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SUBJECT: Application for amend to license NPF-21,modifying requirement that cold-worked austenitic stainless steel used in newly designed ECCS pump suction strainers must have yield strength not greater than 90,000 psi.

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WASHINGTON PUBLIC POWER SUPPLY SYSTEM
P.O. Box 968 • Richland, Washington 99352-0968

April 16, 1998
GO2-98-071

Docket No. 50-397

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Gentlemen:

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

References:

1) NRC Bulletin 96-03, dated May 6, 1996, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling Water Reactors"

2) Letter GO2-96-202, dated October 16, 1996, JV Parrish (Supply System) to US NRC Document Control Desk, "WNP-2, Operating License NPF-21, Request for Extension in Implementation of Emergency Core Cooling System Suction Strainer Modification Activities Associated with NRC Bulletin 96-03"

In accordance with the Code of Federal Regulations, Title 10, Parts 50.59, 50.90, and 2.101, the Supply System hereby submits a request for amendment of the WNP-2 Operating License. Specifically, the Supply System is requesting modification, by May 22, 1998, of the requirement that cold-worked austenitic stainless steels used in the newly designed Emergency Core Cooling System (ECCS) pump suction strainers must have a yield strength not greater than 90,000 psi. We are requesting this amendment as required by 10 CFR 50.59(c) - a change in the facility described in the Safety Analysis Report which involves an unreviewed safety question (USQ). Approval of the proposed change is necessary to allow restart of WNP-2 following completion of the R-13 refueling outage this spring.

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Requesting approval of the proposed amendment by May 22, 1998 is justifiable. This is due to: the short time between the discovery of a nonconforming material condition with the newly fabricated ECCS suction strainers (03/02/98); subsequent determination by WNP-2 plant staff that the nonconformance constituted a USQ; determination that the strainers are acceptable to install during our outage as committed in Reference 2; and the Technical Specification requirement to have the strainers operable (05/23/98) when refueling activities are complete. This condition was not created by the failure to make a timely application for a license amendment.

This nonconformance was caused by a failure to include the FSAR 90,000 psi yield strength requirement in the new suction strainer purchase specification and was discovered during the final stages of the manufacturing process. As documented in Reference 2, WNP-2 will be installing the new ECCS suction strainers in R-13. The suction strainers will be installed only when their respective ECCS system is not required to be operable (some in Mode 4 and the remainder in Mode 5).

By reviewing the requirements noted in Attachment 1, we have determined that the proposed activity is a USQ in that it reduces the margin of safety as defined in the basis for the ECCS operability Technical Specification. ECCS operability requires operable pump suction strainers to protect the pumps from damage and prevent plugging of the spray nozzles.

Cold-worked austenitic stainless steels with a yield strength of no more than 90,000 psi have a reduced probability of stress corrosion cracking. Fabrication of the screens entailed operations which cold-worked the screen material (i.e., punching drilling, de-burring, and / or forming). The cold-working caused yield stresses, as determined by micro hardness testing, to exceed 90,000 psi. However, NRC criteria in Reg Guide 1.70, Rev 2, Section 6.1.1.1, Item 3a, indicate that use of cold-worked austenitic stainless steels with > 90,000 psi yield strength in ESF systems can be acceptable 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, a detailed WNP-2 analysis determined that the probability of stress corrosion cracking is not increased for the functional life of the strainers. To facilitate any future material evaluations, we will install a coupon station in the suppression pool along with the new ECCS suction strainers that contains samples of the cold-worked strainer material.

It is the objective of this request to present for your review and concurrence our safety assessment of a proposed modification to the ECCS suction strainer material requirements. We have performed the evaluation described in Attachment 1 to provide the technical support necessary to operate WNP-2 with the design change as described. We request your concurrence with our position that this modification to the licensing basis is acceptable and preserves the health and safety of the public.

Additional information has been attached to this letter to complete the Supply System's amendment request. Attachment 1 provides a detailed evaluation of the proposed change. Attachment 2 summarizes the proposed change and provides marked up pages of the Safety Analysis Report. Attachment 3 describes an evaluation of the proposed change in accordance with 10CFR50.92(c) and concludes that it does not result in a significant hazards consideration. Attachment 4 provides the

environmental assessment applicability review and notes that the proposed change meets the eligibility criteria for a categorical exclusion as set forth in 10CFR51.22(c)(9). Therefore, in accordance with 10CFR51.22(b), an environmental assessment of the change is not required.

This request for an amendment has been reviewed and approved by the WNP-2 Plant Operations Committee and the Supply System Corporate Nuclear Safety Review Board. In accordance with 10CFR50.91, the State of Washington has been provided a copy of this letter.

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

Respectfully,

/For

P.R. Bemis
Vice President, Nuclear Operations
Mail Drop PE23

Attachments:

1. Evaluation of the Proposed Change
2. Revised Safety Analysis Report
3. Evaluation of Significant Hazards Considerations
4. Environmental Assessment Applicability Review

cc: EW Merschoff - NRC RIV
KE Perkins, Jr. - NRC RIV, Walnut Creek Field Office
C Poslusny, Jr. - NRR
NRC Sr. Resident Inspector - 927N
DL Williams - BPA/399
DJ Ross - EFSEC
PD Robinson - Winston & Strawn

STATE OF WASHINGTON)
)
COUNTY OF BENTON)

Subject: Request for Amendment Emergency, Core Cooling System Suction Strainers

I, G. O. Smith, being duly sworn, subscribe to and say that I am the Acting Vice President, Nuclear Operations for the WASHINGTON PUBLIC POWER SUPPLY SYSTEM, the applicant herein; that I have the full authority to execute this oath; that I have reviewed the foregoing; and that to the best of my knowledge, information, and belief the statements made in it are true.

