Duke Power Company
McGuire Nuclear Generation Department
12700 Hagers Ferry Road (MG01A)
Huntersville, NC 28078-8985

T. C. McMEEKIN
Vice President
(704)875-4800
(704)875-4809 FAX

DUKE POWER

December 15, 1992

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

Subject: McGuire Nuclear Station
Inplant Review Report Number 92-20

Gentlemen:

Attached is Inplant Review Report Number 92-20. This report is being submitted to the NRC as a voluntary special report to address a postulated scenario that could introduce air into the Auxiliary Feedwater suction piping.

Very truly yours,

T.C. McMeekin

TLP/bcb

Attachment

xc: Mr. S.D. Ebneter
Administrator, Region II
U.S. Nuclear Regulatory Commission
101 Marietta St., NW, Suite 2900
Atlanta, GA 30323

INPO Records Center
Suite 1500
1100 Circle 75 Parkway
Atlanta, GA 30339

Mr. Tim Reed
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Mr. P.K. Van Doorn
NRC Resident Inspector
McGuire Nuclear Station

IE22 1/1

McGUIRE SAFETY REVIEW GROUP

INPLANT REVIEW REPORT

1. REPORT NUMBER: 92-20

2. DATE OF REVIEW: October 26, 1992 through December 10, 1992

3. SUBJECT DESCRIPTION:

This Inplant Review is submitted to the NRC as a voluntary special report of the circumstances relating to the incident described in Problem Investigation Report (PIR) 0-M92-0406, Introduction of Air Into the CA System Resulting From a Seismic Event. The specific purpose of the review is to determine the cause of the incident and to formulate solutions to prevent future problems of a similar nature.

4. EVALUATION AND COMMENT:

On October 27, 1992, PIR 0-M92-0406 was issued by the McGuire Safety Review Group to address a postulated scenario that could introduce air into the Auxiliary Feedwater (CA) suction piping. The concern was identified by the McGuire Engineering Group during the review of calculations performed to verify Auxiliary Feedwater swapover pressure switch setpoints. The calculations were part of the Design Basis Document (DBD) analysis review. During this review, questions were raised concerning the operability of the CA Pumps following a seismic event that resulted in a break in the normal CA pump suction line at the service/auxiliary building wall prior to pump start. A piping break at this location would permit the draining of condensate (CM), which provides normal suction to the CA pumps. The resulting drain down would occur before the Nuclear Service Water (RN) Swapover Pressure Switches, which activate the assured makeup supply, could detect the drop in the pump suction pressure. Upon CA pump startup, the air introduced into the pump supply header as a result of water drainage, would be forced into the pump inlet ahead of assured CA suction source (RN) water, resulting in potential pump damage/inadequate pump performance.

4.1 Background:

The CA system is a nuclear safety related system which is designed to provide a means of dissipating heat from the Reactor Coolant (NC) system if the CM system and Main Feedwater (CF) system are not available. The CA system is also used during normal startup and shutdown. The CA system is provided with two motor driven (MD) pumps and one turbine driven (TD) pump. In addition to the three primary sources which supply the CA system suction, the RN system provides the nuclear safety related assured CA system suction source.

CA pump suction diversity is provided by using several water sources and adequate valving for source change. The CA pumps are normally supplied from a common header which can be aligned to the upper surge tank, the CA condensate storage tank, or the condenser hotwell. In accordance with the requirements set forth in Regulatory Guide 1.70 and NUREG-0611, safety grade instrumentation is provided to detect loss of normal pump suction sources and swapover to the assured RN supply. This swapover logic and instrumentation is required to ensure that long term safety grade supply of water is available to mitigate the consequences of a design basis event.

When the CA pump suction pressure drops below 2 psig for three seconds, RN will automatically align to the CA suction header. A low suction pressure on the associated pump will cause the following valves to open:

CA PUMP	PRESSURE SWITCH	ISOLATION VALVE
MDP A	CAPS 5002	CA-15A
	CAPS 5350	RN-69A
MDP B	CAPS 5360	CA-18B
	CAPS 5012	RN-162B

TDP	CAPS 5042	CA-86A
	CAPS 5370	RN-69A
	CAPS 5390	CA-116B
	CAPS 5381	RN-162B
	CAPS 5044	CA-161C
	CAPS 5380	CA-162C

The RN system consists of Trains A and B which are normally aligned to Lake Norman. The RN system assured suction source to the CA system is available to each of the 3 CA system pumps by independent flow paths. Three independent flow paths are also available to the Turbine Driven Auxiliary Feedwater (TDCA) pump. Each flow path is isolated by 2 valves in series. The normal supply valves are motor operated and can be controlled either in the Control Room or at local panels. One of the assured CA system suction sources for the TDCA pump is controlled at the Standby Shutdown Facility (SSF).

