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U. S. Nuclear Regulatory Commission
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Washington, D. C. 20555

Edwin I. Hatch Nuclear Plant - Unit 2
Inservice Inspection of Feedwater Sparger

Gentlemen:

During the Unit 2 Spring 1997 refueling outage, Southern Nuclear Operating Company (SNC) performed examinations of the reactor pressure vessel feedwater nozzle regions, feedwater spargers, and the feedwater sparger thermal sleeve. The initial examinations consisted of a remote in-vessel visual examination of the accessible portions of two feedwater sparger locations. As a result of the initial examinations, visual examinations were also performed for the accessible portions of the other feedwater sparger locations. While the feedwater spargers do not perform a safety-related function and are not classified as American Society of Mechanical Engineers (ASME) code components, examinations of the spargers are performed consistent with NUREG 0619 which is primarily concerned with cracking in the feedwater nozzle inner radius.

The initial examination identified indications associated with the 'A' feedwater sparger thermal sleeve to the tee weld and end bracket. The indications on the 'A' sparger thermal sleeve are located on the bottom of the pipe and are predominately axial in orientation. One of the indications is approximately four inches long and appears to traverse the sleeve to the tee weld. The indication on the end bracket is located on the tack weld of the nut to the end bracket at each of the two bolt locations. No additional indications were identified on the other three feedwater sparger locations. Previous inspections of spargers in 1989 and 1992 did not identify indications.

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The NUREG 0619 examinations also included external automated ultrasonic (UT) examinations of the 'A' and 'B' feedwater nozzles. The UT examination inspects the nozzle inner radius and bore regions. No indications involving the feedwater nozzles were identified. A visual inspection was also performed for the inner radius of the 'A' and 'B' feedwater nozzles with no indications identified.

The indications on the sparger and the bracket have been evaluated. The indication on the sparger would not compromise safety-related functions and the cracked tack welds on the end bracket would not adversely affect the function or structural integrity of the feedwater sparger. Consequently, operation for at least one cycle is acceptable. The enclosure provides SNC's evaluation of the examination results.

Should you have any questions in this regard, please contact this office.

Sincerely,

Lewis Sumner

H. L. Sumner, Jr.

JKB/eb

Enclosure: Inservice Inspection of Feedwater Sparger

cc: *Southern Nuclear Operating Company*
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Enclosure

Edwin I. Hatch Nuclear Plant
Inservice Inspection of Feedwater Sparger

Background

During the Unit 2 Spring 1997 refueling outage, Southern Nuclear Operating Company (SNC) performed inservice inspections of the reactor pressure vessel feedwater nozzle regions, feedwater sparger, and the feedwater sparger thermal sleeve. The examination consisted of a remote in-vessel visual examination of the accessible portion of the feedwater sparger locations near the nozzle regions. The technique and equipment is capable of resolving a 0.001 inch wire on a neutral gray background. The accessible area of the sparger comprised approximately 2/3 of the circumference. All four sparger locations were examined as described above during the refueling outage. Previous inspections of the spargers in 1989 and 1992 did not identify indications.

Additionally, external automated ultrasonic (UT) inspections of the 'A' and 'B' feedwater nozzles were performed to inspect the nozzle inner blend region. Also, a visual inspection was performed for the inner radius of the 'A' and 'B' feedwater nozzles.

Inspection Results

No indications were identified in the UT examinations of the feedwater nozzles. No indications were identified from the visual inspection of the 'A' feedwater nozzle inner radius.

Indications were identified on the 'A' feedwater sparger thermal sleeve to the weld and the 'A' feedwater sparger end bracket. The indications on the thermal sleeve to the end bracket are located on the bottom of the pipe and are predominately axial in orientation. One of the indications is approximately four inches long and appears to traverse the sleeve to the tee weld. The indications do no appear to be connected. A UT inspection of the indication was not performed due to the unavailability of a qualified technique and equipment for this application. Figure 1 provides the arrangement of the feedwater sparger and end bracket.

The indication on the sparger end bracket is located on the tack weld of the nut to the end bracket at each of the two bolt locations. The tack welds were cracked through the weld material and some displacement was observed. The tack welds of the nut to the end of the bolt and the tack welds for the bolt head to the end plate showed no indications. No indications on the feedwater sparger thermal sleeve to the tee weld or sparger end bracket were identified at the other three sparger locations.

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Inservice Inspection of Feedwater Sparger

Evaluation of Cracking Mechanism

There are two likely mechanisms of cracking: integranular stress corrosion cracking (IGSCC) and fatigue. Observation of the visual indications shows cracking with relatively straight segments going through the weld metal. This is not characteristic of IGSCC cracks, which are usually confined to the weld heat affected zone (HAZ). Also, the subject weld was solution annealed after welding. This leads to the conclusion that the indications are not IGSCC cracks. Fatigue is therefore the most likely mechanism. Fatigue cracking could be due to two potential causes; mechanical cyclic loading or thermal cycling. Cyclic loading is not considered the likely cause of fatigue cracking in this case for the following reasons:

1. Sparger internal pressure and hydraulic forces are very low as determined by both analysis and testing.

2. Sparger forces due to annulus flow is low and the sparger is supported on each end in such a manner that loads transmitted to the area of the indications would be negligible.

