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

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ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS MANDATORY INFORMATION COLLECTION REQUEST: 50.0 HRS. REPORTED LESSONS LEARNED ARE INCORPORATED INTO THE LICENSING PROCESS AND FED BACK TO INDUSTRY. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (T-6 F33), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

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

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TITLE (4)

Containment Recirculation Spray, Quench Spray, and Safety Injection Systems Outside Design Basis Due to Design Errors

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
04	03	96	96	007	02	12	13	96	FACILITY NAME	DOCKET NUMBER

OPERATING MODE (9)	5	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)			
POWER LEVEL (10)	000	20.2201(b)	20.2203(a)(2)(v)	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)	[X] 50.73(a)(2)(v)	Specify in Abstract below or in NRC Form 366A
		20.2203(a)(2)(iv)	50.36(c)(2)	[X] 50.73(a)(2)(vii)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
J.M. Peschel, MP3 Nuclear Licensing Manager	(860)437-5840

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

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

On April 3, 1996, at 13:55, with the plant in Mode 5 at 0-percent power, it was determined that the plant had operated in a condition that was outside the design basis due to a deficiency in specific design conditions for a system needed to remove residual heat and mitigate the consequences of an accident. It was determined that the Containment Recirculation System (RSS) spray piping and supports were not adequately designed for thermal loads resulting from accident temperatures. Accident temperatures could result in stresses above the design allowable stresses for plant "Faulted" conditions.

It was initially determined that the higher RSS temperatures could result from a postulated loss of Service Water (SWP) to one or more RSS heat exchangers. It was subsequently determined that: (a) unacceptable stresses in RSS piping, Quench Spray System (QSS) piping, and portions of piping which comprise the Safety Injection (SI) flowpath, and the associated supports for those systems, could also result from the design basis accident temperatures inside containment, and (b) the original design basis analyses for the RSS and QSS systems utilized support anchor movements which were nonconservative.

At the time of discovery the plant was completing a shutdown for unrelated reasons. Plant systems responded normally to the shutdown. No Engineered Safety Features Actuations were required or were initiated as part of the shutdown.

As corrective actions, design reviews of the RSS, QSS, SI, and other systems are being performed, design improvements will be made, and the systems wil be restored to appropriate design basis requirements prior to declaring the systems operable for other than modes 5 and 6. As action to prevent recurrence, those systems which would be exposed to a Post-LOCA or Post HELB environment and which are required to mitigate the consequences of a design basis accident are being reviewed in order to determine whether or not they are susceptible to the same types of design deficiencies.

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I. Description of Event

On April 3, 1996, at 13:55, with the plant in Mode 5 at 0-percent power, it was determined that the analyzed design basis for a system needed to remove residual heat and mitigate the consequences of an accident did not bound all conditions expected to occur during the postulated accident. It was determined that the Containment Recirculation System (RSS) spray piping and supports were not adequately designed for thermal loads resulting from accident temperatures. Accident temperatures could result in stresses above the design allowable stresses for plant "Faulted" conditions.

It was initially determined that the higher RSS temperatures could result from uncooled flow due to a postulated loss of Service Water (SWP) to one or more RSS heat exchangers. It was subsequently determined that: (a) unacceptable stresses in the RSS piping, Quench Spray System (QSS) piping, and portions of piping which comprise the Safety Injection (SI) flowpath, could also result from the design basis accident temperatures inside containment, and (b) the original design basis piping analyses for the RSS and QSS systems utilized support anchor movements which were nonconservative. SI flowpath piping consists of portions of the Low Pressure Safety Injection (SIL), High Pressure Safety Injection (SIH), Chemical and Volume Control (CHS), and Residual Heat Removal (RHS) systems.

At the time of discovery the plant was completing a shutdown for unrelated reasons (Reference: LER 96-006-00). Plant systems responded normally to the shutdown. No Engineered Safety Features Actuations were required or were initiated as part of the shutdown.

A design question with the RSS and QSS piping was first identified while the plant was shutting down on March 31, 1996, when the plant was in Mode 4, at 0-percent power, with the Reactor Coolant System (RCS) at 340 degrees Fahrenheit (^{0}F). The issue was identified as part of a comprehensive design review of the operating temperature changes in the portion of the RSS system located outside of containment.

