Attachment 3 to JAFP-98-0306

JAF-SE-98-025, High Pressure Coolant Injection and Reactor Core Isolation Cooling Suppression Pool Suction Strainer Replacement

New York Power Authority

JAMES A. FITZPATRICK NUCLEAR POWER PLANT
Docket No. 50-333
DPR-59

Nuclear Engineering
NUCLEAR SAFETY EVALUATION FORM

☐ IP3 ☒ JAF Nuclear Station NSE Number: JAF-SE-98-025 Revision #: 0 Full Rev: ☒; Partial Rev. ☐ (See Note 1 below)

Activity Number: F1-98-100 Activity: ☒ Modification ☐ Procedure ☐ Test ☐ Experiment ☐ Other

Title: High Pressure Coolant Injection and Reactor Core Isolation Cooling Suppression Pool Suction Strainer Replacement

A. The proposed activity:

1.	☐ does	☒ does not	increase the probability of occurrence of an accident evaluated in the safety analysis report.
2.	☐ does	☒ does not	increase the consequences of an accident evaluated previously in the safety analysis report.
3.	☐ does	☒ does not	increase the probability of occurrence of a malfunction of equipment important to safety evaluated previously in the safety analysis report.
4.	☐ does	☒ does not	increase the consequence of a malfunction of equipment important to safety evaluated previously in the safety analysis report.
5.	☐ does	☒ does not	create the possibility of an accident of a different type than any evaluated previously in the safety analysis report.
6.	☐ does	☒ does not	create the possibility of a malfunction of equipment important to safety of a different type than any evaluated previously in the safety analysis report.
7.	☐ does	☒ does not	reduce the margin of safety as defined in the basis of any Technical Specification. [See Attach. 4.4 Question A7 for guidance on the use of other documents in determining the margin of safety]
8.	☐ does	☒ does not	involve an unreviewed safety question based on questions 1 through 7.
9.	☐ does	☒ does not	degrade the Security Plans (Physical Security Plan, Guard Training & Qualification Plan, Safeguards Contingency Plan), the Quality Assurance Program, the Fire Protection Program, the Environmental Report (including Appendix B to TS, Offdose Calculation Manual, Process Control Manual), or the Emergency Plan.

B. The proposed activity:

1.	☒ does	☐ does not	require a change to the Final Safety Analysis Report as indicated in Section 3 of this Nuclear Safety Evaluation (NSE).
2.	☐ does	☒ does not	require action tracking of the items indicated in Section 5 of this NSE.
3.	☐ does	☒ does not	require a change to the item(s) indicated in Section A9 above.

C. This proposed activity:

1.	☐ does	☒ does not	require a change to the Technical Specifications.
2.	☒ does	☐ does not	require a change to Design Basis Documents.
3.	☐ does	☒ does not	require a change to Core Operating Limits Report (COLR), IP3 OS or JAF AP-01.04.

Note 1: Full revisions are complete and do not contain revision bars in the NSE.

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Recommended: Approval ☒ Disapproval ☐; PORC Meeting 98-053 Date: 7/28/98

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1.0 PURPOSE

The existing High Pressure Coolant Injection (HPCI) and Reactor Core Isolation Cooling (RCIC) suppression pool suction strainers are being replaced by plant modification F1-98-100 (Ref. 7.1). The replacement strainers have greater debris loading capacity to better accommodate the debris generated as a result of a small or intermediate break Loss of Coolant Accident and smaller openings for improved filtration.

Since the original design basis documentation for HPCI and RCIC does not explicitly define blockage criteria for the suppression pool suction strainers, this modification imposes the 50% blockage requirement, specified in the current design basis for Residual Heat Removal and Core Spray, on the HPCI and RCIC strainers.

2.0 DESCRIPTION OF PROPOSED ACTIVITY

The original suppression pool strainers for the High Pressure Coolant Injection (HPCI) and Reactor Core Isolation Cooling (RCIC) system pumps will be replaced under modification F1-98-100. HPCI Pump Suction Strainer 23F-9 and RCIC Pump Suction Strainer 13F-8 will be replaced with larger, high capacity stainless steel strainers with substantially higher debris loading capacity. The existing wire mesh strainers currently in place for HPCI and RCIC are installed over the mitered ends of the torus penetration nozzles for each pump. These will be replaced with Performance Contracting Incorporated (PCI) Sure-Flow™ stacked disk strainers which will connect to new flanges on the penetration nozzles and extend axially into the torus bays. The design provides high debris loading capacity, low flow entrance velocities and, therefore, low strainer head losses. The surface area of the existing and replacement strainers for HPCI and RCIC are given in Table 2.1 for comparison.

TABLE 2.1

STRAINER SURFACE AREA COMPARISON

PUMP	STRAINER ID	PEN NO.	PEN SIZE (in)	SURFACE AREA EXISTING STRAINERS (ft^2)	SURFACE AREA REPELACMENT STRAINERS (ft^2)
HPCI 23P-1B	23F-9	X-226	16	6.6	133
RCIC 13-P1	13F-8	X-224	6	1.3	10

Procurement Specification JAF-SPEC-MISC-02871 (Ref. 7.2) specifies the design requirements for the replacement strainer assemblies. Additionally, various analyses/calculations have been prepared to demonstrate the acceptability of the available NPSH, structural integrity of the strainers, piping supports and penetrations, hydraulic flow within the suppression pool, and the heavy load path for installation. (A complete list is included in F1-98-100, Section 10.0) To support installation of the new strainers, the modification removes the existing suction strainers from the suppression pool, modifies the torus penetration nozzles to accept new flanges, and modifies supports on the HPCI suction piping outside containment. No reinforcement of the torus penetrations is required.

