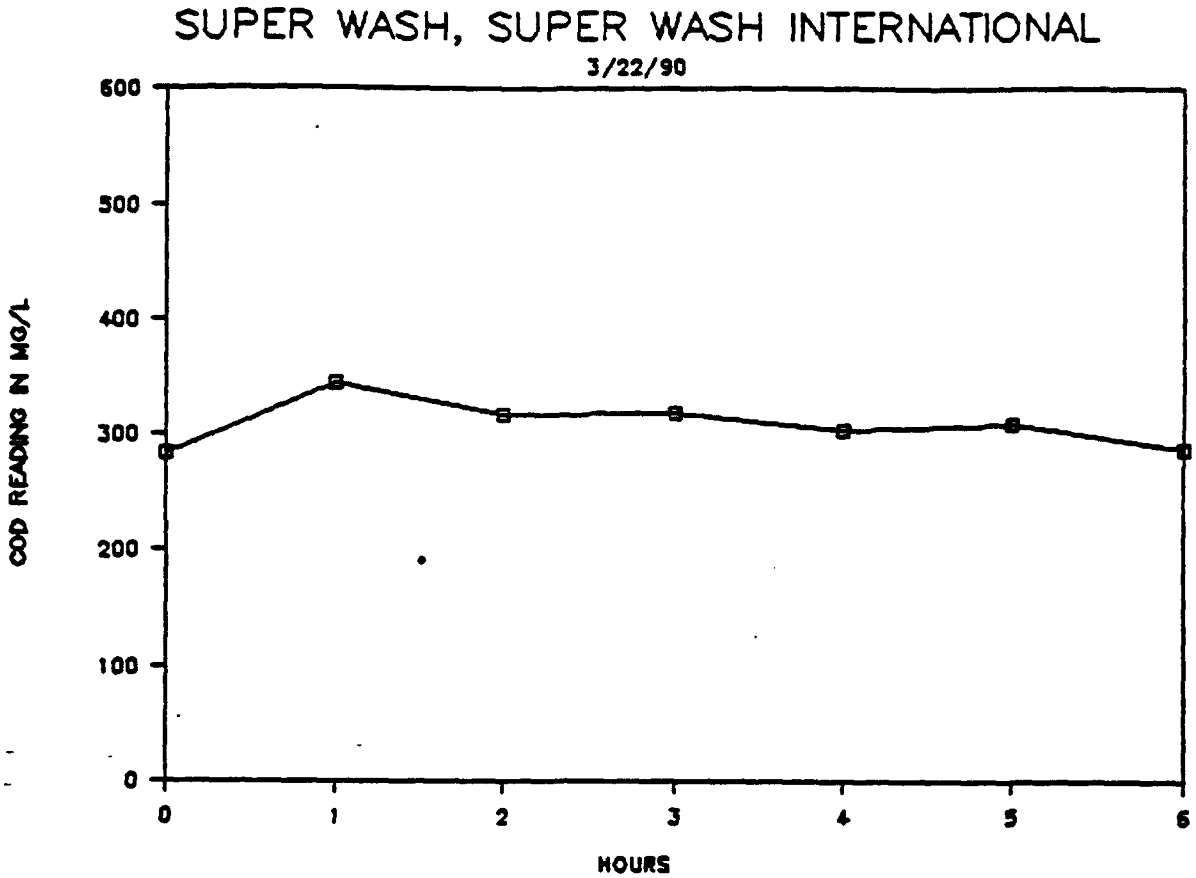
Regression Output:	
Constant	317.9285
Std Err of Y Est	21.93724
R Squared	0.090744
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-2.92857
Std Err of Coef.	4.145750

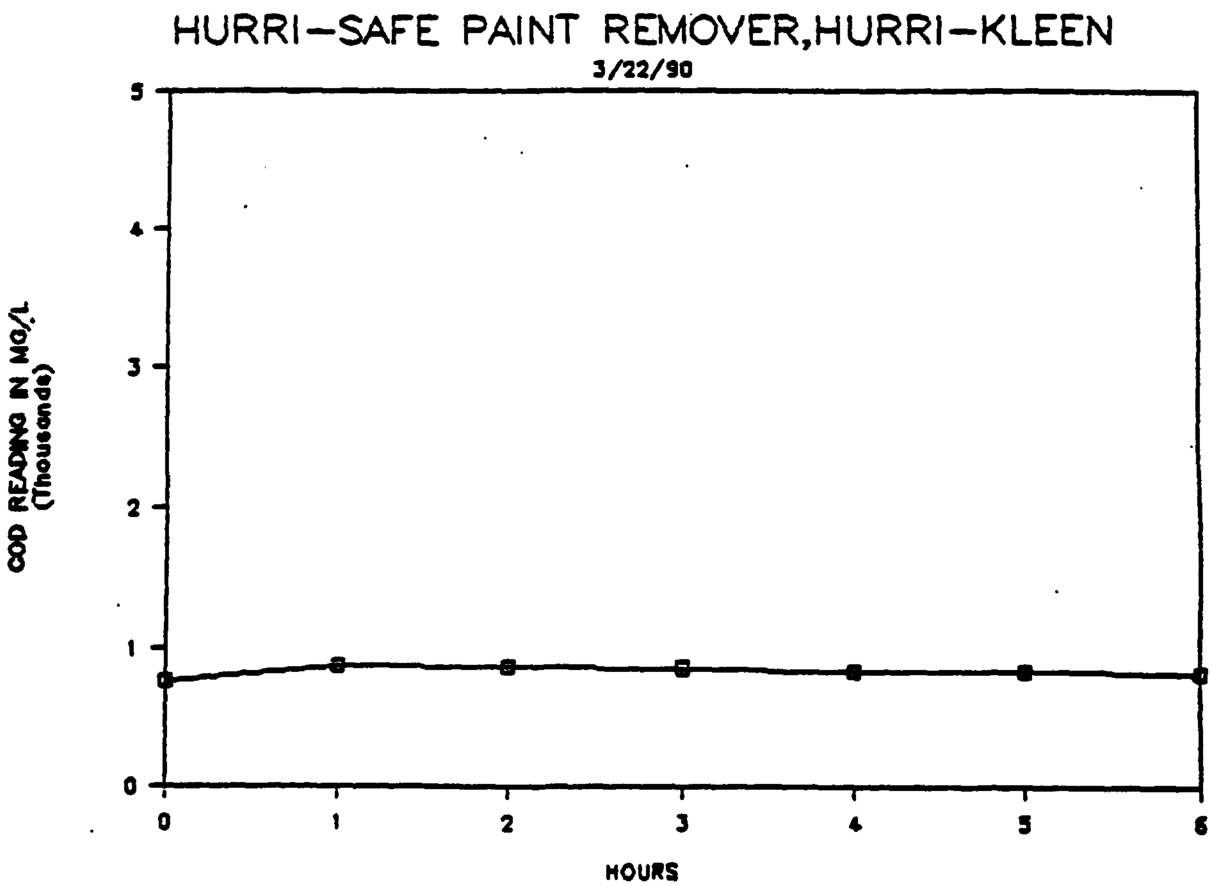
Sample	Hour	Average
Tuff Job	0	395.5
Tuff Job	1	457.5
Tuff Job	2	459.5
Tuff Job	3	439.0
Tuff Job	4	436.5
Tuff Job	5	419.5
Tuff Job	6	462.5

