UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

(34)

AUG 8 1983

MEMORANDUM FOR: C. E. Norelius, Director
Division of Project & Resident Programs
Region III

FROM: Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation

SUBJECT: COMPLETION OF TIA 83-14 - PRAIRIE ISLAND UNIT NO. 1 THIN WALL PIPE CRACKS IN CONCENTRATED BORIC ACID SYSTEM

The purpose of this TIA was to allow NRR to assess the technical and safety aspects of Northern States Power Company's proposed repairs and plans for continued operation after the licensee declared the concentrated boric acid line inoperable. This line connects the boric acid storage tanks to the safety injection system.

NRR's evaluation was to consider:

- Plant condition, system function and component failure
- Examination of defective pipe
- Fracture Mechanics
- Analysis of pipe sample
- Repairs
- Evaluation for operability

The NRR staff met with Northern States Power Company (the licensee) in Bethesda, Maryland, on February 8, 1983 in which the above considerations were addressed for the thin wall pipe crack indications found in the concentrated boric acid line at the Prairie Island Nuclear Generating Plant Unit No. 1 The meeting summary issued on April 18, 1983 (Attachment 1), which serves also as the safety evaluation, concludes that the licensee had adequately restored the concentrated boric acid line to an operable status. Therefore, the Prairie Island Nuclear Generating Plant Unit No. 1 was permitted to resume power operations at the conclusion of this meeting. The corrective action taken by NSP and described in Attachment 1 which we find acceptable can serve as guidance for other licensees having similar thin wall pipe problems.

The repairs described in Attachment 1 were inspected by the Region III inspector, W. J. Key, and no items of noncompliance or deviations were identified. A copy of the inspection report No. 50-282/83-02 (DE); 50-306/83-06 (DE) dated April 13, 1983 is enclosed (Attachment 2).

The memorandum from the Prairie Island PM to R. Baer, IE, dated August 2, 1983 (Attachment 3) suggests this issue be considered generic for those PWRs that have similar concentrated boric acid systems.

This completes NRR actions pursuant to TIA 83-14.

Darrell G. Eisenhut, Director
Division of Licensing

Attachments:
As stated

cc: J. F. Steeter
D. Danielson
W. J. Collins
C. Y. Cheng
W. Hazelton
B. D. Liaw
C. McCracken
I. N. Jackiw
C. D. Feirabend
D. L. Williams

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

APR 18 1983

Docket Nos. 50-282
and 50-306

LICENSEE: Northern States Power Company

FACILITY: Prairie Island Unit Nos. 1&2

On February 8, 1983, the NRC staff met with Northern States Power Company (the licensee) in Bethesda, Maryland to resolve the issue of the crack indications found in the concentrated boric acid line connecting the boric acid storage tanks to the safety injection system (SIS) of Prairie Island Nuclear Generating Plant Unit No. 1. The licensee on Friday, January 28, 1983, declared the safety injection system inoperable because of these crack indications and Unit No. 1 was manually shut down. The purpose of this meeting was to show the basis for declaring the concentrate boric acid line operable and thus permit the restart of the Prairie Island Unit 1. A list of attendees is attached (Attachment 1).

The meeting opened with presentation of the agenda (Attachment 2). The following areas were discussed:

1. Plant Condition, System Function & Component Failure
2. Examination of the Defective Pipe
3. Fracture Mechanics
4. Analysis of Pipe Sample
5. Repairs
6. Evaluation for Operability

1. Plant Condition, System function & Component Failure

Several crack indications were found in the weld areas of the concentrated boric acid supply line that connects the 600 gallon storage tanks to the safety injection system. During normal plant operations this line contained 12% stagnant boric acid. The boric acid line is approximately 214 ft long, 8 inches in diameter, schedule 10 (~0.148 in. thick), 304SS and contains 77 welds. This line is normally under low pressure (~ 10PSI) and is heat traced to 180°F.

Unit No. I was manually shut down on January 28, 1983 when the line was declared inoperable. The concentrated boric acid system is used only to limit the return to power of the reactor during the rapid heat removal from the reactor cooling system during a large steam line break. Such an accident requiring the concentrated boric acid also assumes that the most active shut off rod has not entered the core, the accident occurs near the end of core life and one of the safety injection pumps is inoperable.

8304-0186
pDR

A tiny through wall crack was found in a weld area of the line that was reported to the staff in LER 82-029/0IT-0. Subsequent investigations led to the discovery of other leaks and crack indication when all of the weld areas were examined by ultrasonic testing. The cracks were located in the annealed base metal of the heat affected zone that did not show a significant degree of sensitization.

The licensee observed crack indications only in stagnant lines. However the licensee found no crack indications in the boric acid storage tank or in other lines having more frequent circulation. Nominal amounts of contaminants can be concentrated in stagnant lines by evaporation due to excessive heating and settling effects. In addition, air bubbles can collect in these oxygenated lines. This suggests that stagnation is a major factor in this cracking.