Technical Specification (TS) 3.7.1.2 requires that at least 3 independent CA pumps and associated flow paths be operable in Modes 1 (Power Operation), 2 (Startup), and 3 (Hot Standby). The TDCA pump is required to be operable in Modes 1, 2, and, 3 with secondary steam pressure >/= 900 pounds. With 1 CA pump inoperable, restore the inoperable pump to operable status within 72 hours or place the unit in at least Hot Standby within the next 6 hours and in Mode 4 (Hot Shutdown) within the following 6 hours.

4.2 Description of Incident:

McGuire Engineering Services personnel had completed the Design Basis Document for the CA system on or about October 1, 1992. During performance of Design Study 50, Verification of Instrument Setpoints, Engineer A questioned the operability status of the CA pumps following a seismic event and prior to the starting of the pumps. The CA normal

suction header is seismically qualified up to the junction of the service/auxiliary building wall (AA line). In the postulated scenario, a seismic event ruptures the CA pump suction piping prior to CA pump actuation, and automatic suction supply swapover to RN. If the CA pumps had not yet started, no pipe suction would exist to prevent the normal supply water from draining out of the line break. When the CA pumps then started, after detection of pump suction pressure < 2 psig for 3 seconds by the RN Swapover Pressure Switches, the waterleg remaining in the suction header would be insufficient to prevent the introduction of air into the pumps ahead of the assured suction source. Additionally, the pre-existing 2 psig setpoint that initiates the swapover to the assured source, after inclusion of the maximum post accident instrument inaccuracy and piping configuration, may not be adequate to assure activation of the swapover valves prior to the introduction of air into the pumps, if the normal suction sources are depleted. The introduction of air into the pumps could result in possible pump cavitation and the destruction/inadequate operation of the pumps.

Due to the time considerations involving calculations and modeling, Engineering personnel elected to increase the setpoint of the CA feedwater pump pressure switches by one psig and to evaluate the CA suction piping to elevation 736 feet by Seismic Experience Walkdown Methods (SEWM). The new setpoint ensured that the static head alone would activate the swapover to RN, thus eliminating the potential of air reaching the pumps in a low flow condition. The SEWM evaluated pipe provided the needed volume, and eliminated the potential of air reaching the pumps in a high flow condition.

This action was taken as a proactive measure to ensure current operability. The following setpoint recalibrations were performed:

UNIT 1

Work Order Number	Equipment Number
92081307	1MCAPS-5002
	1MCAPS-5350
92081377	1MCAPS-5042
	1MCAPS-5370
	1MCAPS-5390
	1MCAPS-5381
92081370	1MCAPS-5360
	1MCAPS-5012

UNIT 2

Work Order Number	Equipment Number
92081358	2MCAPS-5002
	2MCAPS-5350
92081366	2MCAPS-5360
	2MCAPS-5012
92081400	2MCAPS-5042
	2MCAPS-5370
	2MCAPS-5390
	2MCAPS-5381

The pressure switches were recalibrated from the current 2 psig to 3 psig, with the exception of 2CAPS-5002 and 2CAPS-5350 which were recalibrated from 3 psig to 4 psig due to a difference in elevation.

During this recalibration, pressure switches 1/2 CAPS-5002, 5012, 5042, 5044, 5350, 5360, 5370, 5380, 5381, and 5390 were found to exhibit potentially excessive inaccuracy/uncertainty in their as found calibration. This situation is addressed in PIR 1-M92-0437 which was generated on October 30, 1992. Component Engineering personnel are currently investigating this condition.

On October 29, 1992, Engineering Services personnel determined that the higher switch setpoint ensured current CA system operability based on calculation MCC-1223.42-00-0030, Rev. 1.