DATE 4/ 16/ , 1998

G. O. Smith
Acting, Vice President, Nuclear Operations

On this date personally appeared before me G. O. Smith, to me known to be the individual who executed the foregoing instrument, and acknowledged that he signed the same as his free act and deed for the uses and purposes herein mentioned.

GIVEN under my hand and seal this 16 day of April 1998.

Heather L. Townsend
Notary Public in and for the
STATE OF WASHINGTON

Residing at Franklin County

My Commission Expires 03.09.01

Evaluation of the Proposed Change

Introduction - USQ Analysis

Nuclear Energy Institute's (NEI) "Guidelines for 10 CFR 50.59 Safety Evaluations", NEI 96-07, dated September 1997, provides the following guidance regarding margin of safety: "To the maximum extent practicable, the Bases for a technical specification should explicitly define or address the margin of safety. If the Bases do not specifically address a margin of safety, then the licensee's safety analysis report (SAR), the NRC's safety evaluation report (SER), and other applicable licensing basis documents should be reviewed to determine if the proposed change, test, or experiment would result in a reduction in a margin of safety." [This guidance is also contained in WNP-2 plant procedure PPM 1.3.43, Attachment 6.3, Page 5 of 5]

Engineered Safety Features (ESF) include the ECCS systems. NUREG-0892, the WNP-2 SER, Chapter 6.0 "Engineered Safety Features", states: "The July 1981 edition of the 'Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants' (SRP, NUREG-0800) includes Chapter 6, 'Engineered Safety Features.' WNP-2 was reviewed in accordance with this SRP." This statement in the WNP-2 SER made NUREG-0800 a basis for the NRC staff determination of the adequacy of the WNP-2 ESF design.

In NUREG-0800, Chapter 6, 'Engineered Safety Features', under 'Criteria for Primary Review Areas' there is a discussion of 'Materials and Fabrication' that includes a section on 'Austenitic Stainless Steels' that states: "To meet the requirements of GDC 4 relative to compatibility of components with environmental conditions; GDC 14 with respect to fabrication and testing of the reactor coolant pressure boundary . . .; and the quality assurance requirements of Appendix B of 10 CFR Part 50 the following guidelines should be used: 1) Cold worked austenitic stainless steels must have a maximum 0.2% offset yield strength of 90,000 psi to reduce the probability of stress corrosion cracking in ESF systems."

By the above noted text, NUREG-0800 specifies that three (3) separate and independent primary criteria apply to materials and fabrication when using austenitic stainless steel:

1) GDC 4;
2) GDC 14; and
3) Appendix B of 10 CFR Part 50.

Therefore, to meet the separate requirements of GDC 4 relative to compatibility of components with environmental conditions, ESF components (not just pressure boundary components) fabricated with austenitic stainless steels must have a maximum yield strength of 90,000 psi [or provide assurance that they will be compatible with the core cooling water and the containment sprays in the event of a loss-of-coolant accident (per Reg Guide 1.70)].

WNP-2's FSAR specifies limits for the use of cold-worked austenitic stainless steel. Chapter 6, Section 6.1.1.1.3.c states: "Austenitic stainless steel with a yield strength greater than 90,000 psi was not used in the ESF systems." The SER for this section of the FSAR states: "the Staff position that the yield strength of cold-worked stainless steels shall be less than 90,000 psi have been met."

From the references noted above, we have determined that the 90,000 psi criterion is a Licensing Basis Acceptance Limit (LBAL). The surface yield stress in the screen material of the ECCS suction strainers exceeds the LBAL of 90,000 psi as determined by micro hardness testing. Since the LBAL will be exceeded upon installation of the new suction strainers, the margin of safety as described in the basis for ECCS operability will be reduced. Therefore, a USQ has been determined to exist.

Summary of the Proposed Change

The proposed replacement strainers have been designed using methodology presented in NUREG/CR-6224, and by the BWR Owners Group in their Utility Resolution Guidance (URG) document for ECCS Suction Strainer Blockage, dated November 1996. Material used in the fabrication of the strainers was determined to be inconsistent with commitments in the WNP-2 FSAR and the NRC SER which limit the use of cold-worked austenitic stainless steel in engineered safety feature (ESF) systems. This change proposes that the suppression pool ECCS suction strainers be an approved exception to the FSAR and SER austenitic stainless steel yield strength limit of 90,000 psi.

Precise Statement of Conditions

The strainers are fabricated using SA 240 Type 304L stainless steel. They are fabricated out of a series of donut shaped rings welded to major and minor diameter bands made of perforated plate material that acts as a filter for debris. The plates are drilled or punched with holes 3/32" in diameter, cut and formed to a 36" or 38" outer diameter, and then welded to the flange tube assembly and body. The drilling, grinding, punching and forming processes cold-worked the material.