2. Examination of Pipe Welds.

The licensee examined all of the welds (total of 77) in the 8 inch boric acid line utilizing ultrasonic techniques. The basic pulse-echo procedures were used in accordance with Appendix III of ASME Section XI 1974 Edition thru the summer 1976 addenda. The inspection team consisted of personnel certified in accordance with ANSI-TC-1A levels I & II. The results of this examination revealed that 16 welds (20.8% of total weld) had intermittent circumferential indications and 3 welds (3.9% of total) contained spot/axial indications. The licensee stated the ultrasonic techniques employed provided conservative and adequate capabilities for detecting stress corrosion cracks in this system. Based on the presentation given by the licensee and our review of the licensee's submittal on this matter, we agree that the use of ultrasonic techniques as described by the licensee provides reasonable assurance that all stress corrosion cracks in the weld areas have been identified.

3. Fracture Mechanics

The licensee performed a flaw evaluation to determine the maximum crack size in the weld areas that would reduce the margin of safety below the code allowable stress levels. The pipe conditions and loads that were used in the analysis consisted of the following:

Temperature $\leq 250^{o}F$

pressure $\sim$ 10 PSI

pipe loads $\sim$ 1/3 of allowable

The analysis presumed thru wall circumferential cracks in locations where there would be the worst case membrane or bending stresses. The results of the analysis performed in two locations showed allowable flaw lengths of 10 and 12 inches when subjected to stress levels of 6900 and 5000 PSI respectively. Based on this analysis the licensee concluded that the observed cracks in the weld area do not reduce the load carrying margins of safety below the Code Allowable stress levels. The staff agrees with this assessment.

4. Analysis of the Pipe Sample

The licensee removed a section of pipe and requested Westinghouse to perform a metallurgical examination of the crack indications. The scope of work consisted of surface, metallographic and fractographic examinations and a chemistry evaluation. This examination revealed the nature of the leak and crack indications to be transgranular stress corrosion cracking (TGSCC). TGSCC is caused by synergistic effects of contaminants (i.e., chlorides, sulfates and flourides), operating stress and residual tensile stresses introduced by welding and grinding. The chemistry evaluation showed the contaminants as 79 to 110 PPM chlorides, 114 to 204 PPM sulfates and 10 to 84 PPM flourides. The sulfates levels and to some degree the chlorides levels are high enough to attack the 304SS when combined with high residual stress levels and the tensile stress caused by cold work and grinding at the weld areas. Two possible sources of these contaminants are: contaminated batch of boric acid or the concentration of contaminants due to resin intrusion in the recycling system. The metallographic surface examinations indicated grinding and deformation adjacent to the welds which,in the presence of the contaminants, provides initiation sites and creates stress slip bands which are preferentially attacked by the stress corrosion cracking mechanism.

The major stresses in this system are the welding residual stresses. This, combined with the cold work introduced during installation and grinding at welds, suggests that piping adjacent to welds is the first area to be attacked. Therefore, piping adjacent to welds is likely to be the only area attacked by TGSCC that approaches an extent which could reduce the design safety factor of the line.

5. Repairs

All nineteen weld joints showing crack indications (as identified by ultrasonic examinations) were reinforced with reinforcing pads or sleeves. The design of the pads or sleeves is similar to reinforcement required for fabricated branch connections in ANSI B.31.1 Power Piping. The reinforcement sleeves and pads were installed around the pipe covering the crack indication areas and were fillet welded to the pipe. In addition sections of pipe removed for analysis are replaced with sections designed in accordance with ANSI B.31.1 code. The repairs and welding were conducted in accordance with ASME Code Section XI 1980 Edition with addenda thru the Summer 1982. The completed fillet welds were inspected by liquid penetrant techniques. Butt welds were inspected by radiographic and liquid penetrant techniques. Inspection methods and criteria were in accordance with the ASME Code Section XI 1974 Edition with addenda thru the summer of 1976. Finally the repaired system was hydrostatically tested to 1.5 times the design pressure.

6. Evaluation for Operability

The staff concurs with the licensee's finding that the concentrated boric acid line has been restored to an operable status. The basis for this conclusion is as follows:

1. The licensee has demonstrated with a reasonable degree of confidence that all crack indications have been identified.

2. The pipe repairs at 19 locations, as described by the licensee, assure that the pipe line is restored to its original design strength.

3. Flushing operations prior to returning the line to service, showed a decrease in the dissolved contaminants in the water samples after several flushes.

4. To ensure that the line will not be subject to future stress corrosion cracking the licensee committed to the following;

   (a) The boric acid will normally be recirculated (90% of the time) thus preventing contaminants from concentrating in an otherwise stagnant line.

   (b) Contaminants (i.e., chlorides, sulfates) will be more closely monitored with the addition of a new analytical chemistry technique (ion-exchange chromatography) having a 10 PPB detection limit.

5. The licensee has committed to replace the line on Unit 1 prior to the start up of cycle 10 (January 1985). In the interim the licensee committed to conduct monthly visual inspections of the line and to ultrasonically examine 10 welds every six months.

6. The ultrasonic examination of the concentrated boric acid line servicing Unit 2 revealed no crack indications. However, the licensee committed to the provisions of item 4 above and to conduct monthly visual inspections.

The licensee has demonstrated the operability of the concentrated boric acid system. Therefore the Prairie Island Nuclear Generating Plant Unit No. 1 can safely resume power operation.