Strainer installation will be performed with the torus suppression pool drained, in accordance with Technical Specification 3.5.F (Ref. 7.3) which provides ECCS operability requirements with the plant in Cold Condition. The strainers will be lowered into the torus through the Torus Access Hatch Penetration 16X-200A (RS#5). A pre-approved rigging plan will be used to control movement of the strainer assemblies from the Reactor Building Track Bay to the final installed positions in the torus (Ref. 7.4). Load paths and rigging details are defined on Engineering approved sketches. The plan and associated calculations evaluate rigging and safe load paths consistent with criteria in NUREG-0612 (Ref. 7.5).

Post modification examinations will be performed to ensure the structural integrity of the strainer assembly components and torus attached piping affected by this modification, in accordance with applicable portions of the ASME code. Preoperational testing will be performed at full flow conditions, as specified in Technical Specifications 3.5, to verify pump performance has not been affected adversely by the modification.

3.0 SAR REVIEW

3.1 A FOLIO search of the JAF FSAR (Ref. 7.6) and Technical Specifications (Ref. 7.3) was performed using the following words: High Pressure Coolant Injection, HPCI, Reactor Core Isolation Cooling, RCIC, Emergency Core Cooling, ECCS, Suppression Pool, Loss of Coolant, LOCA, Small Break, Intermediate Break. A manual search of the FSAR and Technical Specifications tables and figures also was performed. The following FSAR and Technical Specification sections, licensing documents and unincorporated safety evaluations were reviewed for information related to this modification:

- FSAR Sections 1.6.2.11, 1.6.2.12, 4.7, 4.8, 5.2, 6.4, 6.5, 12.2, 12.5, 14.5, 14.6,16.7, 16.9
- Safety Analysis Report Question and Answer 6.4, Supplement 4 (Ref. 7.7)
- NEDC-32016P-1, Rev.1, Power Uprate Safety Analysis for the James A FitzPatrick Nuclear Power Plant, prepared by the General Electric Company (Ref. 7.8)
- NSE JAF-SE-96-048, Rev. 1, Revision to FSAR to Raise Maximum Allowable Lake Temperature form 82°F to 85°F (Ref. 7.9)
- Technical Specifications 3.5/4.5, 3.7/4.7, 5.0, including the Bases
- Core Operating Limits Report, Rev. 5

3.2 The following sections of the FSAR require revision to incorporate this modification:

- Section 12.5.1.3, Incorporation of changes to the Plant Unique Analysis Report
- Section 12.5.4, The computer code PISTAR was used in the torus attached piping analysis and will be added to this section of the FSAR.

3.3 No changes to the Technical Specifications are required.

4.0 REVIEW AND ANALYSIS

The HPCI System is one of the Emergency Core Cooling Systems (ECCS). It provides reactor vessel inventory makeup during small and intermediate break loss-of-coolant accidents (LOCA) to prevent fuel clad melting. The HPCI System permits the plant to be shut down while maintaining sufficient reactor vessel water inventory until the reactor vessel pressure is below the value at which either the LPCI or Core Spray System can maintain core cooling. If a LOCA occurs, the reactor scrams upon receipt of a low water level signal from the reactor or a high pressure signal from the drywell. The HPCI System controls automatically start the system and bring it to design flow rate within 30 seconds from receipt of a reactor vessel low-low water level signal or a drywell high pressure signal. The HPCI System automatically stops when it receives a signal of high water level in the reactor vessel.

HPCI provides its rated flow over a reactor pressure range from 150 psig to a maximum pressure based on the lowest SRV safety setpoint. The system has five modes of operation. Emergency cooling is the only mode where suction from the suppression pool may be used. The HPCI system is maintained in a standby status during normal operation.

The RCIC System is designed to provide makeup to the Reactor Coolant System (RCS) during isolation of the reactor vessel from the main condenser. Though not part of the ECCS, RCIC also serves as a redundant makeup system in the event of a total loss of all offsite power if HPCI is unavailable. The RCIC System provides core cooling during reactor isolation by pumping makeup water into the reactor vessel in response to low vessel water level. The system is capable of supplying sufficient makeup water so that actuation of ECCS is not required for events other than pipe breaks or loss of reactor coolant inventory. The system is also designed to operate with the RHR System in the steam condensing mode.

Both HPCI and RCIC systems are normally aligned to take suction from the Condensate Storage Tanks (CST). One hundred thousand gallons in each of the two tanks is reserved for the use of the HPCI and RCIC systems. Should the CST be drawn down to a low level, HPCI and RCIC suction is automatically transferred to the suppression pool. This transfer can also be manually initiated. Water from each system is pumped into the reactor vessel via separate feedwater lines.

All components necessary to initiate operation of the HPCI and RCIC Systems are completely independent of emergency AC power, requiring only DC power from the Plant Battery System. The power source for the turbine drivers is the steam generated in the reactor vessel by decay heat in the core. The steam is piped directly to the pump turbine drivers; turbine exhaust is piped to the suppression pool.

4.1 Net Positive Suction Head Evaluation (NPSH)

The original General Electric Design Specifications for the RHR and Core Spray system pumps required a suppression pool suction strainer design that would ensure minimum required NPSH could be maintained with the strainer 50% plugged (Ref. 7.10, 7.11). The Design Specifications for HPCI (Ref. 7.12, 7.13) and RCIC (Ref. 7.14) provided no criteria for strainer blockage. Since the original design basis documentation for HPCI and RCIC do not explicitly define a blockage requirement, the 50% requirement imposed on RHR and Core Spray has been used as the current basis for HPCI and RCIC strainer design.

NPSH for HPCI and RCIC was evaluated in Proto-Power calculation 98-019 (Ref. 7.15) assuming a 50% reduction in strainer surface area to account for debris loading. The calculation evaluated HPCI NPSH margin at long-term conditions for a small break LOCA. Since RCIC is not credited in the response to any LOCA, NPSH evaluation determined the limiting quantity of fibrous debris in the suppression pool that the strainer could accommodate without exceeding the allowable head loss specified in the Procurement Specification (Ref. 7.2). The Specification restricts head loss across strainer disks to 5 feet maximum to limit structural loading on the perforated plate. The analysis performed for HPCI and RCIC verified that, with a 50% reduction in suction strainer surface area, adequate NPSH would be available under all operating conditions described in the safety analysis report.

