U. S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No.: 50-245/90-83

License No. DPR-21

Licensee: Northeast Nuclear Energy Company
P.O. Box 270
Hartford, CT 06141-0270

Facility: Millstone Nuclear Power Station, Unit 1

Location: Waterford, Connecticut

Inspection Dates: October 1 through 4, 1990 and November 7, 1990

Reporting Inspector: John T. Shedlosky

Inspectors: A. Lohmeier, Reactor Engineer, Materials and Processes Section, EB, DRS
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Approved by: J S Stewart for 11/23/90
Donald R. Haverkamp, Chief Date
Reactor Projects Section 4A
Division of Reactor Projects

Inspection Summary: Inspection on October 1 through 4 and November 7, 1990 (Inspection Report 50-245/90-83)

Areas Inspected: Events and documentation related to the low pressure coolant injection system inoperability determination made on September 7, 1990, were inspected with emphasis on the present material condition of the system heat exchangers and the licensee's technical evaluation process.

Results: See Executive Summary

EXECUTIVE SUMMARY

Millstone Nuclear Station, Unit 1

NRC Region I Special Team Inspection No. 50-245/90-83

Plant Operations

Revisions were made to station emergency operating procedures on June 29, 1983, to require low pressure coolant injection (LPCI) flow through the system containment cooling heat exchangers as early as possible in an accident scenario without consideration that the resultan. flow exceeded the design flow capacity of the heat exchangers as stated in the final safety analysis report (FSAR). The June 29, 1983, EOP revision placed the LPCI pumps and heat exchangers in a configuration that could have resulted in heat exchanger damage due to excessive flow.

This change may have resulted in creating a potential unreviewed safety question which was not properly addressed through the requirements of 10 CFR 50.59. Additionally, these procedures failed to reflect the design requirements for the LPCI system and its heat exchanger operation required by 10 CFR 50, Appendix B, Criterion III. These are both apparent violations.

Maintenance and Surveillance

The results of periodic inspections, performed during plant refueling outages, provided adequate assurance that the small amount of service experienced by the low pressure coolant injection system heat exchangers had not caused tube degradation. The routine uses for the heat exchanger include cooling of the primary containment suppression chamber water.

Engineering and Technical Support

Although a recent engineering analysis properly identified a potential danger to heat exchanger tube integrity because of flow induced vibrations, the initial engineering review made of this condition following its identification on June 23, 1989, lacked technical basis.

The design basis reconstruction project, which identified this problem is a substantial effort which was instituted as a voluntary self-initiative by the licensee. The finished product was viewed by the inspection team members as a valuable asset without which the concern over flow induced vibration may not have been identified.

Safety Assessment and Quality Verification

The discovery of the potential for flow induced heat exchanger damage was made by a senior licensed operator reviewing a draft design basis reconstruction (DBR) document. He recognized a conflict between the station emergency operating procedures and the design information for the heat exchanger contained in the DBR of the LPCI system. The discrepancy was identified to his immediate supervisor who referred it to the engineering staff. Based on engineering judgment the staff discounted this discrepancy. Not until a later date when this discrepancy was again formally evaluated as a DBR open item (Design Basis Discrepancy MP1-LPCI-7), in parallel with an emergency service water procedure review, did the validity of this discrepancy became obvious.

The failure to take prompt corrective action following the initial discovery of this problem on June 23, 1989, conflicts with the requirements of 10 CFR 50, Appendix B, Criterion XVI and with the licensee's Quality Assurance Program. This is an apparent violation.

The licensee has made improvements to the administrative controls concerning both the design discrepancies identified during the design basis reconstruction project and to the operability determination program.

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DETAILS

1.0 Persons Contacted

1.1 Northeast Nuclear Energy Company

** P. A. Blasioli, Supervisor, Nuclear Licensing
P. Callaghan, Manager, Nuclear Safety Engineering
** S. Chandra, Principal Mechanical Engineer, Generation Engineering
J. A. Chunis, Configuration Management Program Manager
* C. H. Clement, Director, Millstone Unit III
** G. E. Cornelius, Supervisor, Reactor Plant Systems
* H. F. Haynes, Director, Millstone Unit I
** N. K. Jain, Reactor Engineer, Safety Analysis
M. S. Kai, Supervisor, Safety Analysis
R. C. Kraemer, Shift Supervisor, Millstone Unit I
P. J. Miner, Licensing, Millstone Unit I
W. G. Noll, Engineer, Millstone Unit I
** F. G. Nurnberger, Nuclear Safety Engineer
R. J. Palmieri, Operations Manager, Millstone Unit I
M. J. Ross, Operations, Millstone Unit I
* R. W. Vogel, Engineering Manager, Millstone Unit I
G. C. Zitka, Shift Supervisor, Millstone Unit I

1.2 U.S. Nuclear Regulatory Commission

M. L. Boyle, Millstone Unit I Project Manager, Office of Nuclear Reactor Regulation
** D. A. Dempsey, Millstone Unit I Resident Inspector
** D. R. Haverkamp, Chief Reactor Projects Section No. 4A, Division of Reactor Projects (DRP), Region I
# A. Lohmeier, Reactor Engineer, Division of Reactor Safety, Region I
# W. J. Raymond, Senior Resident Inspector. Millstone Nuclear Power Station
# J. T. Shedlosky, Senior Resident Inspector, Haddam Neck Plant
* A. Vegel, Reactor Engineer, Reactor Projects Section No. 4A (DRP)

* Attended Management Exit Meeting on October 4, 1990.
** Attended Meeting and Management Exit on November 7, 1990.
# Attended both Management Meetings

2.0 Event Description

On September 7, 1990, the licensee determined that the low pressure coolant injection (LPCI) system containment cooling heat exchangers may not be capable of performing their intended post accident function because of the possibility of flow-induced tube vibration and failure. A conflict was found between the heat exchanger design maximum flow rate and the requirements of the station emergency operating conditions. Because the operability of the LPCI system in the containment cooling mode could not be assured, both containment cooling subsystems were declared to be inoperable and the reactor, which had been at full power, was placed in cold shutdown in accordance with technical specification requirement 3.5.A.6. There were no actual tube failures involving the September 7 finding.

Station emergency operating procedures, based on the BWR owner's group guidelines, required that containment cooling be started as soon as possible following a design basis accident. Specifically, the plant operators were instructed by procedure and simulator training to direct system flow through the two heat exchangers as soon as possible. These operating requirements were found to be in conflict with component design limitations in that the flow rate developed by two LPCI pumps exceeded the capacity of the containment cooling heat exchangers when the heat exchanger bypass valve was closed.

To insure heat exchanger integrity and to allow for plant restart, the licensee revised emergency operating procedures and normal operating procedures to ensure that no more than one LPCI pump per sub-system would be operating when the LPCI heat exchanger bypass valve was closed. Additionally, in order to assure adequate pump net positive suction head, the containment spray permissive interlock setpoint was increased from five (5) to nine (9) psig. The setpoint change was made through a modification to the operating license technical specifications.

Additional details of this change and restart activities are found in the licensee's application for an emergency technical specification change, dated September 11, 1990, the NRC safety evaluation accompanying Amendment 46 to Facility Operating License No. DPR-21, dated September 17, 1990, and in NRC resident inspection report 50-245/90-17, section 3.3.1, dated October 5, 1990.

2.1 Low Pressure Coolant Injection System Overview

Each of the two LPCI sub-systems has two pumps and one heat exchanger in their common discharge. Each heat exchanger is provided with a normally open bypass valve. The discharge of the sub-systems is directed to either the reactor recirculation loops, the containment spray line, the torus spray line or the torus test line.

Each of the four pumps provides one-third of the required system capacity; to obtain rated system flow each pump is required to develop a minimum head of 221 feet at a flow rate of 4650 gpm. The FSAR requirements for the pumps are:

5000 gpm/pump flow at zero psid (reactor to containment pressure)
2500 gpm/pump flow at 165 psid (reactor to containment pressure)
zero gpm/pump flow at 235 psid (reactor to containment pressure)

Each of the two heat exchangers is described in the FSAR and the manufacturer's heat exchanger specification sheet as having a capacity of 40 E+06 Btu/hr with primary (shell side) and secondary (tube side) flow rates of 5000 gpm.