Dominic C. DiIanni
Project Manager
Operating Reactors Branch #3
Division of Licensing

MEETING SUMMARY DISTRIBUTION

Licensee: Northern States Power Company

*Copies also sent to those people on service (cc) list for subject plant(s).

Docket File
NRC PDR
L PDR
NSIC
ORB#3 Rdg
ORB#3 Summary File
JHeltemes
BGrimes
RAClark
Project Manager
PMKreutzer
OELD
ELJordan
JMTaylor
ACRS-10
NRC Participants

PRAIRIE ISLAND UNIT NO. 1

BORIC ACID LINE CRACK INDICATION

FEBRUARY 8, 1983 MEETING

Attendees

Dominic DiIanni - PM NRR

C. Y. Cheng	MTEB/NRR	P. C. Riccardella	NUTECH
W. J. Collins	IE/NRR	Gary Miller	NSP
W. S. Hazelton	MTEB/NRR	Barry L. Dickerson	Fluor Eng., Inc
B. D. Liaw	MTEB/DE/NRR	Greg Krause	NSP
W. J. Shack	Argonne National Lab.	Michael T. Anderson	NSP
Conrad McCracken	CMEB/DE/NRR	Paul Wu	CMEB/NRR
Tom Parker	NSP	Ed Watel	NSP
R. A. Clark	ORB#3/NRR	C. W. Rowland	Westinghouse
W. J. Key	Reg. III-NRC Reactor Inspector	Lee Spessard	Reg. III
D. H. Danielson	Reg. III	J. T. Crane	Westinghouse
Gutti Rao	Westinghouse		

PRAIRIE ISLAND - NRC MEETING

FEBRUARY 8, 1983

BORIC ACID LINE CRACKING

I. INTRODUCTION

ED WATZL - NSP - PRAIRIE ISLAND PLANT MANAGER
TOM PARKER - NSP - LICENSING ENGINEER

A. DESCRIPTION AND FUNCTION OF SYSTEM
B. HISTORY

II. EXAMINATION OF PIPE

MIKE ANDERSON - NSP - MATERIAL AND SPECIAL PROCESS ENGINEER

A. TECHNIQUE
B. RESULTS
C. CONCLUSIONS

III. FRACTURE MECHANICS

DR. PETE RICCARDELLA - NUTECH - SR. ENGINEERING DIRECTOR
DAVE PITCAIRN - NUTECH - ENGINEERING DIRECTOR, MATERIALS

A. METHOD
B. CRITICAL CRACK SIZE

IV. ANALYSIS OF PIPE SAMPLE

DR. GUTTI RAO - WESTINGHOUSE - SENIOR ENGINEER
JOHN CRANE - WESTINGHOUSE - SENIOR ENGINEER
CHUCK ROLAND - WESTINGHOUSE - PROJECT ENGINEER

A. TYPE OF CRACKING
B. EXTENT OF CRACKING
C. CONTAINMENT

V. REPAIRS

GARY MILLER - NSP - PRAIRIE ISLAND SUPERINTENDENT
OPERATIONAL ENGINEERING

GREG KRAUSE - NSP - MATERIALS AND SPECIAL PROCESSES ENGINEER
BARRY DICKERSON - FLUOR - PRINCIPLE MECHANICAL ENGINEER

A. DESIGN
B. SPECIFIC APPLICATIONS
C. MATERIAL, PROCEDURES, ETC.

VI. OPERABILITY

ED WATZL - NSP - PRAIRIE ISLAND PLANT MANAGER

A. SUMMARY
B. SURVEILLANCE

Attachment
No 2

APR 13 1983

Docket No. 50-282
Docket No. 50-306

Northern States Power Company
ATTN: Mr. C. E. Larson
Director of Nuclear
Generation
414 Nicollet Mall
Minneapolis, MN 55401

Gentlemen:

This refers to the special safety inspection conducted by Mr. W. J. Key of this office on January 26, 27, February 8-10, 1983, and March 30, 1983, of activities at Prairie Island Nuclear Generating Plant, Units 1 and 2, authorized by NRC Operating Licenses No. DPR-42 and No. DPR-60 and to the discussion of our findings with Mr. E. Watzl and others of your staff at the conclusion of the inspection.

The enclosed copy of our inspection report identifies areas examined during the inspection. Within these areas, the inspection consisted of a selective examination of procedures and representative records, observations, and interviews with personnel.

No items of noncompliance with NRC requirements were identified during the course of this inspection.

In accordance with 10 CFR 2.790(a), a copy of this letter and the enclosure(s) will be placed in the NRC Public Document Room unless you notify this office, by telephone, within ten days of the date of this letter and submit written application to withhold information contained therein within thirty days of the date of this letter. Such application must be consistent with the requirements of 2.790(b)(1). If we do not hear from you in this regard within the specified periods noted above, a copy of this letter and the enclosed inspection report will be placed in the Public Document Room.

1601

We will gladly discuss any questions you have concerning this inspection.

