Rev. 0

CLINTON POWER STATION

RAW WATER TREATMENT AND ENHANCEMENT PROGRAM

APRIL, 1992

RWTP

EXECUTIVE SUMMARY

This Work Plan has been developed to address design, implementation and testing of a practical, simple, safe and reliable chemical and/or mechanical treatment system for the Clinton Power Station piping systems and components which utilize lake water as the cooling medium. The treatment system shall be capable of preventing and mitigating effects of corrosion, scaling, micro and macro biological fouling. A systematic and prioritized execution of the program activities is planned in four phases: Inactivate existing Microbiologically Influenced Corrosion (MIC), Prevent it from recurring, Select chemicals for trial treatments, and Implement permanent treatments utilizing the latest treatment technology and industry experience. The Work Plan has been reviewed by the Program Task Force.

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Raw Water Treatment and
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RAW WATER TREATMENT AND ENHANCEMENT PROGRAM

I. Mission

The mission of this program is to implement a practical, simple, safe and reliable chemical and/or mechanical treatment system designed in compliance with the state and federal regulations to prevent and mitigate the effects of corrosion, scaling and biofouling in CPS plant systems which utilize Clinton lake water as the cooling medium.

II. Scope

This program will address general corrosion, scaling, microbiological (induced and influenced) fouling and macrobiological (Asiatic Clams and Zebra Mussels) fouling in the following systems and structures:

- Plant Service Water (WS)
- Shutdown Service Water (SX)
- Circulating Water (CW)
- Fire Protection (FP)
- Makeup Water (WM)
- Potable Water (WD)
- Intake and Discharge Structures

III. Background

A typical raw water treatment program is designed to prevent degradation caused by numerous biological, chemical and physical mechanisms which can collectively result in pressure boundary failures (seen in the Diesel Generator Heat Exchangers (DGHX's)), reduction in heat transfer capabilities (seen in the main condenser tubes as calcium carbonate scale), flow restrictions (silting seen in chilled water coolers) and reduced lifetime of piping and components. The common degradation mechanisms are:

1. **Corrosion:** Corrosion can be defined as the destruction of metal by chemical or electrochemical reaction with its environment. There are several types of corrosion:

   - Pitting
   - Selective leaching
   - Galvanic corrosion
   - Crevice corrosion
   - Intergranular corrosion
   - Stress corrosion cracking
   - Erosion

   In cooling systems, corrosion causes two basic problems - failure of equipment; and decreased plant efficiency due to fouling and loss of heat transfer from corrosion products. Corrosion rates determine the metal loss with respect to time for the different materials of the system. Most piping systems are designed with a corrosion margin. If the corrosion rate exceeds the design margin, premature pipe and equipment replacement will be required to obtain plant design life.

2. **Scaling:** Scale is the precipitation of dense adherent materials on heat exchanger surfaces. Scale acts as an insulator and decreases the ability of the heat exchanger to transfer heat. Although heat exchangers are designed with a fouling factor, high scaling rates will rapidly deplete the reserve margin for the exchanger. This would result in inoperable equipment and frequent maintenance outages for cleaning.

3. **Biofouling:** Biological fouling in cooling systems is the result of abundant growth and development of algae, fungi, and bacteria. Fouling deposits cause poor heat transfer through exchanger tubes, reducing efficiency. Fouling can also restrict flow through equipment and piping.

   a. **Asiatic Clams:** Asiatic clams are a form of macrofouling. These clams travel through water in the larval form and lodge in areas and grow, thereby restricting flow to equipment. Asiatic clams are known to exist in Clinton Lake. RF-3 inspection found an approximate population of 5,000 clams per sq. ft. in the intake structure of the screenhouse.

   b. **Zebra Mussels:** Zebra mussels are somewhat similar to the Asiatic clams and can plug heat exchanger tubes and small pipes. But where the Asiatic clams float freely through the water until deposited, the zebra mussels can attach themselves to pipe walls and to one another, thus creating rapid and major flow restrictions. Although zebra mussels have not yet been detected in Clinton Lake, they do exist in not too distant water bodies and it is believed that it is only a matter of time until they migrate to Clinton Lake.

4. **Microbiologically Influenced Corrosion (MIC) Organisms:** Most waters contain various forms of MIC organisms. If conditions are conducive to their growth, they can rapidly deteriorate system pressure boundaries.

