Duke Power®
A Duke Energy Company

GARY R. PETERSON
Vice President
McGuire Nuclear Station

Duke Power
MG01VP / 12700 Hagers Ferry Road
Huntersville, NC 28078-9340

704 875 5333
704 875 4809 fax
grpeters@duke-energy.com

April 2, 2004

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: McGuire Nuclear Station, Unit 2
Docket No. 50-370
Relief Request 04-MN-001
Relief Request from Immediate Containment
Spray Piping ASME Code Repair

Pursuant to 10 CFR 50.55a(a)(3)(ii), Duke Energy Corporation (Duke) requests relief from the 1998 Edition, through the 2000 Addenda, ASME Section XI Code requirement as stipulated in Paragraph IWC-3122.2 on the basis that the requirement imposes a hardship without a compensating level of quality and safety. Accordingly, please find attached Relief Request 04-MN-001. This relief request is being submitted as a result of through-wall flaws being detected in Containment Spray (NS system) stainless steel piping located in the Unit 2 Containment annulus. No similar flaw was detected in the Unit 1 NS system stainless steel piping.

The circumstances surrounding this relief request were discussed in a March 19, 2004 telephone conference call between representatives of Duke and Mssrs. Nakowski, Haag, Carroll, Lenahan, Chen and Olshan of the NRC. Duke is requesting that the NRC review and approve this relief request at your earliest convenience. Please direct questions pertaining to this request to Norman T. Simms of Regulatory Compliance at (704) 875-4685.

Sincerely,

for G. R. Peterson

Attachments

A047

xc w/attachments:

Mr. L. A. Reyes
US Nuclear Regulatory Commision, Region II
Atlanta Federal Center
61 Forsyth Street, SW, Suite 23T85
Atlanta, Georgia 30303

Mr. L. N. Olshan, McGuire Project Manager (addressee only)
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
One White Flint North, Mail Stop 08H12
11555 Rockville Pike
Rockville, MD 20852-2738

J. B. Brady
Senior NRC Resident Inspector
McGuire Nuclear Station

ATTACHMENT

RELIEF REQUEST NO. 04-MN-001

McGuire Nuclear Station – Unit 2

Relief Request Number 04-MN-001

Proposed Alternative
In Accordance with 10 CFR 50.55a (a)(3)(ii)

-- Hardship or Unusual Difficulty without a Compensating Increase in Level of Quality and Safety --

1. ASME Code Component(s) Affected
ASME Code, Class 2, Containment Spray (NS system) piping weld identification numbers NS2F521 and NS2F490. These welds are located on vertical runs of 8 inch diameter schedule 10 (i.e. 0.148 inch thick) stainless steel piping between the NS heat exchangers and the containment spray nozzles, after the last system isolation valve (there is a check valve and a manual isolation valve between each weld and the spray headers). The first weld is part of NS train 2A1 piping and the second is part of NS train 2B2 piping.

2. Applicable Code Edition and Addenda
ASME Section XI Code, 1998 Edition through the 2000 Addenda.

3. Applicable Code Requirement
ASME Section XI Code, subsection IWC, "Requirements for Class 2 Components of Light-Water Cooled Power Plants", subparagraph IWC-3122.2, "Acceptance by Repair/Replacement Activity".

4. Reason for Request
The two welds described in paragraph 1 above have through-wall flaws as evidenced by the visual discovery of boron deposits at the weld seams and the results of subsequent surface and volumetric examinations. Each weld had two deposits of boron, located on opposite sides of the weld seam circumference. The boron was removed and a visual inspection of the welds was performed. On weld NS2F521, a less than 5/16" long crack was observed on one side of the weld seam circumference while several pin-hole leaks were observed on the other side. On weld NS2F490, no surface cracks were observed. A boron deposit approximately 3/16" long was found on one side of the weld seam circumference while a smaller deposit was noticed on the other side.

   Because the piping is thin-walled, the welds could not be examined using ultrasonic methods to characterize the flaws so they were examined by radiography. The new radiographs were compared to the original construction radiographs; but there was no significant difference between the two radiographs to indicate the presence of a flaw. The weld exam results still passed the original construction code acceptance criteria.

