NRC FORM 366 (4-95) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

APPROVED BY OMB NO. 3150-0104
EXPIRES 04/30/98

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TITLE (4) CAR Fan Service Water Piping Susceptible to Water Hammer

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
										05000
07	22	96	96	013	01	09	05	97	FACILITY NAME	DOCKET NUMBER 0500

OPERATING MODE (9): 1
POWER LEVEL (10): 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)

20.2201(b)	20.2203(a)(2)(v)	X 50.73(a)(2)(i)	50.73(a)(2)(viii)
20.2203(a)(1)	20.2203(a)(3)(i)	X 50.73(a)(2)(ii)	50.73(a)(2)(x)
20.2203(a)(2)(i)	20.2203(a)(3)(ii)	50.73(a)(2)(iii)	73.71
20.2203(a)(2)(ii)	20.2203(a)(4)	50.73(a)(2)(iv)	OTHER
20.2203(a)(2)(iii)	50.36(c)(1)	50.73(a)(2)(v)	Specify in Abstract below or in NRC Form 366A
20.2203(a)(2)(iv)	50.36(c)(2)	50.73(a)(2)(vii)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Jeff Bibby, Manager Engineering	(860)267-2556

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE).	X NO	EXPECTED SUBMISSION	MONTH	DAY	YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On July 22, 1996, at 1820 hours, with the plant in Mode 1 at 100% power, an engineering analysis determined that if a loss of coolant accident or main steam line break inside containment occurred, coincident with a loss of offsite power, the service water piping inside containment downstream of the containment air recirculation (CAR) fan coolers would reach saturation. Upon restart of the service water pumps a water hammer could develop that would exceed the structural design of the piping, rendering the CAR fans inoperable. There is also the potential for excessive piping and support loads in the area of the throttle valves located outside containment. Technical Specification (TS) 3.0.3 was entered at 1820 hours and a plant shutdown was initiated at 1843 hours. At 2215 hours, at less than 10% power, TS 3.0.3 was again entered when the high startup rate (SUR) trip channels were declared inoperable due to the lack of instrumentation uncertainty calculations. The cause of the CAR fan issue was failure to perform an in-depth analysis of the above scenarios. The cause of the high SUR issue was an inadequate design review. Uncertainty calculations for the high SUR instrumentation were performed and no adjustments were necessary. This supplemental report is being issued to retract originally proposed corrective actions that are no longer required as a result of the Haddam Neck plant being in a permanently defueled state.

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TEXT *(If more space is required, use additional copies of NRC Form 366A)* (17)

BACKGROUND INFORMATION

The design basis of the containment air recirculation (CAR) fans (EIIS Code: BK) is to provide cooling and recirculation of the containment atmosphere during normal operation or during and after a loss of coolant accident (LOCA) or main steam line break. There are four CAR fans inside the reactor containment. Following a LOCA, each CAR unit is reconfigured to include moisture separators, particulate filters and charcoal filters. During accident conditions the CAR fans also act as the primary means of depressurizing containment. The CAR fans are cooled by service water which circulates through the cooling coils within each unit. The service water system (EIIS Code: BI) consists of four service water pumps, with two pumps per train, supplying two main headers (each supplying primary plant and secondary plant). Upon receipt of a high containment pressure, safety injection actuation signal or loss of normal power signal, motor operated valves at the beginning of each secondary header will automatically close to isolate service water to non-essential secondary plant systems maximizing flow to the primary plant headers. During a loss of normal power (LNP) one service water pump per emergency diesel generator (EIIS Code: EK) will automatically start, powered from the diesel generator. Taking into account a 10 second delay in diesel start time and the sequencing of loads on the diesel, the service water pump will restart approximately 43 seconds after the LNP. In the event that the first pump does not start, the second pump on that diesel generator will automatically start after an additional 5 second time delay.

The excore nuclear instrumentation system (EIIS Code: IG) consists of four channels each of wide range and power range instrumentation. The wide range channels cover the range from source levels to 200% power. The wide range channels also provide a measurement of the rate of change of neutron flux over the full range of neutron flux. During startup, if any one of four channels exceeds 2 decades per minute (DPM) it will initiate a rod stop signal and alarm if reactor power is less than 10%. If 5 DPM is exceeded on any two of four channels, a reactor trip will occur if reactor power is less than 10%. Above 10% power both protective mechanisms are blocked.