IV. History

The original design of the plant incorporated traveling screens and service water pump strainers to prevent large and small objects from entering the plant systems which are fed by the Clinton lake water. In addition, gaseous chlorine was utilized to treat WS/SX, CW, WD and WM systems. To address IE Bulletin 81-03 (Asiatic Clams), credit was taken for gaseous chlori[illegible] for prevention and compliance. In 1986, a [illegible]ion was made to treat the Fire Protection (FP) system (Plant Mod FP-45) using gaseous chlorine. Due to various design related and hardware problems, frequent gas leaks and an independent evaluation of the modification by MPR Associates, this mod was retired in place. At the same time, a decision was made to utilize liquid chlorine to treat the lake water systems and additionally, the FP system was included in the scope. Plant Mod M-53 was designed and installed in 1988-89 to treat WS/SX, CW, FP, WM, and WD systems. Again, because of a number of hardware and design deficiencies, the system failed to deliver Sodium Hypochlorite (liquid chlorine) at the desired time and locations. Currently, only a small portion of the M-53 modification is being used to treat the Potable Water (WD) system. The remaining portion stands unutilized and is not released for operation. In July, 1989, Generic Letter (GL) 89-13 was issued by the NRC which addressed the following:

- For open-cycle service water systems, implement and maintain an ongoing program of surveillance and control techniques to significantly reduce the incidence of flow blockage as a result of biofouling.

- Conduct a test program to verify heat transfer capability of all safety related heat exchangers cooled by service water.

- Ensure by establishing a routine inspection and maintenance program for open-cycle service water system piping and components that corrosion, erosion, protective coating failure, silting and biofouling cannot degrade the performance of the safety related systems supplied by the service water.

- Confirm that the service water system shall perform its intended function in accordance with the licensing basis of the plant.

- Confirm that maintenance practices, operating and emergency procedures and training are adequate to ensure that safety related equipment will function as intended and that operators of the equipment will perform effectively.

Attachment 1 provides a chronological pictorial representation of the history.

Actions Taken to Date

At CPS, the following actions have been taken to address raw water treatment and GL 89-13:

1. Performance testing is currently being performed on the SX system heat exchangers per CPS operating procedure 2602.01.

2. Screenhouse intake structure is inspected during every outage per CPS operating procedure 2400.01.

3. Between January 1990 and March 1991, forty (40) heat exchangers (HX's) in the SX system were inspected. There was no evidence of MIC in the tube bundles of 35 HX's. However, a mild attack of MIC in the waterboxes and connected piping was noted in SX system. The MIC was removed by hand cleaning prior to restoring the HX's. Five Diesel Generator Heat Exchangers (DGHX's) had evidence of MIC attack in their tube bundles and corrective actions were taken as shown below.

   - **Rework** - Because of various leaks which developed and degradation found upon inspection, rework was performed on the DGHX's which consisted of the following actions.

Diesel Division	Plugged Leaking HX Tubes	Retubed HX	HX Tube Bundle Replaced
I	12/89 (16 cyl)	3/90 (12/16 cyl)	9/91 (12/16 cyl)(1)
II(2)	1/90 (12 cyl)	6/90 (12/16 cyl)	9/91 (12/16 cyl)
III(3)	N/A	N/A	N/A

Notes: (1)12/16 Cyl. indicates the HX located on the 12 or 16 cylinder head of the diesel generator.
(2)Performed closed loop chemical treatment which was determined to be necessary to kill MIC in Div. II HX's in 3/90.
(3)HX was inspected and eddy current tested in 1/90 and 12/90.

   - **Chemical Treatments** - A chemical treatment program was developed in conjunction with Buckman Laboratories to inactivate the MIC which was found to be the cause of the failures noted in "Rework" above. As of this date, three chemical treatments have been completed per CPS operating procedure 2800.37 in each division of the SX system as shown below.

SX Division	CHEMICAL TREATMENT First	Second	Third
I	10-11-90	05-29-91	02-26-92
II	10-02-90	08-13-91	02-14-92
III	10-02-90	08-07-91	02-19-92

- Design change - To help ensure the long-term reliability of the DGHX's, the following actions have been taken in the design area. As of this date, they are not yet field implemented.

  - Field Alt DGF047: Facilitates chemical layup of the heat exchangers when not in use.

