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U. S. Nuclear Regulatory Commission
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Edwin I. Hatch Nuclear Plant
GenericLetter 96-06
Response to Request for Additional Information

Ladies and Gentlemen:

By letter dated January 17, 2003, Southern Nuclear Operating Company (SNC) provided a comparison of the calculation methodology used for Plant Hatch with the Electric Power Research Institute (EPRI) methodology for waterhammer analysis. On April 7, 2003, SNC responded to four additional questions based on a telephone conversation on February 19, 2003 with the NRC staff. On June 24, 2003, SNC provided additional information for an electronic message from the NRC staff dated May 13, 2003.

The enclosure to this letter provides a response to an electronic communication from the NRC staff on September 16, 2003. This letter contains no NRC commitments. If you have any questions, please advise.

Sincerely,

Lewis Sumner

H. L. Sumner, Jr.

HLS/WHC/daj

Enclosure: Hatch GL 96-06 Response to Request for Additional Information

cc: Southern Nuclear Operating Company
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Mr. S. D. Bloom, NRR Project Manager – Hatch
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NRC question regarding Hatch 1 and 2 GL 96-06 waterhammer analysis:

As stated in the 6-24-03 submittal, in analyzing the service water system for the waterhammer event, the licensee found that some piping supports exceeded allowable stresses. The licensee then removed the overloaded supports from the piping analysis model, and the subsequent analysis resulted in the remaining supports not exceeding the allowable stresses. The staff has identified issues regarding this analysis approach, since modeling the piping system without some supports, while actually leaving them in place, does not represent the actual configuration and may not be conservative. If the overloaded supports are actually loaded to complete failure (i.e., breaking), there would be a dynamic load transfer onto the remaining supports and piping, which is not adequately modeled using the licensee's method of simply removing the overloaded supports from the analysis. Particularly where there are one-way supports, the sudden application of loads could result in gaps, where none are predicted with the licensee's method. Provide a discussion regarding the configuration of the overloaded supports and the nature of the possible failure modes. Provide the margin in the adjacent supports and in the piping in sufficient detail to demonstrate that the remaining structure will not be overloaded.

Response:

Conclusion

The piping and support structural model recognizes that a large number of the supports are one-way supports, in that they support piping in the downward direction. A number of other supports are multi-directional that provides downward support, but only a small amount of lateral support or little upward support. Thus, the model was performed with all supports intact to determine the piping displacement and load on the supports and the piping. The model was then iterated, removing supports from the model which provided little or no resistance to the upward or lateral motion. The iteration of the model was designed to maximize the motion and stresses on the piping system and remaining supports. Where localized stresses existed at the interface between the support and the pipe, a localized stress review was performed, and it was determined that the piping stresses remained within allowable values in all cases. Except for two supports discussed below, none of the supports removed from the model failed in the primary support direction (downward). They were removed from the model because they provided little or no upward or lateral support. This allowed the piping to move with maximum displacement in the unrestrained directions, thus maximizing stresses on the piping and adjacent supports. This iteration of the model resulted in all remaining supports being within the allowable values for upward, downward, and lateral motion. Note that the piping motion is an oscillating (vibration) motion with very small displacements in any location along the piping system with and without supports removed. The nature of this motion and of the supports, even when removed from the model, is such that there would not be an inherent dynamic load transfer to the adjacent supports or piping. Thus, there are no gaps in the model.

Two supports exceeded allowable stresses. For one of these supports, on "A" train return piping, all adjacent supports remained within allowable stresses based on an evaluation of the individual upstream and downstream supports, both with supports in the model and supports removed from the model. For the second support, a ganged support on the "B" train supply and return piping, stress margins did not change significantly. Also, the supports and piping retain inherent flexibility when considered with the small displacements due to the postulated waterhammer. Again, the nature of this motion and of the supports, even when removed from the model, is such that there would not be an inherent dynamic load transfer to the adjacent supports or piping, and thus there are no gaps in the model.