The system's post accident functions include: injection of water into the recirculation system to reflood the reactor vessel core shroud through the jet pumps, and containment cooling utilizing the LPCI heat exchangers and the emergency service water pumps.

The injection sequence is automatic: pumps start in sequences based on the availability of off-site power or on-site emergency power. Motor operated valves such as the heat exchanger flow bypass valves, the pump minimum flow valves, and the injection valves automatically position to support injection into the unbroken recirculation loop and also to provide equipment protection. The heat exchanger bypass valves are opened to allow most of the two (2) pump injection flow to bypass the heat exchanger. The licensee's analysis of system flow characteristics indicate that approximately 87 percent of the pump flow will bypass the heat exchanger with the remaining 13 percent flowing through the heat exchanger which has normally open manual isolation valves.

Containment cooling is initiated by the control room operators. A time delay interlock is associated with the heat exchanger bypass valves. Following the delay those valves can be shut. The redirected flow will be cooled by emergency service water (ESW) flowing through the heat exchanger tubes.

In the event that operation of the drywell or suppression chamber spray is desired, it may be initiated when the containment reaches a minimum pressure setpoint which removes an interlock allowing the drywell spray valves to open. The interlock is provided to assure adequate net positive suction head to the LPCI pumps.

The ESW pressure in the containment cooling heat exchanger tubes is maintained higher than shell side LPCI pressure to prevent leakage of radioactive materials to the environment.

The licensee has recently completed additional analysis of system flow capacity. A LPCI sub-system with two (2) pumps operating and the heat exchanger bypass valve closed will have a maximum heat exchanger flow rate of 9,587 gpm with clean suppression chamber suction strainers. Expected post accident debris loading of the strainers is expected to reduce this to 8,675 gpm.

This inspection did not include within its scope a review and analysis of post accident long term decay heat removal in the event that heat exchanger tube failures were caused by flow induced vibration. The licensee has postulated a sequence of events within Licensee Event Report No. 50-245/90-014-00, dated October 9, 1990, which is enclosed as Attachment III to this inspection report. Additional information concerning its safety significance involves analysis of the acceptability of heat exchanger operation following tube failures or the acceptability of other plant systems such as shutdown cooling, isolation condenser, alternate shutdown cooling (standby liquid control and manually opened safety relief valves), or the main condenser.

2.2 Procedural Controls

On June 29, 1983, the plant emergency procedures were modified to include a general caution which required that injection flow be initiated through the containment cooling heat exchangers as soon as possible after the onset of an accident. This change came about through Revision 2 of the BWR Owner's Group Emergency Procedure Guidelines and was placed in an overall administrative section applicable to all EOPs. The procedure was implemented by closing the heat exchanger bypass valve early in the injection phase when two (2) pumps would be operating in each of the subsystems. Prior to this, there was neither a specific requirement to start cooling flow, nor a procedural limitation on heat exchanger flow.

Implementation of Revision 4 to the Guidelines began in September 1989. Included within these changes was the replacement of the general caution statements with specific procedure steps. While rewriting operating procedure OP322, clarifications of the containment cooling process were made. These included verification of the flow capacity of the containment cooling (LPCI) heat exchangers in August 1990. In support of that engineering analysis, contact was made with the heat exchanger manufacturer. The manufacturer's representative cautioned that flow in excess of 5000 gpm (single LPCI pump flow) may cause damage to the tubes because of flow induced vibration.

On September 7, 1990, the LPCI containment cooling systems were declared inoperable and the reactor shut down.

2.3 Design Basis Reconstruction Program

A program to reconstruct the plant design basis has been on going for three of the reactors operated by the licensee. Much of the information is obtained through the nuclear steam system supplier and the architect engineer. In the case of Millstone Unit I, the first package concerned the LPCI Containment Cooling System and was received in draft from General Electric in February 1988 and in final form in December 1988.

Much of this information was combined with the licensee's data into a document issued in draft form in June 1989 for multi-discipline review. Section 3.2.2 of that document cautioned that "...in order to minimize the potential for HX...(heat exchanger)...damage due to flow induced vibration, it is recommended by GE...(General Electric)...that the shell side flow rate through the HX be limited to 5500 gpm."

This draft package was distributed for comment to various organizational groups. A shift supervisor conducting a review for the plant Operations Department noted the significance of this cautionary statement in that it and the station emergency procedures were in conflict. The discrepancy was identified to engineering on June 23, 1989. A preliminary safety assessment of the discrepancy determined no safety significance based on engineering judgement. However, the discrepancy was recorded within the design basis reconstruction program and tracked as an open item (MP1-LPCI-7) pending formal evaluation and resolution.

The LPCI system design basis document, DBDP-M1-LPCI-0010-90, dated November 1, 1989, was issued in final form on April 30, 1990. The discrepancies were routed to engineering for resolution in August 1990.

Additional background to the engineering judgement decision of no safety significance in June 1989 was a pending containment cooling analysis planned for August 1990. It was felt that this issue would be identified by this analysis if it was significant. Consequently, this deficiency was not pursued any further until August 30, 1990, during a review referenced above when the flow-rate limitation on the heat exchanger was again questioned. Following indepth review by licensee engineering and discussions with the vendor, the actual significance of this issue was realized and appropriate actions were taken on September 7, 1990.

3.0 Inspection Scope

The scope of the inspection was to (1) assess the present material condition of the LPCI heat exchangers and the potential for damage to the heat exchangers due to excessive flow; (2) determine the sequence of events leading to the identification of the discrepancy between plant procedures and heat exchanger flow capacity; and (3) review and assess the information available in the past concerning the heat exchanger flow limitations.

4.0 Inspection Details

The inspectors held discussions with various members of the licensee's staff, visually inspected a LPCI heat exchanger, reviewed drawings, documents and procedures as listed in Attachment I to this report, evaluated the events leading to the LPCI heat exchanger inoperability determination and assessed the present material condition of the heat exchangers. At the entrance meeting the licensee made a presentation to the inspectors on the LPCI heat exchanger event. The licensee developed outline is provided in Attachment II to this report.

Based on the above, the inspectors determined that the LPCI heat exchangers are currently in good material condition based on their limited duty to date and the eddy current test data which indicates little or no tube degradation. The inspectors did surmise during their initial review that the heat exchangers could have potentially been damaged if they were subjected to the full two LPCI pump flow rate of approximately 10,000 gpm. In addition, based on preliminary investigation, operating the heat exchangers with one pump at a discharge rate of 5,000 gpm, the heat exchangers would be only 100 gpm (2 percent of full flow), from reaching the critical flow velocity where fluid elastic vibration would initiate, potentially damaging the heat exchangers tubes. In reviewing licensee documents the inspectors surmised that sufficient information was available in the past which could have prevented the use of procedures that had no heat exchanger flow restrictions, and that when the procedures were modified to allow for the excessive flow, insufficient technical reviews allowed the error to be made. These inspection findings are discussed in detail below.

4.1 Present Material Condition of LPCI Heat Exchangers

In order to ascertain that no damage due to excessive shell side flow had been inflicted on the LPCI heat exchangers over their operating lifetime, the inspector reviewed the following reports of eddy current (EC) inspection of heat exchangers A and B over the period from September 1980 through May 1989:

1) EC Inspection of LPCI A & B Heat Exchangers, Millstone Unit I, September 1980, PO #707642.
2) Record of EC Inspection of LPCI A Heat Exchanger, Millstone Unit I, April 1984, Volume VIII of X.

3) Record of EC Inspection of LPCI B Heat Exchanger, Millstone Unit I, December 6, 1985, Volume VI of VII.
4) Record of EC Inspection of LPCI A Heat Exchanger Millstone Unit I, during June 1987 Outage, Volume IV of IV.
5) Record of EC Inspection of LPCI B Heat Exchanger April-May 1989, Volume III of IV.

As a result of reviewing the above stated eddy current test reports, it was concluded by the inspectors that the condition of the tubes in both heat exchangers indicated no sign of damage that could be related to excessive shell side flow tube vibration. The indications that were reported over this period of time were few and believed to be the result of corrosion.

4.2 Potential For Damage to LPCI Heat Exchanger Due to Excessive Flow

The inspector reviewed the design and operating system arrangement of the LPCI heat exchangers and related pumps. The system is such that two pumps of 5000 gpm rated capacity are arranged in parallel to feed directly into a single heat exchanger with a valved bypass line which is normally open. Each heat exchanger has a rated maximum shell flow capacity of 5500 gpm.