Sincerely,

"Original signed by W. S. Little"

W. S. Little, Chief
Engineering Branch

Enclosure: Inspection
Report No. 50-282/82-02(DE);
No. 50-306/83-06(DE)

cc w/encl:
E. L. Watzl, Plant Manager
DMB/Document Control Desk (RIDS)
Resident Inspector, RIII Prairie
Island
Resident Inspector, RIII Monticello
John W. Ferman, Ph.D., Nuclear
Engineer, MPCA

RIII
Key/jp
4/12/83

RIII
Danielson

RIII
Jackiw
4/13

RIII
Little
4/13

U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-282/83-02(DE); 50-306/83-06(DE)

Docket No. 50-282; 50-306 License No. DPR-42; DPR-60

Licensee: Northern States Power Company
414 Nicollet Mall
Minneapolis, MN 55401

Facility Name: Prairie Island Nuclear Generating Plant, Units 1 and 2

Inspection At: Prairie Island site, Red Wing, MN

Inspection Conducted: January 26-27, February 8-10, and March 30, 1983

Inspector: for W. J. Key 4/13/83

Approved By: for D. H. Danielson, Chief 4/13/83
Materials & Processes Section

Inspection Summary

Inspection on January 26-27, February 8-10, and March 30, 1983 (Report No. 50-282/83-02(DE); 50-306/83-06(DE))
Areas Inspected: Review of repair program, procedures, and documentation and observation of activities for the repair of ultrasonic indications and through wall leaks in the safety injection supply line from the boric acid storage tanks. The inspection involved a total of 42 inspector-hours on-site by one NRC inspector.
Results: No items of noncompliance or deviations were identified.

DETAILS

Persons Contacted

Northern States Power Company (NSP)

*E. Watzl, Plant Manager
*P. Krumpus, M&SP Superintendent
*M. Anderson, M&SP Engineer
*D. Mendele, Plant Superintendent (Engineering & RP)
*G. Krause, M&SP Engineer
*G. Colman, M&SP Engineer
*G. Gore, Systems Engineer

Hartford Steam Boiler Insurance (Hartford)

C. Lindstrom, ANI

*Denotes those present at either the entrance or exit meetings.

Functional or Program Areas Examined

1. Safety Injection Supply System Piping

On December 29, 1982, the licensee reported to the NRC RIII office that a through wall leak had been detected in the heat affected zone of a weld in the safety injection supply line from the Boric Acid Storage Tank (BAST) and that an investigation was in progress.

The licensee's investigation determined that this weld had not been volumetrically examined in response to IE Bulletin 79-17, Revision 1.

Piping material supplied for this system is schedule 10, ASTM-A312 Type 304 stainless steel with ASTM-A403 Type 304 fittings. The system was designed and installed in accordance with USAS B31.1.0, 1967 Power Piping Code and design specification for stainless steel piping SS-M380-69 (NSP). The licensee contacted their inservice inspection agency, Lambert MacGill and Thomas (LMT), to perform non-destructive examinations of 100% of the accessible welds in the system utilizing the ultrasonic, liquid penetrant and visual NDE methods. Seventy-seven welds in the system were examined. Nineteen of the welds were identified as either leaking or having indications that would require repair or replacement.

A section of piping containing welds No. 62 and 63 was removed. Weld No. 63 was sent to Westinghouse Electric Corporation (W) for metallurgical and NDE analysis.

The welds identified below were determined to contain indications and were repaired.

Weld No.	Weld No.
51	60 (Leak)
53	61 (leak)
67	62 (leak)
71	63 (leak)
72	64 (leak)
277	87 (leak)
278	76 (leak)
279	80 (leak)
57	85 (leak)
56	

On February 8, 1983, a meeting between the licensee and the NRC staff was held in Bethesda, MD. Members of the Region III staff were in attendance.

The licensee presented their repair program for the temporary repair of welds, adjacent piping and fittings and committed to the replacement of system piping during a future outage.

2. Repair Program

The licensee developed a repair program to meet the requirements of ASME Code Section XI, 1980 Edition, with Addenda through Summer 1982. The repair program consists of welding pads and sleeves around the outside diameter of the pipe, at identified crack indications, using approved welding procedures and welders qualified in accordance with ASME Code Section IX. The design of the sleeves is in accordance with ANSI/ASME B31.1, 1973 Edition with Addenda through Summer 1973.

The program requires that all completed welds and the base metal for one inch each side of the weld be liquid penetrant examined, and that all butt welds be radiographically and liquid penetrant examined, to meet the acceptance criteria of ASME Code Section XI, 1974 Edition through Summer 1976 Addenda.

The inspector identified no items of noncompliance or deviations during his review of the program.

3. Procedure Review

The following examination and repair procedures were reviewed for conformance to referenced codes and standards.

- Welding Specification NSP-PP-150, Revision 2
- Welding Procedure - 83-8TS8-AN5.1, Revision 0.
- Welding Procedure - 83-8TS8-0B-1.2, Revision 0.
- Ultrasonic Procedure - NSP-UT-1, Revision 1.
- Ultrasonic Procedure - NSP-UT-2, Revision 2
- Visual Examination Procedure - NSP-VT-1, Revision 2.
- Liquid Penetrant Procedure - NSP-PT-1, Revision 2.

No items of noncompliance or deviations were identified.

4. Equipment and Materials

The equipment and materials listed below were examined for certification and calibration requirements of the referenced codes and standards.