The current design basis for NPSH analysis differs from that in the FSAR in that the current analysis is based on plant operation at an uprated reactor power level of 2536 MWt (Ref. 7.8) and an increased lake temperature of 85°F (Ref. 7.9). FSAR Figure 6.4-1 specifies HPCI suction flow from the suppression pool during an accident (reactor at high or low pressure) as 4250 gpm at 140°F; FSAR Figure 4.7-3 specifies RCIC suction flow from the suppression pool during an accident (reactor at high or low pressure) as 400 gpm at 140°F (Ref. 7.6). A December 1990 letter from GE to NYPA (Ref. 7.16) indicates that there could be a 4°F suppression pool temperature increase, associated with power uprate operation, for a small break LOCA or during reactor isolation. The GE containment response analysis for increased ultimate heat sink (Ref. 7.17) states that the RHR Service Water temperature increase, associated with the increase in ultimate heat sink temperature, may result in a corresponding increase in the suppression pool water temperature following a transient or accident event due to the reduction in heat removal capability of the RHR heat exchangers. For an increase in lake temperature from 82°F to 85°F, therefore, suppression pool temperature could increase by as much as 3°F.

The NPSH analysis (Ref. 7.15) considered the cumulative impact of power uprate and ultimate heat sink design changes in its determination of a design basis suppression pool temperature. The impact of these two design changes could result in an increase in peak suppression pool temperature for HPCI and RCIC design cases from 140°F to 147°F. This value was conservatively rounded to 150°F for strainer design.

Long-term hot standby operation of the HPCI and RCIC pumps without AC power is discussed in FSAR Section 4.7.6. The RCIC and HPCI Systems are designed for startup and short-term operation without AC power. However, AC power is required for suppression pool cooling (via RHR System) to limit pool temperature for long-term operation. If suppression pool cooling is not available, RCIC and HPCI operation would be limited based on available NPSH. Without the RHR System heat removal capability, the suppression pool would reach 188°F in about 5 hr (Ref. 7.6). The NPSH analysis in Ref. 7.15 shows adequate NPSH margin for both systems up to 190°F with 50% debris loading.

Conditions evaluated in the NPSH analysis were specified in Procurement Specification JAF-SPEC-MISC-02871 (Ref. 7.2). The conditions analyzed and conclusions are summarized in Table 4.1.

TABLE 4.1
NPSH EVALUATION SYSTEM CONFIGURATIONS

SYSTEM	TIME (sec)	FLOW (gpm)	SUPPRESSION POOL TEMP (°F)	NPSH MARGIN: 50% BLOCKED (ft)
HPCI	> 600	4250	150	>10
RCIC	> 600	400	150	>10

4.2 <u>Containment Overpressure</u>

Consistent with the original plant licensing basis (Ref. 7.7), the HPCI and RCIC systems were evaluated at standard atmospheric pressure, i.e. no credit was assumed for containment overpressure.

4.3 Strainer Hole Sizing

No strainer criteria were given in the original General Electric Design Specifications for HPCI or RCIC (Refs. 7.12, 7.13, 7.14). GE Service Information Letter No. 323 (Ref. 7.18) recommended that ECCS pump suction strainer mesh sizes be checked to ensure particulates passing through the strainers could not plug orifices associated with the cyclone separators. The construction of the replacement stacked disk strainer assemblies uses perforated plate with $^3/_{32}$" hole diameters assembled on central core tubes. The strainer openings were specified to ensure removal of particles less than the diameter of the most limiting orifice associated with either pump system.

4.4 Air / Steam Ingestion

Strainer layout and proximity to the SRV T-Quenchers and LOCA downcomers were determined from a three-dimensional AutoCAD™ model of the torus and the strainer layout drawings. The potential for air/nitrogen ingestion into the HPCI and RCIC strainers as a result of bubbles discharged from the SRV T-Quenchers and the LOCA downcomers was evaluated in DE&S calculation A384.F02-04 (Ref. 7.19).

During a large break LOCA, the initial bubble from the downcomers (predominantly nitrogen) is discharged within a fraction of a second as a result of the rapid pressure increase in the drywell. Depending upon the proximity of a pump suction strainer to one of the downcomers, there is a potential for the large bubble to envelop the strainer and, if the pump is in operation, for ingestion into the system. LOCA downcomer bubble sizes have not been quantified for small or intermediate break events. Since the pressure increase from a break <0.2 ft^2 would be significantly less than that for the design basis accident, it can be concluded that the pressure differential acting on the 96 downcomers would not be large enough to force a large bubble into an adjacent strainer. The bubbles discharged through the downcomers as a result of the small/intermediate break will be small in nature. Insufficient driving force would exist to displace downcomer bubbles towards the strainers and buoyancy would cause any small bubbles generated to rise to the pool surface. HPCI and RCIC pump performance, therefore, is not expected to be affected adversely by air ingestion from the downcomers.

Following Safety Relief Valve (SRV) actuation, the compressed air/nitrogen in the discharge line is discharged into the suppression pool forming a high pressure bubble. Depending upon its proximity to the T-Quenchers, there is a potential for the air bubble to overlap a suction strainer. The possibility of air ingestion into the HPCI pump from SRV discharge was not considered credible because of the angle of the T-Quenchers and the location of the HPCI strainer between the ends of two T-Quenchers. Similarly, air ingestion through the RCIC strainer is not postulated due to the location of the strainer and the corresponding T-Quencher which are located at opposite ends of the torus bay.