With the bypass valve open, the flow through the heat exchanger with one or two pumps operating is less than the rated capacity of one or two pumps and is a function of the resistance to flow through the heat exchanger and the bypass valve.

With one pump operation and the bypass valve open, the maximum flow through the heat exchanger is much less than the 5000 gpm capability of the pump. With the bypass valve closed, the heat exchanger shell side could experience the maximum pump capability less the system flow resistance effects.

With two pump operation and the bypass valve open, the heat exchanger shell flow is large and could possibly exceed the rated heat exchanger shell side flow. With the bypass valve closed, the total heat exchanger flow will exceed the design shell side flow capability.

In an emergency technical specification change request dated September 11, 1990, the problem of excessive shell side flow through the LPCI heat exchangers was discussed by the licensee. It was stated in this letter that by limiting flow by operating only one LPCI pump per subsystem, tube vibration from excessive flow could be precluded while providing sufficient cooling capability consistent with the intended operating design function of the system.

Contrary to the assurances provided in the foregoing document, there have been other communications and considerations to indicate to the inspector that the shell side flow capability may be at best marginal with single pump operation and possibly incapable of handling flow from two pump operation. In a design basis reconstitution document, it was suggested by General Electric Company that the flow through the heat exchanger be limited to 5500 gpm. In another communication from the heat exchanger manufacturer, it was indicated that the margin of flow between the operating flow with one pump running and the bypass valve closed, and the flow causing fluid elastic vibration of the tubes is only 2 percent. At its rated flow, the heat exchanger margin to flow induced vibration is nonexistent.

As a result of the foregoing, the inspector more closely examined the design calculations of the heat exchanger relating to that flow causing fluid elastic vibration of the heat exchanger tubes. A telephone conference with the engineer at the heat exchanger manufacturer's office indicated that a flow of 3.7 feet per second (flow through tube pattern openings) was computed for design operation, while a flow of 3.8 feet per second was the estimated critical flow velocity (that causing fluid elastic tube vibration).

The inspector found that the calculation of critical flow velocity was determined from a proprietary computer program developed by the Heat Transfer Research Institute for the purpose of evaluating heat exchanger critical shell side flow velocities. The program is utilized in the heat exchanger industry as a design tool. However, the inspector is not aware of any standards relating to proximity of rated flow to critical flow.

The LPCI heat exchangers are of the counter flow type with segmented tube support baffles. There are 316 one (1) inch outside diameter (OD) tubes on 1-5/16 square pitch. The shell material is carbon steel and the tube material is 18 gauge 70-30 copper nickel. Under this arrangement the flow is generally parallel to the tube length but must turn perpendicular to the tube length in order to circumvent the staggered baffles.

The calculation of detailed flow velocities in this baffled design is a complex one, and the sensitivity to the detailed flow velocity is great. Hence, uncertainties exist as to how precisely one can compute the flow velocities. Furthermore, the dynamics of the fluid elastic vibration of the tubes contain some uncertainties with regard to the tube fixity and damping effects of the supports. The inspector believes, therefore, the slim margin between design flow and critical flow may be insufficient in view of the technical uncertainties with the computation technique.

It was suggested by the inspector to the licensee that a more comprehensive review of the heat exchanger - pump system be performed to provide reassurance that the heat exchanger can sustain the maximum flow for which it was designed.

The licensee has enforced operational limits limiting the flow to one pump operation. Furthermore, the licensee has retained a consultant to reevaluate the design for flow instability.

On November 7, 1990, the inspectors attended a technical presentation by the retained consultant on the subject of possible flow induced vibration in the LPCI heat exchanger. At the meeting, the consultant presented a comprehensive study of the fluidelastic vibration potential of the LPCI heat exchangers. The study included identification of the most vulnerable tubes in the bundle, computing the flow velocities in the vulnerable tube regions, determination of the natural frequency of vibration for the tubes in the vulnerable region, computation of the vibration threshold flow rate of the vulnerable tubes, and determination of the lowest threshold rate for all vulnerable tube spans.

The most crucial problem for the consultant in evaluating the heat exchanger tube vibration potential is in estimating the flow velocity component perpendicular to the tube span. The consultant utilized a numerical solution of the fluid dynamics within the heat exchanger shell. Since the heat exchanger has a double segmented alternate baffle spacing, the flow is generally parallel to the tubes except in the region of turning over the segmented baffles. Therefore, the cross flow velocities are generally low and the regions having flow nearest the critical velocities are few.

As a result of the analysis it was determined that the lowest ratio of actual velocity (at 5,000 gpm) to critical flow velocity was 1.24 This was restricted to a single tube row and span. Furthermore, all other ratios related to the vulnerable tubes spans ranged from 1.85 to 11.34. The threshold heat exchange flow rate was determined to be 6,200 gpm which is more than the max heat exchanger flow that could be developed by one LPCI pump (5,000 gpm).

It was therefore concluded by the licensee that operation of the heat exchangers with one pump did not constitute a potential tube failure cause. It was furthermore concluded by the licensee that, in view of the analytic results, flow testing of the LPCI heat exchangers will not be performed during the next scheduled outage in March of 1991.

It is apparent to the inspector that the Heat Transfer Research Institute (HTRI) calculation does not provide for a sufficiently comprehensive estimate of fluid velocities to allow evaluation of the safety margin relative to onset of fluidelastic vibration. There also appears to be no specified safety margin for this type of vibration.

The licensee calculated the flow in the heat exchanger with the bypass valve open and shut for double pump operation. With the bypass valve open the heat exchanger flow is 1500 gpm and the valve flow is 9400 gpm. With the bypass valve shut, the flow through the heat exchanger is 9587 gpm. Under no circumstance can the heat exchanger accept this flow without incurring major tube vibratory failure in a short time.

The inspector has reviewed the licensee concern for possible flow induced vibration of LPCI heat exchanger tubes under conditions of two pump operation. This review has determined the concern is of such validity that flow restrictions must be applied. The licensee is pursuing this course of action by limiting heat exchanger flow to single pump operation.

4.3 Inspection Findings

The inspection team made the following conclusions concerning the LPCI containment cooling heat exchangers:

1) There is a high degree of assurance that the heat exchangers are operable and able to serve their intended purpose with single LPCI pump flow through the heat exchanger shell.

2) The flow capacity of two (2) LPCI pumps may lead to rapid damage of some heat exchanger tubes because of flow induced vibration.

3) The heat exchangers are protected against damage through procedural controls and operator training. There are no physical interlocks which prevent two (2) pump operation with the heat exchanger bypass valve in the closed position.

4) The licensee acted promptly and responsibly in October 1990 in response to the inspectors' request to confirm the margin to critical flow within the heat exchanger for one LPCI pump (5000 gpm) operation.

5) Previous revisions to station emergency operating procedures were made without an engineering basis for exceeding the component design characteristic, rated shell side heat exchanger flow.

This change may have resulted in creating a potential unreviewed safety question which was not properly addressed through the requirements of 10 CFR 50.59. Additionally, these procedures failed to reflect the design requirements for the LPCI system and its heat exchanger operation required by 10 CFR 50, Appendix B, Criterion III and the licensee's quality assurance program. These are both apparent violations.

The inspectors concluded that there was sufficient information available in the past to have determined the danger of excessive flow through these heat exchangers.

6) The design basis reconstruction process, which is being undertaken at three (3) of the licensee's nuclear facilities is an important process which is developing a valuable resource.

7) The design basis documentation package for the LPCI system was circulated in draft for comment in June 1989. This was the first package completed to that point. Within its component description of the LPCI heat exchanger, it contained a warning against flow rates in excess of 5500 gpm through the shell side in order to prevent tube damage. The warning was part of the nuclear steam system supplier input to the design basis package.

8) In June 1989 an engineering assessment was made of the maximum allowable LPCI heat exchanger shell side flow rates. The question was raised by the plant operating staff who discovered a conflict between a warning against high flow rates within a draft design basis reconstruction document and station emergency operating procedures. The determination of no safety significance was made on judgement. There were no contacts made to either the component manufacturer or the nuclear steam system supplier.