On November 24, 1992, Engineering Services personnel determined that the CA system had been past inoperable from initial startup until October 29, 1992, based on calculation MCC-1223.42-00-0031.

4.3 **Conclusion:**

This incident is assigned a root cause of Functional Design Deficiency, because the margin of instrument inaccuracy of the pressure switches which detect a drop in pump suction pressure was too large to ensure assured pump suction source actuation as designed. The margin of error in this case is equal to +/- 1.31 psi. This resulted in the possibility of the pump suction pressure decreasing to 0.69 psi before automatic RN swapover.

The CA system was determined to be past inoperable based on the previous CA suction pressure switch setpoint of 2 psig. The following combination of events, in the initial portion of an accident sequence, was determined to cause potential loss of function to the CA system:

1. Loss of CA caused by a seismic event, which causes:
   a. A pipe break which results in loss of the

normal CA suction source, but does not cause a loss of offsite power (i.e. no turbine driven pump auto start).

2. A single failure of a CA motor driven pump

In this particular combination of events, the flow rate in the CA suction path could have been such that the pressure switches would not have actuated in time to prevent air introduction by the operating CA MD pump and the air introduction could have then potentially damaged the pump or prevented it from functioning as designed. The subsequent recalibration of the pressure switches precluded this type of event.

This scenario was discovered during the performance of the DBD for instrument setpoint calibration. To date 45 DBD reviews have been performed by Engineering personnel. No other instrument setpoint problems have been found.

4.4 **Safety Evaluation:**

The postulated scenario involved an earthquake coincident with events requiring CA system flow to aid in plant cooldown. The events requiring the CA system flow to aid in long term core cooling include, but are not limited to, loss of non-emergency AC power, loss of normal feedwater, feedwater line break, and small break loss of coolant accident (SBLOCA). An earthquake would potentially result in damage to the non-seismically qualified main feedwater and normal condensate sources rendering them unavailable as a CA water supply. With normal condensate sources lost, automatic swapover to the assured water source should take place when the suction pressure of the CA pumps falls below 2 psig. It is postulated for the scenario in which only one motor driven pump is operable, the CA suction flow would be too low to accomplish the swapover to RN without the introduction of air to the pump. It is assumed these pumps

would fail if subjected to this air. There would not be sufficient flow to the SGs to remove decay heat. Without the necessary heat sink available, procedure EP/1,2/A/5000/13.1, Response To Loss Of Secondary Heat Sink, would direct the operators to establish feed and bleed cooling in the Reactor Coolant (NC) system using the Pressurizer Power Operated Relief Valves (PORVs) as a relief path. The feed and bleed process would supply cooling water to the reactor core to prevent fuel damage due to uncovering of the core. The cooling water would also supply a heat sink to remove heat from the core. This would allow Operations personnel time to take action to return the CA or CF pumps to service.

The sequences of the postulated scenario result in a total loss of the CA function, however this does not lead to core damage unless additional failures occur which would fail the operator ability to perform feed and bleed cooling. The probability of these additional events occurring is approximately 1E-2 per demand. Therefore, the likelihood that the problem identified with the CA System would lead to core damage is approximately 4E-9 per year. The McGuire Probabilistic Risk Assessment (PRA) study had estimated that the normal core damage frequency for McGuire is 7.4E-5 per year. The additional sequence caused by the postulated CA scenario is so low that it would not be reported in the PRA report.

This incident is not Nuclear Plant Reliability Data Systems (NPRDS) reportable.

There were no personnel injuries, radiation overexposures, or uncontrolled releases of radioactivity to the environment as a result of this incident.

5. Corrective Actions:

Immediate: None

Subsequent:

1. The setpoints of the affected pressure switches were increased.

2. The seismically unqualified portion of the CA Suction Piping was evaluated by SEWM.

Committed: Engineering personnel will continue to gather information on the SEWN portion of the CA suction piping in order to formulate corrective actions to resolve this problem.

