March 23, 2009

Mr. David A. Christian
Senior Vice President and Chief Nuclear Officer
Dominion Resources
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

SUBJECT: MILLSTONE POWER STATION - UNIT 3 - NRC SPECIAL INSPECTION TEAM REPORT 05000423/2008010

Dear Mr. Christian:

On February 6, 2009, the U.S. Nuclear Regulatory Commission (NRC) completed a special inspection at the Millstone Power Station, Unit 3. The enclosed inspection report documents the inspection results, which were discussed on February 6, 2009, with Mr. A. J. Jordan, Site Vice President, and other members of your staff.

The special inspection was conducted in response to the October 20, 2008, discovery of an air void in the 24-inch diameter pipe connecting the refueling water storage tank to the suction of the emergency core cooling system (ECCS) pumps. The NRC's initial evaluation of this condition satisfied the criteria in NRC Inspection Manual Chapter 0309, “Reactive Inspection Decision Basis for Reactors,” for conducting a special inspection. The basis for initiating this special inspection team is further discussed in the team’s charter that is included as Attachment B to the enclosed report. The inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The team reviewed selected procedures and records, technical evaluations, calculations, and construction documentation, and interviewed site personnel.

This report documents one self-revealing finding of very low safety significance (Green), which was determined to involve a violation of NRC requirements. However, because of the very low safety significance of the violation and because it was entered into your correction action program, the NRC is treating it as a non-cited violation (NCV) consistent with Section VI.A.1 of the NRC Enforcement Policy. If you contest the NCV documented in the enclosed report, you should provide a response within 30 days of the date of the inspection report, with the basis for your denial, to the Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001; with copies to the Regional Administrator Region I; the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, DC 20555-0001; and the NRC Resident Inspectors at Millstone Power Station.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, and its enclosures, and your response (if any) will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Website at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Lawrence T. Doerflein, Chief
Engineering Branch 2
Division of Reactor Safety

Docket No: 50-423
License No: NPF-49

Enclosures: Inspection Report 05000423/2008010
w/Attachment A: Supplemental Information
w/Attachment B: Special Inspection Charter

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, and its enclosures, and your response (if any) will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Website at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

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w/Attachment A: Supplemental Information
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U. S. NUCLEAR REGULATORY COMMISSION
REGION I

Docket No.	50-423
License No.	NPF-49
Report No.	05000423/2008010
Licensee:	Dominion Nuclear Connecticut, Inc.
Facility:	Millstone Power Station, Unit 3
Location:	P. O. Box 128 Waterford, CT 06385
Dates:	December 15, 2008 through February 6, 2009
Inspectors:	W. Schmidt, Senior Reactor Analyst, Division of Reactor Safety (DRS), Team Leader K. Mangan, Senior Reactor Inspector, DRS M. Davis, Resident Inspector, Division of Reactor Projects (DRP) A. Rao, Project Engineer, DRP (in training) W. Lyon, Senior Reactor Systems Engineer, Office of Nuclear Reactor Regulations (NRR) M. Holmberg, Senior Reactor Inspector, DRS, NRC Region III
State Observer:	D. Galloway, Connecticut, Department of Environmental Protection
Approved by:	Lawrence T. Doerflein, Chief Engineering Branch 2 Division of Reactor Safety

Enclosure

SUMMARY OF FINDINGS

IR 05000423/2008010; 12/15/2008 – 02/06/2009; Dominion Nuclear Connecticut, Inc. (Dominion); Millstone Power Station, Unit 3 (MP3); Special Inspection Team Report.

The report covered three on-site inspection visits by a special inspection team consisting of a Senior Reactor Analyst, Senior Reactor Engineer, a Project Engineer, and a Resident Inspector, with support from a Region III Senior Reactor Inspector and staff members of the Office of Nuclear Reactor Regulation. One finding of very low safety significance (Green) was identified. The significance of most findings is indicated by their color (Green, White, Yellow, or Red) using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process" (SDP). Findings for which the SDP does not apply may be Green or be assigned a severity level after NRC management review. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 4, dated December 2006.

A. NRC-Identified and Self-Revealing Findings

Cornerstone: Mitigating Systems

- Green. The team identified a noncited violation (NCV) of Technical Specification (TS) 3.5.2.d which requires an operable residual heat removal (RHR) pump for each train of the emergency core cooling system (ECCS). The team found that Dominion did not maintain the 24-inch outside diameter piping connecting the refueling water storage tank (RWST) to the suction of the ECCS pumps sufficiently full of water to ensure operability of the RHR pumps following a large break loss-of-coolant accident (LLOCA). Additionally, the team determined that TS Surveillance 4.5.2.b requires that every 31 days Dominion verify the ECCS piping full of water but this section of piping was not checked. While performing actions to address NRC Generic Letter 2008-001, Dominion identified the air void and determined the piping did not have sufficient slope to allow venting back to the RWST. The team concluded the air void had the potential to air bind and make the RHR pumps inoperable during a LLOCA event. Following identification of the air void during the 2008 refueling outage, Dominion isolated and drained the piping, installed a vent valve, refilled the piping, and confirmed that the piping was full using an ultrasonic testing (UT) measurement.

