1990 Annual Nonradiological Environmental Operating Report for Fermi 2

(In accordance with Appendix B to Facility Operating License No. NPF-43)

Table of Contents

Section I

Executive Summary

Executive Summary

In 1990, Fermi 2 generated power for over 284 effective full power days and had an overall capacity factor of 77 percent.

The Environmental Protection Plan (EPP) provides for protection of environmental values during any additional construction and the operation of Fermi 2. The principal objectives of the EPP are as follows:

1. Verify that Fermi 2 is operated in an environmentally acceptable manner, as established by the Final Environmental Statement (FES) and environmental impact assessments.

2. Coordinate NRC requirements and maintain consistency with other State and local requirements for environmental protection.

3. Keep the NRC informed of the environmental effects of facility construction and operation and of actions taken to control those effects.

Environmental concerns identified in the FES which relate to water quality matters are regulated by way of Fermi's National Pollutant Discharge Elimination System (NPDES) permit. As such, water quality issues are not required to be addressed in this report.

The components of the EPP are:

1. A terrestrial monitoring program to detect long-term or sudden changes in vegetation due to operation of Fermi 2.

2. A program to establish the controlled use of herbicides on transmission rights-of-way.

3. A program to ensure that changes to Fermi's design or operation and potential tests or experiments are adequately reviewed prior to implementation to avoid adverse environmental impacts not previously evaluated. Changes in plant design, operation or the performance of tests or experiments which do not effect the environment or which are required to achieve compliance with other Federal, State or local environmental regulations, are not subject to the requirements of this EPP.

4. Routine monitoring for evidence of unusual or important environmental events.

A terrestrial monitoring program was conducted to measure key terrestrial parameters after startup of the Fermi 2 facility for comparison with corresponding measurements obtained prior to startup. This study focuses on effects due to the operation of the cooling towers at Fermi 2. The Fermi 2 Environmental Protection Plan requires aerial remote sensing during the first July-September period after the station has been in operation for one year. Because this type of study focuses on effects caused by the operation of the cooling towers at the Fermi 2 site, Detroit Edison's first post-operational survey was performed during the July-September 1987 period and the first followup of the survey program was performed during the July to September 1988 period. The second of four required followup post-operational surveys was performed during the August-September, 1990 period. Additional followup surveys are required to be performed in 1992 and 1994.

Color infrared aerial photographs were used to delineate cover types, vegetation stress patterns, and crop land use in the 39 square-mile Fermi 2 survey area. Soil samples were collected and analyzed from areas expected to receive a wide range of cooling tower salt drift deposition on soils. These analyses provided the third opportunity since the plant began operation to evaluate vegetation stress that could be attributable to plant operation. In 1990, the signs of vegetation stress were distributed in such a way as to suggest no correlation with the predicted pattern of solid deposition from the cooling towers as described in the Environmental Report-Operating License Stage, Section 5.1.4.2.6. This would suggest that other explanations (i.e. localized soil water logging) appear to be more probable. Soil analyses varied little for 1990 data. No correlation between pH and conductivity values and their respective zones of deposition could be found. The pH and conductivity of the samples continue to be consistent with good fertility and low ionic stress. Although 1990 chloride values were higher than previous years, the highest value remains an order of magnitude below soil-water chloride concentrations that have been associated with severe injury to salt-sensitive plants. Again, no correlation of the 1990 values with deposition zones could be found.

A copy of the 1990 REMOTE SENSING AND VEGETATION GROUND TRUTH PROGRAM report and a set of aerial photograph transparencies covering the area within a 2.5 kilometer radius around the Fermi 2 cooling towers are enclosed (Appendix 1).

The use of herbicides at Fermi 2 must conform to the approved use of selected herbicides as registered by the Environmental Protection Agency, approved by State authorities, and applied in accordance with State requirements. Records are maintained at the site concerning herbicide use. These records include the following information: commercial and chemical names of material used, concentration of active material in formulations diluted for field use; diluting substances other than water; rates of application, method and frequency of application; location; and the date of application.

Before engaging in additional construction or operational activities which might affect the environment, Fermi 2 would prepare and record an environmental evaluation of such activity. If the evaluation should indicate that the proposed activity would involve an unreviewed environmental question, Detroit Edison would provide a written evaluation of the activity and obtain prior approval from the Director, Office of Nuclear Reactor Regulation. Activities are excluded from this requirement if all measurable, non-radiological effects are confined to the on-site areas previously disturbed during site preparation and plant construction. During the period covered by this report, there were no changes to station design or operation, tests, or experiments which involved potentially significant unreviewed environmental issues.

Any unusual occurrence or important event which indicates, or could result in, significant environmental impact causally related to plant operation is reported to the the NRC within 24 hours followed by a written report. The following are considered examples of unusual or important environmental events: excessive bird impaction events, onsite plant or animal disease outbreaks, mortality or unusual occurrence of any species protected by the Endangered Species Act, fish kills, and an increase in nuisance organisms or conditions.

During the reporting period, several environmental incidents/concerns occurred, none of which posed any significant environmental impact causally related to plant operation. As such, they did not warrant classification as unusual or important environmental events (Appendix B to Facility Operating License No. NPF-33, section 4.1). Accordingly no non-routine reports were submitted. However, these incidents are noted in this report to provide an all-encompassing record of environmental incidents at Fermi 2. These are summarized below:

- One spill occurred at Fermi 2 during the reporting period. On January 28, 1990, approximately 50 gallons of raw sewage entered the storm sewer system. The spill was due to a blockage of the sewage forwarding station discharge line, and subsequent failure of septic tank high level alarms. Sewage backed-up into the septic tank and overflowed to an adjacent storm sewer. The system was isolated and flow to the tank terminated. Maintenance crews cleared the blocked discharge line and repaired the faulty level alarms. This was a minor spill and did not produce any observable environmental impact. A copy of the Spill Notification Follow-up Report submitted to the Michigan Department of Natural Resources is included in Appendix 2.

- Monitoring of Fermi 2 raw water cooling systems for the presence of Corbicula (Asiatic clam) and Zebra mussels continued in 1990 in accordance with the Corbicula Monitoring Program (see Annual Non-Radiological Environmental Monitoring Report - 1989, previously submitted).

Zebra mussels were first discovered in 1989, colonizing the General Service Water (GSW) intake structure and GSW cooled heat exchangers. Zebra mussel monitoring conducted in May 1990 revealed a 9.4% increase in Zebra mussel densities present on GSW intake structures over 1989 results. In September 1989, the Zebra mussel populations consisted primarily of young-of-the-year mussels (2/3 of the individuals were less than 2 mm in length). By May 1990, most of the population was 2 - 7 mm in length (see Technical and Engineering Services Report 90H19-1, Appendix 3). Populations of this magnitude did not impose sufficient threat to the GSW supply to warrant the cost of mechanical cleaning of the intake structure. The need for mechanical cleaning will be evaluated again pending results of the May 1991 inspection.

The GSW and Fire Protection systems received two molluscicide applications in 1990. Betz Clam-Trol CT-1 was applied to these systems on July 3, 1990 and November 29, 1990. Zebra mussel mortality due to treatment was estimated at 100% and 85% respectively (see Zebra Mussel Sterilization Reports, Appendix 3).

Approximately three weeks following the July 3, 1990 treatment, while operating at 100% power, reduced heat exchanger efficiency was noted on the top Main Turbine Lube Oil (MTLO) cooler. The standby cooler (bottom MTLO cooler) was placed in service to allow the top cooler to be opened for inspection. Inspection revealed approximately 85% blockage of the GSW inlet tube sheet with dead Zebra mussel shells. The cooler was hydrolased to remove the shell debris and returned to service. The bottom MTLO cooler was then removed from service and similarly cleaned. Performance testing was subsequently performed on all remaining GSW supplied heat exchangers in service (Reactor Building Closed Cooling Water, Turbine Building Closed Cooling Water, and Generator Hydrogen Cooling heat exchangers). Decreased heat exchanger efficiencies were observed on the Reactor Building and Turbine Building closed cooling system heat exchangers of varying degree. Thermal loads for these heat exchangers were shifted to standby coolers to allow for inspection. Inspection revealed varying degrees of fouling by dead Zebra mussel shells. The coolers were cleaned and placed back in service.

The second Zebra mussel sterilization conducted in November 1990 did not result in any decrease in thermal efficiencies for GSW supplied heat exchangers. It is anticipated that reoccurrence of fouling problems such as were experienced in July 1990 will be prevented by scheduling future treatments at sufficient frequency to prevent any newly attached mussels from growing to lengths in excess of the smallest GSW supplied heat exchanger tube diameter (MTLO coolers-5/8" tube diameter). Periodic Zebra mussel sterilizations coupled with increased frequency performance testing and cleaning of GSW supplied heat exchangers should maintain control of Zebra mussels at Fermi.

On July 19, 1990, Fermi's NPDES Permit No. MI0037028 was approved for reissue by the Michigan Water Resources Commission. The Permit, which consolidated the plant's previously existing four permits, contains several new provisions as summarized below:

Previous Outfall Number	New Outfall Number	Parameter	Previous Effluent Limitation	New Effluent Limitation
001 Permit No. MI0037028	*	Total Chromium Total Zinc pH	200 ppb 1000 ppb 6-9	81 ppb 86 ppb 6.5-9
009 Permit No. MI0037028	*	pH	6-9	6.5-9
001 Permit No. MI0001830	011	pH Heat Addition	6-9 17.9E8 BTU/hr	6.5-9 Parameter deleted
00A Permit No. MI0001830	00C	*	*	*
00B Permit No. MI0001830	00D	*	*	*
002 Permit No. MI0001830	012	*	*	*
001 Permit No. MI0039365	013	pH	6-9	6.5-9
002 Permit No. MI0039110	Deleted	N/A	N/A	N/A

* Indicates no change

In addition, several Special Conditions were mandated by the new permit; as follows:

1. Fermi must conduct a one-time short term waste characterization study for Outfall 001. The study requires Fermi to quantify concentrations of metals discharged to Lake Erie (Part I, Special Condition A.14).

2. Fermi must conduct an analysis of a grab sample on Outfalls 009 and 011 for a GC/MS Scan for Volatile compounds , Acid compounds and PCBs (Part I, Special Condition A.15).

3. Fermi must provide the Michigan Department of Natural Resources with sufficient data to demonstrate that concentrations of water additives currently used do not exceed specified effluent limitations (Part I, Special condition A.18).

In accordance with Section 3.2 of the Fermi 2 Environmental Protection Plan, a copy of reissued NPDES Permit No. MI0037028 was submitted to the NRC on August 17, 1990 (NRC-90-0137).

Section II

Appendices

Appendix 1

Appendix 1 consists of the Fermi 2 Power Plant Remote Sensing and Vegetation Ground Truth Program 1990 Final Report, and a full set of aerial photograph transparencies covering all imagery within a 2.5 kilometer radius around the Fermi 2 cooling towers.

Appendix 2

Appendix 2 consists of the follow-up spill report submitted to the Michigan Department of Natural Resources for a sewage spill that occurred January 28, 1990.

Detroit Edison
2000 Second Avenue
Detroit, Michigan 48226
(313) 237-8000

February 8, 1990

Mr. P. D. Zugger, Chief
Surface Water Quality Division
Michigan Department of Natural Resources
P. O. Box 30028
Lansing, MI 48909

Re: Spill Notification Follow-up Report
Fermi-2 Power Plant NPDES Permit No. MI0037028

Dear Mr. Zugger:

In accordance with Part [illegible] of NPDES Permit No. MI0037028 and the Part V Rules of the Water Resources Commission, the Detroit Edison Company is submitting this follow-up report to the spill notification made by the Nuclear Shift Supervisor of the Fermi-2 Power Plant on January 28, 1990 at approximately 2039 hours to Mr. Roy Schrameck of the Detroit District Office.

At approximately 2005 hours on January 28, 1990, a plant operator on routine rounds discovered that approximately 50 gallons of sewage had overflowed from a backup sewage collection tank into the plant parking lot and flowed by way of the storm sewer into Swan Creek through Outfall 002. The system was isolated and flow to the tank terminated. A contractor was called to pump out the contents of the tank and dispose of the sewage.