ENCLOSURE 1

Prepared By: J.M. Washam Date: December 10, 1992

Reviewed By: J.M. Washam Date: December 10, 1993

Date: December 10, 1993

Date: December 10, 1993

Date: December 10, 1993

Date:

Date:

Date:

Approved By: Gary T. Small for T.F. Pedersen Date: December 10, 1993
Manager, Safety Review

Distribution:

T.C. McMeekin
J.W. Boyle
B.H. Hamilton
R.B. White
NRC Representative
CSRG
OSRG
K.L. Crane
G.D. Gilbert
P.R. Herran
B.F. Caldwell
J.N. Pope
J.W. Foster (as necessary)
R.P. Michael (as necessary)
Group File: MC-834.02

ENCLOSURES:

1) Safety Review Signature Sheet
2) References
3) Corrective Action Schedule

ENCLOSURE 2

REFERENCES

1. McGuire Nuclear Station Technical Specification 3.7.1.2

2. Nuclear Generation Department Design Calculation MCC-1223.42-00-0030, Current CA Operability.

3. Nuclear Generation Department Design Calculation MCC-1223.42-00-0031, Past CA Operability.

ENCLOSURE 3

CORRECTIVE ACTION SCHEDULE

Corrective Action	Person(s) Contacted	Person(s) Assigned To	Due Date
	J.R. Pring	T.D. Curtis	June 1, 1993

Duke Power Company
McGuire Nuclear Generation Department
12700 Hagers Ferry Road (MG01A)
Huntersville, NC 28078-8985

T. C. McMEEKIN
Vice President
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(704)875-4809 FAX

DUKE POWER

December 15, 1992

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Atlanta, GA 30339

Mr. Tim Reed
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Mr. P.K. Van Doorn
NRC Resident Inspector
McGuire Nuclear Station

bxc: T.S. Barr
B.L. Walsh
R.C. Futrell (CNS)
R.L. Gill
R.E. Hall
P.R. Herran
R.G. Hull
R.C. Norcutt
M.E. Patrick (ONS)
G.H. Savage
R.O. Sharpe
G.B. Swindlehurst
H.B. Tucker
R.L. Weber
W.M. Sample
D.B. Cook
NSRB Support Staff (EC 12-A)

McGUIRE SAFETY REVIEW GROUP

INPLANT REVIEW REPORT

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3. SUBJECT DESCRIPTION:

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4. EVALUATION AND COMMENT:

On October 27, 1992, PIR O-M92-0406 was issued by the McGuire Safety Review Group to address a postulated scenario that could introduce air into the Auxiliary Feedwater (CA) suction piping. The concern was identified by the McGuire Engineering Group during the review of calculations performed to verify Auxiliary Feedwater swapover pressure switch setpoints. The calculations were part of the Design Basis Document (DBD) analysis review. During this review, questions were raised concerning the operability of the CA Pumps following a seismic event that resulted in a break in the normal CA pump suction line at the service/auxiliary building wall prior to pump start. A piping break at this location would permit the draining of condensate (CM), which provides normal suction to the CA pumps. The resulting drain down would occur before the Nuclear Service Water (RN) Swapover Pressure Switches, which activate the assured makeup supply, could detect the drop in the pump suction pressure. Upon CA pump startup, the air introduced into the pump supply header as a result of water drainage, would be forced into the pump inlet ahead of assured CA suction source (RN) water, resulting in potential pump damage/inadequate pump performance.

4.1 Background:

The CA system is a nuclear safety related system which is designed to provide a means of dissipating heat from the Reactor Coolant (NC) system if the CM system and Main Feedwater (CF) system are not available. The CA system is also used during normal startup and shutdown. The CA system is provided with two motor driven (MD) pumps and one turbine driven (TD) pump. In addition to the three primary sources which supply the CA system suction, the RN system provides the nuclear safety related assured CA system suction source.

CA pump suction diversity is provided by using several water sources and adequate valving for source change. The CA pumps are normally supplied from a common header which can be aligned to the upper surge tank, the CA condensate storage tank, or the condenser hotwell. In accordance with the requirements set forth in Regulatory Guide 1.70 and NUREG-0611, safety grade instrumentation is provided to detect loss of normal pump suction sources and swapover to the assured RN supply. This swapover logic and instrumentation is required to ensure that long term safety grade supply of water is available to mitigate the consequences of a design basis event.

