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SUBJECT: Forwards results of linear elastic fracture mechanics analysis & ASTM A262 Practice E test (Strauss test) as addl info to 980416 request for amend to license NPF-21.

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U.S. Nuclear Regulatory Commission
Document Control Desk
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Gentlemen:

Subject: **WNP-2 OPERATING LICENSE NPF-21**
ADDITIONAL SUPPLEMENTARY INFORMATION REGARDING REQUEST FOR AMENDMENT: EMERGENCY CORE COOLING SYSTEM SUCTION STRAINERS

References:
1) Letter GO2-98-071 dated April 16, 1998, P.R. Bemis (Supply System) to NRC Document Control Desk, WNP-2 Operating License NPF-21 Request for Amendment: Emergency Core Cooling System Suction Strainers

2) Letter GO2- 98-077 dated April 28, 1998, D.W. Coleman (Supply System) to NRC Document Control Desk, Supplemental Information Regarding Request for Amendment: Emergency Core Cooling System Suction Strainers

Reference 1 requests a change to the WNP-2 Operating License allowing the newly designed Emergency Core Cooling System (ECCS) pump suction strainers to be fabricated from cold-worked austenitic stainless steel with a surface yield strength in excess of 90,000 psi. Reference 2 provided supplemental information subsequent to conversations with NRR staff C. Poslusny, J. Davis, and R. Hermann on April 20, 1998.

Further discussions with J. Davis identified the need to submit additional analysis concerning the subject amendment request (Reference 1). Results of a linear elastic fracture mechanics analysis and an ASTM A262 Practice E test (Strauss test) are included in Attachment 1 of this letter.

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Should you have any questions or desire additional information regarding this matter, please contact me or P. J. Inserra at (509) 377-4147.

Respectfully,

D.W. Coleman

D.W. Coleman
Acting Manager, Regulatory Affairs
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Attachment: Linear Elastic Fracture Mechanics Analysis and Strauss Test Results in Support of ECCS Pump Suction Strainer Operating License Amendment

cc: EW Merschoff - NRC RIV
KE Perkins, Jr. - NRC RIV, Walnut Creek Field Office
C Poslusny, Jr. - NRR
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Linear Elastic Fracture Mechanics Analysis and Strauss Test Results in Support of ECCS Pump Suction Strainer Operating License Amendment

FRACTURE MECHANICS ANALYSIS

A linear elastic fracture mechanics analysis was performed to analyze a bounding model that assumed all the martensitic material in the suction strainer screens was cracked and design basis hydrodynamic loads were applied. A crack depth was assumed in performance of this analysis. The assumed crack was based on the depth of the Alpha Prime martensite in the strainer screen material. The depth was determined metallographically by examining the material at a cross section of a hole. The only significant amount of martensite found emanates from the punched or drilled holes. The depth of the martensite was established on the cross section of material measured from the edge of the hole to the core material where no visible martensite was evident. These values were then averaged and determined to be 0.01 inches deep in the 14 GA material and 0.016 inches deep in the 11 GA material. These depths were used as crack depths in a double edge crack model.

Linear elastic fracture mechanics was used to model the crack. This analysis is conservative for this application because the core material is annealed type 304L austenitic stainless steel and the section is of a thickness where elastic plastic or plastic conditions prevail. A more extensive plastic analysis would yield critical flaw size values greater than the relatively straight forward method of linear elastic fracture mechanics.

Cyclic stresses used in the crack growth analysis of the suction strainers were computed using the ANSYS modeling code. ANSYS is a general purpose finite element computer program that was used in a variety of WNP-2 FSAR engineering analyses and is the code previously used to analyze loading combinations of WNP-2 suppression pool piping. The ANSYS program is discussed in detail in the WNP-2 FSAR (section 3.12.10). Fracture mechanics analysis was performed using the NASCRAC computer program. The acronym NASCRAC is formed from NASa CRack Analysis Code. The NRC has previously reviewed and accepted WNP-2 analyses using NASCRAC in studies involving reactor recirculation piping.

The maximum membrane plus maximum bending stress was applied as a uniform through thickness stress to the double edge crack model. The stress value conservatively included direct pressure and inertial components from steam relief valve (SRV) actuation, Operational Basis Earthquake (OBE) loads, and SRV steam chugging. The crack growth evaluation was performed using reverse bending or an R value of (-1). A conservative fracture toughness value (K_{IC}) of 100 Ksi$\sqrt{}$ in. was used in calculating the critical flaw size (a typical fracture toughness value for annealed type 304L stainless steel would be approximately 200 Ksi$\sqrt{}$ in.).

The results are as follows:

- The critical flaw size is an order of magnitude greater than both the width of the web between the holes and the thickness of the screen material.

- The fatigue crack evaluation determined that the assumed cracks will not propagate to a critical size for the remaining life of the plant.

- The maximum computed stress intensity value (K) was less than that required to cause cracking in Alpha martensite formed in austenitic stainless steel.

ASTM A262 PRACTICE E TEST (STRAUSS TEST)

Samples from both the 11 and 14 gage suction strainer screens were subjected to an ASTM A262 Practice E test (Strauss test) to evaluate the susceptibility of intergranular attack. This test involves immersing the specimens in a boiling solution of copper-copper sulfate and 16% sulfuric acid solution for 24 hours. The specimens are then removed and subjected to an 180° bend. To pass, the bend area must be free of cracks or fissures. The thickness of this screen material results in a very severe bend radius; nonetheless, there was no detectable cracking or fissuring of the specimens.

CONCLUSION

NRC criteria in Reg Guide 1.70, Rev 2, Section 6.1.1.1, Item 3a, allow the use of cold-worked austenitic stainless steels with > 90,000 psi yield strength in Engineered Safety Feature (ESF) systems if assurance is provided that the steel will be compatible with the core cooling water and the containment sprays in the event of a LOCA. In accordance with Reg Guide 1.70, detailed WNP-2 analyses of the suppression pool water environment, both normal and post LOCA, determined that the probability of stress corrosion cracking is not increased for the functional life of the plant (Reference 2).

Additionally, a linear elastic fracture mechanics analysis was performed which demonstrated that cracking in the surface martensitic structure will not propagate to a critical size and thus not jeopardize the suction strainers' safety related function of protecting the ECCS pumps and spray nozzles. Using computer analysis methods previously accepted by the NRC, it was demonstrated that the suction strainers have adequate structural integrity (with conservatively assumed martensitic surface cracking) to preclude strainer failure when the forces of design basis hydrodynamic loads are applied.

Finally, an ASTM A262 Practice E test (Strauss test) was performed using actual suction strainer screen samples. The test results functionally demonstrate acceptable stress corrosion cracking resistance in the suction strainer screen material.

Based upon the results of fracture mechanics analysis; Strauss test results, excellent suppression pool water chemistry and a low temperature environment, WNP-2 has determined that the strainers are acceptable for operation and will function to preserve the health and safety of the public.