WATTS BAR NUCLEAR PLANT

MICROBIOLOGICALLY INDUCED CORROSION (MIC) SPECIAL PROGRAM (SP) FINAL REPORT

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MICROBIOLOGICALLY INDUCED CORROSION (MIC)

SPECIAL PROGRAM (SP)

FINAL REPORT

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MIC SPECIAL PROGRAM
FINAL REPORT

1.0 INTRODUCTION

In August 1986, a through-wall leak of approximately seven drops per minute was discovered in the 12-inch Type 316 austenitic stainless steel Essential Raw Cooling Water (ERCW) line at WBN. The line serves as a redundant supply to the motor and turbine driven auxiliary feedwater pumps. As a result of this unanticipated leakage, a metallurgical analysis was performed on the affected piping section to determine the cause of leakage and to assess its potential effect on the remainder of the ERCW system. A detailed evaluation identified the cause of the leakage as Microbiologically Induced Corrosion (MIC) at a butt weld with 316 stainless steel filler metal. This condition was documented in Non-Conformance Report (NCR) W-471-P. Significant Condition Report (SCR) WBNNEB8676 and SCR WBNNEB8677 were written to assess the potential of MIC in the remainder of the ERCW system and other susceptible systems. Although this problem was identified in stainless steel piping, carbon steel raw water piping systems also are susceptible to MIC.

The root cause of the ERCW leakage was that MIC associated problems were not anticipated at the time of design, since the phenomena of MIC was not understood. Designers were unaware of conditions that contributed to MIC colonization, therefore, design did not provide for MIC control methods.

2.0 OBJECTIVE

The objective of this SP is to control MIC in the Essential Raw Cooling Water (ERCW), the Condenser Circulating Water (CCW), the Raw Service Water (RSW), the Raw Cooling Water (RCW), the inlet to the Make-up Water Treatment System, and the High Pressure Fire Protection (HPFP) systems at WBN and to ensure the existing systems comply with design requirements. This objective was accomplished through the installation of a chemical treatment facility for the control of Asiatic clams, MIC, corrosion rates, and the development and implementation of inspection methodology for Carbon Steel (CS) and Stainless Steel (SS) piping. Corrosion monitoring was established to evaluate the effectiveness of the chemical treatment and potential adverse material reactions. Several surveillance and inspection procedures have been implemented to further ensure plant equipment reliability. Enhancements to these procedures and additional procedures will be completed prior to fuel load as the plant systems are completed and operating and maintenance procedures are finalized and approved for operation.

3.0 SCOPE

The scope of this SP included a review of the plant material condition as caused by the MIC bacteria infestation, verification of its acceptability to ASME Section III and the development of a program to monitor, analyze and reduce the extent of the MIC infestation in the Watts Bar raw water systems. The diagram provided as Attachment 1.0 demonstrates the multi directional approach that was initiated upon discovery of MIC and the issuance of NCR W-471-P.

The MIC SP resulted in the development of a design criteria which will be used by engineering in future designs and design enhancements on systems utilizing raw water that could be subjected to MIC. The SP also installed the necessary hardware and implemented a chemistry program to prevent further infestation and reduce pipe narrowing due to MIC nodules where possible. It identified specific critical piping sections and implemented an inspection and monitoring program that will routinely test piping for wall thinning and other signs of MIC related degradation. The SP installed improved monitoring systems to ensure chemical concentrations are maintained at the correct levels and developed and issued the procedures to be utilized by chemistry in monitoring the chemical concentrations in Raw Water Systems. Procedure enhancements and changes will continue to be made as the surveillance program identifies areas for improvement. The diagram provided as Attachment 2.0 pictorially depicts the various portions of the SP actions in more detail.

The discovery and recurrence control related to the completion of this SP as well as software and hardware changes are completed. Corrective action plans for any employee concerns or other administrative control program that had been included within the scope of this SP have been addressed.

4.0 DESCRIPTION OF PROGRAM

4.1 METHODOLOGY USED FOR DEMONSTRATING ASME SECTION III COMPLIANCE OF EXISTING PIPING SYSTEMS

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). Structural integrity calculations, to date, have been performed for SS and CS and are based on a very conservative assumption of MIC degradation with effective wall loss. The actual distribution of MIC degradation in SS is first determined using radiographic (RT) examination techniques. MIC degradation is assumed to be a complete loss of wall for the cumulative circumferential length of degradation and occurrs at the worst possible orientation with respect to the pipe bending loads. A primary input to this methodology for analysis of SS is the distribution of MIC at a weld joint. Calculations, to date, have either involved establishing a bounding flaw size for screening or specific evaluations of Nondestructive Testing (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 CS as a result of MIC. Gross deterioration of CS piping systems before the formation of a pinhole leak is not considered plausible. This is based on the degradation mechanism and power generation industry experiences.[1] The various procedures, criteria and instructions that have been developed for monitoring and evaluation of carbon steel piping are identified on Attachment 3.0.

The following methodology has been developed and was utilized to demonstrate ASME Section III acceptability of MIC degraded CS piping at Watts Bar:

a. Identify most susceptible MIC areas in ASME Section III CS piping based upon flow velocity of raw water.

b. Review existing rigorous analysis to identify the maximum load (stress) in these locations for all pipe diameters.

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

d. Perform UT to determine existing wall thickness at the highest stress node locations and compare to review 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 paragraph e.

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

e. In no case shall actual wall thickness Tact be less than 0.3 nominal wall thickness.

f. Perform random UT on remaining areas to demonstrate existing conditions and compare the measured values to review criteria.