When the CA pump suction pressure drops below 2 psig for three seconds, RN will automatically align to the CA suction header. A low suction pressure on the associated pump will cause the following valves to open:

CA PUMP	PRESSURE SWITCH	ISOLATION VALVE
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	CAPS 5350	RN-69A
MDP B	CAPS 5360	CA-18B
	CAPS 5012	RN-162B

TDP	CAPS 5042	CA-86A
	CAPS 5370	RN-69A
	CAPS 5390	CA-116B
	CAPS 5381	RN-162B
	CAPS 5044	CA-161C
	CAPS 5380	CA-162C

The RN system consists of Trains A and B which are normally aligned to Lake Norman. The RN system assured suction source to the CA system is available to each of the 3 CA system pumps by independent flow paths. Three independent flow paths are also available to the Turbine Driven Auxiliary Feedwater (TDCA) pump. Each flow path is isolated by 2 valves in series. The normal supply valves are motor operated and can be controlled either in the Control Room or at local panels. One of the assured CA system suction sources for the TDCA pump is controlled at the Standby Shutdown Facility (SSF).

Technical Specification (TS) 3.7.1.2 requires that at least 3 independent CA pumps and associated flow paths be operable in Modes 1 (Power Operation), 2 (Startup), and 3 (Hot Standby). The TDCA pump is required to be operable in Modes 1, 2, and, 3 with secondary steam pressure >/= 900 pounds. With 1 CA pump inoperable, restore the inoperable pump to operable status within 72 hours or place the unit in at least Hot Standby within the next 6 hours and in Mode 4 (Hot Shutdown) within the following 6 hours.

4.2 **Description of Incident:**

McGuire Engineering Services personnel had completed the Design Basis Document for the CA system on or about October 1, 1992. During performance of Design Study 50, Verification of Instrument Setpoints, Engineer A questioned the operability status of the CA pumps following a seismic event and prior to the starting of the pumps. The CA normal

suction header is seismically qualified up to the junction of the service/auxiliary building wall (AA line). In the postulated scenario, a seismic event ruptures the CA pump suction piping prior to CA pump actuation, and automatic suction supply swapover to RN. If the CA pumps had not yet started, no pipe suction would exist to prevent the normal supply water from draining out of the line break. When the CA pumps then started, after detection of pump suction pressure < 2 psig for 3 seconds by the RN Swapover Pressure Switches, the waterleg remaining in the suction header would be insufficient to prevent the introduction of air into the pumps ahead of the assured suction source. Additionally, the pre-existing 2 psig setpoint that initiates the swapover to the assured source, after inclusion of the maximum post accident instrument inaccuracy and piping configuration, may not be adequate to assure activation of the swapover valves prior to the introduction of air into the pumps, if the normal suction sources are depleted. The introduction of air into the pumps could result in possible pump cavitation and the destruction/inadequate operation of the pumps.

Due to the time considerations involving calculations and modeling, Engineering personnel elected to increase the setpoint of the CA feedwater pump pressure switches by one psig and to evaluate the CA suction piping to elevation 736 feet by Seismic Experience Walkdown Methods (SEWM). The new setpoint ensured that the static head alone would activate the swapover to RN, thus eliminating the potential of air reaching the pumps in a low flow condition. The SEWM evaluated pipe provided the needed volume, and eliminated the potential of air reaching the pumps in a high flow condition.

This action was taken as a proactive measure to ensure current operability. The following setpoint recalibrations were performed:

UNIT 1

Work Order Number	Equipment Number
92081307	1MCAPS-5002
	1MCAPS-5350
92081377	1MCAPS-5042
	1MCAPS-5370
	1MCAPS-5390
	1MCAPS-5381
92081370	1MCAPS-5360
	1MCAPS-5012

UNIT 2

Work Order Number	Equipment Number
92081358	2MCAPS-5002
	2MCAPS-5350
92081366	2MCAPS-5360
	2MCAPS-5012
92081400	2MCAPS-5042
	2MCAPS-5370
	2MCAPS-5390
	2MCAPS-5381

The pressure switches were recalibrated from the current 2 psig to 3 psig, with the exception of 2CAPS-5002 and 2CAPS-5350 which were recalibrated from 3 psig to 4 psig due to a difference in elevation.

During this recalibration, pressure switches 1/2 CAPS-5002, 5012, 5042, 5044, 5350, 5360, 5370, 5380, 5381, and 5390 were found to exhibit potentially excessive inaccuracy/uncertainty in their as found calibration. This situation is addressed in PIR 1-M92-0437 which was generated on October 30, 1992. Component Engineering personnel are currently investigating this condition.