  - Field Alt DGF041: Allows procurement of a heat exchanger with an alternate tube material. A new heat exchanger with titanium tubes and titanium clad tubesheets will be procured for the diesel generator application.

- Preventive Measures - To prevent stagnant flow conditions in the warm environment of the diesel generator area, started establishing 2 hour/day flow through the DGHX's tubes beginning in October, 1991.

In order to ensure effectiveness of the chemical treatments, an inspection program of the SX system heat exchangers was initiated in the third quarter of 1991. Two heat exchangers, which are picked randomly, are opened and inspected every six months. As of this date, four heat exchangers have been inspected under this program and MIC has not been identified in the tube bundles. Inspection of the next two heat exchangers is scheduled in June, 1992.

5. A parallel HX inspection program was executed for the non-safety related Plant Service Water (WS) system between March, 1990 and November, 1991. Out of a total of 28 HX's, 26 have been inspected with no evidence of MIC in the tube bundles. It should be noted that there was moderate to heavy MIC attack in the waterboxes and connected piping in WS system HX's. The MIC was removed by hand cleaning prior to restoring the HX's.

6. In the CW system, the main condenser waterboxes are routinely inspected during every planned and refueling outage. MIC has not been found so far in these waterboxes during at least seven inspections. The waterbox inspection will continue in future outages.

7. Three locations of galvanized piping were inspected in FP system. There was no evidence of MIC at these locations. Additional locations with carbon steel piping are planned to be opened and inspected.

8. The water supply to potable water (WD) system is from WS via WM system. WD system is currently being chlorinated per Plant Mod M-53, Supplements 3 and 4. One of the goals of this program is to establish a reliable source (surface or ground water) for WD system.

In order to address reduced heat transfer capability of the main condenser, installed a temporary modification in June, 1991, to inject a scale inhibitor in CW system to prevent further scale build-up in the condenser tubes.

10. Initiated development of plans for routine chlorination of WS and CW systems after the RF-3 outage.

V. Goals

The following six goals have been established in support of the mission:

1. Inactivate/kill existing microbiologically influenced/induced corrosion (MIC) in susceptible areas of all the systems which utilize lake water.

2. Establish/implement method(s) to prevent MIC from recurring.

3. Collect and analyze the lake water data to support selection of proper treatment systems which will mitigate effects of general corrosion, scaling, micro and macrobiological fouling.

4. Design, implement and test permanent raw water treatment systems.

5. Develop plans to retire/abandon unutilized portion of installed Plant Mod M-53 (liquid chlorine).

6. Establish/implement plan(s) for a reliable source of potable water.

VI. Regulatory Interface and Compliance

During the planning, design and execution of program activities, interface with the following regulatory and rulemaking organizations will be established and compliance ensured:

- Nuclear Regulatory Commission (NRC)

  The NRC has issued Generic Letter 89-13 (GL 89-13) which deals with numerous ways in which water used as a cooling medium can degrade the ability of the safety related Service Water system. This program will ensure compliance with the NRC GL 89-13 recommendations.

- Environmental Protection Agency (EPA): State and Federal

  Illinois EPA approves the chemical treatments with regard to discharge concentrations which can be released to the lake. It maintains IP's National Pollutant Discharge Elimination System (NPDES) permit. This program will ensure that all the discharge concentrations are within the permit requirements.

- Illinois Department of Public Health (IDPH)

  Currently, lake water supplies the site potable water which must comply with the Federal and State EPA requirements of drinking water quality. IDPH is responsible for enforcing IEPA rules. This program will ensure compliance with the potable water standards.

- Occupational Safety and Health Administration (OSHA)

  Corrosion of piping systems could result in through wall failure(s) of pressurized piping systems thereby endangering plant personnel. One of the objectives of this program is to develop and implement measures to ensure that the corrosion which occurs at CPS is kept to a minimum to help reduce the probability of these types of failures.

- National Fire Protection Association (NFPA)

  The Fire Protection system utilizes lake water as its supply. If left untreated, the water in the system can degrade the system to the point that adequate water flow could not be supplied when required. One of the objectives of this program is to prevent this from occurring at CPS.

- American Society of Mechanical Engineers (ASME) Code

  The modifications in the safety related portion of the raw water systems will comply with the ASME Code and non-safety related will comply with B31.1 Code.