Issue 1:

The 11 GA (0.120" nominal thickness) Type 304L stainless steel drilled, ground, and formed plate used to fabricate the new ECCS suction strainers has surface cold-worked yield strengths (based on hardness test correlations) in excess of that allowed by the FSAR and SER for ESF systems. This was determined by performing micro hardness tests on samples of the drilled and formed materials. WNP-2 uses Rockwell Rb 95 as a screening hardness limit for austenitic stainless steel material to assure that the cold-worked material yield strength does not

exceed 90,000 psi. The measured surface hardness for the 11 GA material averaged Rb 98, with an estimated approximate yield strength of 92 - 100 ksi.

Issue 2

A sample of 14 GA (0.075" nominal thickness) formed material used in the fabrication of the strainers was also tested. The 14 GA material's yield strength also exceeded the FSAR and SER limit based on hardness. The measured surface hardness for the 14 GA material averaged Rc 34 with an estimated approximate yield strength of 110 - 130 ksi.

Change evaluation

The strainers' function to prevent solid particles greater than 3/32"(based on pump seals) from entering the ECCS pumps. Preventing these particles from entering the pumps protects the pumps from damage and assures that spray nozzles in the reactor, drywell and wetwell are not clogged. The strainers do not provide pressure boundary integrity like the piping and other components associated with the ECCS systems.

Upon reviewing the material conditions and the chemically controlled water environment the strainers will be submersed in, we have determined that the probability of stress corrosion cracking is not increased for the functional life of the strainers. NRC criteria in Reg Guide 1.70, Rev 2, Section 6.1.1.1, Item 3a, indicate that use of cold-worked austenitic stainless steels with $>$ 90,000 psi yield strength in ESF systems can be acceptable 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. The evaluation for this acceptability is as follows.

For stress corrosion cracking to occur, three (3) conditions need to exist in combination:

1) A susceptible material condition (e.g., welded austenitic stainless steel with carbon content over 0.03% or severe cold-working which causes martensitic phase transformation);

2) Constant high applied or internal stresses need to be present (e.g., residual stresses caused by cold-working and/or welding or constant applied stresses either by load or by internal phase changes); and

3) The environment necessary to promote stress corrosion cracking (e.g., ions such as chlorides and sulfates with elevated temperature).

The three factors are evaluated as follows:

1) The actual carbon content of the type 304L material is 0.021% for the 11 GA heat and 0.023% for the 14 GA heat. Due to this low carbon content, the material would not be sensitized from the welding operation to a degree that would cause stress corrosion cracking.

The type 304L stainless steel material used in the strainer outer filter (screen) fabrication is potentially susceptible to stress corrosion cracking due to the cold-worked condition and high surface stresses. Cold-working was determined to exist to a depth of approximately 0.007" for the 11 GA (0.120") material and an approximate depth of 0.018" in the 14 GA (0.075") material.

2) Residual stresses exist as a result of cold-working and welding. The cold-working process deforms the grains in the material imparting internal stresses. In some cases, if the deformation stresses are high enough, the microstructure in austenitic stainless steels can transform to martensite. Martensite tends to contribute to crack initiation due to the nature of its microstructure. The martensite formation contributes to sensitization of the material at high temperatures or provides a material structure more susceptible to corrosion reactions. To determine the amount of martensite formation, Fisher Feritscope MP3 measurements were performed on the material. This technique measures the amount of magnetic material present in the stainless steel. Austenitic stainless steel is normally nonmagnetic due to its lattice structure with the exception of small areas of ferrite that can exist in the microstructure. The largest value that was measured using the Fisher Feritscope MP3 on the 14 GA material was 1.5% and on the 11 GA material was 0.77 %. These numbers represent the amount of martensite and ferrite that is present in the material. The levels of martensite measured are a very small part of the austenitic stainless steel microstructure and should not significantly contribute to a reduction of the overall integrity of the component. This is supported by studies on severely cold-worked type 304 material which did not fail until exposure to elevated temperatures was significantly longer than the DBA LOCA time.

Welding residual stresses are considered to be low due to the fabrication processes used. The welds are single pass fillets made with the gas metal arc process (MIG). The residual tensile stresses would be lower when compared to a multiple pass full penetration groove weld. The strainers are designed to remain functional, passing the required ECCS flow under all postulated applied loads (seismic and hydrodynamic).

3) The water environment that the strainers will be submersed in has controlled chemistry that is established to prevent stress corrosion cracking and the temperature is low relative to the reactor water temperatures. The material's susceptibility to stress corrosion cracking in the water environment is driven by two (2) factors. These factors are ionic species that are present for reaction and the temperature of the water. Normally, suppression pool water chemistry is controlled to a quality level better than recommended by the "BWR Water Chemistry Guideline - 1996 Revision" for reactor water in cold shutdown (temperature $\leq$ 200° F). Chlorides and sulfates are normally controlled to levels less than or equal to 20 ppb. These elements are controlled to prevent stress corrosion cracking of pressure boundary piping at high reactor temperatures (> 500° F). Corrosion reactions increase in reactor water when temperatures exceed 200° F and require special water quality chemical controls such as those imposed in the suppression pool.