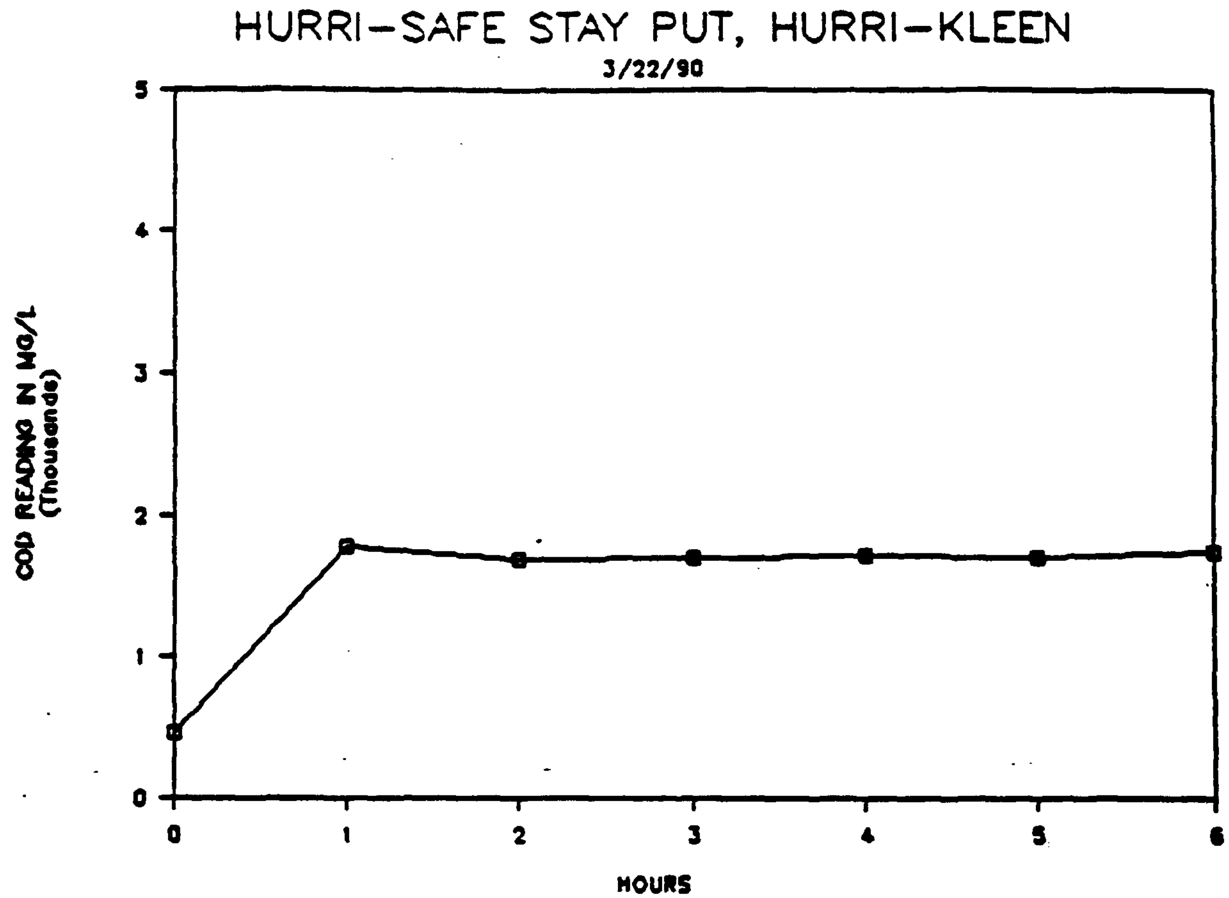
Regression Output:	
Constant	427.6428
Std Err of Y Est	25.37968
R Squared	0.103437
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	3.642857
Std Err of Coef.	4.796310

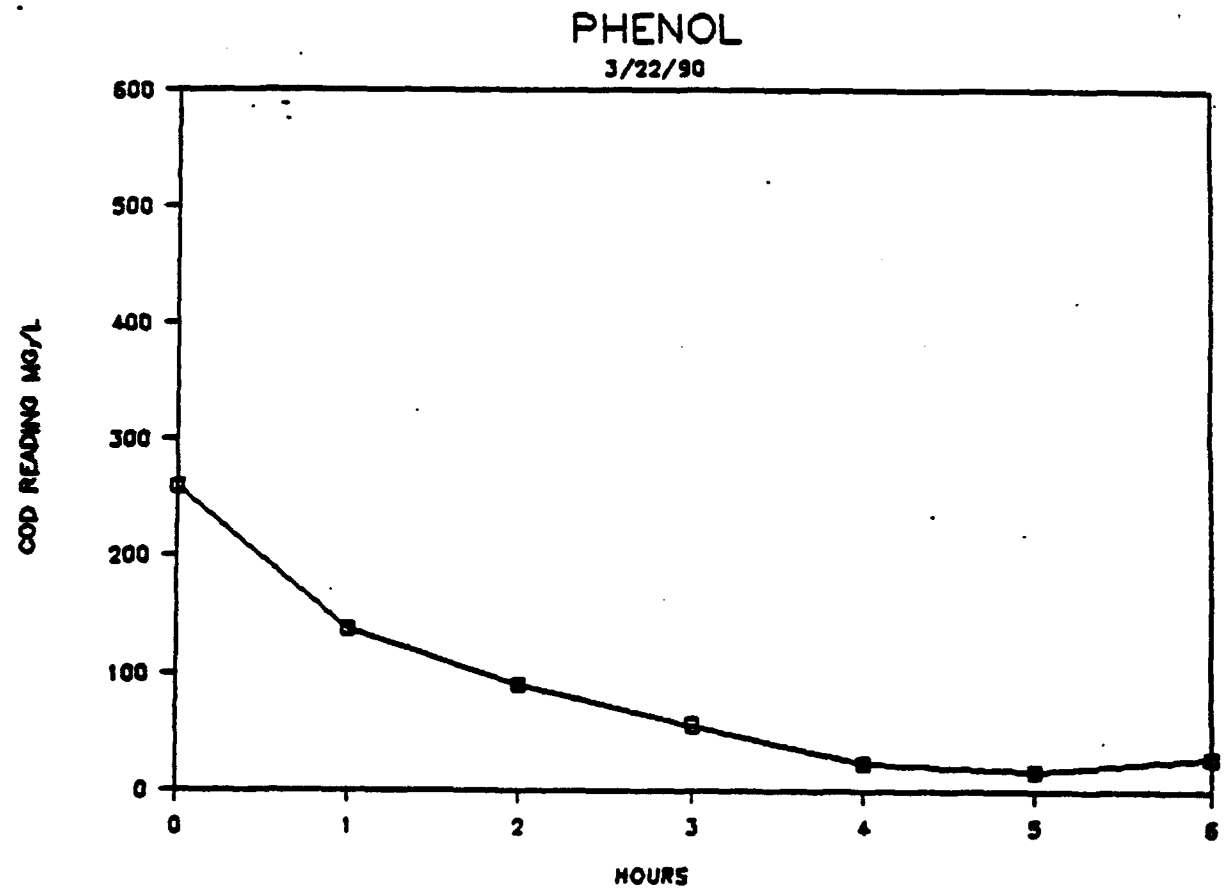
Sample	Hour	Average
Phenol	0	258.5
Phenol	1	138.5
Phenol	2	90.0
Phenol	3	55.5
Phenol	4	24.0
Phenol	5	17.0
Phenol	6	28.5

Regression Output:	
Constant	194.4642
Std Err of Y Est	44.07453
R Squared	0.785852
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	-35.6785
Std Err of Coef.	8.329303