4.5 Vortex Limits

The minimum suppression pool level to prevent vortexing is not specified in the EOP's for HPCI or RCIC pump suction. An evaluation was performed in DE&S calculation A384.F02-03 (Ref. 7.20) to ensure that the minimum submergence is provided with the pool at its Technical Specification minimum level, 13.88' (Ref. 7.3). The analysis used results from test data and analysis conducted at Alden Research Laboratory (ARL). The results were compared against EPRI test data for a prototype PCI strainer. The analysis shows the submergence needed to prevent vortexing is dependent on flow as the square of the entrance velocity. Using a maximum flow of 4250 gpm for the HPCI strainer and 400 gpm for RCIC strainer, the analysis shows that the minimum pool level required to preclude vortexing is 10.4' for HPCI and 5.7' for RCIC.

The torus nozzles for HPCI and RCIC are angled up from the penetration centerlines. Although the strainer centerlines are not parallel with the water level, the flow patterns generated by the strainers are comparable to a strainer with its centerline parallel to the water level. The elevation of the centerline at the end of the strainers (closest to the pool surface) was used conservatively as the submergence of the core tube.

4.6 NUREG-0783 Suppression Pool Temperature Analysis

Following Safety Relief Valve (SRV) actuation, long-term steam blowdown raises pool temperature. As the pool temperature increases, the condensation rate at the T-Quenchers is reduced. Adequate subcooling is required to ensure steam bubbles formed by SRV discharge are prevented from being ingested into the ECCS suction strainers.

The impact of increased ultimate heat sink temperature and power uprate operating conditions on a long-term SRV discharge event was evaluated in GE analysis GE-NE-T23-000737-01 (Ref. 7.17). The evaluation determined that the peak local suppression pool temperature with 87°F RHR Service Water temperature satisfies the NUREG-0783 requirement to have at least 20°F subcooling at the SRV quenchers (Ref. 7.21). The requirement in NUREG-0783 is intended to prevent unstable condensation at the SRV discharge into the suppression pool. Replacement of the HPCI and RCIC suction strainers will not affect either the bulk or local suppression pool temperature, nor the assumptions used in the analysis. The results of the previous analysis, therefore, remain valid.

4.7 Structural Analysis and Qualification

Since the installation of the new strainers involves adding components inside the torus, new hydrodynamic load generation and reanalysis were required. The new load generation and piping system analysis followed the existing methodologies documented in the Plant Unique Analysis Report (PUAR) (Ref. 7.22, 7.23) to the extent practicable. Techniques used which differ from the original plant unique analysis are summarized in a supplement to the FitzPatrick PUAR (Ref. 7.24). The revised PUAR has been approved and accepted, and can be issued following approval of this NSE.

The replacement strainers have been qualified for the loads, load combinations and acceptance criteria established under the Mark I Containment Reevaluation Program. Evaluation of Mark I hydrodynamic loads postulated for the replacement HPCI and RCIC suction strainers followed the generic requirements of NUREG-0661 (Ref. 7.25) and the plant unique methodologies as specified in the PUAR. In addition to deadweight, thermal and seismic loads, the strainers and torus attached piping were evaluated for Condensation Oscillation and Chugging including Fluid Structure Interaction effects, Safety Relief Valve (SRV) air bubble and water jet loads, LOCA water jet and air bubble loads, and Pool Swell fall back loads. A complete listing of the structural analyses is included in F1-98-100 (Ref. 7.1).

As required by NUREG-0661 and as documented in the PUAR, the Torus Attached Piping (TAP) was evaluated using the design rules of the ASME Boiler and Pressure Vessel Code, Subsection NC, 1977 Edition with Addenda up to and including Summer 1977 Addenda. A parametric study was performed to evaluate the impact of the replacement strainers on external torus attached piping (Ref. 7.26). The study determined that replacement of the HPCI strainer will result in a significant increase in mass and submerged structure loads, and more detailed analysis was performed. Re-analysis of the HPCI torus penetration, X-226, internal piping up to and including the new suction strainer, and external piping up to the nozzle on Booster Pump 23P-1B was performed in DE&S calculation A384.F02-13 (Ref. 7.27). The analysis demonstrated that, with modification of existing support (PFSK-2305) downstream of 23MOV-58 and addition of a new vertical support (PFSK-9169) upstream of 23MOV-57, piping stresses, penetration loads, and pump/valve nozzle loads will be within applicable ASME code limits.

The new RCIC strainer will be shorter but wider than the existing strainer. The parametric analysis showed that the new RCIC strainer configuration will not adversely affect the dynamic characteristics of the existing model and will not result in any additional load being transferred to the external piping. Although axial loads on the penetration will increase with the new strainer, the existing pool swell load combinations are bounded by the load included in the existing analysis. The penetration qualification, therefore, remains acceptable and within code limits. The parametric study concluded the replacement will not impact the existing analysis, and the torus attached piping and support analysis for RCIC remain valid. No further analysis was required.

4.8 Hydrodynamic Loads

Mark I hydrodynamic submerged structure loads for the ECCS and RCIC suppression pool strainers were calculated in DE&S calculation A384.F02-07 (Ref. 7.28). The development of the submerged structure loads on the HPCI and RCIC strainers followed the requirements of the Load Definition Report (LDR) (Ref. 7.29), NUREG-0661 and the PUAR except for the use of reduced acceleration drag volumes to account for the geometry and perforated nature of the stacked disk strainer assemblies. The original plant unique analysis, the LDR and the Mark I Application Guides do not provide guidance for modeling perforated structures.

Acceleration drag loads on submerged structures are proportional to the acceleration drag volume of the structure. The theoretical acceleration drag volume for an infinitely long solid cylinder is 2.0 times the displaced water volume ($2\pi R^2 L$); thus the effective hydrodynamic mass coefficient C_m equals 2.

Acceleration drag tests were performed on the PCI prototype strainer assemblies by DE&S to establish the total inertial mass that will act on the strainer when vibrating in water. The test results (Ref. 7.30, 7.31) were used to calculate a the reduction in load due the holes in the strainer. Conservatively, the total added water mass was found to be 50% of the values obtained for the same shape without holes. The 50% reduction was based on a tested strainer that had $^1/_8$" diameter holes and 40% open area.

