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September 2, 1998

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Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subj: Northeast Nuclear Energy Company
(Millstone Station, Unit 3),
Docket 50-423-LA

Dear Administrative Judges:

In accordance with the discussion during the prehearing conference call held today, enclosed is a copy of the submittal made to the NRC Staff on February 16, 1998 (B17050). The submittal is an integrated safety analysis of the Recirculation Spray System.

Sincerely,

David A. Repka

David A. Repka
Counsel for Northeast Nuclear Energy Company

Enclosure

cc: Service List (w/attachment)

SECY-EHD-002 DS03 19503

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The Northeast Utilities System

February 16, 1998

Docket No. 50-423
B17050

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

Millstone Nuclear Power Station Unit No. 3
Response to Notice Request for Information
On The Recirculation Spray System

By letter dated February 3, 1998, the NRC Special Projects Office (SPO) transmitted a request to provide information relating to the Design and Licensing Bases of the Recirculation Spray System (RSS). This letter and its enclosures provide the information requested.

An Integrated Safety Analysis has been performed on the Recirculation Spray System using the Millstone Unit 3 Safety Evaluation Report (NUREG-1031), issued by the Nuclear Regulatory Commission, as the basis. Modifications to the system that have been implemented since the issuance of the Safety Evaluation Report have been evaluated individually and on an integrated basis as they relate to the current RSS configuration. The Integrated Safety Analysis identified an Unreviewed Safety Question (USQ) associated with the modification made in 1986 which eliminated direct injection to the RCS. Our assessment has also concluded that the configuration of the Recirculation Spray System, past and present, has historically been operable despite the 1986 change.

In accordance with the guidance contained within Generic Letter 91-18, Revision 1, a license amendment request to support unit operations with this USQ will be provided prior to entry into Mode 4. The amendment request will be in the form of a FSAR change for the Recirculation Spray System. No Technical Specification changes are required to support this modification.

A review of the preliminary findings from the Independent Corrective Action Verification Program (ICAVP) Tier 1 inspection conducted by the NRC and a review of the potential Discrepancy Reports provided by the ICAVP Contractor found no discrepant conditions, not yet addressed, that would call into question operability or functionality of the Recirculation Spray System. These items will be reviewed in accordance with the criteria provided in the response to question 3 of the NRC's April 16, 1997 letter pursuant to 10 CFR 50.54(f).

Enclosure 1 provides the responses to Questions 1 through 5 of your request. A "roadmap" is provided to allow easy alignment of the questions and answers. A portion of question 4, concerning training on modifications made to the Recirculation Spray System, was discussed in a public meeting on January 29, 1998 at NRC Region 1 Headquarters.

Enclosure 2 provides the response to Question 6 which requests information on our program for compliance with Technical Specification 6.8.4. NNECO will be in compliance with this specification prior to entry into Mode 4.

The outstanding issues with respect to the Recirculation Spray System will be included as part of the overall, comprehensive, mode change assessment process. Each item will be reviewed to assure compliance with the Design and Licensing bases as it applies to the mode change being assessed.

Should you have any questions regarding the information contained herein, please contact Mr. David A. Smith at (860) 437-5840.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

Martin L. Bowling, Jr.
Millstone Unit No. 2 - Recovery Officer

cc: see page 3

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J. P. Durr, Chief, Division of Reactor Projects, SPO
D. Schopfer, Sargent and Lundy ICAVP Project Manager

Attachment 1

Millstone Nuclear Power Station, Unit No. 3

Commitments

February 16, 1998

Attachment 1

Regulatory Commitment Enclosure
List of Regulatory Commitments

The following table identifies those actions committed to by NNECO in this document. Any other actions discussed in the submittal represent intended or planned actions by NNECO. The Director - Regulatory Affairs or Manager - Regulatory Compliance Unit 3 should be notified of any questions regarding this document or any associated regulatory commitments.

REGULATORY COMMITMENT	COMMITTED DATE OR OUTAGE
B17050-01: RWST Back-leakage Verification Test Procedures will be included in the Overall Leakage Reduction Program prior to the next refueling outage.	Prior to the next refueling outage
B17050-02: RWST Backleakage tests will be completed prior to entry into Mode 4.	Mode 4 from current outage
B17050-03: Operator Crews will be tested to show they can accomplish transfer from injection mode to recirculation mode in less than 25 minutes.	Prior to the next refueling outage
B17050-04: A Debris Transport Methodology will be developed and submitted to the NRC for review by December 1, 1998.	December 1, 1998
B17050-05: A FSAR Change containing a USQ on RSS will be submitted to the NRC prior to entry into Mode 4.	Mode 4 from current outage

ENCLOSURE 1

MP3 - RSS SYSTEM;
RESPONSE TO NRC INFORMATION REQUEST
DATED FEBRUARY 3, 1998

OVERVIEW
HISTORY
DESIGN AND OPERATIONAL ISSUES
PLANT LICENSING AND DESIGN BASIS REVIEW
INTEGRATED SAFETY ASSESSMENT RELATIVE TO THE ORIGINAL NRC APPROVED DESIGN (CIRCA 1985)

Table of Contents

1. INTRODUCTION AND HISTORICAL OVERVIEW 1

1.1 Introduction and Summary 1

1.2 Original Design 1

1.3 Current (1998) Design 3

1.4 Historical Changes 4

1.5 Summary of 10 CFR 50.59 Review 5

1.6 Summary of Response to NRC Question 6

2. COMPARISON OF RSS ORIGINAL DESIGN TO THE CURRENT DESIGN ... 8

2.1 Original Design (Circa 1985) 8
2.1.1 Injection Phase 8
2.1.2 Cold Leg Recirculation Phase 8
2.1.3 Hot Leg Recirculation Phase (Two Path-Hot & Cold Leg) 9
2.1.4 Basic Performance Parameters (Flow Rates, Timing, Operator Actions) 9

2.2 Description of 1998 Design 10
2.2.1 Injection Phase 10
2.2.2 Cold Leg Recirculation Phase 10
2.2.3 Hot Leg Recirculation Phase (Two Path-Hot & Cold Leg) 10
2.2.4 Use of Direct Injection 10
2.2.5 Basic Performance Parameters (Flow Rates, Timing, Operator Actions) 11

3. DESCRIPTION OF CHANGES WHICH AFFECTED RSS SYSTEM OPERATION 12

3.1 1986 Elimination of Direct Injection Design Change 12

3.2 1991 Containment Operating Pressure Design Change 12

3.3 Current RSS Modifications 13

3.4 Use of Direct Injection for Limited Passive Failures and Multiple Failures 14

3.5 Operator Action Time Change, 10 to 25 minutes 14

4. ACCIDENT ANALYSIS - ASSESSMENT OF CHANGES SINCE NRC REVIEW AND APPROVAL (CIRCA 1985) 15

4.1 Analysis Computer Code/Design Inputs/Analytical Models/Assumptions 15
4.1.1 Computer Codes/Analytical Models Used in the Safety Analysis 15
4.1.2 Design Inputs/Assumptions used in the Safety Analysis 16

4.2 Impact of the Reduced RSS Flow on Accident Analysis 17
4.2.1 Large Break LOCA Assessment 17
4.2.2 Long-term cooling 17
4.2.3 Boron Precipitation Control 18
4.2.4 Small Break LOCA Assessment 18
4.2.5 Peak Pressure and Temperature 18
4.2.6 Containment Depressurization 19
4.2.7 Pump NPSH: Minimum Sump Level and Maximum Temperature 19
4.2.8 Containment Liner Temperature 20
4.2.9 Equipment Environmental Qualification 20
4.2.10 Radiological Evaluation 20
4.2.11 Combustible Gas Generation 21

4.3 Other Accidents 21
4.3.1 Steam Line Breaks 21
4.3.2 Feedwater Line Breaks 21

4.4 Assessment of the Effect on the Licensing Bases 22

4.5 Summary 22

5. SYSTEM MODIFICATIONS 24

6. PROBABILISTIC RISK ASSESSMENT - ASSESSMENT OF RSS SYSTEM CHANGES SINCE NRC REVIEW AND APPROVAL (CIRCA 1985) 25

6.1 The Impact of Removing Direct Inject from Design Basis on Individual Plant Examination (IPE) 25

6.2 Use of IPE insights during review of RSS design modifications made during mid-cycle 6 shutdown 26

7. OTHER ISSUES 29

7.1 Training 29

7.2 System Testing Considerations 30
7.2.1 Test Program 30
7.2.2 Assessment of RSS Modification Effect On Previous Testing 32
7.2.3 Post Modification Testing for RSS Pump Restriction Orifices 33
7.2.4 Post Modification Testing for RSS Miniflow Valves (3RSS*MOV38A,B) 35

7.3 Operational Issues Resulting from the RSS Modifications 35
7.3.1 Testing Results 36

8. INTEGRATED SAFETY ASSESSMENT 37

8.1 10CFR50.59 Review Of RSS Modifications 37

8.2 Elimination of RSS Direct Injection 38

8.3 Containment Pressure Change From Subatmospheric to Atmospheric 39

8.4 Reduction in RSS Flow Due to Installation of Orifices 39

8.5 Credit for RSS Direct Injection for Failure Mitigation 39

8.6 Increase in Assumed Operator Action Time 40

8.7 Changes in Analysis Methods and Inputs 40

9. CONCLUSION 41

10. REFERENCES 42

10.1 Design Change Documents 42

10.2 Safety Evaluations 42

10.3 Westinghouse Correspondence 43

10.4 Stone & Webster Correspondence 43

11. LIST OF ATTACHMENTS 43

12. LIST OF FIGURES 43

1. INTRODUCTION AND HISTORICAL OVERVIEW

This document prcvides a response to the request for information concerning the Containment Recirculation Spray System (RSS) at Millstone Unit 3, dated February 3, 1998. Specifically, this report addresses the RSS and provides an overview of system history, design and operational issues, plant licensing and design basis review, training, and integrated safety assessment relative to the original NRC approved design (NUREG 1031, July 1984).

1.1 Introduction and Summary

The Containment RSS of Millstone Unit 3 is part of the Engineered Safety Features (ESF) which are designed to mitigate the consequences of a Loss of Coolant Accident (LOCA).

The RSS system uses four pumps to recirculate water from the containment sump and performs the following functions:

1. Supplements the Quench Spray System (QSS) during the early part of the LOCA to depressurize the containment, and provides for long-term control of containment pressure and temperature after QSS has completed its safety function.
2. Provides the Ultimate Heat Sink for the Emergency Core Cooling function after direct injection of the Refueling Water Storage Tank (RWST) has been terminated.
3. Provides the long term iodine scavenging function from the containment atmosphere after QSS is terminated following a large break LOCA.

This system has undergone several modifications over the life of the plant. The purpose of this report is to describe these modifications and how they have affected system functionality and compliance with regulatory requirements. This Introduction and Historical Overview section is intended to highlight the most significant issues and to provide an overview of the report.

1.2 Original Design

In the original design, the RSS assumed the following configurations during the three phases of a LOCA.

Injection Phase

All 4 RSS pumps auto start approximately 11 minutes after a Gontainment Depressurization Actuation (CDA) signal and augment QSS to spray and depressurize the containment.

Cold Leg Recirculation Phase

When the Low-Low level in the Refueling Water Storage Tank is reached (~33min.), the following manual alignment was performed as directed by the EOPs:

2 RSS pumps remain aligned to the containment spray header

The other 2 RSS pumps were isolated from the spray header and realigned to provide direct injection supply to the suction of the injection pumps as follows:

2 RSS pumps --> Supply:

- 2 Charging pumps ------------------------------------> 4 cold legs
- 2 Intermediate Pressure (SIH) pumps ------------> 4 cold legs
- 2 Cold Leg Direct Injection Paths ----------------> 4 cold legs

Hot Leg Recirculation Phase 3

Approximately 9 hours into a LOCA, injection is manually realigned to the hot legs to prevent boron precipitation as follows:

2 RSS pumps remain aligned to Containment sprays

2 RSS pumps --> Supply:

- 2 Charging pumps ------------------------------------> 4 cold legs
- 2 Intermediate Pressure (SIH) pumps ------------> 4 hot legs
- 2 Cold Leg Direct Injection Paths -----------------> ISOLATED
- 1 Hot Leg Direct Injection Path -------------------> 2 hot legs

1.3 Current (1998) Design

In the 1998 current design, the RSS assumes the following configurations during the three phases of a LOCA

Injection Phase

All 4 RSS pumps auto start approximately 11 minutes after a containment Depressurization Actuation (CDA) signal and augment QSS to spray containment.

Cold Leg Recirculation Phase

When the Low-Low level in the refueling water storage tank (RWST) is reached (~33 min) the following manual alignment is performed in accordance with the EOPs:

2 RSS pumps remain aligned to the containment spray header.

The other 2 RSS pumps remain aligned to the containment spray header and are also aligned to the suction of the injection pumps as follows:

2 RSS pumps ----------------------------------> Supply to:

- 2 Charging pumps --> 4 cold legs
- 2 Intermediate pressure (SIH) pumps-------------------------> 4 cold legs
- 2 Cold Leg Direct Injection paths ----------------------------> **Isolated**

Hot Leg Recirculation Phase

Approximately 9 hours into the LOCA, injection is realigned to the hot legs to prevent boron precipitation as follows:

2 RSS pumps remain aligned to the containment spray header only

2 RSS pumps ----------------------------------> Supply to:

- 2 Charging pumps --> 4 cold legs
- 2 Intermediate pressure (SIH) pumps-------------------------> 4 hot legs
- 2 Cold Leg Direct Injection Paths -----------------------------> **Isolated**
- 1 Hot Leg Direct Injection Path ---------------------------------> **Isolated**

1.4 Historical Changes

1986 Elimination of Direct Injection

The issue driving this functional modification was observed vibration of the RSS heat exchangers due to excessive flow. This phenomenon was discussed during pre-ops testing in 1985. Westinghouse analysis demonstrated that the flow provided by the two safety injection pumps and two charging pumps in the recirculation phases was in excess of the flow required for core cooling and therefore, direct injection from the RSS pumps into the cold (and hot) legs was not required. Evaluation of injection flow after RSS direct injection elimination demonstrated accident acceptance criteria were being met. RSS direct injection was eliminated by revising Emergency Operating Procedures to require the operators to close the direct injection flowpaths. However, provisions in the Emergency Operating Procedures were retained to open the valves for direct cold leg injection as a contingency action if required.

1991 Change of containment from subatmospheric to atmospheric

In order to allow for more expedient containment access during power operation, a change was processed and implemented in 1991 to change the containment design from subatmospheric to near atmospheric. This change did not alter system function as described in Section 1.3 above. However, the design basis of RSS was significantly changed. The initial design basis, applicable to subatmospheric containment, required that QSS and RSS bring the containment pressure to subatmospheric conditions within 1 hour after a LOCA. The revised design basis, applicable to an atmospheric containment, requires that QSS and RSS reduce containment pressure below 50% of peak accident pressure within 24 hrs. after a LOCA. This change was reviewed and approved by the NRC in Amendment No. 59 (TAC No. 76066), dated January 25, 1991.

1996 - 1998 RSS Changes

During the current plant shutdown, a number of conditions were identified which affect the RSS system and require corrective actions. The changes implemented to correct these conditions are described in Section 3 and 5 of this report and fall into two distinct categories:

Actions to restore systems and components to the level of reliability expected in the original design. These actions addressed various issues that were present in the original and subsequent designs. These issues include, piping qualifications, expansion joint qualification, sump restoration, ECCS loops seal issues and RSS pump seal and testing issues.

Changes which affect RSS system operation or performance. There are three changes of this type. The first change installs RSS pump restricting orifices. The second change once again recognizes the use of direct cold leg injection. The third change increases the documented time to complete switchover to cold leg recirculation.

1.5 *Summary of 10 CFR 50.59 Review*

This integrated safety assessment reviews the modifications, changes and analysis used to support the RSS design from 1985 until 1998. These changes were evaluated as to whether they affected the functionality of the design or whether they restored or improved the original assumed reliability. The reviews of the functional changes are described below.

- Elimination of direct injection changed an automatic safety function with no operator action to a contingent safety function requiring operator action. Therefore this change could have increased the probability of malfunction of equipment important to safety and is an Unreviewed Safety Question.

- The change in containment operating pressure required a Technical Specification change and received NRC review and approval prior to its implementation. This change resulted in a relaxation of the containment depressurization acceptance criteria.

- RSS pump restriction orifices were added to the system to eliminate the possibility of suction line flashing and potential water hammer. Although, this change significantly affected the system performance, the evaluation of the impact of this change on malfunctions, accidents, and margin of safety determined that there was not an Unreviewed Safety Question.

- The FSAR and supporting documentation are being changed to clearly reflect the use of RSS direct injection as a means for mitigating certain assumed limited passive failures in the design bases. This change does not result in an Unreviewed Safety Question.

- The increase in required time to complete switchover to cold leg recirculation documents a change to the minimum time available for the operators to complete switchover from the Injection Phase to the Cold Leg Recirculation Phase. There is no change to the operator actions or to the probability that the operators or the equipment will fail. This change does not result in an Unreviewed Safety Question.

1.6 Summary of Response to NRC Question

Question 1

Based on the 1986 operational change to the (RSS) and all the subsequent modifications made during the current outage, please provide an integrated safety assessment which compares the current system design to the original NRC-approved RSS design. This assessment should address significant changes to analytical models and inputs used to calculate thermal-hydraulic performance, containment pressure/temperature, and radiological dose consequences of postulated accidents.

Response: This document provides the requested integrated safety assessment of the RSS design and modifications to the current configuration.

Question 2

Based on the limited staff review of the 1986 operational change to the RSS system, it appears that eliminating cold and hot leg direct injection resulted in a reduction to the margin of safety. Please address this concern.

Response: The review of the 1986 change which eliminated the RSS direct injection path concludes that this change should have been considered an Unreviewed Safety Question. Refer to Section 8.

Question 3

Provide a description of each major RSS system modification and your determination of whether an Unreviewed Safety Question exists.

Response: Sections 3 and 5 of this report describe each of the significant modifications to the RSS system. Attachment 2 contains a listing and summary of all design changes since the operating license was issued. Other than the elimination of direct injection in 1986, none of the other changes has resulted in an Unreviewed Safety Question.

Question 4

Discuss the training received by operators on the modifications made to the RSS system since plant was shutdown, as well as any new insights revealed by the IPE for the current system configuration/operation.

Response: The training which has been received by the operators is discussed in Section 7 of this report. In addition the information on training was previously supplied during a public meeting on January 29, 1998 at NRC Region 1 HQ. Section 6 describes how IPE insights were used in evaluating and improving the redesign of the RSS.

Question 5

Provide an evaluation of new operational issues resulting from modifications to the RSS such as the vibration resulting from the installation of the flow restricting orifices.

Response: Section 7 of this report provides a discussion of the vibration issues and testing which is being performed to assure the reliability of the RSS. No other operational issues were identified.

Question 6

With regard to the implementation of Technical Specification 6.8.4, describe the methods by which leakage from the RSS and associated systems outside containment will be controlled and monitored to ensure that the radiological dose consequences of postulated accident are within the plant's licensing bases.

Response: This question is addressed in Enclosure 2.

2. COMPARISON OF RSS ORIGINAL DESIGN TO THE CURRENT DESIGN

2.1 *Original Design (Circa 1985)*

The original RSS design supported both a subatmospheric containment and an ECCS function. The RSS system performs a containment heat removal function during the initial injection phase of an accident when ECCS pumps draw water from the RWST. The RSS system performs both a containment heat removal function and an ECCS function during the recirculation phase of an accident when the RWST is depleted and the containment sump is the only source of water.

2.1.1 Injection Phase

The injection phase of operation is actuated automatically on high-high containment pressure. After approximately an 11 minute time delay to allow the containment sump to fill, all four RSS pumps begin to recirculate water from the sump and discharge through their respective coolers to the spray headers. All RSS flow is initially directed to the RSS spray headers in the containment dome.

In addition to containment spray, several pathways are available to provide core cooling and makeup through the Emergency Core Cooling System (ECCS) as depicted in Figure 1A. Upon receipt of a safety injection signal (SIS), the following pumps start and align to provide core cooling and makeup from the RWST: one centrifugal charging pump starts, one pump is already in operation, and both pumps inject into the cold legs of all four Reactor Coolant System (RCS) loops. Two intermediate head safety injection (SIH) pumps start. Once the RCS pressure is below the shutoff head of the SIH pumps, they begin to take borated water from the RWST and deliver it to the cold legs in all four RCS loops. Two residual heat removal (SIL) pumps start. Once RCS pressure is below the SIL pump shutoff head, they begin to inject into the four RCS cold legs. When the RCS pressure drops below the pressure of the four safety injection accumulator tanks, they discharge their contents into the four RCS cold legs.

The duration of the injection phase depends upon the nature and severity of the accident. When the RWST water level drops to a predetermined point, the injection phase is discontinued and the cold leg recirculation phase is initiated.

2.1.2 Cold Leg Recirculation Phase

When the low-low level in the RWST is reached (approximately 33 minutes for LB LOCA maximum ESF in the original design) two SIL (RHR) pumps are tripped, two RSS spray header isolation valves are manually closed and the flow from the two associated RSS pumps is directed to the two cold leg direct injection flowpaths, the two operating charging pumps, and the two operating SIH pumps. The remaining two RSS pumps continue to operate as before, with their discharge directed to the spray headers (see Figure 1B). After the switchover to the recirculation phase of operation is accomplished, the system is in its basic configuration for long-term operation.