This methodology was applied to the CS piping systems at Watts Bar and the results of these analyses and justification of compliance with ASME Section III was documented in the report dated January 25, 1993 (W. L. Elliott to G. L. Pannell) (RIMS T31930125811). Subsequently, TVA revised the Civil Design Standard for structural evaluation of MIC in degradation in piping to eliminate reference to the evaluation

[1] Electrical Power Research Institute's (EPRIs), Source Book for Microbiologically Induced Corrosion in Nuclear Plants.

methodology of Code Case N-480 for plants under construction. This was documented in a submittal to NRC dated March 24, 1993.

Stainless Steel

MIC in SS 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. Experience has shown that pinhole leaks can develop from MIC degradation of the SS weldment. Evaluation of the structural integrity of MIC degraded SS was performed at Watts Bar. The various procedures, criteria and instructions that were developed for monitoring and evaluation of SS piping are listed on Attachment 3.0.

The following methodology was used for this analysis:

a. Identify most susceptible MIC areas in raw water SS piping.

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

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

  (1) 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 summation of individual MIC indications oriented in the worst manner with regard to applied loads. This provides the review criteria for comparison with NDE results and assures that structural integrity is maintained if MIC degradation is found.

  (2) Perform analysis to demonstrate compliance with ASME Section III stress equations.

    * Equations 8, 9, 10, and 11 in accordance with NC-3652 (1974).
    * Use bounding loads from current analyses.
    * Use degraded cross section (section modulus) based on NDE considering flaw distribution and lack of penetration/lack of fusion (LOP/LOF).

* Use stress intensification factors for butt weld.

d. Review and utilize existing radiographs performed for LOP/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 radiographs will be performed.

e. Evaluate MIC damage observed by radiograph versus the review criteria.

For SS piping this analysis was performed by Aptech and was used to demonstrate the acceptability of the SS piping. To further ensure the acceptability of the SS piping at Watts Bar, the corporate risk assessment staff performed a probabilistic risk assessment calculation that utilized a statistical sample of 74 welds to demonstrate that weld quality of stainless steel and stainless steel to carbon is sufficient to demonstrate a 95/95 confidence level that structural integrity has been maintained. The Aptech report was issued March 6, 1992 (RIMS B26910308224) and the calculation was issued October 22, 1992 (RIMS B26930127240).

WBN has identified and repaired all known (five) leaks attributed to MIC and repaired a total of twelve locations (including leaks) specifically for MIC damage. Of these twelve locations, none had damage exceeding the structural integrity limits of the associated piping systems. No new leak locations have been identified since the second chemical injection skid was placed in service in October of 1992.

4.2 TECHNICAL APPROACH USED FOR CORRECTIVE ACTION AND RECURRENCE CONTROL OF MIC IN EXISTING PIPING SYSTEMS

A primary objective of the MIC Program has been the mitigation of MIC related bacteria throughout the plant. More specifically the goals of the raw water chemical treatment program are to:

* Reduce the concentration of MIC causing bacteria,

* Reduce carbon steel corrosion rates to < 5 mils/year,
  Reduce copper corrosion rates to <0.2 mils/year,

* Over the course of approximately 2 years remove existing nodules and corrosion products from raw water system piping and components to reduce flow restrictions and minimize under deposit corrosion,

* Reduce the potential for Asiatic clam and Zebra mussel infestation.

MIC mitigation involves two aspects: the first is to prohibit new bacteria from colonizing and forming corrosion cells and the second is to eliminate present MIC sites.

MIC mitigation over the last several years has been a secondary benefit of the WBN 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.

Beginning in 1987, TVA hired a consultant and had all raw water systems sampled at the Institute of Applied Microbiology to determine the concentration and types of bacteria in the raw water systems at Watts Bar. This information was the basis for an extensive testing program at TVA Singleton Laboratories to determine if a biocide would decrease bacteria levels and not cause accelerated corrosion of the system materials. Test results were conclusive that a combination of sodium hypochlorite and sodium bromide will decrease the total counts of active bacteria with no significant corrosive effects on system materials.

Based upon laboratory studies and information gathered from several sources, including the EPRI MIC Source Book, a new bromine/chlorine biocide injection system was installed in October 1990. Figure 1 shows a conceptual design flowprint of the system installed at Watts Bar under DCN M-13233. This system provides substantial improvements in the effectiveness of the biocide on Tennessee River water (Ph range 7.5 to 9.0). Results to date have shown up to 90% reduction in bacteria in bulk water which have the potential of forming MIC colonies. This system treats the raw water systems as biocide is fed into the pits at the intake pumping station.

The current chemistry control program has been further enhanced through an on-line cleaning program. A dispersant/corrosion inhibitor chemical treatment system was installed and began operation in October 1992. This chemical treatment program disperses existing iron nodules and exposes bacteria colonies to the biocide treatment, as well as passivates the piping internal surfaces to minimize further corrosion. Figure 2 shows a conceptual design flowprint of the system installed at Watts Bar under DCN M-15496. The benefits of the chemical treatment program also apply to the heat exchangers of the raw water systems. The biocide treatment aspect of this program was covered in TVA's response to GL 89-13 dated January 26, 1990.

In summary, the following chemicals were approved for use under the MIC SP:

Chemical	Purpose
Polyphosphate	Iron sequestering for nodule dissolution
Copolymer Dispersant	Particulate suspension
Zinc Based Corrosion inhibitor	Carbon Steel Corrosion Protection
Azole corrosion inhibitor	Copper corrosion protection

Oxidizing biocide Bromochlorodimethylhydantion	MIC and Macro fouling minimization
Non-oxidizing biocide	MIC and Macro fouling minimization

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

The diagram provided in Attachment 3.0 shows the various sampling and monitoring processes used at Watts Bar to monitor and control MIC. The various chemistry procedures that have been developed for the operation of these injection systems and the long term and short term monitoring of their effectiveness are also listed in this attachment. The various aspects of these programs are described in the Watts Bar Instruction TI-36, "Control of Microbiologically Induced Corrosion at Watts Bar Nuclear Plant." Appendix A of this procedure provides a pictorial summary of the overall site program. (See Attachment 4.0.)