On October 29, 1992, Engineering Services personnel determined that the higher switch setpoint ensured current CA system operability based on calculation MCC-1223.42-00-0030, Rev. 1.

On November 24, 1992, Engineering Services personnel determined that the CA system had been past inoperable from initial startup until October 29, 1992, based on calculation MCC-1223.42-00-0031.

4.3 **Conclusion:**

This incident is assigned a root cause of Functional Design Deficiency, because the margin of instrument inaccuracy of the pressure switches which detect a drop in pump suction pressure was too large to ensure assured pump suction source actuation as designed. The margin of error in this case is equal to +/- 1.31 psi. This resulted in the possibility of the pump suction pressure decreasing to 0.69 psi before automatic RN swapover.

The CA system was determined to be past inoperable based on the previous CA suction pressure switch setpoint of 2 psig. The following combination of events, in the initial portion of an accident sequence, was determined to cause potential loss of function to the CA system:

1. Loss of CA caused by a seismic event, which causes:
   a. A pipe break which results in loss of the

normal CA suction source, but does not cause a loss of offsite power (i.e. no turbine driven pump auto start).

2. A single failure of a CA motor driven pump

In this particular combination of events, the flow rate in the CA suction path could have been such that the pressure switches would not have actuated in time to prevent air introduction by the operating CA MD pump and the air introduction could have then potentially damaged the pump or prevented it from functioning as designed. The subsequent recalibration of the pressure switches precluded this type of event.

This scenario was discovered during the performance of the DBD for instrument setpoint calibration. To date 45 DBD reviews have been performed by Engineering personnel. No other instrument setpoint problems have been found.

4.4 **Safety Evaluation:**

The postulated scenario involved an earthquake coincident with events requiring CA system flow to aid in plant cooldown. The events requiring the CA system flow to aid in long term core cooling include, but are not limited to, loss of non-emergency AC power, loss of normal feedwater, feedwater line break, and small break loss of coolant accident (SBLOCA). An earthquake would potentially result in damage to the non-seismically qualified main feedwater and normal condensate sources rendering them unavailable as a CA water supply. With normal condensate sources lost, automatic swapover to the assured water source should take place when the suction pressure of the CA pumps falls below 2 psig. It is postulated for the scenario in which only one motor driven pump is operable, the CA suction flow would be too low to accomplish the swapover to RN without the introduction of air to the pump. It is assumed these pumps

would fail if subjected to this air. There would not be sufficient flow to the SGs to remove decay heat. Without the necessary heat sink available, procedure EP/1,2/A/5000/13.1, Response To Loss Of Secondary Heat Sink, would direct the operators to establish feed and bleed cooling in the Reactor Coolant (NC) system using the Pressurizer Power Operated Relief Valves (PORVs) as a relief path. The feed and bleed process would supply cooling water to the reactor core to prevent fuel damage due to uncovering of the core. The cooling water would also supply a heat sink to remove heat from the core. This would allow Operations personnel time to take action to return the CA or CF pumps to service.

The sequences of the postulated scenario result in a total loss of the CA function, however this does not lead to core damage unless additional failures occur which would fail the operator ability to perform feed and bleed cooling. The probability of these additional events occurring is approximately 1E-2 per demand. Therefore, the likelihood that the problem identified with the CA System would lead to core damage is approximately 4E-9 per year. The McGuire Probabilistic Risk Assessment (PRA) study had estimated that the normal core damage frequency for McGuire is 7.4E-5 per year. The additional sequence caused by the postulated CA scenario is so low that it would not be reported in the PRA report.

This incident is not Nuclear Plant Reliability Data Systems (NPRDS) reportable.

There were no personnel injuries, radiation overexposures, or uncontrolled releases of radioactivity to the environment as a result of this incident.

5. Corrective Actions:

Immediate: None

Subsequent:

1. The setpoints of the affected pressure switches were increased.

2. The seismically unqualified portion of the CA Suction Piping was evaluated by SEWM.

Committed: Engineering personnel will continue to gather information on the SEWN portion of the CA suction piping in order to formulate corrective actions to resolve this problem.