The geometry of the FitzPatrick strainers, including stacked disk width and gap width, is consistent with the tested strainers, except that the Fitzpatrick strainers have only 33% open area. Linear interpolation of the test data was used to approximate reduction in the acceleration drag volume. For the Fitzpatrick strainers with 33% open area, interpolation yielded in a 40% reduction. Conservatively only a 25% reduction in loads due to the effect of perforations was used for the RHR and Core Spray strainers (reference F1-97-031). Analysis for the HPCI and RCIC strainers used the 40% reduction based on the test results.

In addition to strainer perforations, a reduction in load to account for the finite length of the strainers was developed for HPCI and RCIC. Since the HPCI and RCIC strainers are relatively short, the end effects term becomes significant. The reduction factors, based on the length and diameter of each strainer, were conservatively calculated as 0.915 and 0.705 for the HPCI and RCIC strainers, respectively. Combining the two reduction factors, the effective hydrodynamic mass coefficients (C_m) used in the piping analyses were 1.10 for HPCI and 0.85 for RCIC.

Subsequent to the development of the C_m used in the ECCS and RCIC piping analyses, additional strainer hydrodynamic mass testing (Ref. 7.32) showed that the values used were conservative. Empirical equations derived from the test results showed that C_m is < 0.5 for these geometries. Supplemental analysis of the HPCI system was performed using a C_m = 0.75 to reduce excess conservatism and more realistically determine the accelerations of valve 23MOV-58.

Analysis of fluid structure interaction (FSI) loads, documented in the existing PUAR, utilized accelerations calculated by Continuum Dynamic, Inc. (CDI) using the PUAR torus shell accelerations and included the direct Condensation Oscillation and Chugging loads on submerged structures. The FSI loads for the new strainers were developed using FitzPatrick PUAR torus shell accelerations and bounding attenuation curves developed by NUTECH during the Mark I program. The FSI loads were applied as force time histories and the results were combined absolutely with the direct submerged structure loads and the torus motion loads. The FSI methodology changes are documented in the PUAR Supplement (Ref. 7.24).

4.9 Load Combinations

In the structural analysis for the new HPCI strainer, independent dynamic loads were combined using the Square Root Sum of the Squares (SRSS) method. This method was used in the evaluation of certain components in the original Mark I analysis. The use of the SRSS method, however, was not documented in the PUAR and subsequent SER which state that the Mark I dynamic piping loads were combined by absolute sum. Combining piping system responses from independent dynamic loads by the SRSS method has been shown in NEDE-24632 (Ref. 7.33) to meet the requirements of Paragraph 4.4.3 of NUREG-0661. NUREG-0661 states that, as an alternative to absolute sum combinations, the cumulative distribution function method (CDF) may be used on a component specific basis to combine independent dynamic loads and the CDF combined stress values must show a nonexceedance probability of 84%. NEDE-24632 used the CDF methods to show that the SRSS combination of independent Mark I dynamic loads has a non-exceedance probability of at least 84%. Based on the review of NEDE-24632, the NRC has accepted the use of the SRSS combination of piping system responses due to independent dynamic loads, as documented in a 1983 letter from the NRC to General Electric (Ref. 7.34). This method has been widely used throughout the industry on Mark I plants. A supplement to the PUAR has been prepared, which documents the use of SRSS for FitzPatrick (Ref. 7.24).

4.10 Integral Welded Attachments

Paragraph NC-3645 of ASME III requires that attachments to Class 2 piping shall be designed so as not to cause flattening of the pipe, excessive localized bending stresses or harmful thermal gradients in the pipe wall. The code does not provide a methodology or criteria for evaluating the effects of attachments to piping. Furthermore, the Mark I Plant Unique Analysis Application Guide (Ref. 7.35), the FitzPatrick PUAR and its subsequent SER, and NUREG-0661 also do not describe a methodology or criteria used to evaluate local attachments to piping. The ASME Code, in general, does not limit the engineer's/designer's choice of the methods used to meet the code rules. Therefore, to meet the requirements of NC-3645, Code Cases N-318 and N-392 were chosen as reasonable methods for the qualification of local welded attachments on Class 2 piping. Code Cases N-318 and N-392 were specifically chosen for the following reasons: they are of the same vintage as the design Code (1977 edition with addenda through Summer 77) and their methodology has been accepted previously by the NRC. As the Code Cases are being used solely as a method to meet the requirements of the Code of Record, no code reconciliation is required. This use of Code Cases N-318 and N-392 to evaluate the effects of attachments to Class 2 piping has been documented in a supplement to the PUAR (Ref. 7.24).

4.11 HPCI Pump Suction Valve

The accelerations acting on HPCI pump suction isolation valve, 23MOV-58, were predicted to increase significantly as a result of the strainer replacement (Ref. 7.27). The valve has been evaluated to ensure structural integrity would be maintained under all design conditions (Ref. 7.36). The accelerations acting on the motor operator are bounded by the Limitorque qualification (Ref. 7.37).

4.12 Dose Rates

It is expected that the strainers will accumulate radioactive particulates during normal plant operation in addition to the deposition of debris during an accident. Since the strainers will not generate any additional particulates, offsite dose rates will not be affected. Local dose rates within the torus and external to the torus in the area of the strainers may be impacted during normal plant activities. These would be evaluated and controlled as necessary in accordance with plant procedures to minimize personnel exposure. In an accident scenario, water from the suppression pool is circulated through the systems increasing dose rates in the areas of the pumps. For accident response, it is expected that the dose rate in any area in which operator actions are required would not be affected significantly.

4.13 10CFR 50.59 Evaluation

Replacement of the suppression pool suction strainers for the HPCI and RCIC pumps:

1. **does not increase the probability of occurrence of an accident evaluated in the safety analysis report.**

   HPCI and RCIC are accident mitigation systems. The replacement of the suppression pool suction strainers does not alter any initial condition or assumption used in the accident analysis. FSAR Section 12.2A.6 identifies four major accidents in the Chapter 14 analysis. These events are:

   - Control rod drop accident
   - Postulated piping breaks inside containment
   - Postulated piping breaks outside containment
   - Refueling accident (fuel handling accident)

   Replacement of suction strainers in the suppression pool has no impact on control rod or fuel handling accidents. The passive pump suction strainers are not pressure retaining components and their failure can not affect RCS pressure boundary integrity.