2.1.3 Hot Leg Recirculation Phase (Two Path-Hot & Cold Leg)

In order to prevent boron precipitation following a LOCA, one additional realignment is performed at nine hours after the initiation of the accident. The SIH pumps are realigned to provide flow to all four RCS hot legs. The RSS pumps are aligned to one hot leg direct injection flow path, supplying flow to Loops 2 and 4. The charging pumps continue to provide flow to the four cold legs, as before. The RSS cold leg direct injection paths are isolated. This alignment is illustrated in Figure 1C.

2.1.4 Basic Performance Parameters (Flow Rates, Timing, Operator Actions)

1985 RSS Minimum ESF Flow Performance Data

Mode	Spray Flow, gpm	ECCS Flow, gpm
Injection	7760	----
Cold Leg Recirculation	3880	3950
Hot Leg Recirculation	3880	3950(1)

Notes: (1) Hot leg recirculation ECCS flow is estimated to be approximately equal to the cold leg recirculation ECCS flow.

1985 RSS System Timing / Operator Actions Summary

The RSS pumps start approximately 11 minutes following the receipt of CDA (containment depressurization actuation) signal. During LBLOCA maximum ESF, switchover to cold leg recirculation occurs at approximately 33 minutes following the accident. The process to accomplish switchover to cold leg recirculation utilizes a combination of manual actions, interlocks and automatic actions, and is controlled by the EOPs. The switchover to cold leg recirculation was required to be accomplished in ten minutes.

2.2 *Description of 1998 Design*

2.2.1 Injection Phase

The Injection Phase alignment of the ECCS and RSS system is unchanged from the original 1985 alignment.

2.2.2 Cold Leg Recirculation Phase

The Cold Leg Recirculation Phase operation of the system in 1998 is similar to the original 1985 alignment with two substantial changes. First the RSS pumps are not isolated from the containment spray header when they are aligned to supply ECCS cooling. These pumps will provide a dual function: ECCS injection, as well as, containment spray function. Second, the direct injection paths from the RSS pumps to the RCS cold legs are isolated to prevent direct injection to prevent tube vibration. The direct injection flow path remains available as a contingency action in the event that charging and SIH become unavailable. This alignment is depicted in Figure 2B and is controlled by the EOPs.

2.2.3 Hot Leg Recirculation Phase (Two Path-Hot & Cold Leg)

The Hot Leg Recirculation Phase operation of the system in the 1998 configuration differs from the original 1985 alignment in that 1) the RSS pumps are not isolated from the containment spray header when they are aligned to supply ECCS cooling, and 2) the direct injection path from the RSS pumps to the RCS hot leg is not opened. The 1998 flow paths are shown in Figure 2C.

2.2.4 Use of Direct Injection

The direct injection paths of the RSS pumps to the cold legs are available to the operators as contingencies for mitigating situations in which at least one SIH and one charging pump are not available (Figure 2C). These situations could arise either as a result of multiple failures or from isolating certain limited passive failures in the ECCS. The use of these contingencies are controlled by the EOPs.

2.2.5 Basic Performance Parameters (Flow Rates, Timing, Operator Actions)

1998 RSS Minimum ESF Flow Performance Data

Mode	Spray Flow, gpm	ECCS Flow, gpm
Injection	4030	---
Cold Leg Recirculation	3150[1]	1100
Hot Leg Recirculation	3150[1]	1100

Notes: (1) The total 1998 spray flow is based on one dedicated RSS pump plus the excess flow that is not diverted to the ECCS pump from the second RSS pump.

1998 RSS System Timing / Operator Actions Summary

The RSS pumps start approximately 11 minutes following the receipt of CDA signal. During LBLOCA maximum ESF, switchover to cold leg recirculation occurs at approximately 33 minutes following the accident. The process to accomplish switchover to cold leg recirculation utilizes a combination of manual actions, interlocks and automatic actions. The required time for switchover to cold leg recirculation is increased from ten minutes to twenty five minutes. The 1998 switchover requires the closure of the two RSS direct injection isolation valves, but it has eliminated the closure of the two spray header isolation valves. Two RSS pumps are required to provide both RSS spray and ECCS injection. The switchover is controlled by the EOP.

3. DESCRIPTION OF CHANGES WHICH AFFECTED RSS SYSTEM OPERATION

3.1 1986 Elimination of Direct Injection Design Change

During startup testing (1985) of the RSS system, excessive RSS heat exchanger tube vibration was observed during certain modes of operation. The specific test which resulted in excess flow included operation of one RSS pump feeding the two Charging (CHS) pumps, the two SIH pumps and the hot leg direct injection path. It was determined that excessive RSS heat exchanger tube vibration could occur for heat exchanger flows in excess of 4600 gpm. The corrective action was to eliminate RSS direct injection to reduce RSS heat exchanger flow.

Emergency Operating Procedures EOP 35 ES-1.3, "Transfer to Cold Leg Recirculation" and EOP 35 ES-1.4, "Transfer to Hot Leg Recirculation," were revised to terminate flow from the RSS pumps directly to the RCS immediately after transfer to cold leg recirculation. As a result, the RSS pumps only supplied flow to the suction of the SIH pumps and the CHS pumps. The minimum ESF ECCS alignment for cold leg recirculation consisted of one CHS and one SIH pump injecting into the RCS cold legs. During hot leg recirculation, the SIH pumps were realigned to inject into the hot legs.

With these changes, the long term core cooling and containment heat removal design basis requirements were still met. These changes were evaluated in accordance with 10CFR50.59 and submitted to the NRC as FSAR updates in November, 1987. Northeast Utilities has recognized that this change constituted an Unreviewed Safety Question.

3.2 1991 Containment Operating Pressure Design Change

In 1991, the plant Technical Specification 3/4.6 was changed to increase containment pressure during normal plant operation so as to permit more expedient entry into the containment. With the nearly atmospheric normal operating containment pressure, the post LOCA one hour depressurization requirement to subatmospheric pressure no longer applied and was deleted from Technical Specification 3/4.6. The new design basis for containment pressure is to depressurize containment to less then 50 percent of the peak pressure within 24 hours after the postulated accident. The new design basis significantly reduces the heat removal requirements for QSS and RSS since these systems are no longer required to remove containment sensible and latent heat in order to reach subatmospheric conditions within one hour. Peak containment pressure is a function of energy release and containment depressurization is a function of containment heat sinks. It is the internal containment heat sinks and the 50°F QSS spray that effectively accomplishes containment depressurization in the first three (3) hours of a postulated LOCA. RSS starts after the maximum containment pressure occurs and, together with QSS, initially functions to prevent the occurrence of a second pressure peak.

The RSS is relied upon to provide recirculation water for long term ECCS core cooling and to maintain long term containment depressurization.

The other significant aspect of the change in containment operating pressure was the addition of new safety functions to the QSS and RSS systems. For original plant design, QSS and RSS were not considered to perform a fission product removal function. As a result of the containment pressure change, fission product removal is now a required function of both systems. QSS/RSS is now required to comply with the provisions of SRP 6.5.2, "Containment Spray as a Fission Product Cleanup System", Rev 2, dated December 1988. Per the provisions of SRP 6.5.2, the QSS/RSS is credited with a decontamination factor (DF) of 200 based upon calculations performed using the methodology of ANSI/ANS-56.5. The RSS also performs a long term fission product retention function after QSS is secured. The design of both spray systems has been determined to meet the applicable provisions of SRP 6.5.2. The NRC staff has determined that the QSS/RSS is designed in accordance with requirements of NUREG 0800 SRP Section 6.5.2 and approved the Technical Specification change per Amendment No. 59 (TAC No. 76066), dated January 25, 1991.

3.3 Current RSS Modifications

In 1997, the following concerns were identified with the RSS design: potential for RSS suction line flashing due to excessive frictional losses, potential for vortexing at the sump inlets due to inadequate water level in the sump during startup of the system, and potential for water hammer in the pump discharge piping following a stop and restart of an RSS pump. The suction line flashing and water hammer issues were resolved by installing restriction orifices on the discharge of each RSS pump. The issue of potential vortexing at the sump inlet was resolved by lowering the vortex grating by 12 inches.

Because flow to the RSS spray headers is reduced by the RSS pump restriction orifices, fifty percent of the RSS spray nozzles were plugged in order to maintain adequate pressure drop across the spray nozzles. This was also required to maintain the required spray droplet size distribution for spray thermal effectiveness. Extensive analysis of the containment water level showed that the water level in the sump might be too low to prevent vortexing at the sump suction inlets for a small break LOCA inside the reactor cavity. The vortex breakers located in the sump were lowered by one foot to resolve this potential concern. In order to assure that the qualification of electrical equipment inside containment could be supported, the containment spray isolation valves remain open when the RSS pumps are realigned to the ECCS. The excess RSS pump flow capacity above the flow required for the CHS and SIH pumps is used to supplement the containment spray cooling provided by the RSS pumps dedicated to containment spray.

As a consequence of the reduction in RSS pump flow, the RSS pump mini-flow recirculation valves were changed from normally open to normally closed and the valve opening logic was interlocked with the RSS spray header isolation valves. This change provides added assurance that a large portion of the process flow (about 1000 gpm) from being recirculated and lost from the cooling process. Additionally, flow test loops were added around RSS pumps C and D to facilitate pump testing, similar to the mini-flow test loops that exist for RSS pumps A and B.

3.4 *Use of Direct Injection for Limited Passive Failures and Multiple Failures*

During the 10 CFR 50.54f review it was realized that certain long term passive failures could result in actions that would reduce ECCS core injection flow below the values assumed in the accident analysis. It was also recognized that the original reason for eliminating RSS direct injection (excessive RSS heat exchanger flows) was no longer an issue because of the addition of the RSS orifices. However, direct injection remains in the RSS design basis as a contingency action in response to postulated long term passive failures.

3.5 *Operator Action Time Change, 10 to 25 minutes*

The transition between the injection phase of a LOCA and the cold leg recirculation phase requires manual operator action to realign the suction of the charging and intermediate head SI pumps from the RWST to the discharge of the RSS pumps (see Figures 1B and 2B). Prior to 1998 the FSAR has stated that the operators could complete this transfer within 10 minutes after receipt of the low level RWST alarm. This time was in the original plant design to ensure an adequate RWST inventory for Quench Spray operation and to meet the 1 hour subatmospheric requirement. This requirement was eliminated by the containment design change (see Section 3.2).

As a result of changes in valve stroke times in the command and control communication protocol in the control room, the time for operators to complete the transfer from injection phase to recirculation phase has increased. The FSAR is being modified to state that the switchover will be completed within 25 minutes. Calculations have been performed which demonstrate that sufficient RWST inventory is available to support ECCS pump operation for a minimum of 25 minutes after reaching the Low-Low RWST level.

4. ACCIDENT ANALYSIS - ASSESSMENT OF CHANGES SINCE NRC REVIEW AND APPROVAL (CIRCA 1985)

This section provides a summary of the RSS performance assumed in the safety analysis of the Millstone Unit 3 containment and long-term core cooling. The RSS system is an Engineered Safeguards System that supports both an ECCS function as well as the containment heat removal function.

The current modifications to the RSS system affected its performance and required a complete re-analysis of the containment response to the design basis accidents. This summary is organized in the form of a general comparison of the system performance at the time when it was originally put into service to the performance established after the recent extensive modifications. The safety functions that the system needs to fulfill will also be a part of the comparison. (Refer to Figure 3 for a schematic showing the location of recent major RSS design modifications). The safety functions of the RSS are: containment heat removal after an accident, long-term core cooling, reactor vessel inventory control of the boric acid concentration in the vessel and long term iodine scrubbing.

4.1 Analysis Computer Code/Design Inputs/Analytical Models/Assumptions

4.1.1 Computer Codes/Analytical Models Used in the Safety Analysis

<u>ECCS LOCA Evaluation Model</u>

The original 1985 ECCS analysis used the Westinghouse 1981 Large Break LOCA methodology. In 1990 the methodology was upgraded to include the modeling of the VANTAGE 5H fuel assemblies.

Computer codes used for LOCA licensing analysis:

LBLOCA:	SATAN-IV	global modeling of the RCS and the secondary side
	WREFLOOD	using the data from SATAN-IV, calculates the time to bottom of core recovery during refill)
	BASH	calculates the reflood phase of a Large Break LOCA
	BART	calculates the entrainment rate during reflood
	LOCBART	calculates core average conditions for BASH input
	COCO	containment pressure transient used as a boundary condition in WREFLOOD

SBLOCA:	NOTRUMP	calculates the transient depressurization of the RCS, mass and enthalpy of the break flow
	LOCTA-IV	core thermal analysis using the NOTRUMP data)

Containment Analysis Model

LOCTIC Version 23, Level 02* (1985)
LOCTIC Version 23, Level 03** (1998)

*LOCTIC Version 23, Level 02, permits modeling of: (1) two flow paths for the RSS during ECCS injection phase, (2) one flow path for the RSS during sump recirculation phase, (3) two Service Water flow paths to the RSS heat exchangers during ECCS injection phase, and (4) one Service Water flow path during sump recirculation phase. Service Water flow and heat exchanger overall heat transfer coefficient cannot be varied with time.

**LOCTIC Version 23, Level 03 permits modeling of: (1) four independent flow paths for the RSS during ECCS injection phase, (2) two independent flow paths for the RSS during sump recirculation phase, (3) four Service Water flow paths to the RSS heat exchangers during ECCS injection phase, and (4) two Service Water flow paths during sump recirculation phase. Service Water flow and heat exchanger overall heat transfer coefficient can be varied with time.

4.1.2 Design Inputs/Assumptions used in the Safety Analysis

ECCS Performance Analysis:

The input data in the ECCS analysis has undergone relatively minor changes. The changes to the input reflect mainly the change in the fuel composition, and the increased operating pressure in the containment. These changes had a relatively small impact on the calculated peak cladding temperature. The modifications to the RSS did not impact the ECCS analysis since the RSS provides a long-term ECCS function and has no impact on the calculated maximum temperature in the core after an accident.

Fuel Type:	Westinghouse STANDARD Assembly fuel (1985) Westinghouse VANTAGE 5H fuel (1997)
Break Boundary Conditions:	Subatmospheric containment (1985) Near-atmospheric containment (1997)

Containment Analysis:

The containment analysis has undergone a major revision as a result of the RSS modifications. The RSS affects containment response by providing means for the energy transfer from the sump to the ultimate heat sink, via the RSS heat exchangers. The RSS is also credited in the offsite dose reduction by reducing the pressure in the containment and by scrubbing the fission products from the atmosphere. The changes to the input include:

- increase in the normal operating pressure (subatmospheric to near-atmospheric containment),
- reduced RSS flow rate (3900 gpm to 2200 gpm, per pump),
- increased recirculation system fill time,
- reduction in the RSS spray efficiency,
- inclusion of ±20 second RSS system timer tolerance,
- a new decay heat model incorporating the 24-month fuel cycle,
- no credit for the RSS spray (steam line breaks only),
- new model of the debris transport to the sump,
- heat exchanger tube fouling on the SW side,
- increased containment mass inventory of heat sinks, and
- increased hydrogen generation after a LOCA due to increased zinc and aluminum sources.

There is no substantive change in the modeling of the containment passive sinks, except for small additions of new heat sink inventory.

4.2 Impact of the Reduced RSS Flow on Accident Analysis

4.2.1 Large Break LOCA Assessment

The peak clad temperature is not impacted by the modifications to the RSS since it occurs prior to the RSS becoming active during the accident. By the time the RSS begins to spray the containment, the core temperature will have peaked over due to the cooling from the safety injection. The peak cladding temperature in the current cycle is 2054° F for the large break LOCA.

4.2.2 Long-term cooling

For long-term recirculation from the sump, the RSS and ECCS systems provide flow to the vessel in excess of the minimum required to remove the decay heat and replenish the inventory lost to boiloff in the core. The vendor analysis (NSAL Letter NSAL 95-001, Minimum Cold Leg Recirculation Flow) shows that at 30 minutes after shutdown, at the time of the switchover to cold leg recirculation, the vessel make up requirements are 531 gpm to due to the decay heat, and 107 gpm due to extended boiling in the reactor vessel downcomer and the lower plenum, for a total of 638 gpm.

In the original design, one RSS pump delivered 3950 gpm, feeding one charging (CHS) pump, one high head safety injection (SIH) pump, and direct injection to the cold legs. The excess injection spilled out of the break.

In the modified design, one RSS pump delivers 2200 gpm, feeding one CHS pump, one SIH pump and an RSS spray header. The flow split is 1100 gpm to the spray header, and 1100 gpm combined to the CHS and SIH pumps. Assuming that 275 gpm (25% of the 1100 gpm) is lost from the break and 531 gpm is needed for makeup, the minimum flow required for long-term cooling is

913 gpm. That still leaves 187 gpm of excess flow which goes to spillage. The modified alignment will provide sufficient ECCS flow.

4.2.3 Boron Precipitation Control

For boron precipitation control, the recirculation from the sump is split into the cold legs and into the hot legs. The vendor analysis shows that the minimum flow required for boric acid flushing is 31 lb/sec. (225 gpm) into the cold legs and 36 lbs/sec. (260 gpm) to the hot legs, for a total of 485 gpm.

In the 1985 configuration, one RSS pump was capable of delivering approximately 3950 gpm, which supplied direct injection to the hot legs, the suction side of the CHS pumps aligned to the cold legs, and the suction side of the SIH pumps aligned to the hot legs. This alignment provided adequate hot leg flow for boron precipitation control.

In the modified design, the RSS pump still supplies the CHS and SIH pumps as in the original design 1100 gpm is injected by the SIH (590 gpm) and CHS (510 gpm) pumps. Given a worst case passive failure, one SIH pump is aligned for hot leg injection and one cold leg direct injection pathway is aligned. Hence, boron precipitation control is maintained.

4.2.4 Small Break LOCA Assessment

The limiting small break LOCA is a 3-inch diameter rupture of the RCS cold leg. Peak clad temperature is reached during the injection phase of the accident.

The RSS pumps do not contribute to the ECCS flow in the injection phase and therefore RSS changes do not impact the small break LOCA assessment.

4.2.5 Peak Pressure and Temperature

The design basis accident for the maximum containment pressure is the double-ended rupture of a hot leg. Assuming minimum engineered safeguards, the revised peak calculated pressure is 38.40 psig and occurs 18 seconds after the accident initiation. Therefore, the reduced RSS flow has no impact on the peak containment pressure since the RSS will not start operating until about 11 minutes after the accident.

A steam line break results in the highest containment temperature of any postulated accident. The limiting containment temperature is 336° F as a result of the double-ended rupture of a steam line at 75% power. The time of the peak is 14 seconds after the break. Therefore, the reduced RSS flow has no impact on the peak temperature.

4.2.6 Containment Depressurization

Containment depressurization rate after a design basis accident is important for the containment leakage considerations, which have an impact on the magnitude of radiological releases after the design basis accident. In the original design, the RSS and QSS systems function to return the containment to subatmospheric pressure within one hour after an accident. This requirement is no longer necessary with the changes to the plant's Technical Specifications which allow the slightly sub-atmospheric pressure in the containment during normal operation.

The new design basis for containment pressure is to depressurize containment to less than 50 percent of the peak pressure within 24 hrs. The new design basis is met with the reduced RSS flow and the containment leakage rates are within specified limits.

4.2.7 Pump NPSH: Minimum Sump Level and Maximum Temperature

The evaluation of the RSS pump operability issues has identified the limiting transient for the pump NPSH as a 4-inch break at a hot leg nozzle inside the reactor cavity. This is because the break effluent can be trapped inside the cavity which does not drain to the containment sump. This assumption reduces the level of the water collected in the sump when the RSS pumps begin to operate, which could result in vortexing and subsequent air entrainment in the pump suction lines.

It was determined that the existing vortex suppresser was inadequate and that it needed to be lowered 12 inches (see Figure 6). The new location does not invalidate the results of the tests performed by Alden Research Laboratory which originally qualified the device as capable of preventing vortices under the most adverse conditions expected in the sump. The basic design is unchanged. In addition, the sump geometric layout with the new vortex suppressor is consistent with the design recommendations of NUREG 0897, Revision 1.

A loss of cooling to the RSS heat exchangers, due to a failure in the Service Water system, presents a special concern for recirculation piping temperature downstream of the RSS heat exchanger. The resultant piping temperature may reach 260° F. This affects the thermal qualification of the piping and components used in mitigating the consequences of the accident. An evaluation of this concern found that certain piping lines, used for recirculation from the sump, would operate outside their design limits during the transient. As a result of the evaluation, all involved systems have been requalified for the increased thermal loads.

4.2.8 Containment Liner Temperature

The mechanical loads on the liner affected by RSS modifications are primarily those that result from the thermal expansion of the liner and containment pressure. The design basis accident is the transient that produces the largest temperature differential, (ΔT), between accident initiation at time zero and the time when the containment depressurizes to 0 psig. An increase in the liner differential temperature above the analyzed ΔT will increase liner loads.

The design basis accident for the liner temperature is the 0.40 ft^2 main steam line break with failure of an emergency diesel generator. The maximum liner temperature was previously calculated to be 250.9° F and the design ΔT of 200° F was used for stress calculation. The new steam line break analysis does not take credit for the RSS spray function and maximum liner temperature was recalculated to be 255.9° F. The liner stress analysis remains valid since the new liner parameters are enveloped by the design ΔT of 200° F. The new maximum ΔT was calculated to be 180.9° F.

4.2.9 Equipment Environmental Qualification

The Electrical Equipment Qualification (EEQ) requirements for electrical equipment inside the containment are based on the analysis of the containment response to the design basis accident. Newly generated environmental curves indicate that the containment pressure is within the current EEQ limit, but the new temperature profile exceeded the existing EEQ temperature envelope by as much as 10° F one hour after the accident and up to 5 days. To compensate for the increased temperature, the revised temperature envelope provides for a reduction in the profile in the period between 5 and 30 days after the accident, by ramping the profile, rather then reducing it in stepwise fashion (see Figures 5A and 5B). The ramping function follows the actual temperature profile more closely. This satisfies the EEQ requirements for electrical equipment inside the containment.