SUPER WASH, SUPER WASH INTERNATIONAL
3/22/90
COD READING IN MG/L
600
500
400
300
200
100
0
0
1
2
3
4
5
6
HOURS


HURRI-SAFE PAINT REMOVER,HURRI-KLEEN
3/22/90
COD READING IN MG/L (Thousands)
5
4
3
2
1
0
0
1
2
3
4
5
6
HOURS


HURRI-SAFE STAY PUT, HURRI-KLEEN
3/22/90
COD READING IN MG/L (Thousands)
0
1
2
3
4
5
0
1
2
3
4
5
6
HOURS


PHENOL
3/22/90
COD READING MG/L
0
100
200
300
400
500
600
0
1
2
3
4
5
6
HOURS

APPENDIX L

PRELIMINARY PAINT-STRIPPING DATA

PRELIMINARY PAINT STRIPPING TEST

COMPANY	PRODUCT	THICKNESS (MIL)	METAL	PAINT	PASSED	METHOD	TEMP. (C)
3M	SAFEST STRIP	1.93 1.14	AL AL	WHITE GREY	NO	BRUSH	AMB.
AMBION	INSULSTRIP	1.8 1.32	AL AL	WHITE GREY	YES	DIP	65.6
BROCO	BROCO 300	1.8 2.35	AL AL	WHITE GREY	NO	DIP	AMB.
BRULIN	EXP 2187	2 1.75	AL AL	WHITE GREY	NO	DIP	76.7
BRULIN	SAFETY STRIP 1000	1.7 1.6	AL AL	WHITE GREY	NO	DIP	60.0
BRULIN	SAFETY STRIP 2000	1.85 2.11	AL AL	WHITE GREY	NO	BRUSH	AMB.
BRULIN	SAFETY STRIP 4000	1.62 2.08	AL AL	WHITE GREY	NO	BRUSH	AMB.
CHEMCO MFG.	CSP-2015	1.85 1.94	AL AL	WHITE GREY	NO	BRUSH	AMB.
CHEMICAL METHODS	CM-500	5.15 3.65	ST ST	BLACK BLACK	YES	DIP	93.3
CHEMICAL METHODS	CM 550	2.15 2.45	AL AL	WHITE GREY	NO	BRUSH	AMB.
CHEMICAL METHODS	CM 552X	2.00 1.95	AL AL	WHITE GREY	NO	BRUSH	AMB.

PRELIMINARY PAINT STRIPPING TEST

COMPANY	PRODUCT	THICKNESS (MIL)	METAL	PAINT	PASSED	METHOD	TEMP. (C)
CHEMICAL METHODS	CM-3321	1.33	AL	WHITE	NO	DIP	104.4
		1.91	AL	GREY			
CHEMICAL METHODS	CM-3707	1.53	AL	WHITE	YES	DIP	90.6
		2.16	AL	GREY			
CHEMICAL METHODS	CM 3707A	1.55	AL	WHITE	YES	DIP	68.3
		2.21	AL	GREY			
CHEM. SOLVENTS	SP 800	1.04	AL	WHITE	YES	DIP	93.3
		2.9	AL	GREY			
CHEM. SOLVENTS	SP 822	1.24	AL	WHITE	NO	DIP	65.6
		2.47	AL	GREY			
CHEM. SOLVENTS	SP 823	1.05	AL	WHITE	YES	DIP	65.6
		1.09	AL	GREY			
CHEM. SOLVENTS	SP 824	1.3	AL	WHITE	NO	DIP	93.3
		1.5	AL	GREY			
CHEM. SYSTEMS	PS 589X/590	1.23	AL	WHITE	YES	DIP	65.6
		1.8	AL	GREY			
DU PONT	DBE (E60988-37)	1.25	AL	WHITE	NO	BRUSH	AMB.
		2.95	AL	GREY			
ELDORADO	HT-2230	2.04	AL	WHITE	YES	DIP	76.7
		1.96	AL	GREY			

PRELIMINARY PAINT STRIPPING TEST

COMPANY	PRODUCT	THICKNESS (MIL)	METAL	PAINT	PASSED	METHOD	TEMP. (C)
ELGENE	22 SKIDOO	1.4	AL	WHITE		DIP	121.1
		1.57	AL	GREY			
		4.45	ST	BLACK	NO	DIP	100.0
		3.8	ST	BLACK			
ELGENE	FABULENE	1.53	AL	WHITE		DIP	65.6
		2.55	AL	GREY			
		3.4	ST	BLACK	NO	DIP	65.6
		3.45	ST	BLACK			
ENTHONE	ENDOX L-76	1.84	AL	WHITE		DIP	104.4
		1.9	AL	GREY			
		3.6	ST	BLACK	YES	DIP	104.4
		3.8	ST	BLACK			
ENTHONE	ENDOX Q-576	1.28	AL	WHITE		DIP	93.3
		1.79	AL	GREY			
		3.45	ST	BLACK	NO	DIP	93.3
		3.55	ST	BLACK			
ENVIROSOLV	RE-ENTRY ES	1.66	AL	WHITE	NO	DIP	AMB.
		1.65	AL	GREY			
ENVIROSOLV	RE-ENTRY RFS	1.85	AL	WHITE	NO	DIP	AMB.
		2.1	AL	GREY			
EXXON	EXP.#1	1.4	AL	WHITE	NO	DIP	65.6
		2.75	AL	GREY			
EXXON	EXP.#2	1.85	AL	WHITE	NO	DIP	65.6
		2.05	AL	GREY			

PRELIMINARY PAINT STRIPPING TEST

COMPANY	PRODUCT	THICKNESS (MIL)	METAL	PAINT	PASSED	METHOD	TEMP. (C)
EXXON	EXP.#3	1.7 2.2	AL AL	WHITE GREY	NO	DIP	65.6
EXXON	EXP.#4	1.65 2.15	AL AL	WHITE GREY	NO	DIP	65.6
EXXON	NORPAR 13	2.15 2.75	AL AL	WHITE GREY	NO	DIP	65.6
EXXON	NORPAR 15	1.35 2.95	AL AL	WHITE GREY	NO	DIP	65.6
FINE ORGANICS	FO 606	1.9 1.3	AL AL	WHITE GREY	YES	DIP	71.1
FINE ORGANICS	FO 621	1.92 1.53	AL AL	WHITE GREY	NO	DIP	71.1
FINE ORGANICS	FO 623	1.35 1.15	AL AL	WHITE GREY	YES	DIP	71.1
FINE ORGANICS	FO 2115A	1.75 2.60	AL AL	WHITE GREY	NO	BRUSH	AMB.
FREDRICK GUMM	CLEPO ENVIROSTRIP 222	1.32 1.69	AL AL	WHITE GREY	YES	DIP	87.8
FREMONT	F-289	1.7 2.36	AL AL	WHITE GREY	NO	DIP	68.3
GAF	M-PYROL	1.8 1.7	AL AL	WHITE GREY	YES	DIP	65.6