VII. Program Organization

On January 27, 1.92, a full-time Project Manager, K. Bhayana, was assigned to the Raw Water Treatment & Enhancement Program, reporting to R. T. Kerestes, Director - Engineering Projects. Prior to this time, various group in Nuclear Station Engineering Department (NSED) were responsible for inactivation and prevention of MIC, Raw Water Treatment Program, Plant Mod M-53 and Potable Water Consolidation of all these activities in one program provides a centralized focus and more effective execution of pl nned activities. A Task Force has been rmed to support the Project Manager and provide a contact p nt in each affected discipline to coordinate assigned duties. The Task Force currently consists of the following:

- Nuclear Station Engineering Department (NSED)
  - Design & Analysis
  - Systems
- Plant Technical (P. Tech.)
  - Chemistry
  - Testing
  - Radwaste
- Environmental Affairs Department (EAD)
- Licensing & Safety (L&S)
- Nuclear Training Department (NTD)

In addition, an independent water management consultant will be dedicated for three months on this project. As the need for more support arises, additional disciplines will be added to the Task Force. The Program Support Organization is presented in Attachment 2.

VIII. Strategy

It is critical to address each goal of this program with a systematic and prioritized approach. The following strategy has been developed to cover the entire program.

GOAL #1

Inactivate Existing MIC

Purpose: Arrest and inactivate existing MIC in all susceptible areas of the plant systems - SX, WS, CW, FP, WM and WD.

Background: The first incident of MIC was identified in December, 1989 when DG Div. 1 heat exchanger developed a tube leak. Follow-up inspection of Div. II and III heat exchangers also indicated a MIC related problem. In the same time frame, corrective actions were being proposed to address Generic Letter 89-13 at CPS. As a result, an extensive heat exchanger inspection program was started in the safety related SX system and non-safety related WS system. Open and closed loop chemical treatments were performed in the system piping and components. In order to accomplish this goal, the following actions are planned.

Actions:

1. Obtain IEPA discharge permit for SX System chemical treatment on a monthly basis. The treatment shall be performed in accordance with CPS 2800.37 using Sodium Hypochlorite, Sodium Bromide (BULAB 6040) and a penetrant (BULAB 8007). These chemicals are neutralized per IEPA permit limits prior to discharging in the lake. Chemical treatment on a monthly frequency is required to inactivate the existing MIC.

2. Develop and implement the necessary hardware and software changes to perform chemical treatments in a safe and practical manner. This may result in installation of automated dechlorination systems and procurement of portable skids with pumps and tubing installed for chemical injection.

3. Conduct monthly chemical treatments in the SX system beginning within two months after RF-3.

4. Develop chemical and/or mechanical treatment plans for WS, CW, FP, WM and WD systems.

5. Obtain IEPA permit for treating WS, CW, FP, WM and WD systems.

6. Develop and implement necessary hardware and software changes similar to Action 2.

GOAL #1 (Cont'd)

7. Develop a time frame to begin chemical treatment in WS, CW, FP, WM and WD systems.

8. Monitor the effectiveness of chemical treatments on a regular basis using swab culture or an alternate technique.

GOAL #2

Prevent MIC From Recurring

Purpose: Prevent further degradation of the plant systems by preventing MIC from recurring.

Background: Diesel Generator (DG) Div. I and II HX's were retubed in March and June, 1990. The tube bundles of these HX's were replaced again in September, 1991 due to MIC attack. The duration between the first and second chemical treatments was approximately 7 months and 10 months in Div. I and II respectively compared to the recommended frequency of 4 months. It is therefore, very important to continue the chemical treatment on a regular basis to prevent MIC from recurring.

Actions:

1. Establish a frequency of chemical and/or mechanical treatment in SX, WS, FP, CW, WM and WD systems which prevents MIC from recurring.

2. Conduct routine treatments.

3. Monitor the effectiveness of these treatments on a regular basis.

4. Evaluate alternate chemicals (e.g., only liquid chlorine) in place of a combination of chemicals to prevent MIC from recurring.

5. In the post RF-3 diesel generator outages, inspect DGHX's to evaluate the effect of establishing daily flow. Develop a similar plan for other HX's in the SX and WS systems, if applicable.

6. Develop a modification to place the components in chemical layup when not in use. The potential candidates are the components with warm environment and stagnant flow conditions.

7. Perform technical and economic evaluation of an alternate tube material for heat exchangers susceptible to MIC attack.