   Performing a code repair of the weld flaws now would create a hardship for the utility based on the following concerns: 1) on-line running of welding equipment within the containment annulus in close proximity to cable routings creates an unknown risk of electromagnetic interference with operating plant electrical components/systems, 2) the repair effort will require removal of each containment spray system train from service but the repair work is not expected to be completed within the Technical Specification allowed 72-hour LCO, and 3) adverse component/system cycling affects related to a plant shutdown. Neither on-line or outage options are judged to be commensurate with the low severity nature of the identified flaws.

No compensating increase in the level of quality and safety would be gained by immediate repair of the welds. Engineering calculations and judgment provide the basis to state that the NS system piping from penetration number 2M370 (i.e. NS train 2A1) to the containment spray headers, the limiting case, is very robust and capable of performing its design function.

5. <u>Proposed Alternative and Basis for Use</u>
<u>Alternative</u>: Referencing ASME Section XI Code subparagraph IWC-3122.3, "Acceptance by Analytical Evaluation", Duke Power Company proposes to accept the as-found relevant conditions (i.e. through-wall flaws) for continued operation by the following two compensatory actions.

   1. Maintain the validity of the off-site dose analysis by monitoring boron accumulation to empirically determine changes in crack size and leakage rate. This action will be performed monthly.

   2. Maintain a water column in the pipe above each flawed weld to ensure containment integrity. A check to ensure water level is adequate will be performed monthly.

A code repair will be performed during the next refueling outage (EOC-16), which is scheduled to begin in first quarter 2005. If a condition leads to a forced outage of sufficient duration, the repairs will be performed during the unscheduled outage.

<u>Basis</u>: Please reference Attachment 1, "Operability Evaluation – Containment Spray Piping in Annulus" as the basis for considering the system operable and the basis for considering the system degraded/non conforming. This document presents the basis for use of the alternative.

6. <u>Duration of Proposed Alternative</u>
The proposed alternative will be used until the code repair of both NS system welds is performed during the next refueling outage or a forced outage of sufficient duration before the next refueling.

ATTACHMENT 1

Operability Evaluation - Containment Spray Piping in Annulus

Attachment 1

McGuire Nuclear Station – Unit 2
Relief Request Number 04-MN-001

Operability Evaluation – Containment Spray Piping in Annulus

1. Statement of Problem(s)

On Unit 2, two separate piping welds in ASME Section III Code Class 2 Containment Spray (NS) piping from the NS heat exchangers to the containment spray header have through wall leakage.

Weld #1: NS2F521 (located between valve 2NS-29A and 2NS-30, azimuth 225°, Elevation 775', radius 61')

Weld #2: NS2F490 (located between valve 2NS-15B and 2NS-16, azimuth 232°, Elevation 765', radius 61')

The leakage was discovered when boron deposits were visually noted at the two weld seams on the 8" diameter NS piping in UNIT-2 annulus. Each weld seam had two deposits of boron, one on each side of the weld seam. Weld #1, on NS Train 2A1, was noted with boron on 3/11/04, and Weld#2, on NS Train 2B2, was noted with boron on 3/12/04. The boron was removed and a visual inspection of the piping was performed by field technical support on 3/12/04. The results were two independent leak locations on each weld.

Weld #1: < 5/16" crack length on one side with several pin-hole leaks observed on the other.
Weld #2: no observable surface cracks. The boron on the surface of the piping was approximately 3/16" in length and less for the other boron deposit.

2. Relation to QA Condition

This evaluation is QA condition 1 because it serves as the basis for the qualification of a QA condition 1 structure, system or component.

3. Applicable Codes, Standards, Regulations

a. ASME Code Section XI, Division 1 (IWB-3514.3 and IWB-3523.3)
b. NRC Generic Letters 90-05 and 91-18.
c. USA Standard B31.7, Nuclear Power Piping (1-737 Leak Tests)

4. Evaluation Inputs/Methods Used

Leakage: The above conditions were evaluated using an EPRI-developed PICEP program to assess the leakage rate from the NS system to the Unit 2 annulus by Structural Integrity Associates (Attachment 2).

Flaw: Determined an allowable flaw size (including appropriate safety factor) as a function of applied stress using methods as described in ASME Code IWB-3641.2, appendix C, that ensures piping structural integrity.