4.2.10 Radiological Evaluation

The changes to the RSS System have been evaluated for their effect on the calculated radiological consequences of a LOCA. They do not affect the consequences because the iodine removal coefficients and sprayed volume are a result of QSS. The radiological consequences also depend on the mixing rate between spray and unsprayed regions and the containment pressure and its effect on leak rate assumptions. Each of these parameters has been evaluated to have no adverse consequences on the radiological consequence analysis.

The radiological calculation used conservative assumptions with regard to the effectiveness of containment spray. The radiological calculation used quench spray iodine removal coefficients, quench spray volume and mixing rate values which are less than recirculation spray parameters. RSS is only credited with maintaining spray after QSS shuts down. The bounding containment pressure curve used in the analysis is unchanged because it conservatively assumes 45 psig containment design pressure as the pressure for design containment leakage; therefore it is not affected by the reduced flow rate of the RSS spray. The radiological evaluation for offsite doses uses the Standard Review Plan's assumption of a containment leak rate at 0.5 L_a after 24 hours.

The radiological evaluation for control room doses takes exception to the SRP and assumes a containment leak rate at 0.5 L_a after 1 hour. This exception was approved in Amendment 59 (TAC No. 76066), dated January 25, 1991.

Based on this assessment, it is concluded that previous radiological evaluations bound the consequences that are calculated using the revised recirculation spray characteristics.

4.2.11 Combustible Gas Generation

The design changes in the RSS system and the addition of corrosive materials to the containment previous to the RSS changes have necessitated a complete revision of the post-DBA analysis for hydrogen generation in the containment. The sources of hydrogen during an accident are fuel cladding reacting with steam during extended core uncovery, radiolysis, hydrogen released from the primary coolant, and corrosion of zinc and aluminum materials.

The new analysis indicates that the hydrogen generated during the postulated DBA will not exceed the 4% concentration limit. The largest volume of H_2 is generated by the double-ended break at the reactor coolant pump suction, assuming a loss of motor control center MCC32-4T as a single failure. With a single recombiner starting 24 hours after the accident, the volume of hydrogen generated reaches a maximum concentration of 3.98% 19 days later. With two recombiners operating 24 hours after the accident, the concentration will not exceed 3%.

4.3 Other Accidents

4.3.1 Steam Line Breaks

The main steam line break analysis has been revised. The new analysis does not take credit for the RSS spray function in the containment.

The steam line breaks result in the highest containment temperature of any postulated accident. The limiting containment temperature was found to be 335.9° F at 14 seconds and is the result of the full double-ended rupture of a steam line at 75% reactor power. The peak temperature is within the EEQ temperature envelope for this time period. Therefore, the reduced RSS flow has no impact on the EEQ qualifications from the steam line breaks.

4.3.2 Feedwater Line Breaks

The steam line breaks result in the highest containment temperature of any postulated accident and bounds the feed line breaks.

4.4 *Assessment of the Effect on the Licensing Bases*

The effect of the modifications with respect to the original safety analysis documented in the licensing basis of the plant is minimal. The modifications do not affect the safety functions of the equipment used for the protection of the core against the design basis accident, and do not create potential for a new malfunction. The current licensing analysis remains valid. Although there is some reduction in the ECCS flow, the modified performance remains significantly in excess of the minimum required to provide long-term core cooling and boron precipitation control.

The safety functions of the containment are not altered or challenged by the modifications. The RSS system will function in effectively mitigating the consequences of the accidents. The depressurization of the containment after an accident is affected by the reduced system performance, but the containment is operated near atmospheric conditions which requires far less robust spray function of the RSS to remove the energy after a LOCA. The changes to the Containment depressurization do not affect the radiological consequences since the dose calculation assumptions of pressure and leakage rates remain bounding.

4.5 *Summary*

The modifications do not increase the probability of an accident or a malfunction of the equipment important to safety. The RSS and SI equipment have been evaluated and meet standards for design and operation. The changes do not increase the consequences of previously evaluated accidents. No new accidents or malfunctions will result from the modifications. There is no impact on the margin of safety. The containment design pressure, temperature, and liner temperature limits are not exceeded. The core cooling function of the RSS post LOCA is maintained. The changes are safe and do not result in an Unreviewed Safety Question.

The following table provides the summary of the key core and containment parameters that are, or are not, affected by the 1998 configuration.

	AFFECTED BY THE RSS MODIFICATION YES	NO
CORE COOLING		
Peak Clad Temperature: SB		No
Peak Clad Temperature: LB		No
Long-term Core Cooling		No
Boron Precipitation Control		No
CONTAINMENT:LOCA		
Peak Pressure		No
Peak Temperature		No
Post-LOCA Depressurization	Yes[1]	
Sump Temperature		No
Fission Product Removal		No [2]
Offsite Dose		No
EEQ	Yes[3]	
CONTAINMENT:MSLB		
Peak Pressure		No
Peak Temperature		No
Liner Temperature	Yes[4]	
EEQ		No

NOTES:

1. One-hour depressurization to subatmospheric after an accident no longer required.

2. Both the QSS and the RSS are credited for iodine removal from the containment atmosphere.

3. The current EEQ limits are exceeded between 1 hour and 5 days after the DBA by as much as 10° F. A revised profile follows the temperature more closely, rather than in a step-wise fashion. The equipment has been requalified to the revised EEQ function (Sect.4.2.9).

4. The increased liner temperature has no consequences on the analyzed structural loads (Sect. 4.2.8)

5. System Modifications

There have been several modifications to the RSS system which were made to address deficiencies and potential failures. These changes were made to improve RSS system reliability without increasing the probability of a malfunction, adding a new malfunction, or affecting the consequences of a malfunction. The following provides a description of each major RSS system modification and the conclusion of the USQ determination. A complete list of modifications made to the RSS system since 1986 is provided in Attachment 2.

MP3-88-009: Modification to the Cold Leg Recirculation Array

The Cold Leg Recirculation Array on Main Control Board #2 was changed to provide the operator with an arrangement of control switches identical to the action steps reflected in EOP ES-1.3. With this change, the operator can complete all actions required for switchover from cold leg injection to cold leg recirculation at the array location. This design change was determined to not be a USQ.

MP3-96-054: RSS Component Temperature Rerates

Given a single active failure in the Service Water supply to the RSS coolers, the RSS system will be supplying uncooled containment sump water to the RSS spray header. The uncooled sump water temperature can approach 260^0 F. This temperature exceeded the RSS design temperature in the flowpaths downstream of the RSS coolers and required re-analysis and re-rating of the RSS system piping, equipment, and components inside containment. As a result, pipe support modifications were required; the RSS cooler service water expansion joints and the containment penetrations were also analyzed and re-rated. These changes were determined not to be a USQ.

MP3-96-056: RSS Pipe Support Modifications Outside Containment

Given the potential for uncooled sump temperatures of 260^0 F, RSS piping and pipe supports outside containment were re-rated and reanalyzed. The revised analysis resulted in no RSS pipe support modifications, minor service water pipe support modifications were required. These changes were determined to not be a USQ.

MP3-96-063 RSS Support Modifications Inside Containment

Based on a revised containment temperature profile and postulation of a active single failure in the SWS supply to the RSS coolers, RSS piping was reanalyzed and revised pipe support loads were developed for normal/upset ASME Code conditions. Pipe stress levels were qualified per Table 3.9B-11 of the FSAR. Pipe support modifications to 15 RSS supports on the piping system risers and ring headers (increased support weld size, location of gussets) were necessary to support the change in pipe support loads. The revised pipe support loads were also used in a revised containment liner and insert plate analysis. The safety evaluation for this change resulted in no Unreviewed Safety Question.

MP3-97-042: Flow Test Line for RSS Pumps C & D

This design change implements flow test lines for these pumps which allows for testing during any mode of operation. Additionally, this design change improves system availability during Modes 1, 2 and 3 for surveillance testing of these pumps. It also eliminates the need to station a dedicated operator at valve 3RHS*V43 during testing. The change was determined to not be a USQ.

MP3-97-045: RSS Pump Restriction Orifices to Prevent Suction Line Flashing

This design change accomplishes three (3) objectives:

- Installation of restriction orifice plates on the RSS pump discharge lines for 3RSS*P1A-D to prevent suction line flashing (discussed in Section 3)
- Lowering of the RSS sump vortex suppresser grating (discussed in Section 3)
- Installation of vent lines on the RSS pump casing to eliminate air binding (see below)

Based upon an evaluation of the effect of trapped air on startup of the RSS pumps after a LOCA, a calculation determined that a 1-inch vent line needed to be installed on the RSS pump casing. The vent line was routed from the vent plug in the pump casing to approximately 5 feet above in the discharge line of the pump. A check valve is installed in the vent line to prevent any loss of flow from the RSS pump discharge once the pump has started. Judicious location of the check valve (i.e., close to the main run header) eliminated any significant water hammer loading in the vent line due to header fluid transient analysis. This change was determined to not be a USQ.

MP3-97-094: Fill/Vent Lines ECCS Loop Seal

Branch lines from the RSS pump discharge lines down stream of the RSS Containment Recirculation Coolers are non- self venting because the piping forms an expansion loop. Air could accumulate in these lines during system filling after a LOCA in Containment. Upon switch over, this air could reach the Safety Injection and Charging pumps. The design change installs a vent valve and test connection in each thermal expansion loop. These new connections will allow for compliance with Technical Specification requirements to keep the line full. This change was determined to not be a USQ.

6. PROBABILISTIC RISK ASSESSMENT - ASSESSMENT OF RSS SYSTEM CHANGES SINCE NRC REVIEW AND APPROVAL (CIRCA 1985)

6.1 The Impact of Removing Direct Inject from Design Basis on Individual Plant Examination (IPE)

The direct injection function of RSS was removed from the plant's engineering design basis in 1986. However, EOP ES-1.3 retained the capability to reinstate direct injection if high head injection failed. Given the loss of high head injection, direct injection would not result in excessive RSS heat exchanger flow. Therefore, the ability to credit the direct inject function within the IPE, for loss of all high head cooling event was retained.

As part of a PRA model update performed in 1987, a 5% increase in core damage frequency (CDF) was calculated due to changes occurring to the cold leg recirculation function. The overall increase was attributed to the following two changes:

1. Longer surveillance test intervals for MOVs used to establish cold leg recirculation.

2. Modifying the cold leg recirculation alignment to reserve RSS direct injection.

The CDF increase associated with these two changes was calculated to be 3E-06/yr. Since the PRA performed prior to the 1987 update preceded the finalized In-Service Test (IST) program, the surveillance intervals used in the model were all assumed. When the IST program was fully implemented, it was determined that some of the assumed test intervals in the original PRA model were not valid, resulting in an under prediction of the CDF. This was the case for a number of valves needed to establish cold leg recirculation. The fraction of the 3E-06/yr. increase due to this under prediction is difficult to determine; however, the CDF increase due to the cold leg recirculation alignment modification is estimated to be 1E-06/yr.

6.2 *Use of IPE insights during review of RSS design modifications made during mid-cycle 6 shutdown*

The modifications implemented during the current mid-cycle shutdown result in an overall positive safety benefit to the RSS system reliability. Each individual modification has either a positive or no impact on system reliability. The following summarizes the major RSS modifications and their impact on either the IPE analysis or RSS system reliability:

- Due to the possibility of air becoming trapped in the RSS pump casing, a vent line was installed on the casing of each RSS pump by DCR M3-97045 as discussed in Section 5. The addition of the vent line results in a positive benefit to RSS system reliability.

- During redesign of RSS pumps A and B automatic miniflow valve logic IPE insights were used to change the valves to normally closed. This eliminated an unnecessary failure mode associated with diversion of RSS flow in the event the valve(s) fail to close. Having the valves normally closed does not impact pump reliability because the RSS spray header valves remain open, ensuring that the pumps would not operate deadheaded. The redesign of the miniflow valves in conjunction with keeping the spray header valves open results in a positive benefit to RSS system reliability.

- IPE insights identified that the testing method used during quarterly RSS pump surveillances incurred undue unavailability on an entire RSS pump train. As a result, test flow lines were installed for the C and D RSS pumps , eliminating the time both pumps in one train are placed in pull-to-lock during the quarterly surveillance. This design also eliminates the need to station a dedicated operator at 3RHS*V43 to provide a flowpath back to the

RWST during quarterly testing. Installation of the test flow lines results in a positive benefit to RSS system availability.

- Prior to the current outage, the RSS system was designed such that the A and B pumps were dedicated for core recirculation and the C and D pumps were dedicated for recirculation spray. Following installation of the RSS pump discharge orifices the system will be operated such that all four RSS pumps continually provide recirculation spray and a portion of the flow from the A and B pumps provide core recirculation. The success criteria used within the IPE study for the RSS system is 2 of 4 pumps, with 1 pump providing core recirculation and 1 pump providing recirculation spray. The design change has no impact on the IPE success criteria for the RSS system. Two RSS pumps remain capable of adequately providing both the core cooling and containment depressurization functions.

- The RSS piping for each pump train contains a loop seal downstream of each heat exchanger but upstream of the cross-tie header supplying the high head pumps. These piping segments are required to be verified full every month per Technical Specification. Due to the possibility of trapping air within these loop seals and potentially impacting the high head pumps, additional vent valves were installed and the loop seal drain line was capped the design change associated with the RSS piping loop seals results in a positive benefit to RSS and high head injection system reliability.

- The FSAR stated that the operator can align containment recirculation within 10 minutes upon receipt of the low-low level RWST alarm. The Training department collected simulator data from 6 operator crews between 9/96 and 10/96 revealing the average response time to be 15 minutes. The increase in operator response time results from increased valve stroke time and improved command and control communication when performing emergency operating procedures. Analysis shows that at least 25 minutes are available for the operators to complete the switchover to cold leg recirculation while assuring pump operation. The change in required operator response time from 10 to 25 minutes does not, in and of itself, directly impact the human error probability of switchover to containment sump recirculation as modeled in the IPE. The operator failure probability for switchover is a function of average operator response time, variation in that time, and time available before adverse consequences can be realistically expected. Specifying a time limit in the FSAR does not impact the average operator response time, nor the variation in time. These two times are functions of the emergency operating procedures, operator training and experience. Since data have been collected for only one point in plant operating life, that being the 1996 simulator exercises, it can not be determined how these may have changed since plant start-up. Three-way communication in the control room, as well as some increases in MOV stroke time, have tended to increase the time it takes for the operators to perform the switchover. However, increased communication would also tend to minimize the error of commission.

The time available to the operators considers two potential adverse consequences. Prior to the 1991 change, the required operator action time of 10 minutes was limited by the necessity to preserve RWST inventory for quench spray in order to ensure that the containment was rendered sub-atmospheric within 60 minutes. The 1991 change eliminated that design requirement. The 25 minute operator response time now specifies the minimum time available to the operators to avoid net positive suction head problems with the charging pumps. Available operator response times using realistic assumptions are substantially greater, and it is these realistic times that are input to the IPE human error probability, not the 10 or 25 minute limiting criteria.

Hence, within the limits of available data, and existing human reliability modeling capability, it is concluded that there have been no overall adverse impact on the IPE from plant changes related to sump switchover since 1986.

7. OTHER ISSUES

7.1 Training

Due to the nature of the modifications to the Millstone 3 RSS system, significant training has been conducted over the past 2 months. Four modifications have been presented to MP3 operators during two separate presentations.

- DCR M3 96077: ECCS orifices and throttle valves,
- DCR M3-97045: Resolve RSS pump suction issues,
- DCR M3-97042: Testflow line RSS - C & D pumps, elimination of dedicated operator on 3RHS*V43, and
- DCR M3-97079: RSS cubicle flooding and containment structural integrity

The second presentation was a review of the first classroom presentation and included dynamic simulator demonstrations after the MP3 plant specific simulator had been modified to replicate the changes made to the RSS system.

In addition, the following items have been presented to MP3 operators during either a classroom or simulator presentation:

- Design modification to maintain RSS thermal expansion loop piping full of water,
- ECCS surveillance requirement changes,
- Procedure changes (ES-1.3) addressing the RSS modifications,
- FSAR changes that increased operator action time from 10 to 25 minutes to cold leg recirculation, and
- Passive RSS failure post LOCA

The changes to EOP procedure ES-1.3, "Transfer To Cold Leg Recirculation," were covered in significant depth in the classroom, including the basis behind each step. Additionally, each operating and administrative crew performed the transfer to cold leg recirculation on the simulator twice. The first time was a normal transfer with full electrical power available, the second time included the failure of one emergency diesel generator.

The simulator has been updated to ensure that the plant modifications to the plant are included in the Millstone model.

Operator training for the RSS modifications was discussed with the NRC on January 29, 1998 at the Region I headquarters.

7.2 *System Testing Considerations*

7.2.1 Test Program

7.2.1.1 Initial RSS Preoperational Testing

Initial RSS pre-operational testing was performed in 1985/86 using Test Procedure T3306P. This testing was performed to verify that the RSS met its safety functional requirements. The testing encompassed the following:

1) Containment Recirculation Spray Pump Suction Isolation Valves (3RSS*MOV23A,B,C,D), and the annunciation, indication, logic and stroke times associated with these valves, were tested to verify that they can be opened remotely, closed remotely (with no CDA signal present), and that they will open automatically in response to a simulated CDA initiation signal. Stroke time for each valve tested was satisfactory.

2) Containment Recirculation Spray Water Spray Header Isolation Valves (3RSS*MOV20A,B,C,D), and the annunciation, indication, logic and stroke times associated with these valves, were tested to verify that they can be opened remotely, closed remotely (with no CDA signal present), and that they will open automatically in response to a simulated CDA initiation signal. Stroke time for each valve tested was satisfactory.

3) Containment Recirculation Spray System to Residual Heat Removal System Cross Connect Valves (3RSS*MOV8837A,B and 3RSS*MOV8838A,B), and the annunciation, indication and stroke times associated with these valves, were tested to verify that they can be closed remotely, and that they can be opened remotely with the interlocks and logic associated with aligning the valves for the recirculation phase of RSS operation. Stroke time for each valve tested was satisfactory.

4) Containment Recirculation Spray Pump Miniflow Valves (3RSS*MOV38A,B), and the annunciation, indication and logic associated with these valves, were tested to verify manual operation and automatic operation in response to an RSS pump running and flow signal to maintain a flowrate greater than minimum flow requirements. Containment Recirculation Pump Miniflow was measured at 1100 gpm.

5) Containment Recirculation Spray Coolers (3RSS*E1A,B,C,D) were tested to verify that the coolers can be filled and automatically vented via the discharge of the RSS pumps without damage to baffles or other internal components of the coolers.

6) Containment Recirculation Spray Dewatering Pumps (3RSS*P2A,B) were tested to verify manual operation and the pump's capability to dewater the RSS. The test was performed in accordance with OP 3306, Section 7.3.

7) Containment Recirculation Spray Pumps (3RSS*P1A,B,C,D), and the annunciation, indication, logic and interlocks associated with these pumps, were tested to verify manual operation and automatic response to a simulated CDA initiation signal. The test included RSS train A and B alignment for taking a suction from the containment sump and discharging for cold and hot leg recirculation, with cold and hot leg RSS direct injection.

All pump logic, safeguard signals, blocking signals, permissives, interlocks were verified for remote and automatic pump operation using Procedure 3INT-2004, EOP 35 1.3 and EOP 35 1.4.

Each RSS train was tested individually. Testing was performed by installing a temporary cofferdam in the containment sump with a capacity of 30,000 gallons of water for about 6 minutes of pump operation. Makeup to the cofferdam was from a temporary connection from the RWST. Each RSS train was aligned to take a suction on the containment sump and discharge to the suction of a single CHS and SIH pump and to provide direct cold leg injection to 2 RCS loops. The test was initiated using Procedure 3INT-2004 and EOP 35 1.3 for transfer to cold leg recirculation using the recirculation changeover array at MB-2.

The RSS pumps ("A" and "B") were started on miniflow recirculation and was first aligned for RCS cold leg direct injection. Once the air was purged from the RSS into the RCS cold legs, each RSS pump was aligned to the suction of one CHS and SIH pump, which were realigned from RWST recirculation to RCS cold leg injection. The test was run for 5 minutes with total flow recorded every minute. The test acceptance criterion for RSS pump flow was to be less than 5000 gpm. The total flow from each pump was verified to be less than that.

Each RSS train was tested individually. Testing was initiated from the cold leg recirculation configuration, with the RSS pump discharging to the suction of both trains of CHS and SIH pump and to the cold leg direct injection path. The test was initiated using EOP 35 1.4 for transfer to hot leg recirculation using the Recirculation Changeover Array at MB-2. The RSS was realigned from cold leg to hot leg direct injection and continued to supply the suction of the CHS and SIH pumps. The SIH pumps were realigned from cold leg to hot leg injection. The test was run for about 5 minutes with total flow recorded every minute. Restoration from hot leg recirculation was performed using EOP 35 1.4 for transfer to hot leg recirculation using the recirculation changeover array at MB-2.

This test acceptance criterion for RSS pump flow was to be less than 5000 gpm. However, the total flow from RSS Train A was verified to be greater than 5000 gpm. The test therefore was unsatisfactory and led to the elimination of RSS hot and cold leg direct injection in 1986.

7.2.2 Assessment of RSS Modification Effect On Previous Testing

Of the eighteen (18) modifications made since OL that affect the RSS, eight (8) were completed prior to the 1996 MP3 shutdown and ten (10) are in-process for completion prior to restart.