   FSAR Section 12.2A.7 describes other design basis events including events in which inadvertent operation of the HPCI pump results in a decrease in moderator temperature. Since this modification involves only the installation of passive pump suction strainers, there is no impact on any pump control function and this modification can not increase the probability of an accidental pump start.

   The replacement of the suppression pool strainers for these systems with the new strainer assemblies, therefore, will not increase the probability of an accident previously evaluated in the SAR.

2. does not increase the consequences of an accident evaluated previously in the safety analysis report.

HPCI is designed to provide reactor vessel inventory makeup during small and intermediate break loss-of-coolant accidents (LOCA) to prevent fuel clad melting. System operation is independent of AC power. RCIC serves as a redundant makeup system in the event of a total loss of all offsite power if HPCI is unavailable. Installation of new passive suction strainers will not affect the operation or performance of either system.

Analysis performed for the HPCI and RCIC system pumps verified that, with a 50% reduction in suction strainer surface area, adequate Net Positive Suction Head (NPSH) would be available under all operating conditions described in the safety analysis report. The replacement strainers have larger surface areas than those currently installed, increasing the likelihood of long-term pump availability following a small or intermediate break LOCA.

Thermal input to the suppression pool is not increased and the heat capacity of the RHR heat exchangers is not affected. The reduction in suppression pool inventory resulting from installation of the larger HPCI and RCIC strainers is negligible. The suppression pool level specified in Technical Specification 3.7 and minimum pool water volume described in Technical Specification Bases 3.7 are not affected. Suppression pool temperatures under accident conditions, therefore, will not be affected by the modification.

The strainers, torus penetration, and torus attached piping have been analyzed and qualified for the loads, load combinations and acceptance criteria established under the Mark I Containment Reevaluation Program. The design ensures the strainer assemblies can withstand seismic events and hydrodynamic loads associated with a design basis LOCA without loss of structural integrity.

Dose rates in any area in which operator actions are required during an accident would not be affected significantly by the debris accumulation on the strainers. Dose rates in the areas around the HPCI and RCIC pumps increase as a result of circulating suppression pool water through the systems when the pumps are in operation. The additional source term associated with debris accumulated on the strainers would not add to the dose rates in those areas substantially.

The installation of larger suppression pool strainers for HPCI and RCIC system pumps will not adversely impact the ability of either system to perform its accident mitigation functions during a postulated small or intermediate break LOCA. Analysis has demonstrated that the modification will not adversely affect containment pressure vessel integrity or alter the heat removal functions of the suppression pool. This modification, therefore, will not increase the current predicted radiological release for a design basis accident and there will be no increase in the consequences of an accident evaluated previously in the SAR.

3. does not increase the probability of occurrence of a malfunction of equipment important to safety evaluated previously in the safety analysis report.

The surface areas of the new strainer assemblies are greater than those of the current strainers to accommodate a larger accumulation of debris, while still meeting pump net positive suction head requirements. Strainer design minimizes entrance velocities and, therefore, head loss, and precludes the formation of a vortex from entraining air into the system. The NPSH analysis (Ref. 7.15) verifies that, with 50% reduction in strainer surface area, the HPCI and RCIC pumps would have adequate $NPSH_{AVAILABLE}$ to perform their accident mitigation functions. The perforated holes in the disk assemblies were sized to ensure particles do not pass through which could plug system clearances.

The evaluations in Ref. 7.19 conclude that, for HPCI and RCIC, vapor bubble ingestion as a result of LOCA downcomer discharge or SRV initiation is not credible for a small or intermediate break accident.

The new strainer assemblies were structurally evaluated to ensure integrity with debris loading in excess of 50%. The replacement suction strainers, torus attached piping and torus penetrations were evaluated for dead weight, pressure, thermal and seismic loads, safety relief valve discharge loads, and Mark I containment hydrodynamic loads acting directly on the submerged assemblies and indirectly by torus motions transmitted to the piping at the torus attachment points. The design ensures the integrity of the strainers and associated piping and supports under design basis conditions and verifies that the additional loads on the primary containment pressure vessel remain within code allowables.

The new passive suction strainer assemblies provide the same function as the existing strainers. The design of the new strainer assemblies has been fully evaluated through analyses, calculations, and scaled testing to ensure the design requirements of seismic, structural loading, hydrodynamic loading, and NPSH are met. This modification does not increase the probability of occurrence of a malfunction of equipment important to safety evaluated previously in the safety analysis report.

4. does not increase the consequences of a malfunction of equipment important to safety evaluated previously in the safety analysis report.

The modification does not introduce any new failure modes to any existing equipment. The new strainers are passive components and, therefore, have no active failure modes which could affect the availability of the safety systems.

The modification has been evaluated to ensure adequate NPSH would be available for long-term operation, that air or steam ingestion would not degrade pump performance, and that the heat sink functions of the suppression pool are not adversely affected. Structural analyses have demonstrated the structural integrity of the strainer assemblies under hydrodynamic loads associated with a design basis LOCA and that the installation will not adversely affect the containment pressure vessel.

The installation of larger suction strainers does not alter the assumptions made in the safety analysis, does not degrade the performance or impact the independence of any safety significant system. The consequences of a malfunction of equipment important to safety previously evaluated in the SAR, therefore, will not increase as a result of this modification.

5. does not create the possibility of an accident of a different type than any evaluated previously in the safety analysis report.