In addition to visual observations, short term corrosion monitoring is being performed through the use of side stream corrosion coupons. The first periodic reviews of the effectiveness for the program to mitigate MIC were issued in July and August 1993, and concluded that the WBN raw water systems were within applicable code requirements for wall thickness and design corrosion. The review also concluded that the monitoring of the carbon steel corrosion coupons in cold water had shown a marked reduction in corrosion rate since the implementation of the program. It was concluded that this trend as well as an improvement in the condition of the internal surfaces of the systems should occur once operation of the system in the normal configuration has commenced.

4.3 EVALUATION OF STAGNANT, INTERMITTENT AND LOW FLOW PIPING

To further enhance the effectiveness of the biocide injection system, a study was performed of the safety-related raw water piping systems to identify potential stagnant sections of piping that might require special injection actions or additional drains or connections to be installed that ensure an adequate concentration of biocide reaches the necessary points. The study identified sections of stainless steel piping and carbon steel piping that had a flow rate of less than 5 ft/sec (A conservative value which exceeds the chemical supplier criteria of greater than 3 fps) or piping that could remain stagnant for greater than 7 days under normal operating conditions. The results of this study and the subsequent engineering recommendations to Operations and Chemistry for special injection actions were released in DCNs 22250 and 26454.

For the ERCW system, the 2 inch and under carbon steel piping (and selected larger piping sections) were replaced with stainless steel and the main supply and discharge headers were lined with cement mortar. Preoperational testing will further ensure the adequacy of the piping through full flow balancing testing. In the HPFP system, additional piping, threaded fittings, and flush connections will be added to facilitate a more effective flush of the system and allow for proper discharge of the water into the correct disposal system. This work is being performed under DCN M-16020 (RIMS T56921209846).

5.0 PROGRAM INTERFACES

The MIC SP interfaced with the Hanger Analysis and Update CAP through the use of the large and small bore piping stress analysis problems for identifying the worst stressed piping locations and the development of acceptance criteria for the inspection points selected.

6.0 DOCUMENTATION

The various corrective action program issues and licensing actions that were completed under this SP are listed in the SP documentation packages that were prepared by Site Licensing and used for support in the 75% and closure inspections of this SP. These packages also contain a more complete listing of the various DCNs, procedures and reports that were prepared to support or implement this SP. The results of the material acceptability review portion of this program are documented in the carbon steel report dated January 25, 1993 (RIMS T31930125811) and the Aptech evaluation issued March 6, 1992 (RIMS B26910308224). The baseline material condition is established and documented in the Periodic Evaluation of the Program for the Mitigation of MIC at WBN issued as two reports in July and August of 1993.

This report, its references, the MIC SP documentation packages and the completion status of the specific corrective actions referenced herein are the basis for the closure of the MIC special program.

Any open actions that remain to be completed are listed in Attachment 5.0 and scheduled for completion in accordance with the site procedures for tracking licensing commitments or site schedules.

7.0 VERIFICATION OF COMPLETION

The Verification of the MIC project completion was performed by TVA Quality Assurance. This verification ensures that issues pertaining to this project are adequately addressed to support licensing of Watts Bar Nuclear Plant. The verification was in accordance with the Integrated Verification Program through focused and selective monitoring, reviews, audits, and inspections. The selected areas reviewed included:

- Identification of affected systems.
- Assessment of MIC bacteria infested locations.
- Establishment of criteria for recurrence control.
- Repair of identified damaged systems.
- Development of specifications and procedures.

The following is a summary of the overall verifications performed to support completion of this project.

a. Procedures have been established to adequately describe and define the MIC program requirements. Unimplemented procedure revisions are identified in Attachment 5.0.

b. Systems potentially affected by MIC have been identified.

c. Installation of weight loss coupons/corrators and corrosion monitoring equipment have been installed in raw water systems.

d. Testing of water samples, visual inspections, bulk water biological screening and appropriate inspections (visual, UT & RT) are being performed to monitor any MIC degradation to systems and is acceptable.

e. ERCW and HPFP calculations and associated quality information requests (QIRs) have been reviewed (except as noted in Attachment 5.0) and are technically adequate for the MIC program.

f. Design Criteria and system descriptions for raw water systems susceptible to MIC have been revised to include a chemical treatment program to minimize and control MIC and are acceptable.

g. Appropriate mechanical equipment and skids have been designed and installed to implement a comprehensive chemical injection program to treat MIC and corrosion in raw water systems. A recent malfunction on August 23, 1993 of the Bromination System is being investigated as described in Attachment 5.0. Corrective action to return the system to acceptable operation has been identified and is being implemented with very little impact on the chemical injection program.

h. Design Change Notices (DCNs) associated with MIC (PWL DE) with the exception of DCN 26454 (see Attachment 5.0) have been implemented, completed, and/or cancelled.

i. CAQs associated with MIC with the exception of WBFIR930140, have been closed and adequately implemented. The corrective action and recurrence controls for WBFIR930140 have been determined, approved, and are scheduled for completion by November 12, 1993.

j. Commitments have been adequately followed and closed except as noted in Attachment 5.0.

k. Records related to the MIC Program have been properly submitted to the Records Information Management System (RIMS) and/or the Document Control and Records Management System (DCRM).

CONCLUSION: Overall, Quality Assurance Monitoring Assessment NQA-WB-92-33, MIC Vertical Slice Assessment QWB-R-92-0529 and Assessment Report NA-WB-93-0076 attest to the quality and completeness of elements of the MIC Special Program. The remaining actions to be performed and verified for the MIC Program have been punchlisted in Attachment 5.0. QA will continue to follow-up on implementation of these actions as they are completed and verify acceptance of the results.