The eight (8) modifications completed prior to the MP3 shutdown are as listed below:

MP3-85-004, "Tubing Protection Barriers"

MP3-85-014, "Supports Required for Seismic Interaction"

MP3-86-094, "Modifications to the ESF Status Panel (31HA-ANNMB2E)"

MP3-88-009, "Modification to the Cold Leg Recirculation Array"

MP3-89-013, "MP3 Containment Design Pressure Change"

MP3-92-004, "Limitorque Torque Switch for Operators Material Change"

MP3-93-015, "Replacement of 3RSS*MOV23A through D"

MP3-94-162, "Installation of RSS Containment Sump Flanges"

None of these modifications invalidated the RSS initial preoperational startup testing results.

The ten (10) modifications in-process for completion prior to restart include:

MP3-96054, "RSS Component Temperature Rerates"

MP3-96056, "RSS Support Modifications Outside Containment"

MP3-96063, "RSS Support Modifications Inside Containment"

MP3-97042, "Mini-Flow Test Line for RSS Pumps C & D"

MP3-97045, "RSS Pump Restriction Orifices to Prevent Suction Line Flashing"

MP3-97063, "RSS Expansion Joint/Support Modifications"

MP3-97094, "Fill/Vent Lines ECCS Loop Seal"

MP3-97102, "Reinstatement of RSS Cold Leg Direct Injection"

MP3-97106, "Switchover Time Increased (10 min.-25 min.)"

MP3-98008, "Modification of RSS Pumps' Seal Water Coolers"

Of these, the only in-process modification which potentially affects RSS preoperational testing results is MP3-97045, "RSS Pump Restriction Orifices to Prevent Suction Line Flashing". Post modification testing for each task under this modification is described below.

7.2.3 Post Modification Testing for RSS Pump Restriction Orifices

Containment Recirculation Spray Pumps (3RSS*P1A,B,C,D)

Based upon the initial preoperational testing results, the RSS pump performance has been periodically tested for conformance with the degraded manufacturer's pump curve per the currently approved Technical Specification requirements. Post modification RSS pump and restriction orifice testing will validate the initial preoperational testing by performing a full flow test for each RSS pump and orifice in accordance with the Inservice Testing (ISI) Program for the Proposed Technical Specification Change for this modification.

Previously performed pump performance calculations and system hydraulic analysis have been modeled to produce results that are in reasonable agreement with the preoperational testing results. For the RSS Pump Restriction Orifice modification, the same computer modeling and calculational methodology has been applied in performing pump performance calculations and system hydraulic analyses, with the restriction orifice modeled.

The purpose of the post modification test is to verify that the performance of the RSS pump, with the restriction orifice installed, is as predicted in the computer model of the RSS test loop. If the results of the test validate the computer model pump and orifice performance calculation and system hydraulic analyses predictions, then the pump performance test is appropriate to validate the plant safety analyses as was done using the original preoperational test results.

Each RSS pump will be tested. The test will be performed by recirculating the flow to/from the Refueling Water Storage Tank (RWST) via the cross connect to the RHR pump test line. Flow measurements will be taken in the pump discharge and the differential pressure measured across the pumps, across the restriction orifices, and across the pumps and the orifice plates. Test results will be verified to be in conformance with the acceptance criteria for the revised degraded pump curve per Proposed Technical Specification Change (PTSCR) #3-35-97.

Test results will also be compared to the calculated pressure drops and flow rates predicted by the computer model of the RSS test loop to verify that the orifices are correctly sized and that the orifice loss coefficient (K value) is correctly modeled. This will ensure that the restriction orifices will limit the maximum RSS pump flow to prevent suction line flashing and, at the same time, provide sufficient flow to support the plant safety analysis. With this verification, the computer modeling, calculational methodology, and the calculated orifice flow characteristics used in the current performance calculations and hydraulic analyses will be validated as reasonably predicting RSS flow rates for each recirculation phase flow path combination.

Preliminary testing indicates that the acceptance limits for each orifice resistance can be satisfied. The flow rates achieved in the preliminary full flow tests are within 3 percent of the flow rate predicted by the hydraulic model of the RSS test alignment. Based on this result, it is concluded that the methodology for predicting RSS flow rates, including the modeling of system resistances, can be validated with the test data. Therefore, the RSS flow calculation is considered to be sufficiently accurate to predict the flow rates after an accident and RSS system response and performance appropriate to support the plant safety analysis.

Additional Testing

Additional testing for the other design changes made under DCR M3-97-045 include:

- Vibration measurement of the piping as well as the pumps will be performed during the pump performance testing to identify any vibration issues with the pump or the piping system. See Section 7.3, for more detail.

- The RSS pump vent lines will be tested by confirming that the check valve closes when the pump is operating and that the check valve is open when the pump is not running. This will be done by running the pumps and verifying that there is no back leakage through the valve and then with the pumps not running, verifying the valve is open by passing air through the valve to ensure the valve has not stuck shut.

- The pump casing vent line will be verified to vent the air out of the pump suction casing by filling the RSS pump discharge with the vent line isolation valve closed. Once the discharge line is filled to an adequate level, the vent line vent valve will be opened and the pump suction casing will be verified to be vented when the vent line vent valve discharges water. Since the vent lines are identical on all four RSS pumps, only one pump vent will be tested.

- The new weld joints will be tested in accordance with ASME III Nondestructive Examination criteria and ASME XI N416-1 pressure test to be performed to the 1992 Edition of ASME. The RSS Spray Headers will be tested to verify that there are no leaks and no obstructions from the plugged spray nozzles per Surveillance Procedure SP31106. The electrical modifications will be tested in accordance with Test Procedure C-PT-1408.

7.2.4 Post Modification Testing for RSS Miniflow Valves (3RSS*MOV38A,B)

Containment Recirculation Spray Pump Miniflow Valves (3RSS*MOV38A,B), and the annunciation, indication and logic associated with these valves, will be tested to verify manual operation and automatic operation in response to an RSS pump running and flow signal to maintain a flowrate greater than minimum flow requirements.

During the RSS pump performance test, the flow will be redirected from the RWST to the miniflow and test recirculation lines. The flow and differential pressure across the pump and also across the pump and orifice plates will be measured through these lines. This data will form the baseline for future operational testing through the miniflow and test recirculation lines.

The miniflow valves control logic will be verified that the electrical scheme functions as designed. A visual check of cable termination's to ensure that the cabling agrees with the interconnection diagrams as well as a test of the circuits ability to function as shown on the all applicable diagrams will be performed. Finally, a functional test will be performed of all possible combinations of components in order to uncover possible sneak circuits.

7.3 Operational Issues Resulting from the RSS Modifications

With the exception of vibration there are no new operational issues resulting from modifications to the RSS system. Unlike the other characteristics of the system, vibration due to operation is evaluated during the testing phase of modification implementation. Other operational issues (e.g. seismic response, thermal expansion, waterhammer) can be adequately evaluated through the utilization of computer codes during the design phase of the modification process. Walkdowns and as-built drawings are then used to confirm the adequacy of the piping system layout.

7.3.1 Testing Results

7.3.1.1 Pumps and Motors

Initial vibration test results have been obtained for the B and D RSS pumps. (Refer to Figure 7 for RSS system flow test vibration monitoring points). The data indicates no significant changes in pump/motor vibration and overall vibration amplitudes remain well within acceptable limits. The pump shaft vibration amplitudes did not change, indicating that the pump mechanical seal and bearings are unaffected. Vibration levels on the motor frame have increased due to flow induced vibration from the orifice plates. The flow induced vibration is seen in the vibration spectrum as increased amplitudes at the motor/ pump structural natural frequencies and an increase in the noise floor. There have been no significant changes at the vibration frequencies which could impact the operation of the pumps or motors. The changes due to the flow induced vibration are of little consequence because of the low amplitudes, and the fact that the motor rotor and frame move together at the structural natural frequencies. This type of vibratory motion contributes very little to the limiting factors of bearing loading and rotor deflection relative to the stator.

The vibration data from the initial test of A RSS pump was lost as a result of the failure of a newly installed vent line. Further testing of the A and C pumps is expected to verify acceptable vibration performance.

7.3.1.2 Piping

The one inch vent line associated with the A RSS pump failed during initial testing of the A RSS pump/piping. System operating vibration and a weak structural design was determined to be the cause of the vent line failure. The vent lines have been redesigned to accommodate system operating vibration (e.g. A flex hose has been installed between the pump and the vent line. A six way restraint has been located at the interface of the flex hose and the one inch vent line). Piping vibration data has been obtained for the B and D revised vent line piping arrangement (refer to Figure 7 for vibration monitoring location and the revised vent line piping arrangement). All piping component vibrations for the B and D pump/piping loops are confirmed to be within acceptable limits with the exception of the two cantilevered pressure taps associated with each pump. Additional vibration monitoring and evaluations are required to determine if structural modification is required to meet ASME OM3 and EPRI guidelines for these taps. Similar results are anticipated for A and C piping.

The potential failure of the vent line check valve to seat was evaluated to determine the impact to the vent lines structural integrity. the revised vent line support arrangement and the flex hose ensure that the vent line system can accommodate the potential for reverse flow. The flex hose is designed for the reverse flow that would result from a check valve failure.

7.3.1.3 Expansion Joints

The expansion joints located in the pump discharge lines for the "B" and "D" pumps were noted to have relatively high vibration amplitudes on their center rings in the axial direction. The center rings appear to vibrate at their natural frequency of 28 Hz. The maximum vibration amplitude was .12 inches peak to peak. The expansion joint vendor, Senior Flexonics, has specified a not to exceed limit of .24 inches, above which a closer evaluation is required. Since the recorded peak to peak displacement is less than the maximum allowable displacement, the expansion joint displacement is acceptable similar results are expected for the "A" and "C" pump expansion joints.

8. INTEGRATED SAFETY ASSESSMENT

8.1 10CFR50.59 Review Of RSS Modifications

The modifications to the RSS from the original design approval in 1985 until the current proposed configuration have been summarized in Sections 3 and 5. These changes can be categorized in two categories:

- Changes to restore systems and components to the level of reliability expected in the original design
- Changes which affect RSS system operation or performance

Each of the modifications to the system were evaluated against the criteria of 10CFR50.59 to determine whether the change constituted an Unreviewed Safety Question. A large number of the changes were implemented to restore the functionality or reliability of the system as assumed in the original design. These were described in Section 5 and will not be addressed in detail.

The changes which affect system operation or performance are:

- 1986 elimination of the use of RSS direct injection
- Containment pressure change from subatmospheric to atmospheric
- Reduction in RSS flow due to installation of orifices
- Reestablishing the credited use of RSS direct injection to assure mitigation of an assumed limited passive failure
- Increase in required operator action time to complete switchover to cold leg recirculation
- In addition, changes in analysis methods and inputs will be evaluated.

8.2 *Elimination of RSS Direct Injection*

The 1986 change to the EOP's and the MP-3 design basis to eliminate the use of RSS direct injection during cold leg and hot leg recirculation was a change to system operation. This modification changed the RSS direct core cooling safety function from a redundant safety function and flow path to a contingency action in the event of failures to the other injection paths. The EOP's have maintained steps to use the cold leg direct injection path in the event that an SIH and CHS path was not available. This guidance would support the core cooling function for the design basis limited passive failure mitigation as well as the beyond design basis multiple failure situation. It should be noted that the safety evaluation written to support this change in 1986 did not specifically address the limited passive failure condition.

With respect to the 10CFR50.59 questions, this change does not:

- increase the consequences of a malfunction of equipment important to safety
- create the possibility of a malfunction of a different type
- increase the probability of a previously evaluated accident
- increase the consequences of a previously evaluated accident
- create the possibility of an accident of a different type

The other two questions of 50.59 bear closer examination.

In the original design as described in the SAR, the direct inject valves remained open in the switch over to cold leg recirculation. In order to prevent excessive tube vibration due to high flow, the 1986 change required operator action to isolate the direct injection paths. Since the probability of failure of operator action is not zero, the probability of failure of the RSS heat exchanger increased relative to the facility described in the SAR.

The original design of the RSS system included direct injection during the recirculation phase, without operator action. After 1986, direct injection was available, but required operator action. Since the probability of failure of operator action is not zero, the probability of failure for using RSS direct injection increased.

Based on the additional operator actions discussed above, elimination of RSS direct injection was a Unreviewed Safety Question.

In considering the impact on the margin of safety as defined in the bases of the Technical Specifications, the impact of the change on design basis analyses must be evaluated. There was no change in the results of the design basis analysis due to elimination of direct injection nor was there an impact on other margins of safety defined in the Technical Specifications. Therefore, there was no reduction in the margin of safety from this change.

After the direct injection path was eliminated, an evaluation of the impact of this change on the core damage frequency was performed by the PRA section. This evaluation is discussed in Section 6 and concluded that the change resulted in an increase in the CDF. The probability of core damage in this evaluation is the result of multiple failures which are outside the bounds of the design bases.

8.3 Containment Pressure Change From Subatmospheric to Atmospheric

The change in the allowable containment pressure from subatmospheric to atmospheric was submitted and approved as a License amendment in 1992.

8.4 Reduction in RSS Flow Due to Installation of Orifices

The evaluation of the reduction in RSS flow from the flow orifice installation included assessments of the impact of this flow reduction on all of the applicable safety analyses. The analyses yielded acceptable results and therefore no reduction in the margin of safety was identified. The impact of the reduced flow on various failure mechanisms and reliability standards was addressed in the safety evaluations. The conclusion of these safety evaluations was that the changes do not involve a Unreviewed Safety Question.

8.5 Credit for RSS Direct Injection for Failure Mitigation

The change to implement the direct injection for failure mitigation consists primarily of an FSAR change and providing guidance to the Station Emergency Response Organization to assist the operators in mitigating an assumed limited passive failure. In addition, physical plant changes are being made to enhance the ability to identify the location of passive failures. The EOP's currently have guidance which will initiate direct injection. These changes formalize the use of direct injection for the design bases and are consistent with the SAR description of the operator response to a limited passive failure. These changes do not result in an Unreviewed Safety Question.

8.6 *Increase in Assumed Operator Action Time*

The current FSAR identifies a 10 minute allowance for the operators to switchover from the injection mode to cold leg circulation after receipt of the RWST low level alarm which occurs at approximately mid-level (520,000 gallons). Timing of operator crews have indicated that the 10 minute allowance is not bounding. Therefore the FSAR is being modified to change the time available for the switchover period.

DCR M3-97106 modifies these FSAR sections to document an allowable switchover time of 25 minutes. This 25 minutes is shown through conservative calculations of the drawdown of the RWST to result in adequate NPSH for the ECCS pumps throughout the switchover period. The evaluation used higher pump flow rates, lower RWST inventory and longer operator response times than the original evaluation. In addition, the NPSH requirements for the charging pumps have increased from 18 ft to 30 ft. The 25 minutes, therefore, is considered to be a conservative minimum time available for the operators to complete the switchover.

The acceptance criteria for this calculation is that the equipment (pumps) are not in a degraded condition due to NPSH or vortexing during the drawdown period. This calculation sets the time limits which the operators must meet in simulations (i.e. the required response time). The changes being processed in DCR M3-97106 justifies an increase in the required response time for the operators and therefore, is not a USQ.

8.7 *Changes in Analysis Methods and Inputs*

The changes in the LOCTIC code and inputs were discussed in Section 4. These changes are minor in nature and do not invalidate the review and acceptance of the original analyses.

In evaluating the changes associated with the RSS orifice installation the calculations on sump vortex suppression, NPSH and suction line flashing were revisited. The original calculations assumed the large break LOCA to provide the most limiting conditions because of the amount of debris generated by that accident. However, the calculations supporting this change have concluded that small break LOCA's can result in lower sump inventory at the time of RSS initiation. Also, the initial start up transient for the RSS results in an initial high flow condition for the pump prior to filling the spray header. This start up period could potentially result in more adverse conditions at the pump suction than the steady state conditions evaluated originally. In order to calculate the start up transient, a methodology was used to examine the debris transport to the sump screens following initiation of RSS. This methodology is generally consistent with the guidance provided in NUREG 0897 Rev. 1. However, the new debris methodology was not used in the original evaluation. The major change resulting from these new calculations was the lowering of the vortex suppression grate in the sump to assure this grate was covered during the start up transient. An additional assessment of the sump level and vortex grate location was performed and confirmed that using the original debris evaluation method did not result in a reduction in the margin of safety as defined by the original methods. (The original method assumed all of the debris, which could be transported, was on the screens and used the steady state sump flow rate.) The change to the facility (vortex grate location) is not an Unreviewed Safety Question.

9. CONCLUSION

The original design basis of the RSS was reviewed along with all of the changes up to the present time. The results of the review identified that the elimination of RSS direct injection was an Unreviewed Safety Question that was not identified at that time. All changes, however, were safe.

10. REFERENCES

10.1 Design Change Documents

1) MP3-85-004, 03/23/88, Tubing Protection Barriers (DMR-481 and 482)
2) MP3-85-014, 10/29/93, Supports Required for Seismic Interaction
3) MP3-86-094, 04/17/86, Modifications to the ESF Status Panel (31HA-ANNMB2E)
4) MP3-88-009, 07/17/89, Modification to the Cold Leg Recirculation Array
5) MP3-89-013, 01/30/91, MP3 Containment Design Pressure Change
6) MP3-92-004, 02/02/93, Limitorque Torque Switch for 00 Operators Material Change
7) MP3-93-015, 11/16/93, Replacement of 3RSS*MOV23A through D
8) MP3-94-162, 12/21/94, Installation of RSS Containment Sump Flanges
9) PDCR-94-135: "Installation of TSP Baskets in Containment, Millstone Unit 3"
10) M3-96054, RSS Component Temperature Rerates
11) M3-96056, RSS Support Modifications Outside Containment
12) M3-96063, RSS Support Modifications Inside Containment
13) M3-97042, Mini-Flow Test Line for RSS Pumps C & D
14) M3-97045: RSS Pump Restriction Orifices To Prevent Suction Line Flashing.
15) M3-97063, In-Process, RSS Expansion Joint/Support Modifications
16) M3-97094, In-Process Fill/Vent Lines ECCS Loop Seal
17) M3-97102, In-Process Reinstatement of RSS Cold Leg Direct Injection
18) M3-97106, In Process, Switchover Time Increased (10 Min., to 25 min.)
19) M3-98008, RSS Pump 3RSS*P1A, B, C and D Seal Tank Tubing Modification

10.2 Safety Evaluations

1. Safety Evaluation No. S3-EB-97-0293, Rev. 1, "RSS Pump Restriction Orifices to Prevent Suction Line Flashing."
2. Integrated Safety Evaluation No. E3-EV-97-0040, Rev. 0, "Addition of RSS*P1C, D Test Recirculation Lines and Ultrasonic Flowrate Transducers for 3RSS*P1A, B, C, D Recirculation Lines," 10-28-97.
3. Integrated Safety Evaluation No. E3-EV-97-0014, Rev. 0, "Millstone Unit 3 Modifications to the QSS, RSS and Safety Injection Systems," 11-10-97.
4. Safety Evaluation No. SE-EV-97-0375, Rev. 0, "RSS Expansion Joint/Piping Support Modifications," 10-21-97.
5. Safety Evaluation No. S3-EV-97-0014, Rev. 02, "Millstone Unit 3 ECCS Orifices and Throttle Valves."
6. Safety Evaluation No. S3-EV-97-0045, Rev. 0, "MP3 Containment Recirculation System Modifications."
7. E3-EV-97-0043, ISE for M3-97-045, RSS Pump Restriction Orifices to stop flashing

10.3 Westinghouse Correspondence

8. Westinghouse Letter NEU-6098, dated March 5, 1986, Integrated Safety Evaluation on EOP's ES-1.3 and 1.40.

10.4 Stone & Webster Correspondence

1. SWEC correspondence No. NES-40346, dated January 11, 1986, MP3-Post LOCA containment Heat Removal Analysis Safety Evaluation

11. LIST OF ATTACHMENTS

ATTACHMENT 1 REVIEW RSS HISTORICAL KEY CONTAINMENT / RSS PERFORMANCE PARAMETERS COMPARISON

ATTACHMENT 2 SUMMARY OF PLANT DESIGN CHANGES FOR RSS

12. LIST OF FIGURES

- Figure 1 A,B,C "Original System Alignments (Injection, Cold Leg Recirculation, Hot Leg Recirculation Phase)"
- Figure 2 A,B,C "1998 System Alignments (Injection, Cold Leg Recirculation, Hot Leg Recirculation Phase)"
- Figure 3 "RSS System Schematic Showing Location of Major Design Modifications
- Figure 4A "Containment EEQ Temperature Profile Overlay (1998 versus original 1985)
- Figure 4B Containment Temperature Profile Overlay (Transients versus 1998 EEQ Envelope)
- Figure 5A Containment EEQ Pressure Profile Overlay (1998 versus original 1985)
- Figure 5B Containment Pressure Profile Overlay (Transients versus 1998 EEQ Envelope)
- Figure 6 "Vortex Suppression Plate Design and RSS Pump Layout"
- Figure 7 "RSS System Flow Test Vibration Monitoring Points"

