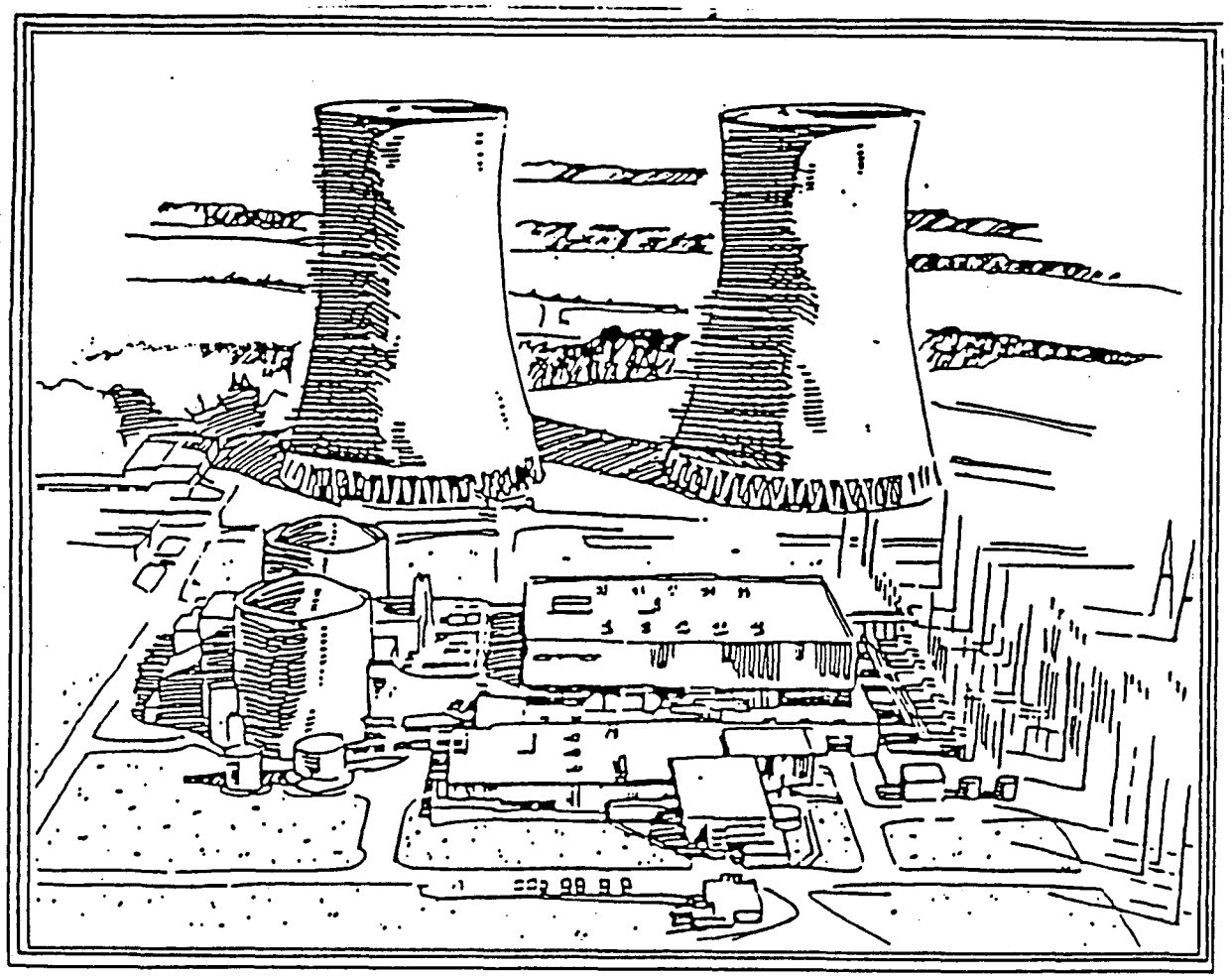
TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT



MICROBIOLOGICALLY INDUCED CORROSION

PROGRAM REPORT

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PDR ADOCK 05000390
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TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT

MICROBIOLOGICALLY INDUCED CORROSION (MIC) PROGRAM REPORT

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TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT (WBN)

MICROBIOLOGICALLY INDUCED CORROSION (MIC)

PROGRAM REPORT

1.0 BACKGROUND

As a result of corrosion product build-up in the Essential Raw Water (ERCW) System in the early 1980s, Engineering Change Notices (ECNs) were issued to replace carbon steel piping with stainless steel; also at that time, the main yard ERCW headers were lined with concrete. Also, Technical Instruction (TI) (TI-27) was implemented to assure system cleanliness during system breaches, and a wall thinning monitoring program (TI-31.13) was instituted.

In August 1986, a leak was discovered in a 12-inch diameter 316 austenitic stainless steel ERCW line. This line serves as a redundant supply to the motor and turbine-driven auxiliary feedwater pumps. To determine the underlying cause of the leak, a metallurgical analysis was performed. This analysis identified the cause as MIC attack of a 316 stainless steel butt weld. Nonconformance Report (NCR) W-471-P was initiated to document the problem. Subsequent to the NCR, two Significant Condition Reports (SCRs) were initiated to generically address MIC in stainless steel piping at WBN. The SCRs were SCRWBNNEB8676 and SCRWBNNEB8677 for units 1 and 2, respectively.

In December 1986 a MIC project team was formed and beginning in January 1987, the following activities were initiated/accomplished:

- Process Specification 4.M.1.2 was issued to establish the upper tier technical requirements for MIC.
- The Institute of Applied Microbiology confirmed MIC bacteria and types.
- Random RT was performed on ERCW stainless steel butt welds.
- Informal inspections by Chemistry and Engineering were undertaken to further identify evidence of MIC.

By August 1987, improvements had been made to the Hypochlorite Biocide Injection System to ensure a more effective biocide treatment and by January 1988, a dry layup program had also been implemented for non-raw water systems. During the remainder of 1988, biocide and MIC testing was performed by Singleton Laboratory, which demonstrated that a combination of sodium hypochlorite and sodium bromide would decrease the total counts of active bacteria without any significant corrosive effects on system materials.

During 1989, Nuclear Engineering (NE) performed further detailed evaluations of additional ERCW stainless steel piping and a corporate level MIC program was established. On January 26, 1990, TVA submitted the response to Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment," which included WBN's specific response as Enclosure 2 of that submittal. This response addresses all the NRC's recommendations including those related to inspection and mitigation for MIC. By July 1990, a MIC project plan had been issued and a comprehensive WBN site specific MIC program had been issued/established.

During the fall of 1990, a WBN MIC assessment matrix was developed based upon a "Probability Assessment" for all wetted systems. Results of the assessment were compared with the earlier matrix developed for Sequoyah Nuclear Plant (SQN).

Additional background information is given in Section I of Attachment 1 of this report.

2.0 MIC DESCRIPTION, IDENTIFICATION, AND EVALUATION

The root cause of MIC is bacteria which colonize on metal surfaces in contact with aqueous environments resulting in localized corrosion under the colony. The severity of this condition is influenced by flow velocities within a given piping system and materials of fabrication.

In carbon steel, the microbiological attack occurs randomly throughout the piping systems and shows no preferential attack of weldments. MIC in carbon steel results in random pits and does not normally result in gross degradation and failure, but can result in pinhole leaks in a piping system.

The mechanism of attack starts with the formation of a slime film on the pipe wall in which bacteria can adhere and live. Formation of an iron oxide deposit results in a deaerated nodule where sulfate reducing bacteria concentrate. Under the nodule, these sulfate reducing bacteria cause the formation of a sulfuric acid (H_2SO_4) solution which causes accelerated corrosion.

In stainless steel, the microbiological attack occurs only at the butt welds and may include the heat affected zone. The attack morphology is normally a small pit with a large cavernous opening propagating as tunnels in the circumferential and through wall direction of the pipe. Eventually, a small pinhole leak will develop from the tunneling.

The mechanism of attack starts with preferential colonization of bacteria at a weldment. This colony of bacteria creates an oxygen concentration cell which results in the dissolution of ferrous and manganous ions under the colony deposit. In order for the ionic system to maintain charge neutrality, chloride ions are attracted to the dissolution sites and concentrate. This concentration results in a highly corrosive acidic chloride solution in the developing pit. Due to the chloride ions, a low pH condition exists within the concentration cell. This localized chemistry increases the rate of metal dissolution to the point of through wall pitting, resulting in pinhole type leaks. Once leakage occurs, the concentration cell is diluted by bulk water chemistry, eliminating the corrosive effect of the cell, thus minimizing further degradation.

Section II of Attachment (1) to this report contains the matrix "MIC Assessment of Systems at WBN Plant," which itemizes 38 systems that are wetted or have the potential to be wetted. Each system has been evaluated for its potential to develop MIC degradation and is assigned a probability which affects the inspection and corrective actions for that system. This evaluation identified that the six raw water containing systems are the only systems with a high probability of developing MIC. These six systems have been inspected visually to confirm and determine the extent of MIC.

Additionally, some nondestructive examinations have been performed on the safety-related systems. Specific maintenance and inspection activities associated with raw water systems were identified in Enclosure 2 of TVA's response to Generic Letter 89-13 dated January 26, 1990, these include inspections of piping, pumps, and heat exchangers which are susceptible to MIC.

Results of the most recent nondestructive examinations (NDE) are being used for the structural integrity evaluations which are discussed in Section 3.0 of this report. Additionally, these results are being retained for comparison with future examinations. Mitigation of the identified MIC will be discussed in section 4.0 of this report.

3.0 STRUCTURAL INTEGRITY IMPLICATION/EVALUATION

The structural integrity issues associated with MIC are directly related to wall thinning for carbon steel (CS) and a net section reduction at welds in stainless steel (SS). MIC degradation, as such, is not addressed by American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (hereafter referred to as ASME) Section III. ASME Section III does not provide detailed rules for corrosion or other service induced degradation; nor does it provide guidance for the evaluation of degradation. Therefore, analytical methodology based on stress margins inherent to ASME Section III and the analytical techniques of ASME Section XI will be applied to demonstrate Section III qualification and compliance. This analytical methodology and the MIC abatement program will be incorporated in a revision to the Class 3 Piping Design Specification in accordance with paragraph NB-2160 of Section III of the code. This revision to the Design Specification will assure code qualification and compliance for the MIC affected piping systems.

Structural integrity calculations, to-date, have been performed primarily for stainless steel and are based on a very conservative assumption of MIC degradation with effective wall loss. The actual distribution of MIC degradation is first determined using radiographic (RT) or ultrasonic (UT) examination techniques. Cumulative circumferential length of MIC degradation is assumed to be complete loss of wall, occurring at the worst possible orientation with respect to the pipe bending loads. A primary input to this methodology for analysis of stainless steel is the distribution of MIC pits at a weld joint. All calculations to date have either involved establishing a bounding flaw size for screening or specific evaluations of NDE results for individual welds.

CARBON STEEL

In carbon steel piping, MIC degradation is a general corrosion phenomena associated with defined tubercles which can occur anywhere on the interior pipe wall. Experience and historical data from TVA plants both fossil and nuclear, have shown that pinhole leaks develop in carbon steel as a result of MIC. Gross deterioration of carbon steel piping systems before the formation of a pinhole leak is not considered plausible. This is based on the degradation mechanism and the power generation industries experience.*

The following methodology has been developed and will be utilized to demonstrate ASME Section III acceptability of MIC degraded carbon steel piping:

I. Identify most susceptible MIC areas in ASME Section III carbon steel piping based upon flow velocity of raw water.

II. Review existing rigorous analysis to identify maximum loads (stress) in these locations at each pipe geometry for all pipe diameters.

III. Calculate minimum wall (TMIN) based on ASME Section III criteria utilizing highest stresses for that size of piping.

IV. Perform UT to determine existing wall thickness at the highest stress node locations and compare to acceptance criteria. Verify that the actual remaining wall thickness is greater than or equal to that required by design.

That is verify TACT $\geq$ TMIN, if not, go to parapragh V, D through G below.

Where: TACT = Actual measured wall thickness
TMIN = Minimum required wall thickness to satisfy ASME Section III stress equations.

* Electric Power Research Institute's (EPRI) "Sourcebook for Microbiologically Influenced Corrosion in Nuclear Power Plants"

V. Perform analysis based on the methodology described in Code Case N-480** and outlined below to determine maximum permissible degradation (acceptance criteria) in highest stressed (maximum value) locations for various piping diameters in these locations. Note Step A through C are performed in I through III above.

A. Determine highest stressed node.
B. Calculate minimum wall (TMIN) based upon ASME Section III criteria utilizing highest stresses for that size of piping.
C. Verify that the actual remaining wall thickness is greater than or equal to that required by design. That is verify TACT $\geq$ TMIN, if not, go to D through G below.
Where: TACT = Actual measured wall thickness
TMIN -Minimum required wall thickness to satisfy ASME Section III stress equations
D. Case 1 - Calculate TMIN based on an internal surface pit sized by ultrasonic wall thickness measurements in accordance with Code Case N480, paragraph 3622.1.
E. Case 2 - Calculate TMIN again with same parameters as Case 1 in accordance with Code Case N480, paragraph 3622.2.
F. When measured wall thickness TACT is less than acceptable by D above, recalculate TMIN utilizing actual Geometry and local stresses in accordance with Code Case N480, paragraph 3622.3.
G. However, in no case shall actual wall thickness TACT be less than 0.3 design wall thickness.