The cause of the spill was a blockage in the line between the plant and the municipal sewer system and the failure of the high level alarm on the tank. The sewer line has been cleared and the high level alarm repaired. The system has been returned to service.

The plant staff is reviewing the system's preventive maintenance program and the system design to determine if further medial action is required to prevent a reoccurrence of the incident.

If you have any questions relative to the incident or this report, please contact me on (313) 237-7021.

Sincerely,

Arthur Heidrich, Jr.
Administrator
Water and Land Use Programs
Environmental Protection

AH:ll

cc: R. Schrameck
Hae-Jin Yoon

bcc: J. Flynn
F. Lehmann
M. Sterling
W. Terrasi

Appendix 3

Appendix 3 contains a copy of Detroit Edison - Technical and Engineering Services Report 90H19-1 delineating the status of the Zebra mussel infestation at Fermi. Appendix 3 also contains copies of Zebra mussel sterilization reports prepared by Betz Industrial for molluscicide applications conducted at Fermi in 1990.

Detroit
Edison

Date: July 10, 1990

To: F. M. Lehmann
Nuclear Operations

From: W. P. Kovalak
Technical and Engineering Services

Subject: **Abundance of Zebra Mussels at Fermi 2**
Technical & Engineering Services Report 90H19-1

This report summarizes results of quantitative sampling of zebra mussels (Dreissena polymorpha) on concrete surfaces at the general service water (GSW) pumphouse at Fermi 2. Sampling was carried out on September 8, 1989 and May 7, 1990. These studies were part of Company-wide monitoring of zebra mussels at cooling water intakes.

Similar sampling procedures were used on both dates. The sampler was a metal sleeve with a square opening at one end and a round opening at the other (Figure 1). The round end is fitted with a knee-length nylon stocking. In September 1989 the sampler was used as a scraper. It was pushed vertically along the concrete surface over a distance of 8 inches. The dislodged mussels accumulated in the stocking. In May 1990 the sampler was held perpendicular to the concrete surface while a spatula was used to remove mussels around the sampler. The spatula was then used to dislodge the mussels enclosed by the sampler and direct them into the stocking.

Twelve quantitative samples were collected on each date. Samples were collected near surface, mid-depth and near bottom at 4 locations on vertical concrete surfaces of the GSW pumphouse. In September 1989 samples were collected 1,5 and 10 feet below surface and in May 1990 samples were collected 4, 7 and 12-14 feet below surface. In September 1989 the area of each sample was 32 sq. inches whereas in May 1990 sample area was 16 sq. inches.

In September 1989 mean density was 26,415 (range 4,408-69,411) mussels per sq. meter. There was no consistent relationship between density and water depth although the highest density was near the surface. In May 1990 mean density was 28,893 (range 1,356-50,666) mussels per sq. meter. Densities were greater near the bottom than near the surface.

In September 1989 the population was composed primarily of young-of-the-year mussels spawned during 1989. More than 2/3 of the individuals were less than 2 mm in length (Figure 2). By May 1990 growth and mortality produced a more even size distribution. Most of the population was 2-7 mm in length.

There are several notable differences in the demographic characteristics of mussels at the GSW pumphouse at Fermi 2 and the cooling water intake at Monroe Power Plant. First, the density of mussels is about 30 times less at Fermi 2. Lower densities appear to be related to lower flow rates. At capacity Monroe draws about 1.4 million gpm whereas Fermi 2 draws about 35,000 gpm; the difference is about 40-fold. High flow rates concentrate large numbers of larvae in the intake resulting in rapid development of high population densities. Second, growth rates at Fermi 2 are lower than at Monroe Power Plant. In September 1989, 40 percent of the mussels at Monroe were less than 2 mm in length whereas at Fermi 2 70 percent were less than 2 mm in length. In May 1990 at Monroe 70 percent of mussels were 9-16 mm length whereas at Fermi 2 60 percent were 3-6 mm in length. Higher growth rates at Monroe probably were attributable to higher flow rates. Dr. R. Griffiths (Ontario Ministry of the Environment) indicated that in European waters growth rates are higher in flowing waters, including industrial water systems, than in still waters of lakes.

Overall, flow conditions at the GSW pumphouse operate to minimize infestation and fouling by zebra mussels. However, this does not preclude the possibility of serious fouling in the future. In Lake Erie the mussel population is growing at an explosive rate. Consequently, each spawning will yield increasing numbers of larvae to colonize intake structures and water systems. It is prudent to expect that this will continue until food or some other factor limits population growth. Presently, there is no way of predicting how large the population will grow before stabilization occurs.

Minimization of operational problems depends on effective monitoring and control programs. Monitoring should be most intense between late July and early November. Newly spawned mussels become visible in late July-early August. During this period, routine visual inspections allow rapid determination of control needs.

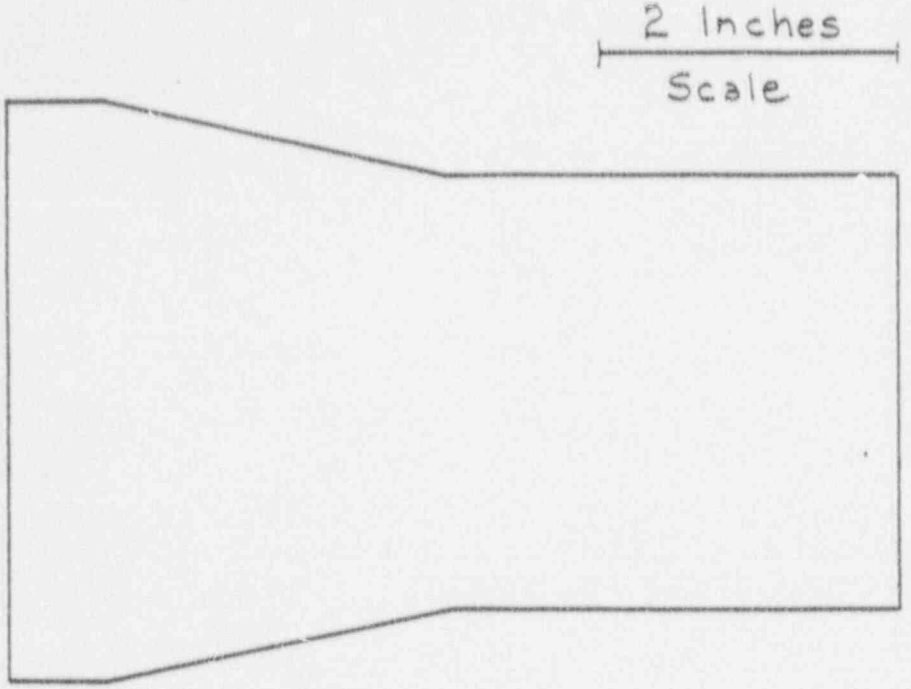
Where possible, mechanical removal, which is more environmentally acceptable, should be used. Chemical control should be used prudently. Indiscriminate use of toxicants allows rapid development of resistant strains as has occurred with a large number of insect pests.

Approved by: J. P. Cross /wgm

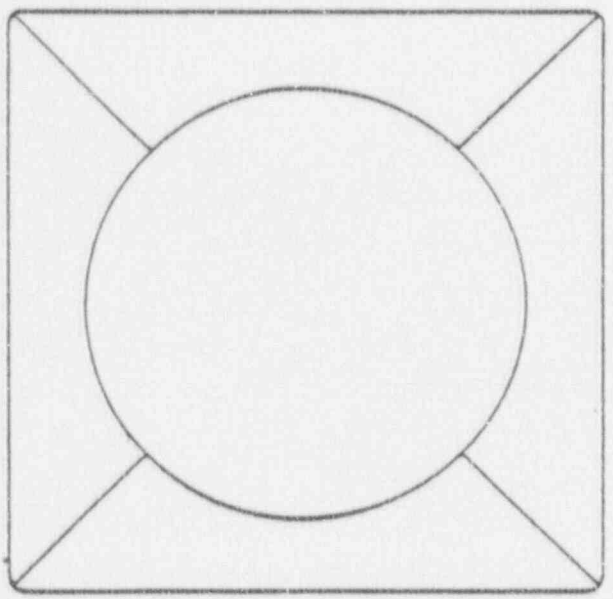
J. P. Cross
Supervisor, Environmental and
Regulatory Compliance

VPK/pah

Copies to: W. D. Gilbert
G. A. Horuczi (file)
G. D. Longton
R. D. Smithee



Side View



Front View

FIGURE 1: Design of sampler used to collect quantitative samples of zebra mussels.

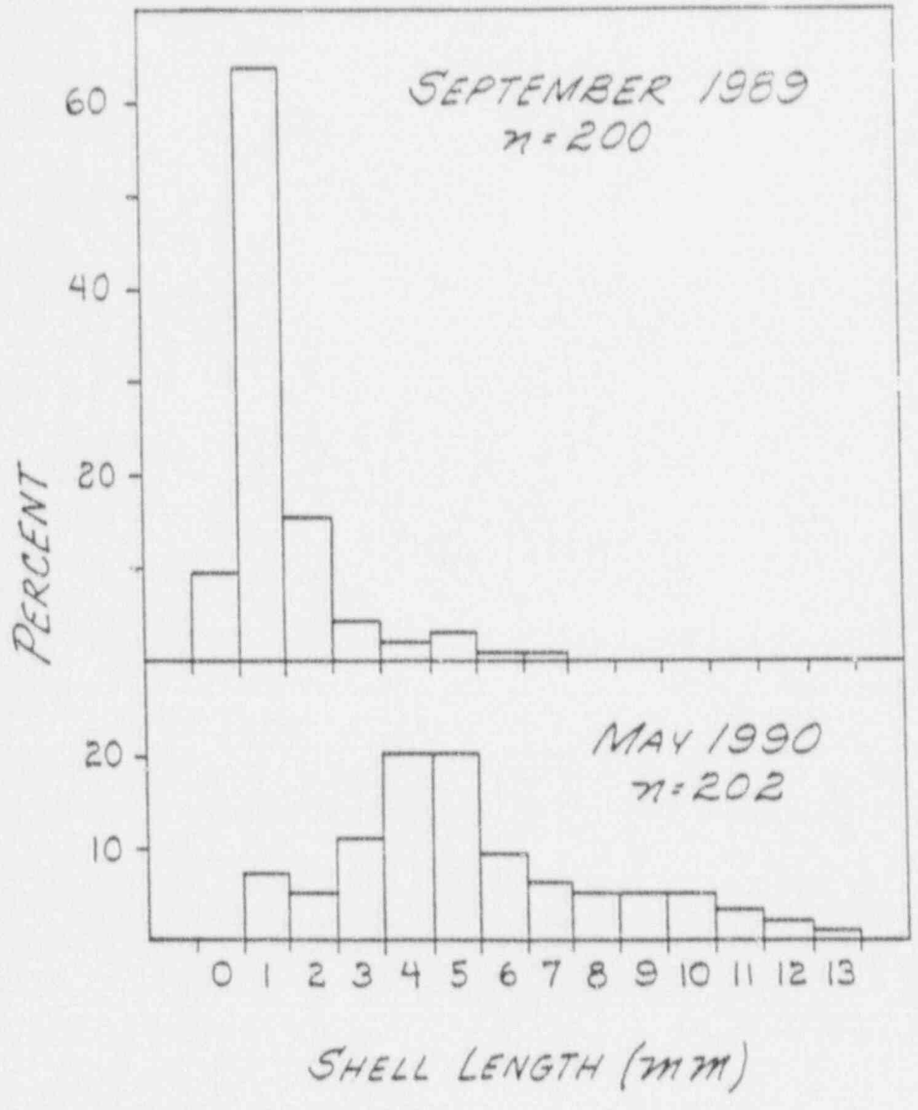


FIGURE 2: Comparison of the size frequency distribution of zebra mussels from the general service water pumphouse at Fermi 2 in September 1989 and May 1990

DETROIT EDISON
FERMI II NUCLEAR PLANT
NEWPORT, MI.