  The performance deficiency was a failure to maintain the common ECCS suction piping sufficiently full of water, as required by TS surveillance 4.5.2.b, to ensure RHR pump operability in the event of a LLOCA, as required by TS 3.5.2.d. The finding is more than minor because it is associated with the design control attribute of the Mitigating Cornerstone and affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. In accordance with NRC IMC 0609, Attachment 4, "Phase 1 – Initial Screening and Characterization of Findings," the Phase 1 screening identified that this issue was a design/qualification deficiency which resulted in the loss of the RHR system low pressure injection (LPI) safety function and required a Phase 2 evaluation.

In accordance with IMC 0609, Appendix A, “Determining the Significance of Reactor Inspection Findings for At-Power Situations,” a Region I senior reactor analyst determined that the finding was of very low safety significance (Green) using a modified Phase 2 analysis and the MP3 plant-specific Phase 2 Notebook worksheet for a LLOCA. This assessment resulted in an increase in the core damage frequency on the order of low E-8 per year, which was dominated by the LLOCA frequency of E-5 per year and the probability of high pressure injection (HPI) failure, due to some other unrelated cause. The safety injection, charging and recirculation spray systems were still available to prevent core damage following a LLOCA initiating event, by performing the HPI and high pressure recirculation safety functions.

The finding did not have a crosscutting aspect.

B. Licensee-Identified Violations

None.

REPORT DETAILS

1. INTRODUCTION

1.1 Background

On October 20, 2008, with Millstone Power Station Unit 3 (MP3) in a refueling outage (Operating Mode 5), Dominion Nuclear Connecticut, Inc. (Dominion or the licensee) detected a gas void in the 24-inch outside diameter pipe that connects the refueling water storage tank (RWST) to the suction of emergency core cooling system (ECCS) pumps (residual heat removal (RHR), safety injection (SI) and charging (CHS)[1]). The ultrasonic testing (UT) measurements that identified the gas were being performed to address potential voiding concerns as outlined in NRC Generic Letter (GL) 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems," dated January 11, 2008. In Mode 5 the Technical Specifications (TS) did not require the ECCS suction from the RWST to be operable.

The 24-inch ECCS supply pipe exits the side of the RWST and proceeds underground where it then enters through the wall of the engineered safety feature (ESF) building. In the ESF building the pipe splits to supply the ECCS pumps. The SI system supply is taken off the bottom of the 24-inch pipe, and the 24-inch pipe then proceeds to a 24 to 16-inch reducer. The RHR suction is taken off the 16-inch pipe at a 45 degree angle while the 16-inch pipe continues to a 16 to 8-inch reducer, and the CHS suction is directly off the 8 inch pipe. The gas void was quantified as 15% of the internal diameter of the 24-inch diameter pipe (approximately 3.5-inch at the top of the pipe), or a 9% static void fraction (Φ)[2].

Dominion's examination of this location in the ESF building for the GL 2008-01 piping review was based on their evaluation that there was a potential for a small amount of air at the top of the pipe after reviewing as-welded piping configurations. The measured void depth was substantially larger than the expected depth. Once identified, Dominion prepared a modification to install a vent valve in the 24-inch piping in the ESF building. Dominion drained the line, installed the vent valve, and refilled the line prior to the RWST needing to be operable to support the outage activities. Dominion also confirmed that the piping was full with a UT measurement.

The observed void existed in the 10-foot section of 24-inch pipe within the ESF building (from the wall to the 24 to16-inch reducer). The actual total gas void volume could not be accurately quantified because of the inaccessibility of the underground header between the ESF building and RWST. Construction (as-built) isometric drawings showed that an 85-foot section of the buried 24-inch header was at approximately the same elevation as the exposed piping in the ESF building. For the remainder of the 24-inch header the as-

[1] At MP3, the residual heat removal (RHR) system functions in a low pressure safety injection (LPI) mode, and the safety injection (SI) and charging pumps are considered the high pressure safety injection (HPI) system. The RHR system is not used for containment sump recirculation. Instead, the recirculation spray system (RSS) provides low pressure recirculation (LPR) from the sump and supplies the SI and charging pumps for high pressure recirculation (HPR).

[2] Φ - Void fraction is expressed in percent (%) and calculated as the ratio of the internal cross sectional area of a pipe that is voided to the total internal cross sectional area of the pipe.

built drawings showed the pipe to be sloped upwards towards the RWST or vertical, with the exception of the short horizontal run exiting the RWST. Dominion conservatively assumed that the air void extended at the same elevation, as in the 10-foot section within the ESF building, through the 85 foot of horizontal underground piping section. With the RWST at a lower than normal operating level during the outage, the as-found static Φ of 9% in the 95 feet of 24-inch pipe resulted in a calculated volume of approximately 63 standard cubic feet (scf) of air. This equated to an approximate static Φ of 8% if the RWST was at its normal TS required operating level (higher pressure).

Dominion's preliminary operability review concluded that, assuming a consistent distribution to all ECCS pumps, the pumps would experience a worst case entrained dynamic suction Φ of 7%, given the high flowrate in the 24-inch piping following a large loss-of-coolant accident (LLOCA). They further assumed that this dynamic Φ of 7% would cause air binding and damage the RHR, SI and CHS pumps if a LLOCA occurred. This dynamic Φ of 7% assumed some attenuation of the original static Φ of 8%. For the other assumed small and medium loss-of-coolant accidents (SLOCA, and MLOCA) the licensee determined that the flowrates in the RWST supply piping would be low enough so that a lower entrainment rate of the air would occur. This would result in a low void fraction at the pump suctions and pump operability would not be impacted.