Dose: Source Term as described in Regulation Guide 1.4. Radiological consequences of the design basis LOCA with unfiltered inleakage to the control room beyond that assumed in current design basis analysis have been analyzed (Ref, MCC-1227.00-00-0095). The calculated radiological consequences include offsite radiation doses and radiation doses to the control room. The limiting offsite radiation dose was found to be the thyroid radiation dose to the Exclusion Area Boundary (EAB). The limiting rate of NS leakage in the annulus was derived by an approximation of what leak rate would increase the EAB thyroid radiation dose to its acceptance criterion (300 Rem). The EAB thyroid dose was reviewed and adjusted as necessary. The margin between it and the acceptance criteria was identified. Finally, the rate of NS leakage into the annulus was approximated by comparison to the increase in ESF leakage in the Auxiliary Building associated with EAB thyroid radiation dose just within the acceptance criterion of 300 Rem. The details are reported in MCC-1227.00-00-0101 (Attachment 3).

VE Filter Efficiencies were modified in the dose computer code to account for multiple release points. The filter efficiencies used were 95% for elemental iodine and 80% for organic iodine.

5. Other Evaluation Criteria

Containment Spray System shall remove fission product iodine from a post-accident containment atmosphere, and reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following a loss of coolant accident and maintain them at acceptably low levels. Additionally, the piping serves as a pressure boundary to provide containment vessel integrity.

6. Applicable Licensing References

a. Applicable Technical Specification:

   3.6.1 Containment
   3.6.3 Containment Isolation Valves
   3.6.6 Containment Spray System
   5.5.3 Primary Coolant Sources Outside Containment

b. UFSAR Chapter 6.5

7. Assumptions*

a. LOCA pressure at the piping design pressure of 170 psig.
b. Temperature of the spray water of 190°F (Design Temperature out of NS heat exchangers is 117°F)
c. Smooth Fatigue Type Crack – Assumption used in the determination of leak rate from the crack; a fatigue type crack is conservative since it yields the highest flow rates.
d. Gravity Bending Moment with thermal effects of 5 ksi
e. Crack Length of 0.5 inches equivalent
f. During a LOCA, all iodine entrained in the leakage is assumed to be educted into the Annulus Ventilation (VE) System which filters it once and then either exhausts it or recirculates it.
g. Only the EAB radiation dose will be considered in deriving the limit of acceptable NS leak rate in the annulus of Unit 2 because the EAB thyroid radiation dose has the smallest relative margin to its acceptance criterion.

* a, b, c, and d are design data as documented in the stress analysis calculation (Ref. 8c) and have been verified.

8. References

a. MCFD-2563-01.00 Flow Diagram
b. MC-2414-19.20-01 Piping Layout
c. MCC-2206.02-83-2009 NS-203 Stress Analysis Calculation
d. Pipe Specifications: PS 151.2 (8" diameter Sch. 10 S/S Pipe Class-B)
e. PIP M-04-1262
f. PIP M-04-1294
g. MCC-1227.00-00-0094
h. MCC-1227.00-00-0095

9. Calculation/Evaluation

a. Determined the leak rate from each of the cracked welds.

a) Used the PICEP program (see Attachment 2 for calculation performed by Structural Integrity Associates) to determine the leak rate during a LOCA.

a. Using the assumptions listed, the leak rate was determined to be 0.005 GPM. Therefore, each suspect weld would conservatively pass 7.2 gallons in 24 hours during a LOCA.

b. If a crack were to grow to one inch in length, the leak rate would be 0.0497 per the SIA analysis.

b) Determined the leak rate during normal operations based on the leak rate during a LOCA, assumed at 170 psig.

a. The leak rate is proportional to the square root of pressure; therefore by multiplying 0.005 GPM by the square root of the ratio of normal operating pressure to 170 psig, the leakage rate from the welds during normal operations can be determined.

b. Determined normal operating pressures on the welds. Pressures during normal operation are determined by the static head of FWST level above the weld. The borated water inside the annulus piping is normally at FWST level due to gravity fill during quarterly cycling of the motor operated containment isolation valves. The elevation of the FWST surface ranges from the makeup level (482" indicated) and the high level (490" indicated). Therefore the elevation of the borated water in the tank will vary between 801.8 and 802.5 feet and the water level in the annulus containment spray piping will be at or slightly lower than that level. Weld #2 is the limiting case due to its lower elevation, therefore the pressure on this weld would be a head of (802.5 feet – 765 feet) or 37.5 feet, yielding 16.2 psig.