ZEBRA MUSSEL STERILIZATION
JULY 17, 1990

PREPARED BY:

Len Wall

LEN WALL
TECHNICAL SPECIALIST

TABLE OF CONTENTS

A. INTRODUCTION:

The following is a synopsis of the recent zebra mussel sterilization. This bi-annual sterilization is part of your macrofouling control program for the GSW and fire protection systems. The goal of this program is the control of zebra mussel infestation into these systems before the organisms reaches macrofouling sizes, thus preventing reduced efficiencies, increasing system reliability and eliminating potential downtime.

B. PROCEDURE:

The following is a guideline for the CT-1 sterilization of the GSW and fire protection systems. These procedures were modified due to the system being down during the sterilization.

1) Run a CT-1 demand test of the water to be treated.

2) Run baseline and CT-1 residual standards for the analytical test curve.

3) Place the system into recirculation mode.

4) Feed the CT-1 product to the suction side of the GSW circulating pumps. The product is fed via a positive displacement pump and through a sparger line. The exact product feedrate (gph) will be determined by a system demand and the number of circulating pumps in operation.

5) Feed the product such that at least 15 ppm. of product is in contact with the GSW systems for a period of six hours. The application duration was based on a water temperature of 70 F.

6) Run hourly tests on the bio-box monitor and throughout the treated systems in order to assure a 15 ppm product concentration.

7) Once the GSW system concentration has been verified at 15 ppm or greater, flush the fire protection system until a concentration of 15 ppm. is verified at the discharge. Upon residual verification, button up this system for a period of at least six hours.

8) Once a six hour application to all systems has been achieved, discontinue product feed.

9) Run a CT-1 test on the pond water to determine if detox. feed is needed. If required, feed appropriate quantity of detox.

10) Run analytical CT-1 test to insure complete product detoxification.

11) Resume normal system operation once product is verified detoxified.

C. APPLICATION SYNOPSIS:

The CT-1 sterilization was initiated at 8:45 AM on July 3, 1990. The chemical feed pump was set at approximately 17 gph. This feedrate was based on a water demand of 2.5 ppm (total product feedrate of 17.5 ppm.) and two GSW circulating pumps in operation.

At 9:45 AM, analytical test results indicated a CT-1 residual of 18.8 ppm at the bio-box (see monitoring section) outlet. At this time (since the CT-1 residual was greater than the minimum 15 ppm required), various auxiliary cooling systems and the fire header system were valved into service. The fire protection system was flushed until a residual of greater than 15 ppm. was achieved (21.1 actually achieved) and then the system was buttoned back up.

The CT-1 feed was continued until 5:00 PM. The extended time period was needed to insure a six hour contact time to some of the auxiliary cooling systems that were valved in last. As you can see from the feedrate chart and graph, the chemical feedrate was around 15 gph throughout the application. Unfortunately, the chemical feed pump that was incorporated was initially de

signed for a system operation of four GSW circulating pumps and the corresponding feedrate (the outage allowed for reduction to two pumps) and could not be lowered below the 7% stroke it was set at during this application. The total product usage amounted to 132 gallons of CT-1.

The analytical results from the bio-box monitor outlet indicated that CT-1 residuals of 18.8 to 21.7 ppm. were achieved for the desired six hour exposure (see chart and graph). Additionally, various samples from the GSW and fire protection system indicated a 15 ppm residual was achieved throughout.

At 5:00 PM, the chemical feed was stopped. Analytical tests of the cooling pond revealed a CT-1 residual of 0.14 ppm. The discharge permit was for less than 0.10 ppm. The feed of two drums of detox was therefore, necessary. This product was added at 5:45 PM. A subsequent pond test at 6:30 PM, indicate a residual of less than 0.10 ppm and the system was soon returned to normal operation.

CT-1 RESIDUALS

DATE	SAMPLE PT.	TIME	ELAPSED TIME	ABSORBANCE	CT-1 CONC.
07/03/90	BIOBOX	8:45 AM	0.00	TREATMENT STARTED	0.0
07/03/90	BIOBOX	9:10 AM	0.42	0.155	4.2
07/03/90	BIOBOX	9:45 AM	1.00	0.614	18.8
07/03/90	BIOBOX	10:45 AM	2.00	0.842	26.1
07/03/90	BIOBOX	11:45 AM	3.00	0.780	24.1
07/03/90	BIOBOX	12:45 PM	4.00	0.725	22.4
07/03/90	BIOBOX	1:45 PM	5.00	0.717	22.1
07/03/90	BIOBOX	2:45 PM	6.00	0.697	21.5
07/03/90	BIOBOX	3:45 PM	7.00	0.765	23.6
07/03/90	BIOBOX	4:45 PM	8.00	0.704	21.7
07/03/90	POND	4:15 PM	7.50	0.043	0.6
07/03/90	POND *	4:30 PM	7.75	0.153	0.14
07/03/90	POND	5:00 PM	8.25	TREATMENT STOPPED	
07/03/90	POND	5:45 PM	9.00	DETOX ADDED	
07/03/90	POND *	6:30 PM	9.75	0.100	< 0.1

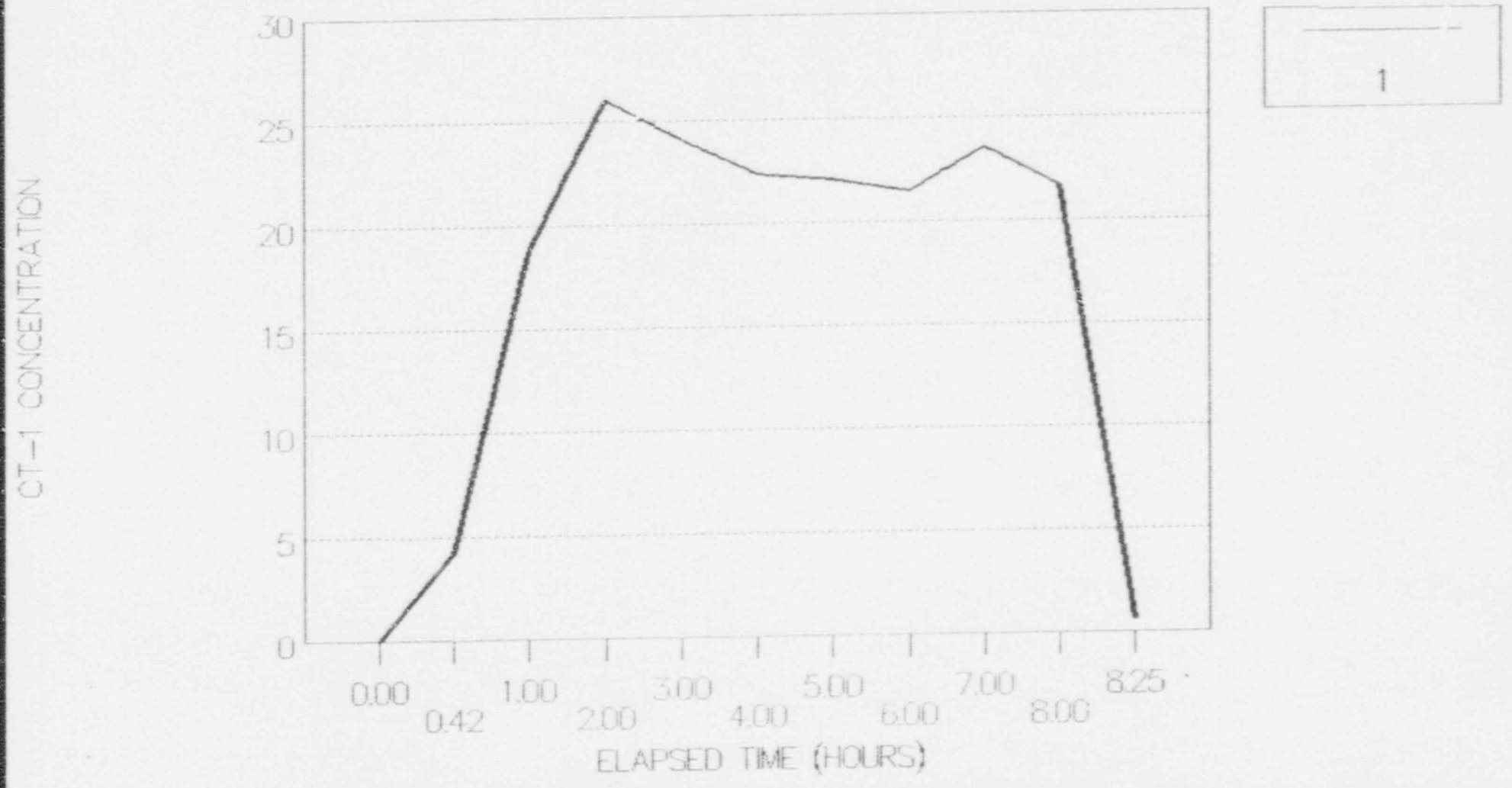
* LOW LEVEL TEST

OTHER PTS.

DATE	SAMPLE PT.	TIME	ABSORBANCE	CT-1 CONC.
07/03/90	GSW HEADER	10:15 AM	0.579	17.7
07/03/90	FIRE HEADER	12:45 PM	0.356	10.6
07/03/90	FIRE HEADER	1:15 PM	0.471	14.3
07/03/90	FIRE HEADER	3:15 PM	0.684	21.1

DETROIT EDISON: FERMI II

BIOBOX CT-1 CONCENTRATIONS



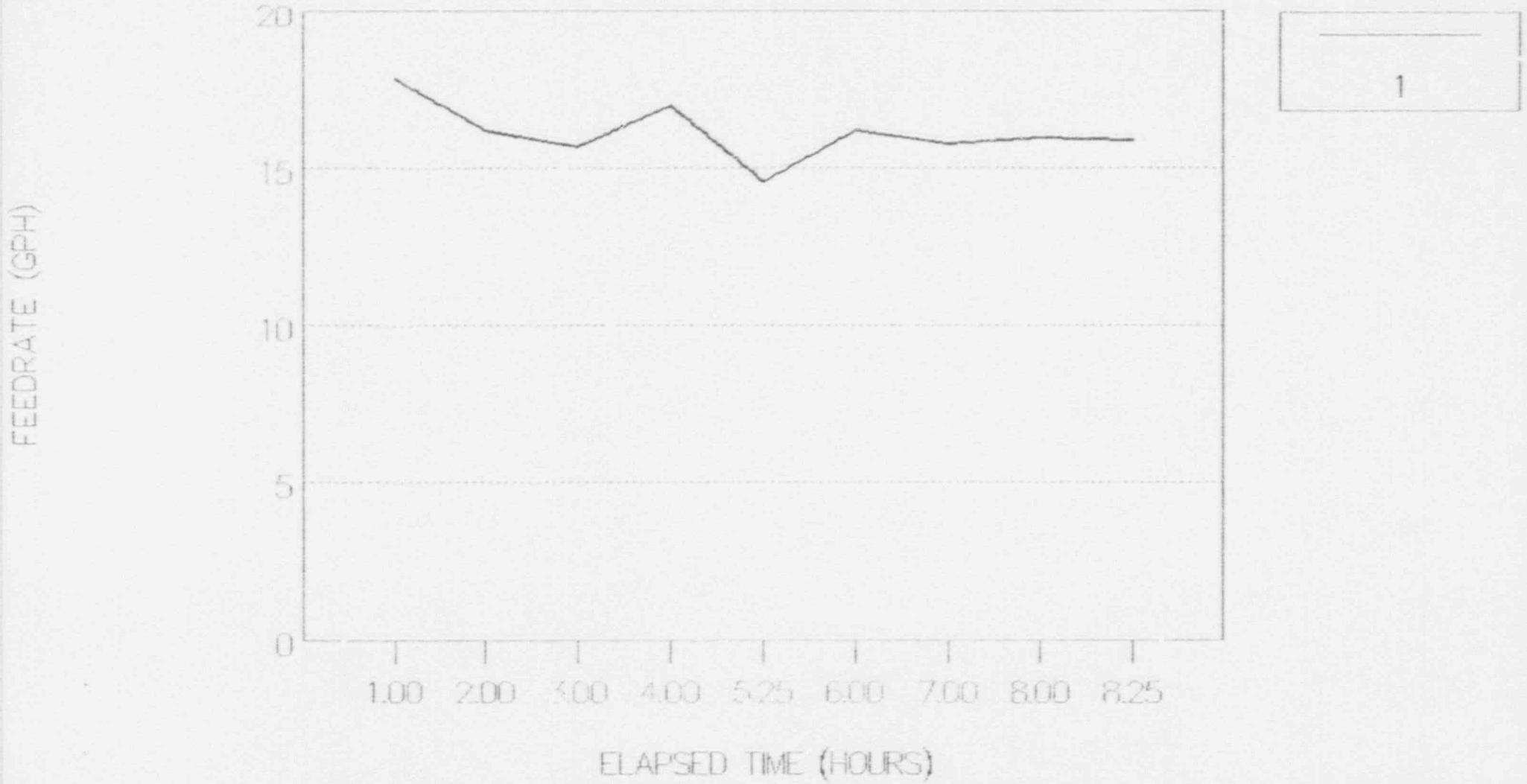
CHEMICAL USAGE

TIME	ELAPSED TIME	FEED RATE (GPH)	TOTAL USAGE (CUMULATIVE)
8:45 AM	0.00	START	---
9:45 AM	1.00	17.9	17.9
10:45 AM	2.00	16.2	34.1
11:45 AM	3.00	15.7	49.8
12:45 PM	4.00	17.0	66.8
2:00 PM	5.25	14.6	84.3
2:45 PM	6.00	16.2	96.5
3:45 PM	7.00	15.8	112.3
4:45 PM	8.00	16.0	128.3
5:00 PM	8.25	15.9	132.3
TOTAL:			132.3 GALLONS