8. Evaluate establishing continuous flow through SX system to prevent stagnant flow conditions in DGHX's in summer and chemical layup in winter.

GOAL #2 (Cont'd)

9. Evaluate use of mechanical scrapers and hydrolasing to reduce potential of MIC.

GOAL #3

Analysis/Data Collection to Support Decision on Final Treatment

Purpose: Collect and analyze the lake water data to support selection of treatment systems which will mitigate the effects of general corrosion, scaling, microbiological (algae, slime, bacteria) and macrobiological (Asiatic clams and zebra mussels) in the plant systems and intake/discharge structures.

Background: During RF-3, over 70 tons of calcium carbonate scale was removed from the main condenser tubes. Also, during the RF-3 inspection of the screenhouse intake structures, an Asiatic clam population of approximately 5,000/sq. ft. was found. Zebra mussels are moving in the Illinois rivers and are expected to be in Clinton lake in the near future.

The key to determining any treatment program is identification of problem mechanism. Once the mechanism is identified, a treatment scheme can be developed to arrest that mechanism without creating a new mechanism. The following actions will accomplish this goal.

Actions:

1. Install a leased mobile lab to measure corrosion rates (both coupons and corrators) for system metal (mild carbon steel, copper-nickel, stainless steel), pH, conductivity, chlorine levels, biofouling, fouling factors and deposition on a continuous basis. This data will be utilized to select proper chemicals, determine material changes and will provide an input to the permanent treatment design.

2. Install monitors for the size, population and propagation of asiatic clams and zebra mussels in Clinton Lake. Utilize this data in the design of permanent treatment system.

3. Evaluate installation of "model condensers" at the entrance and exit locations of the main condenser to determine the effectiveness of scale inhibitor and chlorination.

GOAL #4

Design, Implement and Test Permanent Raw Water Treatment Systems

Purpose: Design and implement a permanent chemical and/or mechanical treatment system in SX, WS, CW, FP, WM and WD systems which addresses MIC, general corrosion, scale, pitting, micro and macrobiological fouling.

Background: The key to a successful and effective permanent treatment system is proper selection of treatment methods and chemicals and using these on a trial basis prior to the final design. Raw water treatment is a dynamic process with constant changes in regulatory requirements and treatment technology. This goal will be accomplished in two phases.

Phase I: Implementation of trial treatments
Phase II: Implementation of permanent treatments

The following actions are planned for this goal.

Actions: 1. Retain services of an independent water management consultant with the following four specific tasks:

Task #1: Perform a comprehensive review and analyze existing data for determination of raw water treatment needs.

Task #2: Recommendation for additional data collection to complete analysis of treatment requirements.

Task #3: Evaluate existing treatment programs and recommend viable alternative treatment programs.

Task #4: Recommend additional treatment programs which are required to support the Program mission but do not currently exist at CPS. Prepare a final report providing details of the recommended and alternative treatment programs along with a monitoring plan to ensure effectiveness of the treatment. Identify advantages and disadvantages of each treatment schemes.

GOAL #4 (Cont'd)

2. Evaluate use of scale inhibitor in CW system to prevent scale build-up in the main condenser tubes.

3. Review water management consultant's final recommendation for treatment systems.

4. Develop a permanent treatment plan.

5. Obtain necessary discharge permits from IEPA. Lease skids from the chemical treatment suppliers.

6. Perform treatments on a trial basis in various systems. This will facilitate the earliest treatment of corrosion and fouling problems with minimum impact on site personnel and establish effectiveness of chemicals prior to major capital expenditures.

7. Conduct routine treatments.

8. Monitor the effectiveness of these treatments.

9. Make necessary changes in the chemicals being utilized.

10. Following successful trial chemical treatments, develop and implement the modifications required to make the treatment system permanent. This includes design, permits, new building for the treatment system, hardware installation, CPS procedures, testing and successful operation.

GOAL #5

Closure Pl(for Plant Mod M-53

Purpose: Retire/abandon portion(s) of Plant Modification M-53 which is currently not being utilized and has no future application at CPS.