1.2 Preliminary Conditional Risk Assessment

Using NRC Inspection Manual Chapter (IMC) 0309, "Reactive Inspection Decision Basis for Reactors," the NRC staff recommended and NRC management approved the conduct of this special inspection team (SIT) on November 20, 2008. The identified suction gas void was determined to be a significant unplanned degraded condition, due to the past potential common cause operability impact on the RHR, SI and CHS pumps following a LLOCA. Several deterministic criteria were met and the risk assessment, conducted by a Region I Senior Reactor Analyst (SRA), estimated the incremental conditional core damage probability (ICCDP) to be in the low E-6 per year range, which was in the overlap region between normal and a special inspection review of this condition. This risk assessment, which used the MP3 Standardized Plant Analysis Risk (SPAR) model, in a bounding case assumed that, given the frequency of a LLOCA over a year's time, that the gas void would become entrained and cause damage to all the RHR, SI, and CHS pumps. This assumption of RHR, SI, and CHS pump failure would result in core damage in the event of a LLOCA. The SRA discussed this result with the Dominion risk assessment staff who had calculated a similar result with similar assumptions, using their plant specific risk model.

1.3 Special Inspection Scope

As outlined in the SIT charter, provided as Attachment B, the team assessed the impact of the as-found conditions on the accident mitigation functions of the ECCS and reviewed the timeliness and effectiveness of the licensee's corrective actions for this and any prior similar events related to voiding in safety related piping systems.

The SIT used NRC Inspection Procedure 93812, "Special Inspection," as a guide to complete their review which included: procedures, corrective action documents, modifications, work requests, engineering calculations and analyses, initial plant

construction records, the apparent cause evaluation prepared by Dominion and scale model hydraulic testing results. The team also interviewed key plant personnel regarding the discovery and resolution of the condition. A list of site personnel interviewed and documents reviewed are provided in Attachment A to this report.

2. SPECIAL INSPECTION AREAS

2.1 Sequence of Events

a. Inspection Scope

The team developed a complete sequence of events related to Dominion's discovery of the voided piping and their follow-up actions to address the condition. The team also included events that occured prior to the identification of the void, which put the issue in context, relative to the total potential length of time which the condition existed and the potential points at which Dominion could have identified the condition.

b. Condition Identification and Resolution Chronology

1997 Refueling Outage	ECCS supply line from RWST isolated, drained and subsequently refilled due to outage work.
April - June 2004	Air identified in the A RHR piping system, due to outage activities and inadequate fill and venting.
April 2005	Dominion issues Technical Evaluation M3-EV-05-0008; Determination of Allowable ECCS Gas Accumulations in Support of Surveillance 4.5.2.b.1.
January 11, 2008	GL 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems," issued.
January - October 2008	Millstone Engineering staff conducted an intensive review of ECCS piping configurations in response to GL 2008-01, documented in M3-EV-08-00261. Based on the as-built drawing it was recommended that the ECCS supply line from the RWST be UT examined, because of a noted potential small difference in elevation in the piping at the ESF building.
October 12, 2008	MP3 shutdown for Refueling Outage 3R12.
October 20, 2008	Gas void identified in the 24-inch piping, in the ESF building, connecting the RWST to the suction of the ECCS pumps. Condition Report (CR) 115088 initiated.
October 27, 2008	New vent valve installed. Work Order 53102195865 completed.

October 28, 2008	24-inch piping connecting the RWST to the suction of the ECCS refilled and verified by UT examination to be full.
November 13, 2008	Technical issues were discussed in a conference call with Dominion, the NRC Office of Nuclear Reactor Regulation (NRR) staff, and Region I Staff. The consensus view of the NRC staff, based on the licensee's information, was that there was doubt as to past ECCS pump operability during potential LLOCA scenarios.
November 13 - 20, 2008	IMC 0309 review completed and SIT charter approved by NRC management.
November 24, 2008	MP3 restarted following 3R12.
December 8, 2008	Dominion completed Technical Evaluation M3-EV-08-0035 "Evaluation of Gas Void Discovered in the 24-inch RWST ECCS Supply Line" (CR115088).
December 15 - 19, 2008	SIT onsite, debriefed with site management on Friday.
December 19, 2008	Licensee Event Report (LER) 2008-004, Gas Void in ECCS Suction Line, submitted. This LER reported a condition prohibited by Technical Specification (TS) 3.5.2, in that, given the identified gas void, the RHR pumps were not operable to respond to a LLOCA.
January 27 - 29, 2009	SIT onsite, debriefed with site management on Thursday.
February 3 - 6, 2009	SIT onsite, exited with site management on Friday. Outstanding issues included: 1) SIT review of the results from Dominion's planned ¼ scale system flow and Φ testing and 2) SIT review of potential stresses in the 24-inch piping between the ESF building and the RWST, due to the potential that the piping had settled from its as-welded configuration.
February 10 - March 11, 2009	Dominion conducted and reviewed ¼ scale testing to validate the use of RELAP 5 Mod 3.3 to evaluate the transport of the air void. NRC Region III Senior Reactor Inspector observed portions of the testing, on February 11. Dominion provided and the team reviewed information concerning the potential deflection and stress in the 24-inch piping between the ESF building and the RWST. This resolved the outstanding issue from the February 6, 2009 exit meeting concerning the potential stresses in the 24-inch piping between the ESF building and the RWST.

March 11, 2009	The results of the ¼ scale testing and RELAP analysis were discussed in a conference call with Dominion, members of the SIT, and Region I and NRR technical staffs. The consensus view of the NRC staff, based on the scale testing, was that Dominion adequately predicted the distribution of the air void to the ECCS pump suctions. This resolved the outstanding issue from the February 6, 2009 exit meeting concerning the ¼ scale testing.