CT-1

DETROIT EDISON: FERMI II

CT-1 CHEMICAL FEEDRATE



D. MONITORING AND RESULTS:

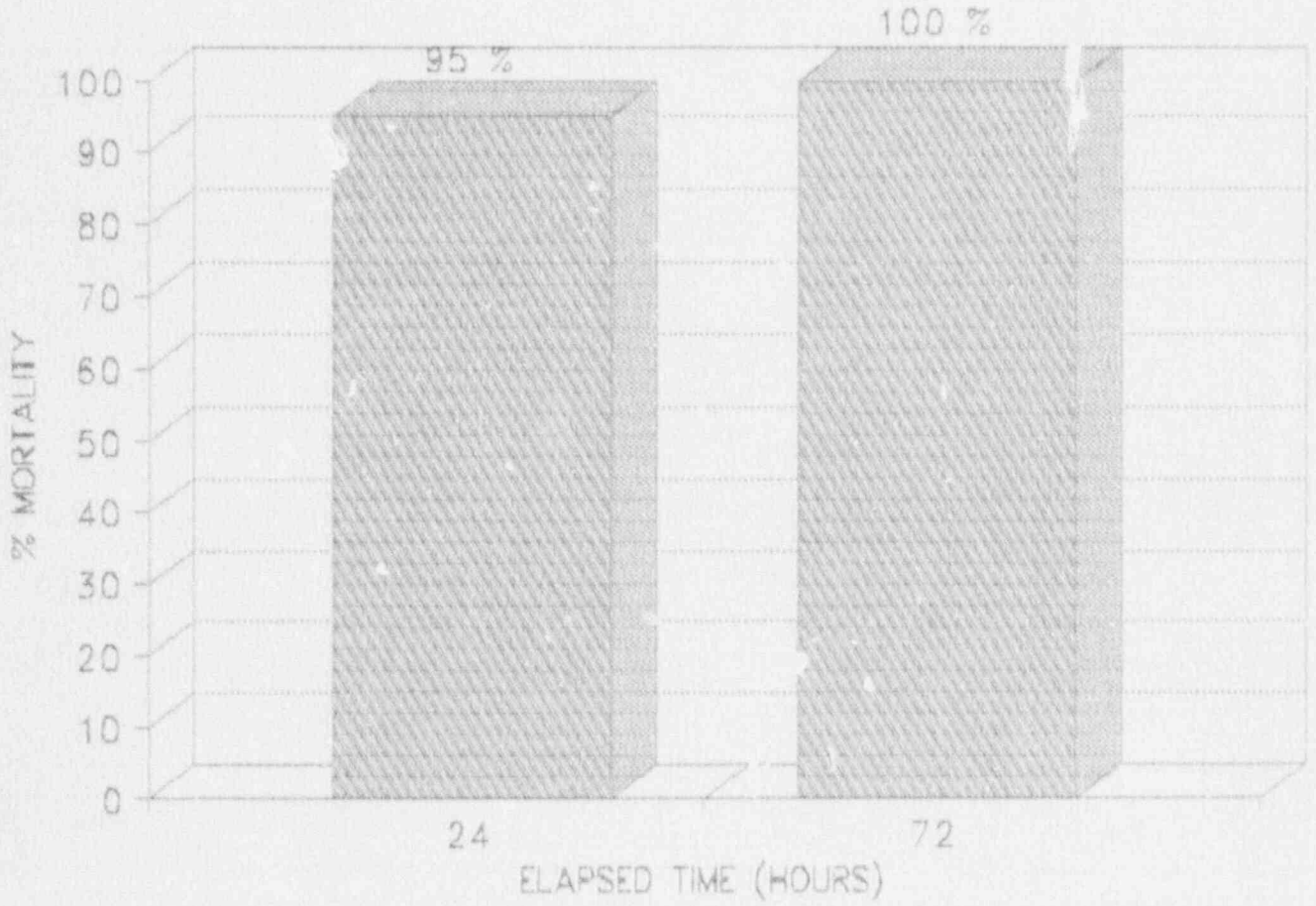
The CT-1 application effectiveness was monitored through the use of a flow-through bio-box. This piece of equipment is a plexiglass container with six separate compartments in it. It was installed such that water flow from the GSW header was continually passing through the unit. In this way, the test mussels would see the same conditions as the systems being treated.

The bio-box was installed five days prior to the start of the system sterilization and approximately 1000 zebra mussels were placed in the various bio-box compartments. The mussels were thus, allowed to acclimate to the water conditions and resume normal feeding similar to any mussels in the systems to be treated. These mussels would be monitored for latent mortality once the sterilization was completed.

The mussel mortality achieved was 100%. As you can see from the enclosed graph, there was a 95% mortality achieved after 24 hours and a 100% mortality after 72 hours. The time lapse between the stoppage of treatment and mortality is due to the latent toxic effect of the CT-1 molluscicide.

DETROIT EDISON: FERMI II

ZEBRA MUSSEL MORTALITY: JULY, 1990



E. CONCLUSION:

The CT-1 sterilization of your GSW and fire protection systems achieved the product dosage rate of at least 15 ppm for the desired six hour exposure period. This application resulted in 132 gallons of CT-1 and 600 pounds of detox being fed. This product usage corresponds to a total system sterilization cost of only $2900 ($2300 for CT-1 and $600 for detox).

The monitoring of the sterilization effectiveness resulted in a zebra mussel mortality of 100%. With the continued monitoring of your systems for zebra mussel fouling potential and correlating this monitoring with subsequent CT-1 applications, your system will be protected from macrofouling. The net result is increased system reliability, optimum efficiencies and prevention of downtime.

BASELINE TESTS

HIGH RANGE

CONCENTRATION	ABSORBANCE
5 ppm.	0.180
10 ppm	0.289
20 ppm	0.701

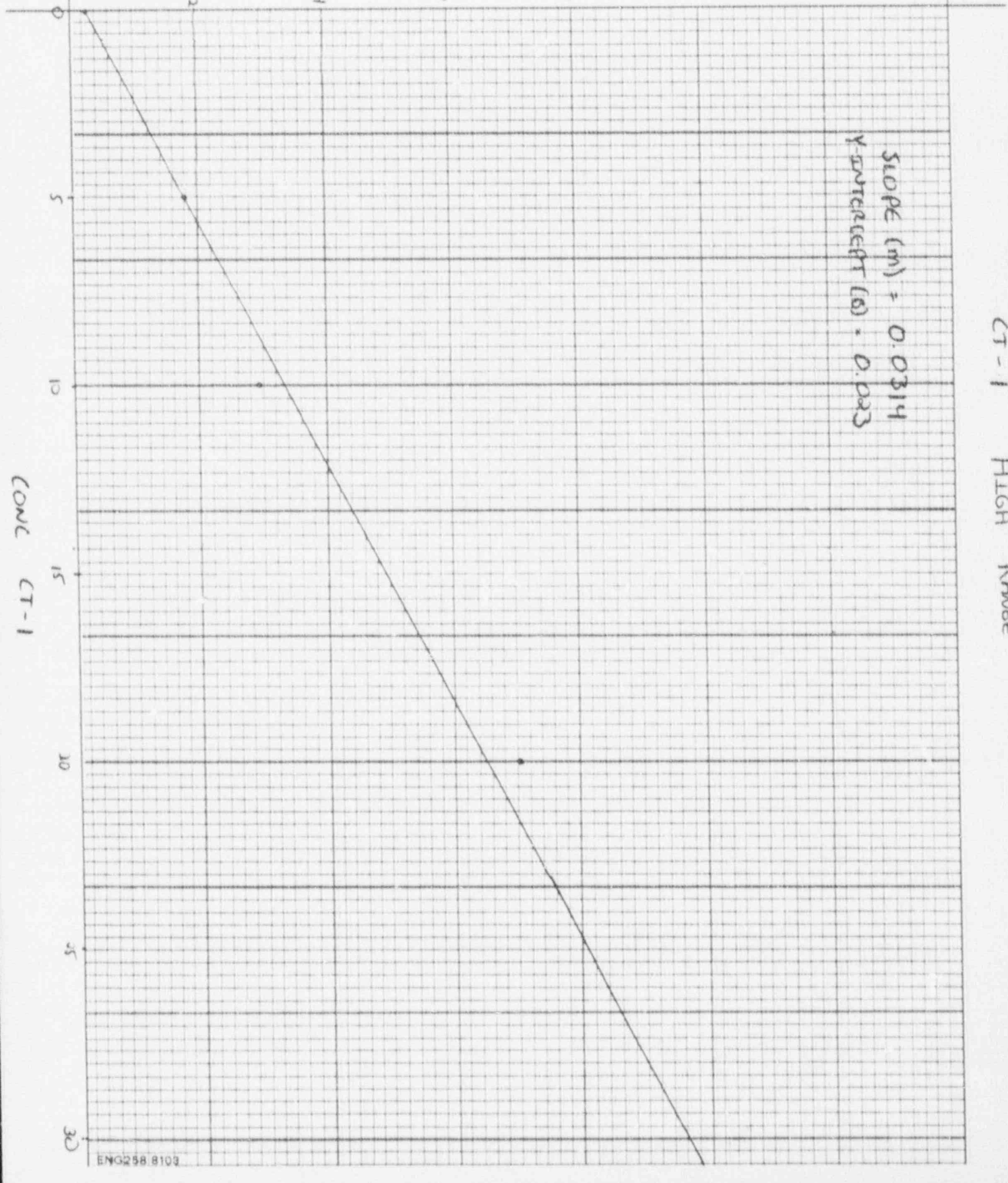
LOW RANGE

CONCENTRATION	ABSORBANCE
0 ppm	0.031
0.1 ppm	0.109
0.5 ppm	0.486

Betz Industrial
The Water Management Division of Betz Laboratories, Inc.