Pressures for suspect welds-

Weld	Design	Normal Power Operations
Weld#1	170 psig	11.6 – 11.9 psig
Weld#2	170 psig	15.9 – 16.2 psig

c. Calculated the leak rate during normal operations. The leak rate would then be reduced by a ratio of the square root of the differences in the pressure at the weld, approximately [square root (16.2/170)]*(0.005) = 0.0015 gpm. However, as the level in NS piping lowers, the weld would see less static head and the leak rate would decrease. For example, when the weld has five feet of head over the weld, it would see 2.17 psig, with a corresponding leak rate of 0.0006 GPM. This does not include any head loss for boron crystal accumulation at the surface of the weld.

Head(FT)	Leak Rate (GPM)
25	0.0013
20	0.0011
15	0.0010
10	0.0008
5	0.0006

b. Determined an acceptable leakage for offsite dose considerations. The analysis below is a summary of MCC-1227.00-00-0101 (Attachment 3). The limits for the control room dose, the low population zone, and the exclusion area boundary were evaluated against known leakage and doses to determine the acceptable leakage.

a) From the Operability Evaluation for Control Room Unfiltered In-leakage (MCC-1227.00-00-0095). The Exclusion Area Boundary (EAB) thyroid radiation dose is limiting. Control room radiation doses are controlled by lowering the stated limit of effectiveness of the Potassium Iodine (KI) program from the rate of control room unfiltered inleakage (QCRU) = 610 cfm to QCRU = 210 cfm.

EAB thyroid radiation dose for containment leakage (mqcru01) =73.93 Rem.

This calculation was performed with Annulus Ventilation (VE) filter efficiencies increased to account for the release points and control room exchange rate's (X/Q's) being different for upper compartment leakage to the annulus and upper compartment bypass leakage. Therefore, the thyroid radiation dose has to correspond to unadjusted VE filter efficiencies. An approximation is made by multiplying the EAB thyroid dose for containment leakage by a ratio of thyroid radiation doses for containment leakage with unadjusted VE filter efficiencies and adjusted VE filter efficiencies.

b) From MCC-1227.00-00-0094, the EAB thyroid radiation doses for containment leakage are:

EAB thyroid radiation dose for containment leakage and unadjusted VE filter efficiency =45.11 Rem.
EAB thyroid radiation dose for containment leakage and modified VE filter efficiency =45.06 Rem.
Adjusted EAB thyroid radiation dose for containment leakage=74.01 Rem.

c) The allowed increase in radiation dose from accommodating the NS leakage into the annulus was determined by taking the EAB target thyroid dose and subtracting the dose from ESF leakage and the adjusted EAB thyroid radiation dose.

EAB thyroid dose for ESF leakage = 85.11 Rem.
Target radiation dose (10 CFR 100 limit) =300.00 Rem.
Adjusted = Target – ESF leak – Containment leak
Therefore,
Containment Leak = Target – ESF Leak – Adjusted
Containment Leak = 300 – 85.11 – 74.01 = 140.88

d) ESF System leak rates have already been obtained (MCC-1227.00-00-0094) and are as follows:

EAB leak rate in the Auxiliary Building = 0.70 GPM.

e) Over the first 2 hours, 10% of the iodine in the ESF leakage in the Auxiliary Building becomes airborne. This iodine is filtered once by the VA System then released via the Unit Vent Stack. Therefore, the iodine partition fraction, f (partiodine), for 0-2 hr is 0.10.

f) Additional equivalent containment leak rate to the annulus is found by taking the ratio of the differential EAB thyroid radiation dose (140.88) to the ESF thyroid radiation dose (85.11) and applying it to the ESF leak rate (0.70 gpm) times the iodine partition fraction (0.10) for the first 2 hours (the time of the EAB radiation doses).

The limiting post accident leak rate from the NS System =Leak ESF * f(partiodine) * (Thyroid dose - EAB)/(Thyroid dose – from ESF leak)) = (0.70)*(0.10)*(140.88/85.11) = 0.116 GPM

g) In order to add conservatism, the limiting NS system post-accident leak rate into the annulus is divided by 2 to account for leak detection and measurement under conditions for normal unit operation vs. potential for higher leak rate under post accident conditions.

Therefore, the limiting NS leak rate in the annulus is 0.058 GPM or 3.48 GPH.

c. Determined containment integrity is supported. The NS 2A1 line is bounding the operability evaluation of the NS 2B2 line since the 2B2 line currently has only a small pin hole leak.