2.2 Review of Operating Experience

a. Inspection Scope

The team reviewed operating experience concerning air voids in the suction of ECCS pumps. This included MP3 specific issues from the past. The team examined the specific issues associated with Dominion's recent void discoveries to assess any new generic issues of industry interest for prompt communication and dissemination.

b. Findings and Observations

No findings of significance were identified.

In 2005, following other issues with air in ECCS piping, Dominion completed an evaluation to ensure compliance with Technical Specification (TS) Surveillance 4.5.2.b.1, and to clarify what "full of water" means in the TS Basis. This change was implemented to assess the potential areas where gas could accumulate and to allow the use of UTs to determine that piping was "full enough" to support ECCS pump operability. As part of this assessment the 24-inch piping was not evaluated and was assumed to be full.

The team did not identify any new generic issues.

2.3 Review of Root Cause and Extent-of-Condition

a. Inspection Scope

The team examined the licensee's apparent cause evaluation and engineering technical evaluation for the ECCS suction pipe air void and assessed the condition for evidence of inadequate design and/or system operations. The team independently evaluated plant isometric and piping drawings, plant records including as-welded piping configuration, historical photographs from construction, ECCS pre-operational and outage surveillance testing, and engineering technical evaluations. Additionally the team conducted a detailed field inspection of the ECCS piping in the ESF building. The team also reviewed the work order used to install a new vent valve in the 24-inch pipe in the ESF building.

b. Findings and Observations

No findings of significance were identified.

Dominion characterized the root causes as latent design errors because there was no vent valve installed in the 24-inch piping and the 24-inch piping did not have sufficient slope to allow venting back to the RWST. These design errors allowed gas to remain in the piping following system restoration after draining and refilling of the 24-inch piping for maintenance activities. Dominion ruled out settling of either the ESF building or the RWST as a cause. They also stated that settling of the 24-inch pipe between the ESF building and the RWST was unlikely because this area was refilled with QA Cat1 backfill.

The team agreed with Dominion's assessment of the latent design errors. However, based on review of construction photographs and welding information, the team believed that the nearly 3.5-inch deep void indicated that a portion of the 24-inch piping between the ESF building and the RWST was lower than indicated by the as-welded isometric drawing. This piping was installed when the area between the ESF building and the RSWT foundation was excavated, the pipe welds were completed and as-built drawings recorded the centerline elevation of sections of the pipe run to be 15-feet 5 1/8-inches above sea level, for the 85-foot horizontal portion of the pipe. The team noted that the piping up to the RWST was installed and backfilled prior to construction of the RWST. There are no permanent pipe supports installed or documentation of temporary supports for the pipe during backfill. Additionally, pipe elevation was not verified during backfill of the excavated area.

At the team's request, Dominion provided information on calculated pipe deflection and stress due to the weight of the piping assuming the 24-inch pipe was only supported at the ESF building wall and at the RWST foundation. This calculation indicated that a maximum deflection of approximately 3.5-inches would occur at the upstream end of the 85-foot section of the originally assumed horizontal piping.

The extent-of-condition for this issue was enveloped by the GL 2008-01 review conducted for other similar configurations of suctions from the RWST though buried pipe. This included the quench spray system, where the licensee determined, and the inspectors verified, that given the flowrates involved in the normal monthly test and the size of the piping any air in the suction piping would be be removed during the test.

The team found that the modification to install the vent valve in the ECCS suction piping was conducted properly, after the piping was isolated and drained. The use of the vent valve during refilling and subsequent UT demonstrated that this corrective action had been successful. The team also found this corrective action acceptable even if a portion of the 24-inch piping between the ESF building and the RWST had sagged and was lower than as indicated by the as-welded isometric drawing.

2.4 Independent Review of Engineering Calculations and Operability Determination

a. Inspection Scope

The team reviewed the detailed engineering evaluations and calculations used to assess the transport of the void to the suction of the ECCS pumps, completed subsequent to the

initial operability determination, discussed in section 1.0. The detailed Φ calculations were completed using RELAP 5 Mod 3.3. Additionally, the team reviewed Dominion's scale model testing of a piping configuration similar to that of the plant, to validate the results of the RELAP calculations. The team conducted independent calculations to validate the flowrates used during the ¼ scale testing and a Region III senior inspector observed portions of the testing.

The team also reviewed the information provided by Dominion concerning the possible deflection and associated stresses on the 24-inch piping between the ESF building and the RWST.

b. Findings and Observations

No findings of significance were identified.

Dominion conducted a detailed technical evaluation to determine the dynamic Φ at the suction of the ECCS pumps for different sizes of LOCAs using the RELAP 5, Mod 3.3 thermo-hydraulic code to model the piping and the void transport to the suction of the ECCS pumps for large, medium and small LOCA (LLOCA, MLOCA, and SLOCA). To validate the RELAP results Dominion contracted the conduct of ¼ scale model fluid flow testing. The team reviewed the Dominion analysis and scale model testing, determining the following:

- Use of the 63 scf void was conservative. The team noted that assuming that the entire 24-inch pipe that was designed to be horizontal had the static Φ of 8% was conservative, because of the team's assessment that the piping was not horizontal and likely at some point lower by at least 3.5-inch. This would tend to make the size of the air void in the pipe approximately half what was assumed in the analysis. This would result in less potential for the RHR pump to be damage following a LLOCA. However, without any specific information concerning the actual configuration of the buried portion of piping this assumption was not included in the team's analysis.