VI. Perform random UT on remaining areas to demonstrate existing conditions and compare the measured values to acceptance criteria (III above). If acceptance criteria is not met, follow steps outlined in paragraph V; Steps D, E, F, and G above.

** The analytical methodology of Code Case N480 is specifically referenced for use by NRC in Generic Letter 90-05 dated June 15, 1990. Enclosure 1 of this letter, Section C, Paragraph 3, subparagraph b states:

"b. 'Wall Thinning' Approach
This approach assumes wall thinning and evaluates the structural strength of the flawed piping based on the acceptance standards in Article 3000 of ASME Code Case N-480. Although ASME Code Case N-480 addresses wall thinning as a result of erosion/corrosion, the acceptance standards in ASME Code Case N-480 are extended by the staff to all wall thinning mechanisms such as microbiologically induced corrosion (MIC) for applications within the scope of this generic letter."

STAINLESS STEEL

MIC in stainless steel piping has been limited to pitting of butt welds and the corresponding heat affected zones, propagating as tunnels in the circumferential and through wall direction of the pipe. Additionally, heat affected zones of attachment welds could be affected. This tunneling condition has the potential to reduce the structural integrity of the piping system. However, experience has shown that pinhole leaks also develop from the MIC degradation of the stainless steel weldment. Evaluation of the structural integrity of MIC degraded stainless steel is currently being performed to demonstrate ASME Section III acceptability. The following methodology is used for this analysis:

I. Identify most susceptible MIC areas in raw water stainless steel piping.

II. Review existing TVA analyses to determine maximum load values for each piping diameter.

III. Calculate maximum permissible degradation (acceptance criteria) for each piping diameter based on maximum load values as follows:

A. Perform analysis to demonstrate compliance with structural acceptance criteria per ASME Section XI.

- Net section plastic collapse (ASME Section XI, Appendix C).
- Required factors of safety (load capacity/applied load) upset 2.77, faulted 1.38.
- Use bounding loads (enveloping maximum loads).
- Assume MIC defects are through-wall for their entire length.
- Use single flaw characterization based on a summation of individual MIC indications oriented in the worst manner with regard to applied loads.
- This provides the acceptance criteria for comparison with NDE results and assures that structural integrity is maintained if MIC degradation is found.

B. Perform analysis to demonstrate compliance with ASME Section III stress equations.

- Equations 8, 9, 10, and 11 per NC-3652.
- Use bounding loads from current analyses.
- Use stress intensification factor for butt weld.

IV. Review and utilize existing radiographs performed for lack of penetration (LOP)/lack of fusion (LOF) evaluations, along with previous radiographs performed specifically for MIC. This should establish an appropriate sample size for statistical analysis. If an appropriate sample size does not exist, additional radiography will be performed.

V. Evaluate MIC damage observed by radiography versus the acceptance criteria.

Consideration of LOP/LOF weld flaws in conjunction with MIC degradation will be analyzed utilizing a multiple flaw evaluation. This will be accomplished by using a degraded cross section (section modulus), based on NDE, considering flaw distribution of LOP/LOF and assuming MIC defects are through-wall for their entire length. The analysis of combined MIC and LOP/LOF can be performed by the technique previously described utilizing the proximity rules of ASME Section XI.

Further information concerning structural integrity and ASME Boiler and Pressure Vessel Code Section III qualifications and compliance are given in Section III of Attachment 1 of this report.

4.0 MIC MITIGATION

A primary objective of the MIC Program has been the mitigation of MIC related bacteria throughout the plant. MIC mitigation involves two aspects, the first is to prohibit new bacteria from colonizing and forming corrosion cells; the second is to eliminate present MIC sites.

MIC mitigation over the last 12 years has been a secondary benefit of WBN Plant Asiatic clam control program. This program required continuous chlorination of the raw water when the Tennessee River was greater than 60°F. However, before August 1987, the system used for the chlorination was unreliable. Therefore, significant improvements had to be made to that system to ensure a more effective program.

Based upon laboratory studies and information gathered from several sources, including the Electric Power Research Institute's (EPRI) MIC Source Book, a new bromine/chloride biocide injection system was installed in October 1990. This system provides substantial improvement in the effectiveness of the biocide on Tennessee River water (pH range 7.5-9.0). Results to date have shown up to a 90 percent reduction in bacteria which have the potential of forming MIC colonies.

The current chemistry control program will be further enhanced through an on-line cleaning program. A dispersant/corrosion inhibitor chemical treatment system will be installed and is scheduled to begin operation in the second quarter of calendar year 1991. This chemical treatment program will disperse tubercles and expose bacteria colonies to the biocide treatment, as well as, passivate the piping internal surfaces to minimize further corrosion. The benefits of the chemical treatment program also apply to the heat exchangers of the raw water systems. Biocide treatment was covered in TVA's response to Generic Letter 89-13 dated January 26, 1990.

A comprehensive corrosion monitoring program has been established to monitor the effectiveness of the biocide and dispersant/corrosion inhibitor treatments.

This monitoring program includes the following:

A. Betz Cosmos Portable Corrosion Monitor
B. Weight Loss Coupon Racks
C. Total Residual Oxident (TRO) Analyzer
D. Visual Observation Test Spool Pieces
E. Sessile Bacteria Bead Monitors

Results, to date, with the bromine/chloride biocide injection chemistry have been very good. This monitoring program will assure that the effectiveness and affects of the MIC Chemical Treatment Program will be continuously known and available for engineering evaluation and management review.

Section IV of Attachment 1 provides supplemental information on the Chemical Treatment Program.

5.0 FUTURE CONSIDERATIONS

The "MIC Assessment" Matrix that has been developed will be confirmed through additional data collection and NDE evaluations. Technical Instructions and preventive maintenance procedures will both implement a comprehensive MIC management program and provide analytical data for future evaluations of chemical treatment effectiveness and system piping structural integrity. As described previously, an on-line chemical treatment system will be used to both mitigate MIC in the raw water systems and to disperse existing tubercles and passivate the piping so that the effect of bacterial attack on these system's piping will be minimized.

Once WBN receives its Operating License, a complete ASME Section XI Program will be put in place which will be similar to Sequoyah's operational program. This program will include the following:

A. Inspection and NDE Evaluation

B. Chemistry Control and Monitoring

C. Structural Integrity Methodology

D. Operation With Leakage

E. Leak Monitoring Program

F. Operational Impact of Leaks

G. Protection From Sprays

6.0 SUMMARY

In the last six months, MIC at WBN Plant has been made a management priority, which has resulted in pulling together all aspects of the MIC issue into an overall program. This program which has been described in the preceding sections, is being managed as a special project with management overview.

The MIC Program has defined the probability of MIC occurrence in all wetted systems, defined a program for inspection and trending, mitigated the potential for developing new MIC sites and in the second quarter of calendar year 1991 will provide a chemical treatment program to address dissolution of existing MIC sites. Additional potential MIC locations

as defined by the program will be confirmed and verified with additional NDE followed by subsequent analysis to demonstrate Section III compliance. Based upon the structural integrity analysis performed to date, Section III compliance should be assured. Additionally, the program will be continually reviewed and enhanced to support the plant with an operational program once an Operating License is granted.

ENCLOSURE 2

List of Commitments

1. This analytical methodology and the MIC abatement program will be incorporated in a revision to the Class 3 Piping Design Specification in accordance with paragraph NB-2160 of Section III of the code.

2. The methodology has been developed and will be utilized to demonstrate ASME Section III acceptability of MIC degraded carbon steel piping as defined in the report.

3. Evaluation of the structural integrity of MIC degraded stainless steel is currently being performed to demonstrate ASME Section III acceptability.

4. Consideration of lack of penetration (LOP)/lack of fusion (LOF) weld flaws in conjunction with MIC degradation will be analyzed utilizing a multiple flaw evaluation.

5. A dispersant/corrosion inhibitor chemical treatment system will be installed and is scheduled to begin operation in the second quarter of 1991.

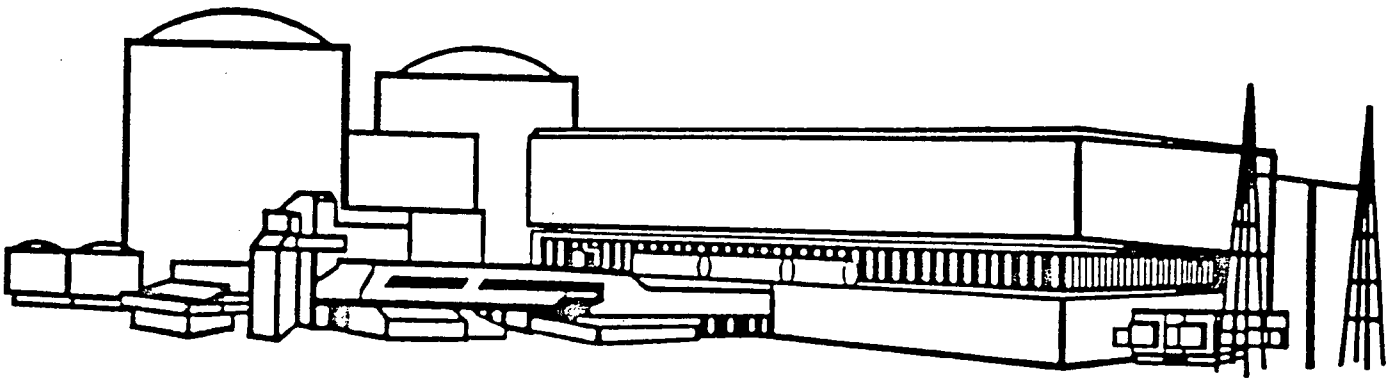
6. Additional potential MIC locations as defined by the program will be confirmed and verified with additional NDE followed by subsequent analysis to demonstrate Section III compliance.

INFORMAL TECHNICAL MEETING WITH THE NRC STAFF

WATTS BAR NUCLEAR PLANT

JANUARY 10, 1991

MICROBIOLOGICALLY INDUCED CORRISION AT WATTS BAR NUCLEAR PLANT



ATTACHMENT 1
TO
MICROBIOLOGICALLY INDUCED CORROSION
PROGRAM REPORT

TVA

WATTS BAR NUCLEAR PLANT

MICROBIOLOGICALLY INDUCED CORROSION (MIC) PROGRAM PRESENTATION

NUCLEAR REGULATORY COMMISSION (NRC) MEETING

AGENDA

I. INTRODUCTION
   - A. HISTORY AND PREVIOUS RESPONSES
   - B. OPERATIONAL CONSIDERATIONS
   - C. WBN PLANT MIC PROGRAM

II. MIC EVALUATION AND IDENTIFICATION AT WBN PLANT

III. STRUCTURAL INTEGRITY - SECTION III VALIDATION

IV. CHEMICAL TREATMENTS
   - A. BIOCIDE INJECTION SYSTEM PROGRAM
   - B. DISPERSANT/CORROSION INHIBITOR TREATMENT INJECTION SYSTEM PROGRAM AND PLANS

V. SUMMARY

SECTION I

INTRODUCTION

WATTS BAR NUCLEAR PLANT

MICROBIOLOGICALLY INDUCED CORROSION (MIC)
PROGRAM PRESENTATION

HISTORY AND PREVIOUS RESPONSES

A GREAT DEAL OF DATA EXISTS ON THE PRESENCE OF MIC IN SYSTEMS AT WATTS BAR. ADDITIONAL DATA IS BEING COLLECTED TO CONFIRM THE "EXTENT OF MIC" MATRIX.

THE PREVIOUS APPROACH TO DISPOSITION OF MIC OBSERVATIONS HAS BEEN MODIFIED TO BE MORE COMPREHENSIVE AND TO ADDRESS ASME SECTION III CONFIRMATION.

PREVIOUS ACTIVITIES TO ADDRESS MIC HAVE INCLUDED REPLACEMENT OF PIPING, AND TREATMENT OF RAW WATER SYSTEMS WITH HYPOCHLORITE BASED CHEMISTRY.

AN EFFECTIVE BIOCIDE INJECTION SYSTEM HAS BEEN INSTALLED AND HAS BEEN IN OPERATION FOR TWO MONTHS.

ON-LINE CHEMICAL CLEANING HAS BEEN SELECTED TO RESPOND TO THE MIC PRESENTLY IN THE PIPING SYSTEMS AT WATTS BAR. MATERIAL COMPATIBILITY, ENVIRONMENTAL DISCHARGE ACCEPTANCE, COST, SPECIFIC CHEMICAL, AND INJECTION TECHNIQUES ARE ALL BEING EVALUATED IN PARALLEL.

OPERATIONAL CONSIDERATIONS

A COMPLETE ASME SECTION XI PROGRAM WILL BE DEVELOPED AT A LATER DATE. PROGRAM ASPECTS WILL INCLUDE THE FOLLOWING:

- STRUCTURAL INTEGRITY
- CODE ACCEPTANCE OF OPERATION WITH LEAK
- LEAK MONITORING
- OPERATIONAL IMPACT OF LEAKS
- PROTECTION FROM SPRAYS

WATTS BAR NUCLEAR PLANT MIC PROGRAM

WE HAVE BEEN ADDRESSING THE FOLLOWING ISSUES/QUESTIONS WITH WBN PLANT'S MIC PROGRAM, BOTH IN THE PAST AND PRESENT.