Upon identifying the concern, a preliminary operability determination was performed. Based on the existing plant condition (RCS less than 350 ^{0}F and shutting down) there was reasonable assurance that the RSS piping inside containment was operable because of the relatively low energy content of the RCS at that time. Further engineering review of the concern determined on April 3, 1996, that the RSS spray piping, which was designed for 150 ^{0}F, would see significantly higher temperatures during a design basis accident, such as a Loss of Coolant Accident (LOCA), or a High Energy Line Break (HELB), and had been analyzed utilizing nonconservative support movements. The higher temperature would be possible as the result of either: (a) the loss of SWP to one or more RSS heat exchangers, prior to or following an automatic start of the RSS pumps at approximately 11 minutes, resulting in higher than analyzed temperatures in the recirculation flow from the containment sump to the RSS piping downstream of the RSS heat exchangers, or (b) increased containment ambient temperatures following a design basis accident (LOCA or HELB).

It was not apparent that the plant operators would have a clear, unambiguous indication, or procedural requirements to isolate the RSS headers to prevent an unanalyzed condition in the headers. Accordingly, as a result of the engineering determination, a prompt report was issued on April 3, 1996.

Engineering evaluations of the RSS and QSS piping systems, and the piping which makes up the SI flowpath, were performed. The results indicated the following:

- RSS, QSS, and SI piping systems located inside containment would be subjected to temperatures in excess of those used in the original design, following a design basis accident (LOCA or HELB). As stated previously, the increased temperatures in the RSS and SI systems can result from two sources. Temperature increases would occur in containment as the result of a design basis accident (LOCA or HELB), thus significantly increasing the containment ambient temperature following the accident. In the second scenario, with power available to the

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associated RSS pumps following a design basis accident coupled with a single active failure of one train of SWP to the RSS heat exchangers, the affected RSS train would provide hot sump water to the RSS piping, and in the longer term, to the SI system during the cold leg and hot leg recirculation modes. For the QSS system, ambient temperature increases which occur in containment as the result of a design basis accident (LOCA or HELB) would result in increased piping temperatures. Further, the original design basis piping analyses for the RSS and QSS systems utilized support anchor movements which were nonconservative. Appropriate anchor movements are being taken into account during the reanalysis of those systems.

- RSS and SI piping systems located outside of containment would be subjected to temperatures in excess of those used in the original design, as a result of a design basis accident (LOCA or HELB). With power available to the associated RSS pumps following a design basis accident, coupled with a single active failure of one train of SWP to the RSS heat exchangers, the affected RSS train would provide hot sump water to the RSS piping, and in the longer term, to the SI system during the cold leg and hot leg recirculation modes. This results in the systems being subjected to temperatures above those to which a majority of the piping was analyzed.

As such, the increases in thermal range and the revised application of anchor movements resulted in pipe stresses and pipe support loads that were outside of the plant's design basis. Multiple trains of independent systems were affected.

II. Cause of Event

The conditions have existed as part of the original plant design of the RSS, QSS, and portions of the SI systems.

A review of the original Architect/Engineer Stress Data Packages, which define the piping system operating conditions, indicates that the RSS and QSS piping was analyzed for "ambient" temperature conditions which were contained in a reference design document. While the ambient temperature conditions identified in this document during and following a design basis accident were correct, the temperature value utilized for the piping stress analyses was nonconservative. Based on the stated requirement of analyzing for the range of "sustained" temperature conditions, a steady-state temperature of 150 ^{0}F, which occurs approximately one hour after the accident, was used for analysis purposes. A current review determined that a peak ambient temperature of approximately 260 ^{0}F exists for approximately 30 minutes following the accident. Since the RSS and QSS piping has no internal flow for the first few minutes and is subject to this ambient temperature, the original design piping stress analyses by the Architect/Engineer were determined to be nonconservative. Piping associated with the SI flowpath, in containment, will also be subject to this 260 ^{0}F temperature condition following the accident.

A second condition was identified which could also cause an increased temperature in the RSS piping and portions of the SI piping, over that for which it was analyzed. It was determined that a loss of SWP to one or more RSS heat exchangers could result in the associated piping of the faulted train being subjected to temperatures which ranged from 230 ^{0}F to 250 ^{0}F following a design basis accident. The RSS piping had originally been analyzed to 150 ^{0}F, while the SI piping had been analyzed to temperatures between approximately 115 ^{0}F and 350 ^{0}F. Therefore, the piping stress analyses for the RSS piping and portions of the SI piping were determined to be nonconservative. The Architect/Engineer had identified the loss of SWP condition, via written correspondence to the plant, during the original design of the system in 1985, and identified three options which were available to address the condition. A review of design documentation in this area indicates that the resolution of the loss of SWP condition was overlooked by Northeast Nuclear Energy Company (NNECO).