Based on engineering judgment the NS piping from penetration 2M370 (2A1 NS Line) to the containment spray headers is considered to be very robust and capable of performing its design function in spite of having 2 small linear indications on the 45 degree elbow at approximately elevation 775'.

This judgment is based on the following:

a) The piping is exceptionally well supported with numerous supports. Specifically, there are a series of two-way lateral supports spaced less than 10 feet apart as the piping climbs the reactor building wall.

b) The welds in question are TIG welds. This means that the weld material behaves the same as the base metal stainless steel. This is significant because stainless steel is a ductile material at the given temperatures. This means that piping would tend to behave elastically and resist fracturing.

c) Seismic qualification by inspection criteria (SQUG), although not specifically applicable to the McGuire plant, has shown welded piping to be very robust during actual seismic events unless certain factors are present. The most important of these factors are type of joint (i.e. screwed vs. welded) and differential building movement such that large seismic displacements stretch the piping between two buildings. Neither of these conditions are present in this area of NS system.

d) Radiographs of the "A" and "B" trains of the NS welds (NS2F490 and NS2F521) were made on 3/13/04. The radiographs were 360 degree shots of the entire welds. These radiographs were compared with the original radiographs from 1979. The comparison resulted in virtually identical radiographs with no changes. This demonstrates that the indications in the welds are extremely small.

e) The stress analysis has been reviewed and the stresses in this piping are below 50% of code allowables. Additionally, the code allowables have a significant amount of safety factor built in.

f) The design temperature and pressure of the piping is relatively low (190 degrees and 170 psi). Pressure and thermal stresses are therefore relatively low.

g) A fracture mechanics analysis has shown that if the pipe stress was at the faulted allowable, a crack of greater than 30% of the circumference would be required to lose structural integrity (Attachment 2).

h) Train A currently has two cracks and they are about 150 degrees to 180 degrees apart on the weld. This is judged to be less critical than a long single continuous crack since as one of them expands due to a moment, the other crack would absorb a compressive stress and pinch off leakage from the piping.

d. Determined that Containment Structure is satisfied - (TS 3.6.1 / TS 3.6.3) This function is satisfied by the condition of the containment isolation check valves downstream of the suspect welds and the column of water above the suspect welds within the NS piping. The single failure criterion is satisfied by showing that either condition will preserve containment integrity.

The containment spray penetrations are non-leak tested penetrations because of the closed system outside containment that is designed to remain intact following a design basis accident and that the system is in service during the accident. Both containment isolation valves on each penetration are fully credited as containment isolation valves without leak rate testing performance requirements consistent with 10CFR50 Appendix J Containment Leak Testing.

a) Although the inside containment isolation valve check valve is not subjected to leak rate testing, it has been inspected by sample disassembly under the IST program. The check valve internals are inspected and the valves are considered in like new condition (ref WO 98044204, completed 4/10/1999 on 2NS-30). 2NS-30 and 2NS-16 check valves have no wear because they only see service after an accident.

b) Additionally, while NS is in service, if a containment isolation check valve were to fail, the water seal in the riser would be sufficient to prevent containment atmosphere from leaking through the suspect weld for all postulated conditions of operation. As explained below, the approximate FWST level is established any time an outside containment isolation valve is stroked. The FWST head on the system normally prevents leakage of the water seal back toward the NS pump.

c) The water in the containment spray lines is prevented from leaking backflow by the containment spray discharge check valves, 2NS-161 and 2NS-163. The pump discharge check valves are Category A IST valves with a stringent leakage test designed to maintain a certain water column during intermittent containment spray operation. Thus, for normal operation and post accident, containment spray operation water inside the annulus piping is maintained. For the case of the pump failing to operate, the pump discharge check valve as well as the closed system outside containment isolation valve will prevent water from leaking toward the NS pumps. The following maintenance history demonstrates the integrity of these check valves.