8.0 LICENSING

8.1 REGULATORY STRATEGY, POSITION SUMMARY, HISTORY, AND CONCLUSIONS

Although the NRC has not issued any regulations specific to MIC, it considers MIC as part of the problem in maintaining service water system (SWS) reliability. WBN has acknowledged these concerns and initiated an ongoing program which will control or minimize the effects of MIC activity in raw water piping and components. NRC noted in the Safety Evaluation Report (SER) to the Nuclear Performance Plan (NPP) Volume 4 that the program will address MIC situations unique to WBN. Evaluation of the program will be addressed by the NRC in a future SER after WBN completes initiation of the program.

SSER 8 issued September 1991 concluded that the WBN MIC program for detection, assessment, and control of MIC in the ERCW system will provide reasonable assurance that the system will not lose its capability to perform its safety function. SSER 10 issued October 1992 included the fire protection system in the MIC monitoring program.

<u>History</u>

In August 1986, a through-wall leak was discovered at a butt weld in a 12-inch, Type

316, austenitic stainless steel ERCW line, the cause of which was attributed to MIC. This condition adverse to quality (CAQ) was documented on Nonconforming Condition Report (NCR) W-471-P. NRC identified follow up of the corrective action for W-471-P as Inspector Followup Item (IFI) 390/86-25-04.

NRC Inspection Report 390, 391/87-23 documented NRC's review of the MIC program, and during the inspection period, no violations or deviations were found.

MIC was also found at other TVA nuclear plants, and on December 15, 1987, TVA met with NRC to discuss TVA's corporate approach to the MIC problem. During this meeting, TVA committed to develop a corporate program to address MIC.

In Volume 4 to TVA's NPP, TVA committed to implement a MIC program which would identify systems susceptible to MIC by testing water samples, performing visual inspections, reviewing design and operating documents, reviewing preexisting nondestructive examination (NDE) results, and taking necessary corrective action.

The NRC approved the WBN technical approach and method of implementation by SSER issued September 13, 1991 and October 13, 1992 stating that if properly implemented and commitments are met, it will provide reasonable assurance that the ERCW system and fire protection system will not lose the capability to perform their safety function due to MIC.

Over the years, NRC has also issued various bulletins, information notices, and generic letters which require licensees to confirm that SWS will perform their intended function in accordance with the licensing basis for the plant. In response, WBN has noted the programs which are in place to ensure that SWS will perform their intended function in support of licensing.

A NRC inspection conducted February 22 through February 26, 1993 evaluated the MIC special program at the 75 percent implementation stage. Four inspector followup items were identified that required resolution. An evaluation of the MIC control process could not be made during this inspection since TVA could not provide enough operating experience to make an adequate evaluation of its effectiveness.

Current data indicates positive results in reducing corrosion rates and in removing deposits of corrosion byproducts. The data reveals the corrosion rate of carbon steel in the raw water systems has been reduced from an average of 10.4 mils per year to 1.9 mils per year (water temperature $< 70°F$) since initiation of chemical treatment.

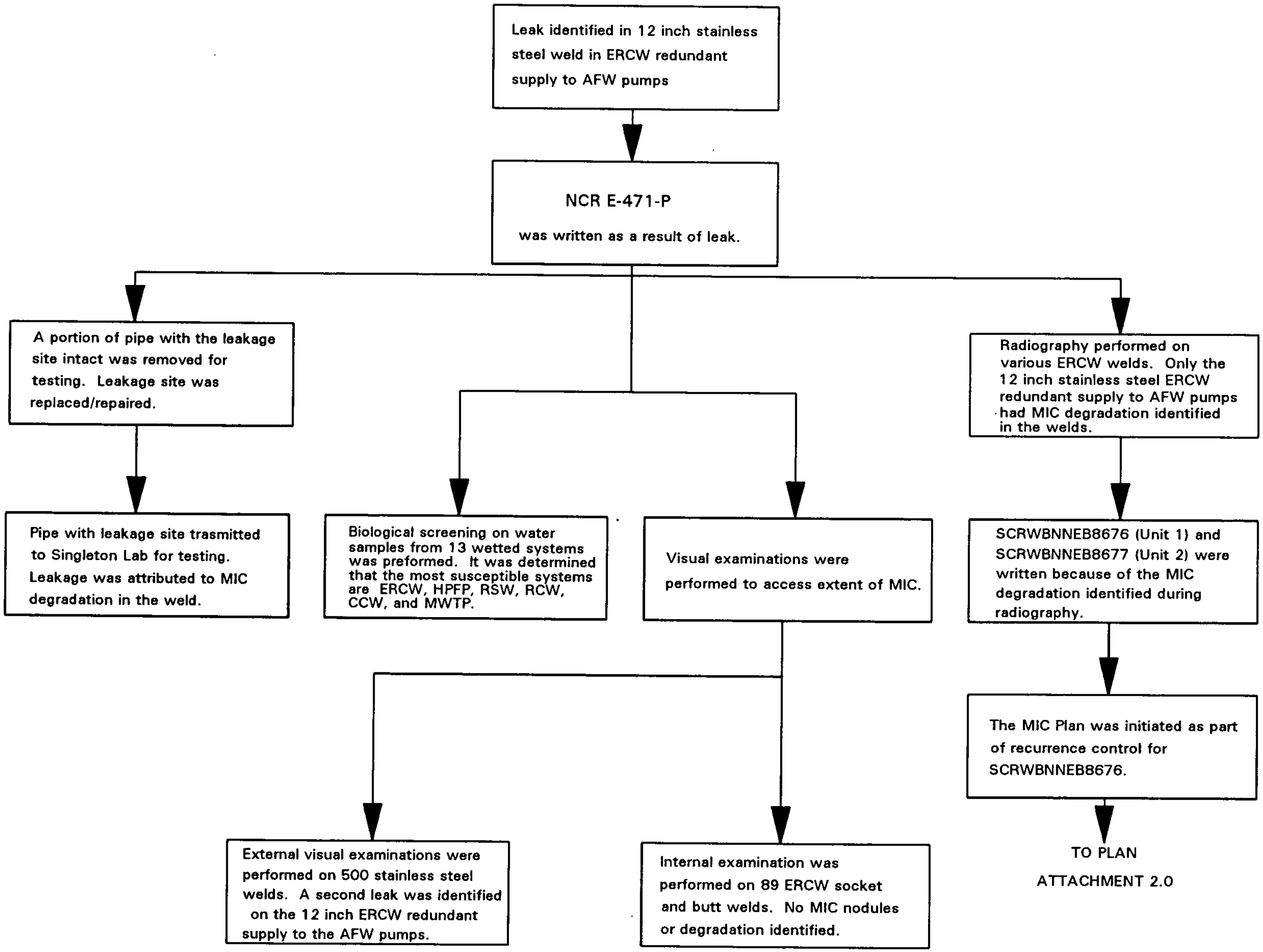
Corrosion product removal is taking place in the raw water systems that received adequate flow (> 3 fps). Analytical results indicate that over the first half of 1993 an average of 50 ppb increase in iron concentration has been observed in raw water as it flows through the systems from inlet to discharge. This combined with an average raw water flow of 20,000 gpm would equate to 12 lbs per day of iron removal or 2.2 tons per year.