9) The conflict between the design basis document and the station emergency operating procedures was tracked as a discrepancy within the reconstruction program.

10) The issue of maximum allowable heat exchanger flow rates was again raised on August 30, 1990, in support of additional revisions to operating procedures and in light of the design basis reconstruction program discrepancy. Contacts were made with the heat exchanger manufacturer, who reinforced the warning against high shell side flow-rate.

The failure to take prompt corrective action following the initial discovery of this problem on June 23, 1989, conflicts with the requirements of 10 CFR 50, Appendix B, Criterion XVI and with the licensee's Quality Assurance Program. This is an apparent violation.

11) Prior to design basis reconstruction program findings there was no specific warning of tube damage due to flow induced vibration. However, documents such as the FSAR and the manufacturer's heat exchanger specification sheet describe the heat exchanger as being rated at 5000 gpm on both the shell and tube sides.

12) This issue may be generic to other Boiling Water Reactors because of the common nature of the Owners Group Emergency Operating Procedure Guidelines and procurement practices for early plants.

5.0 Exit Interviews

During this inspection, periodic meetings were held with station management to discuss the inspection observations and findings. Exit meetings were held on October 4 and on November 7, 1990, to summarize the conclusions of the inspection. No written material relating to inspection findings was given to the licensee; the licensee identified both a written report addressing flow induced vibration of heat exchanger tubes and a General Electric report of the LPCI system design basis as containing proprietary information.

No proprietary information is included in this inspection report (50-245/90-83).

Attachment I

DOCUMENTS REVIEWED

Millstone Nuclear Station, Unit 1

NRC Region I Special Team Inspection No. 50-245/90-83

Technical Specification 3.5, Core and Containment Cooling.

Emergency Technical Specification Change Request, Containment Spray Interlock, letter Northeast Nuclear Energy Company to NRC dated September 11, 1990.

Amendment No. 46 to Facility Operating License No. DPR-21, dated September 17, 1990.

Updated Final Safety Analysis Report, dated February 1987, Sections 6.2.1 and 6.2.2.

Final Safety Analysis Report, dated May 1980, Sections 5.2.3, and 6.3.4.

Licensee Safety Evaluation, ISE/MP1-90-70, Modification of Containment Spray Interlock from 5 psig to 9 psig.

Licensee Safety Evaluation, ISE/MP1-90-71, Limit LPCI Flow to 5000 gpm through one LPCI Heat Exchanger.

Licensee Safety Evaluation, ISE/MP1-90-72, Modification of Containment Spray Interlock from 5 psig to 9 psig.

Amendment 18 to the Application for an Operating License, Section A-11.

LPCI System Design Specification, General Electric Nuclear Energy Division, document No. 257HA347, Revision 2, dated November 11, 1969.

LPCI/Containment Cooling System Process Diagram, General Electric Company, Atomic Power Equipment Division, drawing No. 730E801.

LPCI System Design Basis Requirements, General Electric Nuclear Energy Division, document No. PED-07-0288, DRF-A00-03236-18, dated December 1988.

Attachment I

Design Basis Documentation Package, Low Pressure Coolant Injection System, Revision 0, document No. DBDP-MI-LPCI-001-90, dated November 1, 1989.

Licensee Event Report 90-014-00, Low Pressure Coolant Injection Heat Exchanger Flow Rates, dated October 9, 1990.

Functional Control Diagram LPCI/Containment Cooling System, drawing No. 25202-28056 Sheet 3.

Containment Cooling During Accident Conditions, EOP 590.26, Revision 0.

Containment Cooling During Anticipated Transient Without Scram Conditions, EOP 590.27, Revision 0.

Operability and Reportability Determinations, NEO 2.25, Revision 2, dated June 4, 1990.

Initiation, Tracking and Handling of Design Discrepancies Identified During the Design Basis Reconstruction Effort, REB 3.15, Revision 0, dated September 8, 1990.

Record of Eddy Current Inspection of LPCI A & B Heat Exchangers, Millstone Unit I, September 1980, PO #707642.

Record of Eddy Current Inspection of LPCI A Heat Exchanger, Millstone Unit I, April 1984, Volume VIII of X.

Record of Eddy Current Inspection of LPCI B Heat Exchanger, Millstone Unit I, December 6, 1985, Volume VI of VII.

Record of Eddy Current Inspection of LPCI A Heat Exchanger Millstone Unit I, during June 1987 Outage, Volume IV of IV.

Record of Eddy Current Inspection of LPCI B Heat Exchanger April-May 1989, Volume III of IV.

Long Term Cooling Study, Project Assignment 85-049, Revision 5, dated January 14, 1988.

Upgrade of LPCI Heat Exchangers, Project Assignment 85-083, Revision 4, dated December 28, 1987.

Attachment I

Residual Heat Removal Heat Exchanger Sizing, letter, S. Levy Inc. to Northeast Utilities Service Company, dated May 20, 1985.

Long Term Cooling Concern; Preliminary Evaluation of Hardware Modification Options, document No. NE-86-SAB-025, dated January 17, 1886.

LPCI Heat Exchanger Upgrade, document No. PSE-CE-86-113, dated March 25, 1986.

Utility Comparison RHR Heat Exchanger Effectiveness, letter, General Electric to Northeast Utilities Service Company, document G-EH-5-056, dated April 26, 1985.

Probabilistic Safety Study - Results and Summary Report, letter Northeast Nuclear Energy Company to NRC, document No. B11601, dated July 10, 1983.

Size of New Heat Exchangers, document No. NE-86-R-100, dated March 10, 1986.

Post LOCA Containment Cooling, document No. NE-85-SAB-056, dated March 6, 1985.

LPCI Heat Exchanger Performance, calculation No. W1-517-921-RE, dated June 21, 1989.

Instruction Manual for General Electric Company (GE), Atomic Power Equipment Division, Equipment Piece No. 1503A&B, Containment Heat Exchanger, GE P.O. No. 205-92180, Perfex Reference No. 7B-2566, Revision 1, dated January 23, 1968. Contains the manufacturer's heat exchanger specification sheet.

The following Automated Work Orders (AWO) concerning the LPCI system containment cooling Heat exchangers:

AWO No.	Date Complete
M1 87 09304	05/21/89
M1 89 11213	10/06/89
M1 90 06487	07/22/90
M1 85 05177	06/27/85
M1 84 02200	12/18/85
M1 86 07617	06/24/87
M1 89 04868	05/03/89
M1 85 06173	11/30/85
M1 86 07620	06/27/87
M1 87 09308	05/21/89

ATTACHMENT II

Licensee Presentation

on

LPCI Heat Exchanger Event

MILLSTONE 1

Low Pressure Coolant Injection System Heat Exchanger Event

Harry F. Haynes
Director - Millstone Unit 1

Millstone
Nuclear Power Station

LPCI SYSTEM HEAT EXCHANGER EVENT

- Introduction............................H. F. Haynes
- LPCI System Operation..........W. G. Noll
- Historical Perspective and Problem Identification..........W. G. Noll
- Short Term Resolution...........N. K. Jain
- Design Basis Reconstruction Project...........C. L. Pietryk
- Safety Significance................G. E. Cornelius
- Closing Remarks......................H. F. Haynes

INTRODUCTION

EVENT DESCRIPTION

Low Pressure Coolant Injection (LPCI) Heat Exchanger flow rates directed by Operating Procedures may have exceeded heat exchanger design flow limits

Design Information:

LPCI Pumps:

- design flow 5000 gpm per pump
- two pumps per loop

LPCI Heat Exchangers:

- design flow 5000 gpm per heat exchanger
- one heat exchanger per loop

LPCI SYSTEM OPERATION

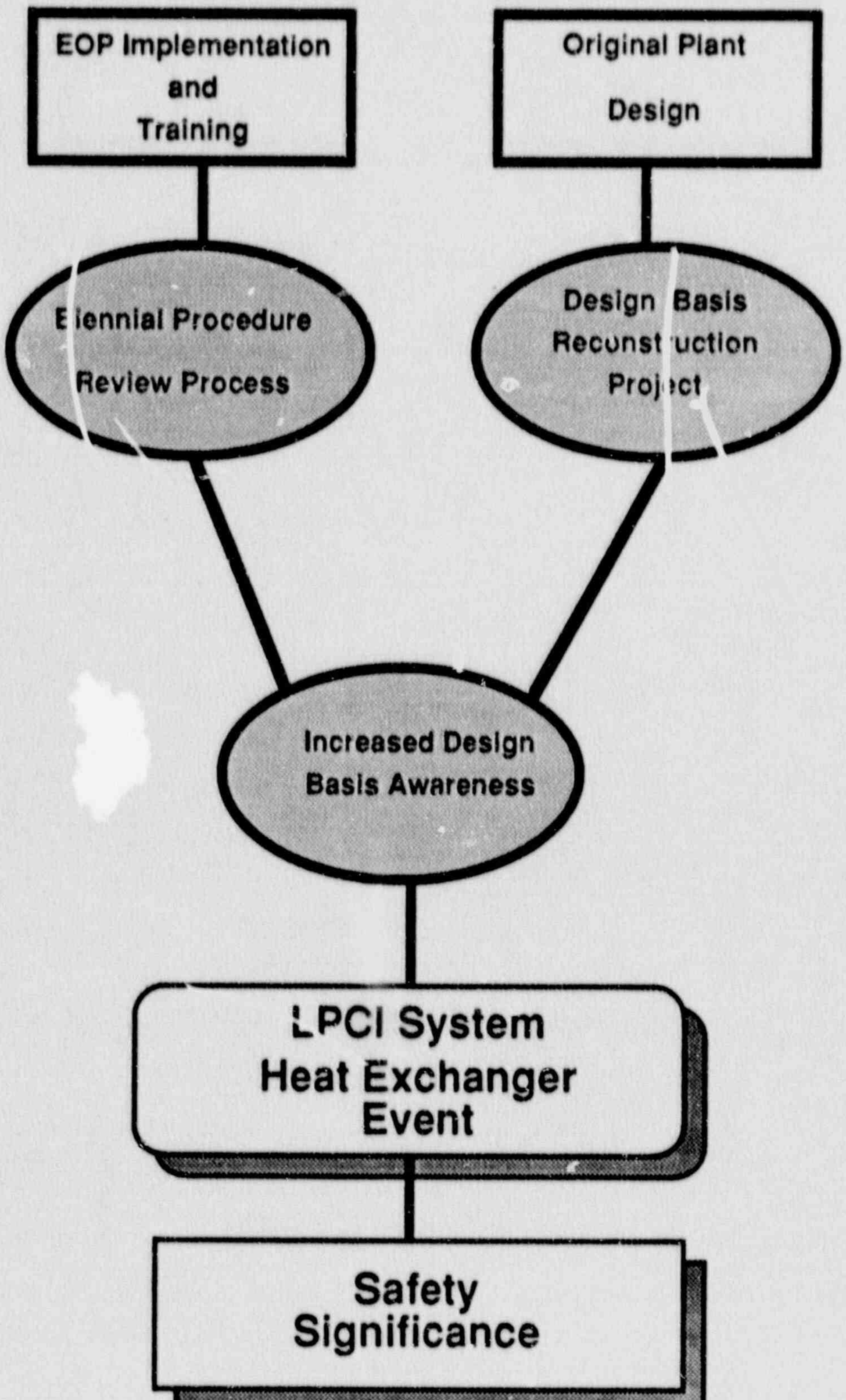
1. Post LOCA Core Reflooding

2. Post Accident Long Term Containment Cooling

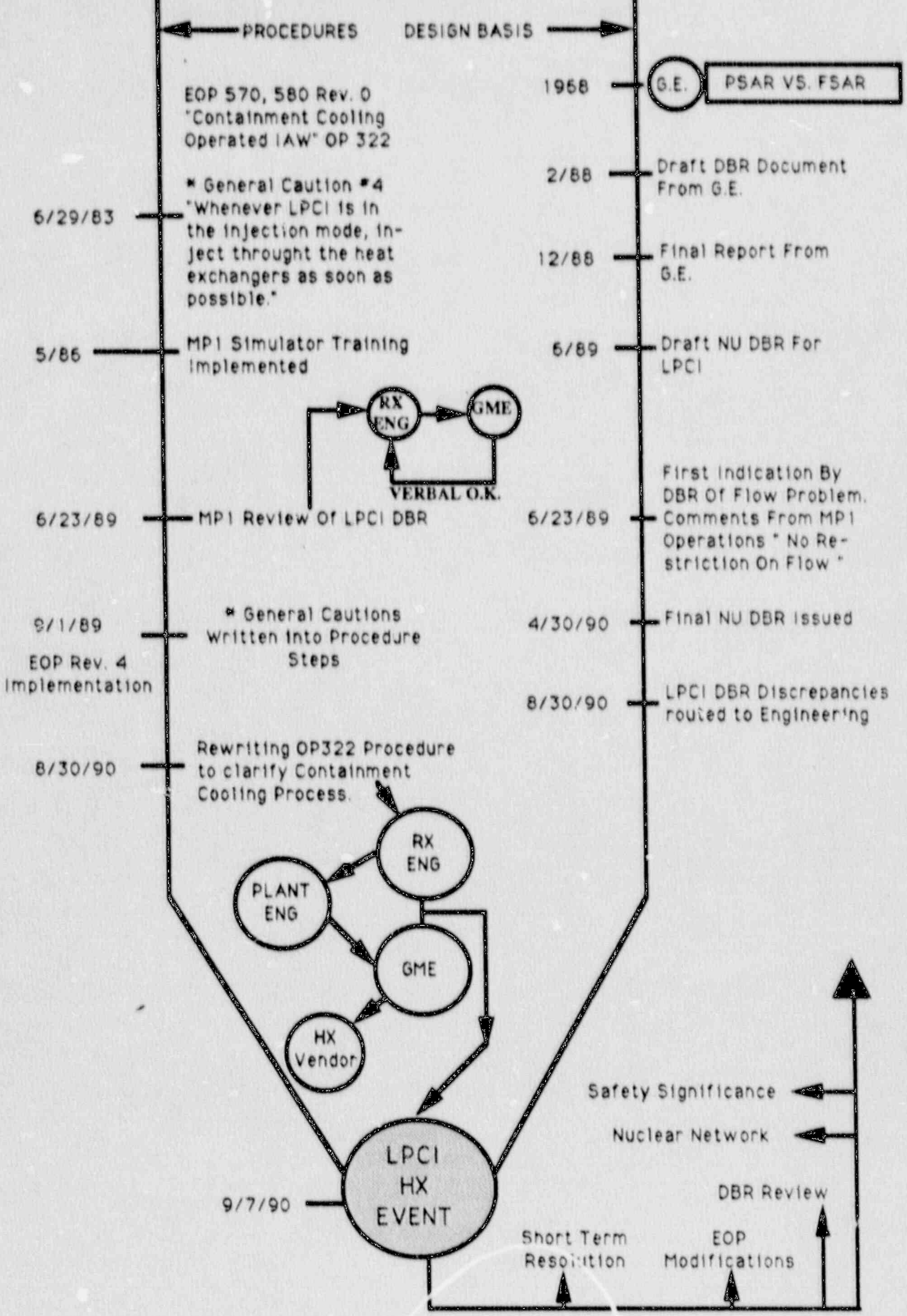
3. Containment Spray

4. Torus Cooling During Normal Operation

HISTORICAL PERSPECTIVE



HISTORICAL EVENTS



SHORT TERM RESOLUTION

- Modified Emergency Operating Procedures to restrict LPCI operation to one LPCI pump per train for post LOCA containment cooling.

- Increased the containment spray interlock setpoint from 5 psig to 9 psig to provide adequate pump NPSH as demonstrated in Amendment 18 of the FSAR.

- Changed the Technical Specification to reflect the new containment spray interlock setpoint.

- Adequacy of the procedure changes was confirmed through verification and validation using the Millstone Unit One specific simulator.

- All Licensed Operators received simulator training reflecting EOP changes.

SUPPORTING ANALYSES

- General Electric was requested to perform additional analyses with more current methodologies to provide confirmation of the conclusion on adequate NPSH in Amendment 18 of the FSAR.

- This analysis confirmed the conclusion using more realistic initial condition limits for containment parameters.

- Additional operating restrictions have been implemented to ensure that these more realistic initial conditions are met.