PRELIMINARY PAINT STRIPPING TEST

COMPANY	PRODUCT	THICKNESS (MIL)	METAL	PAINT	PASSED	METHOD	TEMP. (C)
HURRI-KLEEN	PAINT REMOVER	1.93 2.8	AL AL	WHITE GREY	NO	BRUSH	AMB.
HURRI-KLEEN	STAY-PUT	1.95 2.75	AL AL	WHITE GREY	NO	BRUSH	AMB.
IND. CHEM. PROD. OF DETROIT	ENAMEL STRIP 77	1.8 1.82	AL AL	WHITE GREY	YES	DIP	65.6
KEY CHEMICAL	KEY CHEM 04570H	1.85 2.22	AL AL	WHITE GREY	YES	DIP	121.1
MAN-GILL	POWER STRIP 5163/0846	1.94 2.51	AL AL	WHITE GREY	YES	DIP	AMB.
McGEAN-ROHCO	CEE-BEE A245	1.49 1.9	AL AL	WHITE GREY	YES	DIP	121.1
McGEAN-ROHCO	CEE-BEE A477	1.64 1.62	AL AL	WHITE GREY	YES	DIP	100.0
OAKITE	STRIPPER ALM	2.05 2.25	AL AL	WHITE GREY	NO	DIP	65.6
PATCLIN	103 B	1.78 1.69	AL AL	WHITE GREY	NO	DIP	87.8
PATCLIN	104 C	1.51 1.44	AL AL	WHITE GREY	NO	DIP	68.3
PATCLIN	106 Q	1.52 1.81	AL AL	WHITE GREY	NO	DIP	68.3

PRELIMINARY PAINT STRIPPING TEST

COMPANY	PRODUCT	THICKNESS (MIL)	METAL	PAINT	PASSED	METHOD	TEMP. (C)
PATCLIN	PATCLIN 126	2.65	AL	WHITE	YES	DIP	87.8
		1.55	AL	GREY			
PAVCO	DECOATER 3400	1.26	AL	WHITE	YES	DIP	93.3
		2.38	AL	GREY			
ROCHESTER MID.	PSS 600	1.36	AL	WHITE	YES	DIP	65.6
		1.35	AL	GREY			
ROCHESTER MID.	PSS 601	1.73	AL	WHITE	NO	BRUSH	AMB.
		1.90	AL	GREY			
SUPER WASH INTERNATIONAL	SUPER WASH	2.25	AL	WHITE	NO	DIP	AMB.
		2.06	AL	GREY			
TEXO	TEXO LP 1582	1.9	AL	WHITE	NO	BRUSH	AMB.
		2.45	AL	GREY			
TURCO	T-5351 (CONTROL)	1.79	AL	WHITE	CONTROL	DIP	AMB.
		2.4	AL	GREY			
		5.45	ST	BLACK			
TURCO	T-5668	1.31	AL	WHITE	YES	DIP	71.1
		1.5	AL	GREY			
TURCO	T-6088A	2.1	AL	WHITE	NO	BRUSH	AMB.
		2.25	AL	GREY			
TURCO	T-6744	1.51	AL	WHITE	NO	BRUSH	AMB.
		1.93	AL	GREY			

PRELIMINARY PAINT STRIPPING TEST

COMPANY	PRODUCT	THICKNESS (MIL)	METAL	PAINT	PASSED	METHOD	TEMP. (C)
TURCO	T-6776	1.78	AL	WHITE	YES	BRUSH	AMB.
		2.06	AL	GREY			
U.S. POLYCHEM	PXP SALOME	1.45	AL	WHITE	YES	DIP	65.6
		2.05	AL	GREY			
WITCO	STRIPPER MCR	2	AL	WHITE	YES	DIP	71.1
		2.05	AL	GREY			

NOTE:

The white paint was an epoxy water-borne primer and polyurethane topcoat on alodined aluminum.

The grey paint was an epoxy water-borne primer and polyurethane topcoat on anodized aluminum.

The black paint was an epoxy polyamide primer and polyurethane topcoat on steel.

APPENDIX M

STRIPPING EFFICIENCY TEST DATA

PAINT STRIPPING EFFICIENCY TEST

COMPANY: Ambion Corp.
PRODUCT: Insulstrip
TEMPERATURE (C): 65.5 (150 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Failed	Failed
A3	Failed	Failed	Failed
A4	Passed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Failed	Failed	Failed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

COMPANY: Chemical Methods
PRODUCT: CM-500
TEMPERATURE (C): 93 (200 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
S1	Failed	Failed	Passed
S2	Passed	Passed	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Passed	Passed	Passed
S6	Failed	Failed	Failed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: Chemical Methods
PRODUCT: CM-3707
TEMPERATURE (C): 90.6 (195 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Passed	Passed	Passed
A3	Failed	Failed	Failed
A4	Passed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Passed	Passed	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

COMPANY: Chemical Methods
PRODUCT: CM-3707A
TEMPERATURE (C): 68.3 (155 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Passed	Passed	Passed
A3	Failed	Failed	Failed
A4	Failed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Failed	Passed	Passed
S2	Passed	Passed	Passed
S3	Failed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: Chemical Solvents
PRODUCT: SP-800
TEMPERATURE (C): 93.3 (200F) [Should have been run at 65.6 (15
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Passed	Passed	Passed
A3	Failed	Failed	Passed
A4	Passed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Passed	Passed	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Passed	Passed
S6	Failed	Failed	Passed

COMPANY: Chemical Solvents
PRODUCT: SP-823
TEMPERATURE (C): 65.6 (150 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Failed	Passed
A3	Failed	Failed	Failed
A4	Failed	Failed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Failed	Failed	Passed
S2	Failed	Failed	Failed
S3	Failed	Failed	Failed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: Chemical Systems
PRODUCT: PS 589X/590
TEMPERATURE (C): 65.6 (150 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Failed	Failed
A3	Failed	Failed	Failed
A4	Passed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Failed	Passed	Passed
S2	Failed	Failed	Failed
S3	Failed	Failed	Failed
S4	Passed	Passed	Passed
S5	Failed	Failed	Failed
S6	Failed	Failed	Failed

COMPANY: Eldorado
PRODUCT: HT-2230
TEMPERATURE (C): 76.7 (170 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Failed	Failed
A3	Failed	Failed	Failed
A4	Failed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Passed	Passed	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Passed	Passed
S6	Failed	Failed	Failed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: Enthone
PRODUCT: ENDOX L-76
TEMPERATURE (C): 104.4 (220 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
S1	Failed	Failed	Failed
S2	Passed	Passed	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Passed	Passed	Passed
S6	Passed	Passed	Passed

COMPANY: Fine Organics
PRODUCT: FO 606
TEMPERATURE (C): 71.1 (160 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Passed	Passed	Passed
A3	Failed	Failed	Failed
A4	Passed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Passed	Passed	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: Fine Organics
PRODUCT: FO 623
TEMPERATURE (C): 71.1 (160 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Passed	Passed
A3	Failed	Failed	Failed
A4	Passed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Passed	Passed	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

COMPANY: Fredrick Gumm
PRODUCT: Clepo Envirostrip 222
TEMPERATURE (C): 87.8 (190 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Passed
A2	Failed	Passed	Passed
A3	Failed	Failed	Failed
A4	Failed	Failed	Passed
A5			
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Failed	Passed	Passed
S3	Failed	Failed	Passed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: GAF
PRODUCT: M-Pyrol
TEMPERATURE (C): 65.6 (150 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1			
A2	Failed	Failed	Failed
A3	Failed	Failed	Failed
A4	Failed	Failed	Failed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Failed	Failed	Failed
S3	Failed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Failed	Failed
S6	Failed	Failed	Failed