Inspections in piping, which receive adequate flow, are showing visual effects of deposit removal. In some areas, clean pipe surfaces are being seen. A videoscope is being used to document the cleanup process in these areas.

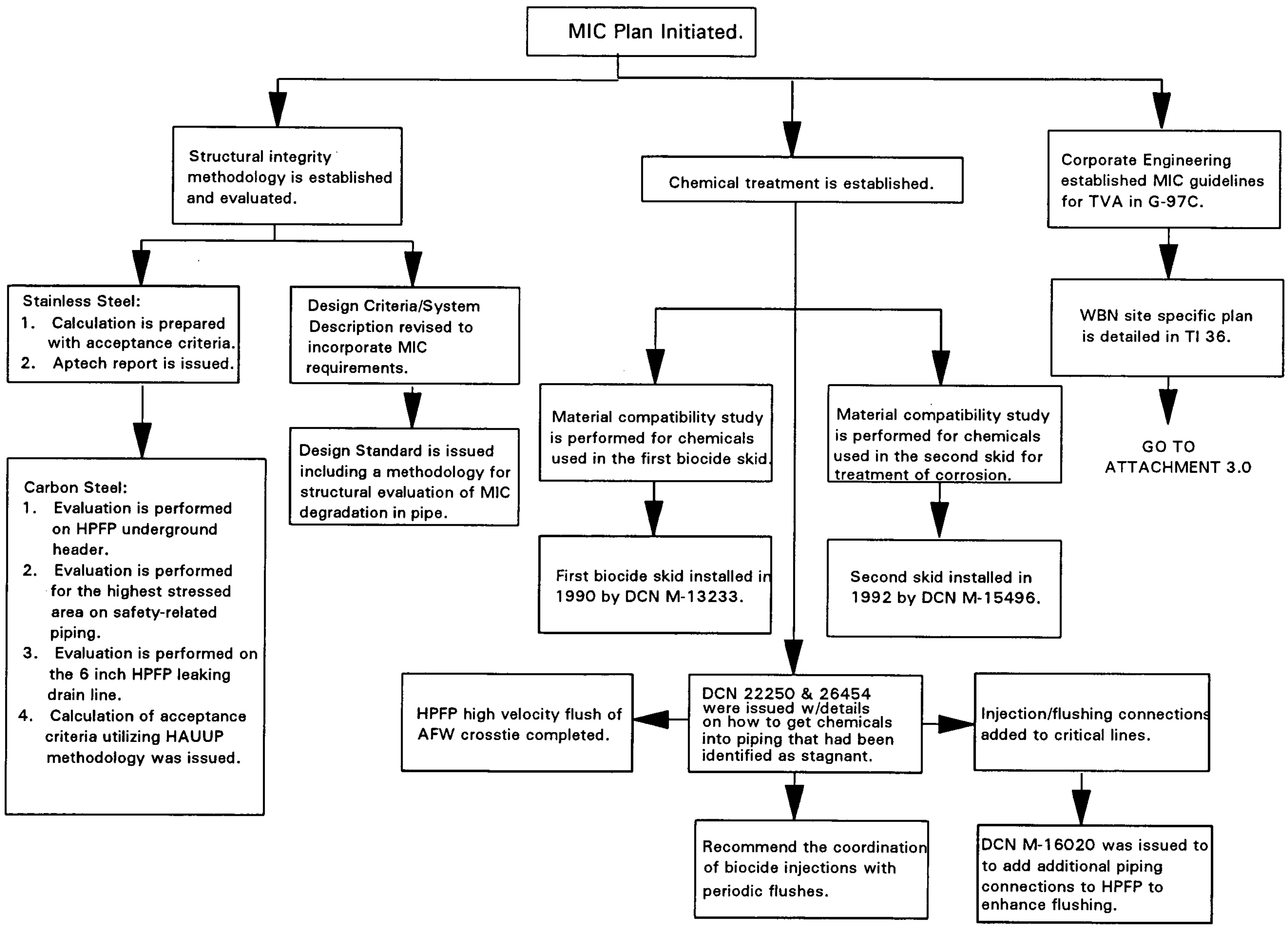
Side-stream test spool pieces which are exposed to low flow conditions have experienced an increase in silt deposition and corrosion. Actions are being taken to ensure chemically treated water is flowing through portions of plant raw water systems which have been stagnant for long periods of time. Startup and Test engineers have written temporary operating procedures (TOPS) to establish flow through portions of the ERCW system which have been stagnant due to minimal heat load during non-operational periods. Piping and components that receive continuous chemical treatment should experience gradual cleanup and reduced corrosion rates.