Background: Plant Mod M-53 was designed and installed in 1988-1989 to treat lake water in the WS, CW, FP systems in the Screenhouse; and WM and WD systems in the Makeup Water Pump House using Sodium Hypochlorite (liquid chlorine). Due to various inadequate design considerations and hardware problems such as material incompatibility, gas generation, pump binding, insufficient capacity of metering pumps and deterioration of fittings, a major portion of this modification was not released for operation. In order to correct deficiencies in the original design, four supplements were prepared. The design documents for the entire modification are shown below:

Modification	No. of Design Documents
M-53	15
Supplement #1	49
Supplement #2	13
Supplement #3	5
Supplement #4	1

All these design documents have generated numerous new support drawings, P&ID's, equipment and structural drawings. Currently, only Supplements 3 and 4 are being utilized to treat Potable Water (WD) system. The remaining documents are open and associated hardware unutilized.

Actions:

1. Review water management consultant's final recommendation for chemical treatment.

2. Develop a closure plan to retire/abandon or complete removal of Mod M-53 hardware.

3. Implement the plan during the installation of a permanent treatment system(s).

GOAL #6

Reliable Source of Potable (WD) Water

Purpose: Provide a continuous, safe and disinfected supply of potable water at CPS.

Background: The Safe Drinking Water Act was passed by Congress in 1974 and has been amended several times since then. The EPA is the federal government agency which writes the regulations to carry out the provisions of the Act. The purpose of the Act is to make sure that the potable water supplied to the public is safe and wholesome. This federal drinking water program is designed to be delegated to the approved state government agencies to ensure compliance on a day-to-day basis. In Illinois state, it is the Illinois Department of Public Health (IDPH).

Potable Water Standards: EPA sets the following standards:

- Primary - health based and are enforceable
- Secondary - esthetic quality (taste, odor or color) based and are non-enforceable

Requirements of the Safe Drinking Act:

- Sampling and Reporting -- Lab samples are submitted to the agency
- Record Keeping - Lab results, sample points, location and other information are kept in files
- Public Notification - Violations are Tier 1 or Tier 2 depending on the seriousness of violations

Types of Contaminants: EPA sets the standards for the following groups of contaminants.

- Microorganisms - bacteria, viruses and protozoa
- Turbidity - a measure of the cloudiness of water caused by suspended material
- Legionella - Heterotrophic bacteria
- Inorganics - Metals - such as arsenic, barium, cadmium, chromium, fluoride, mercury, nitrate, silver and lead

GOAL #6 (Cont'd)

- Synthetic Organics - Man-made carbon containing chemicals (currently regulated are pesticides and herbicides)
- Volatile Organics - These readily volatilize or travel from water into the air
- Radionuclides - Naturally occurring radioactive chemicals
- Disinfection By-products - Chemicals formed when a disinfectant such as chlorine is added to the water containing organic matter

Surface water systems obtain their water from sources open to the atmosphere, such as rivers, lakes, reservoirs and streams. Ground water systems under the influence of surface water may include shallow wells, infiltration galleries and springs which have water quality characteristics similar to surface waters.

All surface and ground water systems must provide disinfection. Systems will be required to monitor the disinfectant residual leaving the treatment plant at various points in the distribution system. The water leaving the treatment plant must have at least 0.2 mg/L of the disinfectant, and the samples taken in the distribution system must have a detectable residual. Certain guidelines must be followed to ensure that there is enough contact time between the disinfectant and the water so that the microorganisms are inactivated.

The current source of potable water (WD) is from WS through WM system. Use of certain chemicals (e.g., bromine) are prohibited in potable water. The chemical selection for the Raw Water Treatment and Enhancement Program will dictate the selection of a permanent source of potable water.

Actions:

1. Select ground water source location.
2. Perform well drilling, if required.
3. Evaluate quality of ground water.
4. Make final selection of reliable source - ground water vs. surface water.
5. Prepare final design for implementation.

IX. Performance Indicators

Performance of the overall project will be reflected on performance indicators which are being developed. These p.. formance indicators will be based on the Level II schedule and will be updated on a monthly basis to reflect actu . progress against the overall schedule and mission.

X. Schedule

A Level I schedule is provided as Attachment 3 which lays out six major goals for the Raw Water Treatment and Enhancement Program. A Leve. II schedule with applicable details is currently being deve..ped.

This plan will be adjusted as more experience and knowledge is gained pertaining to lake water chemistry, chemicals, environmental restrictions, treatment technology, regulatory requirements and costs. At the completion of this program, all modifications will have been released for operation following satisfactory post mod testing.