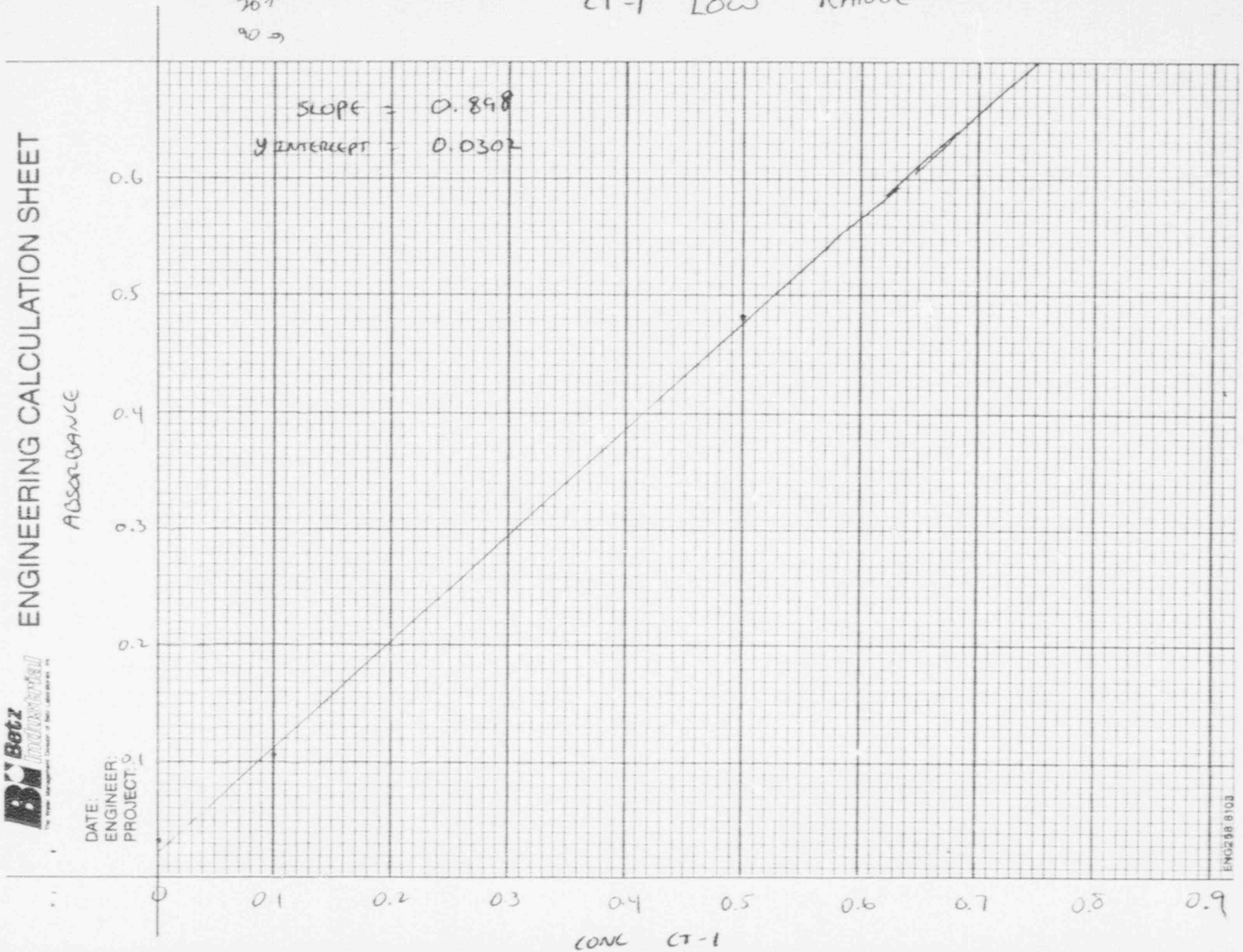
ENGINEERING CALCULATION SHEET

DATE:
ENGINEER:
PROJECT:



ENG258 8103

CT-1 LOW RANGE



F. Appendix

Clam-Trol CT-1 Analytical Method

This method must be customized to each specific application. This is done by varying the volumes of sample, CT-1 Buffer Reagent and 1,2-dichloroethane used in the procedure. Table 1 lists several combinations of reagents that can be used to obtain three different test ranges. When optimizing the procedure, if a higher absorbance is needed, the volume of sample should be increased or the volume of 1,2-dichloroethane should be decreased. When increasing the sample volume it may be necessary to increase the volume of CT-1 Buffer Reagent used. For sample volumes of less than 150 mL use 10 mL of the CT-1 Buffer Reagent; for volumes between 150 and 300 mL use 15 mL of CT-1 Buffer Reagent. When determining the amount of 1,2-dichloroethane to use it is necessary to make sure that the volume used is large enough to have sufficient 1,2-dichloroethane to leave a small plug of solvent in the separatory funnel when removing the bottom layer of solvent while having enough solvent to fill the optical cell properly.

GENERAL PROCEDURE FOR TEST

Use a well ventilated or hooded area to run the test. Always use a safety bulb when pipetting liquids.

1. Transfer an aliquot of the water sample to a separatory funnel (the sample). Transfer the same volume of distilled (or deionized) water to a second separatory funnel (the blank). It is only necessary to run the blank once for each set of samples tested (see notes 1 and 2).

Table 1: Suggested Volumes for Various Ranges of CT-1

Range mg/L CT-1	volume (mL) CT-1 Buffer	volume (mL) dichloroethane	volume (mL) sample	optical cell size
0.2 - 3.0	15	10	250	1.0 cm *
1.0 -25.0	10	30	50	2.5 cm **
0.2 - 1.0	10	15	100	5.0 cm ***

* The 1.0 cm cell can be used with Hach spectrophotometers utilizing a 1 cm cell adapter.

** The 2.5 cm cell is the standard Hach 1 inch cell (Betz code 2601) that can be used with Hach spectrophotometers.

*** 5 cm cells are not available for the Hach photometers. Many laboratory spectrophotometers require an adapter to accommodate 5 cm cells. Check with the instrument manufacturer.

2. Add the CT-1 Buffer Reagent to both the sample and the blank (see note 6).

3. Using a pipette, add the 1,2-dichloroethane to both separatory funnels.

4. Insert the stoppers in each of the separatory funnels, invert and briefly open the stopcock to vent the funnels (see notes 3 and 4). When venting the funnels point the tip of the funnel away from yourself and others.

5. Shake the funnels moderately for 30 seconds, vent the funnels, then allow to stand for 10 minutes (but no longer than 15 minutes).

6. Collect the lower layer from each funnel (the 1,2-dichloroethane) in 50 mL beakers. It is most convenient to allow a small amount of the 1,2-dichloroethane (~1-2 mL) to remain in the funnel. This prevents any significant removal of water from the separatory funnel when the 1,2-dichloroethane is being removed.

7. Using the plastic dipper, add 2 scoops of Drying Reagent to each beaker and stir with a glass rod for 10 seconds (but no longer than 20 seconds).

8. Wait approximately 1 to 2 minutes (but not more than 5 minutes) then carefully decant the extract off of the drying reagent into an optical cell.

9. Set the spectrophotometer at 415 nm and zero with 1,2-dichloroethane. Measure and record the absorbance of the blank and the sample.

10. The sample absorbance minus the blank absorbance is used to determine the concentration of CT-1 in the sample. From a prepared calibration curve, determine the CT-1 concentration in the sample (see Calibration Preparation).

11. Clean the cells after each measurement (see note 5).

CALIBRATION PREPARATION

1. Prepare a 1000 mg/L CT-1 stock solution by accurately weighing out 1.00 gram of CT-1 into 1 liter of distilled or deionized water.

2. Pipet designated volumes of the stock solution into 1 liter volumetric flasks. These are the standard solution to be used in preparing a calibration curve. Use Table 2 to determine the appropriate dilutions to make of the stock solution for each specific application.

CLAM-TROL CT-1
METHYL ORANGE METHOD

APPARATUS REQUIRED

	Code
Beaker, glass, 50 mL (x2)	---
Cylinder, graduated, 25 mL	2622
Funnel rack, separatory	936
Funnel, separatory, w/teflon stopcock, 250 mL (x2)	---
Glass rod	114
Optical cell, (x2)	---
Spectrophotometer	---

GENERAL APPARATUS *

	Code
Cylinder, graduated, 100 mL	121
Cylinder, graduated, 250 mL	917
Flask, volumetric, 1 liter, glass (x4)	935
Pipette, glass, volumetric, 1 mL	866
Pipette, glass, 1 mL, graduated	140
Pipette, glass, volumetric, 3 mL	---
Pipette, glass, volumetric, 5 mL	124
Pipette, glass, volumetric, 10 mL	123
Pipette, glass, volumetric, 15 mL	861
Pipette, glass, volumetric, 20 mL	---
Pipette, glass, volumetric, 25 mL	117
Pipette, glass, volumetric, 30 mL	---

* The general apparatus required for the test is determined by the specific test procedure used.

CHEMICALS REQUIRED

	Code
1,2-Dichloroethane (reagent grade or equivalent)	1666
CT-1 Buffer Reagent	1591
Methanol (reagent grade or equivalent)	322
Drying Reagent w/plastic dipper	1271

Note: Apparatus and chemicals not available through Betz Lab Supply should be obtained through a local supplier.

DISCUSSION OF THE METHOD

In this test procedure, methyl orange complexes with the active ingredients in Clam-Trol CT-1. This complex is extracted into 1,2-dichloroethane. The organic layer containing the complex is separated from the aqueous layer and dried with anhydrous sodium sulfate. The color intensity of the 1,2-dichloroethane layer is then measured at 415 nm.

Table 2: Dilutions for Calibration Curve Preparation (based on final solution volume of 1 liter)

Conc. mg/L CT-1 desired	mL CT-1 Stock solution added to make 1 liter
0.2	0.2
0.4	0.4
0.6	0.6
0.8	0.8
1.0	1.0
5.0	5.0
10.0	10.0
15.0	15.0
20.0	20.0
25.0	25.0

3. Follow the procedure listed (utilizing the specific solution volumes that have been determined for the application) and prepare a calibration curve. Determine the absorbance of a blank solution using distilled or deionized water. This blank can be subtracted from the sample absorbance or used to zero the photometer so that the calibration curve goes through the origin. The calibration curve should be linear over the indicated ranges.

NOTES

1. For maximum accuracy the calibration curve should be checked by every operator using the test and should be verified a minimum of twice per month using a freshly prepared CT-1 standard.

2. A blank measurement must be recorded for each set of samples. The blank reading may vary slightly, however the absolute difference between the sample and the blank remains relatively constant.

3. A slight emulsion may form when using natural water samples. Correct for this by using a variation in step 5 of the procedure. Shake the funnel for 30 seconds then allow to stand for 5 minutes. Gently invert the funnel once then allow the funnel to stand for 5 minutes (don't forget to vent the funnel).

4. It is important to vent the separatory funnel both before and after shaking it. Otherwise, a pressure will build up in the funnel that can cause the stopper to be forced out of the top of the funnel.

5. It is imperative that the sample cells are kept clean during the running of the test. It is recommended that the cells are cleaned after each measurement by the following procedure:

   a) Rinse the cell three times with distilled or deionized water.
   b) Rinse the cell three times with methanol.

c) Finally rinse the cell three times with 1,2-dichloroethane to remove any methanol from the cell.

6. Chlorine causes a negative interference in the test. This can be eliminated by adding 0.1 N sodium thiosulfate (code 235) to the water sample before running the test. The amount to be added must be determined based on the concentration of chlorine in the system. For a 100 mL water sample containing 0.3 mg/L chlorine, 10 drops of 0.1 N sodium thiosulfate will remove the interference.

7. This method is based upon L. K. Wang and D. F. Langly, Ind. Eng. Chem., Prod. Res. Dev., (1975) Vol. 14, No. 3, 210-212

Betz Industrial

DETROIT EDISON
FERMI II NUCLEAR PLANT
NEWPORT, MI.

ZEBRA MUSSEL STERILIZATION
DECEMBER 28, 1990

PREPARED BY:

Len Wall

LEN WALL
TECHNICAL SPECIALIST

TABLE OF CONTENTS

A. INTRODUCTION:

The following is a synopsis of the recent zebra mussel sterilization. This bi-annual sterilization is part of your macrofouling control program for the GSW and fire protection systems. The goal of this program is the control of zebra mussel infestation into these systems before the organisms reaches macrofouling sizes, thus preventing reduced efficiencies, increasing system reliability and eliminating potential downtime.

B. PROCEDURE:

The following is a guideline for the CT-1 sterilization of the GSW and fire protection systems. These procedures were modified due to the system being down during the sterilization.