EVENT DESCRIPTION

On July 22, 1996, at 1820 hours, with the plant in Mode 1 at 100% power, an engineering analysis determined that if a LOCA or main steam line break inside containment occurred, coincident with a loss of offsite power, the service water piping inside containment, downstream of the containment air recirculation (CAR) fan coolers, could be subjected to severe water hammer transients that could exceed the structural design of the piping, resulting in piping failure, and the loss of the CAR fan units and/or the loss of containment integrity.

A LNP trips the operating service water pumps and CAR fans, resulting in a temporary depressurization of the service water supply to the CAR fans. Power to the CAR fans and the service water pumps is not restored immediately due to the time delay associated with the diesel generator startup and sequencing of service water pumps and CAR fans. During this time both the air flow and the service water flow in the CAR fan cooling coils decreases. While the decrease in service water flow is expected to be rapid the decrease in air flow will be much slower because of the inertia of the CAR fan rotating assemblies. During the 48 second maximum time period between the LNP and service water pump start, it is postulated that enough heat could be added to the depressurized, stagnant water that it would result in the creation of steam voids in the CAR fan cooling coils and the downstream piping . When the service water pumps restart, water slugs may form in the horizontal discharge lines which may be carried downstream, creating a potential for water hammer in the service water piping. If the water hammer was severe it could result in piping failure, and the loss of the CAR fan units and/or the loss of containment integrity.

In addition, subsequent analysis of dynamic, thermal-hydraulic piping loads has revealed the potential for significant, unanalyzed piping and support loads downstream of the CAR unit outlet isolation/throttle valves in the event of a LOCA, with or without a loss of normal power. The isolation/throttle valves are located outside containment in the Primary Auxiliary Building (PAB).

Technical Specification (TS) 3.0.3 was entered at 1820 hours and a plant shutdown was initiated at 1843 hours. At 2215 hours, at less than 10% power, TS 3.0.3 was again entered when the high startup rate (SUR) trip channels were declared inoperable due to the lack of instrumentation uncertainty calculations. The lack of uncertainty calculations had been identified on June 5, 1996 as part of an NRC design basis inspection. Startup rate trip protection was not required at the time of discovery since the reactor was above 10% power. After discovery, the uncertainty calculation was initiated. Although the uncertainty calculation was in the review stage, it was not completed before power decreased below 10%. The unit was taken off line at 2228 hours and Mode 5 (cold shutdown) was entered at 0335 on July 24, 1996.

CAUSE OF THE EVENT

The cause of the CAR fan issues was the failure to properly couple a water hammer analysis with a LOCA event with and without a loss of normal power . Previous water hammer analyses assumed limited CAR unit heat duty during the first 43 seconds due to the fact that CAR unit tube and air side flow rates were minimal with the service water pumps and CAR units de-energized. A recent in-depth transient analysis has identified the potential for significant steam generation and service water pipe steam void creation during the first 43 seconds. Further analysis has revealed that in the event of a LOCA, with or without a LNP, there is a potential for excessive piping and support loads in the area of the throttle valves, located outside containment, as a result of steam flashing across the throttle valves.

The cause of the high SUR issue is attributed to inadequate design review. Plant design change request PDCR No. 954, "Nuclear Instrumentation System Replacement", completed in 1990, identified and provided the required setpoints for the system via the Master Setpoint Log. However, no formal uncertainty calculation was performed as part of the PDCR, nor was there any explicit requirement to do so. Engineering review was intended to be the self checking mechanism for these types of requirements and should have identified the necessity for the calculation.

SAFETY ASSESSMENT

This CAR fan issue is reportable under the following criteria:

10CFR50.73(a)(2)(ii)(B) as a condition that was outside the design basis accident analysis for the plant.

10CFR50.73(a)(2)(i)(B) as a condition prohibited by the plant's Technical Specifications due to the entry into Technical Specification 3.0.3.

10CFR50.73(a)(2)(i)(A) as the completion of a shutdown required by the Technical Specifications.