Based on the positive results and the continued implementation of the MIC program the licensing commitment to develop a program to monitor, analyze, and reduce the extent of MIC bacteria infestation in WBN raw water systems has been met. The remaining activities listed in this final report (Attachment 5.0) are the result of activities scheduled to be completed in conjunction with turnover of activities to the plant. These open items mainly consist of system turnover related activities and do not represent program problems or discovery work.

DISCOVERY


Leak identified in 12 inch stainless steel weld in ERCW redundant supply to AFW pumps
NCR E-471-P was written as a result of leak.
A portion of pipe with the leakage site intact was removed for testing. Leakage site was replaced/repaired.
Pipe with leakage site trasmitted to Singleton Lab for testing. Leakage was attributed to MIC degradation in the weld.
Biological screening on water samples from 13 wetted systems was preformed. It was determined that the most susceptible systems are ERCW, HPFP, RSW, RCW, CCW, and MWTP.
Visual examinations were performed to access extent of MIC.
External visual examinations were performed on 500 stainless steel welds. A second leak was identified on the 12 inch ERCW redundant supply to the AFW pumps.
Internal examination was performed on 89 ERCW socket and butt welds. No MIC nodules or degradation identified.
Radiography performed on various ERCW welds. Only the 12 inch stainless steel ERCW redundant supply to AFW pumps had MIC degradation identified in the welds.
SCRWBNNEB8676 (Unit 1) and SCRWBNNEB8677 (Unit 2) were written because of the MIC degradation identified during radiography.
The MIC Plan was initiated as part of recurrence control for SCRWBNNEB8676.
TO PLAN ATTACHMENT 2.0

PLAN


MIC Plan Initiated.
Structural integrity methodology is established and evaluated.
Chemical treatment is established.
Corporate Engineering established MIC guidelines for TVA in G-97C.
Stainless Steel:
1. Calculation is prepared with acceptance criteria.
2. Aptech report is issued.
Design Criteria/System Description revised to incorporate MIC requirements.
Material compatibility study is performed for chemicals used in the first biocide skid.
Material compatibility study is performed for chemicals used in the second skid for treatment of corrosion.
WBN site specific plan is detailed in TI 36.
GO TO ATTACHMENT 3.0
Carbon Steel:
1. Evaluation is performed on HPFP underground header.
2. Evaluation is performed for the highest stressed area on safety-related piping.
3. Evaluation is performed on the 6 inch HPFP leaking drain line.
4. Calculation of acceptance criteria utilizing HAUUP methodology was issued.
Design Standard is issued including a methodology for structural evaluation of MIC degradation in pipe.
First biocide skid installed in 1990 by DCN M-13233.
Second skid installed in 1992 by DCN M-15496.
HPFP high velocity flush of AFW crosstie completed.
DCN 22250 & 26454 were issued w/details on how to get chemicals into piping that had been identified as stagnant.
Injection/flushing connections added to critical lines.
Recommend the coordination of biocide injections with periodic flushes.
DCN M-16020 was issued to to add additional piping connections to HPFP to enhance flushing.

SITE MONITORING

WBN monitoring plan for MIC (TI-36).

Procedures for stainless steel:

1. 1-PIPE-067-C File 01, 02 - Visual examinations performed semiannually on all ERCW SS to SS and SS to CS welds. Leaking weld identified on 6 inch line during first performance.
2. 1-PIPE-067-C File 05 - Radiography is is performed yearly on approx. 15 welds.
3. 1-PIPE-067-C File 03 - Visual examination performed weekly on leaking welds (applies to operating plants only).
4. 1-PIPE-067-C File 04 - Radiography performed weekly on leaking welds (applies to operating plants only).
5. TI-106 - Provides the structural integrity evaluation after radiography.
6. TI-27 Part III - Visual inspection after breech of raw water system.

Procedures for Carbon Steel:

1. TI-31.13 - Ultrasonic testing is performed semiannually in 17 locations for MIC.
2. TI-27 Part III - Visual inspection after breech of raw water system.

Procedures Covering Chemical Treatment/Monitoring:

1. Chemisrty Manual Ch 6-02 - Water samples are checked quarterly.
2. Chemisrty Manual Ch 4.0 - Chemical injection is defined for several chemicals; frequency varies with each chemical.
3. Chemistry Manual Ch 4.01 - Coupons/Heat exchangers are examined; frequency varies.
4. Chemistry Manual Ch 4.02 - Chemical injection varies.
5. Chemistry Manual Ch. 4.03 - Coppertrol Injection
6. Chemitry Manual Ch. 4.04 - BCDMH Injection
7. Chemisrty Manual Ch 4.05 - Clamtrol Injection
8. TI- 79 - Heat Exchanger Monitoring Program

ATTACHMENT 4.0

WBN SITE PROGRAM PLAN FOR MIC

TECHNICAL INSTRUCTION (TI) -36

Control of Microbiologically Induced Corrosion at Watts Bar Nuclear Plant

1. Stainless Steel

- 1-PIPE-067-C File 01, 02 (Visual Examinations - Semiannually)
- 1-PIPE-067-C File 05 (Radiography - Yearly)
- 1-PIPE-067-C File 03 (Visual Examination - Weekly on leaking welds)
- 1-PIPE-067-C File 04 (Radiography - Quarterly on leaking welds)
- TI-106 (Structural Integrity Evaluation after Radiography)
- TI-27 Part III (Visual Examination - System Breach)