DESIGN BASIS RECONSTRUCTION

DISCREPANCY RESOLUTION

OLD METHOD	•CMP Steering Committee •Informal Review •Incorporate in DBDPs •Engineering Resolution
NEW METHOD	•Perceived Weaknesses •Parallels NUMARC Guidelines •Formal Review •Prioritization for Engineering Resolution
RESCREENING	•3 Modules Issued •30 Discrepancies •11 Potential Reportables
DETERMINATION	•4 Associated with LPCI Event •2 Judged Reportable •All Others Not Reportable

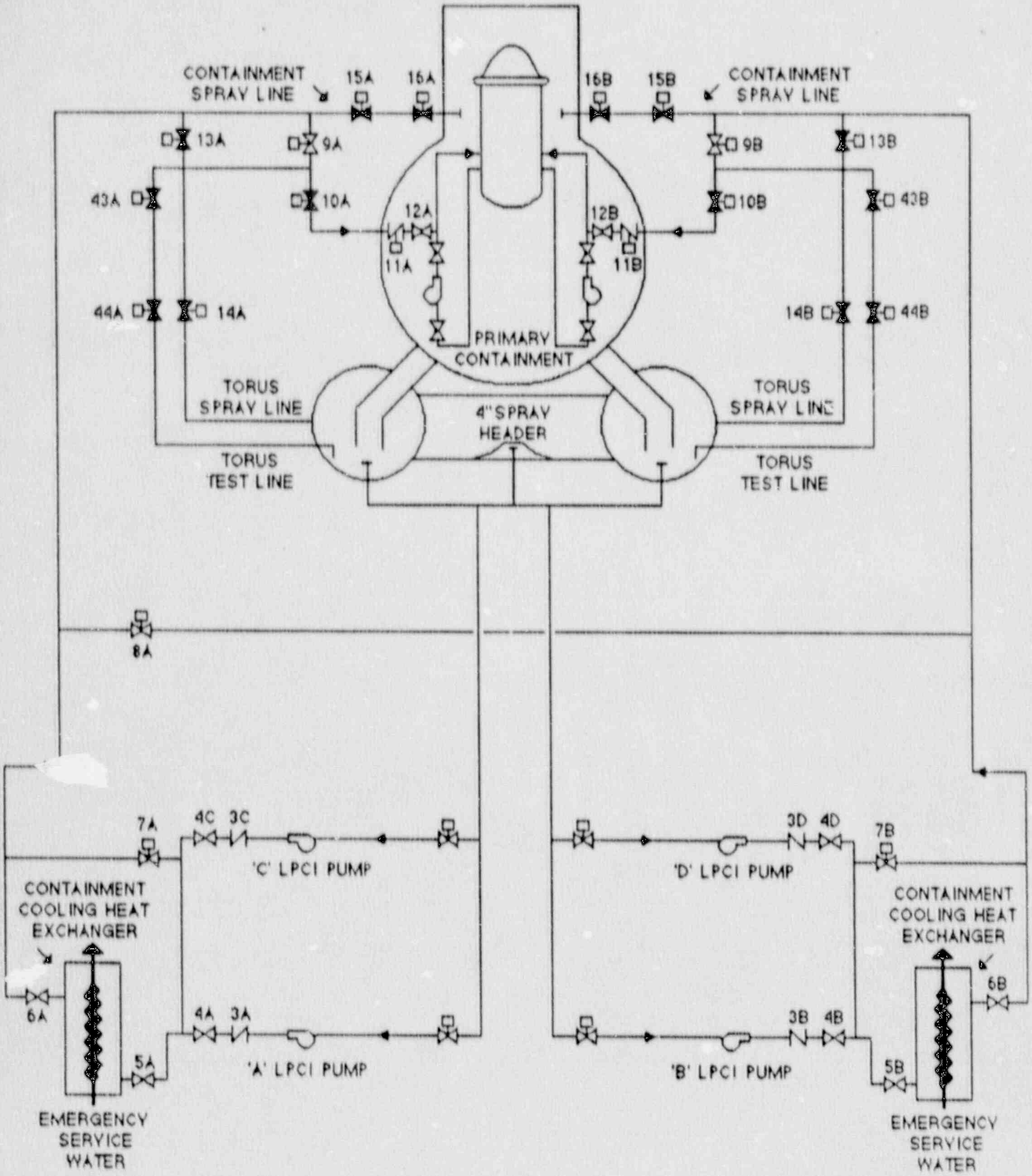
SAFETY SIGNIFICANCE

- Additional information from the heat exchanger vendor is now available for an operability determination
  - LPCI heat exchangers have limited duty to date
  - Heat exchanger tube eddy current test data indicates little or no degradation of tubes
  - Conservatisms in heat exchanger (TEMA) analysis

- Based upon the above, it is the judgement of the vendor that the LPCI heat exchanger will perform its intended safety function for at least several weeks to a month.

- The effect of heat exchanger degradation after the initiation of the event is reduced significantly due to the decreasing decay heat load which allows the LPCI flow to be decreased.

- Based upon the above, Northeast Utilities has concluded that this event is not safety significant.



LPCI SYSTEM DIAGRAM

ATTACHMENT III

LICENSEE EVENT REPORT

50-245/90-014-00

NORTHEAST UTILITIES
The Connecticut Light And Power Company
Western Massachusetts Electric Company
Holyoke Water Power Company
Northeast Utilities Service Company
Northeast Nuclear Energy Company

General Offices Selden Street, Berlin Connecticut

P.O. BOX 270
HARTFORD, CONNECTICUT 06414-0270
(203) 665-5000

October 9, 1990
MP-90-1097
Re: 10CFR50.73(a)(2)(v)

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

Reference: Facility Operating License No. DPR-21
Docket No. 50-245
Licensee Event Report 90-014-00

Gentlemen:

This letter forwards Licensee Event Report 90-014-00 required to be submitted within thirty (30) days pursuant to the requirements of 10CFR50.73(a)(2)(v).

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

FOR: Stephen E. Scace
Director, Millstone Station

BY: Harry F. Haynes
Millstone Unit 1 Director

SES/WGN:mo

Attachment: LER 90-014-00

cc: T. T. Martin, Region I Administrator
W. J. Raymond, Senior Resident Inspector, Millstone Unit Nos. 1, 2 and 3
M. Boyle, NRC Project Manager, Millstone Unit No. 1

NRC Form 366 (6-89) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104
EXPIRES: 4/30/92

Estimated burden per response to comply with this information collection request: 50.0 hrs. Forward comments regarding burden estimate to the Records and Reports Management Branch (p-530), U.S. Nuclear Regulatory Commission, Washington, DC 20555, and to the Paperwork Reduction Project (3150-0104), Office of Management and Budget, Washington, DC 20503.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Millstone Nuclear Power Station Unit 1	0 5 0 0 0 2 4 5	1 OF 0 7

TITLE (4): Low Pressure Coolant Injection Heat Exchanger Flow Rates

EVENT DATE (5) MONTH	DAY	YEAR	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	REPORT DATE (7) MONTH	DAY	YEAR	OTHER FACILITIES INVOLVED (8) FACILITY NAMES	DOCKET NUMBER(S)
0 9	0 7	9 0	9 0	— 0 1 4 —	0 0	1 0	0 9	9 0		0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9): N

POWER LEVEL (10): 1 0 0

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

[ ] 20.402(b)	[ ] 20.405(c)	[ ] 50.73(a)(2)(iv)	[ ] 73.71(b)
[ ] 20.405(a)(1)(i)	[ ] 50.36(c)(1)	[X] 50.73(a)(2)(v)	[ ] 73.71(c)
[ ] 20.405(a)(1)(ii)	[ ] 50.36(c)(2)	[ ] 50.73(a)(2)(vii)	[ ] OTHER (Specify in Abstract below and in Text, NRC Form 366A)
[ ] 20.405(a)(1)(iii)	[ ] 50.73(a)(2)(i)	[ ] 50.73(a)(2)(viii)(A)	
[ ] 20.405(a)(1)(iv)	[ ] 50.73(a)(2)(ii)	[ ] 50.73(a)(2)(viii)(B)	
[ ] 20.405(a)(1)(v)	[ ] 50.73(a)(2)(iii)	[ ] 50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER AREA CODE	
William G. Noll, Sr. Engineer (Ext. 4442)	2 0 3	4 4 7 - 1 7 9 1

