Evaluation of the Acceptability of FDDR No. 1E6AR-FDDR-001 for the Shroud Repair Program at Quad Cities Unit 2

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Abstract

During the installation of the shroud repair hardware, pockets were cut in the shroud flange to accommodate the long upper supports. One of the pockets was cut too deep, and the cut went through the back of the shroud flange. This cut produced a steam bypass flow area. This document provides the evaluation of the disposition of FDDR Number 1E6AR-FDDR-001, which addresses this deviation for the shroud repair hardware installation at Quad Cities Unit 2.

Executive Summary

During the installation of the shroud repair hardware, pockets were cut in the shroud flange to accommodate the long upper supports. One of the pockets was cut too deep, and the cut went through the back of the shroud flange. This cut produced a steam bypass flow area. This document provides the evaluation of the disposition of FDDR Number 1E6AR-FDDR-001, which addresses this deviation for the shroud repair hardware installation at Quad Cities Unit 2.

The areas covered in this report are:

- Pressure forces on the long upper support
- Stresses in the shroud flange
- Bypass flow through the shroud flange
- Steam cutting / erosion
- IGSCC at fillet welds connecting the shroud flange and the steam dam

The result of this report is that the final disposition of the FDDR, "Accept-As-Is", is correct. Also, the report demonstrates that the fillet welds between the shroud flange and the steam dam do not need to be looked at for at least the next five years.

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1.0 Introduction

Shroud repair hardware was described and evaluated as summarized in the previously issued 10CFR50.59 Safety Evaluation (Reference 5.1). Installation of the shroud repair hardware at the Quad Cities Unit 2 plant requires that pockets be cut into the shroud flange in order to install the long upper supports
These pockets are cut at eight locations in the shroud flange. They are cut using the Electrical Discharge Machining (EDM) process. When the upper right hand position pocket at the 290 degree azimuth was being cut into the shroud flange, it was cut too deep, resulting in a burnthrough to the inside of the shroud flange
. The purpose of this report is to document the justification of the "Accept-As-Is" disposition of the FDDR

2.0 Description of Deviation

The pockets in the shroud flange are supposed to be EDM'ed into the shroud flange as described in the Installation Drawing, leaving 1/2" of the shroud flange material at the back of the pocket. Instead, the EDM process cut all the way through the back of the shroud flange. This burnthrough resulted in a hole at the back of the shroud flange that will allow the saturated steam-water leakage from the core upper plenum to the annulus between the shroud and the RPV. The hole also could potentially create a crevice between the back of the shroud flange and the steam dam. This area was not previously exposed to reactor water because the steam dam was welded to the shroud flange at both the top and bottom by a 1/4" fillet weld (See Drawing 718E861, Attachment 3). The burnthrough did not go through the steam dam nor did it destroy the integrity of the fillet welds themselves, but exposure of the space between the shroud flange and the steam dam to reactor water cannot be ruled out.

3.0 Areas of Concern

This report looks at the following areas to assure the acceptability of the "Accept-As-Is" disposition of the FDDR.

3.1 Pressure Force

3.2 Stresses in the Shroud Flange

A stress analysis was performed on the shroud utilizing the existing 180° shroud finite element model.

This stress is directly under the long upper support. The analysis utilized the bounding conservative loading condition of the maximum differential pressure under an MSLB combined with the asymmetric loads due to a recirculation line break and a design base earthquake. The stress analysis proved the acceptability of the stresses in the shroud, even with the notches going all the way through.

3.3 Bypass Flow Through the Shroud Flange

The current evaluation shows that a leakage path exists. The impact of leakage through the holes machined in the shroud support plate, as well as postulated leakage through the weld cracks (H1 through H8) and the replacement access hole covers, was previously evaluated (Reference 5.1).

The leakage paths result in additional leakage of about 0.21% of core flow at 100% rated power and 87 to 108% rated core flow. When combined with the leakage through the shroud support plate, the welds and the access hole covers (Reference 5.1), the total leakage is about 0.44% of core flow.

These leakage flows are predicted based on applicable loss coefficients and reactor internal pressure differences (RIPDs) across the applicable shroud components. Leakage bypasses the steam separators and dryers and is assumed to be two-phase fluid at the core exit quality. The steam portion of the leakage flows will contribute to increasing the total carryunder from the steam separators. Performance impacts of leakage flows were previously discussed in Reference 5.1. This discussion concluded that there is no impact on plant safety due to this evaluated leakage. The additional leakage impacts the performance results only for the steam separation system and the fuel cycle length as follows:

> Steam Separation System - The leakage flow above the top guide support ring includes steam flow, which effectively increases the total carryunder in the downcomer by a maximum of about 0.03% at 100% rated power and 87 to 108% rated core flow. The carryunder from the separators is based on the applicable separator test data at the lower limit of the operating water level range. The combined effective carryunder from the separators and from above the top guide support ring is about 0.18% and is bounded by the design value.
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> Fuel Cycle Length - The increased carryunder due to leakage flow above the top guide support ring results in a slight increase in the core inlet enthalpy, compared with the no-leakage condition. The combined impact of the reduced core inlet subcooling and the reduced core flow due to the leakage results in a minor effect (~0.8 days) on fuel cycle length and is considered negligible.

The conclusion of the leakage assessment is that there is no impact on plant safety due to the additional leakage through the pockets in the shroud flange.

3.4 Steam Cutting / Erosion

Because the velocities calculated above are relatively low compared to this, there will be no steam cutting or erosion.

3.5 Crevice Between Shroud Flange and Steam Dam

3.5.1 Purpose of the Steam Dam

The purpose of the steam dam is to create a water leg at the junction between the shroud flange and the shroud head flange. This water leg will keep the steam at this elevation away from the junction of the flanges. The steam dam is not a structural component as there is no pressure differential across it. Any loads are carried by the shroud flange and the shroud head flange.

3.5.2 Intergranular Stress Corrosion Cracking Assessment

3.5.3 Lost Parts

There is no concern at this time for SCC to cause the fillet welds between the steam dam and the shroud flange to fail and thus create any lost parts inside the reactor. Because the potential for SCC is very low, there is no need to look at these welds for at least five years.

4.0 Conclusion

The result of this study is that the Final Disposition of "Accept-As-Is", is correct. Also, it is felt that the susceptibility of the fillet welds connecting the steam dam to the shroud flange to IGSCC is too small to be of concern for at least five years.

5.0 References

5.1 10CFR50.59 Safety Evaluation, Mod M4-1&2-94-007, NEP 04-03 Attachment B.