A review of the RSS and QSS pipe support anchor movements indicated they also were nonconservative. These pipe support anchor movements were used as original plant design inputs to the pipe stress analysis. A major portion of

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the pipe support anchor movements are a function of the temperature and pressure conditions in the containment structure during and following a design basis accident. While the maximum support anchor movements were used by the Architect/Engineer in the analyses, they did not coincide with the most limiting temperature conditions. As a result, the calculated piping stresses, pipe support loads, and containment penetration loads were nonconservative.

III. Analysis of Event

Based upon a current review of the Final Safety Analysis Report (FSAR), design documents, and licensing documents, it has been determined that the RSS, QSS, and portions of the SI piping systems were not designed to the limiting plant conditions as defined in the FSAR.

Essential systems are required to be designed to accommodate specific plant operational conditions including, where appropiate, ambient conditions during and following a design basis accident. The temperatures resulting from the design basis accident, for which these systems had been originally analyzed, were determined to be nonconservative. Similarly, nonconservative pipe support anchor movements were used in the corresponding analyses for the RSS and QSS systems.

In addition, the RSS and SI systems could be subjected to temperatures in excess of those to which it was originally designed as the result of a loss of SWP to one or more of the RSS heat exchangers. This condition should have been identified as a specific operational condition for the system, but was overlooked during the original plant design phase.

There were no adverse safety consequences which resulted from this condition. These systems have never been required to operate in a post-LOCA or post-HELB environment and as such have not been subjected to temperatures above those to which the piping was analyzed. However, this condition is significant in that had the plant experienced a design basis accident in containment such as a LOCA or a HELB, then the potential existed that these systems may not have been able to fulfill their required safety function.

IV. Corrective Action

As immediate action, the plant remained in Mode 5 at 0-percent power.

As corrective actions, design reviews of the RSS, QSS, and SI piping systems are being performed, design improvements are in the process of being made, and the systems will be restored to appropriate design basis requirements prior to declaring them operable. Review plans are currently under development, as part of the unit's Operational Readiness Program, which will confirm the validity of system operating conditions and modes. The plant's Stress Data Packages (SDPs), which define the ASME required design and service loadings for piping, are being reviewed, verified, and corrected. The SDPs will be added to the control document list.

With regard to generic implications, it is recognized that an opportunity to correct the postulated loss of SWP condition in the original design of the plant was overlooked by NNECO, and that there were deficiencies in the Architect/Engineer design. Piping systems that would be exposed to adverse accident temperatures and containment movements are being reviewed to ensure that the piping and associated active components will perform the intended accident mitigation functions as described in the FSAR Chapters 6 and 15. The review and any related corrective actions required to ensure operability and design basis compliance will be implemented prior to entry into mode 4 from the current outage.

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V. Additional Information

At the time of discovery the plant was in a shutdown required by Technical Specifications. See LER 96-006-00, "Plant Shutdown Required by Technical Specifications, for Auxiliary Feedwater Containment Isolation Valves Declared Inoperable."

Similar Events

LER 96-006-00: "Plant Shutdown Required by Technical Specifications, for Auxiliary Feedwater Containment Isolation Valves Declared Inoperable."

This LER reported an original plant design deficiency with Auxiliary Feedwater containment isolation valves. It was determined that the valves would not remain closed against the containment peak design pressure. The valves were capable of isolating as credited for long term analyzed pressures. However, they did not meet an interpretation of General Design Criteria 57 for closed-loop systems, in that they would not remain closed against the containment peak design pressure. A review of all other GDC-57 penetrations identified no similar conditions. This event was similar, with respect to the cause being an original plant design deficiency. The corrective action for the valves could not have revealed a deficiency with QSS and RSS piping system load combinations for "Faulted" conditions.

LER 94-006-00: "Auxiliary Feedwater Pipe Restraints, Inadequate Design Due to Design Error."

This LER reported an original plant design deficiency with portions of the Auxiliary Feedwater system having inadequate pipe rupture restraints for high energy line breaks. The installed supports were adequate for "Faulted" stress limits, but not for system operation during normal plant startup, hot standby, and shutdown. The additional designed restraints on affected portions of the system were not installed during original plant construction, due to changes in the intended use of the system. The corrective action was focused on the Auxiliary Feedwater system. If a review of all pipe rupture restraints on all systems had been done, it would not have revealed a deficiency with QSS and RSS piping system load combinations for "Faulted" conditions.

Manufacturer Data

EIIS System Code
Containment Spray System - BE

EIIS Equipment Code
Pipe Supports - SPT