ATTACHMENT 1

REVIEW RSS HISTORICAL KEY CONTAINMENT / RSS PERFORMANCE PARAMETERS COMPARISON

	Original License/ Design Basis **NUREG 1031**	**1985** ***Original License*** **US(B)-273, Rev. 4**	**1986 Eliminated RSS Direct Injection** **US(B)-337, Rev. 1**	**1992 Atmospheric Containment** **US(B)-273, Rev. 5**	**1998 RSS Pump Restriction Orifice** **US(B)-273, Rev. 6**
CONTAINMENT: NORMAL					
Normal Operating Pressure Range (psia) Normal Operating Temperature Max(^{0}F)	8.0 - 10.6 120	8.9 - 9.8 120	8.9 - 9.8 120	10.6 - 14.0 120	10.6 - 14.0 120
CONTAINMENT: POST LOCA					
LOCA Peak Pressure (psig)	45 design	36.09	36.09	38.49	38.40
LOCA Peak Temperature (^{0}F)	280 design	263.3	263.3	261.81	262.0
LOCA Max. Depressurization Time (sec)	3600 design	2560	2560	NR	NR
LOCA Sump Temperature (^{0}F)	-	257.1	257.1	256.9	256.9
LOCA Long Term Sump pH	7.0 - 10.5	7.4	7.4	7.4	7.4
QSS/RSS Fission Product Removal (DF)	No Credit	No Credit	No Credit	Credited 12	Credited 200
Containment Leak Rate (vol%/day)	-	0.9	0.9	0.65	0.3
Secondary Bypass Leak Rate (vol%/day)	-	0.009	0.009	0.0278	0.0126
LOCA - EAB - Whole Body Dose (Rem)	25	16.8	16.8	19.5	8.2 see note 1
LOCA - EAB - Thyroid Dose (Rem)	300	238	238	150	100 see note 1
LOCA - LPZ - Whole Body (Rem)	25	1.59	1.59	3.54	1.3 see note 1
LOCA - LPZ - Thyroid Dose (Rem)	300	16.1	16.1	31.6	9.6 see note 1
INADVERTENT QSS (psia)	8.0	8.02	8.02	8.02	8.02
CONTAINMENT: POST MSLB					
MSLB Peak Pressure (psig)	45 design	31.49	31.49	34.14	34.14
MSLB Peak Temperature (^{0}F)	350	327.4	327.4	335.94	335.94
Containment Liner Temperature				250.9	255.9
RECIRCULATION SPRAY SYSTEM:					

	Original License/ Design Basis NUREG 1031	1985 Original License US(B)-273, Rev. 4	1986 Eliminated RSS Direct Injection US(B)-337, Rev. 1	1992 Atmospheric Containment US(B)-273, Rev. 5	1998 RSS Pump Restriction Orifice US(B)-273, Rev. 6
TDH @ Rated Flow (ft)	342	342	342	300	300
Rated Flow (gpm)	3950	3950	3950	4130	2200
$NPSH_a$ / $NPSH_r$ (ft) w/Debris Loading, As Applicable @RSS Pump Start @Effective Spray Time	-	13.27/11.0 17.49/5.0	13.27/11.0 17.49/5.0	13.27/11.0 17.49/5.0	19.1/4.0 Note 2 21.5/<4.0
Spray Nozzles (per header)	322	322	322	322	162
LOCA Spray Header Fill Time (sec)	-	87.2	87.2	87.6	153.64
Sump Screen Approach Velocity (ft/sec) LBLOCA 0% blockage bases Full submergence bases SBLOCA 0% blockage bases Full submergence bases	0.24@724 sec 0.12 N/A	0.24 @ 724 sec 0.12 N/A	______ N/A	______ N/A	0.17@740 sec <0.1 0.3@1200 sec N/A
CORE COOLING:					
ECCS Minimum Safeguards Flow; Appropriate Gross Pathway Flow, LOCA Recirculation Phase (gpm)	-	3950 (RSS Direct +CHS+SIH)	1100 (CHS+SIH)	1100 (CHS+SIH)	1100 (CHS+SIH)

Note 1 - Reduction in offsite doses are not affected by RSS changes. Offsite doses were affected by a reduction in containment leak rate and change in spray assumptions per SRP 6.5.2, Revision 2.

Note 2 - 4" small break LOCA in hot leg is the limiting case

ATTACHMENT 2

SUMMARY OF PLANT DESIGN CHANGES FOR RSS

CHANGE NO.	TITLE	DATE	USQ DETERMINATION
MP3-85-004	Tubing Protection Barriers (DMR-481 and 482)	03/23/88	NO USQ
MP3-85-014	Supports Required for Seismic Interaction	10/29/93	NO USQ
MP3-86-094	Modifications to the ESF Status Panel (31HA-ANNMB2E)	04/17/86	NO USQ
MP3-87-059	RSS Pump Suction LLRT Plug Strongback	Voided	NO USQ
MP3-88-009	Modification to the Cold Leg Recirculation Array	07/17/89	NO USQ
MP3-89-013	MP3 Containment Design Pressure Change	01/30/91	NO USQ
MP3-92-004	Limitorque Torque Switch for 00 Operators Material Change	02/02/93	NO USQ
MP3-93-015	Replacement of 3RSS*MOV23A through D	11/16/93	NO USQ
MP3-94-162	Installation of RSS Containment Sump Flanges	12/21/94	NO USQ
MP3-96-054	RSS Component Temperature Rerates	In-Process	NO USQ
MP3-96-056	RSS Support Modifications Outside Containment	In-Process	NO USQ
MP3-96-063	RSS Support Modifications Inside Containment	In-Process	NO USQ
MP3-97-042	Mini-Flow Test Line for RSS Pumps C & D	In-Process	NO USQ
MP3-97-045	RSS Pump Restriction Orifices to Prevent Suction Line Flashing	In-Process	NO USQ
MP3-97-063	RSS Expansion Joint/Support Modifications	In-Process	NO USQ
MP3-97-094	Fill/Vent Lines ECCS Loop Seal	In-Process	NO USQ
MP3-97-102	Limited Passive Failure (Design Basis Reinstatement of Direct Injection)	In-Process	NO USQ
MP3-97-106	Switchover Time Increased (10 min. to 25 min.)	In-Process	NO USQ
MP3-98-008	Modification of RSS Pumps' Seal Water Coolers	In-Process	NO USQ

MP3-85-004 Tubing Protection Barriers (DMR-481 and 482)

Added protective barriers to a number of instrument tubing sections for the sensing line of 3RSS-FT40C, upstream of root valve 3RSS*V925. Due to the proximity of instrument tubing routing to aisle ways and personnel access ways, this modification of barriers was required in order to reduce the potential for tubing damage. This design change had no safety significance to the RSS design.

MP3-85-014 Supports Required for Seismic Interaction

Provided additional supports to limit sway of non-seismic Category I piping during a seismic event to preclude unacceptable interaction with seismic Category I RSS piping and equipment. No design changes were made to the RSS system itself.

MP3-86-094 Modifications to the ESF Status Panel (31HA-ANNMB2E)

Modified RSS Status Lights on the ESF Status Panel (31HA-ANNMB2E) for 3RSS*MOV20A, B, C, D to provide proper display information by correcting deficiencies identified by the NUSCO MP3 Control Room Review Team per NUREG 0700. This design change had no safety significance to the RSS design.

MP3-88-009 Modification to the Cold Leg Recirculation Array

Changed the Cold Leg Recirculation Array on Main Control Board #2 to provide the operator with an arrangement of control switches identical to the action steps reflected in EOP 35 ES-1.3. With this change, the operator can complete all actions required for switchover from cold leg injection to cold leg recirculation at the array location. Each train for the cold leg recirculation array was modified to hold three (3) additional control switches (for a total of 13 switches) for control of 3SIL*MV8809A,B, 3CHS*MV8511A,B and 3CHS*MV8512A,B. This design change had no safety significance beyond the existing changes reflected in EOP 35ES1.3 (i.e. elimination of the cold leg direct injection flow paths).

MP3-89-013 MP3 Containment Design Pressure Change

Changed the maximum allowable containment operating pressure during Modes 1-4 from 9.8 psia to 14.0 psia. This pressure change incorporated a reduction in containment leak rate (L_a) from 0.9 to 0.65 weight percent per day and an increase in secondary containment bypass leakage from the containment from 0.01 to 0.042L_a. The new DBA LOCA maximum containment accident pressure (P_a) is 38.57 psig (53.27 psia). The change was implemented because the original sub-atmospheric containment operating pressure increased the potential for personnel injury when entering containment for minor repairs that do not require the plant to be in cold shutdown. The change enabled operating personnel access into containment during all modes of power operation while reducing the potential for personnel injuries. This change takes credit for QSS and RSS fission product removal and thus constitutes a design basis change; no system design changes were necessary. This containment design pressure change was accepted under Amendment No. NPF-49, dated 1/25/91.

MP3-92-004 Limitorque Torque Switch for 00 Operators Material Change

This change allowed the use of Limitorque's modified 00 torque switch (Part Number PN 11500-158) in the replacement of either PN 11500-009 (non-QA) or PN 11500-010 (QA) torque switches. Replaced a 3/32" roll pin with a 1/8", 416 stainless steel groove pin. The new part number was the result of changes incorporated to correct a 10 CFR Part 21 condition (basic component deficiency), resulting from fatigue failures of the roll pin. This material change was applicable to Limitorque operators employed on RSS MOVs and did not change the form, fit or function of the original design. The safety evaluation for this change resulted in no Unreviewed Safety Question.

MP3-93-015 Replacement of 3RSS*MOV23A through D

Replaced 3RSS*MOV23A through D containment isolation valves with new valves that had an improved seat design. The original valves were EPT (Ethylene Propylene Terpolymer) rubber lined Henry Pratt model N-MK-II butterfly valves. The replacement valves were Henry Pratt model 1202 butterfly valves purchased under specification SP-ME-784. The change was implemented because of operating problems experienced where the EPT seat became detached from the valve body and prevented the valve from seating properly. Since the seat was bonded directly to the valve body, it was not field replaceable. This caused two failures of LLRTs during outages. The replacement valve material for body, seat, shaft and bearings is identical to that of the original design and utilized the original valve operators; however, the replacement valves now have field replaceable seats. This design change did not change the form, fit or function of the original design. The safety evaluation for this change resulted in no Unreviewed Safety Question.

MP3-94-162 Installation of RSS Containment Sump Flanges

Permanent 1" thick SA240 TP304 SS test rings with drilled and tapped holes were installed on the four RSS suction lines in the containment sump in order to provide a mounting location for a 14" 150# ANSI blind flange to be used in conducting LLRT Type C testing of the RSS pump inlet isolation valves 3RSS*MOV 23A-D. The test rings are the same diameter as the outside diameter of the RSS suction piping. The safety evaluation for this change resulted in no Unreviewed Safety Question. (Note: This PDCR was the subject of review in a NRC Report on the Special Inspection of Engineering and Licensing Activities at Millstone Nuclear Power Plant, September 1996).

The following three (3) design changes (MP3-96054, 96056 and 96063) collectively implement design changes resulting from a revised containment temperature profile and a postulated single failure in the SWS supply to the RSS coolers coincident with a LOCA. These were identified as item 1 in the Significant Items List.

MP3-96-054 RSS Component Temperature Rerates

Based on a revised containment temperature profile and postulation of a active single failure in the SWS supply to the RSS coolers coincident with a LOCA, uncooled containment sump water will be flowing through the RSS from the sump to the spray header. The uncooled sump water temperature approaches 260 ^{0}F. This temperature exceeded the previous RSS design temperature and required re-rating and re-analysis of the RSS system piping, equipment and components inside containment and resulted in pipe support modifications; the RSS cooler service water expansion joints and the containment penetrations were also re-rated and analyzed. The safety evaluation for this change results in no Unreviewed Safety Question.

MP3-96-056 RSS Pipe Support Modifications Outside Containment

Based on a revised containment temperature profile and postulation of a active single failure in the SWS supply to the RSS coolers coincident with a LOCA, RSS piping and pipe supports outside containment were re-rated and reanalyzed; this revised analysis resulted in no RSS pipe support modifications. Further, revised movements of the RSS coolers resulted in revised analysis of the SWS piping and supports; this revised analysis resulted in minor SWS pipe support modifications (one (1) spring hanger adjustment and two (2) snubber replacements). The safety evaluation for this change results in no Unreviewed Safety Question.

MP3-96-063 RSS Support Modifications Inside Containment

Based on a revised containment temperature profile and postulation of a active single failure in the SWS supply to the RSS coolers, RSS piping was reanalyzed and revised pipe support loads were developed for normal/upset ASME Code conditions. Pipe stress levels were qualified per Table 3.9B-11 of the FSAR. Pipe support modifications to 15 RSS supports on the piping system risers and ring headers (increased support weld size, location of gussets) were necessary to support the change in pipe support loads. The revised pipe support loads were also used in a revised containment liner and insert plate analysis. The safety evaluation for this change resulted in no Unreviewed Safety Question.

MP3-97-042 Flow Test Line for RSS Pumps C & D

Previously, 3RSS*P1C and 3RSS*P1D could not be tested during Mode 4 due to the need to use a RHR flow path from the RWST. This design change implements mini-flow test lines for these pumps, similar to the flow test lines currently installed for 3RSS*P1A and 3RSS*P1B. This will allow testing of the pumps during any Mode of operation. Additionally, this design change eliminates a high risk condition which also existed when 3RHS*V43 was open during Modes 1-3 for ISI testing of these pumps, should a DBA occur during the testing. It also eliminates the need to station an operator at 3RHS*V43 during testing. The safety evaluation for this change results in no Unreviewed Safety Question.

MP3-97-045 RSS Pump Restriction Orifices to Prevent Suction Line Flashing

This design change accomplishes three objectives:

- Installation of restriction orifice plates on the RSS pump discharge lines for 3RSS*P1A-D to prevent suction line flashing
- Installation of vent lines on the RSS pump casing to eliminate air binding
- Lowering of the RSS sump vortex suppresser grading

The installation of RSS suction line restriction orifice plates is necessary to prevent suction line flashing with containment sump water temperature as high as 260 ^{0}F. This design change reduces the peak RSS flow to 3000 gpm. With this design change, several other design changes are required. In conjunction with the installation of RSS suction line restriction orifice plates, the number of spray nozzles will be reduced from 322 to 162 per spray header to maintain the required droplet size for acceptable heat removal from Containment. The lower flow velocity due to the orifice plate installation has the added value of reducing the impact force of water hammer on the RSS heat exchanger baffle plate such that conformance with ASME code allowable is maintained. Additionally, with the installation of the RSS pump discharge orifice plates, operation of the RSS is changed such that flow to the spray headers will be increased by permitting flow from the pumps which supply core cooling to also continue to supply their respective spray headers.

Based upon an evaluation of the effect of trapped air on startup of the RSS Pumps after a LOCA, a 1 inch vent line will be installed on the RSS pump casing. The vent line will be routed from the vent plug in the pump casing to approximately 5 feet above in the discharge line of the pump. A check valve will be installed to prevent any loss of flow from the discharge line once the RSS pump has started. The check valve will be installed with an isolation valve and a test valve to allow inspection of the valve. Judicious location of the check valve (i.e., close to the main run header) eliminates any significant water hammer loading in the vent line due to header fluid transient analysis.

The hydraulic analysis of the sump water level, determined that the sump water level could be as much as 4 inches below the bottom of the vortex suppresser grating at the time of RSS pump start in the event of a small break LOCA in the reactor cavity. This was outside the geometric dimension specified in NUREG 0897, Revision 1, published October 1985.

To correct this condition, the vortex grating has been lowered by approximately 12 inches to position the grating in accordance with the guidance provided in NUREG 0897. The new sump design is consistent with the geometric dimension specified in NUREG 0897 and therefore, a new model sump test is not required.

Tests on these types of vortex suppressers at Alden Research Laboratory (ARL) have demonstrated their capability to reduce air ingestion to zero even under the most adverse conditions simulated.

By lowering the vortex grating by 12 inches, the Millstone Unit 3 sump design has been brought back into compliance with the geometric dimensions specified in NUREG 0897, Revision 1. Based on the testing performed by ARL and documented in the NUREG, the Millstone Unit 3 containment sump is determined to be qualified by the testing performed by ARL. Additional testing is not warranted. The safety evaluation for these changes results in no Unreviewed Safety Question.

MP3-97-063 RSS Expansion Joint/Support Modifications

Defective design of the RSS expansion joint tie rod assembly was reported under LER 97-021-00. Subsequent analysis of the expansion joints 3RSS*EJ1A/B/C and D and 3RSS*E2A/B/C and D determined that design changes to the RSS pump discharge piping was required relative to the expansion joint allowable movement and stiffness. The resulting design change included: 1) RSS pump discharge piping support design change, 2) an additional pipe support added, 3) the expansion joint reorientation relative to expansion joint tie rod orientation, and 4) expansion joint liner replacement for expansion joints 3RSS*EJ2A/B/C and D only. These changes restore the expansion joints to within their original design parameters. The safety evaluation for this change results in no Unreviewed Safety Question.

MP3-97-094 Fill/Vent Lines ECCS Loop Seal

Branch lines from the RSS pump discharge lines: down stream of the RSS Containment Recirculation Coolers are non- self venting because the piping forms an expansion loop. Air could accumulate in these lines during system filling after a LOCA in Containment. Upon switch over, this trapped air could reach the Safety Injection and Charging pumps and potentially cause pump performance degradation until the air is passed through the pump.

These modifications will allow for compliance with Technical Specification Section 4.5.2.b.1, modification to the RSS system will mitigate the possibility for air entrainment in the RSS thermal expansion loops.

MP3-97-102 Limited Passive Failure (Design Basis Reinstatement of Direct Injection)

Assuming limited passive failure in the ECCS system in the long term post design basis accident (DBA) is a licensing requirement. Discrepancies in MP3 conformance with this criterion were identified during the FSAR verification process as part of the MP3 CMP a Condition Report (CR) was initiated to address inconsistencies in the licensing and design basis documents for the issue and definition of ECCS limited passive failure with respect to the single failure criterion for fluid system design. The CR provides guidance on the proper application of the passive failure criterion. The corrective action was to generate a DCR to implement changes as required to adequately establish the design basis for ECCS limited passive failure and implement any necessary physical modifications.

MP3-97-106 Switchover Time Increased (10 min. - 25 min.)

The transition between the injection phase of a LOCA and the cold leg recirculation phase requires manual operator action to realign the suction of the charging and intermediate head SI pumps from the RWST to the discharge of the RSS pumps (see Figures 2-A and 2-B). Prior to 1998 the FSAR has stated that the operators could complete this transfer within 10 minutes.

As a result of changes in the valve stroke times from re-gearing of the MOV's and changes in the command and control communication protocol in the control room, the time for operators to complete these steps has increased. Therefore, the FSAR is being modified to state that the switchover will be completed within 25 minutes. Calculations have been performed which demonstrate that the remaining inventory in the RWST after 25 minutes is sufficient to meet the requirements of the ECCS pumps.

MP3-98-008 Modification of RSS Pumps' Seal Water Coolers

The Containment Recirculation Pumps 3RSS*P1A/B/C/D utilize a tandem seal to preclude leakage of the process fluid from the pump to the atmosphere. These seals are designed to ensure the seal leakage is pushed back to the process fluid stream. This is accomplished by using two seals and maintaining a higher pressure in the outboard seal cavity then the inboard seal cavity. The pressure differential between the inboard and outboard seal cavities is maintained at approximately 1 psi by a pressure chamber. It has been determined through calculation that due to line losses in the outboard seal cooling lines the pressure at the outboard seal cavity is not greater then the pressure at the inboard seal cavity. This means the inboard seal may leak to the outboard seal and subsequently to the atmosphere during pump operation. This modification will apply the output from the pressure chamber directly to the outboard seal cavity, thereby preventing seal leakage.

ENCLOSURE 2

MP3 - RSS SYSTEM;
RESPONSE TO NRC INFORMATION REQUEST
DATED FEBRUARY 3, 1998

TECHNICAL SPECIFICATION 6.8.4.a
LEAKAGE REDUCTION PROGRAM

1. Purpose

The purpose of this report is to describe the Technical Specification 6.8.4.a Leakage Reduction Program for the integrity of systems outside containment likely to contain radioactive materials at Millstone Unit 3. This report addresses the request made by Question 6 of the NRC letter to NNECO of February 3, 1997 concerning Millstone, Unit 3 - Recirculation Spray System.

2. Background

The following is a summary of the background issues relevant to the current status of the Technical Specification 6.8.4.a Leakage Reduction Program.

A. NUREG 0737, "Clarification of TMI Action plan Requirements"

NUREG 0737 Section III.D.1.1 (Reference 1) discusses systems located outside containment that will or may handle liquids or gases containing large radioactive inventories after a serious transient or accident. The NUREG position, in part, was to establish and implement a program of preventive maintenance to reduce leakage to as-low-as-practical levels. This program shall include periodic integrated leak tests at a frequency not to exceed refueling cycle intervals. NU has committed (FSAR Table 1.10-1) to establish these requirements as a continuing program.

The original 1985 leakage reduction program instituted at Millstone Unit 3 conformed to Technical Specification 6.8.4.a and was accepted by the NRC (Reference 2) as appropriate in meeting the criteria of NUREG 0737 III.D.1.1.

B. NRC Information Notice (IN) 91-56 "Potential Radioactive Leakage to Tank Vented to Atmosphere"

Issued in September 1991, IN 91-56 (Reference 3) broadened the scope of NUREG 0737 to include leakage past valves which would not be externally visible. IN 91-56 described potential situations involving radioactive water back-leakage in flowpaths, outside of containment, that were not previously recognized as falling under Technical Specification 6.8.4.a criteria. Specifically, it was identified that the potential existed for certain ECCS isolation valves located outside of containment to fail to fully isolate and be vulnerable to highly radioactive containment sump water back leakage. The highly radioactive back leakage could then be recirculated into tanks which are vented directly to atmosphere.

Based primarily on the credibility of valve failure in the leakage flow paths, results of a NU review of IN 91-56 (Reference 4) concluded that the probability was low that the situation described could occur at MP3. Although the report focused on the leakage paths identified in IN 91-56, it did not expand into other areas that could contain potential leakage paths. During a design basis seat leakage review under the Configuration Management Program (Reference 5), however, an issue of potential post accident back-leakage from the Recirculation Spray System (RSS) to the Refueling Water Storage Tank (RWST) was identified (CR M3-97-1936). Since the RWST is vented directly to atmosphere, there was a potential for an inadvertent release of radioactivity not previously accounted for in offsite dose assumptions.