Detailed Discussion

Piping supports which were removed from the model for the service water piping are divided into two categories. The first category is supports that had little or no uplift in the original design basis load combinations and had a significant uplift component in the water hammer load combinations. These supports either had no upward restraint capability or had clip angles welded to building steel that failed to meet allowables due to the increased upward load and were removed from the analysis. These supports make up the largest number of supports removed in the analytical models and are divided into 3 sub-categories discussed in more detail below. These supports were also demonstrated to meet allowables for the downward water hammer load combinations and retain some support function after the water hammer event. The second category is those supports that did not meet allowables and are considered not to provide any restraint function after the water hammer event. On train A there is one support in this category and on train B there is one gang hanger with 2 supply and 2 return restraint locations. These also are discussed in more detail below.

First Category

The majority of supports analytically removed from the analysis models are rod hangers, stanchions or pipe saddles. There are multiple variations of these support configurations and can be categorized by restraint function as either A) Vertical restraint (downward only), B) Vertical restraint (upward and downward), or C) lateral/vertical (upward and downward) restraint. These supports were removed due to the water hammer event causing high positive vertical loads in excess of the original design basis load combinations. In the case of downward only supports uplift from the support steel occurs and for supports with an upward vertical restraint capability the hold-down clip angles exceeded allowable stresses at the building steel attachment weld. These three support sub-categories are each treated differently and are discussed separately below.

Vertical Restraints (downward only)

This population of supports consists of rod hangers, stanchions welded to the pipe and resting on building steel (with a baseplate) and pipe saddles resting on support or building steel with no restraint at the top of the pipe. Downward only supports are fairly common for plants of Hatch's vintage, and in low seismic demand areas, and are used extensively on the Hatch service water piping. These supports have unrestricted lateral and upward vertical motion. In the original design basis load combinations, these supports had no uplifting component because the downward dead load at the support exceeded the other combined upward loads (including seismic). However, at some locations the water hammer loads introduced a significantly higher upward load and, through an iterative process, the restraints were removed from the analysis.

However, in all cases, these supports were qualified (including IWA's) for load combinations that included the downward water hammer loads and still remain functional after the water hammer event.

Vertical restraints (upward and downward)

These supports are stanchion type supports with clip angles welded to the containment structural steel with one leg of each clip angle overhanging the baseplate with a 1/16" top gap (or less). A larger lateral gap is provided to allow lateral pipe movement. These supports typically had a large downward load and a small uplifting load in the original design basis load combinations. The clip angle is welded along the axis of the angle which places the weld in weak axis bending when an uplift load is applied to the overhanging angle. These welds have a low capacity and were the limiting attribute for each of these type hangers. If the clip angle weld was overstressed, the support was removed from the analysis. Due to the flexibility of the weld and clip angle, catastrophic failure is not expected, only local yielding. However, these supports were qualified (including the IWA) for a downward load combination that included the downward water hammer load and still remain functional in the downward direction after the water hammer event.

Vertical (upward and downward) and lateral restraint

These supports are stanchion type supports with clip angles welded to the containment structural steel with one leg of each clip angle overhanging the baseplate with a 1/16" top gap (or less). Additionally, a 1/16" gap or smaller between the edge of the baseplate and edge of clip angles provide the lateral restraint. These supports act as a guide on the piping in the original design basis evaluations. Some of these supports had additional plate metal welded to the containment steel which provided restraint in the other lateral direction and made the support a 3-way restraint. The clip angle welds were again limiting due to stresses associated with the higher uplifting loads. If the clip angles weld was overstressed, the support was removed from the analysis, in both the vertical and lateral directions. Due to the flexibility of the weld and clip angle, catastrophic failure is not expected, only local yielding with lateral restraint likely not impacted. However, these supports were qualified (including the IWA) for downward load combinations that included the downward water hammer load and the pre-failure lateral load (to maximize IWA stresses) and still remain functional in the downward direction after the water hammer event.