2. Carbon Steel

- TI-31.13 (Ultrasonic Testing - Semiannually)
- TI-27 Part III (Visual Examination - System Breach)

3. Chemistry

- Chemistry Manual Chapter 4.0 (Chemical Injection)
- Chemistry Manual Chapter 4.01 (Corrosion Monitoring - Varies)
- Chemistry Manual Chapter 4.02 (Chemical Injection - Varies)
- Chemistry Manual Chapter 4.03 (Chemical Injection - Coppertrol)
- Chemistry Manual Chapter 4.04 (Chemical Injection - BCDMH)
- Chemistry Manual Chapter 4.05 (Chemical Injection - Clamtrol)
- Chemistry Manual Chapters 6.02 (Water Samples - Quarterly)

4. Heat Exchanger Performance Testing

- TI-79 (Heat Exchanger efficiency testing after fuel load during normal system operation)

ATTACHMENT 5.0
LIST OF REMAINING ITEMS

1. **Revise TI-79, Heat Exchanger Performance Testing Technical Instruction / Close IFI 93-09-01**

Scope:

Include in TI-79 the requirement to forward the results of periodic heat exchanger efficiency tests performed during normal plant operation to Nuclear Engineering and Plant Chemistry for utilization in the MIC Program Evaluations as required by TI-36.

Justification:

The requirement for periodic review of the MIC program effectiveness is addressed in TI-36. TI-36 has been revised to discuss the use of heat exchanger effectiveness results from TI-79. TI-79 is scheduled for major rewrite as a part of the procedure upgrades program. The procedure has been placed on ADMIN HOLD and will not be removed/revised until after this upgrade has occurred. The requirement to revise TI-79 to include the reference to TI-36 is tracked in the site commitment tracking program and scheduled for completion by 12-31-93.

2. **Install Additional HPFP Flush Connections (M-16020)**

Scope:

Adds miscellaneous piping, drain lines, and hose connections that were identified by the system engineering fire protection organization as needed to support periodic flushes as required by the HPFP System Description or various sections of the 10 CFR 50 Appendix A fire protection/suppression system.

Justification:

The flush connections and piping being installed under this DCN are required to allow for disposal of the chemically treated water into the proper waste water system through the roof drains. No flush connections are required for the safety-related portion of the HPFP system. This activity is scheduled to be implemented per the Modification's system waterfall by October 1993.

3. **Revise TI-31.13, Wall Thinning Monitoring Program**

Scope:

(1) Evaluate and add any new grids as appropriate for the non-safety (BOP) raw water systems which are highly susceptible to MIC and contain stagnant, intermittent, or low flow areas based on any TI-27 data sheet inspections. (2) Evaluate and add any new grids as appropriate from TI-27 data sheet inspections of the ERCW Flood Mode Spool Piece lines when quick-disconnect connections are added to flanges to implement DCN W-26454. (3) Revise minimum pipe wall thickness review criteria as required by QIRCEBWBN92061, 92069, and MNMWBN93019. (4) Provide schedule requirements for notification of performance cycle and completion of work request and work orders. These actions are required to close WBFIR930140.

Justification:

This revision of TI-31.13 is to support the future performance of UTs and is an ongoing part of the MIC program with closure of WBFIR930140 scheduled for 12/93. Specifically, the items are addressed as follows:
(1) Results from reviewing the TI-27 data sheets will not adversely impact the MIC program.
(2) Results from reviewing the TI-27 data sheets should be typical of the HPFP Flood Mode lines which have been inspected and found relatively clean and will not adversely impact the MIC program.
(3) UT value exceeds review criteria. Subsequent revision of TI-31.13 is not necessary until prior to the next performance of the UTs.
(4) Delinquent UTs have been requested by issuance of a work request. UT and evaluation of the results will be completed before fuel load.

4. **Complete Work Order(s) to install quick-disconnect injection connections to spool piece flanges to implement DCN W-26454. Revise Chemistry Manual Chapter 4.05, Non-Oxidizing Biocide injection, to incorporate chemical treatment using quick-disconnect fittings / Complete closure of NCO 890112036**

Scope:

Complete work order to install quick-disconnect injection connections to spool piece flanges with TI-27 data sheets reviewed and fiberscope inspections for those with double isolation valves and as determined from a review of the breached ERCW system. Revise Chemistry Manual Chapter 4.05 to address the detailed mechanics to inject non-oxidizing biocide (Clamtrol) into the HPFP and ERCW systems using quick disconnects on flanges for spool piece connections.

Justification:

The injection of Clamtrol is to be performed during monthly toxicity testing for which the next test is scheduled for the third week of September. A work order(s) will be completed to add chemical injection quick-disconnects before the injection of Clamtrol. As a part of the ongoing program, completion of TI-27 data sheets will be completed when the flanges are removed. A work order will be completed to perform fiberscope inspections of Flood Mode lines in the ERCW System which have double isolation valves. Implementation of quick-disconnect flange connections, completion of TI-27 data sheets, fiberscope inspections, Chemistry Manual revision, and the injection of Clamtrol is scheduled to complete by 9/24/93.

5. **Revise TI-36, Control of Microbiologically Induced Corrosion at Watts Bar Nuclear Plant**

Scope:

- Revise to require an annual system effects evaluation of program effectiveness instead of "perform overview of all elements of site plan ... on a periodic basis, not to exceed twenty-four months, to assess program effectiveness and adjust program as required."

- Revise to add, list, and reference Chemistry Manual chapters 4.03, 4.04, and 4.05. Review Chemistry Manual Chapter 4.04 for any changes to TI-36.