RAW WATER TREATEMENT AND ENHANCEMENT PROGRAM HISTORY

ORIGINAL PLANT DESIGN
- Traveling Screens
- Pump Strainers
- Gaseous Chlorination for WS/SX,CW,WM,WD

1981 — IE Bulletin 81-03 - Asiatic Clams

1985 — Diesel Gen. Heat Exchangers (DGHX's) placed in service

1986 — Installed Gaseous Chlorine Mod FP-45 for Fire Protection System

1987 — Decisions to eliminate Chlorine gas from CPS and utilize liquid chlorine for WS/SX,FP,CW,WM,WD Systems

1988 — Implemenation of Liquid Chlorine Mod M-53 begins

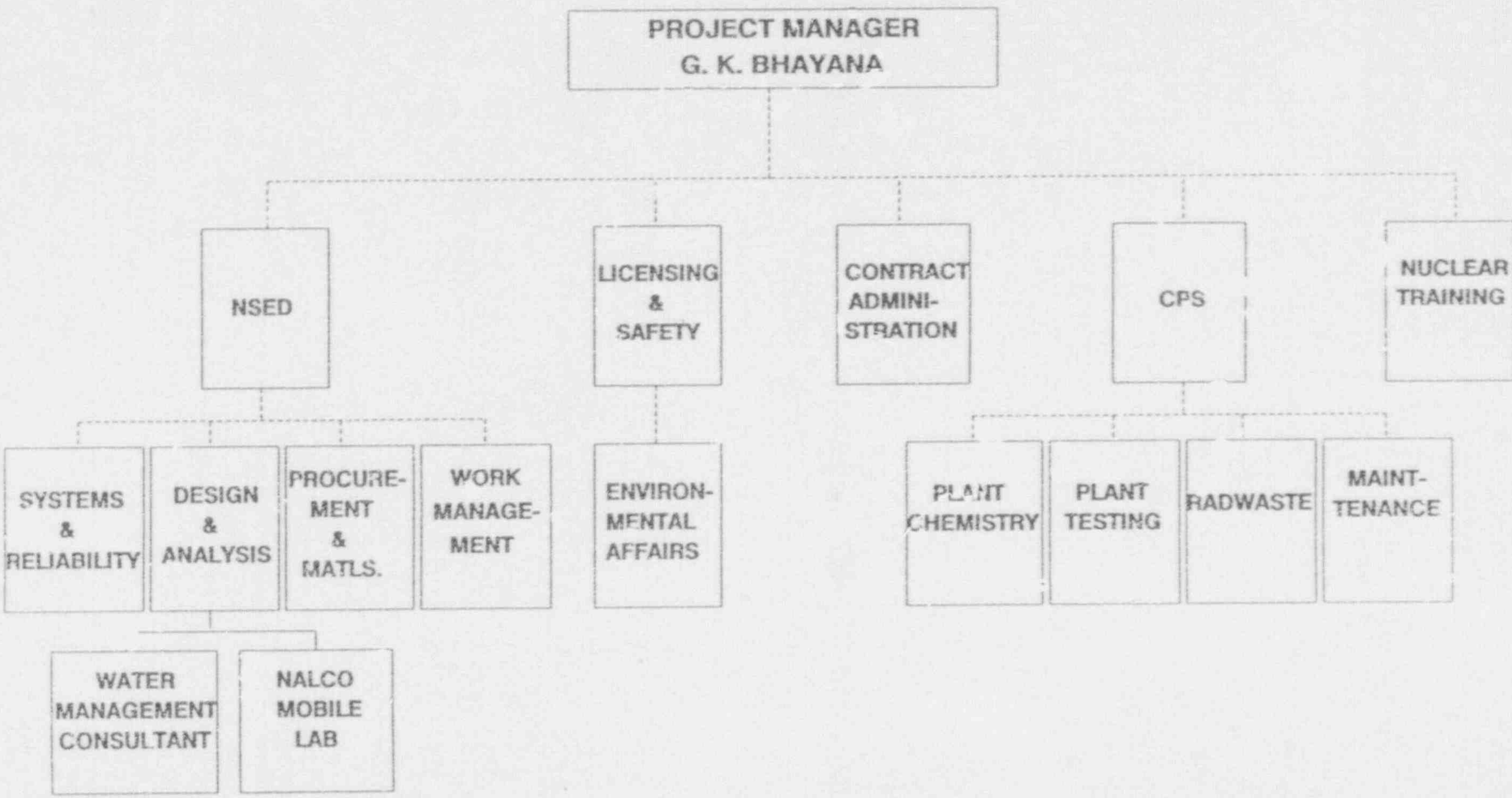
1989 —
- July
  - Generic Letter 89-13 is issued by the NRC
- December
  - DGHX develops leak - Diagnosed as MIC attack