During the NRC ICAVP Out of Scope Inspection, the NRC also questioned (Question 321) how the utility accounted for post accident back-leakage to the RWST (CRs M3-97-3218 and M3-97-4482). This same issue, but in a more programmatic sense, was subsequently identified during the NRC ICAVP Tier 2 Inspection, i.e., the Tech Spec 6.8.4.a Leakage Program was questioned (Question 135) regarding the lack of surveillances to address some possible leak paths such as heat exchangers and valves which may contain leakage that is not externally visible (CR M3-97-4588). This condition was determined to be reportable and was reported (LER 97-061) pursuant to 10CFR 50.73(a)(2)(i)(B), as any operation or condition prohibited by the plant's Technical Specifications.

C. Recirculation Spray System (RSS) Issues

Recently, the NRC has requested additional information (Reference 8) regarding changes made to RSS system design and operating modes. Included, was a request for additional information with regard to Technical Specification 6.8.4.a, describing the methods by which leakage from RSS and associated systems outside containment will be controlled and monitored to ensure that the radiological dose consequences of postulated accidents are within the plant's licensing basis. The potential for RWST back-leakage from RSS is discussed above. In addition, the following RSS issues have been resolved as indicated:

1. The RSS Pump Seal Water sub-system has a tank and accumulator designed to provide a supply of clean water to the RSS pump seal for a period of approximately 7 days (Reference 9). The NRC inspection (UIR 1014; CR M3-97-4823) identified that the mechanical calculation for leakage from systems identified in Technical Specification 6.8.4.a (Reference 10) assumed a zero leakage rate for the RSS pump seals. The expected, worst case leakage rate from these pumps, however, is 21 cc/hr per pump (Reference 9) which is consistent with the leakage rates from the other ECCS pumps described in the calculation. The mechanical calculation (Reference 10) will be revised to include RSS pump seal leakage as a source for contaminated fluid outside containment post accident. In order to maintain the calculation output value for total leakage constant, the assumption for "miscellaneous" (unidentified) leakage of 3,000 cc/hr will be reduced by the above RSS pump seal leakage values. This activity is considered a post restart activity since the calculation input to dose assessment calculations will not change.

2. The RSS heat exchangers have a potential for leakage across the tube sheet into the Service Water System. During NRC inspections, it was noted that measurement of RSS heat exchanger leakage was not included in component surveillances as required by the Technical Specification (CR M3-97-4827). Leakage testing of RSS heat exchanger leakage has now been specified as described in Section 3.D below.

Leakage across the tube sheets of the RHS heat exchangers into the Component Cooling Water (CCP) is not of concern with regard to the Technical Specification, since the CCP surge tank vent effluent is within the Supplemental Leakage Collection and Release System boundary.

3. Implementation of the Technical Specification 6.8.4.a Leakage Reduction Program

The following discussion provides the details of the existing program to satisfy the requirements of Technical Specification 6.8.4a, along with the program enhancements to address the issues identified above:

Technical Specification 6.8.4.a states:

"The following programs shall be established, implemented, and maintained:

a. <u>Primary Coolant Sources Outside Containment</u>

A program to reduce leakage from those portions of systems outside containment that could contain highly radioactive fluids during a serious transient or accident to as low as practical level. The systems include the Recirculation spray, Safety Injection, charging portion of chemical and volume control, and hydrogen recombiners. The program shall include the following:

1) Preventive maintenance and periodic visual inspection requirements, and

2) Integrated leak test requirements for each system at refueling cycle intervals or less."

The Leakage Reduction Program comprises the preventive maintenance, periodic visual inspection and integrated leak testing elements of the specification for the indicated Millstone Unit 3 systems as follows:

A. Preventive Maintenance

1. Program Requirement - The systems identified in Technical Specification 6.8.4.a shall be included in preventative maintenance programs.

2. Implementation - Each of the systems identified in Technical Specification 6.8.4.a is included in the Plant Preventative Maintenance Program. Since all equipment in these systems is either welded or considered passive (i.e. gaskets, packing, pump seals, etc.) and is subject to the visual inspections described below, the normal Plant Preventive Maintenance Program is deemed appropriate and satisfies the intent of the program. No special preventative maintenance activities which specifically reference Technical Specification 6.8.4.a, is required.

B. Periodic Visual Inspections

1. Program Requirement - Periodic visual inspections of the systems identified in Technical Specification 6.8.4.a shall be conducted.

2. Implementation - Each of the systems identified in Technical Specification 6.8.4.a is included in the Visual Inspection Program. Inspections are performed during such activities as ASME Section XI Pressure Tests, Operator Rounds, Health Physics Surveillances and Walkdowns, and, for systems not routinely in service, during Operability Surveillance Testing. Any leakage or residual boric acid buildup is identified using a trouble report and corrected in accordance with the Corrective Action Program.

C. Integrated Leak Test Requirements - Visible Leakage

1. Program Requirement - Integrated, external leak tests for each of the systems identified in Technical Specification 6.8.4.a are performed at refueling cycle intervals or more frequently.

2. Implementation - An integrated External Leak Test Program has been implemented. Testing is performed in External Leaktightness Verification procedures for each of the applicable systems or sub-systems. In general, these procedures inspect the system or sub-system boundary, measure visible leakage from mechanical joints, and compare with acceptance criteria, sum the total leakage, and trend leakage results over time. Leakage totals are maintained by the Operations Department. The External Leaktightness Verification procedures used to perform these inspections are identified in Attachment 1.

   A calculation (Reference 10) quantifies the potential total external leakage from system components such as piping, pump seals, flanges, and valve stem leakoffs, and miscellaneous (unidentified) external leakage. The calculation also establishes an assumed RSS heat exchanger tube leakage which would leak internally into Service Water. The total leak rate of 5,000 cc/hr derived from this calculation, is the maximum operational leak rate which, when doubled for conservatism, is the maximum post-LOCA equipment leakage within the filtered (SLRCS) boundary assumed in the radiological consequences analysis for the LOCA event (Reference 11). The current acceptance criteria for the total external leakage tests measured in these tests is 5,000 cc/hr with the exception of a zero leakage criteria for several piping segments which extend beyond the SLCRS boundary. Since these tests do not measure the internal leakage across the RSS heat exchangers, the acceptance criteria for the external tests will be reduced by the assumed total internal leakage across the RSS heat exchangers of 60 cc/hr per heat exchanger. (Reference 10). This activity is considered a post restart activity since the total leakage criteria remains at 5,000 cc/hr and the corresponding input to dose assessment calculations will therefore not change. Leakage testing of the RSS heat exchangers is discussed in Section D.2 below.

Where practical, the inspection boundary for the external leakage inspections is consistent with the ASME Section XI Class 1 pressure test requirements which states that the VT-2 examination (visual) shall extend to and include the second closed valve at the boundary extremity. A review of the current test boundaries has been performed. As a result of the review, some additional tests will be performed prior to Mode 4, and the test procedures will be revised to incorporate the additional tests prior to the next refueling.

D. Integrated Leak Test Requirements - System-To-System Leakage

1. Program Requirement - Integrated, system-to-system leak tests for each of the analyzed pathways among systems identified in Technical Specification 6.8.4.a are performed at refueling cycle intervals or more frequently.

2. Implementation - A System-To-System Leak Test Program has been developed and is being implemented. Testing will be performed to measure potential internal leakage from the RSS system back-leakage flowpaths to the RWST and from RSS into Service Water through the RSS heat exchangers.

   Leakage testing for each of the identified RWST back-leakage pathways is currently in progress and tests are planned for completion prior to Mode 4. The identified pathways comprise the pump suction and recirculation lines from the Charging, Residual Heat Removal, and Safety Injection Pumps, the RHR Purification Cross-Connect, and the RSS Test Line and De-watering Connections. In general, the testing will pressurize system piping segments and inspect for leakage from vented piping segments or components on the RWST side of boundary isolation points. A mechanical calculation (Reference 7) provides the basis for the leakage acceptance criteria for each pathway. A radiological assessment has been completed using the back-leakage values assumed in the mechanical calculation. Based on these leakage assumptions, the dose contribution from these pathways would be approximately 1% of the federal limit. If the actual leakage measured during testing exceeds the values assumed, attempts will be made to reduce the leakage or, the mechanical calculation will be revised and the radiological assessment re-performed. RWST Back-Leakage Verification Test procedures will be incorporated into the overall Leakage Reduction Program prior to next refueling.

   Leak tests to quantify RSS leakage into Service Water through the RSS heat exchangers are in progress, and are also planned for completion prior to Mode 4. The acceptance criteria for this leakage is 60 cc/hr for each RSS heat exchanger (Reference 10). In general, the testing is performed by pressurizing one side of the RSS heat exchangers with the other side isolated and drained. Any leakage across the tube sheets is noted by monitoring the open drains. RSS Heat Exchanger Leakage Verification Test procedures will be incorporated into the overall Leakage Reduction Program prior to next refueling.

4. Summary

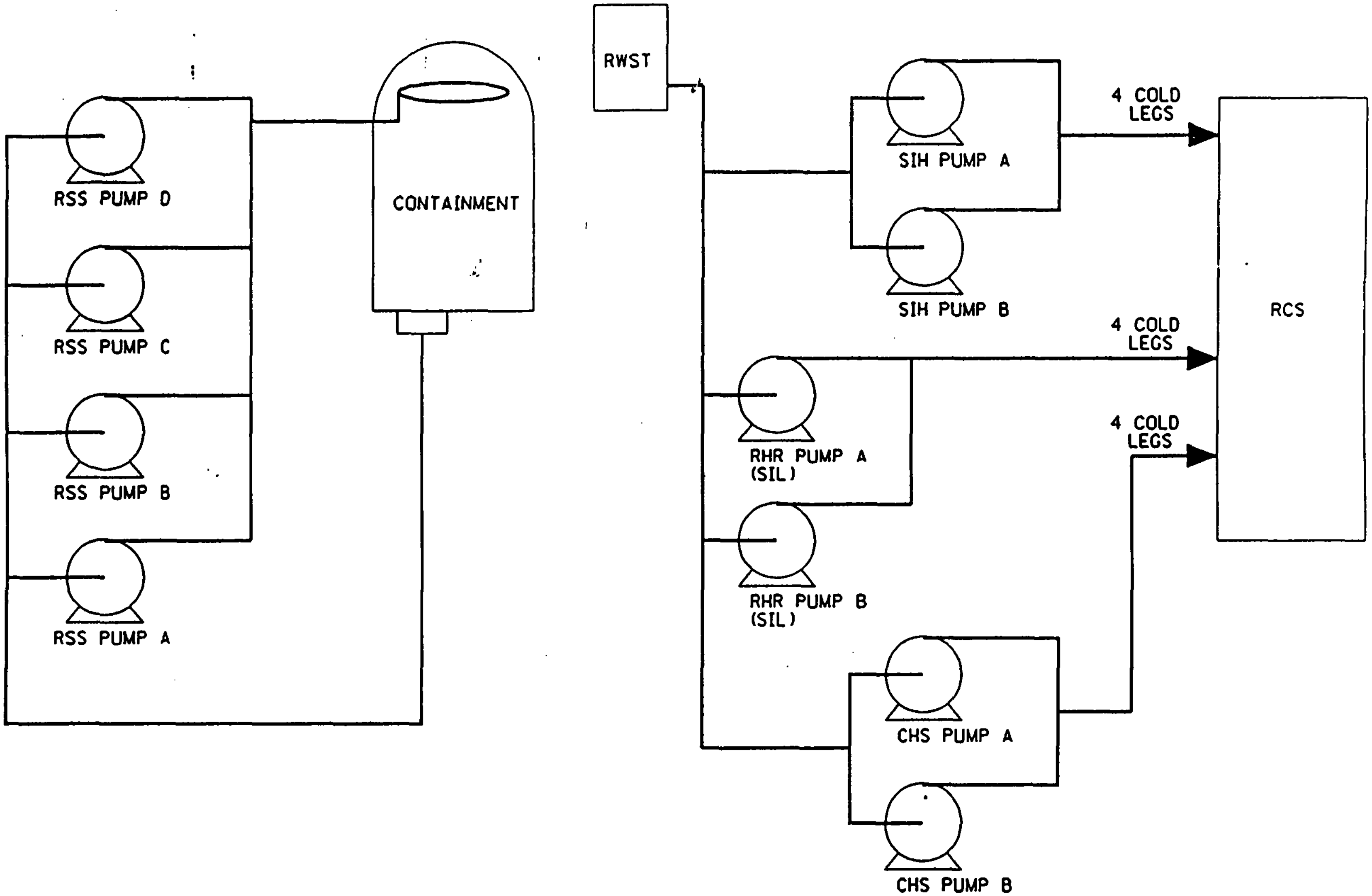
The Leakage Reduction Program described above satisfies the requirements of Technical Specification 6.8.4.a. The program addresses the issues raised in NRC Information Notice (IN) 91-56 along with relevant NU and NRC identified issues associated with the RSS system, RWST back-leakage, and other system-to-system leakage pathways.

5. References

1) NUREG 0737, "Clarification of TMI Action Plan Requirements - Integrity of Systems Outside Containment Likely to Contain Radioactive Materials for Pressurized-Water Reactors and Boiling Water Reactors".
2) NRC Letter "Issuance of Supplement No. 4 to NUREG 1031 - Millstone Nuclear Power Station, Unit No. 3", c161001, dated 12/6/85.
3) NRC Information Notice 91-56: Potential Radioactive Leakage To Tank Vented To Atmosphere, dated 9/19/91.
4) NU Memo MP3-92-260, "IEN 91-56: Potential Radioactive Leakage To Tank Vented To Atmosphere", C. H. Clement to T. J. Dente, dated 7/31/92.
5) Stone & Webster Memo MP-0148, "Refueling Water Storage Tank (RWST) Radioactive Fluid Back-Leakage Concern - Millstone Nuclear Power Plant - Unit 3", J. T. Creamer to M. Etre, dated 6/23/97.
6) LER 97-061-00, "Technical Specification 6.8.4.a Leakage Reduction program Does Not Address All Leakage Paths", B16934, dated 1/17/98.
7) Calculation RWST-01543-D3, "ECCS Back Leakage to the RWST During Post LOCA Sump Recirculation", Rev. 0, dated 1/16/98.
8) NRC Letter E. V. Imbro to M. L. Bowling, "Millstone Nuclear Power Station, Unit 3 - Recirculation Spray System (Significant Items List Items 1 and 85", dated 2/3/98.
9) MPR Associates Calculations 282-025-jlh-2, "Time That Pressure Chamber Can Provide Water to Seals", Rev. 1 and 282-025-jlh-3, "Leak Rate to Atmosphere After Pressure Chamber Water Volume is Gone," Rev. 1.
10) Calculation 1279-746P(R), ECCS System Leakage Outside Containment", Rev. 0, CCN 1, dated 5/12/97.
11) MNPS-3 FSAR, Table 15.6-9, "Assumptions Used for the Radiological Consequences of a LOCA Analysis", Amendment June 1996.

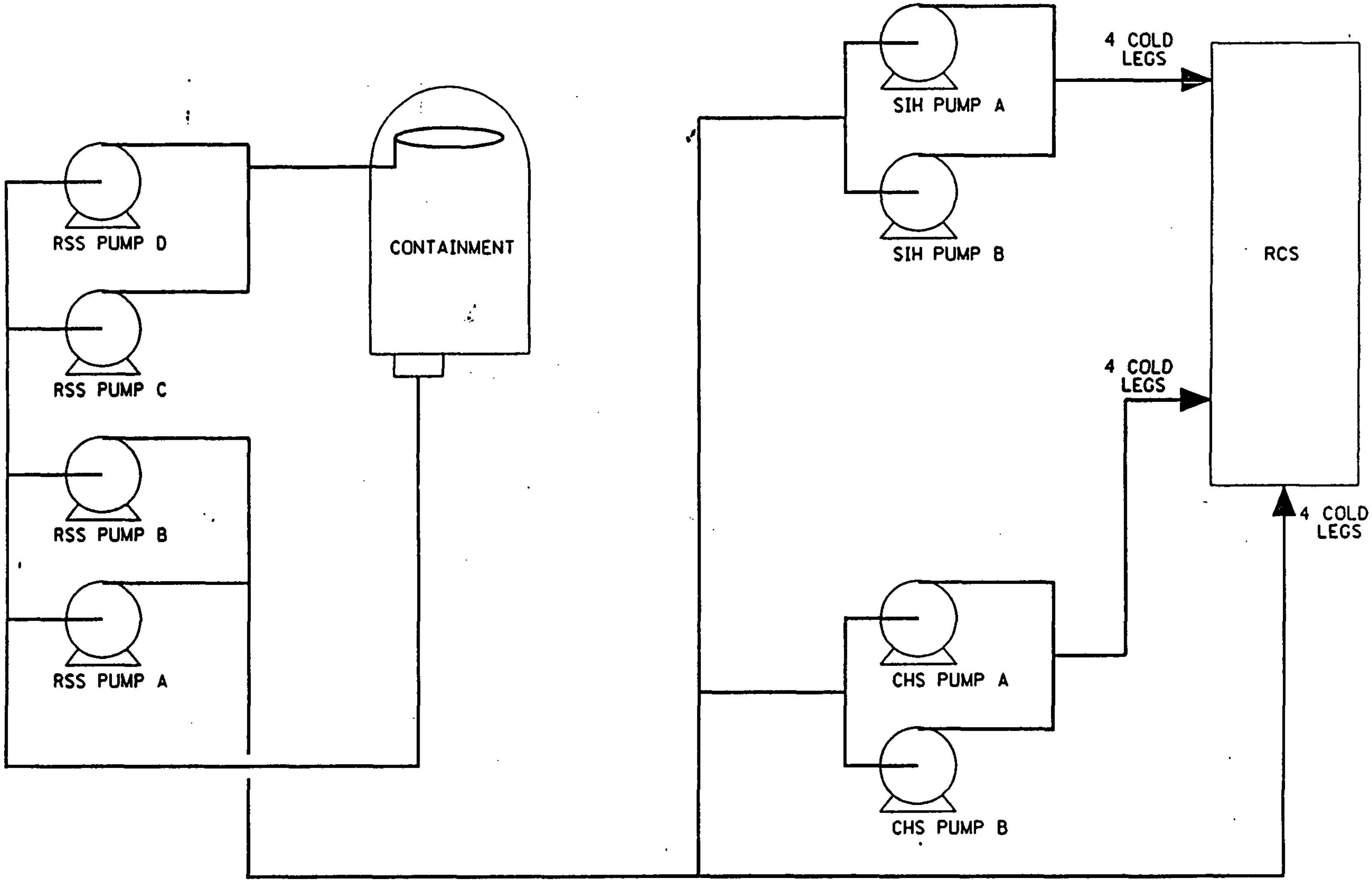
ATTACHMENT 1
External Leakage Tests Performed

Proc. No.	Title	Freq.	Response
3604A.1-2	Charging Pump A Leaktightness Verification Check	RO	Tech Spec.
3604A.1-3	Charging Pump Common Discharge Header Leaktightness Verification Check	RO	Tech Spec.
3604A.2-2	Charging Pump A Leaktightness Verification Check	RO	Tech Spec.
3604A.3-2	Charging Pump B Leaktightness Verification Check	RO	Tech Spec.
3606.1-2	Leaktightness Verification of 3RSS*P1A Suction and Discharge Header, Common Piping and Valves	RO	Tech Spec.
3606.2-2	Leaktightness Verification of 3RSS*P1B Suction and Discharge Header, Common Piping and Valves	RO	Tech Spec.
3606.3-2	Leaktightness Verification of 3RSS*P1C Suction and Discharge Header, Common Piping and Valves	RO	Tech Spec.
3606.4-2	Leaktightness Verification of 3RSS*P1D Suction and Discharge Header, Common Piping and Valves	RO	Tech Spec.
3608.1-3	Safety Injection Pump A and Common Header Leaktightness Verification Check	RO	Tech Spec.
3608.2-3	Safety Injection Pump B Leak Tightness Verification Check	RO	Tech Spec.
3613A.2-1	Hydrogen Recombiner Train A Leak Tightness Verification Check	RO	Tech Spec
3613A.2-2	Hydrogen Recombiner Train B Leak Tightness Verification Check	RO	Tech Spec
3613A.4-1	Hydrogen Recombiner Train A Leak Tightness Verification Following Pressure Boundary Maintenance	As Req.	Tech Spec
3613A.4-2	Hydrogen Recombiner Train B Leak Tightness Verification Following Pressure Boundary Maintenance	As Req.	Tech Spec