- The RELAP input data adequately modeled the in-plant piping configurations, which included the assumption of the initial size of the air void and an appropriate pumps start transient.

- Based on the relatively low flowrates in the 24-inch piping, during normal RHR, SI, and CHS system in-service testing and outage integrated testing, the team validated that the air void would not have passed to the suction of the pumps during normal operations and maintenance testing.

- The team agreed that the air void was likely in the piping since the 1997 RFO, when the line was isolated, drained, and refilled.

- The estimated dynamic Φ near the suctions for both RHR pumps following system actuation in response to a LLOCA exceeded the 5% limit provided by the pump manufacturer and was greater than the current NRC proposed acceptance criteria for centrifugal pump of less than or equal to 2% for steady state operation

(greater than 20 seconds) and less than 10% for 5 seconds. For example the 'A' RHR pump was estimated to receive a distributed dynamic suction Φ above 5% for 10 seconds with an average of 9% and a maximum of 13%. This included a 13 second period where the dynamic Φ was above 2%, with an average of 8% and above 10% for 5 seconds with an average of 11%.

- The SI pumps would experience essential no void transfer to the suction of the pumps for any LOCA situation, due to the location of the suction piping tie-in point at the bottom of the 24-inch pipe.

- The CHS pumps would receive suction Φ of less than 2% steady state for SLOCAs and MLOCAs, and for LLOCAs where the RCS depressurizes quickly.

- Dominion also analyzed several, specific LLOCA situations where the RHR pumps would be injecting with the reactor coolant system pressure just below their shutoff head of approximately 200 psig, along with SI and charging pumps, to determine if there were any situation where more than just the RHR pumps could have been affected. In these cases, Dominion found, and the team agreed, that the suction Φ void fraction to the RHR pumps would be less than a steady state 2% and that the void fraction to the CHS pumps could increase, but would not likely damage these multi-stage pumps. Additionally, the team concluded that if the CHS pumps were damaged due to air voiding the RHR pumps would not be damaged, so there could not be a potential impact on both high head and low head injection sources.

- The scaled testing setup, including the established flowrates, represented the Froude number calculated for the in-plant piping and system flow conditions.

- The RELAP calculations and the ¼ scale model testing validated Dominion's position that only the RHR pumps operating in response to a LLOCA would be impacted by the air void.

- The technical evaluation also covered and properly analyzed that there would have been no impact on HPR, if the A RHR pump became damaged and the air volume was distributed in the common section of recirculation spray system (RSS) and RHR pumping used for both LPI and HPR. The B RHR pump was not of concern because the common section of piping would not have trapped the air void.

With respect to the potential that the buried section of 24-inch piping had deflected (see Section 2.3 above) following welding but before backfill of the excavated area the team found:

- The lack of observed settling in the area above the piping indicated that the piping has not continued to deflect significantly since the area was backfilled during construction.

- Based on the additional information provided by the licensee, including seismic loads, the two connection points (at the ESF wall and the RWST) would not be

stressed above ASME allowable values and the original piping seismic analysis would remain valid given the assumed deflection.

2.5 Final Risk Assessment of the Condition

The team assessed the final risk of the air void in the ECCS supply piping from the RWST finding that the only likely impact on the ECCS pumps would be on RHR pump operations following a LLOCA. The final ICCDP for this condition over a year of exposure was on the order of low E-8 based on the Phase 2 SDP assessment documented below in Section 2.6. This was a significant reduction, in the range of two orders of magnitude, from the initially assumed risk of the condition. This was because the air void was determined not to have impacted the SI and CHS pumps, as was originally assumed. Functionality of the SI and CHS pumps allowed crediting the HPI safety function and, in conjunction with RSS, the HPR safety function to prevent core damage in the event of a LLOCA.

2.6 Review of Technical Specification Compliance - Gas Void Discovered in the ECCS Suction Line - (Closed) LER 05000423/2008004-00

a. Inspection Scope

The team reviewed Dominion's compliance with applicable TS and the licensee event report submitted subsequent to the discovery of the air void in the ECCS suction piping, which reported a condition prohibited by TS, in that, given the identified gas void, the RHR pumps were not operable to respond to a LLOCA.

b. Findings and Observations

Introduction: The team identified a Green, self-revealing, non-cited violation (NCV) of TS 3.5.2.d which requires an operable (RHR) pump for each train of the ECCS. The team found that Dominion did not maintain the 24-inch piping connecting the RWST to the suction of the ECCS pumps sufficiently full of water to ensure operability of the RHR pumps following a LLOCA.

Discussion: The team reviewed Dominion's assessment of the operability of ECCS suction piping and associated ECCS pumps following the identification of the 3.5-inch gas void in the 24-inch piping that connects the RWST to the suction headers of the ECCS pumps. The team observed that Dominion assumed a conservatively high 63 scf void for their analysis and used the RELAP 5, Mod 3.3 thermo-hydraulic code to model the piping and the void transport to the suction of the ECCS pumps for LLOCA, MLOCA, and SLOCAs. The resulting estimated dynamic Φ near the suctions for both RHR pumps following system actuation in response to a LLOCA exceeded the 5% limit provided by the pump manufacturer and the NRC staff criteria (ML083250536) of 10% for 5 seconds limit. Additionally, Dominion evaluated that the SI and CHS pumps would not have been impacted for any LOCA scenarios nor would the RHR pumps be impacted for SLOCAs or MLOCAs. The team reviewed Dominion's analysis and agreed with the assessment. Given the presence of the air void, absent any specific pump testing to prove operability, the team determined that the RHR pumps were inoperable for response to a LLOCA, with respect to the pump manufacturer and NRC suction Φ limits.