1) Run a CT-1 demand test of the water to be treated.

2) Run aseline and CT-1 residual standards for the analytical test curve.

3) Place the system into recirculation mode.

4) Feed the CT-1 product to the suction side of the GSW circulating pumps. The product is fed via a positive displacement pump and through a sparger line. The exact product feedrate (gph) will be determined by a system demand and the number of circulating pumps in operation.

5) Feed the product such that at least 15 ppm. of product is in contact with the GSW systems for a period of aprox. 12 to 18 hours. The application duration was based on a water temperature of 45 F.

6) Run bi-hourly tests on the bio-box monitor and throughout the treated systems in order to assure the product concentration obtained is greater than 18 to 20 ppm.

7) Once the GSW system concentration has been verified at 20 ppm or greater, flush the fire protection system until a concentration of 20 ppm. is verified at the discharge. Upon residual verification, button up this system for a period of at least eighteen hours.

8) Once an eighteen hour application to all systems has been achieved, discontinue product feed.

9) Run a CT-1 test on the pond water to determine if detox. feed is needed. If required, feed appropriate quantity of detox.

10) Run analytical CT-1 test to insure complete product detoxification.

11) Resume normal system operation once product is verified detoxified.

C. APPLICATION SYNOPSIS:

The CT-1 sterilization was initiated at 10:30 AM on November 29, 1990. The chemical feed pump was set at approximately 19 gph. This feedrate was based on a water demand of 2.0 ppm (total product feedrate of 25.0 ppm.) and two GSW circulating pumps in operation.

At 12:30 PM, analytical test results indicated a CT-1 residual of 26.9 ppm at the bio-box (see monitoring section) outlet. At this time (since the CT-1 residual was greater than the minimum 20 ppm required), various auxiliary cooling systems and the fire header system were valved into service. The fire protection system was flushed until a residual of greater than 20 ppm. was achieved (26.4 actually achieved) and then the system was buttoned back up.

The CT-1 feed was continued until 5:30 AM on November 30, 1990. This feed duration amounted to an application duration of nineteen hours. This extended duration was necessary due to the lower water temperatures at the time of treatment (Note: The July, 1990 application was for six hours and was based on a water temperature of 70 F.) As you can see from the feedrate chart and graph, the chemical feedrate stabilized around 8.5 to 11

gallons per hour throughout the application. The lower feedrate was possible due to partial recirculation of treated water from the pond. The total product usage amounted to approximately 213.5 gallons of CT-1.

The analytical results from the bio-box monitor outlet indicated that CT-1 residuals greater than 18.0 ppm. were achieved for the desired eighteen hour exposure (see chart and graph). Additionally, various samples from the GSW and fire protection system indicated a 18 ppm residual was achieved throughout.

At 5:30 AM on November 30, 1990, the chemical feed was stopped. Based on previous application experience, two drums of detox were added to the pond in order to neutralize any active CT-1. Pond test at 8:50 AM (confirmed at 9:00 AM) indicated a CT-1 residual of less than detectable (< 0.1 ppm). This was within the permit limits and subsequently, the system was returned to normal operational mode.

Betz Industrial

CT-1 RESIDUALS

DATE	SAMPLE PT.	TIME	ELAPSED TIME	ABSORBANCE	CT-1 CONC.
11/29/90	BIOBOX	10:30 AM	0.00	TREATMENT STARTED	0.0
11/29/90	BIOBOX	12:30 PM	2.00	1.092	26.9
11/29/90	BIOBOX	1:40 PM	3.17	1.522	37.9
11/29/90	BIOBOX	2:30 PM	4.00	1.312	32.6
11/29/90	BIOBOX	3:40 PM	5.17	0.768	18.7
11/29/90	BIOBOX	4:25 PM	5.92	0.770	18.7
11/29/90	BIOBOX	6:00 PM	7.50	0.912	22.4
11/29/90	BIOBOX	9:00 PM	10.50	0.712	17.3
11/30/90	BIOBOX	12:00 AM	13.50	0.892	21.8
11/30/90	BIOBOX	1:15 AM	14.75	1.186	29.3
11/30/90		3:15 AM	16.75	1.157	28.6
11/30/90		5:15 AM	18.75	1.522	38.8
11/30/90	BIOBOX	5:30 AM	19.00	TREATMENT STOPPED	
11/30/90	POND	6:00 AM	19.50	DETOX ADDED	
11/30/90	BIOBOX *	6:40 AM	20.17	0.191	0.84
11/30/90	POND *	8:30 AM	22.00	0.058	0.13
11/30/90	POND *	8:50 AM	22.33	0.047	< 0.1
11/30/90	POND *	9:00 AM	22.50	0.042	< 0.1

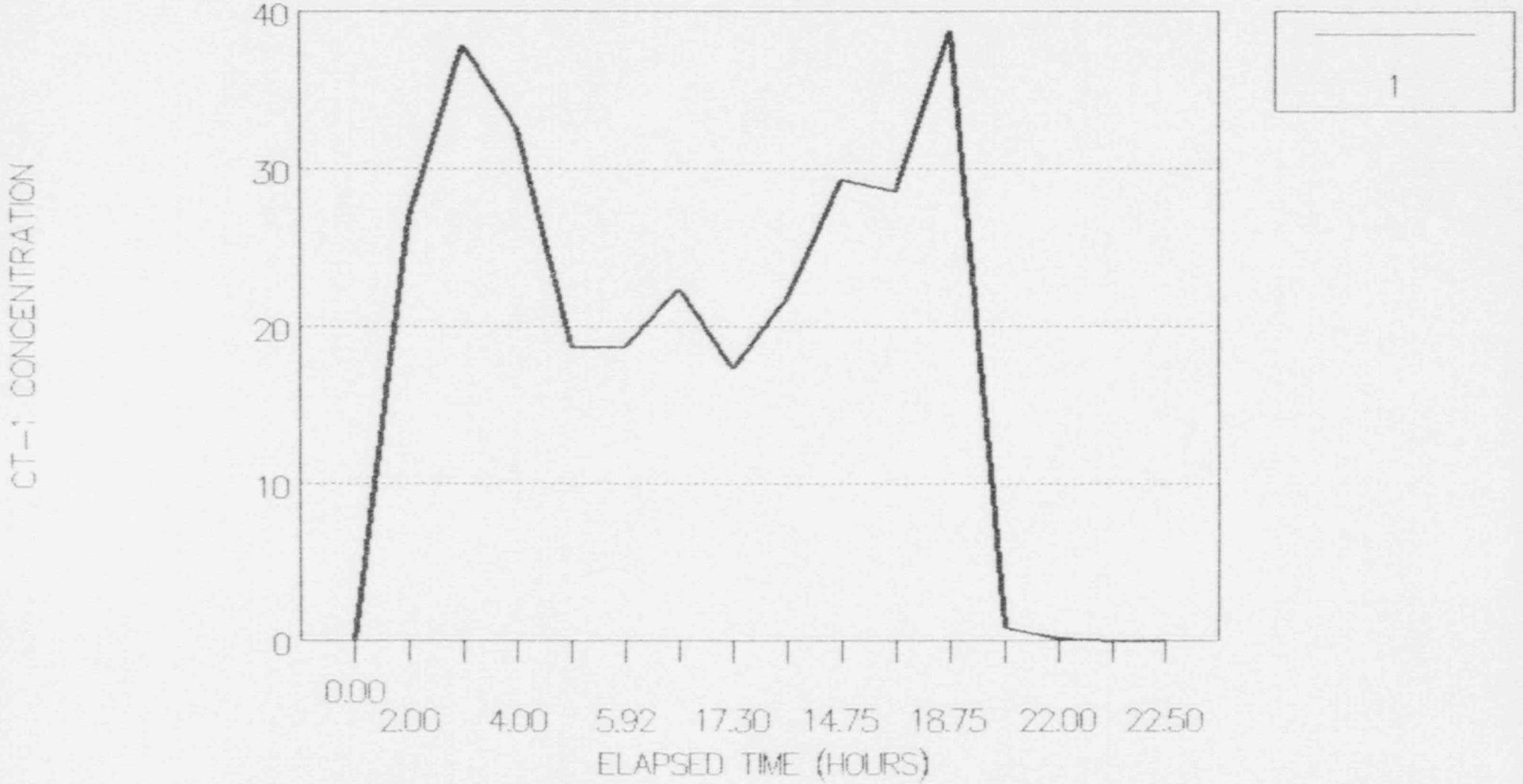
* LOW LEVEL TEST

OTHER PTS.

DATE	SAMPLE PT.	TIME	ABSORBANCE	CT-1 CONC.
11/29/90	GSW HEADER	12:30 PM	0.362	8.3
11/29/90	FIRE HEADER	1:40 PM	0.926	22.7
11/29/90	FIRE HEADER	3:30 PM	1.071	26.4

DETROIT EDISON: FERMI II

BIOBOX CT-1 CONCENTRATIONS



Betz Industrial

CHEMICAL USAGE

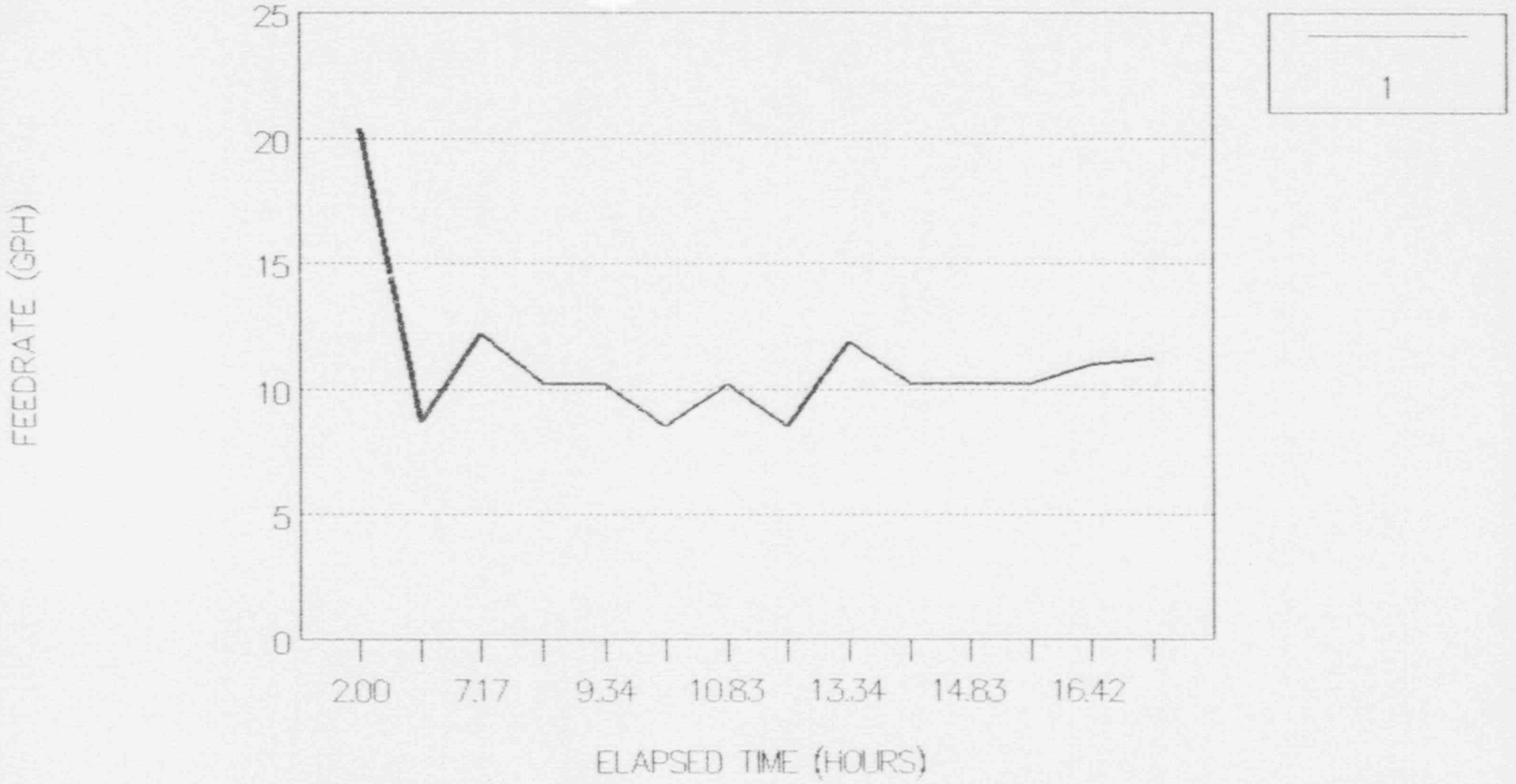
DATE	TIME	ELAPSED TIME	FEED RATE (GPH)	TOTAL USAGE (CUMULATIVE)
11/29/90	10:30 AM	0.00	START	---
11/29/90	12:30 PM	2.00	20.4	40.8
11/29/90	4:51 PM	6.35	8.7	78.6
11/29/90	5:40 PM	7.17	12.2	88.6
11/29/90	6:40 PM	8.17	10.2	98.8
11/29/90	7:50 PM	9.34	10.2	110.7
11/29/90	8:50 PM	10.34	8.5	119.2
11/29/90	9:20 PM	10.83	10.2	124.2
11/29/90	9:50 PM	11.34	8.5	128.5
11/29/90	11:50 PM	13.34	11.9	152.3
11/30/90	12:50 AM	14.34	10.2	162.5
11/30/90	1:20 AM	14.83	10.2	167.5
11/30/90	1:50 AM	15.34	10.2	172.7
11/30/90	2:55 AM	16.42	11.0	184.6
11/30/90	4:00 AM	17.50	11.2	196.7
11/30/90	5:30 AM	19.00		213.5