The suppression pool temperature during operation is required to be maintained at a temperature less than 120° F or the plant placed in mode 4 in 36 hours. The typical operating temperature for the suppression pool is approximately 90° F. The limiting temperature for the suppression pool would occur during a DBA LOCA. The maximum temperature in the wetwell predicted for a DBA LOCA is estimated to be 204° F. The time period for the temperature to be above 200° F is approximately five (5) days which is a short duration that should not significantly increase the probability of cracking. Stress corrosion cracking can occur at temperatures as low as 165° F to 200° F in cold-worked austenitic stainless steel with 5 ppm chloride in the water. Concentrations need to be in the range of 15 - 30 ppm to have stress corrosion cracking at normal operating temperatures of 90° F. Suppression pool water, under both normal and accident conditions, is not considered detrimental because the concentrations and temperatures are significantly below the levels that studies have shown immunity to stress corrosion cracking of cold-worked austenitic stainless steel.

During a LOCA, contribution to the total levels of Cl + F in the suppression pool was evaluated, conservatively assuming that all drywell insulation is transported to the suppression pool and releases all of the maximum allowed leachable elements. We assumed that the insulation contained 600 ppm of Cl + F (maximum allowed by Reg. Guide 1.36). It was determined that the total increase in Cl + F in the suppression pool after dilution would be $<$ 1 ppm. Actual transport models predict only a small fraction of the total drywell insulation reaches the suppression pool which would further reduce the Cl + F concentrations.

The low temperature of the wetwell water and the controlled chemistry during normal operation and postulated accidents, minimizes the potential of stress corrosion cracking in the suction strainer screens. As identified in NUREG 0313, Rev. 2, removing one or two of the elements that contribute to stress corrosion cracking can provide acceptable assurance of continued integrity and reliability of the components.

Additional considerations:

- Creviced conditions were considered in this evaluation. Crevices can cause local environments to become acidic as a result of metal corrosion or contain ions such as chlorides that can make the material more susceptible to stress corrosion cracking. The chemistry of the suppression pool is tightly controlled to minimize the concentration of ions such as chlorides and to provide a controlled pH range. The low temperatures and the controls on chemistry should minimize the susceptibility of creviced material to stress corrosion cracking. As discussed previously, the suppression pool water chemistry is controlled to a quality level better than recommended by the "BWR Water Chemistry Guideline - 1996 Revision" for reactor water in cold shutdown (temperature $\leq$ 200° F). This guideline was established to reduce the probability of stress corrosion cracking in the reactor and vessel internals. In the vessel, many material conditions exist including creviced and cold-worked material. Therefore comparison to reactor water quality controls can be used to adequately address crevice corrosion in the suppression pool suction strainers.

- In evaluating the effects of O_2 and H_2, the concentrations at normal operating conditions and DBA LOCA were evaluated. During normal operation the containment vessel is filled with nitrogen in both the drywell and wetwell. The maximum allowable O_2 concentration is 3.5 % by volume in the atmosphere above the water. The expected suppression pool water O_2 concentration is <1.0 ppm (measured 800 ppb on 03/06/98). Hydrogen concentrations in the suppression pool are less than the oxygen concentrations and are expected to be <0.1 ppm. During a DBA LOCA, temperatures in the suppression pool increase and reduce the solubility of both O_2 and H_2. The greatest concentration of O_2 and H_2 would be during a DBA LOCA that results in fuel clad degradation. In this event, the expected O_2 level in the suppression pool would be 1 - 2 ppm and H_2 would be expected to be approximately 1 ppm.

- Studies in BWR environments demonstrate that highly cold-worked (3/4 hard) 304 stainless steel at reactor temperatures loaded to a value of 173,000 psi in 7 ppm O_2 and 1.5 ppm Cl did not fail in 59 days of exposure (Ref. GE Technical Information Memorandum: "Stress Corrosion Tests on Selected Reactor Structural Steels"). The test conditions were more severe than those that would be experienced in the wetwell considering loading, temperatures and chemical species. The screen material in the new WNP-2 strainers is estimated to be approximately 1/4 to 1/2 hard. No failures were documented for the 1/4 to 1/2 hard material in the identified test environment.

- Electrochemical potential (ECP) tests were considered and deemed unnecessary. Normally, suppression pool water chemistry is controlled to a quality level better than recommended by the "BWR Water Chemistry Guideline - 1996 Revision" for reactor water in cold shutdown (temperature $\leq$ 200° F). As discussed previously, the probability of stress corrosion cracking in the screen material is not increased in the wetwell environment of low temperature and high water quality for both normal and DBA LOCA conditions. Additionally, there will be representative screen material coupons installed in the suppression pool, available to evaluate if there is a concern for cracking as a result of a water quality excursion due to chemical ingress.

- The Supply System has considered the possibility of testing samples of the cold worked material to demonstrate that stress corrosion cracking will not occur at the conditions that could exist post LOCA (i.e., 204° F and 1 ppm chlorides). We have concluded that additional testing is unnecessary because the concentrations and temperature are below the levels that studies have shown immunity to stress corrosion cracking of cold-worked austenitic stainless steel. The previous tests were performed on more severely cold worked stainless steel at higher temperatures and/or higher chloride concentrations. In other words, the previous tests bound the conditions that could exist in the WNP-2 suppression pool post-LOCA.

- NRC criteria in Reg Guide 1.70, Rev 2, Section 6.1.1.1, Item 3a, indicate that use of cold-worked austenitic stainless steels with > 90,000 psi yield strength in ESF systems can

be acceptable 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. As discussed above, a DBA LOCA will not create an environment that contributes to stress corrosion cracking for the duration of the event.