   Maintenance History - 2NS-161, 2NS-163

2000-09-11	2NS-161 passed leak test (1 ml/min). 2NS-163 passed leak test (0 ml/min).
2002-05-21	WO: 98467246 / 2NS-163 passed leak test (5 ml/min).
2002-07-2	WO: 98461656 / 2NS-161 passed leak test.
2003-11-18	WO: 98579883 / 2NS-161 passed leak test (0.02 ml/min).
2003-12-30	WO: 98579884 / 2NS-163 passed leak test (10 ml/min).

d) Determined that the welds would remain covered with water during a LOCA. The NS 2A1 line is bounding since the suspect weld on the 2B2 line is at a lower elevation. The elevation of the containment check valve is 873 feet while the suspect weld on the 2A train is at the 775 feet elevation.

   i. Determined the amount of water the piping holds above the welds. The length of piping from the weld#1 to the containment check valves is 149'-7". The length of piping for weld#2 is 159'-7". The pipe's cross sectional area is 54.5 sq. in. Therefore, the piping above weld #1 would hold 423 gallons. Weld#2 would have more water in the piping over it, since it is at a lower elevation, but weld#1's volume is used since it is lower and more conservative.

   ii. Determined the time required for check valve and weld leakage to uncover the welds. Based on the a leak rate of 10ml/min (0.00264 gpm) from the NS Pump discharge check valves and a weld leak rate of 0.005 gpm, it would take 38.5 days to drain the 8 in Sch 10 piping to the elevation of weld#1, 775 feet elevation. Longer for the suspect 2B2 NS weld at the 765'elevation. Containment spray would be cycled at a frequency greater than once every month during a LOCA.

e) Determined that the welds would remain covered during normal operations.

   i. Determined the amount of water over weld#1. The piping rises vertically upward from each weld to 833 feet elevation, therefore the length of filled piping above the weld (775 feet elevation) is the elevation difference between the weld and the FWST level less an allowance for check valve resistance of three feet, 23.8 feet. Similar to the LOCA volume determination, the volume above the weld would be approximately 65 gallons.

ii. Determined that it would take approximately 76 days to drain the column of water 23.8 feet to the weld. Calculated this time by using calculus to account for the constantly changing leak rate as the column of water falls (see Appendix to Operability Evaluation).

iii. For the final height of the water column to equal one foot after 30 days, the initial height was calculated to be 8.6 feet. Therefore the water column should be verified at or above 783.6 feet elevation at a 30 day periodicity to maintain one foot or more of water column.

f) Validated that water seals are a sufficient barrier to prevent a breach of containment for containment integrity, TS 3.6.1, in the case of penetration M-221 (WL header to VUCDT). There is no prohibition for crediting water loop seals for performing a leak path blockage function under Generic Letter 91-18.

g) Thus the inside containment isolation check valve and the water column within the pipe above the suspect welds can each be credited with maintaining containment leakage within acceptance criteria required by the Containment Leakage Program.

10. Compensatory Actions Required For Operability

Compensatory Action #1: Maintain validity of offsite dose analysis by monitoring boron accumulation to empirically determine changes in crack size and leakage rate. Containment integrity is maintained operable as long as the leak rate for all cracks together is less than the allowable leakage rate of 0.058 gpm. The analysis from Structural Integrity Associates determined that a flaw size of one inch would leak at 0.0497 GPM. Leakage rate from the crack is roughly proportional to the accumulation of boron crystals; therefore a change in boron accumulation by a factor of 2 would be a precursor to a leak rate increase by a factor of nine. The acceptance criteria would provide notification of precursors to that leakage rate.

This compensatory action should be performed monthly to assure conditions do not change. A monthly timeframe is supported by the leak rate from the welds and the rate of boron accumulation at the welds. Additionally, the piping and crack see substantially less pressure (16 psig versus 125 psig) than it would during accident conditions thereby minimizing defect propagation.

Plant Condition: Modes 1-6 and No Mode
Specific Operator Action:

i. Measure width, length, and thickness of boron accumulation outside of piping. Measurement may be performed with a tape measure and should be accurate to +/- 0.25 inches. Determine average thickness to +/- 1/16" using depth gauge.

ii. Acceptance Criteria is less than or equal to 0.54in^3/month; i.e.

Width and Length	at an Average Thickness
< 2-3/8 inches	1/8"
< 3-1/4" Width	1/16"

Justification: With a defect size of 5/16 inch, the boron was found to grow at 0.27 in^3/month by observations at the piping. If the leak rate doubled, the build up of boron crystals would approximately double to 0.54 in^3/month. At an average depth of 1/8", the area of the boron would be 4.32 in^2. A circle of the same area would have a diameter of 2.35 inches or approx 2-3/8inches. The same method can be used for differing boron thicknesses on the pipe.

iii. Clean boron from piping.