The new strainers are passive, non pressure-retaining components which perform the same function as the existing strainers. No new operating/failure modes are introduced by the replacement and no new system interactions are created. The evaluations performed verified the modification will not adversely affect the safety functions of the suppression pool or the structural integrity of the primary containment pressure boundary. No other safety systems are affected by this modification. This modification, therefore, does not create the possibility of an accident of a different type.

6. **does not create the possibility of a malfunction of equipment important to safety of a different type than any evaluated previously in the safety analysis report.**

The new strainers are passive, non pressure-retaining components as are the existing strainers. No new failure modes or system interactions are introduced by the modification and independence of the safety trains is not affected.

HPCI and RCIC system control functions and independence from AC power are not impacted in any way by this modification. The ability of either system to provide core cooling following a loss of AC power is unaffected.

The evaluations in Ref. 7.19 conclude that vapor bubble ingestion, as a result of LOCA downcomer discharge or SRV initiation, is not credible for a small or intermediate break accident.

The materials of the strainer assemblies are fully compatible with the Reactor Coolant System and support the structural requirements of the design. The new strainers and piping supports have been analyzed for design basis seismic and Mark I hydrodynamic loads. The analyses also confirm that the installation will not adversely affect the integrity of the containment pressure vessel. The strainers will be mounted to prevent any seismic/blowdown event from inducing a failure of the strainer assemblies, suction piping or the penetration. System response is not altered due to the new strainers.

This modification, therefore, does not create the possibility of any malfunctions of equipment important to safety of a different type than previously evaluated in the SAR.

7. **does not reduce the margin of safety as defined in the basis for any Tec Specification.**

The Bases for Technical Specification 3.5.A describe the function of the HPCI system as providing adequate cooling to the core for all pipe breaks smaller than those for which the LPCI or Core Spray systems can protect the core. RCIC is described as a redundant makeup system for total loss of all offsite power in the event HPCI is unavailable. Installation of passive suction strainers in the suppression pool will not affect system performance or impact, in any way, the initiating functions for either pump.

Technical Specification 3.7.1, Containment Design, Primary Containment, limits suppression pool level to between 13.88 and 14.00 ft. The Bases relate the specification requirement to the downcomer submergence levels assumed in the containment analyses. The water level height of the suppression pool is necessary to assure complete condensation of steam during the blowdown phase of an accident. The reduction in suppression pool inventory resulting from installation of the larger HPCI and RCIC strainers is negligible. The minimum pool water volume described in Technical Specification Bases 3.7, therefore, will remain unchanged and the water level required to ensure complete condensation during an accident will be maintained. Also, the suppression pool water volume required to act as the heat sink for the RCS energy release following a postulated LOCA will not be reduced below that discussed in the Bases.

The design of the new strainer assemblies has been fully evaluated through analyses, calculations, and scaled testing to ensure the design requirements of seismic, structural loading, hydrodynamic loading, and NPSH/head loss are met. The systems will continue to operate as currently designed and the margins of safety defined for the Technical

Specification will not be reduced.

8. **does not involve an unreviewed safety question based on questions 1 through 7.**

9. **does not degrade the Security Plans (Physical Security Plan, Guard Training & Qualification Plan, Safeguards Contingency Plan), the Quality Assurance Program, the Fire Protection Program, the Environmental Report (including Appendix B to TS, Offdose Calculation Manual, Process Control Manual), or the Emergency Plan.**

   No protected or vital area barriers are affected, no security equipment is altered or affected in any way, nor is the configuration of any equipment altered which could interfere with the operation of any security equipment.

   All components affected by the proposed modification will be procured and installed in accordance with the applicable requirements for Category I components. There will be no impact on the Quality Assurance Program.

   The proposed changes will not impact the site fire protection program. No fire barrier is affected, no flammable or combustible material is added or removed from any area of the plant, and no fire detection/suppression equipment or emergency lighting is impacted. FPES-04A Exhibit 1, (Ref. 7.38) has been prepared, reviewed and approved. The modification has been evaluated for impact on the Fire Protection Program and Appendix R Safe Shutdown Analysis and the commitments made therein are not impacted, invalidated, or affected.

   Touch-up painting, required at the completion of strainer and support installation, will be controlled by existing plant procedures which specify use of pre-approved paints. The modification has no other effect on air or water quality, does not involve use of any hazardous substance, does not affect any property outside the plant buildings, does not introduce any new effluent paths, involve storage of any radioactive material, or affect the Meteorological Tower.

   The installation of replacement strainers for the HPCI and RCIC pumps will not affect the operation or performance of any component or system required for accident mitigation. No EOP revisions will be required. This modification has no impact on Emergency Plan staffing, notification, monitoring or reporting systems. No structures outside the reactor building will be affected.

5.0 ACTION ITEMS TO BE TRACKED

None

6.0 10CFR50.59(B)(2) SUMMARY OF ACTIVITY AND NUCLEAR SAFETY EVALUATION

Modification F1-98-100, Rev. 0, "High Pressure Core Injection and Reactor Core Isolation Cooling Suppression Pool Suction Strainer Replacement", installs new suppression pool suction strainers for HPCI and RCIC system pumps. The replacement strainers are larger than the current strainers and provide additional margin for debris loading following a small or intermediate break loss-of-coolant-accident. Consistent with the original licensing basis for FitzPatrick, the replacement strainers have been evaluated to ensure adequate NPSH would be available to the pumps with the suction strainers 50% blocked. The strainer assemblies have been analyzed and qualified for seismic and Mark I hydrodynamic loads specified in the FSAR and Plant Unique Analysis Report.

A review of the modification in accordance with 10CFR 50.59 concluded that the modification does not increase the probability or consequences of an accident or of a malfunction of equipment important to safety previously evaluated in the safety analysis report. Further, the possibility of an accident or malfunction of a different type than any evaluated previously in the safety analysis report will not be created. The margin of safety as defined in the Technical Specification Bases is not reduced and no Technical Specification change is required. This change, therefore, does not involve an unreviewed safety question.