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)

[X] YES (If yes, complete EXPECTED SUBMISSION DATE) [ ] NO

EXPECTED SUBMISSION DATE (15): MONTH 0 1 DAY 1 5 YEAR 9 1

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

On September 7, 1990, at 1845 hours, with the plant at 100% power (530 degrees Fahrenheit and 1030 psig), an inconsistency between procedural and design parameters associated with the Low Pressure Coolant Injection (LPCI) heat exchanger flow rates was identified. The inconsistency was associated with the maximum LPCI flow permitted through the heat exchanger to preclude failure due to erosion and flow-induced vibration, and the heat exchanger flow rates required by the Emergency Operating Procedures (EOP's). After review of the procedures, the design basis, and discussions with the heat exchanger manufacturer, it was determined that operability of the containment cooling system could not be assured due to potential mechanical limitations of the heat exchanger. Both containment cooling subsystems were declared inoperable and a plant shutdown to cold shutdown was immediately initiated as required by Technical Specifications. Cold shutdown was achieved on September 8, 1990 at 1705 hours. No safety systems were required to function as a result of this event and no safety consequences resulted from this event.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

I. Description of Event

On September 7, 1990, at 1845 hours, with the plant at 100% power (530 degrees Fahrenheit and 030 psig), an inconsistency between procedural and design parameters associated with the Low Pressure Coolant Injection (LPCI) heat exchanger flow rates was identified. The inconsistency was associated with the maximum LPCI flow permitted through the heat exchanger to preclude failure due to erosion and flow-induced vibration, and the heat exchanger flow rates required by the Emergency Operating Procedures (EOP's). After review of the procedures, the design basis, and discussions with the heat exchanger manufacturer, it was determined that operability of the containment cooling system could not be assured due to potential mechanical limitations of the heat exchanger. Both containment cooling subsystems were declared inoperable and a plant shutdown to cold shutdown was immediately initiated as required by Technical Specifications. Cold shutdown was achieved on September 8, 1990 at 1705 hours. No safety systems were required to function as a result of this event and no safety consequences resulted from this event.

II. Cause of Event

A review of the original Millstone Unit One emergency procedures and the system operating procedures indicated that no precautions or limitations associated with excessive heat exchanger flow rates existed for the LPCI heat exchangers since initial plant start-up in 1970. In 1987, Northeast Utilities implemented a voluntary program for design basis reconstruction at Millstone Unit One. It was during a review of the LPCI Design Basis draft document on the LPCI system that the discrepancy between the design heat exchanger flow rates and the procedural required flow rates was identified.

The Design Basis Reconstruction program was the original source of the inconsistency between the component design limitations and the system operating procedures. Although the original discrepancy was identified in June of 1989, a preliminary engineering assessment of the discrepancy determined no safety significance based upon engineering judgement. However the design basis discrepancy associated with the LPCI heat exchanger flow rates continued to be evaluated under the resolution process implemented by the Design Basis Reconstruction process.

Implementation of Revision 2 of the BWR Owner's Group Emergency Procedure Guidelines in June 1983, required LPCI injection flow be established through the LPCI heat exchanger as soon as possible. This procedural requirement was established by General Caution #4, and was contained in an administrative section of the EOP's applicable to all EOP steps. Revision 4 of the BWR Owner's Group Emergency Procedure Guidelines and subsequent EOP's implemented in September 1989, incorporated the administrative guidance into the actual EOP procedure steps. The continuing effort to enhance the general guidance provided by the EOP's resulted in procedure changes to the Emergency Service Water (ESW) system operating procedure. The ESW operating procedure was undergoing revision to more clearly identify the required heat exchanger flow rates for containment cooling. The ESW procedure revisions prompted discussions with plant engineering, the heat exchanger manufacturer, and corporate engineering and concluded that LPCI heat exchanger flow rates in excess of 5000 gpm could jeopardize LPCI heat exchanger operability. The excessive flow rates could be experienced during a design basis accident by following the procedure guidance contained in the EOP'S. As a result of this information, the LPCI containment cooling sub-systems were declared inoperable and a plant shutdown was initiated.

The root cause of this event has been determined to be inadequate evaluation of original plant design documentation that permitted component operation such that the design limitations would have been exceeded. Therefore, operation of the LPCI system with all flow being directed through the heat exchanger did not take into consideration the potential long term damage to the heat exchanger component.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

III. Analysis of Event

This event is reportable pursuant to 10CFR 50.73(a)(2)(v), any event or condition that alone could have prevented the fulfillment of the safety systems that are needed to mitigate the consequences of an accident. Immediate notifications were performed in accordance with 10CFR 50.72 (b)(1)(i)(A).

The Emergency Operating Procedures were developed with the philosophy of establishing as high a heat exchanger flow rate as possible. Therefore, the EOP's would allow the operator to perform the long term containment cooling funtion utilizing two 5000 gpm LPCI pumps to provide flow through each LPCI heat exchanger. This would also be the same active equipment used during the LOCA injection phase. However, as part of the Design Basis Reconstruction project, it was discovered that the LPCI heat exchanger was designed for only 5000 gpm. Thus, the Emergency Operating Procedures would have allowed the operator to exceed the design parameters for the LPCI heat exchangers.

The most limiting design basis event affected by excessive heat exchanger flow rates is as follows:

1. The initiating event is a LOCA.

2. LPCI is automatically placed in the Post LOCA Core Reflood mode and injection starts.

3. Valves LP-7A and LP-7B (LPCI heat exchanger bypass valves) are interlocked in the open position to prevent closure until one minute after initiation of the injection mode.

4. Some time after the interlock clears, the operator would close LP-7A and LP-7B to initiate cooling through the LPCI heat exchanger. The operators are directed by the Emergency Operating Procedures to perform this action as soon as practical.

Closing the LPCI heat exchanger bypass valves LP-7A and B, will direct all LPCI flow to the shell side of the heat exchanger. Therefore as much as 10,000 gpm could be passed through each heat exchanger designed for only 5000 gpm. Flow through the heat exchangers would be decreased only if adequate core cooling has been assured, and only for the following reasons:

1. Torus water temperature decreases to a 90 - 110 degree F range

2. LPCI Net Positive Suction Head (NPSH) requirements dictate that the operator decrease LPCI flow to maintain adequate NPSH, or

3. Direction is given from the Emergency Response Organization

Based on the scenario discussed above, it is possible that the high flow condition could have been maintained for some period of time resulting in potential heat exchanger damage. Therefore, it was determined that the LPCI heat exchangers were inoperable and a shutdown was initiated as required by Technical Specifications.

While the actual LPCI heat exchanger flow rate could be considerably above the design flow rate, the heat exchanger manufacturer subsequently has communicated the judgement that based on the ultimate capability of the heat exchanger, rather than design limits, that the heat exchanger would still perform its safety function for an extended period of time. This judgement is based upon the following:

1. To date, the LPCI heat exchangers have seen very little service.

2. Eddy current testing indicates little or no degradation of the tube wall thickness.

3. The failure mechanisms associated with high flow, such as erosion and flow induced vibration, will take a considerable time to develop.

III. Analysis of Event (Continued)

Based on this judgement, it was concluded that the heat exchanger would still perform its intended safety function for a period of several weeks to a month. The safety significance of a heat exchanger degradation weeks after the initiation of the event is greatly reduced due to the reduction in decay heat.

In the unlikely event that the LPCI heat exchangers failed early in the postulated LOCA, the following sequence of events could be postulated:

1. The likely failure modes would be a failure of some of the tubes in the heat exchanger and a reduction in heat transfer capability.

2. Since the ESW pressure is higher than the LPCI pressure, tube leakage would result in emergency service water addition to the LPCI flow. This would result in an increase in Torus water level. This could alert the operators to the potential for a tube leak.

3. The heat exchanger heat removal capability would be degraded, but this would somewhat be offset by the addition of cold ESW flow to the torus.

4. If there were a major degradation in the performance of both heat exchangers and inadequate heat removal for a long period of time, it may not be possible to maintain torus water temperatures at acceptable levels.

5. Very high torus water temperatures could lead to inadequate LPCI or Core Spray pump NPSH, LPCI or Core Spray pump seal failure or containment pressurization to the point were venting would be required.