UT Couplant - LMT Gel, Batch No. 1110812

Penetrant Cleaner - Spotchek-SKC-NF/Zc-7, Batch - 81C041

Penetrant - Spotchek-SKL-HF/S, Batch - 82F059/82G059

Developer - Spotchek-SKD-NF-ZP-9B, Batch - 82G057

UT Instruments - Nortec 131D,
S/N 126, 167, 291, 360

Strip Recorders - Gould, Model 220
S/N 08343, 3018

Gulton, Model Tr. 722
SN-71147, 8082502, 2091002
Astro, Model Dash II
S/N-1A335

Transducers	Size	S/N	MHZ
Harisonic	1/4"x1/4"	R12347	5.0
Harisonic	1/4"	V10600	5.0
Harisonic	1/2"x1/2"	T7463	2.25
Harisonic	1/4"x1/4"	R12200	2.25
Harisonic	1/4"x1/4"	R941	5.0
Harisonic	1/4"x1/4"	P6104	5.0
Harisonic	1/4"x1/4"	R9167	5.0
Harisonic	1/4"x1/4"	V12539	5.0
Harisonic	Special	V12538	5.0

No items of noncompliance or deviations were identified.

5. Personnel Qualification and Certification

The following licensee and contract NDE examination personnel records were reviewed by the inspector for conformance to referenced codes and standards.

Northern States Power (NSP)

Name	UT	MT	PT	VT
M. T. Anderson	I			
R. J. Coleman	I			
L. C. Dahlman	II	III	III	

Lambert MacGill & Thomas (LMT)

Name	UT	MT	PT	VT
M. W. Blew	II	II	II	II
R. M. Cappell	I	II		
A. J. Harry	I			
K. M. King	II		II	II
R. W. Pachacek	II	II	II	II
R. A. Seals	II		II	II

Welder Qualifications

The inspector examined the qualification records of six NSP welders who performed welding on the safety injection system. All were found to be qualified in accordance with ASME Code Section IX, and had welded on a shop mock-up prior to welding on the SI system piping.

No items of noncompliance or deviations were identified.

6. Observation of Examination & Repair Activities

The inspector witnessed inprogress NDE examinations being performed by LMT and repair welding of identified cracks. All activities were being performed in accordance with the approved procedures and repair program.

Following all repair welding and nondestructive examinations the SI system was flushed at 150 PSI to remove solids and chloride buildup, followed by a hydrostatic test of the system at 1.5 times the design pressure (315 PSI), held for 35 minutes. All welds in the BAST suction were examined and witnessed by the ANI.

No items of noncompliance or deviations were identified.

7. Documentation Review, Unit 1

The inspector reviewed documentation on the following weld repairs to the SI system suction piping:

Work Request No. G0722-SI-Q
Weld No. 53-G0722
Drawing No. XH-106-89

Work Request No. G0732-SI-Q
Weld No. 64-G0655-1

Work Request No. G0742-SI-Q
Weld No. 85-G0742

Work Request No. G0650-1-2
Weld No. 62A

Work Request No. GO 721-1-1-3-4
Weld No. 279

Work Request No. GO 651-1
Weld No. 63A

Work Request No. GO 719-1-2-3-4
Weld No. 72

No items of noncompliance or deviations were identified.

8. Documentation Review, Unit 2

Following the licensee's repair of through wall leaks and ultrasonic examination indications in the Unit 1 safety injection system, ultrasonic examination of all accessable welds in the Unit 2 safety injection system was performed using the same equipment, procedures, and personnel as were used on Unit 1.

The results of the Unit 2 examinations revealed no thru wall leakage. Some spot ultrasonic indications were observed, however, none of the indications required repair.

During the licensee's presentation of their repair program for Unit 1, to the NRC staff, the licensee also committed to the replacement of piping in the Unit 2 safety injection system at a future outage.

The inspector reviewed the ultrasonic examination documentation listed below as well as strip chart recordings of Unit 2 examinations of the safety injection system.

- UT Report No. 83A-001, Calibration Report No. GJS-11 ISO-2-ISI-66, Revision 1, Calibration Block No. 30, Weld No. 60, 12".

- UT Report No. 83A-002, Calibration Report No. GJS-11, Weld No. 59, Block No. 30.

- UT Report No. 83A-003, Calibration Report No. RDB-11, ISO-2-ISI-74, Revision 1, Block No. 30, Weld No. 45.

- UT Report No. 83A-004, Calibration Report No. RDB-11, Weld No. 42, Block No. 30.

- UT Report No. 83A-005, Calibration Report No. RDB-11, Weld No. 41, Spot indication, SCAN 4

- UT Report No. 83A-008, Calibration Report No. RDB-11, Weld No. 273.

- UT Report No. 83A-010, Calibration Report No. RDB-11, Weld No. 276.

- UT Report No 83A-11, Calibration Report RAS-13, Weld No. 38.

- UT Report No. 83A-016, Calibration Report No. GJS-11, Weld No. 47, Block No. 33.

- UT Report No. 83A-018, Calibration Report No. GJS-11, ISO-2-ISI-61, Revision 1, Weld No. 45, liner indication, SCAN 5.

- UT Report No. 83A-022, Calibration Report No. RDB-12, Weld No. 73, liner indication, SCAN 3 & 4.

- UT Report No. 83A-031, Calibration Report No. GJS-12, ISO-2-ISI-66, Revision 1, Weld No. 61.