7.0 REFERENCES

7.1 JAF Modification F1-98-100, Rev. 0, High Pressure Coolant Injection and Reactor Core Isolation Cooling Suppression Pool Suction Strainer Replacement

7.2 Specification No.: JAF-SPEC-MISC-02871, Rev. 5, Technical Procurement Specification for Residual Heat Removal (RHR), Core Spray (CS), High Pressure Coolant Injection (HPCI) and Reactor Core Isolation Cooling (RCIC) Suction Strainers

7.3 Technical Specifications 3.5/4.5, 3.7/4.7, Updated through Amendment 240

7.4 JAF-RPT-MISC-02940, Rev. 0, Rigging Plan - ECCS Strainer Replacements

7.5 NUREG-0612, Control of Heavy Loads at Nuclear Power Plants, July 1980

7.6 FSAR, 1997 FSAR Update

7.7 U.S. Atomic Energy Commission Safety Evaluation of the James A. FitzPatrick Nuclear Power Plant, Docket No. 50-333, November 20, 1972

7.8 NEDC-32016P, Rev. 1, Power Uprate Safety Analysis for the James A. FitzPatrick Nuclear Power Plant, prepared by GE Nuclear Energy

7.9 JAF-SE-96-048, Rev. 1, Revision to FSAR to Raise Maximum Allowable Lake Temperature from 82°F to 85°F, Modification F1-97-016

7.10 General Electric Design Specification 22A1472, Rev. 1, Residual Heat Removal System (with Steam Condensing)

7.11 General Electric Design Specification 22A1435, Rev. 1, Core Spray System

7.12 General Electric Design Specification 22A1362, Rev. 5, High Pressure Coolant Injection System

7.13 General Electric Design Specification 22A4313, Rev. 0, High Pressure Coolant Injection System

7.14 General Electric Design Specification 22A4314, Rev. 0, Reactor Core Isolation Cooling System

7.15 Proto-Power Corp. Calculation No. 98-019, Rev. B, Emergency Core Cooling and Reactor Core Isolation System Pump Suppression Pool NPSH

7.16 C.A. Stool, GE Nuclear Energy, letter to Richard Chi, New York Power Authority, JA FITZPATRICK (JAFNPP) POWER UPRATE PROGRAM - Assessment of Impact on HPCI and RCIC Systems, 12/21/90

7.17 GE-NE-T23-0737-01, James A FitzPatrick Nuclear Power Plant Higher RHR Service Water Temperature Analysis, General Electric Company, August 1996

7.18 General Electric Service Information Letter (SIL) No. 323, Suppression Pool Suction Strainer Mesh Size Mismatch with Emergency Core Cooling System (ECCS) Pump Seal Orifices, 1980

7.19 DE&S Calculation, A384.F02-04, Rev. 1, ECCS Suction Strainer Bubble Ingestion

7.20 DE&S Calculation No. A384.F02-03, Rev. 0, RHR, CS, HPCI and RCIC Suction Strainer Vortex/Minimum Submergence

7.21 NUREG-0783, Suppression Pool Temperature Limits for BWR Containments, November 1981

7.22 Teledyne Engineering Services, Technical Report TR-5321-1, Mark I Containment Program Plant Unique Analysis Report of the Torus Suppression Chamber for James A. Fitzpatrick Nuclear Power Plant, Rev. 1, November 1984

7.23 Teledyne Engineering Services, Technical Report TR-5321-2, Mark I Containment Program Plant Unique Analysis Report of the Torus Attached Piping for James A. Fitzpatrick Nuclear Power Plant, Rev. 1, November 1984

7.24 JAF-RPT-MULTI-03000, Rev. 1, ECCS Suction Strainer Replacement Modification Supplement to the Plant Unique Analysis Report

7.25 NUREG-0661, Safety Evaluation Report Mark I Containment Long-Term Program, Resolution of Generic Technical Activity A-7, July 1980, including Supplement 1, August 1982

7.26 JAF-RPT-MULTI-02921, Rev. 1, Torus Attached Piping Parametric Study for the ECCS Suction Strainer Replacements

7.27 DE&S Calculation No. A384.F02-13, Rev. 0, HPCI Penetration X-226 TAP Piping Reanalysis for the Replacement Suction Strainer Assemblies

7.28 DE&S Calculation No. A384.F02-07, Rev. 1, Mark I Hydrodynamic Submerged Structure Loads on the Replacement Core Spray, RHR, HPCI, and RCIC Suction Strainer Assemblies

7.29 NEDO-21888, Rev. 2, November 1988, General Electric, Mark I Containment Program Load Definition Report

7.30 DE&S Test Report No. TR-ECCS-GEN-01-NP, Rev. 2, Test Report for Hydrodynamic Inertial Mass Testing of ECCS Suction Strainers

7.31 DE&S Test Report No. TR-ECCS-GEN-05-NP, Rev. 1, Supplement 1 to Hydrodynamic Inertial Mass Testing of ECCS Suction Strainers - Free Vibration Analysis

7.32 DE&S Test Report No. TR-ECCS-GEN-011, Rev. 0, ECCS Suction Strainer Hydrodynamic Test Summary Report

7.33 GE Report NEDE-24632, Mark I Containment Program - Cumulative Distribution Functions for Typical Dynamic Responses of a Mark I Torus and Attached Piping Systems, December 1980

7.34 D.B. Vassallo (USNRC) letter to H. C. Pfefferlen (GE), Acceptability of SRSS Method for Combining Dynamic Responses in Mark I Piping Systems, March 10, 1983

7.35 NEDO-24583-1, "Mark I Program, Structural Acceptance Criteria, Plant Unique Analysis Application Guide," October 1979

7.36 Altran Calculation No. 93179-C-61, Rev. 0, Valve Thrust Assessment 16" Powell Gate Valve 23MOV-58

7.37 Limitorque Report B0115, Hydrodynamic Vibration Test (New Loads), 6/24/82

7.38 ESM: FPES-04A, Rev. 1, Fire Protection/Appendix R Compliance Procedure