Due to the manufacturer's reassessment of heat exchanger performance discussed previously, and the relatively long time frame involved where alternative mitigating strategies could be developed, it is judged that this scenario is very unlikely and, therefore, the flow discrepancy event is judged to be not safety significant.

IV. Corrective Action

Amendment 18 of the original Millstone Unit One FSAR was utilized as the design analysis of record for containment cooling capability. Case study #5, Table A-11.1, of FSAR Amendment 18 shows that one LPCI pump and heat exchanger is capable of satisfying containment cooling requirements, but requires a higher containment spray interlock pressure to ensure adequate NPSH is available for the remaining ECCS pumps.

FSAR Amendment 18 Analysis was performed in 1969 with details of the analytical techniques unavailable for evaluation. On September 8, 1990, General Electric was requested to perform additional analyses with more current methodologies and provide confirmation of the conclusion on adequate NPSH in Amendment 18 of the FSAR.

Both the original FSAR Amendment 18 analysis and the more recent analysis performed by General Electric demonstrated that one LPCI pump and heat exchanger were capable of providing adequate containment cooling.

The following actions were completed to restore the containment cooling system to an operable status:

1. The Emergency Operating Procedures (EOPs) and normal operating procedures (OP's) were changed to allow only a single LPCI pump per train to supply each heat exchanger when in the containment cooling mode.

IV. Corrective Action (Continued)

2. The containment spray interlock switch was recalibrated from 5 psig to 9 psig to ensure adequate low pressure emergency core cooling system pump net positive suction head (NPSH). This action was completed following receipt of the Emergency Technical Specification Change Request for the Containment Spray Interlock.

3. Simulator verification and validation of the EOP's were performed in accordance with the EOP program. In addition, all operating crews were trained on the EOP changes by performing scenarios that exercised the EOP changes and demonstrated the changes on the containment cooling system. This training was completed for each operating shift prior to assuming control room duties.

The discrepancy between the heat exchanger design flow limits and the system operating procedures was first identified during the Millstone Unit One Design Basis Reconstruction Program which was completed for the LPCI system in late 1989. Other design discrepancies were also identified on the LPCI system and were either directly related to the heat exchanger flow issue, or were dispositioned as not reportable and did not affect system operability. At the time of the LPCI heat exchanger event, two other Millstone Unit One systems had completed the design basis review process. To ensure other design deficiencies did not exist that could threaten system operability, a review of each design deficiency was performed for the Control Rod Drive System (CRD), and the Feedwater Coolant Injection system (FWCI). The reviews performed on the CRD and FWCI systems did not identify any additional operability concerns. A corporate procedure which was under development at the time of this incident has been implemented to specify the "initiation, tracking, handling, and disposition of design discrepancies" identified during the design basis reconstruction effort. Implementation of this program will ensure all design basis discrepancies identified during the reconstruction program receive a thorough and timely review for operability and reportability concerns.

A design review of other safety related heat exchangers was imple. ented to ensure similar operating design limits were not exceeded. The Turbine Building Seconda- Closed Cooling Water (TBSCCW) heat exchangers were identified as having a potential for essive flow rates during normal operation. A reportability e luation is in progress to resolve this issue.

The Design Basis reconstruction process will be utilized to identify potential design deficiencies on Millstone Unit One safety related systems and other selected systems. This effort will also contain a dedicated review of system operating and emergency procedures to ensure components are operated within their design limitations.

The original engineering assessment of the LPCI heat exchanger by the manufacturer indicated that the heat exchanger would still perform its intended safety function for several weeks to a month. Further analysis using the Heat Transfer Research Insitute (HTRI) computer model indicated that less than 2% margin existed between the design flow rates and critical flow rates. The HTRI analysis is highly conservative and cannot predict heat exchanger failure following exposure to critical flows.

Millstone Unit One has commissioned an independent firm to perform additional heat exchanger analysis to qualify the results obtained from the heat exchanger manufacturer. The results of this analysis and its potential affects on the safety significance of this event will be documented in a supplemental response.

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V. Additional Information

The following information is being provided to identify the system and components affected by the design discrepancy associated with the LPCI heat exchangers.

EIIS Codes

System	Components	Manufacturer
Low Pressure Coolant Injection - BO	Heat Exchanger - HX	P160 - Perfex

NRC Form 366A (6-89) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104 EXPIRES: 4/30/92

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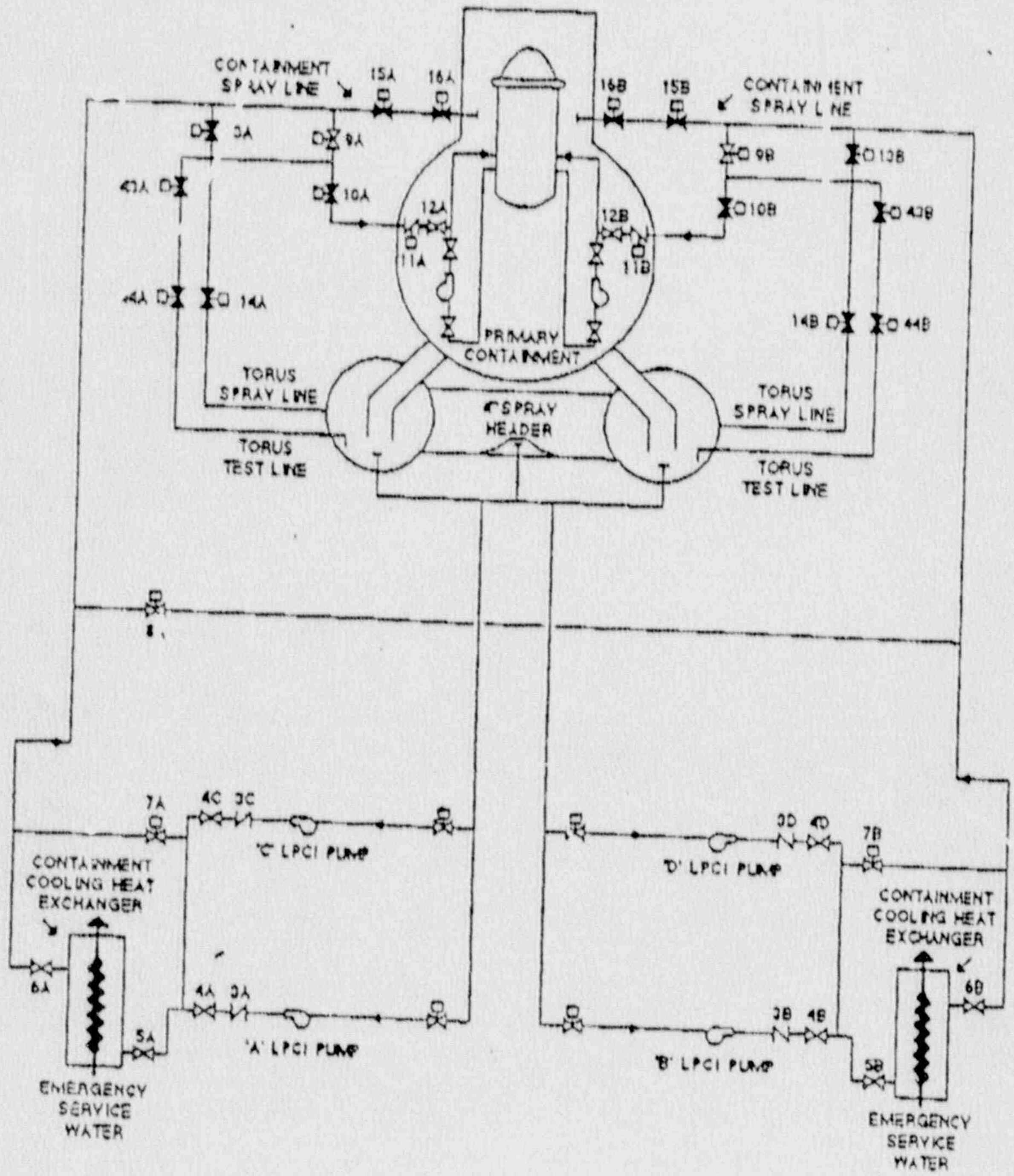

LPCI SYSTEM DIAGRAM