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Design Report for Improved Shroud Repair Lower Support Latches

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REVISION STATUS SHEET

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IMPORTANT NOTICE REGARDING

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1.0 INTRODUCTION

The purpose of this report is to provide the results of an evaluation performed by GE regarding the redesign of the spring latch which holds the lower wedge in place and is part of the shroud repair assembly. The original function of the latch was to provide a locking feature for the lower wedge which is held onto the lower spring assembly. In the course of installing the lower wedge, the latch only experiences dead weight loads. During plant operation, the original latch was not designed to accommodate sliding of the lower wedge with respect to the lower spring assembly, since it was postulated that the lower wedge would slide on the vessel wall. Since sliding will occur at the wedge to lower spring interface when the lower wedge does not slide on the vessel wall, the redesign of the latch includes a flexible member which can accommodate vertical displacements which occur during plant operation. See Figure 4.1 for the configuration of the new latch.

2.0 SUMMARY

This report demonstrates that the new latch design is a significant improvement over the previous design, and that even under very conservative assumptions regarding the loading and displacement of the latch that no failure of the latch will occur in the next operating cycle. It is fully expected that the new latch will last for a significantly longer time based on a 8 to 12 factor of improvement which has been determined based on its ability to accommodate vertical movements. For the expected sliding case where the movement is always along the lower wedge/lower spring interface, the latch will last the remaining life of the plant. Therefore, based on the new latch improvements in combination with the installation change to remove looseness in the lower attachment to the shroud support, satisfactory shroud tie rod repair hardware performance is expected in the future.

3.0 EVALUATION

The following evaluations were performed using nominal conditions. In reviewing the issues associated with the latch failure phenomena, there are numerous variables such as friction factors, material properties, dimensional tolerances, reactor operating conditions, hardware installation details, equipment measurement accuracy, etc. Therefore, the use of nominal conditions is the most realistic approach to assess the redesign of the lower spring latch.

3.1 Plant Operating Conditions

The following paragraphs identify the plant operating conditions which cause loads to occur on the latch. The geometry of the hardware at the lower spring support of the shroud repair is shown in figure 1.1. Relative vertical movements between the tie rod components that could affect the loading on the new latch are described in sections 3.1.1 through 3.1.5. Section 3.3 will utilize the displacements defined in sections 3.1.1 through 3.1.5 to establish the maximum latch vertical deflections for the wedge sliding scenarios defined in section 3.2. The adequacy of the new latch to meet the required stress criteria is then demonstrated in section 4.0.

3.1.1 Hydrotest

4.3 Finite Element Model

A 2D plain stress finite element model was prepared for the latch and the Algor© linear static analysis software (Algor © Linear Stress Analysis - SSAP0H Rel. 15-FEB-95 Ver. 11.08-3H) was used to determine the latch stresses. Figure 4-1 contains a sketch of the model. Figure 4-2 contains stress contour plot of the Z-direction component stress. The plots show that at the maximum stress location, the stress is almost exclusively bending.

4.4 Comparison of Latch Designs

A 2D plain stress finite element analysis was also performed for the original latch. Figure 4-3 contains a sketch of the model for the original latch. Figure 4-4 contains a stress contour plot of the maximum stress location for the original latch for a 0.100" applied displacement. The calculated membrane + bending + peak stress was 772 ksi and the membrane + bending was approximately 400 ksi (using a linear elastic analysis). The original latch was much more highly stressed (by a factor of 8 to 12 times) than the new latch.

5.0 CONCLUSIONS

The new latch has been designed to accommodate larger vertical displacements while still maintaining its original function of locking the wedge to the lower spring structure. The stresses are within ASME code limits and the latch has been analyzed to be resistant to stress corrosion for a minimum of 2 years assuming conservative worst case displacements in the latch. It is fully expected that the latch will last for a significantly longer time based on the factor of improvement which has been demonstrated from the original design. For the expected sliding case where the movement is always along the lower wedge/lower spring interface, the latch will last the remaining life of the plant. Consistent with the inspection recommendations made for the original shroud repair hardware installation, it is recommended that the latches should be visually inspected after the next operating cycle. The condition of the latches and the position of the lower wedge should be evaluated based on a criteria which utilizes reactor temperature and pressure information from the operating cycle. As discussed in this report, some amount of displacement of the lower wedges can be expected which would be considered normal.