1. WHERE IS THE MIC IN THE PLANT?

   ANS: A MATRIX HAS BEEN DEVELOPED BASED ON MANY PAST OBSERVATIONS AND THE DATA WILL BE SUPPLEMENTED BY ADDITIONAL TESTING.

   CONTACT: GARY RINER

2. HOW DO YOU SHOW STRUCTURAL INTEGRITY TO ASME SECTION III?

   ANS: THE ANALYTICAL TECHNIQUE TO DISPOSITION MIC WILL DETERMINE SECTION III INTEGRITY. A SCHEDULE TO PERFORM THESE CALCULATIONS HAS BEEN DEVELOPED.

   CONTACT: FRANK KOONTZ

3. WHAT WILL YOU DO ABOUT EXISTING MIC IN THE PLANT?

   ANS: ON-LINE CHEMICAL CLEANING HAS BEEN SELECTED.

   CONTACT: FRANK KOONTZ/RALPH MATTHEWS

4. WHAT WILL YOU DO TO ADDRESS MIC OCCURRENCE IN THE FUTURE?

   ANS: A BIOCIDE INJECTION SYSTEM HAS BEEN INSTALLED AND BIOLOGICAL MONITORING WILL BE PERFORMED TO ENSURE EFFECTIVENESS.

   CONTACT: RALPH MATTHEWS

WATTS BAR NUCLEAR PLANT
MICROBIOLOGICALLY INDUCED CORROSION (MIC)
PROGRAM PRESENTATION

MICROBIOLOGICALLY INDUCED CORROSION

* MICROBIOLOGICALLY INDUCED CORROSION - DETERIORATION OF METALS AS A RESULT OF THE METABOLIC ACTIVITY OF MICROORGANISMS. (METALS HANDBOOK, VOLUME 13, 9TH EDITION)

* MOST MATERIALS LOCATED IN AN AQUEOUS ENVIRONMENT ARE SUSCEPTIBLE TO MIC DAMAGE

* THE MECHANISMS AND TYPES OF BACTERIA ASSOCIATED WITH THE ATTACK OF VARIOUS MATERIALS IS QUITE DIFFERENT

BIOLOGICAL CORROSION OF CARBON STEELS

BIOLOGICAL ATTACK OF CARBON STEELS OCCURS RANDOMLY THROUGHOUT THE MATERIAL AND SHOWS NO PREFERENTIAL ATTACK OF WELDMENTS

THE ATTACK ON CARBON STEEL RESULTS AS SHALLOW RANDOM PITS OF VARIOUS DEPTHS AND NOT GROSS DEGRADATION

THE MECHANISM OF ATTACK:

* THE FORMATION OF A SLIME FILM ON THE PIPE WALL IN WHICH THE BACTERIA CAN ADHERE AND LIVE

* THE FORMATION OF AN IRON OXIDE DEPOSIT RESULTING IN A DEARREATED NODULE

* THE ATTACHMENT OF SULFATE REDUCING BACTERIA UNDER THE NODULE

* THE FORMATION OF A H_2SO_4 SOLUTION THUS ENCOURAGING RAPID CORROSION

BIOLOGICAL CORROSION OF STAINLESS STEELS

* ATTACK OF AUSTENITIC STAINLESS STEELS IS ASSOCIATED SOLELY WITH BUTT WELDS

* THE ATTACK IS SEEN IN BOTH THE WELD METAL AND HEAT AFFECTED ZONES. IT IS USUALLY SEEN AS A SMALL PIT WITH A LARGE CAVERNOUS OPENING AND THEN A SMALL PIN HOLE LEAK.

THE MECHANISM OF ATTACK INVOLVES:

* ORIGINAL COLONIZATION OF BACTERIA AT THE WELD SEAM CREATES AN OXYGEN CONCENTRATION CELL

* DISSOLUTION OF FERROUS AND MANGANOUS IONS UNDER THE DEPOSITS

* ATTRACTION OF CHLORIDES IONS AS THE MOST ABUNDANT ANION TO MAINTAIN CHANGE NEUTRALITY

* THESE MECHANISMS COMBINE TO FORM A HIGHLY CORROSIVE ACIDIC CHLORIDE SOLUTION IN THE DEVELOPING PIT

WATTS BAR NUCLEAR PLANT
MICROBIOLOGICALLY INDUCED CORROSION (MIC)
PROGRAM PRESENTATION

CHRONOLOGY OF MIC ACTIVITIES AT WATTS BAR NUCLEAR PLANT

* EARLY 80'S - CORROSION PRODUCT BUILDUP NOTED IN THE ESSENTIAL RAW COOLING WATER (ERCW) SYSTEM.

  - ENGINEERING CHANGE NOTICES ISSUED TO CHANGE CS PIPING IN THE ERCW TO SS. CEMENT-LINED ERCW MAIN YARD HEADERS.

  - TECHNICAL INSTRUCTION TI-27 IMPLEMENTED TO ASSURE CLEANLINESS MAINTAINED IN ALL BREACHED SYSTEMS.

  - WALL THINNING MONITORING PROGRAM

* 1984 - WATTS BAR IMPLEMENTS A RAW WATER HEAT EXCHANGER PROGRAM.

* APRIL 1985 - NRC ISSUES IE INFORMATION NOTICE NUMBER 85-30, "MICROBIOLOGICALLY INDUCED CORROSION OF CONTAINMENT SERVICE WATER SYSTEM."

* AUGUST 1986 - LEAK NOTED IN ERCW SYSTEM. FAILURE ANALYSIS CONFIRMS THROUGH WALL LEAK IN 316 SS BUTT WELD.

CHRONOLOGY OF MIC ACTIVITIES AT WATTS BAR NUCLEAR PLANT

* DECEMBER 1986 - MIC PROJECT TEAM FORMED

* JANUARY 1987 - PROCESS SPEC 4.M.1.2 ISSUED AS UPPER TIER TECHNICAL REQUIREMENTS FOR MIC

  - INSTITUTE OF APPLIED MICROBIOLOGY CONFIRMS BACTERIA TYPES AND LEVELS

  - RANDOM RT PERFORMED ON ERCW SS BUTT WELDS FOR MIC

  - INFORMAL INSPECTION FOR MIC BEGIN BY CHEMISTRY AND ENGINEERS

  - STRUCTURAL INTEGRITY PERFORMS PROBABILITY ASSESSMENT OF MIC IN ALL WETTED SYSTEM FOR SQN

* AUGUST 1987 - IMPROVEMENTS MADE TO HYPOCHLORITE SYSTEM TO ENSURE EFFECTIVE BIOCIDE TREATMENT

* JANUARY 1988 - WBNP IMPLEMENTS DETAILED DRY LAYUP PROGRAM

CHRONOLOGY OF MIC ACTIVITIES AT WATTS BAR NUCLEAR PLANT

* APRIL 1988 - EXTENSIVE BIOCIDE AND MIC TESTING BEGINS AT SINGLETON LABORATORY

* JUNE 1988 - 4.M.1.2 REVISED

* NOVEMBER 1988 - SWEC MIC CORPORATE PROGRAM ISSUED

* MARCH 1989 - ISSUE IC TO TI-11 & 16, 32 FOR SAMPLING AND ANALYSIS OF BACTERIA SCREENING

* JUNE 1989 - NE PERFORM DETAILED MIC EVALUATION OF ERCW SS PIPING

* NOVEMBER 1989 - NRC ISSUE GENERIC LETTER 89-13 REQUIRES FORMAL RESPONSE

  - CORPORATE MIC PROGRAM ISSUED

* MAY 1990 - 4.M.1.2 REVISED

* JULY 1990 - MIC PROJECT PLAN ISSUED

CHRONOLOGY OF MIC ACTIVITIES AT WATTS BAR NUCLEAR PLANT

* AUGUST 1990 - TECHNICAL INSTRUCTION TI-36 - "CONTROL OF MICROBIOLOGICALLY INDUCED CORROSION AT WATTS BAR NUCLEAR PLANT"

* OCTOBER 1990 - INSTALLED BROMINATION SYSTEM TO MITIGATE MIC DAMAGE

* FEBRUARY 1991 - TECHNICAL INSTRUCTION TI-106 - "NON-DESTRUCTIVE EXAMINATION OF STAINLESS STEEL BUTT WELDS TO ASSESS DAMAGE FROM MIC"

- TECHNICAL INSTRUCTION TI-31.13 - "WALL THINNING MONITORING PROGRAM"

SECTION II

MIC EVALUATION AND IDENTIFICATION AT WBN PLANT

MIC EVALUATION AND IDENTIFICATION AT WATTS BAR NUCLEAR PLANT

- PLANT SYSTEM EVALUATIONS PERFORMED TO ESTABLISH PROBABILITY OF MIC DEGRADATION

- RAW WATER PIPING SYSTEMS IDENTIFIED AS MOST SUSCEPTIBLE TO MIC DEGRADATION (ERCW, RCW, HPFP, RSW, WTP, CCW)

- AD HOC SYSTEM INSPECTION (VISUAL, RT & UT) FOCUSED ON RAW WATER SYSTEM SS AND CARBON STEEL PIPING

- WALL THICKNESS DATABASE IS UNDER DEVELOPMENT FOR STRUCTURAL INTEGRITY EVALUATIONS

- ONGOING AND FUTURE INSPECTIONS (VISUAL, RT & UT) WILL BE PERFORMED AND THE DATABASE UPDATED FOR CONTINUING STRUCTURAL EVALUATIONS

MIC ASSESSMENT IN SYST[redacted]AT WATTS BAR NUCLEAR PLANT

	SYSTEM	MATERIAL	PROBABILITY OF MIC	EXTENT OF MIC	CORRECTIVE ACTIONS
1	Main Steam	(CS)	Low due to dry layup & water treatment during wetted layup (hydrazine & ammonia). Will not eliminate MIC but will reduce subsequent corrosion effects.	None (Visual)	None Required
2	Condensate	(CS,Cu)	Low due to dry layup & water treatment during wet layup (hydrazine and ammonia) on secondary side.	None (Visual)	None Required
3a	Main Feedwater	(CS, Cu)	Low due to dry layup & water treatment during wet layup (hydrazine & ammonia).	None (Visual) None (RT)	None Required
3b	Auxiliary Feedwater	(CS)	Low due to dry layup & water treatment during wet layup, but slightly higher than for main FW due to stagnant water in normal operation, and closer coupling with raw water systems (HPFP & ERCW).	None (Visual)	None Required
5	Extraction Steam	(CS)	Low due to dry layup & water treatment during wetted layup. (Same as Main Steam)	None (Visual)	None Required
6	Heater Drains	(CS)	Low due to dry layup & water treatment during wetted layup. (Same as Main Steam)	None (Visual)	None Required
7	Turbine Extraction & Drains	(CS)	Low due to dry layup & water treatment during wetted layup. (Same as for Main Steam)	None (Visual)	None Required
12	Auxiliary Boilers	(CS, Cu)	Low to Moderate. Nearly stagnant operation during summer months may have increased susceptibility to MIC. Treated with hydrazine & ammonia.	None (Visual)	None Required

MIC ASSESSMENT IN SYST[redacted]T WATTS BAR NUCLEAR PLANT

	SYSTEM	MATERIAL	PROBABILITY OF MIC	EXTENT OF MIC	CORRECTIVE ACTIONS
14	Condensate Polishers	(CS)	Low due to layups & water treatment during wet layup. (hydrazine & ammonia)	None (Visual)	None Required
15	SG Blowdown	(CS)	Low due to dry layup & water treatment during wet layup. (hydrazine & ammonia)	None (Visual)	None Required
18	Diesel Fuel Oil	(CS, Cu)	Moderate. MIC can be observed in fuel oil systems that remain stagnant for long periods.	None Fuel Oil sampled for bacteria prior to being added to system & during operation.	None Required
24	Raw Cooling Water	(CS,Cu)	High. Combination of raw water and normally stagnant areas in addition to extended outage are prime contributors to MIC. Plenty of organisms available from normal operation to get MIC started.	Tubercules noted on all CS piping. Ht Exchangers look acceptable. Little or no damage to Cu tubing. Corrosion degradation on nearly the entire system.	Biocide injection modified from chlorination to bromination 10/05/90 to prevent further MIC initiation. Corrosion Inhibitor/Dispersant Treatment being assessed to remove existing nodules.
25	Raw Service Water	(CS,Cu)	High. MIC probably present from normal operation (raw water, stagnant areas). Outage gives more time for microbe colonies to become established. Maybe higher probability than for raw cooling water system.	MIC noted on all CS piping. Ht Exchanger look acceptable little or no damage to Cu tubing.	Biocide injection modified from chlorination to bromination 10/05/90 to prevent further MIC initiation. Corrosion Inhibitor/Dispersant Treatment being assessed remove existing nodules.