Environmental conditions Expected: Typical Annulus Conditions
Scaffolding will be required to reach welds.
VT-2 Qualified Inspector and Engineering Personnel

Compensatory Action #2: Maintain water column above weld to ensure containment integrity. Periodicity of monthly to ensure boundary exists.

Plant Condition: Modes 1-6 and No Mode
Specific Operator Actions will be per a documented procedure:

i. UT NS Piping and verify water inside NS 2B2 and NS 2A1 lines at an elevation at or above 785 feet elevation.

ii. If UT does not detect water at or above 785 feet elevation, determine height of water column. Notify operations of water column height above the suspect weld in that line.

iii. If UT does not detect water in piping, cycle 2NS-29A for NS 2A1 Line and 2NS-15B for NS 2B2 line.

iv. Report results to system engineer.

Environmental conditions Expected: Typical Annulus Conditions
UT Qualified personnel (under SNT-TC-1A/CP-189)

11. Conclusions

Recommend that the NS System be considered Operable But Degraded/Non Conforming for all modes and conditions and fulfills its function as stated in the UFSAR and technical specifications.

The basis for considering the system operable is:

For dose considerations; the total leak rate from the cracks (0.010 gpm) is below the acceptance criteria (0.058 gpm).

For Containment Integrity; a water column above the suspect welds provides a backup to the containment isolation check valves.

For Containment Structure; a civil analysis determined the weld cracks do not challenge the containment penetration or piping.

The basis for considering the system degraded/non conforming is:

A loss in required quality: the margin for offsite dose has been reduced due to the additional NS leakage in the annulus.

The piping no longer meets the ASME Section XI Code which the plant has been licensed to. Specifically; IWB-3523.3(b) states that the depth of an allowable inservice flaw shall not exceed 12.5% of weld thickness; the length shall not exceed 75% of weld thickness. The two suspect welds have flaws that fully penetrate the welds.

If additional suspect welds are discovered or if an existing defect propagates to one inch in length (determined by failing to meet the acceptance criteria of the compensatory actions), then this operability evaluation should be reopened to further analyze operability. The one inch length was chosen based on meeting limits of dose and structural integrity. Based off of the Structural Integrity Associates calculation, a one inch flaw would yield a leak rate during a LOCA of 0.0497 GPM, below the 0.058 GPM limit as determined by the calculation from Radiological Engineering. The Structural Integrity Associates calculation determined a flaw would need to extend to 30% of pipe circumference before structural integrity would be jeopardized. Thirty percent of 8" NPS exceeds one inch so this criteria is also satisfied.

APPENDIX TO OPERABILITY EVALUATION

Determination of what the level above the weld would be such that the weld would be uncovered in 30 days.

Variables

dt *change in time*

dh *change in height of water above weld*

h_o *Initial Height*

h_f *Final Height*

$$Time = \frac{Volume}{Rate} \therefore \Delta Time = \frac{\Delta Volume}{Rate}$$

$$dt = \frac{\frac{2.83\ gallons}{ft - pipe} \times dh}{(0.005 gpm) \times \sqrt{\frac{h\,(0.43308 psi/ft)}{170 psig}}}$$

$$\int_{ho}^{hf} dt = \int_{h0}^{hf} \frac{2.83}{-2.52 \times 10^{-4} \sqrt{h}} dh \therefore Time_{hf-ho} = -11{,}213 \int_{h0}^{hf} \frac{1}{\sqrt{h}} dh = (-11{,}213)(2)\sqrt{h}\,\Big|_{ho}^{hf}$$

$$Time_{min} = (22{,}426)\left(\sqrt{h_O} - \sqrt{h_F}\right)$$

$$Time = (30 days)\left(\frac{24 hours}{day}\right)\left(\frac{60 \min}{hour}\right) = 43{,}200 \min$$

Set these equal to find h_O *with* $h_f = 0$ *in 30 days.*

$$43200 = (22{,}426)\left(\sqrt{h}_O - 0\right) \quad \therefore \quad h_O = 3.7 \text{ feet above weld}$$

Additionally, if the final height is desired to be 1 foot above the weld instead of zero after 30 days, the initial height is:

$$43{,}200 = (22{,}426)\left(\sqrt{h_O} - \sqrt{1}\right) \quad \therefore \quad h_O = 8.56 \text{ feet above weld}$$