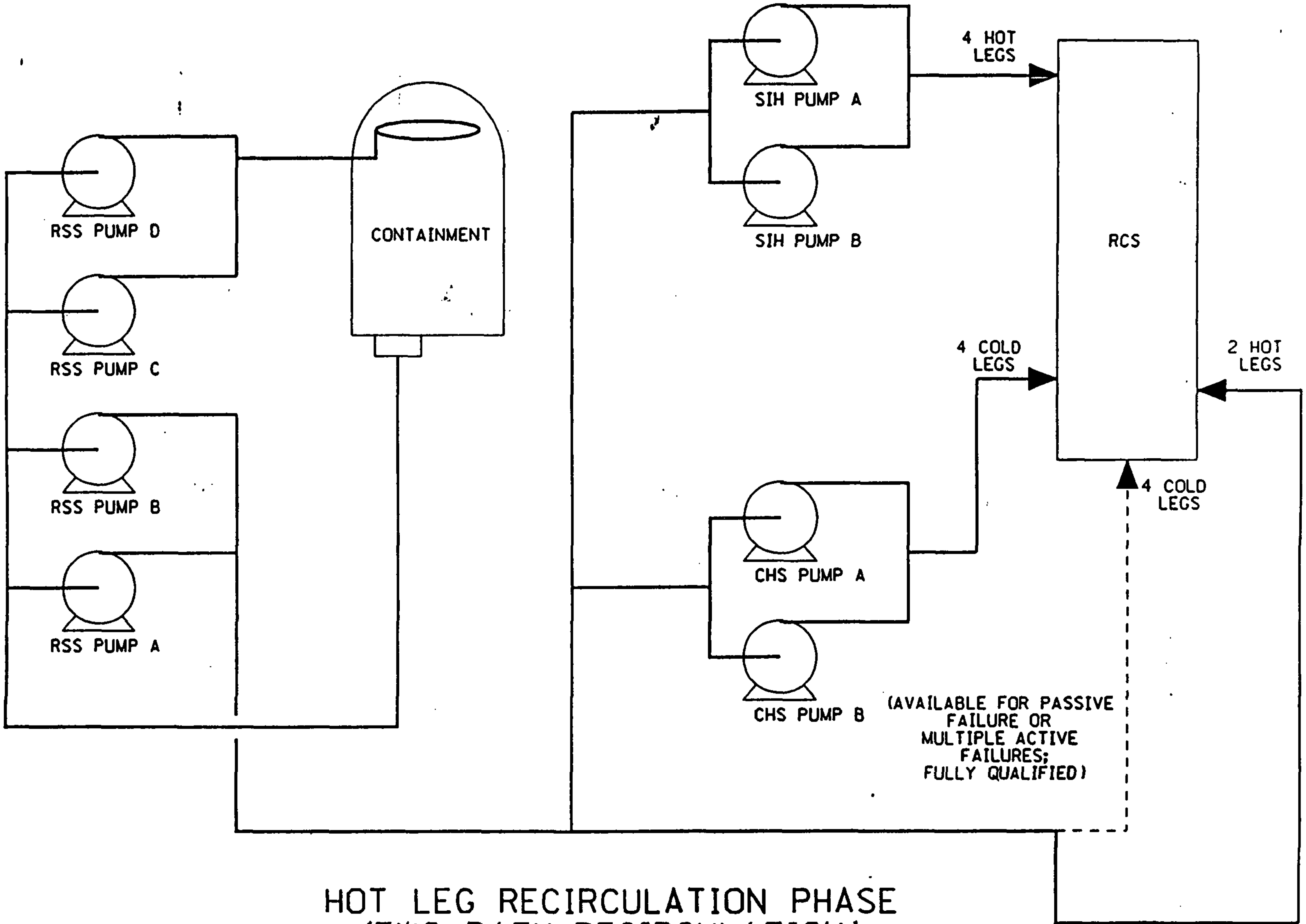
INJECTION PHASE
(1985 - ORIGINAL SYSTEM ALIGNMENT)

FIGURE 1A



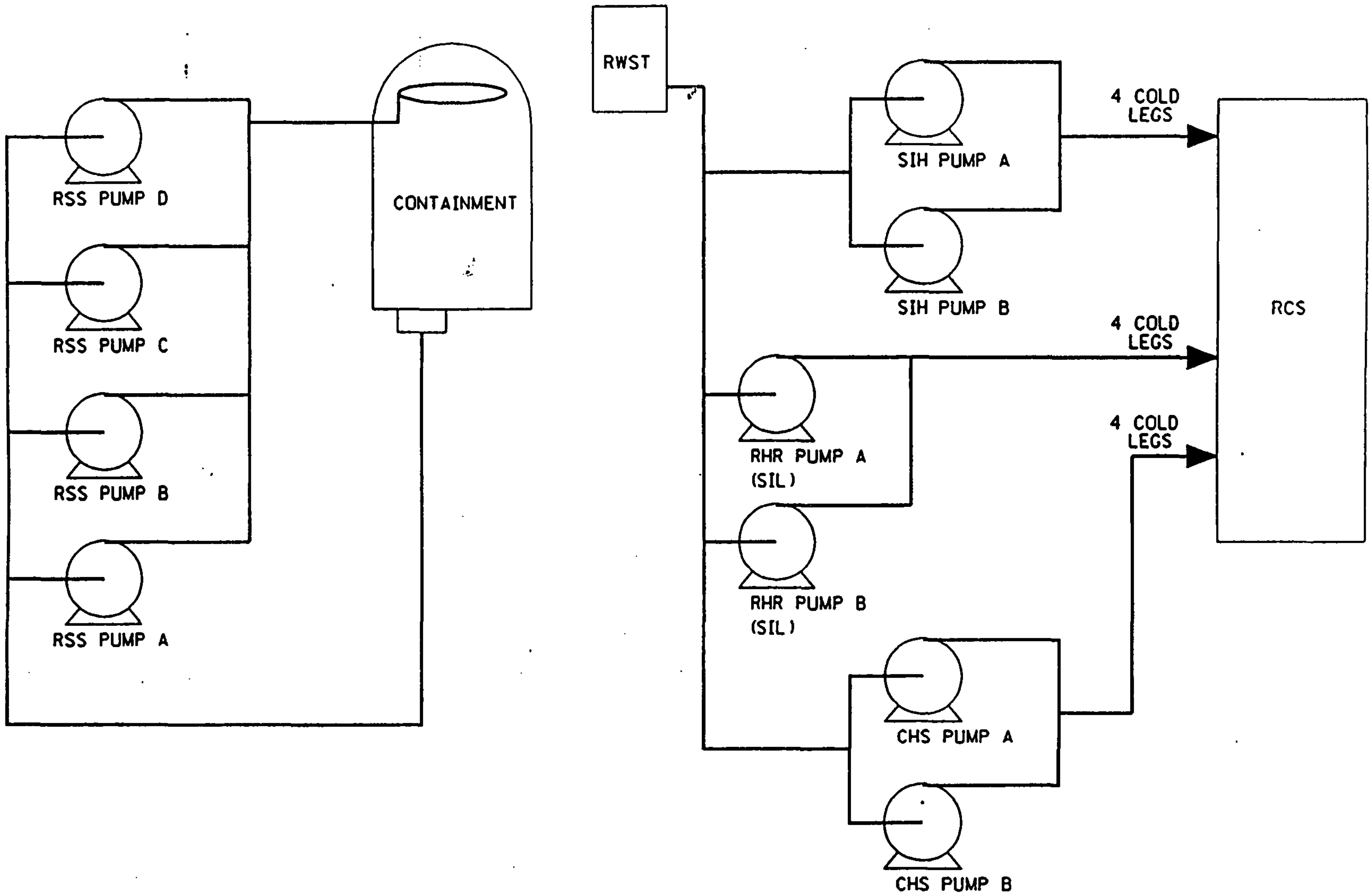
COLD LEG RECIRCULATION PHASE
(1985 - ORIGINAL SYSTEM ALIGNMENT)

FIGURE 1B



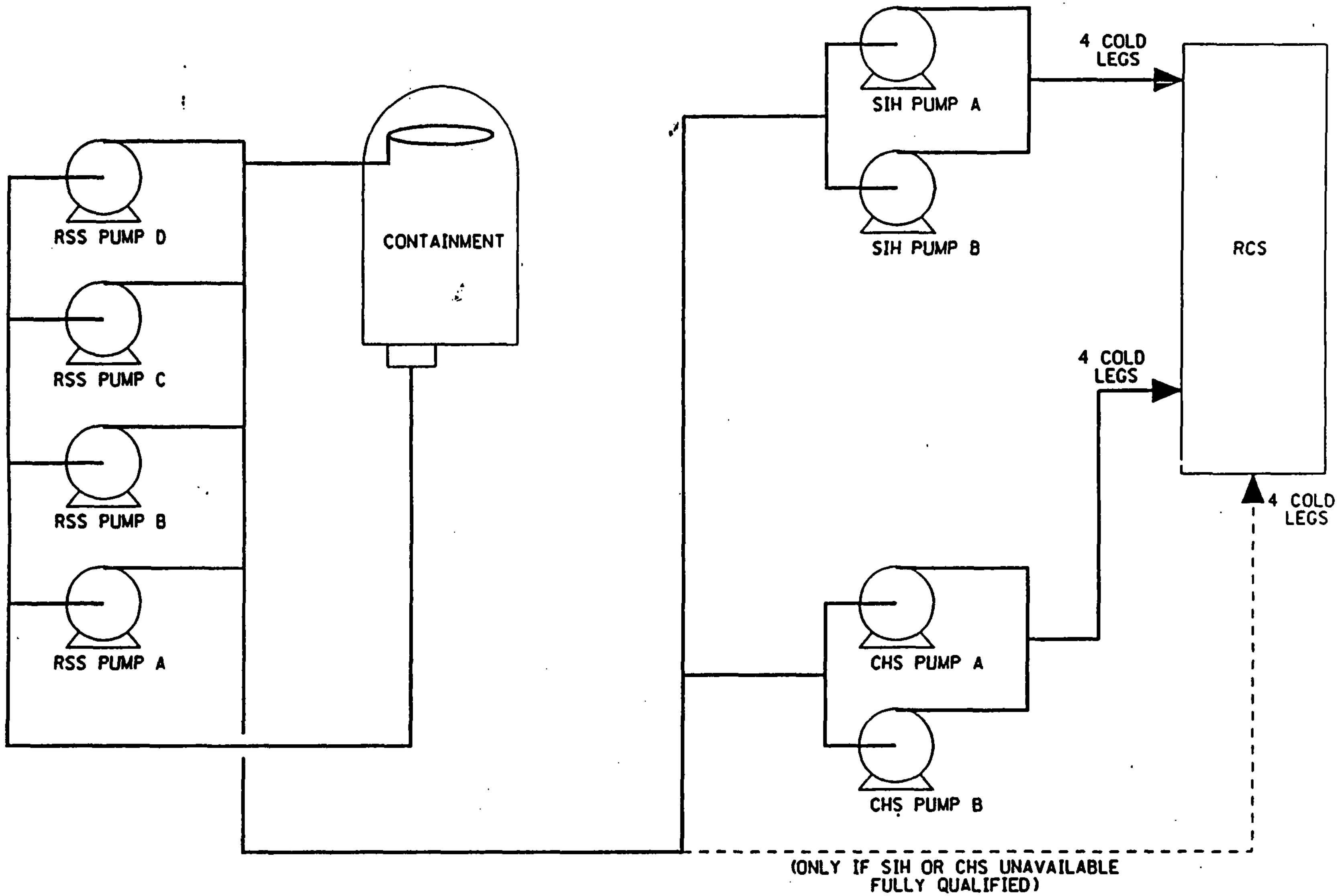
HOT LEG RECIRCULATION PHASE
(TWO PATH RECIRCULATION)
(1985 - ORIGINAL SYSTEM ALIGNMENT)

FIGURE 1C



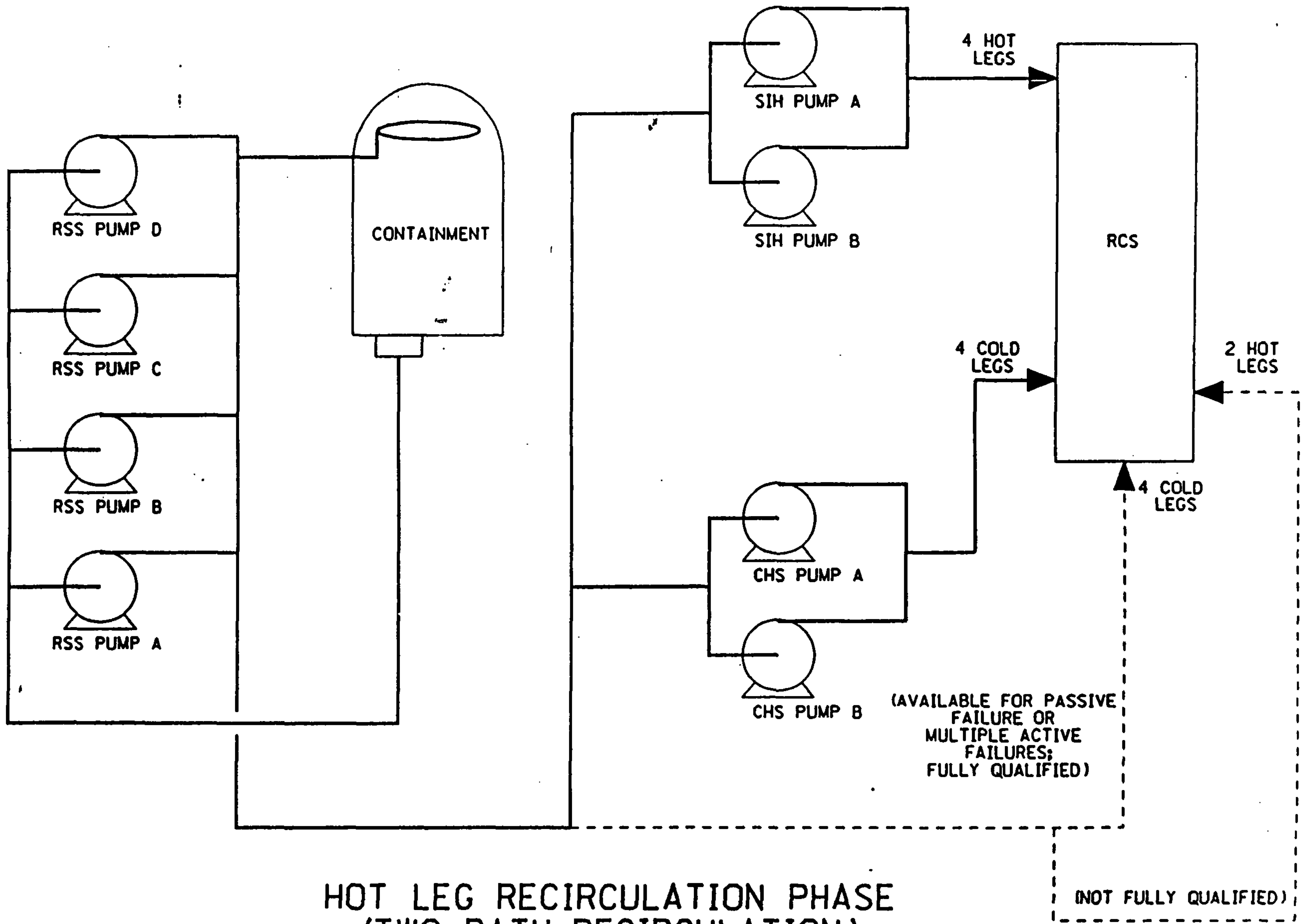
INJECTION PHASE
(1998 - SYSTEM ALIGNMENT)

FIGURE 2A



COLD LEG RECIRCULATION PHASE
(1998 - SYSTEM ALIGNMENT)

FIGURE 2B



HOT LEG RECIRCULATION PHASE
(TWO PATH RECIRCULATION)
(1998 - SYSTEM ALIGNMENT)

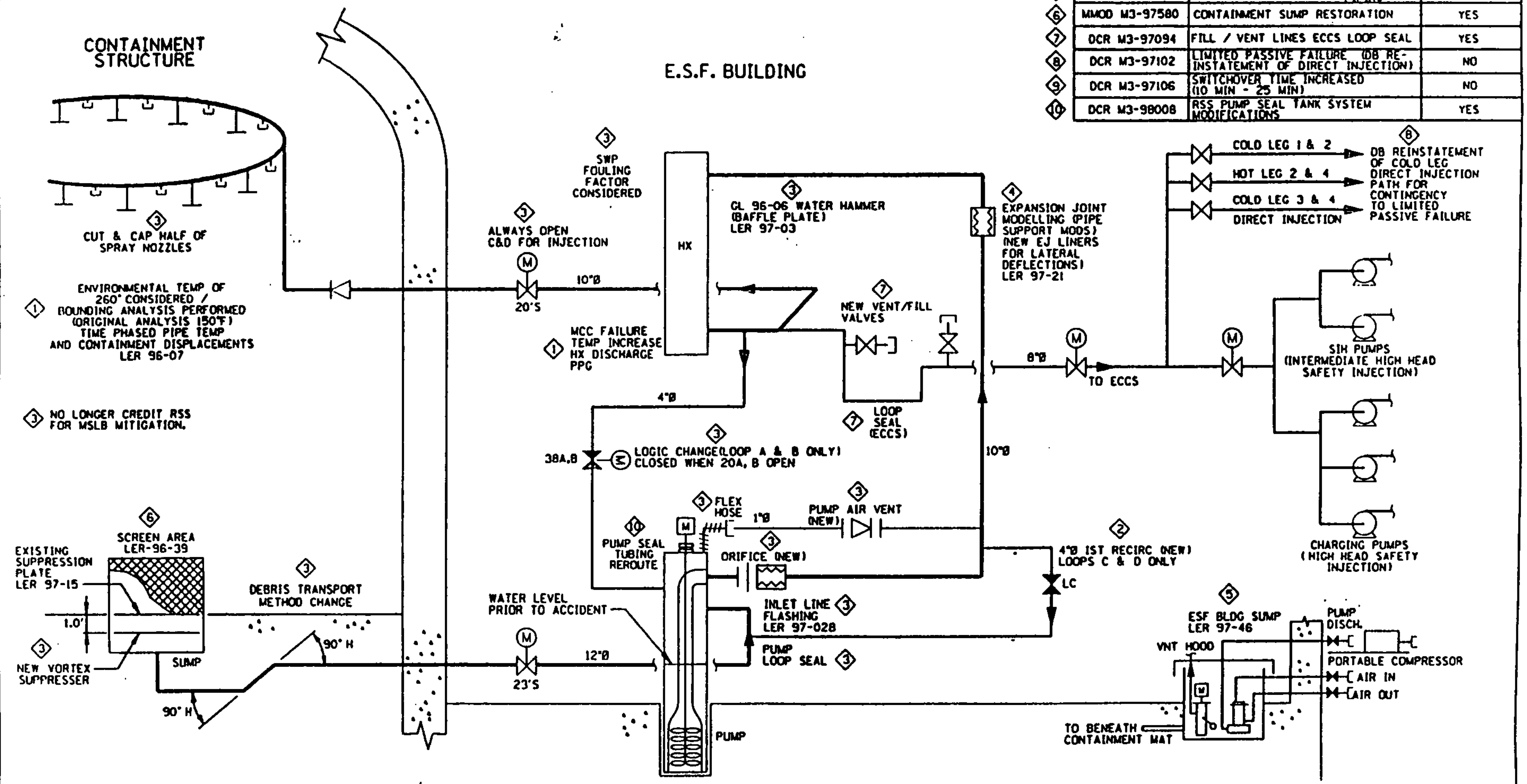
FIGURE 2C

FIGURE 3
RSS SYSTEM SCHEMATIC SHOWING LOCATION OF MAJOR DESIGN MODIFICATIONS.