3. Cracking at the observed locations would be circumferentially oriented rather than axial if vibration of the sparger was the cause.

Thermal cycling is the most likely cause of fatigue cracking in this case. The thermal transient loads vary during plant operation, but the steady state normal operation temperature differentials between the feedwater and vessel temperatures are relatively low. During steady state operations, the flow in the feedwater spargers is at full flow and essentially no temperature fluctuations occur during this type of operation. Thus, thermal cycling during steady state operation is unlikely to have played a significant role in the observed cracking. However, during low flow operation such as during plant startup or hot standby, the temperature of the flow in the sparger and the flow rates are lower. Therefore, the temperature differences between the reactor water and the feedwater sparger flow are larger. If there is adequate mixing of the reactor water and the feedwater flow, this can set up temperature stratification. This could lead to thermal stresses due to the top-to-bottom temperature variations. Also, if the hot/cold interface changes, the region of the stratification can experience temperature cycles. Depending on the magnitude of the temperature induced stresses and the cyclic frequency, crack initiation can occur. Crack growth could continue due to the gross stresses from stratification, but can also self arrest if the driving forces are eliminated or not acting on the crack tip.

Evaluation of Concerns

1. Feedwater flow pattern changes

In the highly unlikely event that normal sparger flow was altered, the worst postulated effect would be an asymmetric power distribution in the core. In this case, it would be detected and corrective action would be taken by the operators in the control room.

2. RPV inner radius nozzle cracking

Leakage through the thermal sleeve could impinge on the inner radius or bore areas of the feedwater nozzle and cause thermal fatigue cracks. The feedwater sparger is not a safety related component. Therefore, cracking of the sparger in itself does not have any significant safety consequences. Cracking of the sparger is unlikely to lead to large leakage since the cracks are typically tight and the pressure difference which drives the leakage is small. The experience with slip fit spargers where leakage did occur is useful in evaluating the effect of leakage from the cracks in the sparger. Leakage from the slip fit spargers had no operational consequences. Leakage from the sparger cracking is expected to be less than that in the slip fit spargers. Therefore, the conclusion on the impact of leakage in slip fit spargers also applies to the sparger cracks.

Leakage from sparger cracks could cause thermal cycling in the blend radius and potentially cause cracking. However, the Hatch 2 feedwater nozzles have been inspected and no cracking has been observed. Even if one considers the potential thermal cycling, there are no safety consequences since the feedwater nozzle has been analyzed with a quarter inch crack and found to be acceptable.

3. Impact on other RPV internals

The sparger itself is non-safety and is not classified as an ASME code component, but is seismically supported, and the sparger and supports were visually inspected during this outage. There were no indications on either the sparger or sparger supports which were of any concern. Although the present indications do not support a total separation scenario, the sparger supports will support the sparger even if it is totally separated from the thermal sleeve at the crack location. Therefore, there would be no impact on other vessel components.

For the feedwater sparger end bracket, the observed tack weld cracking is typical of a fatigue crack since it cracked in the weld material and through the minimum thickness area. The two possible fatigue mechanisms are mechanical cyclic loading or thermal cycling. The location of the cracked tack weld is not in the immediate vicinity of the feedwater flow from the nozzles, but due to the turbulent mixing of feedwater flow from the sparger nozzles and downcomer flow from the steam separator, thermal fatigue cannot be ruled out. In comparison, the tack welds of the bolt head to the end plate are closer to the outboard sparger nozzle, but no indications were found at this location.

The other fatigue mechanism is mechanical cyclic loading. Due to the flow in the feedwater sparger, there is some vibration which the entire sparger experiences. For this bolted connection, the preload in the bolt would normally react to any vibration type loads. However, if the bolts had a very low preload, the tack welds could have been loaded. The fact that there has been some displacement at the crack interface suggests that fatigue loading of the tack weld is a potential cause. Also, the nut to end bracket which failed only has one tack weld; whereas, the corresponding location on the other side of the bolted connection (bolt head to end plate) has two welds which have no indications. Therefore, the failed location is the weakest structural location as compared to the other tack weld locations which all have two welds.

From the above either fatigue mechanism could have caused the cracked conditions, but the mechanical vibration fatigue cycling is the more likely cause.