As this population of supports are not considered active during the second run (providing no restraint, vertical or lateral in the system) the piping dynamic displacements during the water hammer event are maximized thereby maximizing pipe stresses and loads on the remaining supports. Additionally, due to support configurations with clip angles relying on weak axis weld yielding, the rapid load transfer concern is bounded by the support being totally removed. During all the support removal iterations required to achieve the final remaining support configuration, the pressure integrity of the piping was checked and determined to be well below code allowables (2.4Sh). While a non-linear finite element analysis may provide a more accurate representation of what may occur in the field, the method of analysis used was designed to maximize piping stresses and support loads and to bound the results expected of a non-linear analysis.

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Second Category

The containment cooling system consists of two parallel trains of piping and coolers, A and B. On each train there is one structure that does not meet allowable stresses and are considered not to provide any restraint function after the water hammer event. On train A there is one support in this category and on train B there is one gang hanger with 2 supply and 2 return restraint locations.

On the A train return piping, one vertical support on a riser exceeded allowable stresses and was removed from the analysis. The support is cantilevered to the containment structural steel, which is considered rigid, relative to the cantilevered support. Although the support is considered to fail (exceed allowable stresses), it would not be expected to fail completely by virtue of the flexibility inherent in the cantilever, and because of the minimal displacement of the piping in the vertical upward and downward directions (maximum of 0.011"). The load due to this failed support is thus transferred to the adjacent supports, all of which were retained in the model for the first and second runs. With respect to rapid transfer of load at the point of failure of the support, this would not be expected to occur because of the previously stated inherent flexibility of the support, and because the adjacent supports are in horizontal runs of the piping system and are sufficiently far enough away from the failed support that the inherent flexibility of the piping system would prevent overloading the adjacent supports and structure. The adjacent supports saw significant load increases with the riser support removed. On one side of the piping run is a vertical strut that meets allowables with an Interaction Ratio (IR) = 0.65, (or 35% margin). On the other is an in-line pipe anchor that saw an overall load decrease from the original design basis loads and was acceptable.

On the B train piping, one ganged support is considered to have failed. Four pipes are supported by this support, two supply (2 XYZ restraints) and two return (1 XY restraint and 1 Y only restraint) from the same containment cooler. The adjacent support in one direction for each of these pipes are the associated four containment cooler nozzles. The largest stress imparted in the nozzles with the support in the model is 2428 psi. With the support removed from the model, the largest stress is 2883 psi and remains well below the nozzle allowables of 12,000 psi ((12,000-2883)/12000 = 76% margin. The stresses in adjacent remaining supports in the other direction on the piping system are less than or only slightly above the original design stresses when modeled with the supports removed. Thus, original design margins are maintained. This is due to the piping system becoming more flexible with the failing support removed. In either case, the piping and supports have some inherent flexibility such that significant impact loading is not expected on adjacent piping and supports due to a rapid transfer of load and the point of failure of the support. .

This ganged support can be best described as two vertical steel columns with four cross members and multiple attachments to the containment building. Each cross member supports one of the horizontal pipes with the two supply locations restraining upward, downward, lateral, and axial movement and with one return location restraining upward, downward and lateral movement and the other restraining vertical movement only. The support has limited out of plane bracing with the primary contributor to exceeding allowables being the large axial load increases from the two supply lines. This support configuration provides inherent flexibility, that, although not specifically modeled in a simplified linear type analysis, would be expected to allow deflection and possible deformation of the support components without complete failure by breakage, due to small displacements of the piping in both the restrained (support in place) and unrestrained (support removed) configurations. This inherent feature would prevent the rapid transfer of loads as stated above and is more conservative for both the piping and adjacent support loads to consider the support removed. Additionally, water hammer loads from the four service water pipes were considered to occur concurrently when in actuality they all occurred at different time steps in the water hammer event. Consideration of the actual load sequence may have qualified the support but it was more conservative to actually consider the restraint functions removed at these locations.