COMPANY: Industrial Chem. Products
PRODUCT: Enamel Stripper 77
TEMPERATURE (C): 65.6 (150 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Failed	Failed
A3	Failed	Failed	Failed
A4	Passed	Failed	Failed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Failed	Failed	Passed
S2	Passed	Passed	Passed
S3	Failed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: Key Chemical
PRODUCT: Key Chem 04570H
TEMPERATURE (C): 121.1 (250 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Failed	Passed
A3	Failed	Failed	Failed
A4	Passed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Failed	Failed	Failed
S2	Failed	Failed	Passed
S3	Failed	Failed	Failed
S4	Passed	Passed	Passed
S5	Failed	Failed	Failed
S6	Failed	Failed	Failed

COMPANY: Man-Gill
PRODUCT: Power Strip 5163
TEMPERATURE (C): Ambient
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Failed	Failed
A3	Failed	Failed	Failed
A4	Failed	Failed	Failed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Failed	Passed	Passed
S2	Failed	Passed	Passed
S3	Failed	Failed	Passed
S4	Failed	Failed	Passed
S5	Failed	Failed	Failed
S6	Failed	Failed	Failed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: McGean-Rohco
PRODUCT: Cee-Bee A245
TEMPERATURE (C): 121.1 (250 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Passed	Passed
A3	Failed	Failed	Failed
A4	Passed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Failed	Failed	Passed
S2	Passed	Passed	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Passed	Passed	Passed
S6	Failed	Passed	Passed

COMPANY: McGean Rohco
PRODUCT: Cee-Bee A477
TEMPERATURE (C): 100 (212 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Failed	Passed
A3	Passed	Passed	Passed
A4	Passed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Passed	Passed	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Passed	Passed	Passed
S6	Failed	Passed	Passed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: McGean-Rohco
PRODUCT: Cee-Bee A227D (Control)
TEMPERATURE (C): Ambient
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Passed
A2	Failed	Failed	Passed
A3	Passed	Passed	Passed
A4	Passed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Passed	Passed	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Passed	Passed
S6	Failed	Failed	Failed

COMPANY: McGean Rohco
PRODUCT: Cee-Bee A458 (Control)
TEMPERATURE (C): Ambient
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Passed	Passed
A3	Failed	Failed	Failed
A4	Failed	Failed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Passed	Passed	Passed
S3	Failed	Failed	Failed
S4	Passed	Passed	Passed
S5	Failed	Failed	Failed
S6	Failed	Failed	Failed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: McGean Rohco
PRODUCT: Cee-Bee J-59 (Control)
TEMPERATURE (C): 93.3 (200 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
S1	Failed	Failed	Passed
S2	Passed	Passed	Passed
S3	Failed	Failed	Passed
S4	Passed	Passed	Passed
S5	Failed	Passed	Passed
S6	Failed	Failed	Failed

COMPANY: Patclin Chemical
PRODUCT: Patclin 126 Hot Dip
TEMPERATURE (C): 87.8 (190 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Passed	Passed	Passed
A2	Failed	Failed	Passed
A3	Failed	Failed	Passed
A4	Failed	Failed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Failed	Failed.	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Passed	Passed
S6	Failed	Failed	Passed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: Pavco
PRODUCT: Decoater 3400
TEMPERATURE (C): 93.3 (200F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Passed	Passed	Passed
A3	Failed	Failed	Failed
A4	Failed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Failed	Failed	Passed
S3	Failed	Failed	Failed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

COMPANY: Rochester Midland
PRODUCT: PSS 600
TEMPERATURE (C): 65.6 (150 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Failed	Failed
A3	Failed	Failed	Failed
A4	Failed	Failed	Failed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Failed	Failed	Failed
S3	Failed	Failed	Failed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: Turco
PRODUCT: T-5668
TEMPERATURE (C): 71.1 (160 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Passed	Passed
A3	Failed	Failed	Failed
A4	Passed	Passed	Passed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Passed	Passed	Passed
S3	Passed	Passed	Passed
S4	Passed	Passed	Passed
S5	Passed	Passed	Passed
S6	Failed	Failed	Failed

COMPANY: U.S. Polychem
PRODUCT: PXP Salome "M"
TEMPERATURE (C): 65.5 (150 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Failed	Failed
A3	Failed	Failed	Failed
A4	Failed	Failed	Failed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Passed	Passed	Passed
S3	Failed	Failed	Passed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

PAINT STRIPPING EFFICIENCY TEST

COMPANY: Witco
PRODUCT: Stripper MCR
TEMPERATURE (C): 71.1 (160 F)
CONCENTRATION: Neat

PAINT SYSTEM AND METALS	15 MINUTES	30 MINUTES	60 MINUTES
A1	Failed	Failed	Failed
A2	Failed	Failed	Failed
A3	Failed	Failed	Failed
A4	Failed	Failed	Failed
A5	Failed	Failed	Failed
A6	Failed	Failed	Failed
S1	Passed	Passed	Passed
S2	Passed	Passed	Passed
S3	Failed	Passed	Passed
S4	Passed	Passed	Passed
S5	Failed	Failed	Passed
S6	Failed	Failed	Failed

APPENDIX N
IMMERSION CORROSION TEST DATA

CORROSION DATA

COMPANY: CHEMICAL METHODS
PRODUCT: CM 3707
CONDITIONS: 166 hrs., concentrated
TEMPERATURE: 90.6 C
DATE: May 2-9, 1990

COUPON	CORROSION RATE (mils/yr)	DESCRIPTION
AL7075#10	0.08	No pits.
AL7075#11	0.13	No pits, brown discoloration on back.
AL7075#12	0.05	No pits.
AL2024#19	0.03	No pits.
AL2024#20	0.00	No pits.
AL2024#21	0.05	No pits
AL2024AN#19	*-0.16	No pits.
AL2024AN#20	*-0.11	No pits.
AL2024AN#21	*-0.11	No pits.
C1020#34	*-0.02	No pits, brown discoloration
C1020#35	*-0.01	No pits, brown discoloration
C1020#36	0.01	No pits, brown discoloration
C1020CD#25	1.08	Cadmium coating severely pitted, 0.001mm deep, 0.008mm in diameter, steel not corroded.
C1020CD#26	1.46	Cadmium coating severely pitted, 0.0015mm deep, steel not corroded.
C1020CD #27	1.26	Cadmium coating severely etched, 0.002mm deep, steel not corroded.
MAG#19	*-5.81	No pits, heavy brown film over entire surface.
MAG#20	*-5.97	No pits, heavy brown film over entire surface.
MAG#21	*-5.68	No pits, heavy brown film over entire surface.
TI#10	0.00	No pits.
TI#11	0.03	No pits.
TI#12	*-0.03	No pits, brown discoloration.

*(- is gain)

CORROSION DATA

COMPANY: CHEMICAL SOLVENTS
PRODUCT: SP 800
CONDITIONS: 87.5 hrs., concentrated
TEMPERATURE: 93.3 C
DATE: May 16-24, 1990

COUPON	CORROSION RATE (mils/yr)	DESCRIPTION
AL7075#16	*-0.23	No pits, patchy brown and blue discoloration.
AL7075#17	*-0.12	No pits, patchy brown and blue discoloration.
AL7075#18	*-0.07	No pits, patchy blue and brown discoloration.
AL2024#25	*-0.21	No pits, patchy brown discoloration.
AL2024#26	*-0.05	No pits, upper right corner discolored black.
AL2024#27	*-0.07	No pits, brown discoloration.
AL2024AN#32	*-0.28	No pits.
AL2024AN#33	*-0.38	No pits.
AL2024AN#37	*-0.26	No pits.
C1020#5	*-0.04	No pits, blue and brown discoloration.
C1020#6	0.00	No pits, blue and brown discoloration.
C1020#37	0.02	No pits, blue and brown discoloration.
C1020CD#38	0.39	Cadmium coating corroded down uniformly, 0.002mm deep, all of steel surface still coated thinly.
C1020CD#39	0.34	Cadmium coating corroded down uniformly, less than 0.001mm deep, all of steel surface still coated.
C1020CD#40	0.34	Cadmium coating corroded down uniformly, less than 0.001mm deep, all of steel surface still coated.
MAG#25	*-5.77	Brown and gray scale not removed by acid treatment, 233 areas of radial etching, average depth 0.015mm.
MAG#26	*-1.40	Brown scale not removed by acid treatment, 197 areas of radial etching, average depth 0.020mm.
MAG#27	*-4.77	Brown scale not removed by acid treatment, 261 areas of radial etching, average depth 0.015mm.
Ti#16	*-0.03	No pits, patchy brown discoloration.
Ti#17	0.00	No pits, patchy brown discoloration.
Ti#18	*-0.02	No pits, patchy brown discoloration.