SYSTEM	MATERIAL	PROBABILITY OF MIC	EXTENT OF MIC	CORRECTIVE ACTIONS
26 HP Fire Protection	(CS)	High. Stagnant, raw water system. MIC observed in Fire Protection systems elsewhere.	MIC noted on underground CS piping. Moderate amounts seen on plant piping per visual inspections and RT.	Biocide injection modified from chlorination to bromination 10/05/90 to prevent further MIC initiation. Investigation of non-oxidizing biocide to improve control of MIC & and clams in stagnant piping is underway. Corrosion Inhibitor/Dispersant Treatment being assessed to remove existing nodules.
27 Condenser Circulating Water	(CS,Cu, Cement)	High. Raw water made up from RCW & ERCW. Has been in dry layup. Flow velocity above that of common MIC occurrence.	Some. Nodules observed in minor populations little damage seen under nodules.	Treatment same as ERCW, RCU, etc.
28 Makeup Water Treatment Plant	(CS,SS,Al)	High. Up to the plant. Low. Leaving plant water has minor probability of MIC.	Some. Only observed nodules in the clear well tanks where totally stagnant flow occurs.	Influent water treatment same as ERCW, RCW, etc. Make up DI's flocs, filter & demins this water.
30 Ventilation	(CS,Cu,SS)	Low in air ducting, High in coolers. Stagnant, untreated water are keys. Carbon steel will pit and corrode generally; stainless will pit at welds.	None (Visual)	None Required

MIC ASSESSMENT IN SYST[illegible]T WATTS BAR NUCLEAR PLANT

SYSTEM	MATERIAL	PROBABILITY OF MIC	EXTENT OF MIC	CORRECTIVE ACTIONS
31 Air Conditioning	(CS,Cu)	Same as for ventilation (System 30)	None (Visual)	None Required
32 Control Air	(Cu,SS)	Low to Moderate. MIC might occur in areas of condensation.	None (Visual)	None Required
41 S/G Wet Layup Recirc	(CS)	Low - N2H4+NH4OH DI water to S/Gs - pH 9.8 - 10.5 N2H4 75-200 ppm	None (Visual)	None Required
43 Sampling System	(SS)	Low. All sample lines are SS & have been in dry layup.	None (Visual)	None Required
58 Isolated Phase Bus Cooling	(CS, Cu)	Low. System has been in dry layup & operates with treated water.	None (Visual)	None Required
59 Demin Water	(SS,Al)	Moderate. Probability of MIC due to possible microbial infestation moving through.	None (Visual)	None Required
61 Ice Condenser	(CS, SS)	Very Low. Ice is not expected to melt. No corrosion expected. Note that freezing will probably not kill microbes, however.	None (Visual)	None Required
62 CVCS	(SS)	Low. Much of this system is stagnant and warm during operation and MIC may become established even in borated water. Water treatment may inhibit growth of pits.	None (Visual)	None Required
63 Safety Injection	(SS/SS clad)	Low. Same comments as for CVCS tanks apply to entire system.	None (Visual)	None Required

SYSTEM	MATERIAL	PROBABILITY OF MIC	EXTENT OF MIC	CORRECTIVE ACTIONS
65 Emergency Gas Treatment	(CS,SS,Cu)	Low. This system heated to maintain 70% relative humidity during operation; condensation should be low. Outages may aggravate this condition but MIC not expected.	None (Visual)	None Required
67 ERCW	(CS,SS,Cu Cement lined)	High. Low flow, raw water. All carbon steel areas are susceptible (manifested by general corrosion and massive deposition). Welds (weld metal and base metal near welds) in stainless steel. MIC already observed SS and CS. Focal point of most utilities MIC programs.	MIC leaks & damage noted on both CS & SS. CS has nodules on all piping with some degradation. SS damage is minimal based upon RT & Borescope inspections.	Biocide injection modified from chlorination to bromination 10/05/90 to prevent further MIC initiation. Corrosion Inhibitor/Dispersant Treatment being assessed to remove existing nodules.
68 Reactor Coolant	(SS)	Low to Very Low. Dry layup. System has been in dry layup. Amount of organic activity should be less than in other systems. Major caution here is related to any additions from systems that have been stagnant for long periods (e.g., from BWST) early in outage.	None (Visual)	None Required
70 Component Cooling	(CS,SS, Cu)	Low probability, moderate in areas stagnant during power operation). Layup water treatment (hydrazine & ammonia) or (molybdate/tolytrazole) minimizes subsequent corrosion effects.	None (Visual)	None Required
72 Containment Spray	(SS)	Low to Moderate. Dry layup. Stagnant borated water much as CVCS and Safety Injection Systems.	None (Visual)	None Required

MIC ASSESSMENT IN SYSTEMS AT WATTS BAR NUCLEAR PLANT

SYSTEM	MATERIAL	PROBABILITY OF MIC	EXTENT OF MIC	CORRECTIVE ACTIONS
74 RHR	(SS or SS Clad)	Low to Moderate. Dry layup. Stagnant borated water during plant operation. During long shutdown have intermittent flow at best, probably through only one loop. Communication with component cooling water at HXs and RWST may be microbial source.	None (Visual)	None Required
77 Waste Disposal	(CS, SS)	Moderate. Drain system with various sources, some likely to be infested. Flows intermittently.	None (Visual)	None Required
78 Spent Fuel Cooling	(SS)	Low to Moderate. Dry layup. Some flow throughout operation, demin water.	None (Visual)	None Required
81 Primary Water	(SS)	Low to Moderate. Deminaralized water & SS piping.	None (Visual)	None Required
82a Standby Diesel Generator (Water)	(CS)	Moderate. Supp. water demineralized & treated with corrosion inhibitors. MIC probably established during normal operation due to long periods of stagnation, untreated water. May kill microbes but reduce effects.	None (Visual)	None Required
82b Standby Diesel Generator (Starting Air)	(CS, SS)	Low to Moderate. MIC might be observed in areas of condensation although unlikely. If microbes are present oil in supply lines provide a source of nutrients.	None (Visual)	None Required
83 Hydrogen Recombination	(SS)	Low to Moderate. System normally carries a mixture of air and hydrogen. Moisture in air may carry microbes. Similar to control air.	None (Visual)	None Required

FOCUS RESULTS FROM MIC ASSESSMENT

SYSTEM	MATERIAL	PROBABILITY OF MIC	EXTENT OF MIC	CORRECTIVE ACTIONS
24 Raw Cooling Water	(CS,Cu)	High. Combination of raw water and normally stagnant areas in addition to extended outage are prime contributors to MIC. Plenty of organisms available from normal operation to get MIC started.	Tubercules noted on all CS piping. Ht Exchangers look acceptable. Little or no damage to Cu tubing. Corrosion degradation on nearly the entire system.	Biocide injection modified from chlorination to bromination 10/05/90 to prevent further MIC initiation. Corrosion Inhibitor/Dispersant Treatment being assessed to remove existing nodules.
25 Raw Service Water	(CS,Cu)	High. MIC probably present from normal operation (raw water, stagnant areas). Outage gives more time for microbe colonies to become established. Maybe higher probability than for raw cooling water system.	MIC noted on all CS piping. Ht Exchanger look acceptable little or no damage to Cu tubing.	Same as above.
26 HP Fire Protection	(CS)	High. Stagnant, raw water system. MIC observed in Fire Protection systems elsewhere.	MIC noted on underground CS piping. Moderate amounts seen on plant piping per visual inspections and RT.	Biocide injection modified from chlorination to bromination 10/05/90 to prevent further MIC initiation. Investigation of non-oxidizing biocide to improve control of MIC & and clams in stagnant piping is underway. Corrosion Inhibitor/Dispersant Treatment being assessed to remove existing nodules.

FOCUS RESULTS FROM MIC ASSESSMENT

	SYSTEM	MATERIAL	PROBABILITY OF MIC	EXTENT OF MIC	CORRECTIVE ACTIONS
27	Condenser Circulating Water	(CS,Cu, Cement)	High. Raw water made up from RCW & ERCW. Has been in dry layup. Flow velocity above that of common MIC occurrence.	Some. Nodules observed in minor populations little damage seen under nodules.	Biocide injection modified from chlorination to bromination 10/05/90 to prevent further MIC initiation. Corrosion/Inhibitor/Dispersant Treatment being assessed to remove existing nodules.
28	Makeup Water Treatment Plant	(CS,SS,Al)	High. Up to the plant. Low. Leaving plant water has minor probability of MIC.	Some. Only observed nodules in the clear well tanks where totally stagnant flow occurs.	Same as above.
67	ERCW	(CS,SS,Cu Cement lined)	High. Low flow, raw water. All carbon steel areas are susceptible (manifested by general corrosion and massive deposition). Welds (weld metal and base metal near welds) in stainless steel. MIC already observed SS and CS. Focal point of most utilities MIC programs.	MIC leaks & damage noted on both CS & SS. CS has nodules on all piping with some degradation. SS damage is minimal based upon RT & Borescope inspections.	Same as above.

2387C

SECTION III

STRUCTURAL INTEGRITY - SECTION III VALIDATION

STRUCTURAL INTEGRITY ANALYSIS - CODE POSITION

A. INTRODUCTION - PROVIDE AN OVERVIEW OF WBN MIC STRUCTURAL INTEGRITY PROGRAM FOR ASME SECTION III ADDRESSING BOTH CARBON AND STAINLESS STEELS.

B. APPROACH - ASME SECTION III DOES NOT PROVIDE DETAILED RULES FOR CORROSION OR OTHER SERVICE INDUCED DEGRADATION NOR DOES IT PROVIDE GUIDANCE FOR THE EVALUATION OF DEGRADATION; THEREFORE, ANALYTICAL METHODOLOGY BASED ON STRESS MARGINS INHERENT TO SECTIONS III AND XI SHALL BE APPLIED TO DEMONSTRATE SECTION III QUALIFICATION AND COMPLIANCE.

C. RESULT - THIS METHODOLOGY AND THE CORPORATE MIC PROGRAM INCLUDING ABATEMENT PROGRAM WILL BE REFERENCED IN THE CLASS III DESIGN SPECIFICATION BY REVISION OF THE DESIGN SPECIFICATIONS.

D. CONCLUSION - THE RESULTS OF THIS ASSESSMENT AND THE MODIFICATION OF THE DESIGN SPECIFICATION SHALL DOCUMENT STRUCTURAL INTEGRITY AND ASME SECTION III CODE COMPLIANCE.

EVALUATION OF ASME SECTION III

CARBON STEEL PIPING TO ASSESS MIC

- IDENTIFY MOST SUSCEPTIBLE MIC AREAS IN SECTION III CARBON STEEL PIPING.

- REVIEW EXISTING RIGOROUS ANALYSIS TO IDENTIFY MAXIMUM LOADS (STRESS) IN THESE LOCATIONS.

- PERFORM ANALYSIS PER METHODOLOGY DESCRIBED IN CODE CASE N-480 TO DETERMINE MAXIMUM PERMISSIBLE DEGRADATION (ACCEPTANCE CRITERIA) IN HIGHEST STRESS (MAXIMUM VALUE) LOCATIONS FOR VARIOUS PIPING DIAMETERS IN THESE LOCATIONS.

- PERFORM UT TO DETERMINE EXISTING WALL THICKNESS AT THESE LOCATIONS AND COMPARE TO ACCEPTANCE CRITERIA.

- PERFORM RANDOM UT ON REMAINING AREAS TO DEMONSTRATE EXISTING CONDITIONS COMPARE MEASURED VALUES TO ACCEPTANCE CRITERIA. IF ACCEPTANCE CRITERIA IS NOT MET, ACTUAL STRESS CONDITIONS SHALL BE APPLIED.

- EXPERIENCE AND HISTORICAL DATA AT TVA PLANTS, BOTH FOSSIL AND NUCLEAR, HAVE SHOWN THAT PINHOLE LEAKS DEVELOP AS A RESULT OF MIC AND THAT GROSS DETERIORATION OF PIPING SYSTEMS IS NOT CONSIDERED PLAUSIBLE. THIS IS ALSO CONSISTENT WITH THE POWER GENERATION INDUSTRY'S EXPERIENCE.

ANALYTICAL APPROACH FOR ASSESSMENT

OF MIC DEGRADATION IN CARBON STEEL

- CODE CASE N-480 APPROACH, "EXAMINATION REQUIREMENTS FOR PIPE WALL THINNING DUE TO SINGLE PHASE EROSION AND CORROSION," TO DEMONSTRATE STRUCTURAL MARGINS PER ASME SECTION III AND SECTION XI.

- VERIFY TACT $\geq$ TMIN

  WHERE: TACT = ACTUAL MEASURED WALL THICKNESS
  TMIN - MINIMUM REQUIRED WALL THICKNESS TO SATISFY ASME SECTION III STRESS EQUATIONS

  APPROACH:
  A) DETERMINE HIGHEST STRESS NODE

  B) CALCULATE MINIMUM WALL (TMIN) BASED UPON SECTION III CRITERIA UTILIZING HIGHEST STRESSES FOR THAT SIZE OF PIPING

  C) CASE 1 - CALCULATE TMIN BASED ON AN INTERNAL SURFACE PIT SIZED BY ULTRASONIC WALL THICKNESS MEASUREMENTS IN ACCORDANCE WITH CODE CASE N480 PARAGRAPH-3622.1.*

  D) CASE 2 - CALCULATE TMIN AGAIN WITH SAME PARAMETERS AS CASE 1 IN ACCORDANCE WITH CODE CASE N480 PARAGRAPH-3622.2.

  E) WHEN MEASURED WALL THICKNESS TACT IS LESS THAN ACCEPTABLE BY (D) ABOVE, RECALCULATE TMIN UTILIZING ACTUAL GEOMETRY AND LOCAL STRESSES IN ACCORDANCE WITH CODE CASE N480 PARAGRAPH-3622.3.