Justification:

A planned site standard practice is scheduled to address all aspects of a general corrosion program at Watts Bar Nuclear Plant of which MIC is a part. TI-36 requirements will be incorporated into this new SSP and TI-36 cancelled by 12/93.

6. **Perform initial surveillance flow test of non-safety related HPFP standpipes in the Auxiliary Building, Diesel Generator Building, and Intake Pumping Station**

Scope:

- Surveillance flow testing is a special requirement of the HPFP System Description N3-26-4002. The HPFP flow calculation used a corrosion factor C of 100 for new pipe rather than a C of 55 for corroded pipe. The calculation concludes the HPFP satisfies design criteria requirements under clean conditions but requires surveillance testing of standpipes to monitor any corrosion buildup.

Justification:

- Periodic surveillance testing will detect any corrosion buildup with identification and resolution of any deficiencies if the test results do not meet the acceptance criteria. Surveillance instruction 0-TRI-26-2 will be issued and implemented before fuel load which will contain the engineering requirements and acceptance criteria.

7. **Complete Incident Investigation Report involving the release of bromide gas from BCDMH tank and evaluate recommendations**

Scope:

- Complete report with root cause, extent of condition, and corrective actions/recommendations to prevent recurrence.
- Evaluate use of alternative chemicals which reduce the concentration of bacteria which cause MIC.

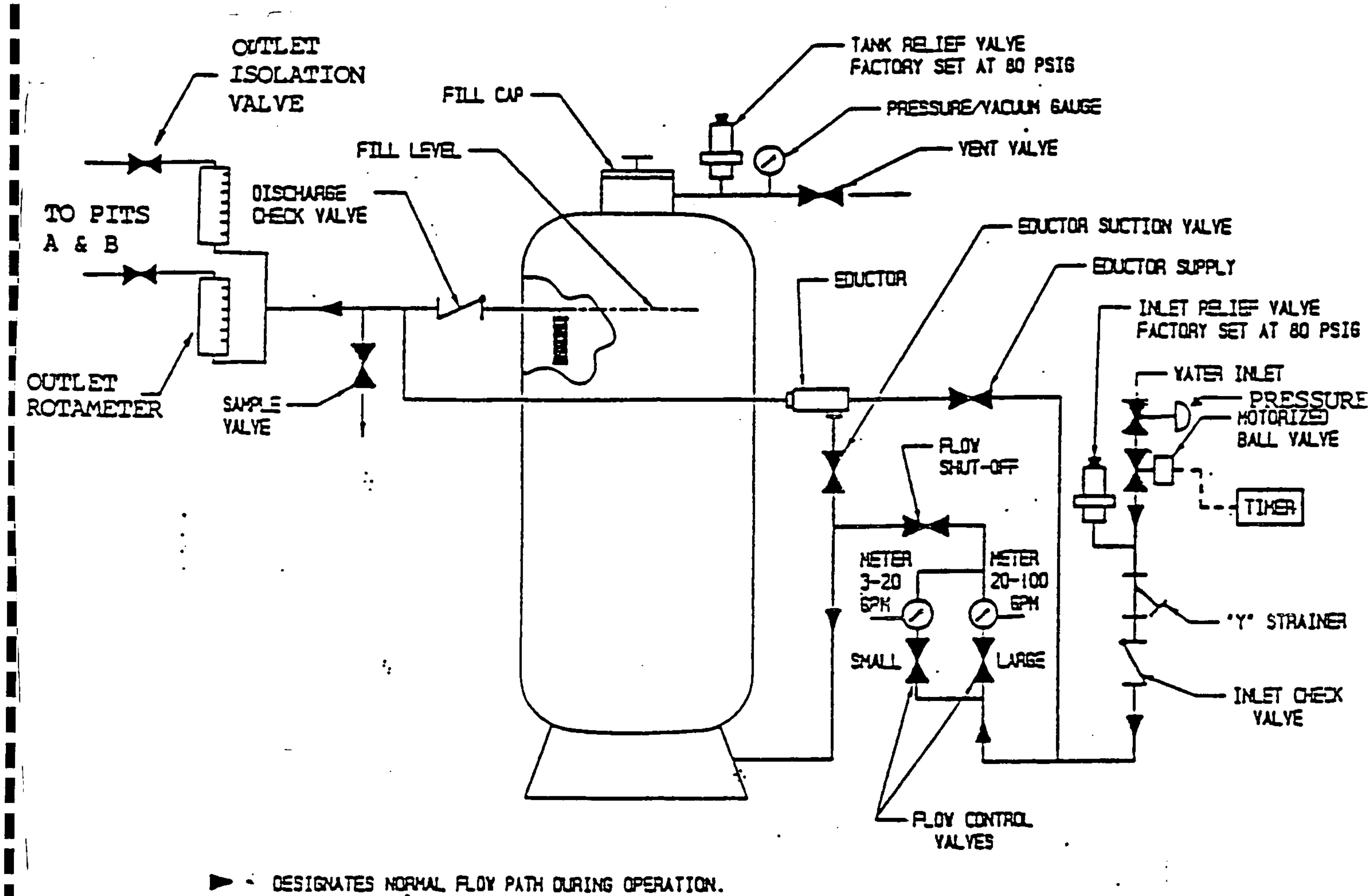
Justification:

- BCDMH tank has been returned to service. Any use of an alternative chemical will be evaluated to ensure effectiveness for the MIC program.

MIC SPECIAL PROGRAM
FINAL REPORT

FIGURE 1.0

CONCEPTUAL DESIGN
BROMIDE/CHLORIDE BIOCIDE INJECTION SYSTEM



CONCEPTUAL DESIGN
DISPERSANT/CORROSION INHIBITOR TREATMENT SYSTEM