*(- is gain)

CORROSION DATA

COMPANY: FINE ORGANICS
PRODUCT: F.O. 606
CONDITIONS: 164 hrs., concentrated
TEMPERATURE: 71.1 C
DATE: April 11-18, 1990

COUPON	CORROSION RATE (mils/yr)	DESCRIPTION
AL7075#28	81.71	Uniform corrosion 0.04mm deep, surface smooth with light etching.
AL7075#29	75.49	Uniform corrosion 0.09mm deep, surface smooth with light etching, 33 pits along top edge where original surface persists, 0.04mm deep, 0.4mm diameter.
AL7075#30	80.38	Uniform corrosion 0.09mm deep, surface smooth with light etching.
AL2024#10	66.87	Bottom 4/5 corroded uniformly, 0.040mm deep, heavy etching, severe pitting between top 1/5 & bottom 4/5, depth 0.10mm, discolored brown within pitted area.
AL2024#11	65.81	Bottom 4/5 corroded uniformly, 0.080mm deep, heavy etching 0.3mm across, severe pitting between top 1/5 and bottom 4/5, 0.09mm deep and discolored brown.
AL2024#12	66.44	Bottom 4/5 corroded uniformly, 0.060mm deep, heavy etching 0.4mm across, severe pitting between top 1/5 and bottom 4/5, 0.10mm deep and discolored brown.
AL2024AN#7	82.68	Uniform corrosion 0.12mm deep, severe pitting 0.004mm below corroded surface.
AL2024AN#8	80.52	Uniform corrosion 0.10mm deep, severe pitting 0.005mm below corroded surface.
AL2024AN#9	84.87	Uniform corrosion 0.10mm deep, severe pitting 0.005mm below corroded surface.
C1020#13	0.08	No pits.
C1020#14	0.06	No pits.
C1020#15	0.11	No pits, blue and brown discoloration.
C1020CD#A	1.53	Cadium coating gone, no pits in steel surface, beige film covers surface.
C1020CD#17	2.67	Cadium coating gone bottom 4/5 beige film covers bottom 4/5, top 1/5 severely pitted, 0.002mm deep, top 1/5 discolored pink, green & yellow.
C1020CD#18	3.32	Cadium coating gone over 2/3 surface and beige film covers these areas, other 1/3 of surface severely pitted, 0.002mm deep, discolored pink, green & yellow.
MAG#1	15.12	Severely pitted, 0.02-0.34mm deep, located on left half of front, discolored brown where no pits.
MAG#2	16.08	Severely pitted, 0.05-0.23mm deep, located on left 1/3 and top 1/3, discolored brown where no pits.
MAG#3	13.10	Severely pitted, 0.03-0.27mm deep, located on top 1/3 and bottom 1/3, brown discoloration where no pits.
Ti#31	0.01	No pits.
Ti#32	0.01	No pits.
Ti#33	0.03	No pits.

CORROSION DATA

COMPANY: FREDRICK GUMM
PRODUCT: CLEPO ENVIROSTRIP 222
CONDITIONS: 166 hrs., concentrated
TEMPERATURE: 87.8 C
DATE: May 2-9,1990

COUPON	CORROSION RATE (mils/yr)	DESCRIPTION
AL7075#13	148.64	Uniform corrosion over entire surface 0.04mm deep, scattered patches of black film.
AL7075#14	114.99	Uniform corrosion over entire surface 0.03mm deep, half of surface covered by dark gray film.
AL7075#15	151.88	Uniform corrosion over entire surface 0.04mm deep, half of surface covered by dark gray film.
AL2024#22	185.41	Severely pitted, 0.04-0.12mm deep, blue discoloration.
AL2024#23	187.52	Severely pitted, 0.04-0.15mm deep.
AL2024#24	187.63	Severely pitted, 0.04-0.10mm deep, black discoloration.
AL2024AN#22	174.06	Uniform corrosion, 0.02mm deep, patchy green film.
AL2024AN#23	172.48	Uniform corrosion, 0.04mm deep, patchy green film.
AL2024AN#24	177.18	Uniform corrosion, 0.03mm deep, patchy green film.
C1020#31	98.73	Uniform corrosion, 0.03mm deep, green discoloration.
C1020#32	98.19	Uniform corrosion, 0.03mm deep, green discoloration.
C1020#33	100.40	Uniform corrosion, 0.03mm deep, green & brown discol.
C1020CD#22	102.88	Cadmium coating completely gone, steel surface corroded uniformly 0.008mm deep, green discoloration.
C1020CD#23	119.10	Cadmium coating completely gone, steel surface corroded 0.007mm deep.
C1020CD#24	115.73	Cadmium coating completely gone, steel surface corroded 0.008mm deep.
MAG#22	148.98	Severely corroded in two uniform layers, at 0.06mm and 0.10mm deep, gray discoloration.
MAG#23	153.67	Severely corroded in two uniform layers, at 0.05mm and 0.10mm deep, gray discoloration.
MAG#24	153.75	Severely corroded in two uniform layers, at 0.06mm and 0.10mm deep, gray discoloration.
TI#13	0.00	No pits.
TI#14	0.05	No pits, brown discoloration.
TI#15	0.03	No pits.

CORROSION DATA

COMPANY: GAF
PRODUCT: M-PYROL
CONDITIONS: 168 hrs, concentrated.
TEMPERATURE: 65.5 C
DATE: March 28 - April 4, 1990

COUPON	CORROSION RATE (mils/yr)	DESCRIPTION
AL7075#25	*-0.03	No pits.
AL7075#26	0.05	No pits.
AL7075#27	0.03	No pits.
AL2024#4	0.00	No pits.
AL2024#5	0.00	No pits.
AL2024#6	0.00	No pits.
AL2024AN#28	0.03	No pits.
AL2024AN#29	*-0.08	No pits.
AL2024AN#30	0.05	No pits.
C1020#1	1.32	Orange & black oxidation, blue discoloration, 63 pits, red inside deepest pits, 0.008-0.26mm deep.
C1020#2	1.22	Orange oxidation, 57 pits, 0.02-0.05mm deep.
C1020#3	1.23	Orange oxidation, 43 pits, red inside deepest pits, 0.03-0.06mm deep.
C1020CD#4	0.38	Cadmium plating corroded away 0.008mm deep, steel not corroded covered by transparent film shaded blue, pink, yellow, and green.
C1020CD#5	0.31	45% of CD plating corroded away, average depth 0.008mm, some areas, plating gone and other areas are intact, steel not corroded, covered by transparent film.
C1020CD#6	0.27	CD plating corroded away uniformly 0.008mm deep, steel not corroded, covered by transparent film shaded pink, yellow, green, and blue.
MAG#28	0.33	No pits,orange and blue discoloration.
MAG#29	0.29	No pits, orange, blue, and brown discoloration.
MAG#30	0.33	No pits, orange, brown, and pink discoloration.
Ti#1	*-0.05	No pits, light orange discoloration.
Ti#2	*-0.08	No pits.
Ti#3	*-0.06	No pits, 1 area of orange discoloration.