TOTAL: 213.5 GALLONS

CT-1

DETROIT EDISON: FERMI II

CT-1 CHEMICAL FEEDRATE



Betz Industrial

MISC. DATA

DATE	TIME	WATER TEMP.
11/29/90	6:00 PM	12 C
11/29/90	9:00 PM	12 C
11/30/90	12:00 AM	12 C

D. MONITORING AND RESULTS:

The CT-1 application effectiveness was monitored through the use of a flow-through bio-box. This piece of equipment is a plexiglass container with six separate compartments in it. It was installed such that water flow from the GSW header was continually passing through the unit. In this way, the test mussels would see the same conditions as the systems being treated.

The bio-box was installed three days prior to the start of the system sterilization and approximately 300 zebra mussels were placed in the various bio-box compartments. These mussels had been in a "control" bio-box for a period of five weeks in order to acclimate them to the system and so that they would resume normal feeding similar to any mussels in the systems to be treated. Also, any stressed mussels that died off could be removed and a control group of mussels would be available for any mortality comparisons (untreated). The treated mussels would be monitored for latent mortality once the sterilization was completed.

The mussel mortality achieved was 85%. This corresponded to 275 dead mussels out of a group of 323 total. As you can seen from

the enclosed graph and chart, mortality rates were ~70% after 1 week, ~80% after two weeks, and a final count of 85%. The first two counts were approximations due to the problems of counting dead mussels while leaving others unaffected. The time lapse between the stoppage of treatment and mortality is due to the latent toxic effect of the CT-1 molluscicide. Finally, it should be mentioned that there was less than a 1% mortality in the untreated control group.

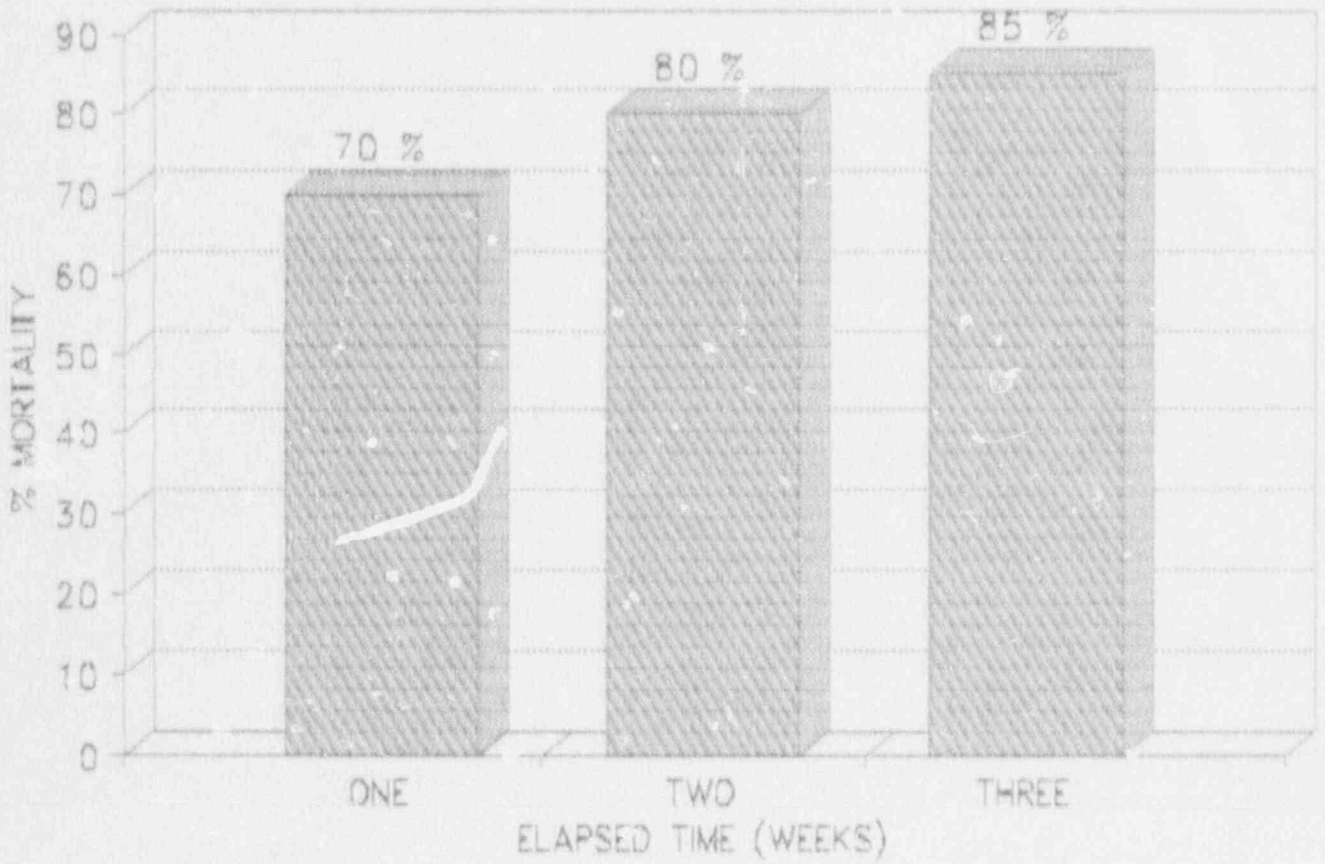
Betz Industrial

ZEBRA MUSSEL
MORTALITY

ELAPSED TIME	% MORTALITY
1 WEEK	70 %
2 WEEKS	80 %
3 WEEKS	85 %

DETROIT EDISON: FERMI II

ZEBRA MUSSEL MORTALITY: NOVEMBER, 1990



E. CONCLUSION:

The CT-1 sterilization of your GSW and fire protection systems achieved the product dosage rate of at least 18 ppm for the desired eighteen hour exposure period. This application resulted in 213.5 gallons of CT-1 and 600 pounds of detox being fed. This product usage corresponds to a total system sterilization cost of only $4592 ($3992 for CT-1 and $600 for detox).

The monitoring of the sterilization effectiveness resulted in a zebra mussel mortality of 85%. With the continued monitoring of your systems for zebra mussel fouling potential and correlating this monitoring with subsequent CT-1 applications, your system will be protected from macrofouling. The net result is increased system reliability, optimum efficiencies and prevention of downtime.

Betz Industrial

BASELINE TESTS

HIGH RANGE

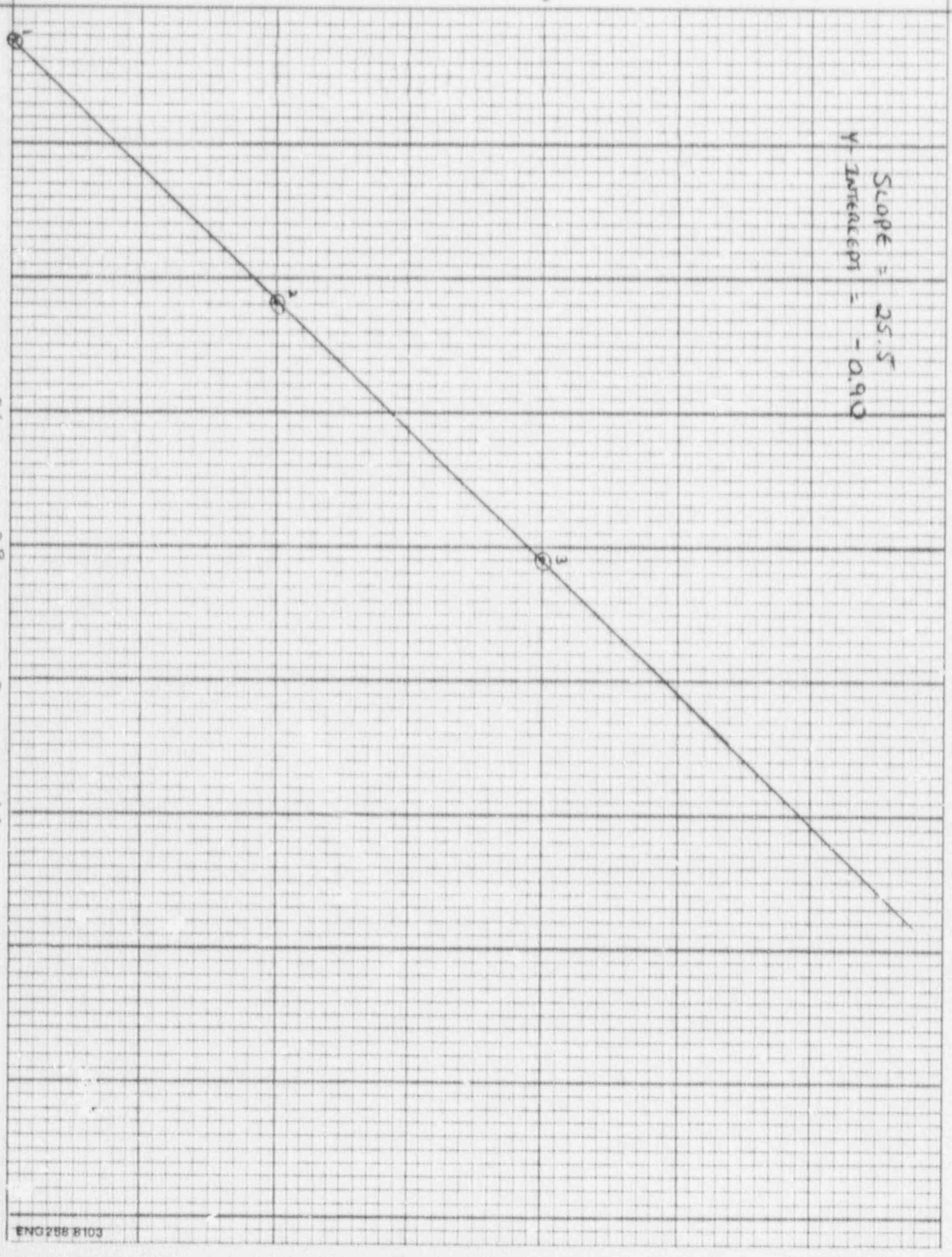
CONCENTRATION	ABSORBANCE
0 ppm	0.043
10 ppm	0.438
20 ppm	0.817

LOW RANGE

CONCENTRATION	ABSORBANCE
0 ppm	0.035
0.2 ppm	0.071
1.5 ppm	0.201
3.0 ppm	0.628

ENGINEERING CALCULATION SHEET

DATE:
ENGINEER:
PROJECT:

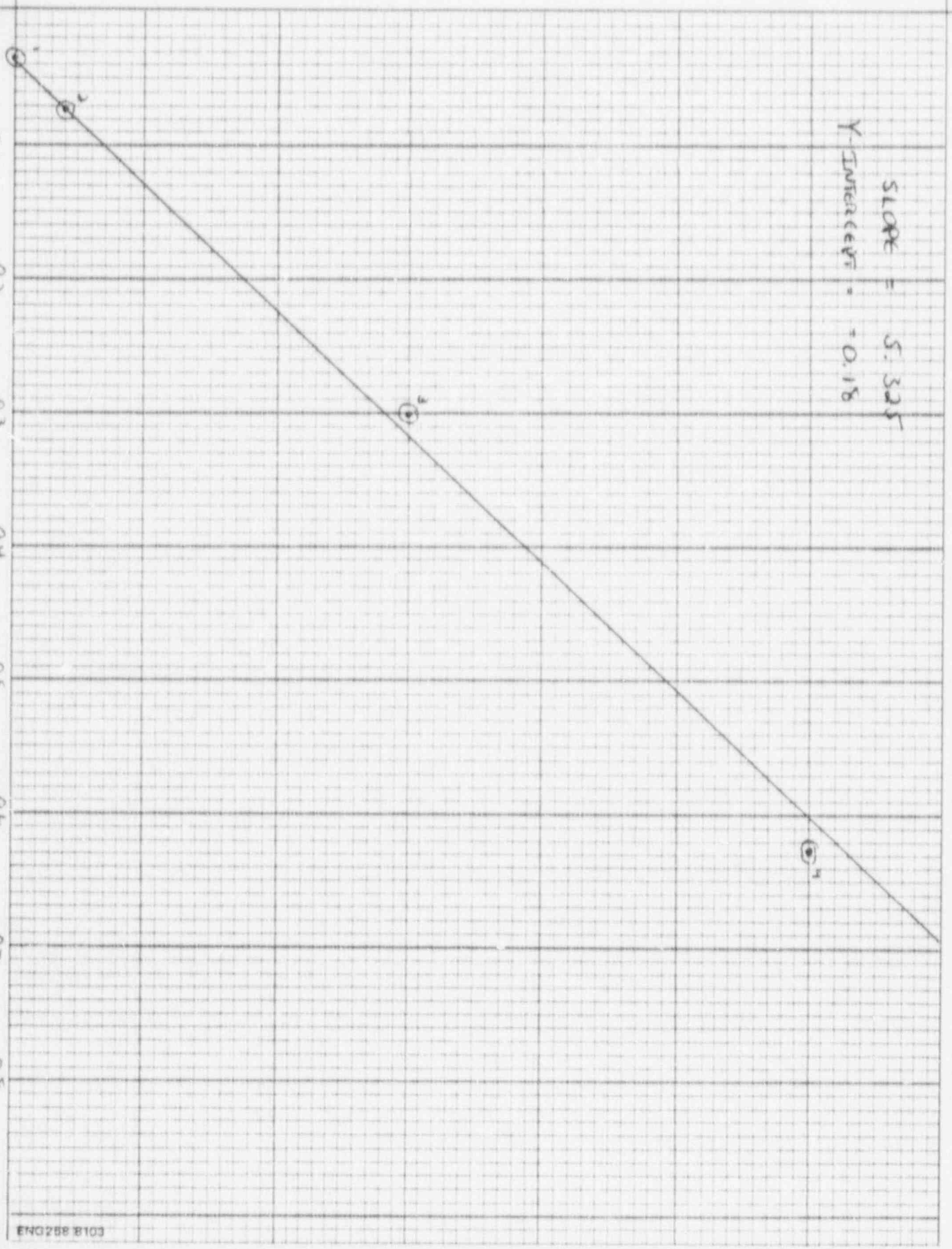


CT-1 RESIDUAL (HIGH RANGE)

Betz Industrial

ENGINEERING CALCULATION SHEET

DATE:
ENGINEER:
PROJECT:



CT-1 RESIDUAL (LOW RANGE)

ENG 258 8103

F. Appendix

Clam-Trol CT-1 Analytical Method

This method must be customized to each specific application. This is done by varying the volumes of sample, CT-1 Buffer Reagent and 1,2-dichloroethane used in the procedure. Table 1 lists several combinations of reagents that can be used to obtain three different test ranges. When optimizing the procedure, if a higher absorbance is needed, the volume of sample should be increased or the volume of 1,2-dichloroethane should be decreased. When increasing the sample volume it may be necessary to increase the volume of CT-1 Buffer Reagent used. For sample volumes of less than 150 mL use 10 mL of the CT-1 Buffer Reagent; for volumes between 150 and 300 mL use 15 mL of CT-1 Buffer Reagent. When determining the amount of 1,2-dichloroethane to use it is necessary to make sure that the volume used is large enough to have sufficient 1,2-dichloroethane to leave a small plug of solvent in the separatory funnel when removing the bottom layer of solvent while having enough solvent to fill the optical cell properly.

GENERAL PROCEDURE FOR TEST

Use a well ventilated or hooded area to run the test. Always use a safety bulb when pipetting liquids.

1. Transfer an aliquot of the water sample to a separatory funnel (the sample). Transfer the same volume of distilled (or deionized) water to a second separatory funnel (the blank). It is only necessary to run the blank once for each set of samples tested (see notes 1 and 2).

Table 1: Suggested Volumes for Various Ranges of CT-1

Range mg/L CT-1	volume (mL) CT-1 Buffer	volume (mL) dichloroethane	volume (mL) sample	optical cell size
0.2 - 3.0	15	10	250	1.0 cm *
1.0 -25.0	10	30	50	2.5 cm **
0.2 - 1.0	10	15	100	5.0 cm ***

* The 1.0 cm cell can be used with Hach spectrophotometers utilizing a 1 cm cell adapter.

** The 2.5 cm cell is the standard Hach 1 inch cell (Betz code 2601) that can be used with Hach spectrophotometers.

*** 5 cm cells are not available for the Hach photometers. Many laboratory spectrophotometers require an adapter to accommodate 5 cm cells. Check with the instrument manufacturer.

2. Add the CT-1 Buffer Reagent to both the sample and the blank (see note 6).

3. Using a pipette, add the 1,2-dichloroethane to both separatory funnels.

4. Insert the stoppers in each of the separatory funnels, invert and briefly open the stopcock to vent the funnels (see notes 3 and 4). When venting the funnels point the tip of the funnel away from yourself and others.

5. Shake the funnels moderately for 30 seconds, vent the funnels, then allow to stand for 10 minutes (but no longer than 15 minutes).

6. Collect the lower layer from each funnel (the 1,2-dichloroethane) in 50 mL beakers. It is most convenient to allow a small amount of the 1,2-dichloroethane (~1-2 mL) to remain in the funnel. This prevents any significant removal of water from the separatory funnel when the 1,2-dichloroethane is being removed.

7. Using the plastic dipper, add 2 scoops of Drying Reagent to each beaker and stir with a glass rod for 10 seconds (but no longer than 20 seconds).

8. Wait approximately 1 to 2 minutes (but not more than 5 minutes) then carefully decant the extract off of the drying reagent into an optical cell.

9. Set the spectrophotometer at 415 nm and zero with 1,2-dichloroethane. Measure and record the absorbance of the blank and the sample.

10. The sample absorbance minus the blank absorbance is used to determine the concentration of CT-1 in the sample. From a prepared calibration curve, determine the CT-1 concentration in the sample (see Calibration Preparation).

11. Clean the cells after each measurement (see note 5).

CALIBRATION PREPARATION

1. Prepare a 1000 mg/L CT-1 stock solution by accurately weighing out 1.00 gram of CT-1 into 1 liter of distilled or deionized water.

2. Pipet designated volumes of the stock solution into 1 liter volumetric flasks. These are the standard solution to be used in preparing a calibration curve. Use Table 2 to determine the appropriate dilutions to make of the stock solution for each specific application.

CLAM-TROL CT-1
METHYL ORANGE METHOD

APPARATUS REQUIRED

	Code
Beaker, glass, 50 mL (x2)	---
Cylinder, graduated, 25 mL	2622
Funnel rack, separatory	936
Funnel, separatory, w/teflon stopcock, 250 mL (x2)	---
Glass rod	114
Optical cell, (x2)	---
Spectrophotometer	---

GENERAL APPARATUS *

	Code
Cylinder, graduated, 100 mL	121
Cylinder, graduated, 250 mL	917
Flask, volumetric, 1 liter, glass (x4)	935
Pipette, glass, volumetric, 1 mL	866
Pipette, glass, 1 mL, graduated	140
Pipette, glass, volumetric, 3 mL	---
Pipette, glass, volumetric, 5 mL	124
Pipette, glass, volumetric, 10 mL	123
Pipette, glass, volumetric, 15 mL	861
Pipette, glass, volumetric, 20 mL	---
Pipette, glass, volumetric, 25 mL	117
Pipette, glass, volumetric, 30 mL	---

* The general apparatus required for the test is determined by the specific test procedure used.

CHEMICALS REQUIRED

	Code
1,2-Dichloroethane (reagent grade or equivalent)	1666
CT-1 Buffer Reagent	1591
Methanol (reagent grade or equivalent)	322
Drying Reagent w/plastic dipper	1271

Note: Apparatus and chemicals not available through Betz Lab Supply should be obtained through a local supplier.

DISCUSSION OF THE METHOD

In this test procedure, methyl orange complexes with the active ingredients in Clam-Trol CT-1. This complex is extracted into 1,2-dichloroethane. The organic layer containing the complex is separated from the aqueous layer and dried with anhydrous sodium sulfate. The color intensity of the 1,2-dichloroethane layer is then measured at 415 nm

Table 2: Dilutions for Calibration Curve Preparation (based on final solution volume of 1 liter)

Conc. mg/L CT-1 desired	mL CT-1 Stock solution added to make 1 liter
0.2	0.2
0.4	0.4
0.6	0.6
0.8	0.8
1.0	1.0
5.0	5.0
10.0	10.0
15.0	15.0
20.0	20.0
25.0	25.0

3. Follow the procedure listed (utilizing the specific solution volumes that have been determined for the application) and prepare a calibration curve. Determine the absorbance of a blank solution using distilled or deionized water. This blank can be subtracted from the sample absorbance or used to zero the photometer so that the calibration curve goes through the origin. The calibration curve should be linear over the indicated ranges.

NOTES

1. For maximum accuracy the calibration curve should be checked by every operator using the test and should be verified a minimum of twice per month using a freshly prepared CT-1 standard.

2. A blank measurement must be recorded for each set of samples. The blank reading may vary slightly, however the absolute difference between the sample and the blank remains relatively constant.

3. A slight emulsion may form when using natural water samples. Correct for this by using a variation in step 5 of the procedure. Shake the funnel for 30 seconds than allow to stand for 5 minutes. Gently invert the funnel once then allow the funnel to stand for 5 minutes (don't forget to vent the funnel).

4. It is important to vent the separatory funnel both before and after shaking it. Otherwise, a pressure will build up in the funnel that can cause the stopper to be forced out of the top of the funnel.

5. It is imperative that the sample cells are kept clean during the running of the test. It is recommended that the cells are cleaned after each measurement by the following procedure:

    a) Rinse the cell three times with distilled or deionized water.
    b) Rinse the cell three times with methanol.

c) Finally rinse the cell three times with 1,2-dichloroethane to remove any methanol from the cell.

6. Chlorine causes a negative interference in the test. This can be eliminated by adding 0.1 N sodium thiosulfate (code 235) to the water sample before running the test. The amount to be added must be determined based on the concentration of chlorine in the system. For a 100 mL water sample containing 0.3 mg/L chlorine, 10 drops of 0.1 N sodium thiosulfate will remove the interference.

7. This method is based upon L. K. Wang and D. F. Langly, Ind. Eng. Chem., Prod. Res. Dev., (1975) Vol. 14, No. 3, 210-212