The team also reviewed procedures SP 3610A(B)-3, RHR System Venting and Valve Lineup – Train A(B) performed to meet the intent of TS surveillance 4.5.2.b. This TS surveillance requires that Dominion verify every 31 days that the ECCS piping is verified full of water. The team concluded that this procedure was inadequate because Dominion had assumed that the as-built drawings were correct and, therefore, did not verify portions of piping that they believed self-vented back to the RWST were full of water. Because of this assumption the portion of piping where the air was found had not been checked by the procedure.

Finally, the team found the corrective actions to install and use a vent valve in the 24-inch piping located in the ESF building and to conduct confirmatory UT verification that the piping is full, were acceptable to prevent recurrence.

Analysis: The performance deficiency was a failure to maintain the common ECCS suction piping sufficiently full of water, as required by TS surveillance 4.5.2.b, to ensure RHR pump operability in the event of a LLOCA, as required by TS 3.5.2.d. The finding was more than minor because it was similar to NRC IMC 0612, Appendix E, “Examples of Minor Issues,” Example 2e. Specifically, vendor limits for allowable RHR pump suction flow air void fraction of 5% would have been exceeded, in the event of a LLOCA accident, which would have adversely impact the pump’s safety function. The finding is associated with the design control attribute of the Mitigating Cornerstone and affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. Traditional enforcement does not apply because the issue did not have any actual safety consequences or potential for impacting the NRC’s regulatory function, and was not the result of any willful violation of NRC requirements. In accordance with NRC IMC 0609, Attachment 4, "Phase 1 – Initial Screening and Characterization of Findings," the Phase 1 screening identified that this issue was a design/qualification deficiency which resulted in the loss of the RHR system LPI safety function and required a Phase 2 evaluation.

In accordance with IMC 0609, Appendix A, “Determining the Significance of Reactor Inspection Findings for At-Power Situations,” a Region I SRA determined that the finding was of very low safety significance (Green) using a modified Phase 2 analysis and the MP3 plant-specific Phase 2 Notebook worksheet for a LLOCA. The modified Phase 2 assessment was needed to account for the assumed complete loss of the low pressure injection (LPI) safety function of RHR. The following assumptions were made during the evaluation: 1) the LPI safety function of RHR would fail due to air ingestion following a LLOCA; 2) the exposure period was one year (>30 days). This assessment resulted in an increase in the core damage frequency on the order of low E-8 per year, which was dominated by the LLOCA frequency of E-5 per year and the probability of HPI failure, due to some other unrelated cause. The SI, CHS, and RSS systems were still available to prevent core damage following a LLOCA initiating event, by performing the HPI and HPR safety functions.

The finding did not have a crosscutting aspect, because it represented a latent design issue and there was not a reasonable opportunity to identify the issue within the recent performance guideline period.

Enforcement: TS 3.5.2.d requires one operable RHR pump for each train of ECCS. Contrary to the above, on October 20, 2008, Dominion identified that an air void existed in the suction piping of the RHR pump which caused both trains of RHR pumps to be inoperable. Dominion concluded, and the team agreed, that the air was in the pipe for several years. Dominion corrected the latent design error by installing a vent valve and refilling the piping on October 28, 2008. Because this violation is of very low safety significance and has been entered into the licensee's corrective action program (CR 115088), this violation is being treated as a non-cited violation, consistent with Section VI.A.1 of the NRC Enforcement Policy: **(NCV 05000423/2008010-01, RHR pumps inoperable in the event of a LLOCA, due to a suction air void)**

4. OTHER ACTIVITIES

4OA2 Identification and Resolution of Problems (IP 71152)

a. Inspection Scope

The team reviewed problems that Dominion had identified and entered into their corrective action program associated with this issue. The team reviewed these issues to verify an appropriate threshold for identifying issues and to evaluate the effectiveness of corrective actions. In addition, CRs written on issues identified during the inspection were reviewed to verify adequate problem identification and incorporation of the problem into the corrective action system. The specific corrective action documents that were sampled and reviewed by the team are listed in the attachment.

b. Findings

No findings of significance were identified.

4OA3 Event Followup

(Closed) LER 05000423/2008-004-00, Gas void in ECCS Suction Piping. The team reviewed the LER associated with this event submitted on December 19, 2008 and did not identify any additional issues other than the NCV discussed in section 2.6 of this report. This LER is closed.

4OA6 Meetings, Including Exit

On December 19, 2008, and January 29, 2009, the team conducted a debrief meeting with Mr. A. J. Jordan and other members of his staff to discuss the status of the team's inspection activities, to date. On February 6, 2009, the team presented the inspection results to Mr. A. J. Jordan and other members of his staff. Proprietary information that was reviewed during the inspection, as noted in Attachment A to this report, was returned to Dominion or destroyed.

ATTACHMENT A

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee Personnel:

J. Jordan	Site Vice President
G. Closius	Licensing Engineer
A. Ghanakhanian	Safety Analyst
M. Van Haltern	Mechanical Engineering
R. DeConto	Mechanical Engineering

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened/Closed

05000423/2008010-01	NCV	RHR pumps inoperable in the event of a LLOCA, due to a suction air void.