*(- is gain)

CORROSION DATA

COMPANY: McGEAN-ROHCO
PRODUCT: CEE BEE A-245
CONDITIONS: 187.5 hrs., concentrated
TEMPERATURE: 121.1 C
DATE: May 16-14, 1990

COUPON	CORROSION RATE (mils/yr)	DESCRIPTION
AL7075#31	0.12	Upper 2/3 gray scale not removed by acid rinse, bottom 1/3 uniformly corroded 0.04mm deep with black discoloration.
AL7075#32	*-1.33	Upper 2/3 gray scale not removed by acid rinse, bottom 1/3 uniformly corroded 0.03mm deep with black discoloration.
AL7075#33	*-2.78	Upper 3/4 gray scale not removed by acid rinse, bottom 1/4 uniformly corroded 0.03mm deep with black discoloration.
AL2024#16	2.36	Severe pitting, 0.002-0.12mm deep, located bottom 2/3, black film over bottom 1/4, orange discoloration, acid cleaned
AL2024#17	2.83	Severe pitting, 0.002-0.08mm deep, severe etching, 0.002-0.01mm deep, located bottom 1/2, patchy black film bottom 1/4, brown discoloration, acid cleaned.
AL2024#18	2.50	Severe pitting, 0.002-0.10mm deep, located bottom 1/2, patchy black film over bottom 1/4, brown discoloration, acid cleaned
AL2024AN#25	6.14	Severe pitting, 0.002-0.085mm deep, severe etching, 0.002-0.008mm deep, patchy black film over bottom 2/3, brown discoloration, acid cleaned.
AL2024AN#26	6.73	Severe pitting, 0.002-0.08mm deep, severe etching, 0.002-0.008mm deep, patchy black film over bottom 2/3, brown discoloration, acid cleaned.
AL2024AN#27	5.69	Severe pitting, 0.002-0.06mm deep, severe etching 0.002-0.008mm deep, patchy black film over bottom 2/3, brown discoloration, acid cleaned.
C1020#28	*-0.24	No pits, thin gray film in patches.
C1020#29	*-0.26	No pits, thin gray film in patches.
C1020#30	*-0.22	No pits, thin gray film in patches.
C1020CD#19	*-0.16	No pits, yellow and pink discoloration.
C1020CD#20	*-0.14	No pits, yellow and pink discoloration.
C1020CD#21	*-0.11	No pits, yellow and pink discoloration.
MAG#4	*-5.47	No pits, brown scale over all even after acid.
MAG#5	*-5.29	No pits, brown scale over all even after acid cleaning.
MAG#6	*-4.85	No pits, brown scale over all even after acid cleaning.
TI#38	*-0.11	No pits, blue, pink, yellow, and green discoloration.
TI#39	*-0.12	No pits, blue, pink, yellow, and green discoloration.
TI#40	*-0.14	No pits, blue, pink, yellow, and green discoloration.

*(- is gain)

CORROSION DATA

COMPANY: McGEAN-ROHCO
PRODUCT: CEE BEE A-477
CONDITIONS: 168 hrs., concentrated
TEMPERATURE: 100 C
DATE: April 4-11, 1990

COUPON	CORROSION RATE (mils/yr)	DESCRIPTION
AL7075#22	33.04	Upper half discolored, brown & 492 pits, average depth 0.004mm and of 295 pits around middle, 0.014-0.026mm deep, bottom half corroded uniformly 0.012mm.
AL7075#23	32.13	Upper half discolored, brown & severe pitting, average depth 0.003mm, band of pits across middle, 0.04-0.06mm deep, bottom half corroded uniformly 0.022mm.
AL7075#37	33.02	Upper half discolored, brown & 300 pits, average depth 0.004mm, band of 270 pits across middle, 0.03-0.06mm deep, bottom half uniformly corroded 0.010mm.
AL2024#1	19.62	Dull, uniform corrosion approx. 0.001mm deep.
AL2024#2	19.62	Dull, uniform corrosion approx. 0.001mm deep.
AL2024#3	19.57	Dull, uniform corrosion approx. 0.001mm deep.
AL2024AN#1	38.33	Severe pitting of entire surface, average depth 0.005mm, average diameter 0.01mm, original surface completely gone.
AL2024AN#2	41.30	Severe pitting of entire surface, average depth 0.004mm, average diameter 0.009mm, original surface gone.
AL2024AN#3	40.94	Severe pitting of entire surface, average depth 0.004mm, average diameter 0.012mm, original surface gone.
C1020#16	0.06	No pits.
C1020#17	3.71	Dull, widespread corrosion 0.002mm deep, brown discoloration.
C1020#18	3.40	Dull, widespread corrosion 0.003mm deep, brown discoloration.
C1020CD#10	6.05	Dull, discolored, orange & blue, bottom 4/5 of coupon CD coating is gone & 45 pits, average depth 0.012mm.
C1020CD#11	3.93	Dull, discolored, orange & blue, bottom 4/5 of coupon CD coating is gone & 21 pits, average depth 0.008mm.
C1020CD#12	6.43	Dull, discolored, orange & blue, bottom 4/5 of coupon CD coating is gone & 37 pits, average depth 0.007mm.
MAG#31	*-4.80	No pits, dull, orange & blue film covers surface.
MAG#32	*-4.80	No pits, dull, orange & blue film covers surface.
MAG#33	*-4.96	No pits, dull, orange & blue film covers surface.
TI#28	0.00	No pits.
TI#29	0.00	No pits.
TI#30	*-0.05	No pits.

*(- is gain)

CORROSION DATA

COMPANY: PATCLIN CHEMICAL
PRODUCT: PATCLIN 126 HOT DIP
CONDITIONS: 166.5 hrs., concentrated
TEMPERATURE: 87.6 C
DATE: March 7-14, 1990