The Containment Air Recirculation (CAR) Fans are designed to provide cooling and depressurization of the containment atmosphere for the following design basis accidents inside containment : a Loss of Coolant Accident (LOCA), and Main Steam Line Break (MSLB). The CAR fans also provide filtration of the post accident containment atmosphere to reduce particulate and radioiodine concentrations, thereby limiting the potential for significant radioactive releases.

The CAR fans are cooled by service water circulating through cooling coils within each unit. A loss of this cooling medium could result in elevated containment temperatures and pressures. The probability of containment failure as a function of elevated temperatures and pressures have been evaluated for the Probabilistic Risk Assessment (PRA) analysis. Elevated temperature effects on containment temperatures have little influence on containment response. The median containment pressure for failure is 90 psig which is 225% of the design pressure of 40 psig.

The ultimate temperature and pressure that would be reached during this postulated event are unknown, however, they are expected to exceed the design basis parameters.

For a postulated break of the service water cooling line inside containment, the potential existed for a loss of containment integrity or pressure boundary. The location of the water hammer and subsequent line break has the potential for a path leading to a radioactive release through the discharge canal or to the atmosphere. There are manually operated valves on the return side of the service water system outside of containment, located within the primary auxiliary building, that can be isolated to minimize the extent of the release if the leak occurred upstream and inside

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containment. On the supply side of the system, there are check valves that would also help to minimize the potential for a radioactive release.

The probability of containment failure and coincident fuel damage remains low given that the following would have to occur coincidentally : initiation of either a LOCA, or MSLB inside of containment and the loss of offsite power.

The potential also existed that a line break could occur upstream or downstream of the outlet isolation/throttle valves, outside containment, which could have eliminated the isolation capabilities of these valves for a LOCA with or without a loss of normal power. This could have resulted in an uncontrolled release if it occurred coincident with both fuel damage and a service water line break inside containment.

The nuclear instrumentation issue is reportable under 10CFR50.73(a)(2)(i)(B) as a condition prohibited by the plants Technical Specifications due to the entry into Technical Specification 3.0.3. Specifically, operating with inoperable wide range startup rate trip channels due to the lack of uncertainty calculations.

Uncertainty calculations for the high startup rate instrumentation have been performed and no adjustments were required to the existing setpoints. The results of this evaluation determined the total uncertainty is +/- 0.19 decades per minute. Therefore, the wide range startup rate channels will operate within the existing analytical limits, Technical Specification allowable value, and the Technical Specification trip setpoint.

CORRECTIVE ACTION

A comprehensive review of the entire SWS was performed. The purpose of which was to ensure all water hammer issues pertaining to the SWS have been identified and resolved.The result of this effort identified two locations (supply and return to spent fuel pool heat exchangers) in the SWS piping which maintain the potential to produce a water hammer event. A check valve was installed in the SWS supply line to the spent fuel pool heat exchangers to remedy the situation.

Uncertainty calculations for the high startup rate instrumentation have been performed and no adjustments were required to the existing setpoints. Instrumentation setpoints are now controlled through the Design Control Manual. Additionally, steps have been incorporated into the detailed review checklist, contained in the Design Control Manual, to address initiation and revision to instrumentation uncertainty calculations.

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ADDITIONAL INFORMATION

This supplemental report is being issued to retract the following originally proposed corrective actions.

Modifications to the SWS prior to plant startup, which would provide uninterrupted service water flow to the CAR fans utilizing a pressurized water supply tank. Resolution of this issue, including any required modifications as a result of the potential for water hammer downstream of the outlet isolation/throttle valves was also to be completed.

The basis for retracting this corrective action pertains to the fact that HNP has permanently ceased power operation and all fuel has been removed from the reactor vessel as such any potential hardware modifications will not be implemented.

PREVIOUS SIMILAR EVENTS

LER 96-012-00 "Feedwater Regulating Valve May Not Close During Steam Line Break"

LER 95-008-00 "Main Steam Line Break Reanalysis Resulted in Higher Containment Temperature"

LER 95-010-00 "Pressure Locking of Safety Injection Valves"

LER 95-011-00 "High Differential Pressure Could Render Containment Sump MOV Inoperable"