  F) HOWEVER, IN NO CASE SHALL ACTUAL WALL THICKNESS TACT BE LESS THAN 0.3 DESIGN WALL THICKNESS. *

- STRESS EQUATIONS

  - LONGITUDINAL STRESS; NC/ND - 3652; EQUATIONS 8, 9, 10, AND 11 REARRANGED TO CALCULATE TMIN.

    EXAMPLE: EQUATION 9, UPSET

    $$TMIN = \frac{1}{1.2\ SH}\left(\frac{PDo}{4} + \frac{.75\ I\ (MA + MB)}{3.14R^2}\right)$$

    USE BOUNDING LOADS FOR THE PIPE SIZE/AREA IN QUESTION FROM CURRENT ANALYSIS.

    USE STRESS INTENSIFICATION FACTOR (I) APPROPRIATE FOR LOCATION IN QUESTION.

  - HOOP STRESS; ND-3641

    $$TMIN = \frac{PDo}{2(SE + PY)}$$

* Modified 01/13/91
WBEP - 1263T

ASME SECTION III CLASS 3 PIPE DESIGN

$$S_{SL} = \frac{PD_o}{4t_n} + \frac{0.75i\ M_A}{Z} \leq 1.0\ S_h \qquad \text{(Eq. 8)}$$

$$S_{OL} = \frac{P_{max}D_o}{4t_n} + 0.75i\left(\frac{M_A + M_B}{Z}\right) \leq 1.2\ S_h \qquad \text{(Eq. 9)}$$

$$S_E = \frac{iM_c}{Z} \leq S_A \qquad \text{(Eq. 10)}$$

$$S_{TE} = \frac{PD_o}{4t_n} + 0.75i\left(\frac{M_A}{Z}\right) + i\left(\frac{M_c}{Z}\right) \leq (S_h + S_A) \qquad \text{(Eq. 11)}$$

EQUATION 8 IS FOR PRESSURE AND DEAD WEIGHT LOADS.

EQUATION 9 IS FOR PRESSURE, DEAD WEIGHT, AND OCCASIONAL LOADS INCLUDING UPSET AND FAULTED CONDITIONS.

EQUATION 10 IS FOR THERMAL BENDING.

EQUATION 11 IS FOR PRESSURE, DEAD WEIGHT, AND EXPANSION LOADS.

EVALUATION OF ASME SECTION III

STAINLESS STEEL PIPING TO ASSESS MIC

- IDENTIFY MOST SUSCEPTIBLE MIC AREAS IN RAW WATER STAINLESS STEEL PIPING.

- REVIEW EXISTING TVA ANALYSES TO DETERMINE IF MAXIMUM LOAD VALUES ALREADY EXIST FOR THESE LOCATIONS. PERFORM ADDITIONAL ANALYSES AS REQUIRED.

- CALCULATE MAXIMUM PERMISSIBLE DEGRADATION (ACCEPTANCE CRITERIA) FOR EACH PIPING DIAMETER BASED ON MAXIMUM LOAD VALUES.

- REVIEW AND UTILIZE EXISTING RADIOGRAPHS PERFORMED FOR LOP/LOF EVALUATION, ALONG WITH PREVIOUS RADIOGRAPHS PERFORMED SPECIFICALLY FOR MIC, IN ORDER TO DETERMINE IF APPROPRIATE SAMPLE SIZE FOR STATISTICAL ANALYSIS EXIST. IF APPROPRIATE SAMPLE SIZE DOES NOT EXIST, PERFORM ADDITION RADIOGRAPHY AS REQUIRED.

- EVALUATE MIC DAMAGE OBSERVED IN RADIOGRAPHY VERSUS TVA ACCEPTANCE CRITERIA.

- SUMMARIZE HISTORICAL DATA FROM WATTS BAR AND SEQUOYAH TO CONFIRM THAT THROUGH WALL LEAKAGE OCCURS BEFORE ACCEPTANCE CRITERIA IS VIOLATED.

- TRENDING - (FLAW AND NODULE SIZE COMPARISONS)

ANALYTICAL APPROACH FOR ASSESSMENT OF MIC DEGRADATION IN STAINLESS STEEL

- PERFORM ANALYSIS TO DEMONSTRATE COMPLIANCE WITH STRUCTURAL ACCEPTANCE CRITERIA PER ASME SECTION XI.
  - NET SECTION PLASTIC COLLAPSE (SECTION XI, APPENDIX C)
  - REQUIRED FACTORS OF SAFETY (LOAD CAPACITY/APPLIED LOAD)
    UPSET 2.77
    FAULTED 1.38
  - USE BOUNDING LOADS
  - USE SINGLE FLAW CHARACTERIZATION

- PERFORM ANALYSIS TO DEMONSTRATE COMPLIANCE WITH ASME SECTION III STRESS EQUATIONS.
  - EQUATIONS 8, 9, 10, AND 11 PER ND-3652
  - USE BOUNDING LOADS FROM CURRENT ANALYSES
  - USE DEGRADED CROSS SECTION (SECTION MODULUS) BASED ON NDE CONSIDERING FLAW DISTRIBUTION AND LOP/LOF
  - USE STRESS INTENSIFICATION FACTOR FOR BUTT WELD

- CONSISTENT WITH LOP/LOF ASSESSMENT.

- CONSISTENT WITH SQN MIC ASSESSMENT.

WATTS BAR NUCLEAR PLANT
MICROBIOLOGICALLY INDUCED CORROSION (MIC)
PROGRAM PRESENTATION

SECTION III QUALIFICATION

ARTICLE NUMBER	CRITERIA	REQUIREMENT	REFERENCE	ACCEPTABLE TODAY	ACCEPTABLE AFTER DESIGN SPEC. MOD (2)
[redacted]0	DEFINITION OF RULES	ND-1100	NA-1130	NO	YES
2000	MATERIALS	ND-2160	NB-2160	NO	YES
			NA-3250 (1)		
3000	DESIGN	ND-3600	NC-3600	NO	YES
4000	FABRICATION	ND-4000	NC-4000	YES	YES
[redacted]	EXAMINATION	ND-5220	NB-5000	YES	YES
6000	TESTING	ND-6110	NB-6000	YES	YES
7000	PROTECTION AGAINST OVERPRESSURE	ND-7000	N/A	YES	YES
8000	REPORTS (N-5)	ND-8100	NA-8000	YES	YES

1. REQUIREMENT FOR DESIGN SPECIFICATION THAT COVERS ALL ASPECTS OF COMPONENT CODE COMPLIANCE.

2. REVISE DESIGN SPECIFICATION TO INCLUDE MIC DEGRADATION EVALUATION AND ASSESSMENT PROGRAM BASED ON STRESS MARGINS INHERENT TO SECTION III AND XI, INCLUDING GENERIC LETTER 90-05, AND RECOGNITION OF MIC ABATEMENT PROGRAM.

SUBSECTION ND REQUIREMENTS FOR CLASS 3 COMPONENTS

ARTICLE ND-1000 INTRODUCTION

ND-1100 SCOPE

(*a*) Subsection ND contains rules for the materials, design, fabrication, examination, testing, overpressure relief, marking, stamping and preparation of reports by the Manufacturer and/or Assembler of components, parts and appurtenances which are intended to conform to the requirements for Class 3 construction.

(*b*) The rules for the construction of Class 3 vessels are contained herein and, by reference, in Section VIII, Division 1. Vessels which are designed and fabricated to the rules of Section VIII, Division 1, shall conform to the rules for materials, examination, testing, inspection and stamping of this Subsection.

(*c*) The rules of Subsection ND cover the strength and pressure integrity of components, parts and appurtenances the failure of which would violate the pressure-retaining boundary. The rules cover load stresses but do not cover deterioration which may occur in service as a result of corrosion, radiation effects or instability of material. (See also NA-1130 for further limits to the rules of this Section of the Code.)

SUBSECTION NA
GENERAL REQUIREMENTS

ARTICLE NA-1000

SCOPE OF SECTION III

NA-1100 SCOPE

NA-1110 NATURE OF THESE RULES AND COMPONENTS TO WHICH THEY ARE APPLICABLE

The rules of this Section of the Code constitute requirements for the construction[1] of nuclear power plant[2] components and appurtenances such as vessels, storage tanks, piping, pumps, valves and core support structures for use in, or containment of portions of, the nuclear power system of any power plant.[3] A nuclear power system, as used in this Code, is that system which serves the purpose of producing and controlling an output of thermal energy from nuclear fuel and those associated systems essential to the functions and overall safety of the nuclear power system. The rules for inservice inspection of the components of the nuclear power system are covered in Section XI of the Code and its rules may influence construction under Section III of this Code.

NA-1120 DEFINITION OF NUCLEAR POWER SYSTEM COMPONENTS AND CONTAINMENT VESSELS

(*a*) Nuclear power system components for which rules are specified by this Section of the Code are those components which are designed to provide a pressure-containing barrier or to act as a pressure-retaining member in the nuclear power system or to support the reactor core.

(*b*) Containment systems for which rules are specified by this Section of the Code are those components which form structures that may enclose nuclear power systems or that may be connected to other containment components and which are designed to provide a pressure-containing barrier for the primary purpose of containing, within leakage limits, or of channeling for containment or for controlled disposal, radioactive or hazardous effluents released from nuclear power system components so enclosed.

NA-1130 LIMITS OF THESE RULES AND COMPONENTS TO WHICH THEY ARE NOT APPLICABLE

The rules of this Section of the Code provide requirements for new construction and include consideration of mechanical and thermal stresses due to cyclic operation. They do not cover deterioration which may occur in service as a result of radiation effects, corrosion, erosion or instability of the material. These effects shall be taken into account with a view to realizing the design or the specified life of the components. The changes in properties of components subjected to neutron irradiation can be checked periodically by means of material surveillance programs. The rules are not intended to be applicable to valve operators, controllers, position indicators, pump impellers, pump drives or other accessories and devices, unless such items themselves are pressure-retaining parts or act as core support structures.

[1] *Construction*, as used in this Section of the Code, is an all-inclusive term comprising materials, design, fabrication, examination, testing, inspection and certification required in the manufacture and installation of components, parts and appurtenances.

[2] A *nuclear power plant* consists of one or more nuclear power systems and containment systems as well as other systems not covered by the rules of this Section of the Code.

[3] Specifically excluded from consideration in this Section of the Code are tubes or other forms of sheathing used only for cladding nuclear fuel.

pressure test required by a materials specification need not be performed provided the material is identified as not having been pressure tested and it is subsequently pressure tested as a component in the nuclear power system in accordance with NB-6114, except when the location of the material in the component or the installation would prevent performing any nondestructive examination required by the material specification to be performed subsequent to the hydrostatic pneumatic test.

ND-2124 Size Ranges

The size range shall be the same as stated in NB-2124.

ND-2130 CERTIFICATION BY MATERIALS MANUFACTURER

The requirements for certification by the Materials Manufacturer shall be the same as stated in NB-2130.

ND-2140 WELDING AND BRAZING MATERIALS

For the requirements governing the materials to be used for welding and brazing, see NB-2400.

ND-2150 MATERIAL IDENTIFICATION

All material shall be marked in accordance with the marking requirements of the material specification.

ND-2160 DETERIORATION OF MATERIALS IN SERVICE

The requirements for deterioration of materials in service shall be the same as stated in NB-2160.

ND-2170 HEAT TREATMENT TO ENHANCE IMPACT PROPERTIES

The provisions for heat treatment to enhance impact properties shall be the same as stated in NB-2170.

ND-2200 MATERIALS TEST COUPONS AND SPECIMENS FOR FERRITIC STEEL MATERIALS

The requirements for materials test coupons and specimens shall be in accordance with the materials specifications.

ND-2300 SPECIAL MATERIALS TESTING

ND-2310 IMPACT TESTING

Charpy V-notch or dropweight tests shall be used as applicable, for impact testing.

ND-2320 CLASS 3 VESSELS, PIPES, PUMPS AND VALVES

When the Design Specifications (NA-3250) for Class 3 appurtenances and components require impact testing, the requirements shall be the same as stated in NB-2300, except the Charpy V-notch acceptance values shall be as listed in Tables I-7.0 and I-8.0. The requirements for vessels shall be the same as for pipes, pumps and valves.

ND-2400 WELDING AND BRAZING MATERIALS

The requirements for welding and brazing materials for vessels shall be in accordance with the rules of Section VIII, Division 1, and the requirements for other components shall be the same as stated in NB-2400.

ND-2500 EXAMINATION AND REPAIR OF PRESSURE-RETAINING MATERIALS

ND-2510 PRESSURE-RETAINING MATERIALS

Pressure-retaining materials for Class 3 components shall be examined and repaired in accordance with the material specification and as otherwise required by this Subarticle except for pumps and valves with inlet piping connections 4 in. nominal pipe size and less.

ND-2530 EXAMINATION AND REPAIR OF PLATE

ND-2531 Required Examination

Plates for Class 3 components shall be examined in accordance with the requirements of the material specification.

ND-2537 Time of Examination

Acceptance examinations shall be performed at the time of manufacture as follows:

(*a*) Examinations required by the material specification shall be performed at the time of

specification grade and classification number, supplier's name and trade designation. Welding and brazing materials shall be controlled during the repair of materials and the manufacture and installation of components so that they are identifiable as acceptable material until the material is actually consumed in the process (see NB-4122).