Closed

05000423/2008-004-00	LER	Gas void in ECCS suction piping

LIST OF DOCUMENTS REVIEWED

The inspectors reviewed the following documents and records:

Procedures

OP 3310A, Residual Heat Removal System, Rev. 16
SP 3610A.1, 3RHS*P1A Operational Readiness Test in MODE 5, 6, or 0, Rev. 4
SP 3610A.3, Residual Heat Removal Pump 3RHS*P1A Operational Readiness Test, Rev. 11
MP-UT-5, Ultrasonic Examination Proc. for Ultrasonic Straight Beam Measurements, Rev. 0
C-967, Spec. for Placement of Structural and Random Fill, Stone and Webster, March 1977, Rev. 3

Condition Reports (CRs)

CR-04-10129	CR 118381
CR-04-09306	CR 319295
CR-04-06166	CR 118935
CR 115088	ACE014062

Drawings

12179-EM-112A, Low Pressure Safety Injection, Rev. 47
12179-EM-112C, Low Pressure Safety Injection/ Containment Recirculation, Rev. 38

12179-EM-113A, High Pressure Safety Injection/ Containment Recirculation, Rev. 30
12179-EM-113B, High Pressure Safety Injection, Rev. 36
12179-EP-119A, D, F, G, Sleeve & Thimble Location ESF Bldg., Rev. 6
12179-EP-111G Sht. 7, Yard Piping Plan, Rev. 10
12179-EP-EY-12A-8 and 12b-7, Sht. 1&2, Backfill Plan and Details, Rev 7&8
12179-EP-82D, LP Safety Injection Piping ESF Building, Rev. 12
25212-25026, Sht. 13 & 60, Fabrication Installation Control Drawing, Rev. 10 & 10
25212-26913, Sht. 1, High Pressure Safety Injection, Rev. 27
Composite Piping Isometrics for SIL, SIH, RHS, RSS, RCS, QSS; Numbers: 1, 2, 4, 5, 6, 7, 9, 10, 11, 12, 15 and 16, No Rev.
12179-C.I.-SIL-9T, Sht. 1-4, Fabrication Installation Control Drawing for SIL Suction in ESF, Rev. 9
25212-25026, Sht. 60, Fabrication Installation Control Drawing for ECCS Suction from RWST (Buried Pipe), Rev. 10

Calculations/Technical Evaluation

M3-EV-05-0008, Technical Evaluation for Determination of Allowable ECCS Gas Accumulations in Support of Surveillance, Rev. 2
M3-EV-08-0026, Technical Evaluation for Generic Letter 2008-01 Response, Rev. 0
M3-EV-08-0035, Technical Evaluation for Evaluation of Gas Void Discovered in the 24-inch RWST ECCS Supply Line, Rev. 3
US(B)-294, NPSH Available for ECCS Pumps, Rev. 6.1
N929, RHR 8x20A30 Pump Curve
Root Cause Evaluation for CR-04-06166, Reportability Evaluation for Unit 3 “A” Residual Heat Removal Pump
12179-NP(B)-104 X9, Buried Piping Analysis, Rev. 0
12179-NP(B)-274-FASIH, Waterhammer Due to Rapid Check Valve Closure Following Pump Trip, Rev. 1
12179-NP(F)-X7927, High Pressure Safety Injection ESF Building (ASME Class 2), Rev. 2

Modifications/Work Orders

DM3-000321-08, SIL Vent Valve Relocation (3SIH*V993) and New Vent Valve (3SIL*V817), Rev. 0
WO 53102195865, Install New Vent Valve 3SIL*V817 in Line 3-SIL-024-001-2, Rev. 0

Miscellaneous

SP 3610A-3, RHR System Venting and Valve Lineup – Train A, performed 9/19/08
SP 3608.4, High Pressure Safety Injection Vent Valves – Train A and Common Header, performed 10/3/08
VTM-25212-001-007, Installation, Operation, and Maintenance of the Residual Heat Removal Pumps, Rev. 2
ENG-U3-24-IST-ISTBD, Millstone Unit 3 Pump and Valve Inservice Testing Basis Document, Rev. 3

Technical Papers

TM-1876A, Transport of a Small Air Pocket, Creare, dated February 1998

WCAP-16631-NP, Testing and Evaluation of Gas Transport to the Suction of ECCS Pumps, Volume 1, October 2006
PA-SEE-450, Task 2 Pump Interim Gas Ingestion Tolerance Criteria, Westinghouse PROPRIETARY CLASS 2, dated October 10, 2008

Scale Test Reports

FAI-2009-022, Test Results for Millstone-3 Gas/Water Transport Tests, dated March 2009
FAI-09-044, Post Test Analysis of the FAI Millstone-3 RWST1/4 Scale Gas Entrainment Test, March 2009, PROPRIETARY