Summary

Based upon the evaluations above as permitted by Reg Guide 1.70, Rev 2, Section 6.1.1.1, Item 3a, the strainers are acceptable for operation and will function to preserve the health and safety of the public. The screens are acceptable for the reasons summarized:

- The screens of the non-pressure retaining strainers will not have an increased probability of stress corrosion cracking due to the environment of low temperature and very low ionic concentrations in the suppression pool.

- The normal operating temperature is well below 200° F above which special water quality controls are considered necessary to limit stress corrosion cracking in cold-worked material. Normal operating temperature is approximately 90° F and the analyzed DBA LOCA time above the elevated temperature of 200° F (204° F) is a short duration (approximately 5 days).

- Normal suppression pool water chemistry, with chloride and sulfate limits below 20 ppb and controlled pH of 5.3 - 8.6, is equal to or better than that recommended by the "BWR Water Chemistry Guideline - 1996 Revision" for a reactor in cold shutdown (temperature $\leq$ 200° F). The control limits for chlorides and sulfates for normal and LOCA conditions are below the threshold considered necessary for stress corrosion cracking at low temperatures. Typical levels of chloride and sulfate are less than 1 ppb. During a LOCA, ion release (Cl + F) from insulation is conservatively assumed to result in suppression pool concentrations below 1 ppm. Additionally, the O_2 concentration is less than 1 ppm (measured 800 ppb on 03/06/98) and H_2 concentrations are less than O_2 concentrations.

References:

1) "Stress Corrosion Tests on Selected Reactor Structural Steels," M. C. Rowland, GE report APED 4010, R62APE7, January 29,1962.

2) "Investigation of Stress Corrosion Cracking Susceptibility of Fe-Ni-Cr Alloys in Nuclear Reactor Water Environments," W. L. Clarke and G.M. Gordon of GE, Op. Cit., Corrosion, v29,nl,pl-12, Jan. 1973.

3) " Chloride Stress Corrosion Cracking of Austenitic Stainless Steel Effect of Temperature and pH," L. R. Scharfstein and W.F. Brindley, NACE Conference, March 17-21 1958.

4) " Ambient Temperature Stress-Corrosion Cracking of Sensitized Stainless Steels," Brookhaven National Laboratory, Paper Number 224 from the International Corrosion Forum Sponsored by the National Association of Corrosion Engineers, March 22-26, 1982.

5) " Intergranular Stress Corrosion Cracking of Austenitic Stainless Steels at Temperatures Below 100 C - A review," G Cragnolino and D.D. MacDonald, Corrosion- NACE 1982 page 406.

6) " Effect of Chloride, Thiosulfate, and Flouride Addition on the IGSCC Resistance of Type 302 Stainless Steel in Low Temperature Water," S. M. Bruemmer and A.B. Johnson, Jr., 1st International Symposium NACE 1983.

7) " The Effect of Cold Work on the Sensitization of 304 Stainless Steel,"C. L. Briant and A. M. Ritter, General Electric Corporation Research and Development Center, Schenectady, New York .

8) " Intergranular Stress Corrosion Cracking and Grain Boundary Composition of Fe-Ni-Cr Alloys," R. L. Cowan,II and G.M. Gordon, General Electric, Stress Corrosion Cracking and Hydrogen Embrittlement of Iron Base Alloys, NACE-5 Conference, June 12-16, 1973.

9) "Evaluating the Intergranular SCC Resistance of Sensitized Type 304 Stainless Steel in Low-Temperature Water Environments," Stephen M Bruemmer, et. al., Reprint from Special Technical Testing Publication 821, American Society for Testing and Materials, 1984.

Revised Safety Analysis Report

The Final Safety Analysis Report, Section 6.1.1.1.3, 'Controls for Austenitic Stainless Steel', is modified to allow exceeding a yield strength of 90,000 psi in the screen material of the ECCS suppression pool strainers:

<u>Present FSAR Section 6.1.1.1.3(c) text reads,</u> "Austenitic stainless steel with a yield strength greater than 90,000 psi was not used in ESF systems."

<u>Revised FSAR Section 6.1.1.1.3(c) text would read,</u> "Austenitic stainless steel with a yield strength greater than 90,000 psi was not used in ESF systems with the exception of screen material in the ECCS suppression pool strainers. Fabrication of the screens entailed operations which cold-worked the screen material (i.e., punching drilling, de-burring, and / or forming). The cold-working caused yield stresses, as determined by hardness testing, to exceed 90,000 psi. The screens were found to be acceptable due to their non-pressure retaining function, and the controlled chemistry and pool temperature of the suppression pool."

6.1 ENGINEERED SAFETY FEATURE MATERIALS

Materials used in the engineered safety feature (ESF) components have been evaluated to ensure that material interactions will not occur that could potentially impair operation. Materials have been selected to withstand the environmental conditions encountered during normal operation and postulated accidents. Their compatibility with core and containment spray solutions has been considered, and the effects of radiolytic decomposition products have been evaluated.

Coatings used on exterior surfaces within the primary containment are suitable for the environmental conditions expected. Nonmetallic thermal insulation employed is required to have the proper ratio of leachable sodium plus silicate ions to leachable chloride ions in order to minimize the possibility of stress corrosion cracking.