- UT Report No. 83A-038, Calibration Report No. RAS-15, Weld No. 292.

- UT Report No. 83A-049, Calibration Report No. RDB-14, Weld No. 275.

- UT Report No. 83A-050, Calibration Report No. RDB-14, Weld No. 294.

- UT Report No. 83A-055, Calibration Report No. GJS-14, Weld No. 57.

- UT Report No. 83A-062, Calibration Report No. RDB-15, Weld No. 290, Spot indications SCANS, 2-3-4.

- UT Report No. 83A-066, Calibration Report No. RDB-15, Weld No. 2, Spot indications SCANS 2-3-4.

- UT Report No. 83A-075, Calibration Report No. CEB-01, Weld No. 31.

- UT Report No. 83A-094, Calibration Report No. CEB-02, Weld No. 81.

- UT Report No. 83A-103, Calibration Report No. GJS-17, Weld No. 29W, Spot Indications, SCANS, 2-3-4.

- UT Report No. 83A-111, Calibration Report No. CEB-04, Weld No. 290.

- UT Report No. 83A-153, Calibration Report No. CEB-05, Weld No. 42.

- UT Report No. 83A-160, Calibration Report No. GJS-19, Weld No. Liner indication Scans, 1 & 2.

No items of noncompliance or deviations were identified.

Exit Interview

The inspectors met with licensee representatives (denoted in Persons Contacted Section) at the conclusion of the inspection on February 10, and March 30, 1983. The scope of the inspections and activities presented to the NRC staff on February 8, 1983 in Bethesda, MD were discussed.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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Docket Nos. 50-282
and 50-306

LICENSEE: Northern States Power Company

FACILITY: Prairie Island Unit Nos. 1&2

On February 8, 1983, the NRC staff met with Northern States Power Company (the licensee) in Bethesda, Maryland to resolve the issue of the crack indications found in the concentrated boric acid line connecting the boric acid storage tanks to the safety injection system (SIS) of Prairie Island Nuclear Generating Plant Unit No. 1. The licensee on Friday, January 28, 1983, declared the safety injection system inoperable because of these crack indications and Unit No. 1 was manually shut down. The purpose of this meeting was to show the basis for declaring the concentrate boric acid line operable and thus permit the restart of the Prairie Island Unit 1. A list of attendees is attached (Attachment 1).

The meeting opened with presentation of the agenda (Attachment 2). The following areas were discussed:

1. Plant Condition, System Function & Component Failure
2. Examination of the Defective Pipe
3. Fracture Mechanics
4. Analysis of Pipe Sample
5. Repairs
6. Evaluation for Operability

1. Plant Condition, System function & Component Failure

Several crack indications were found in the weld areas of the concentrated boric acid supply line that connects the 600 gallon storage tanks to the safety injection system. During normal plant operations this line contained 12% stagnant boric acid. The boric acid line is approximately 214 ft long, 8 inches in diameter, schedule 10 (~0.148 in. thick), 304SS and contains 77 welds. This line is normally under low pressure (~ 10PSI) and is heat traced to 180°F.

Unit No. 1 was manually shut down on January 28, 1983 when the line was declared inoperable. The concentrated boric acid system is used only to limit the return to power of the reactor during the rapid heat removal from the reactor cooling system during a large steam line break. Such an accident requiring the concentrated boric acid also assumes that the most active shut off rod has not entered the core, the accident occurs near the end of core life and one of the safety injection pumps is inoperable.

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A tiny through wall crack was found in a weld area of the line that was reported to the staff in LER 82-029/0IT-0. Subsequent investigations led to the discovery of other leaks and crack indication when all of the weld areas were examined by ultrasonic testing. The cracks were located in the annealed base metal of the heat affected zone that did not show a significant degree of sensitization.

The licensee observed crack indications only in stagnant lines. However the licensee found no crack indications in the boric acid storage tank or in other lines having more frequent circulation. Nominal amounts of contaminants can be concentrated in stagnant lines by evaporation due to excessive heating and settling effects. In addition, air bubbles can collect in these oxygenated lines. This suggests that stagnation is a major factor in this cracking.

2. Examination of Pipe Welds.

The licensee examined all of the welds (total of 77) in the 8 inch boric acid line utilizing ultrasonic techniques. The basic pulse-echo procedures were used in accordance with Appendix III of ASME Section XI 1974 Edition thru the summer 1976 addenda. The inspection team consisted of personnel certified in accordance with ANSI-TC-1A levels I & II. The results of this examination revealed that 16 welds (20.8% of total weld) had intermittent circumferential indications and 3 welds (3.9% of total) contained spot/axial indications. The licensee stated the ultrasonic techniques employed provided conservative and adequate capabilities for detecting stress corrosion cracks in this system. Based on the presentation given by the licensee and our review of the licensee's submittal on this matter, we agree that the use of ultrasonic techniques as described by the licensee provides reasonable assurance that all stress corrosion cracks in the weld areas have been identified.