COUPON	CORROSION RATE (mils/yr)	DESCRIPTION
AL7075#38	194.53	Dull, scattered etching heaviest near edges, 0.7-2.0mm wide, depth 0.3mm, severe pitting, depth 0.02-0.06mm, pale blue discoloration.
AL7075#39	182.85	Dull, scattered etching, 1.0mm wide, 0.2mm deep, severe pitting depth 0.02-0.08mm, blue discoloration, bottom of etching shiny.
AL7075#40	175.25	Dull except bottom of etching, scattered etching, 1.0mm wide, 0.4mm deep, severe pitting, depth 0.02-0.10mm, blue discoloration.
AL2024#38	249.15	Dull, scattered etching heaviest near edges, width 1.0-4.0mm, depth 0.4mm, severe pitting, depth 0.06-0.10mm, black oxidation in pits.
AL2024#39	252.18	Dull, scattered etching heaviest near edges, width 1.0-5.0mm, depth 0.4mm, severe pitting, depth 0.06-0.08mm.
AL2024#40	246.12	Dull, scattered etching heaviest near edges, width 1.0-3.0mm, depth 0.3mm, severe pitting, depth 0.02-0.09mm, black oxidation in pits.
AL2024AN#38	441.53	Dull, scattered black oxidation, severe corrosion, one layer, widespread 0.03mm deep, severe pitting, depth 0.02-0.25mm, diameter 0.02-0.50mm.
AL2024AN#39	460.32	Dull, light oxidation in pits, edges discolored pale blue, severe corrosion, one layer, widespread 0.05mm deep, severe pitting, depth 0.01-0.17mm, diameter 0.3mm.
AL2024AN#40	447.80	Dull, pale green discoloration, light oxidation in pits, severe corrosion, one layer, widespread 0.02mm deep, severe pitting, depth 0.01-0.3mm, di0.15mm.
C1020#38	82.21	Dull, brown, green, orange discoloration, uniform corrosion over entire surface, 0.01mm deep, 567 pits, depth 0.01-0.06mm, diameter 0.4mm.
C1020#39	89.29	Dull, dark orange, brown discoloration, pits black inside, widespread uniform corrosion 0.02mm deep, 360 pits, depth 0.03-0.08mm, diameter 0.2mm.
C1020#40	82.51	Dull, dark orange, brown discoloration, uniform corrosion over entire surface, 0.02mm deep, 763 pits, depth 0.02-0.26mm, diameter 0.09-0.40mm.
C1020CD#7	75.88	Cadmium coating gone, yellow, red, orange discoloration, dull scattered layers of uniform corrosion 0.02-0.08mm deep, 71 pits, depth 0.12-0.30mm.
C1020CD#8	94.17	Scattered areas of CD coating remain near edges only, yellow, red, orange discoloration, scattered layers of uniform corrosion, 0.005-0.12mm deep.
C1020CD#9	71.24	CD coating gone, yellow, red, orange discoloration, one layer corrosion 0.08mm deep, severe pitting, depth 0.004mm, dull, pits red inside.

CORROSION DATA

COMPANY: PATCLIN CHEMICAL
PRODUCT: PATCLIN 126 HOT DIP
CONDITIONS: 166.5 hrs., concentrated
TEMPERATURE: 87.6 C
DATE: March 7-14, 1990

COUPON	CORROSION RATE (mils/yr)	DESCRIPTION
MAG#7	229.68	Dull, white, 56 pits penetrate coupon, severe pitting, depth 0.04-0.08mm, 123 larger pits, depth 0.20-0.60mm, diameter 1.0mm, gray discoloration.
MAG#8	255.70	Dull, gray discoloration, 41 pits penetrate coupon, severe pitting, depth 0.04-0.08mm, 157 larger pits, depth 0.2-0.5mm, diameter 1.0-1.6mm.
MAG#9	233.36	Dull, white, 34 pits penetrate coupon, severe pitting, depth 0.04-0.09mm, 231 larger pits, depth 0.5-0.9mm, diameter 0.5-1.0mm.
Ti#7	40.23	Dull, uniform corrosion of entire surface 0.007mm deep, obscures grain of metal.
Ti#8	31.60	Dull, uniform corrosion of entire surface 0.005mm deep, obscures grain of metal, light orange discoloration.
Ti#9	39.91	Dull, uniform corrosion of entire surface 0.007mm deep, obscures grain of metal, light orange discoloration.

CORROSION DATA

COMPANY: ROCHESTER MIDLAND
PRODUCT: PSS 600
CONDITIONS: 168 hrs, concentrated
TEMPERATURE: 65.6 C
DATE: March 28 - April 4, 1990

COUPON	CORROSION RATE (mils/yr)	DESCRIPTION
AL7075#19	0.08	No pits.
AL7075#20	0.00	No pits.
AL7075#21	0.05	No pits.
AL2024#7	*-0.03	No pits.
AL2024#8	0.00	No pits.
AL2024#9	0.00	No pits.
AL2024AN#34	0.00	No pits.
AL2024AN#35	*-0.08	No pits.
AL2024AN#36	0.00	No pits.
C1020#7	3.17	Orange discoloration, uniform layer of corrosion, 0.004mm deep, areas of original surface still present.
C1020#8	3.91	Orange & blue discoloration, areas of corrosion 0.012-0.014mm deep, areas of original surface still present.
C1020#9	3.92	Orange discoloration, scattered areas of corrosion 0.01-0.02mm deep, areas of original surface left.
C1020CD#1	2.00	No pits, cadmium plating completely gone.
C1020CD#2	1.87	No pits, 85% of CD plating corroded away in patches.
C1020CD#3	1.23	No pits, 75% of CD plating corroded away in patches.
MAG#38	123.10	Dull, two layers of corrosion, one layer 0.04-0.06mm deep, discolored brown and orange, second layer 0.08-0.10mm deep colored shiny silver, both interspersed.
MAG#39	121.91	Dull, two layers of scattered areas of corrosion, one layer 0.04-0.06mm deep, discolored, solid brown and orange, second layer shiny silver, 0.09-0.12mm deep.
MAG#40	113.80	Dull, two layers of scattered areas of corrosion, one layer 0.04-0.06mm deep, discolored, solid brown and orange, second layer shiny silver, 0.09-0.16mm deep.
Ti#4	*-0.03	No pits.
Ti#5	0.00	No pits.
Ti#6	0.00	No pits.

*(- is gain)

CORROSION DATA

COMPANY: TURCO
PRODUCT: TURCO 5668
CONDITIONS: 164 hrs., concentrated
TEMPERATURE: 71.1 C
DATE: April 11-18, 1990

COUPON	CORROSION RATE (mils/yr)	DESCRIPTION
AL7075#34	*-0.27	62 pits, 0.002-0.008mm deep, black discoloration, transparent film over entire surface.
AL7075#35	*-0.19	96 pits, 0.002-0.006mm deep, red and black discoloration, transparent film over surface.
AL7075#36	*-0.19	53 pits, 0.002-0.006mm deep, light oxidation, brown discoloration, transparent film over surface.
AL2024#13	*-1.57	249 pits, 0.002mm deep, transparent film over all, top 4mm corroded at 0.004mm deep.
AL2024#14	*-1.56	431 pits, 0.002mm deep, transparent film over all, top 5mm corroded at 0.004mm deep.
AL2024#15	*-1.65	464 pits, 0.002mm deep, transparent film over all, top 5mm corroded at 0.004mm deep.
AL2024AN#4	*-0.92	Heavy gray film over 1/2 surface, not removed by acid.
AL2024AN#5	*-0.78	Heavy gray film over 1/2 surface, not removed by acid.
AL2024AN#6	*-1.81	Heavy gray film over 1/2 suurface, brown discoloration.
C1020#10	0.04	No pits, thin line of brown discoloration 1/4 from top.
C1020#11	*-0.06	No pits, brown discoloration over top 1/4, white film covers bottom 3/4.
C1020#12	*-0.04	No pits, white film over surface, brown discoloration top 1/4 of coupon.
C1020CD#13	1.09	Uniform corrosion of cadmium coating 0.002mm deep, no corrosion of steel, brown discoloration.
C1020CD#14	0.86	Uniform corrosion of cadmium coating 0.0012mm deep, no corrosion of steel, brown discoloration.
C1020CD#15	0.90	Uniform corrosion of cadmium coating 0.0015mm deep, no corrosion of steel, brown discoloration.
MAG#34	*-3.82	No pits, dull, orange and blue film over surface.
MAG#35	*-3.78	No pits, dull, orange, blue, & brown film over surface.
MAG#36	*-4.07	No pits, dull, orange, blue, brown & yellow film.
TI#34	*-0.01	No pits.
TI#35	0.00	No pits.
TI#36	0.02	No pits, brown discoloration.

*(- is gain)