6.1.1 METALLIC MATERIALS

6.1.1.1 Materials Selection and Fabrication

6.1.1.1.1 Material Specifications

Table 5.2-4 lists the principal pressure retaining materials and the appropriate material specifications for the reactor coolant pressure boundary components. Table 6.1-1 lists the principal pressure retaining materials and the appropriate material specifications for the engineered safety features of the plant.

6.1.1.1.2 Compatibility of Construction Materials with Core Cooling Water and Containment Sprays

The compatibility of the reactor coolant with materials of construction exposed to the reactor coolant is discussed in 5.2.3. These same materials of construction are found in the engineered safety feature components.

Demineralized water, with no additives, is employed in BWR core cooling water and containment sprays. No detrimental effects will occur on the ESF construction materials from allowable contaminant levels in this high purity water.

6.1.1.1.3 Controls for Austenitic Stainless Steel

a. Control of the Use of Sensitized Stainless Steel

   Controls to avoid significant sensitization discussed in 5.2.3 are the same for ESF components.

b. Process Controls to Minimize Exposure to Contaminants

Process controls for austenitic stainless steel discussed in 5.2.3 are the same for ESF components.

c. Use of Cold Worked Austenitic Stainless Steel

Austenitic stainless steel with a yield strength greater than 90,000 psi was not used in ESF systems.

d. Thermal Insulation Requirements

All thermal insulation materials in ESF systems were selected, procured, tested, stored and installed in accordance with Regulatory Guide 1.36 Rev. 0. The leachable concentrations of chlorides, fluorides, sodium and silicates for nonmetallic thermal insulation for austenitic stainless steel were required to meet the requirements of Regulatory Guide 1.36, Revision 0. Certified reports and test reports for the materials are available.

e. Avoidance of Hot Cracking of Stainless Steel

Process controls to avoid hot cracking discussed in 5.2.3 are the same for ESF components.

6.1.1.2 Composition, Compatibility, and Stability of Containment and Core Spray Coolants

Containment spray and core cooling water for the engineering safety features systems are supplied from the condensate storage tanks or the suppression pool.

The quality of the water stored in the condensate storage tanks is maintained as follows:

Conductivity*	1 µmho/cm at 25°C
Chlorides	0.05 ppm
pH*	6 to 8 at 25°C
Boron (as BO_3)	0.1 ppm

* Conductivity and pH limits apply after correction for dissolved CO_2.

6.1.1.1.3

b. Process Controls to Minimize Exposure to Contaminants

Process controls for austenitic stainless steel discussed in 5.2.3 are the same for ESF components.

c. Use of Cold Worked Austenitic Stainless Steel

Austenitic stainless steel with a yield strength greater than 90,000 psi was not used in ESF systems, with the exception of screen material in the ECCS suppression pool strainers. Fabrication of the screens entailed operations which cold-worked the screen material (ie, punching, drilling, de-burring, and / or forming). The cold-working caused yield stresses, as determined by hardness testing, to exceed 90,000 psi. The screens were found to be acceptable due to their non-pressure retaining function, and the controlled chemistry and pool temperature of the suppression pool.

d. Thermal Insulation Requirements

All thermal insulation materials in ESF systems were selected, procured, tested, stored and installed in accordance with Regulatory Guide 1.36 Rev. 0. The leachable concentrations of chlorides, fluorides, sodium and silicates for nonmetallic thermal insulation for austenitic stainless steel were required to meet the requirements of Regulatory Guide 1.36, Revision 0. Certified reports and test reports for the materials are available.

e. Avoidance of Hot Cracking of Stainless Steel

Process controls to avoid hot cracking discussed in 5.2.3 are the same for ESF components.

6.1.1.2 Composition, Compatibility, and Stability of Containment and Core Spray Coolants

Containment spray and core cooling water for the engineering safety features systems are supplied from the condensate storage tanks or the suppression pool.

The quality of the water stored in the condensate storage tanks is maintained as follows:

Conductivity*	1 µmho/cm at 25°C
Chlorides	0.05 ppm
pH*	6 to 8 at 25°C
Boron (as BO_3)	0.1 ppm

* Conductivity and pH limits apply after correction for dissolved CO_2.

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Evaluation of Significant Hazards Considerations

Summary of Proposed Change:

USNRC Bulletin 96-03 documented problems with maintaining adequate suction head for ECCS pumps from BWR suppression pools due to entrainment of solids created by accident conditions. The WNP-2 strainers that were recently purchased to resolve problems identified in Bulletin 96-03 have stainless steel screens that exceed FSAR and SER yield strength requirements for components installed in engineered safety feature (ESF) systems. WNP-2's FSAR specifies limits for the use of cold-worked austenitic stainless steel. Chapter 6, Section 6.1 .1.1.3.c states: "Austenitic stainless steel with a yield strength greater than 90,000 psi was not used in the ESF systems." The SER for this section of the FSAR states: "the Staff position that the yield strength of cold-worked stainless steels shall be less than 90,000 psi have been met." The purpose in limiting the material's yield strength to 90,000 psi is to reduce the probability of stress corrosion cracking.

The new ECCS suction strainer screens were assembled using 11 GA (0.120") and 14 GA (0.075") Type 304L stainless steel plate that was drilled, surface ground, and formed (11 GA) or punched and formed (14 GA). The surface measured hardness for the 11 GA material averaged Rb 98 with an approximate yield strength of 92 - 100 ksi. The measured surface hardness for the 14 GA material averaged Rc 34 with an approximate yield strength of 110 - 130 ksi.