3. Fracture Mechanics

The licensee performed a flaw evaluation to determine the maximum crack size in the weld areas that would reduce the margin of safety below the code allowable stress levels. The pipe conditions and loads that were used in the analysis consisted of the following:

Temperature $\leq 250^{o}F$

pressure $\sim$ 10 PSI

pipe loads $\sim$ 1/3 of allowable

The analysis presumed thru wall circumferential cracks in locations where there would be the worst case membrane or bending stresses. The results of the analysis performed in two locations showed allowable flaw lengths of 10 and 12 inches when subjected to stress levels of 6900 and 5000 PSI respectively. Based on this analysis the licensee concluded that the observed cracks in the weld area do not reduce the load carrying margins of safety below the Code Allowable stress levels. The staff agrees with this assessment.

4. Analysis of the Pipe Sample

The licensee removed a section of pipe and requested Westinghouse to perform a metallurgical examination of the crack indications. The scope of work consisted of surface, metallographic and fractographic examinations and a chemistry evaluation. This examination revealed the nature of the leak and crack indications to be transgranular stress corrosion cracking (TGSCC). TGSCC is caused by synergistic effects of contaminants (i.e., chlorides, sulfates and flourides), operating stress and residual tensile stresses introduced by welding and grinding. The chemistry evaluation showed the contaminants as 79 to 110 PPM chlorides, 114 to 204 PPM sulfates and 10 to 84 PPM flourides. The sulfates levels and to some degree the chlorides levels are high enough to attack the 304SS when combined with high residual stress levels and the tensile stress caused by cold work and grinding at the weld areas. Two possible sources of these contaminants are: contaminated batch of boric acid or the concentration of contaminants due to resin intrusion in the recycling system. The metallographic surface examinations indicated grinding and deformation adjacent to the welds which,in the presence of the contaminants, provides initiation sites and creates stress slip bands which are preferentially attacked by the stress corrosion cracking mechanism.

The major stresses in this system are the welding residual stresses. This, combined with the cold work introduced during installation and grinding at welds, suggests that piping adjacent to welds is the first area to be attacked. Therefore, piping adjacent to welds is likely to be the only area attacked by TGSCC that approaches an extent which could reduce the design safety factor of the line.

5. Repairs

All nineteen weld joints showing crack indications (as identified by ultrasonic examinations) were reinforced with reinforcing pads or sleeves. The design of the pads or sleeves is similar to reinforcement required for fabricated branch connections in ANSI B.31.1 Power Piping. The reinforcement sleeves and pads were installed around the pipe covering the crack indication areas and were fillet welded to the pipe. In addition sections of pipe removed for analysis are replaced with sections designed in accordance with ANSI B.31.1 code. The repairs and welding were conducted in accordance with ASME Code Section XI 1980 Edition with addenda thru the Summer 1982. The completed fillet welds were inspected by liquid penetrant techniques. Butt welds were inspected by radiographic and liquid penetrant techniques. Inspection methods and criteria were in accordance with the ASME Code Section XI 1974 Edition with addenda thru the summer of 1976. Finally the repaired system was hydrostatically tested to 1.5 times the design pressure.

6. Evaluation for Operability

The staff concurs with the licensee's finding that the concentrated boric acid line has been restored to an operable status. The basis for this conclusion is as follows:

1. The licensee has demonstrated with a reasonable degree of confidence that all crack indications have been identified.

2. The pipe repairs at 19 locations, as described by the licensee, assure that the pipe line is restored to its original design strength.

3. Flushing operations prior to returning the line to service, showed a decrease in the dissolved contaminants in the water samples after several flushes.

4. To ensure that the line will not be subject to future stress corrosion cracking the licensee committed to the following;

   (a) The boric acid will normally be recirculated (90% of the time) thus preventing contaminants from concentrating in an otherwise stagnant line.

   (b) Contaminants (i.e., chlorides, sulfates) will be more closely monitored with the addition of a new analytical chemistry technique (ion-exchange chromatography) having a 10 PPB detection limit.

5. The licensee has committed to replace the line on Unit 1 prior to the start up of cycle 10 (January 1985). In the interim the licensee committed to conduct monthly visual inspections of the line and to ultrasonically examine 10 welds every six months.

6. The ultrasonic examination of the concentrated boric acid line servicing Unit 2 revealed no crack indications. However, the licensee committed to the provisions of item 4 above and to conduct monthly visual inspections.

The licensee has demonstrated the operability of the concentrated boric acid system. Therefore the Prairie Island Nuclear Generating Plant Unit No. 1 can safely resume power operation.

Dominic C. DiIanni
Project Manager
Operating Reactors Branch #3
Division of Licensing

MEETING SUMMARY DISTRIBUTION

Licensee: Northern States Power Company

*Copies also sent to those people on service (cc) list for subject plant(s).