Evaluation of Concerns

1. Disassembly of the end bracket

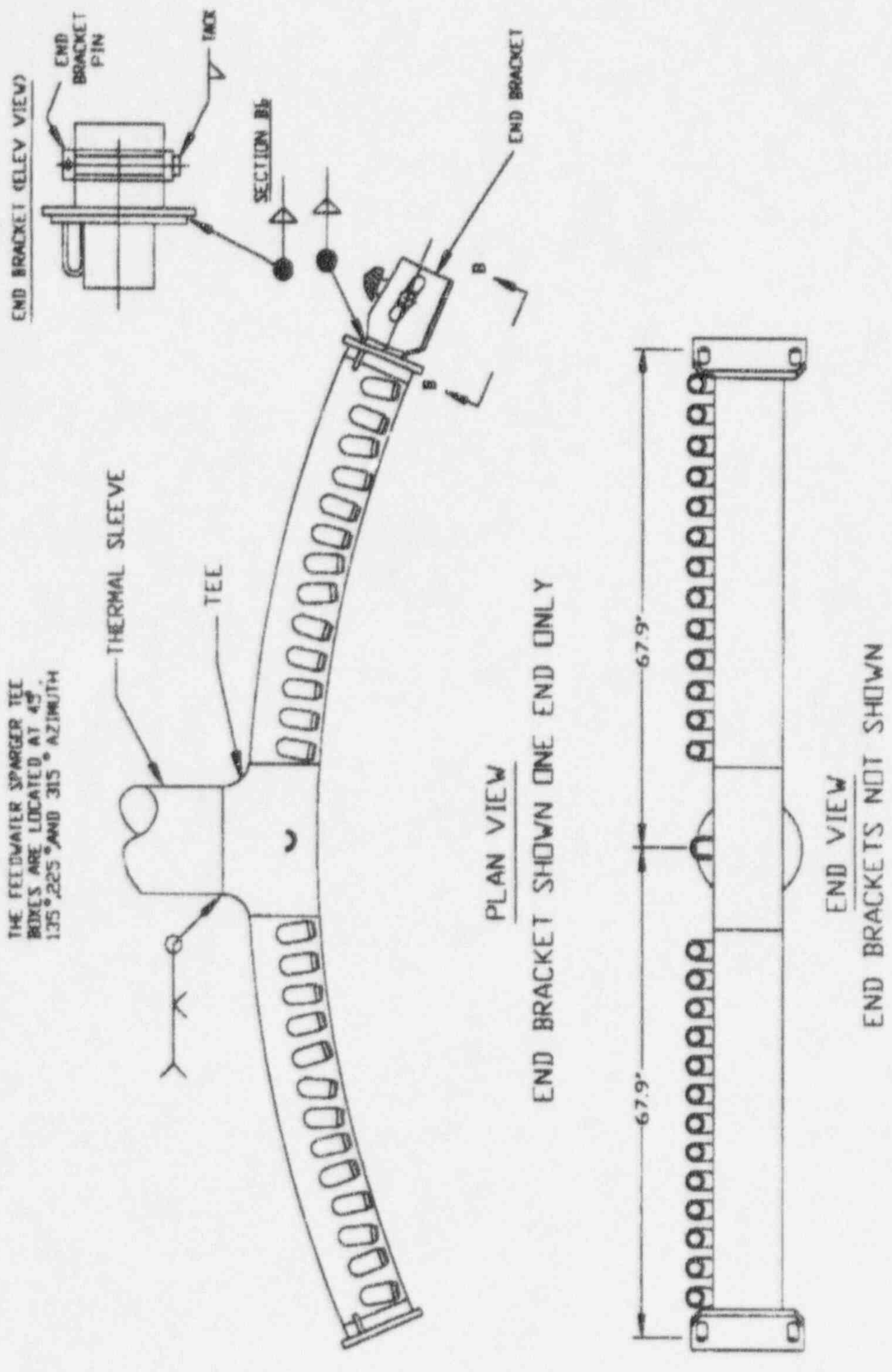
   The location of the cracked tack welds does not affect the function of the bolted connection to keep the assembly together. The tack welds on the nut to bolt end provided this function.

2. Movement of the end bracket

   The cracked tack welds do allow relative movement between the end plate and the end bracket, but the potential movement is limited to the clearances between the bolts and the bolt holes. The end plate is welded to the bracket with four 1/2 inch fillet welds, which would prevent any movement and eliminate any need for the bolts. The bolts were used as a fit-up aid during sparger installation and are not required to support the sparger. Any potential movement does not affect the function of the sparger, or affect the structural integrity of the sparger.

Conclusions

The feedwater spargers do not provide a safety-related function and are not classified as an ASME Code component. The leakage from the indications in the thermal sleeve to the tee weld would not result in an adverse affect to safety-related equipment. The presence of the cracked tack welds on the end bracket does not adversely affect the function or structural integrity of the feedwater sparger. Consequently, continued operation for at least one cycle is acceptable. SNC will perform additional inspections of the affected areas during the next Unit 2 refueling outage currently scheduled for Fall 1998.



END BRACKET (ELEV VIEW)
END BRACKET PIN
TACK
SECTION B-B
END BRACKET
B
B
THERMAL SLEEVE
TEE
THE FEEDWATER SPARGER TEE BOXES ARE LOCATED AT 45°, 135°, 225° AND 315° AZIMUTH
PLAN VIEW
END BRACKET SHOWN ONE END ONLY
67.9"
67.9"
END VIEW
END BRACKETS NOT SHOWN

FIGURE 1