NB-2160 DETERIORATION OF MATERIALS IN SERVICE

Consideration of deterioration of materials caused by service is generally outside the scope of this Code. It is the responsibility of the Owner to select materials suitable for the conditions stated in the Design Specifications (NA-3250) with specific attention being given to the effects of service conditions upon the properties of the materials.

NB-2170 HEAT TREATMENT TO ENHANCE IMPACT PROPERTIES

Carbon steels, low-alloy steels and high-alloy chromium (Series 4XX) steels may be heat treated by quenching and tempering to enhance their impact properties. Postweld heat treatment of the component at a temperature of not less than 1100 F may be considered to be the tempering phase of the heat treatment.

NB-2200 MATERIALS TEST COUPONS AND SPECIMENS FOR FERRITIC STEEL MATERIALS

NB-2210 HEAT-TREATMENT REQUIREMENTS

NB-2211 Test Coupon Heat Treatment for Ferritic Materials

Where ferritic steel materials are subjected to heat treatment during fabrication or installation of a component, the material used for the tensile and impact test specimens shall be heat treated in the same manner as the component, except that test coupons and specimens for P-Number 1 materials with a nominal thickness of 2 in. or less are not required to be so heat treated. The Component Manufacturer shall provide the Materials Manufacturer with the temperature and heating and cooling rate to be used. In the case of postweld heat treatment, the total time at temperature or temperatures for the test material shall be at least 80 percent of the total time at temperature or temperatures during actual postweld heat treatment of the material and the total time at temperature or temperatures for the test material may be performed in a single cycle.

NB-2212 Test Coupon Heat Treatment for Quenched and Tempered Materials

NB-2212.1 Cooling Rates. Where ferritic steel materials are subjected to quenching from the austenitizing temperature, the test coupons representing those materials shall be cooled at a rate similar to and no faster than the main body of the material except in the case of certain forgings and castings (see NB-2223.3 and NB-2226.5). This rule shall apply for coupons taken directly from the material as well as for separate test coupons representing the material and one of the general procedures described in NB-2212.2 or one of the specific procedures described in NB-2220 shall be used for each product form.

NB-2212.2 General Procedures. One of the general procedures stipulated in the following subsubparagraphs may be applied to quenched and tempered materials or test coupons representing the material, provided the specimens are taken relative to the surface of the product in accordance with NB-2220. Further specific details of the methods to be used shall be the obligation of the Materials Manufacturer and the Component Manufacturer.

(*a*) Any procedure may be used which can be demonstrated to produce a cooling rate in the test material that matches the cooling rate of the main body of the product within 25 F and 20 seconds at all temperatures after cooling begins.

(*b*) If cooling rate data for the material and cooling rate control devices for the test specimens are available, the test specimens may be heat treated in the device to represent the material provided that the provisions of (a) are met.

(*c*) When any of the specific procedures described in NB-2220 are used, faster cooling rates at the edges may be compensated for by:

(*1*) Taking the test specimens at least one t from a quenched edge where t equals the material thickness;

(*2*) Attaching a steel pad at least one t wide by a partial-penetration weld (which completely seals the buffered surface) to the edge where specimens are to be removed;

NOTES TO TABLE NA-3120-1

GENERAL: All authorizations relative to Class 1, 2 or MC construction listed on this table require a survey by the Society. For authorization relative to Class 3 construction, see NA-8123.2. The numerals 1, 2 and 3 and the letters MC in the columns headed Required Code Symbol Stamp indicate the class of construction (1, 2, 3 or MC) and shall be stamped below and outside of the official Code symbol.

(1) Manufacturer's authorization may include field operations for field-erected vessels, completion and/or repair of vessels in the field and attachment of appurtenances. When the authorization is extended to the field, the Society requires that an audit acceptable to the Society be performed at each field site operation to ensure that the quality assurance program described in the manual is implemented and enforced.

(2) Manufacturer's authorization may include extension to field operations for completion and/or repair of components, parts or appurtenances constructed in his own authorized shop. When the authorization is extended to the field, the Society requires that an audit acceptable to the Society be performed at each field site operation to ensure that the quality assurance program described in the manual is implemented and enforced.

(3) NV-1 Report Form certifies capacity and also construction for Classes 1, 2 and 3 safety valves which are required to meet the construction rules of line valves. Authorized Inspector required for construction and Authorized Observer required for capacity test. Application of an NV symbol indicates compliance with both capacity and construction rules.

(4) Stress Report may be prepared by component designer.

(5) Alternatively, fabrication and design functions may be combined in a single organization requiring only one Certificate of Authorization. For dual organization, a separate block is provided on Data Report Form for Designer's signature.

(6) Authorization may cover field installation of all types and sizes of components and appurtenances for a complete nuclear power plant at any site, and requires an audit acceptable to the Society at each site to ensure that the program described in the Quality Assurance Manual is being implemented and enforced.

(7) Authorization for single field site only.

(8) Responsible for Design Specifications and coordination of construction of nuclear power plant.

(9) For components of a containment system, Class 1 shall be used when required in the Design Specifications.

(10) Piping fabricator's or Installer's authorization may include field operations for fabrication and installation of piping subassemblies and/or systems. When the authorization is extended to the field, the Society requires that an audit acceptable to the Society be performed at each field site operation to ensure that the quality assurance program described in the manual is implemented and enforced.

NA-3220 CATEGORIES OF THE OWNER'S RESPONSIBILITIES

The responsibilities of the Owner or his agent are considered under the following categories:

(*a*) Obtaining Certificate of Authorization (NA-3230);

(*b*) Provision of adequate structures for supporting the components and appurtenances covered by the rules of this Section of the Code (NA-3240);

(*c*) Provision of Design Specifications covering the construction of such a plant and setting forth the boundaries of jurisdiction (NA-3250);

(*d*) Certification of the Design Specifications for said plant (NA-3255);

(*e*) Review of Stress Report (NA-3260);

(*f*) Filing of Owner's Data Report (NA-3270).

NA-3230 OWNER'S CERTIFICATE OF AUTHORIZATION

The Owner or his agent shall obtain from the Society a Certificate of Authorization for the construction of a nuclear power plant which is to be in compliance with this Code. The information to be supplied by the Owner when making application is set forth in Forms N-20, N-30 and N-40.[1]

[1]Samples of these forms are shown in Appendix V. Copies may be obtained from the ASME Boiler and Pressure Vessel Committee.

NA-3240 PROVISION OF ADEQUATE SUPPORTING STRUCTURES FOR COMPONENTS AND APPURTENANCES

It is the responsibility of the Owner to provide structures adequate to support the components and appurtenances as covered by Subsection NF (in course of preparation) and in the Design Specifications, to provide the Designer with necessary information concerning the load-carrying capacity of structures which are outside the scope of the Code.

NA-3250 PROVISION OF DESIGN SPECIFICATIONS

NA-3251 Provision and Correlation

It is the responsibility of the Owner, who intends that a nuclear power plant or a component or appurtenance thereof be constructed which is to be in compliance with the rules of this Section of the Code, to provide or cause to be provided for each component or appurtenance a Design Specification. The Owner, either directly or through his agent, shall be responsible for the proper correlation of all Design Specifications, including those for components or appurtenances.

EVALUATION OF NONSECTION III

CARBON STEEL PIPING TO ASSESS MIC

- IDENTIFY MOST SUSCEPTIBLE MIC AREAS FOR SYSTEMS.

- PERFORM APPLICABLE PRESSURE AND TEMPERATURE CODE CALCULATION TO ESTABLISH MINIMUM WALL FOR VARIOUS PIPING DIAMETER.

- TREND DURING MAINTENANCE OUTAGES. COMPARE TO MINIMUM WALL CALCULATION AND MAKE A DECISION FOR CONTINUED PIPING SECTION OPERATION WHEN MINIMUM WALL IS EXCEEDED BASED UPON ECONOMICS.

SECTION IV
CHEMICAL TREATMENTS

WATTS BAR NUCLEAR PLANT

MICROBIOLOGICALLY INDUCED CORROSION (MIC)
PROGRAM PRESENTATION

BIOCIDE INJECTION SYSTEM

- INSTALLED BROMATION SYSTEM ON OCTOBER 3, 1990, REPLACING HYPOCHLORITE SYSTEM TO ENSURE A MORE EFFECTIVE BIOCIDE TREATMENT SYSTEM

- RESULTS TO DATE INDICATE THAT MIC CAUSING BACTERIA ARE SIGNIFICANTLY REDUCED FOLLOWING EXPOSURE TO BROMINE TREATMENT

- CONTINUED OPERATION OF THIS SYSTEM WILL ENSURE THAT NO NEW MIC SITES WILL BE ESTABLISHED

- THE EXISTING SYSTEM, COUPLED WITH THE PLANNED DISPERSENT/CORROSION INHIBITOR TREATMENT SYSTEM WILL EFFECTIVELY ELIMINATE MIC DEGRADATION AS AN OPERATIONAL CONCERN

CONSIDERATIONS FOR DETERMINING TREATMENT PROGRAM & VENDOR

★ **EXISTING RAW WATER CONDITIONS AT WBN:**

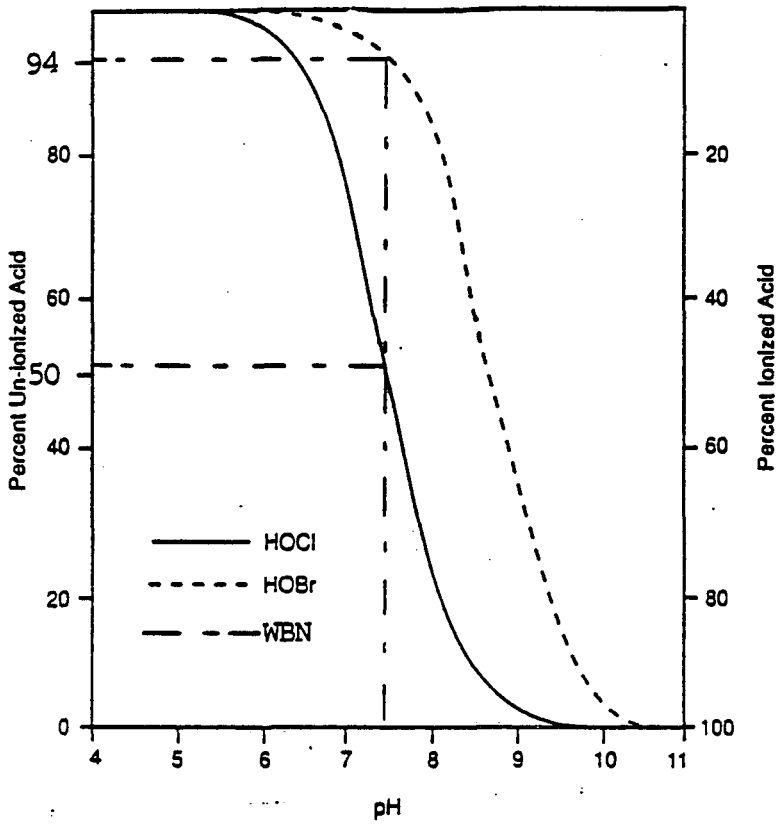
pH OF TN RIVER AVERAGES BETWEEN 7.5 - 8.0

CONTINUOUS CHLORINATION FOR CONTROL OF ASIATIC CLAMS WHEN THE RIVER TEMP IS >60 F WAS PREVIOUSLY IN PLACE, YET WE OBSERVED MIC BACTERIA AND NODULES

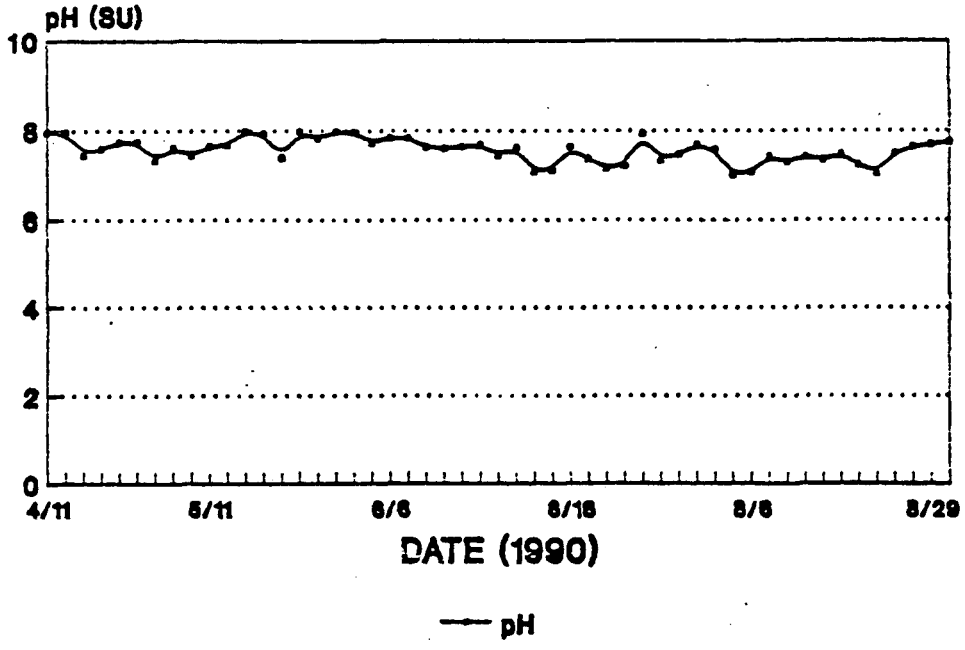
★ EPRI MIC SOURCEBOOK INDICATES THAT THE BIOCIDAL EFFECTIVENESS OF A BROMINE/CHLORINE BIOCIDE IS SUPERIOR TO SODIUM HYPOCHLORITE WITHIN OUR RANGE OF pH VALUES