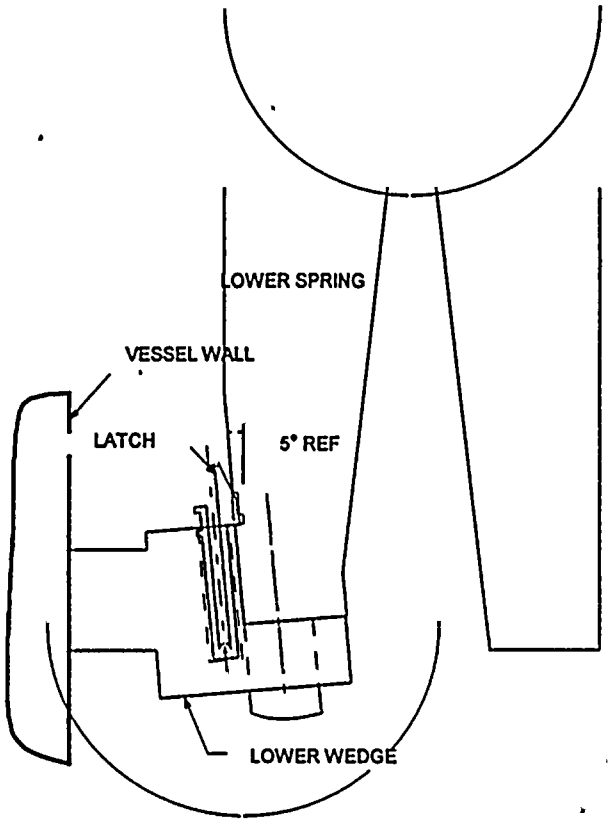

FIGURE 1.1 SHROUD REPAIR LOWER SUPPORT CONFIGURATION

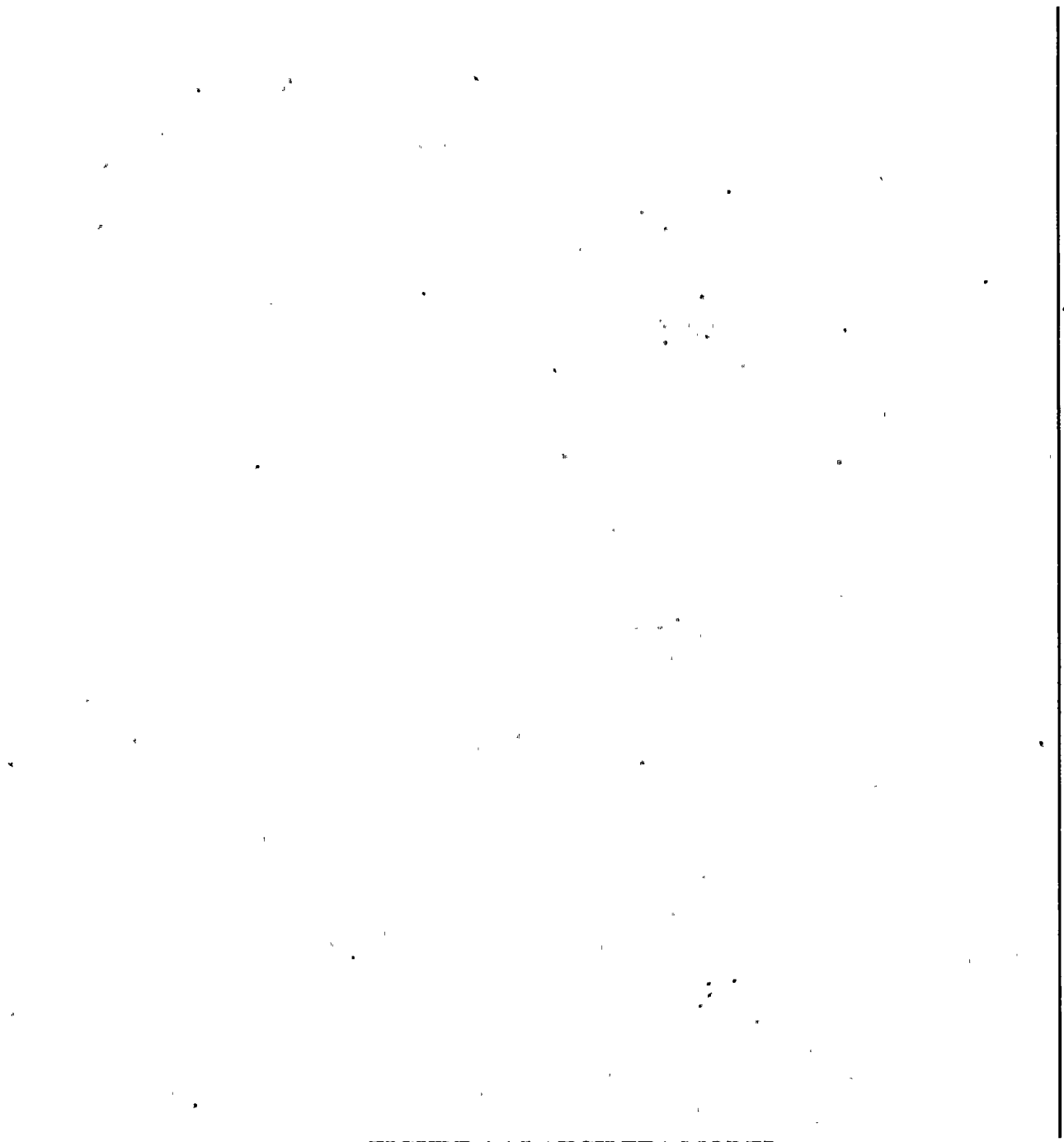

FIGURE 4-1 LATCH FEA MODEL

FIGURE 4-2 STRESS RESULTING FROM A 0.100" DISPLACEMENT

FIGURE 4-3 ORIGINAL LATCH FEA MODEL

FIGURE 4-4 ORIGINAL LATCH STRESSES

(MAXIMUM STRESS LOCATION)