1990 —
- Generic Letter 89-13 actions begin
- Plant Mod M-53 plagued with design deficiencies and hardware problems
- EPRI studies indicate reduced effectiveness of liquid chlorine in water with pH value of 8.0 and above

1991 —
- Continued efforts to make Plant Mod M-53 functional
- Injection of Scale Inhibitor in CW System

1992 —
- January
  - Only Potable Water (WD) portion of M-53 is released for Ops
  - Project Manager named and Raw Water Treatment and Enhancement Program is initiated
- March
  - RF-3 inspection of Screenhouse intake structure finds dense population (5,000 per sq.ft.) of Asiatic Clams

RAW WATER TREATMENT AND ENHANCEMENT PROGRAM SUPPORT ORGANIZATION



Attachment 3 Rev. 0

RAW WATER TREATMENT AND ENHANCEMENT PROGRAM

LEVEL I SCHEDULE

2/92 — 7/94

INACTIVATE EXISTING MIC (2/92 – 7/93)

* OBTAIN IEPA APPROVAL FOR MONTHLY SX TREATMENT
* BEGIN ROUTINE CHEMICAL TREATMENT OF SX SYSTEM
* DEVELOP TREATMENT PLAN FOR WS,CW,FP,WM,WD SYSTEMS
* BEGIN ROUTINE TREATMENT OF WS,CW,FP,WM,WD SYSTEMS
* MONITOR EFFECTIVENESS

PREVENT RECURRENCE OF MIC (7/92 – 10/93)

* EVALUATE INSTALLATION OF DECHLORINATION SYSTEMS
* OBTAIN MAC APPROVAL (IF NECESSARY)
* BEGIN CHLORINATION OF WS, CW SYSTEMS
* INSTALL DGP047 (CHEMICAL LAY-UP OF DGHX'S)
* EVALUATE ALTERNATE TUBE MATERIAL (DGP041)
* ESTABLISH DAILY FLOW
* EVALUATE USE OF SCRAPERS AND HYDROLASING TO REDUCE MIC POTENTIAL
* MONITOR EFFECTIVENESS OF MIC PREVENTION MEASURES

ANALYSIS/DATA COLLECTION TO SUPPORT DECISION ON FINAL TREATMENT (3/92 – 4/93)

* INSTALL A LEASED MOBILE LAB
* IDENTIFY MISSING DATA
* EVALUATE LAKE WATER DATA
* UTILIZE DATA IN PERMANENT TREATMENT PLAN

DESIGN, IMPLEMENT & TEST PERMANENT RAW WATER TREATMENT SYSTEM (4/92 – 7/94)

* RETAIN SERVICES OF AN INDEPENDENT WATER MANAGEMENT CONSULTANT
* DEFINE TREATMENT GOALS
* DEVELOP TREATMENT OPTIONS
* SELECT TREATMENT
* OBTAIN NECESSARY IEPA PERMITS
* IMPLEMENT TRIAL BASIS TREATMENT SYSTEMS
* MONITOR EFFECTIVENESS
* OBTAIN MAC APPROVAL FOR PERMANENT MODS
* IMPLEMENT PERMANENT TREATMENT SYSTEMS

CLOSURE OF PLANT MOD M-53 (8/92 – 09/93)

* DEVELOP PLANS TO RETIRE /ABANDON UNUTILIZED PORTION OF M-53
* REVIEW PERMANENT OVERALL TREATMENT PLAN
* IMPLEMENT CLOSURE OF M-53

RELIABLE SOURCE OF POTABLE WATER (1/93 – 1/94)

* EVAL. CHEMICAL COMPATIBILITY WITH THE POTABLE WATER STANDARDS
* DRILL WELLS FOR GROUND WATER SOURCE AND EVALUATE QUALITY OF WATER
* FORMAL DECISION ON GROUND VS. SURFACE WATER
* DESIGN AND IMPLEMENT THE MODIFICATION