★ SQN HAS REPORTED FAVORABLE RESULTS USING A BROMINE/CHLORINE BIOCIDE TREATMENT PROGRAM

★ DISCUSSIONS WITH THE LEADING INDUSTRIAL WATER TREATMENT COMPANIES REVEALED THAT BROMINE/CHLORINE BIOCIDE TREATMENT FOR MIC CAUSING BACTERIA IS ACCEPTED THROUGHOUT THE INDUSTRY AS BEING AN EFFECTIVE TREATMENT PROGRAM



RAW SERVICE WATER pH



TWO BROMINE/CHLORINE BIOCIDE INJECTION METHODOLOGIES WERE EVALUATED:

1. LIQUID NaBr + NaOCl :

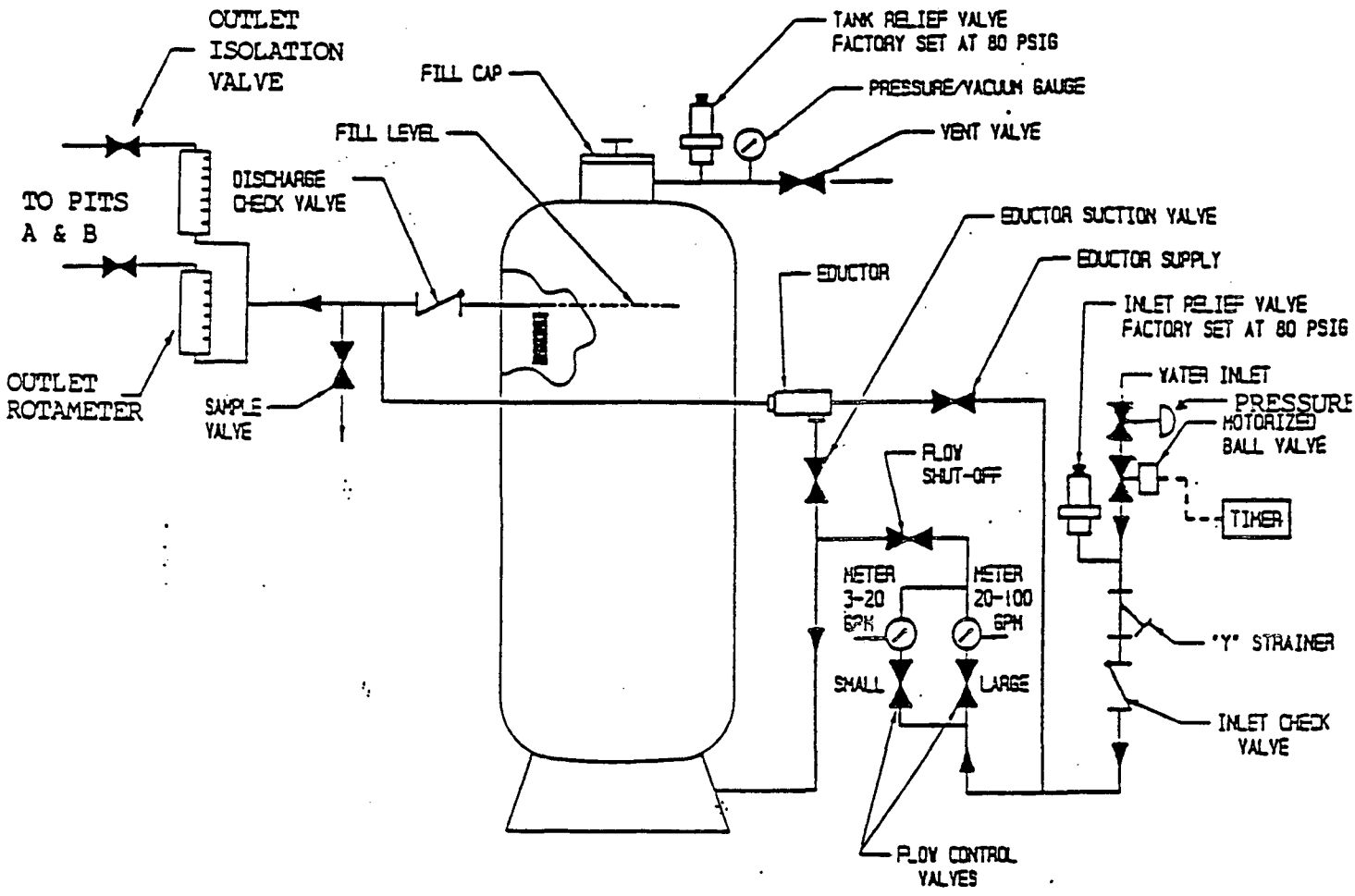
- REQUIRES 2 LARGE STORAGE TANKS
- STORAGE TANKS MUST HAVE CONTAINMENT DIKES
- USES MECHANICAL PUMPS
- HIGH MAINTENANCE EQUIPMENT
- POTENTIAL SAFETY & SPILL HAZARD
- TOTAL EQUIPMENT + CHEMICAL PACKAGE IS EXPENSIVE

2. GRANULAR BROMO-CHLORO-DIMETHYLHYDANTOIN :

- REQUIRES 1 SMALL CHEMICAL FEED TANK
- REDUCED CONTAINMENT REQUIREMENTS
- NO MECHANICAL PUMPS
- SIMPLE EQUIPMENT RESULTS IN REDUCED MAINTENANCE
- EASIER TO OPERATE
- REDUCED POTENTIAL FOR SAFETY OR SPILL HAZARD
- EQUIPMENT + CHEMICAL IS MORE COST EFFECTIVE

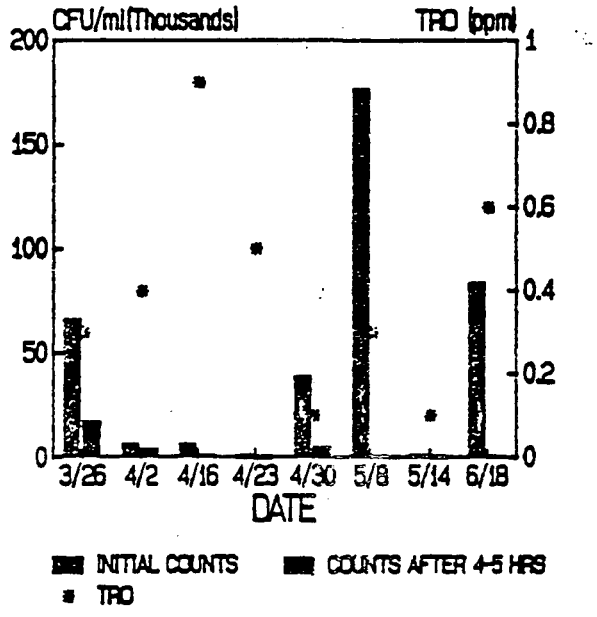
BOTH CHEMICAL TREATMENT PROGRAMS YIELD THE SAME BIOCIDAL PROPERTIES (HOBr + HOCl)

BIOCIDE INJECTION EQUIPMENT FLOWPRINT



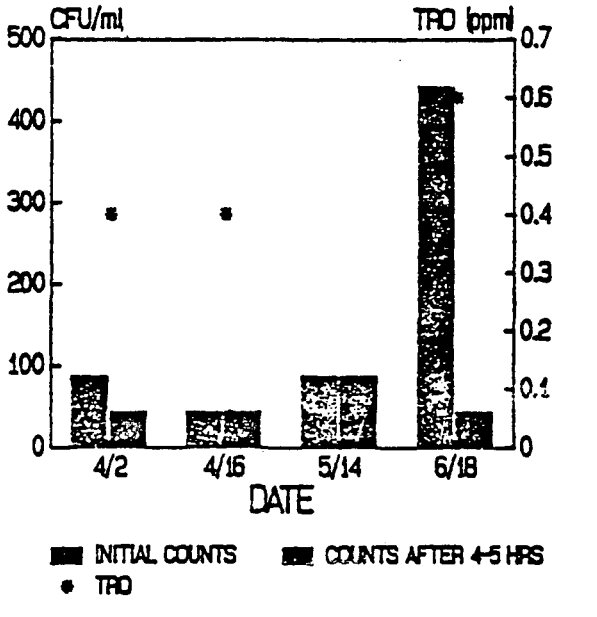
► - DESIGNATES NORMAL FLOW PATH DURING OPERATION.