(ONLY ONE OF FOUR RSS PUMP/HX FLOW PATHS SHOWN)

MODIFICATION SUMMARY (AS OF 2/12/98)

	CHANGE DOCUMENT	DESCRIPTION	PORC APPROVED
1	DCR M3-96054 DCR M3-96056 DCR M3-96063	RSS COMPONENT TEMP RERATES RSS SUPPORT MODS OUTSIDE CONTMT RSS SUPPORT MODS INSIDE CONTMT	YES
2	DCR M3-97042	TEST LINES, PUMP C & D ONLY	YES
3	DCR M3-97045	ORIFICE / NOZZLE REDUCTION / VALVE INTERLOCKS PUMP VENT LINE/VORTEX SUPPRESSER	YES
4	DCR M3-97063	EJ'S / PIPE SUPPORTS	YES
5	DCR M3-97079	ESF SUMP CORE BORE PIPING	YES
6	MMOD M3-97580	CONTAINMENT SUMP RESTORATION	YES
7	DCR M3-97094	FILL / VENT LINES ECCS LOOP SEAL	YES
8	DCR M3-97102	LIMITED PASSIVE FAILURE (DB RE-INSTATEMENT OF DIRECT INJECTION)	NO
9	DCR M3-97106	SWITCHOVER TIME INCREASED (10 MIN - 25 MIN)	NO
10	DCR M3-98008	RSS PUMP SEAL TANK SYSTEM MODIFICATIONS	YES



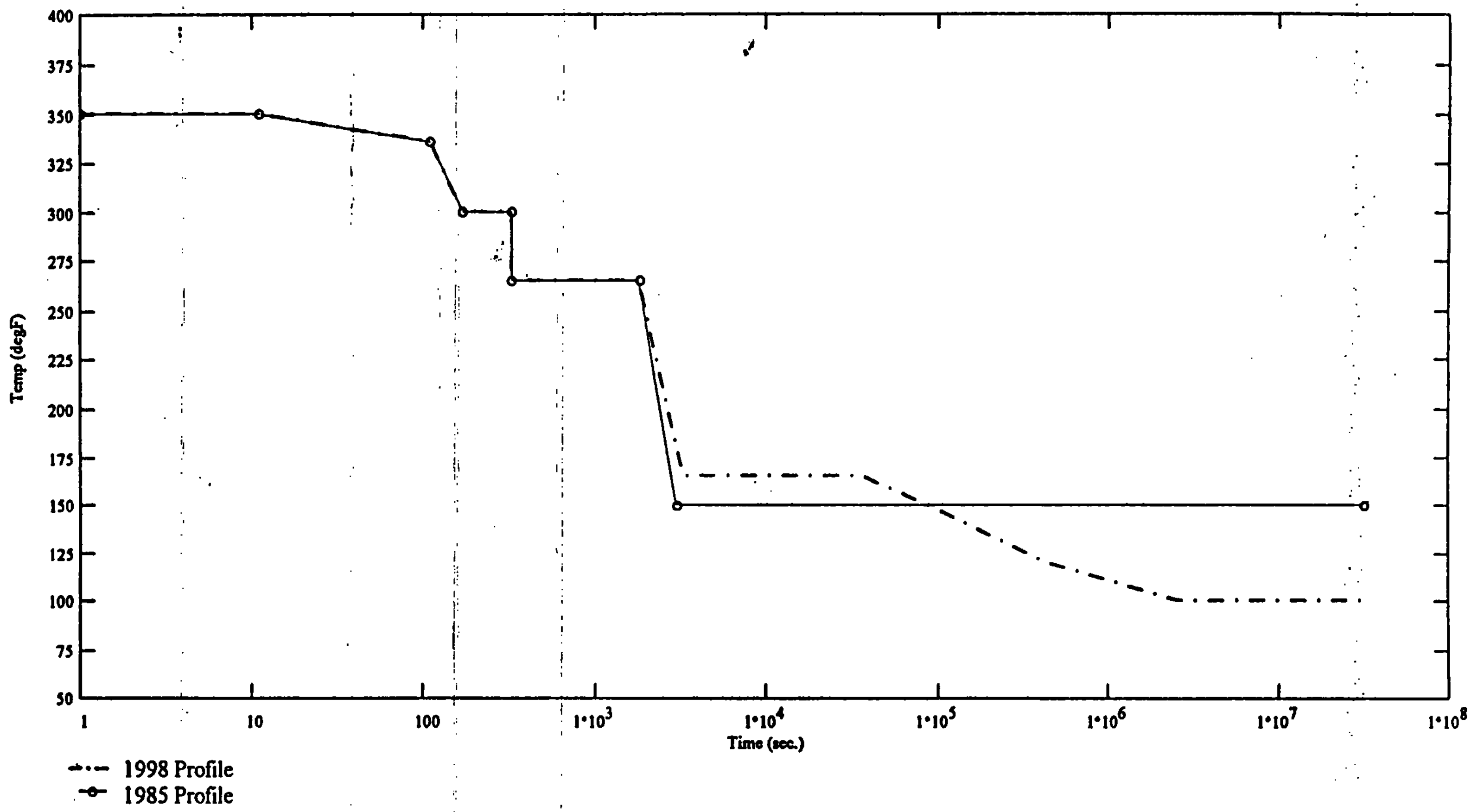


Figure 4a - Containment EEQ Temperature Profile Overlay (1998 versus Original - 1985)

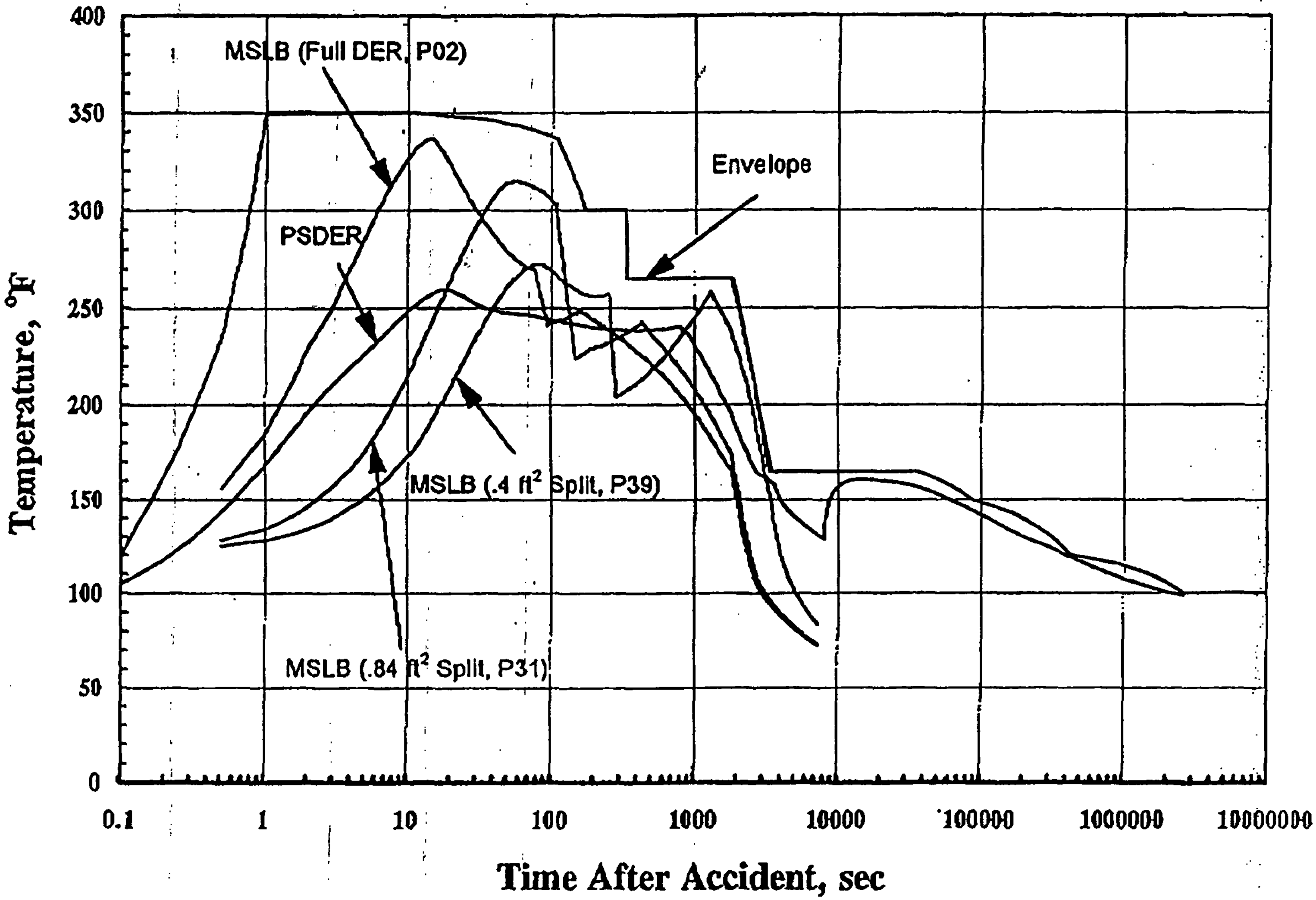


Figure 4B
Containment Temperature Profile Overlay
(Transients versus 1998 EEQ Envelope)

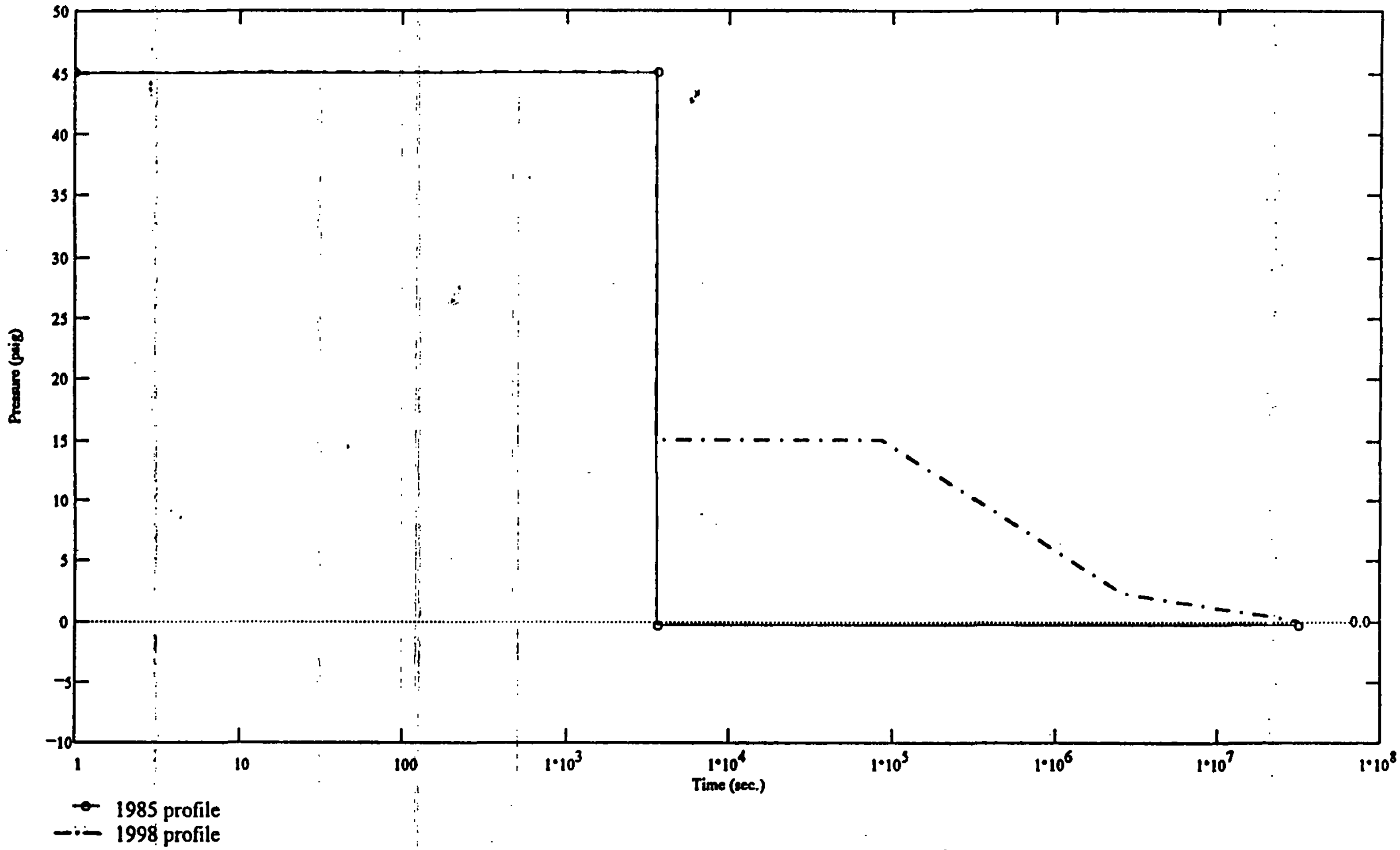


Figure 5a - Containment EEQ Pressure Profile Overlay (1998 versus Original - 1985)

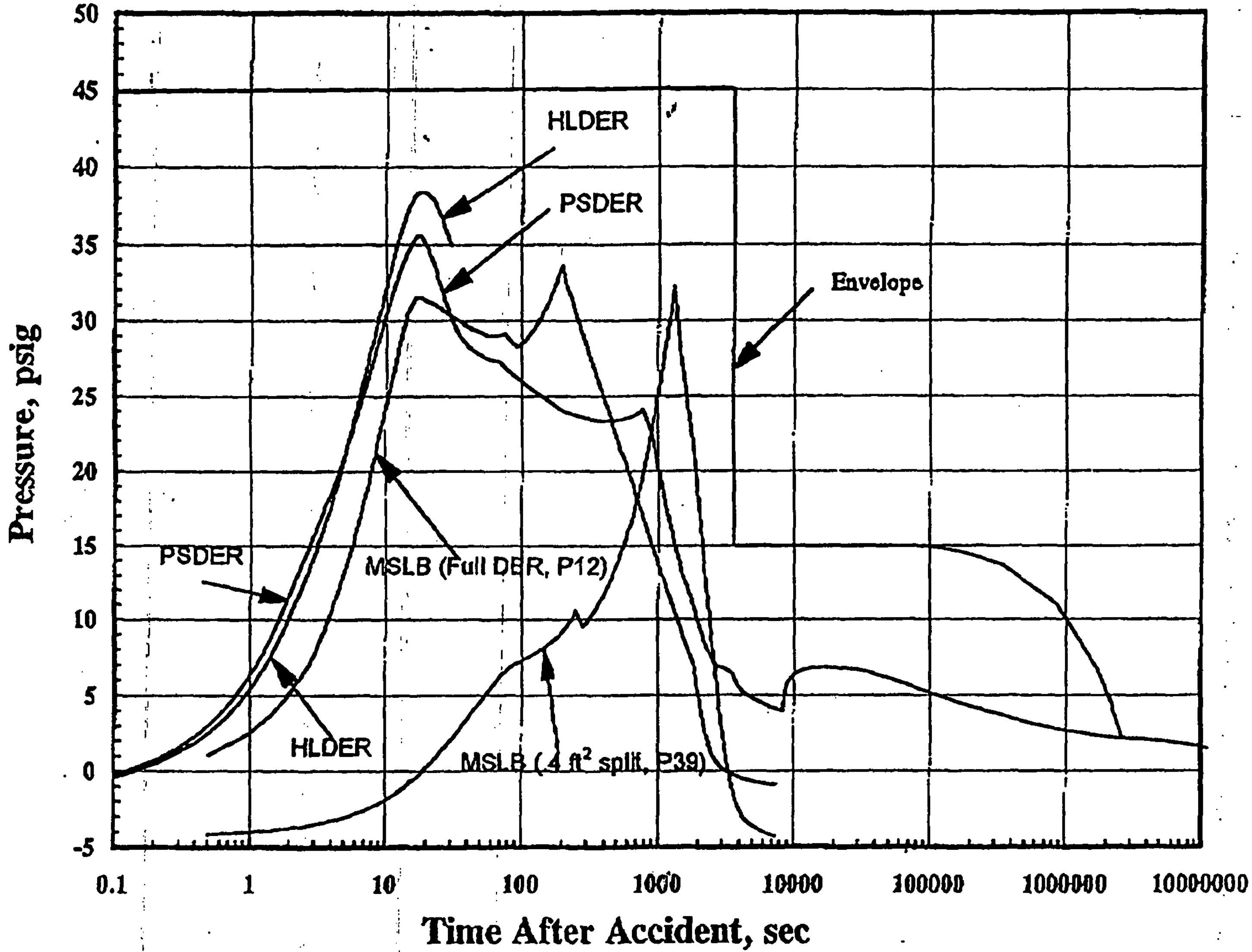


Figure 5B
Containment Pressure Profile Overlay
(Transients versus 1998 EEQ Envelope)

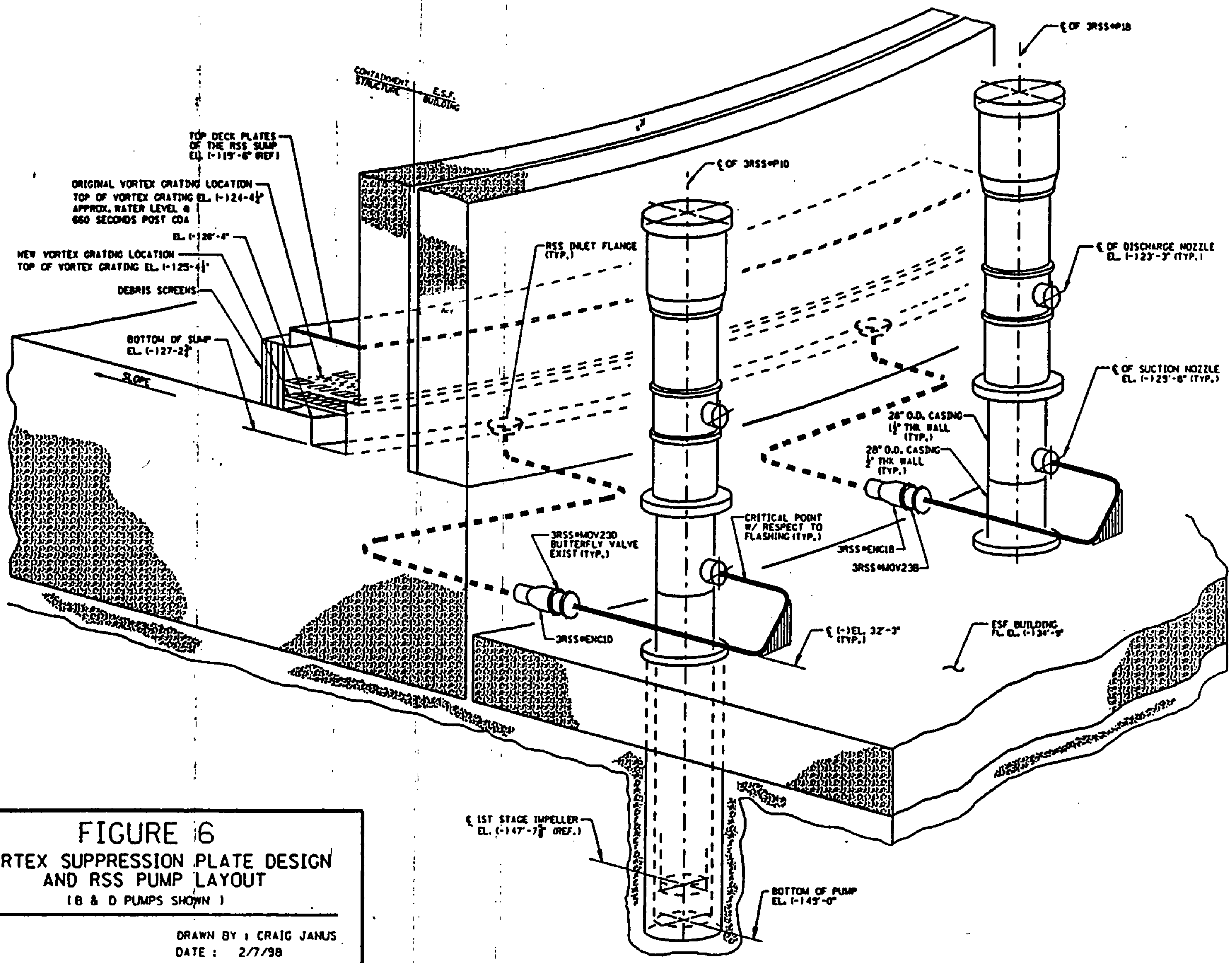


FIGURE 6

VORTEX SUPPRESSION PLATE DESIGN AND RSS PUMP LAYOUT

(B & D PUMPS SHOWN)

DRAWN BY : CRAIG JANUS
DATE : 2/7/98
REVISION : 1

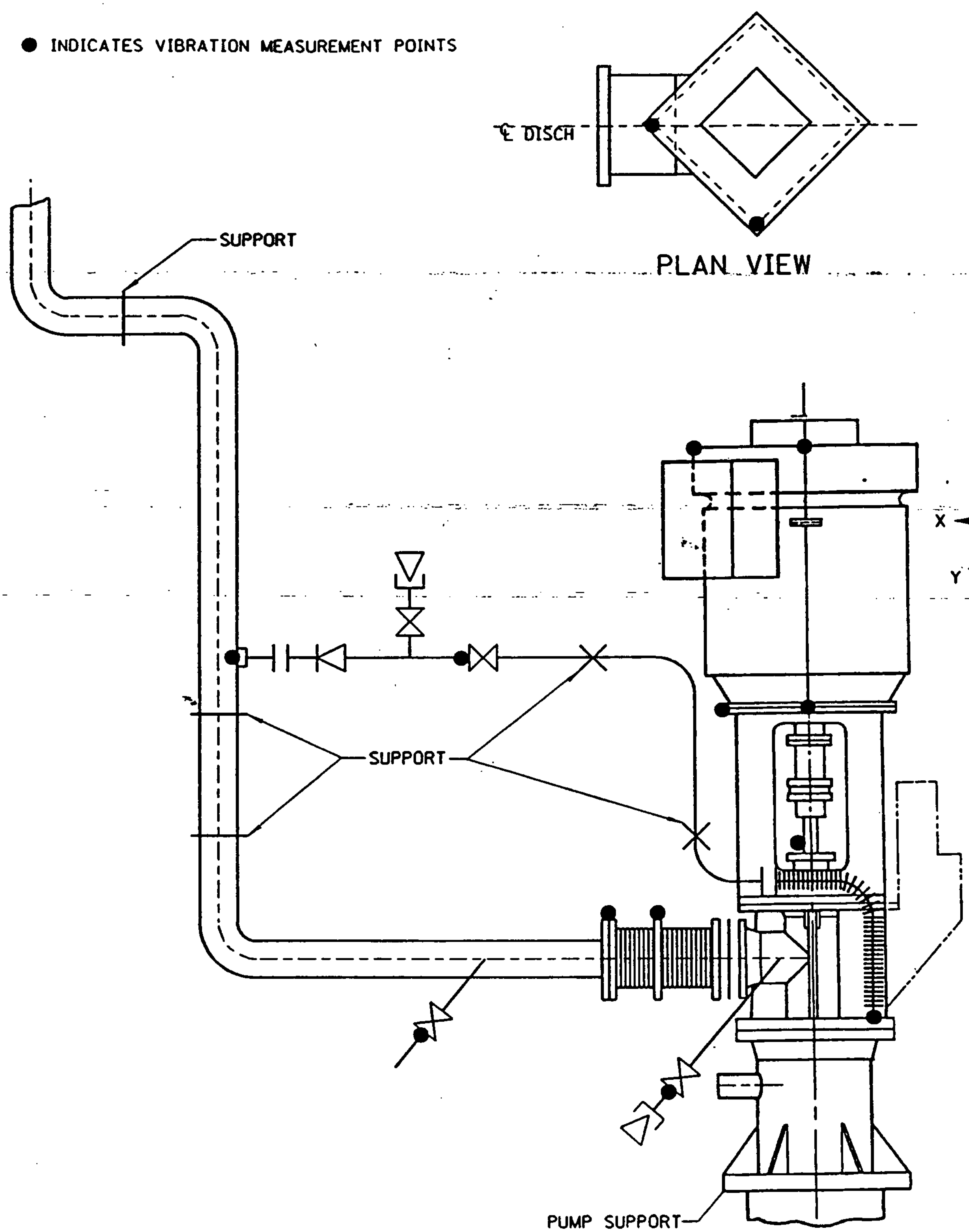


FIGURE 7
RSS SYSTEM FLOW TEST VIBRATION
MONITORING POINTS

SKM-CMC-PUMP