Docket File
NRC PDR
L PDR
NSIC
ORB#3 Rdg
ORB#3 Summary File
JHeltemes
BGrimes
RAClark
Project Manager
PMKreutzer
OELD
ELJordan
JMTaylor
ACRS-10
NRC Participants

PRAIRIE ISLAND UNIT NO. 1

BORIC ACID LINE CRACK INDICATION

FEBRUARY 8, 1983 MEETING

Attendees

Dominic DiIanni - PM NRR

C. Y. Cheng	MTEB/NRR	P. C. Riccardella	NUTECH
W. J. Collins	IE/NRR	Gary Miller	NSP
W. S. Hazelton	MTEB/NRR	Barry L. Dickerson	Fluor Eng., In
B. D. Liaw	MTEB/DE/NRR	Greg Krause	NSP
W. J. Shack	Argonne National Lab.	Michael T. Anderson	NSP
Conrad McCracken	CMEB/DE/NRR	Paul Wu	CMEB/NRR
Tom Parker	NSP	Ed Watel	NSP
R. A. Clark	ORB#3/NRR	C. W. Rowland	Westinghouse
W. J. Key	Reg. III-NRC Reactor Inspector	Lee Spessard	Reg. III
D. H. Danielson	Reg. III	J. T. Crane	Westinghouse
Gutti Rao	Westinghouse		

PRAIRIE ISLAND - NRC MEETING

FEBRUARY 8, 1983

BORIC ACID LINE CRACKING

I. INTRODUCTION

ED WATZL - NSP - PRAIRIE ISLAND PLANT MANAGER
TOM PARKER - NSP - LICENSING ENGINEER

A. DESCRIPTION AND FUNCTION OF SYSTEM
B. HISTORY

II. EXAMINATION OF PIPE

MIKE ANDERSON - NSP - MATERIAL AND SPECIAL PROCESS ENGINEER

A. TECHNIQUE
B. RESULTS
C. CONCLUSIONS

III. FRACTURE MECHANICS

DR. PETE RICCARDELLA - NUTECH - SR. ENGINEERING DIRECTOR
DAVE PITCAIRN - NUTECH - ENGINEERING DIRECTOR, MATERIALS

A. METHOD
B. CRITICAL CRACK SIZE

IV. ANALYSIS OF PIPE SAMPLE

DR. GUTTI RAO - WESTINGHOUSE - SENIOR ENGINEER
JOHN CRANE - WESTINGHOUSE - SENIOR ENGINEER
CHUCK ROLAND - WESTINGHOUSE - PROJECT ENGINEER

A. TYPE OF CRACKING
B. EXTENT OF CRACKING
C. CONTAINMENT

V. REPAIRS

GARY MILLER - NSP - PRAIRIE ISLAND SUPERINTENDENT
OPERATIONAL ENGINEERING

GREG KRAUSE - NSP - MATERIALS AND SPECIAL PROCESSES ENGINEER
BARRY DICKERSON - FLUOR - PRINCIPLE MECHANICAL ENGINEER

A. DESIGN
B. SPECIFIC APPLICATIONS
C. MATERIAL, PROCEDURES, ETC.

VI. OPERABILITY

ED WATZL - NSP - PRAIRIE ISLAND PLANT MANAGER

A. SUMMARY
B. SURVEILLANCE

FACILITY/LICENSEE	NOTIFICATION	ITEM OR EVENT	REGIONAL ACTION
DIVISION OF PROJECT & RESIDENT PROGRAMS			
PRAIRIE ISLAND 2	TELEPHONE-09/23/83 FROM RI	DURING THE CURRENT DURATION REFUELING OUTAGE, THE LICENSEE DISCOVERED THAT A 1 1/2 INCH ANCHORING BOLT FOR THE MAIN FEEDWATER PIPE RESTRAINT SUPPORT PLATE HAD SHEARED OFF. THE LICENSEE IS INVESTIGATING THE CAUSE OF THE FAILURE AND DEVELOPING A REPAIR PROGRAM. THE LICENSEE PLANS TO INSPECT THE REMAINING ANCHOR BOLTS.	FOLLOWUP PER MC 2515.
		THE LICENSEE HAS ALSO DISCOVERED A THROUGH WALL CRACK IN THE BORIC ACID SAFETY INJECTION LINE. THE CRACK IS TRANSVERSE AND IS LOCATED IN A PIPE TO VALVE BODY WELD. THE AFFECTED WELD HAS BEEN ULTRASONICALLY EXAMINED AND SIX SIMILAR PIPE TO VALVE BODY WELDS WILL BE EXAMINED. THE LICENSEE ALSO PLANS TO VISUALLY EXAMINE 24 WELDS ON THE BORIC ACID LINE.	same problem as occurred on unit 1 - this presents no safety problem per se! But raises potential for other systems containment pathways through various pathways. S. Hendrickson is preparing info notice & subject w/a
FERMI 2	TELECON-9/26/83 FROM RI	DURING PREOPERATIONAL TESTING OF THE RHR SYSTEM, HYDRAULIC TURBULENCE CAUSED A NUMBER OF CONTROL ROD DRIVE GUIDES TO LIFT SOME WERE WEDGED WITHIN THEIR CONTAINERS. THE LICENSEE HAS PULLED ALL GUIDES AND TEN CONTROL RODS FOR INSPECTION; ONE ROD APPEARS TO BE BENT. GENERAL ELECTRIC PERSONNEL ARE AT THE SITE TODAY FOR INSPECTION OF THE GUIDES AND RODS.	FOLLOWUP PER MC 2513.
FERMI 2	TELECON-9/26/83 FROM RI	DETROIT EDISON ANNOUNCED THAT AN IMPO TEAM WILL ARRIVE AT FERMI 2 TODAY FOR ITS ANNUAL INSPECTION. THE INSPECTION IS SCHEDULED FOR FOUR WEEKS.	SRI WILL FOLLOW.