TMI SESSILE BACTERIA
BETZ C-78P BIOCIDE PROGRAM



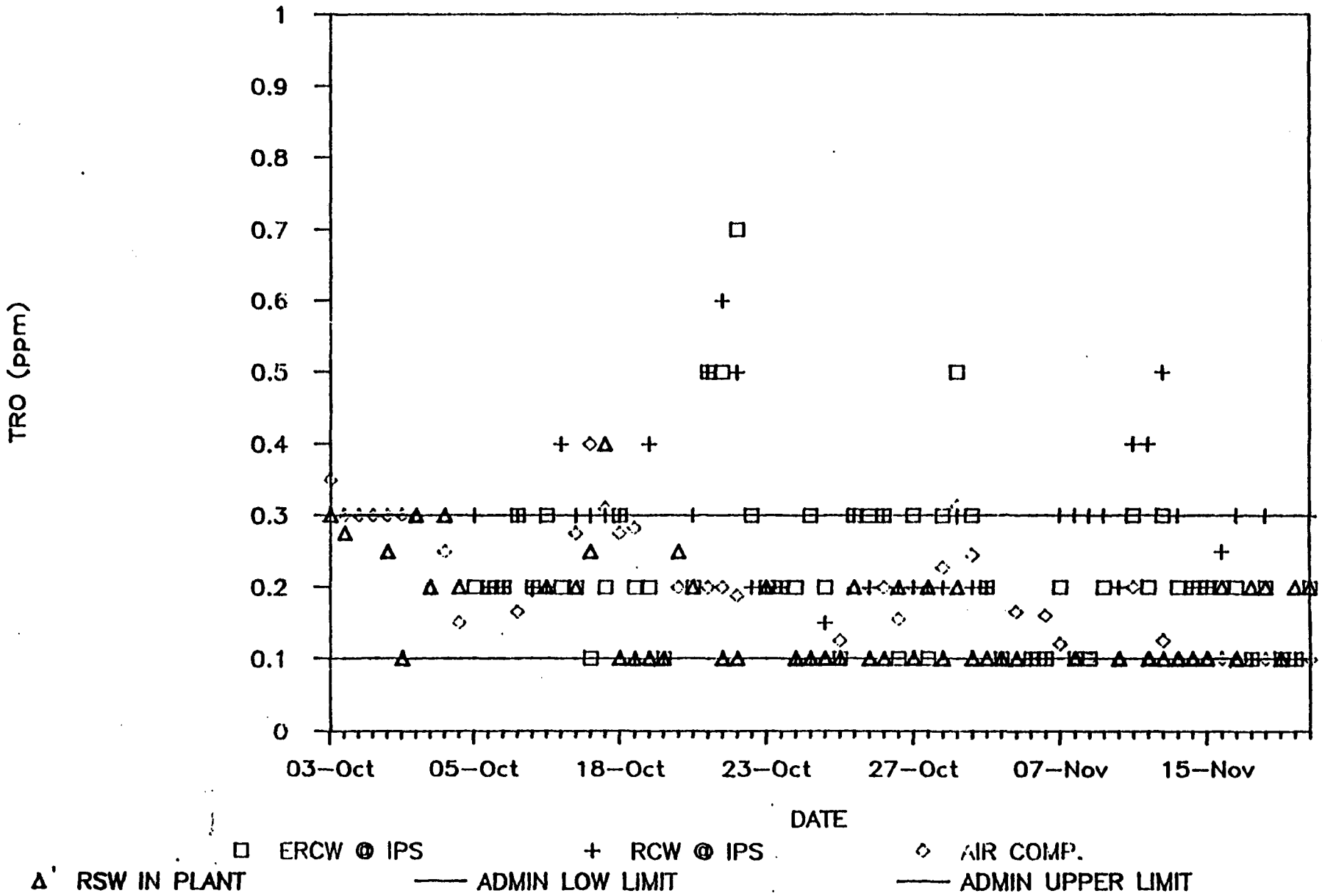
AEROBIC BACTERIA COUNTS

TMI SESSILE BACTERIA
BETZ C-78P BIOCIDE PROGRAM

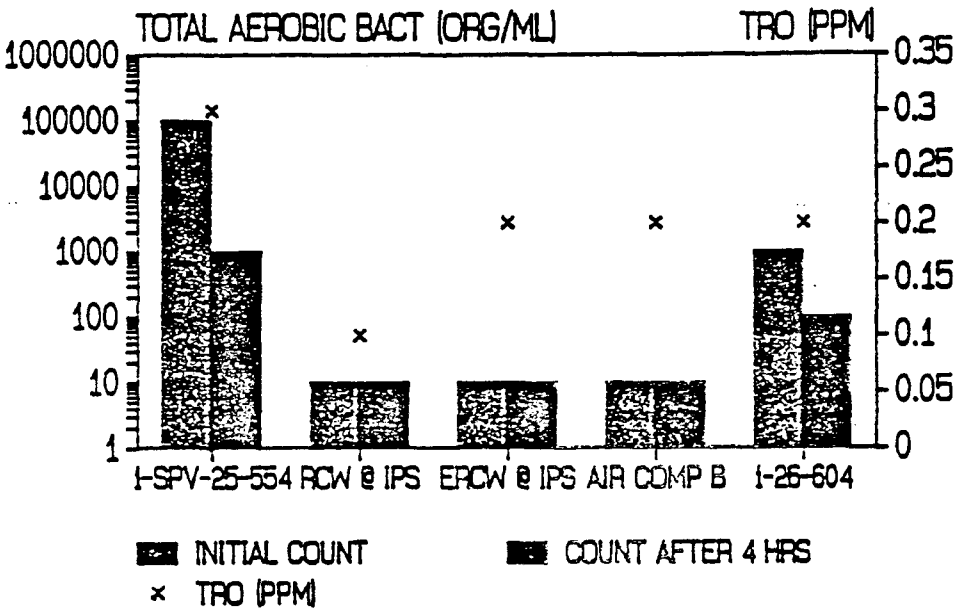


ANAEROBIC BACTERIA COUNTS

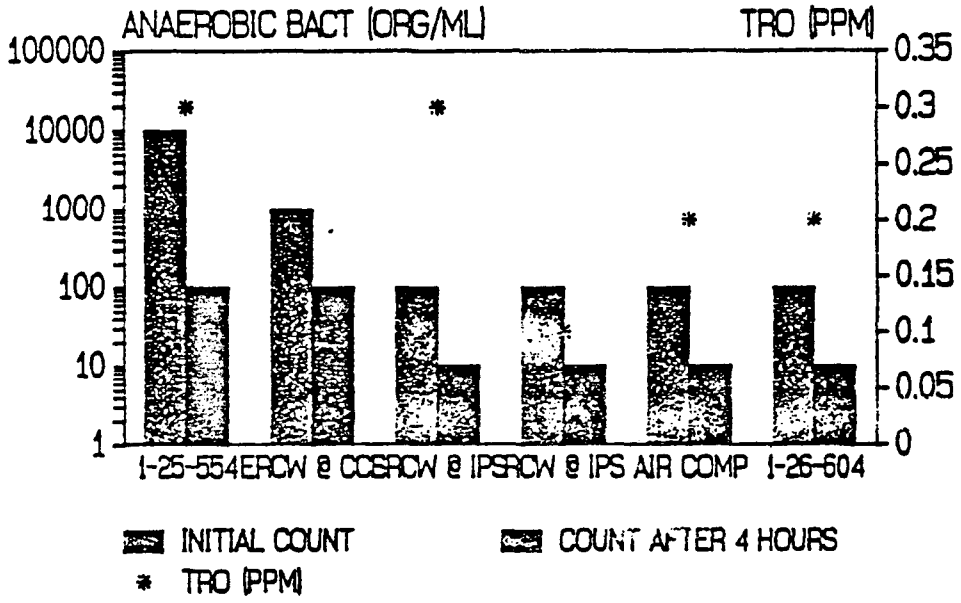
WBN TOTAL RESIDUAL OXIDANT (TRO)



BIOLOGICAL MONITORING
TOTAL AEROBIC BACTERIA USING BROMINE



BIOLOGICAL MONITORING
ANAEROBIC SRB BACTERIA USING BROMINE



SIDE-STREAM CORROSION MONITORING

★ BETZ COSMOS PORTABLE CORROSION MONITOR :

CARBON STEEL & CuNI CORRATOR PROBES FOR CONTINUOUS READOUT OF CORROSION RATES

WEIGHT LOSS COUPONS

SINGLE TUBE HEAT EXCHANGER WITH CARBON STEEL TUBE TO SIMULATE OPERATIONAL SYSTEM CORROSION

CONTINUOUS pH, CONDUCTIVITY, FLOW, AND TEMPERATURE MEASUREMENTS

ON-BOARD COMPUTER TO RECORD DATA AND CALCULATE HEAT EXCHANGER TUBE FOULING FACTOR

★ COUPON RACKS : LONG TERM (180 DAY) AND SHORT TERM (60 DAY) WEIGHT LOSS COUPONS WITH SS, CS, CuNI METALLURGY

SESSILE BACTERIA MONITORS IN STAGNANT AND FLOWING SAMPLE STREAMS

★ TRO ANALYZER : HACH CL-17 CHLORINE ANALYZER FOR CONTINUOUS TRO MONITORING

HACH ANALYZER TIED INTO COSMOS COMPUTER FOR DATA AQUISITION & TRENDING PURPOSES

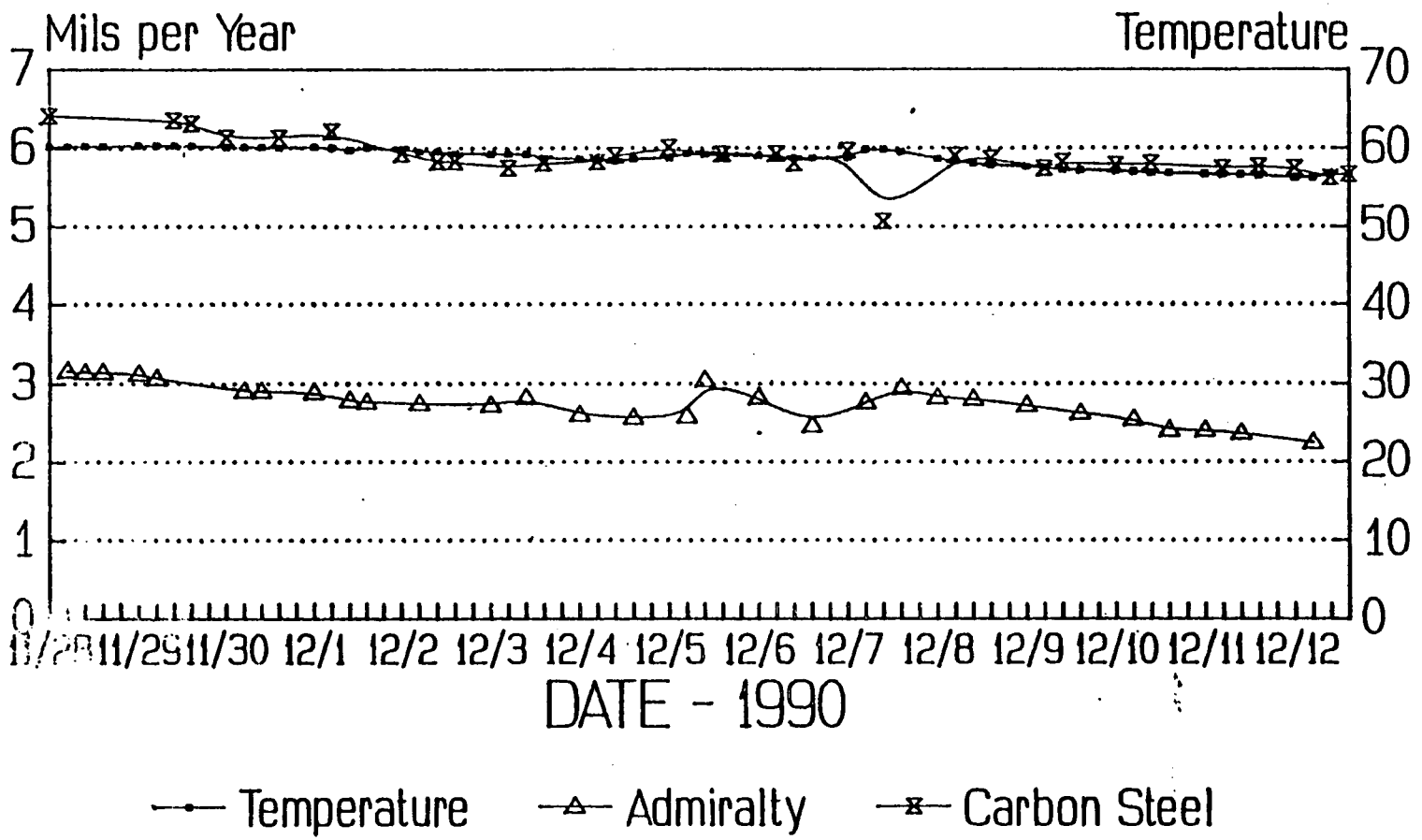
EXPERIMENTING WITH POLYMETRON FREE AVAILABLE CHLORINE ANALYZER

★ VISUAL OBSERVATION TEST SPOOL PIECES :

3 CARBON STEEL PIPES, 2" DIA, 10' LONG EACH EQUIPPED WITH FLANGED ENDS AND PLEXIGLASS FLANGES FOR VISUAL OBSERVATION

PIPES WILL BE USED TO OBSERVE CONDITIONS IN STAGNANT FLOW, MEDIUM FLOW (APPROX 5 FPS),

TVA WATTS BAR - COSMOS DATA
CORROSION RATE



CONCLUSIONS

- ★ OTHER UTILITIES HAVE SUCCESSFULLY USED BROMOCHLORODIMETHYLHYDANTOIN TO TREAT SERVICE WATER SYSTEMS FOR MIC CAUSING BACTERIA
- ★ TRO CONCENTRATIONS & TREATMENT DURATIONS AT WBN ARE CONSISTENT WITH VENDOR RECOMMENDATIONS
- ★ EQUIPMENT DESIGN & OPERATION ARE SIMPLE AND WILL IMPROVE RELIABILITY WHILE REDUCING DOWNTIME DUE TO MAINTENANCE
- ★ HANDLING A DRY CHEMICAL PRODUCT IS SAFER THAN BULK LIQUID CHEMICALS
- ★ COMPREHENSIVE CORROSION MONITORING PROGRAM TO EVALUATE THE EFFECTIVENESS OF BROMINE CHEMISTRY IS BEING IMPLEMENTED

WATTS BAR NUCLEAR PLANT
MICROBIOLOGICALLY INDUCED CORROSION (MIC)
PROGRAM PRESENTATION

DISPERSANT/CORROSION INHIBITOR TREATMENT

1. PROGRAM - ON-LINE IRON AND FOULING CLEANUP CHEMICAL TREATMENT, WHICH ALSO PASSIVATES THE STEEL SURFACES

2. CHEMICAL COMPOSITION - ZINC AND PHOSPHATE BASED CORROSION INHIBITORS WITH EITHER A POLYPHOSPHATE OR DIMETHYL AMIDE AS A PENETRANT/DISPERSANT OR OTHER EQUIVALENTS.

3. GOALS - A) CLEAN-UP/REMOVE EXISTING DEPOSITION
   B) ON-LINE REMOVAL
   C) PREVENT REMOVAL OF LARGE DEPOSITS "CHIPS"
   D) ELIMINATE MIC SITES
   E) PASSIVATE PIPE SURFACES
   F) PROGRAM COMPATIBLE WITH ALL PLANT MATERIALS

4. MONITORING - A) TURBIDITY
   B) SUSPENDED SOLIDS
   C) ACTUAL PIPE ASSESSMENT

5. STATUS - A) EVALUATION OF VENDOR PRODUCTS
   B) SPECIFICATION DEVELOPMENT
   C) PLAN FOR SECOND QUARTER 1991 STARTUP

SECTION V

SUMMARY

WATTS BAR NUCLEAR PLANT

MICROBIOLOGICALLY INDUCED CORROSION (MIC)
PROGRAM PRESENTATION

MIC SUMMARY

WE HAVE BEEN ADDRESSING THE FOLLOWING ISSUES IN THE PREVIOUS AND RECENT MIC EFFORTS.

1. WHERE IS THE MIC IN THE PLANT?

   ANS: A MATRIX HAS BEEN DEVELOPED BASED ON MANY PAST OBSERVATIONS AND THE DATA WILL BE SUPPLEMENTED BY ADDITIONAL TESTING.
   CONTACT: GARY RINER

2. HOW DO YOU SHOW STRUCTURAL INTEGRITY TO ASME SECTION III?

   ANS: THE ANALYTICAL TECHNIQUE TO DISPOSITION MIC WILL DETERMINE SECTION III INTEGRITY. A SCHEDULE TO PERFORM THESE CALCULATIONS HAS BEEN DEVELOPED.
   CONTACT: FRANK KOONTZ

3. WHAT WILL YOU DO ABOUT EXISTING MIC IN THE PLANT?

   ANS: ON-LINE CHEMICAL CLEANING HAS BEEN SELECTED.
   CONTACT: FRANK KOONTZ/RALPH MATTHEWS

4. WHAT WILL YOU DO TO ADDRESS MIC OCCURRENCE IN THE FUTURE?

   ANS: A BIOCIDE INJECTION SYSTEM HAS BEEN INSTALLED AND BIOLOGICAL MONITORING WILL BE PERFORMED TO ENSURE EFFECTIVENESS.
   CONTACT: RALPH MATTHEWS