The proposed change allows exceeding a yield strength of 90,000 psi in the screen material of the ECCS suppression pool suction strainers. Upon reviewing the material conditions and the chemically controlled water and low temperature environment the strainers will be submersed in, the Supply System has determined that this change does not increase the probability of stress corrosion cracking for the functional life of the strainers.

No significant Hazards Determination:

Washington Public Power Supply System has evaluated the proposed change using the criteria established in 10CFR50.92(c) and has determined that it does not represent a significant hazards consideration as described below.

The operation of WNP-2 in accordance with the proposed amendment will not involve a significant increase in the probability or consequences of an accident previously evaluated:

The probability of an evaluated accident is derived from the probabilities of the individual precursors to that accident. The consequences of an evaluated accident are determined by the operability of plant systems designed to mitigate those consequences. The proposed change entails

the replacement of the ECCS strainers in the WNP-2 suppression pool with newly designed strainers that have stainless steel screens which exceed FSAR and SER yield strength requirements for components installed in ESF systems. ECCS suction strainers have no role in the initiation of design basis accidents (DBAs) or transients identified in the FSAR. The strainers are passive, non-pressure retaining components which support the function of the ECCS systems following a DBA or certain other plant transients. The strainers' function is to prevent solid particles greater than 3/32"(based on pump seals) from entering the ECCS pumps. Preventing these particles from entering the pumps protects the pumps from damage and assures that spray nozzles in the reactor, drywell and wetwell are not clogged. Damage of the pump seals or plugging of the spray heads could hinder system performance and potentially result in post-accident conditions that deviate from analyzed pressures and temperatures.

If stress corrosion cracking were to occur in the suction strainer screens, particles exceeding 3/32" might be allowed into the ECCS system. However, for stress corrosion to occur, three (3) conditions need to exist in combination:

1) A susceptible material condition (e.g., welded austenitic stainless steel with carbon content over 0.03% or cold-working which causes martensitic phase transformation);

2) Constant high applied or internal stresses need to be present (e.g., residual stresses caused by cold-working and/or welding or constant applied stresses either by load or by internal phase changes); and

3) The environment necessary to promote stress corrosion cracking (e.g., ions such as chlorides and sulfates with elevated temperature).

The three factors are evaluated as follows:

1) The actual carbon content of the type 304L material is 0.021% for the 11 GA heat and 0.023% for the 14 GA heat. Due to this low carbon content, the material would not be sensitized from the welding operation to a degree that would cause stress corrosion cracking. The type 304L stainless steel material used in the strainer outer filter (screen) fabrication is potentially susceptible to stress corrosion cracking due to the cold-worked condition and high surface stresses. Cold-working was determined to exist to a depth of approximately 0.007" for the 11 GA (0.120") material and an approximate depth of 0.018" in the 14 GA (0.075") material.

2) Residual stresses exist as a result of cold-working and welding. The cold-working process deforms the grains in the material imparting internal stresses. In some cases, if the deformation stresses are high enough, the microstructure in austenitic stainless steels can transform to martensite. Martensite tends to contribute to crack initiation due to the nature of its microstructure. The martensite formation contributes to sensitization of the material at high temperatures or provides a material structure more susceptible to corrosion reactions. To determine the amount of martensite formation, Fisher Feritscope MP3 measurements were performed on the material. This technique measures the amount of magnetic material present

in the stainless steel. Austenitic stainless steel is normally nonmagnetic due to its lattice structure with the exception of small areas of ferrite that can exist in the microstructure. The largest value that was measured using the Fisher Feritscope MP3 on the 14 GA material was 1.5% and on the 11 GA material was 0.77 %. These numbers represent the amount of martensite and ferrite that is present in the material. The levels of martensite measured are a very small part of the austenitic stainless steel microstructure and should not significantly contribute to a reduction of the overall integrity of the component. This is supported by studies on severely cold-worked type 304 material which did not fail until exposure to elevated temperatures was significantly longer than the DBA LOCA time.

Welding residual stresses are considered to be low due to the fabrication processes used. The welds are single pass fillets made with the gas metal arc process (MIG). The residual tensile stresses would be lower when compared to a multiple pass full penetration groove weld. The strainers are designed to remain functional, passing the required ECCS flow under all postulated applied loads (seismic and hydrodynamic).

3) The water environment that the strainers will be submersed in has controlled chemistry that is established to prevent stress corrosion cracking and the temperature is low relative to the reactor water temperatures. The material's susceptibility to stress corrosion cracking in the water environment is driven by two (2) factors. These factors are ionic species that are present for reaction and the temperature of the water. The normal suppression pool water chemistry is controlled to a quality level better than recommended by the "BWR Water Chemistry Guideline - 1996 Revision" for reactor water in cold shutdown (temperature $\leq$ 200° F).

Chlorides and sulfates are normally controlled to levels less than or equal to 20 ppb. These elements are controlled to prevent stress corrosion cracking of pressure boundary piping at high reactor temperatures (> 500° F). Corrosion reactions increase in reactor water when temperatures exceed 200° F and require special water quality chemical controls such as those imposed in the suppression pool.

The suppression pool temperature during operation is required to be maintained at a temperature less than 120° F or the plant placed in mode 4 in 36 hours. The typical operating temperature for the suppression pool is approximately 90° F. The limiting temperature for the suppression pool would occur during a DBA LOCA . The maximum temperature in the wetwell predicted for a DBA LOCA is estimated to be 204° F. The time period for the temperature to be above 200° F is approximately five (5) days which is a short duration that should not significantly increase the probability to crack. Stress corrosion cracking can occur at temperatures as low as 165° F to 200° F in cold-worked austenitic stainless steel with 5 ppm chloride in the water. Concentrations need to be in the range of 15 - 30 ppm to have stress corrosion cracking at normal operating temperatures of 90° F.

During a LOCA, contribution to the total levels of Cl + F in the suppression pool was evaluated, conservatively assuming that all drywell insulation is transported to the suppression pool and releases all of the maximum allowed leachable elements. We assumed that the insulation contained 600 ppm of Cl + F (maximum allowed by Reg. Guide 1.36). It was

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determined that the total increase in Cl + F in the suppression pool after dilution would be < 1 ppm. Actual transport models predict only a small fraction of the total drywell insulation reaches the suppression pool, which would further reduce the Cl + F concentrations.

The low temperature of the wetwell water and the controlled chemistry during normal operation and postulated accidents, minimizes the potential of stress corrosion cracking in the suction strainer screens. As identified in NUREG 0313, Rev. 2, removing one or two of the elements that contribute to stress corrosion cracking can provide acceptable assurance of continued integrity and reliability of the components.

Upon reviewing the material conditions and the chemically controlled water environment the strainers will be submersed in, we have determined that the probability of stress corrosion cracking is not increased for the functional life of the strainers. Therefore, no individual precursors of an accident are affected. In addition, since the functions and capabilities of systems designed to mitigate the consequences of an accident have not changed, the consequences of an accident previously evaluated are not expected to increase.

The operation of WNP-2 in accordance with the proposed amendment will not create the possibility of a new or different kind of accident from any accident previously evaluated:

Creation of the possibility of a new or different kind of accident would require the creation of one or more new precursors of that accident. New accident precursors may be created by modifications of the plant configuration. The replacement strainers are designed - although not code 'N' stamped - to ASME Section III Class 2 requirements. (The original strainers were similarly designed to ASME Class 2 requirements, with no 'N' stamp). The new strainers are Quality Class 1, with procurement, design and fabrication in accordance with 10CFR50 Appendix B. Postulated malfunctions affecting the ECCS systems (e.g., divisional loss or passive failure within the system) are not changed by the replacement strainers. ECCS systems with the new strainers remain in conformance with the requirements of 10CFR50.46, which defines acceptance criteria for those systems. The replacement strainers meet all requirements of the original strainers and the systems to which they attach.

The use of the ECCS strainers with cold-worked screen materials will not create the possibility of a different type of accident. The screen materials have been determined to be satisfactory for the possible environments they may be subjected to and will remain fully functional through all plant conditions and DBAs. The strainers will continue to screen out particles whose size exceeds 3/32". Preventing these particles from entering the pumps protects the pumps from damage and assures that spray nozzles in the reactor, drywell and wetwell are not clogged. Therefore, no new precursors of an accident are created and no new or different kinds of accidents are created.

The operation of WNP-2 in accordance with the proposed amendment will not involve a significant reduction in the margin of safety for the following reasons:

The proposed replacement strainers have been designed using the methodology presented in NUREG/CR-6224 and by the BWR Owners Group in their Utility Resolution Guidance (URG) document for ECCS Suction Strainer Blockage, dated November 1996. However, material used in the fabrication of the new strainers was determined to be inconsistent with commitments in the FSAR and SER. The FSAR and SER limit the use of cold-worked austenitic stainless steel in ESF systems to have a yield strength not greater than 90,000 psi. Cold-worked austenitic stainless steels with a yield strength of no more than 90,000 psi have a reduced probability of stress corrosion cracking. Fabrication of the screens entailed operations which cold-worked the screen material (i.e., punching drilling, de-burring, and / or forming). The cold-working caused yield stresses, as determined by micro hardness testing, to exceed 90,000 psi. NRC criteria in Reg Guide 1.70, Rev 2, Section 6.1.1.1, Item 3a, indicate that use of cold-worked austenitic stainless steels with > 90,000 psi yield strength in ESF systems can be acceptable 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, a detailed WNP-2 analysis determined that the probability of stress corrosion cracking is not increased for the functional life of the strainers. To facilitate any future material evaluations, we will install a coupon station in the suppression pool along with the new ECCS suction strainers that contains samples of the cold-worked strainer material. Therefore, this change will not involve a significant reduction in the margin of safety.

Environmental Assessment Applicability Review

Washington Public Power Supply System has evaluated the proposed amendment against the criteria for identification of licensing and regulatory actions requiring environmental assessment in accordance with 10CFR51.21. It has been determined that the proposed changes meet the criteria for categorical exclusion as provided for under 10CFR51.22(c)(9). This conclusion has been determined because the change requested does not pose a significant hazards considerations nor does it involve a significant increase in the amounts, or a significant change in the types of any effluent that may be released off-site. Additionally, this request does not involve a significant increase in individual or cumulative occupational radiation exposure.