LIST OF ACRONYMS

Φ	Void fraction
CAP	Corrective Action Program
Dominion	Dominion Nuclear Connecticut, Inc.
CHS	Charging System
CR	Condition Report
DRP	Division of Reactor Projects
DRS	Division of Reactor Safety
ECCS	Emergency Core Cooling System
ESF	Engineered Safety Feature
GEM	Graphical Evaluation Module
GL	Generic Letter
IMC	Inspection Manuel Chapter
HPI	High pressure Injection Safety Function
HPR	High Pressure Recirculation Safety Function
ICCDP	Incremental Conditional Core Damage Probability
LER	Licensee Event Report
LOCA	Loss-of-coolant Accident
LLOCA	Large Loss-of-coolant Accident
LPI	Low Pressure Injection Safety Function
MLOCA	Medium Loss-of-coolant Accident
MP3	Millstone Power Station, Unit 3
NRC	Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation
OD	Operability Determination
OE	Operating Experience
PARS	Publicly Available Records
RHR	Residual Heat Removal System
RSS	Recirculation Spray System
RWST	Refueling Water Storage Tank
scf	Standard cubic feet
SDP	Significance Determination Process
SI	Safety Injection System
SIT	Special Inspection Team
SLOCA	Small Loss-of-coolant Accident
SPAR	Standardized Plant Analysis Risk
SRA	Senior Reactor Analyst
TS	Technical Specifications
UT	Ultrasonic Testing

ATTACHMENT B

SPECIAL INSPECTION CHARTER

November 28, 2008

MEMORANDUM TO: Lawrence T. Doerflein, Manager
Special Team Inspection

Wayne L. Schmidt, Leader
Special Team Inspection

FROM: David C. Lew, Director **/RA/**
Division of Reactor Projects

Marsha K. Gamberoni, Director **/RA/**
Division of Reactor Safety

SUBJECT: SPECIAL INSPECTION CHARTER TO EVALUATE MILLSTONE POWER STATION UNIT 3 VOIDED CONDITION IN THE EMERGENCY CORE COOLING SYSTEM SUCTION PIPING FROM THE REFUELING WATER STORAGE TANK

In accordance with Inspection Manual Chapter (IMC) 0309, "Reactive Inspection Decision Basis for Reactors," a Special Inspection Team (SIT) is being chartered to evaluate the October 2008 identification of a significant unplanned degraded condition concerning a trapped volume of gas in the suction piping between the refueling water storage tank (RWST) and the Emergency Core Cooling System (ECCS) pumps (residual heat removal, safety injection, and charging pumps). Several deterministic criteria were met and the risk assessment, which assumed that given a large loss-of-coolant accident (LLOCA), all residual heat removal (RHR), safety injection (SI) and charging pumps would be damaged due to the entrained void fraction, estimated an increase in conditional core damage probability (ICCDP) in the low E-6 per year range. The effect on LLOCA response was evaluated because the high ECCS flowrate and the assumed void volume could generate a sufficient entrained void fraction to cause pump damage. The Special Inspection Charter for the inspection team is attached.

The SIT will expand on the inspection activities started by the resident inspectors immediately after this was discovered, and will review Dominion's determination of the cause of voiding including any design deficiencies and/or operating practices that allowed the voiding condition to exist and, to the extent practicable, will independently verify Dominion's calculation of the void condition and its effect on the ECCS pumps operability.

The inspection will be conducted in accordance with the guidance of NRC Inspection Procedure 93812, "Special Inspection," and the inspection report will be issued within 45 days following the final exit meeting for the inspection.

The special inspection will commence on December 15, 2008. The following personnel have been assigned to this effort:

Manager:	Lawrence T. Doerflein, Branch Chief Engineering Branch 2, Division of Reactor Safety (DRS), Region I
Team Leader:	Wayne L. Schmidt, Senior Reactor Analyst, DRS, Region I
Full Time Members:	Kevin Mangan, Senior Reactor Inspector Engineering Branch 2, DRS, Region I
	Marlone Davis, Resident Inspector Calvert Cliffs Nuclear Power Station Division of Reactor Projects, Region I
Part Time Members:	added as needed

Attachment: Special Inspection Charter

ATTACHMENT C

Special Inspection Charter
Millstone Power Station
Voiding in Emergency Core Cooling System Suction Piping

A. Background

On October 20, 2008, with Unit 3 in a refueling outage (Operating Mode 5), Dominion detected an apparent gas void in the common ECCS pump (residual heat removal (RHR), safety injection (SI) and charging pumps[3]) suction piping from the refueling water storage tank (RWST). The ultrasonic (UT) measurements that identified the gas had been performed to address voiding concerns outlined in GL 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems." In Mode 5, technical specifications did not require suction from the RWST to be operable.

The gas void was quantified as 15% of the height of the 24-inch diameter pipe. The void extended the entire 10' length of 24-inch diameter exposed pipe within the ECCS building. The actual total gas void volume could not be quantified because the rest of the pipe is underground. The licensee conservatively assumed that the void extended at the same height through additional 85' of underground pipe. This section does not appear, based on isometric review, to be significantly sloped toward the RWST. Preliminary evaluations by the licensee, assuming the entire 95' pipe run had the 15% void, concluded that a worst case entrained void fraction of approximately 7% could be generated in the event of a LLOCA, because of the high ECCS suction flowrates. They further assumed that this 7% void faction would damage the RHR, SI and charging pumps if a LLOCA occurred.

Following identification, the suction piping was isolated and drained to allow installation of a high-point vent. The piping was subsequently filled and vented. Dominion currently believes the pipe to be full of water.

Technical issues were discussed in a November 13, 2008, conference call with Dominion, the Millstone Residents, NRR staff, and Region 1 Staff. The consensus view of the Region 1 staff, based on the licensee's information regarding past operability, was that there was doubt as to ECCS pump operability during LLOCA scenarios.

In accordance with IMC 0309, the identified suction gas void was determined to be a significant unplanned degraded condition, due to the past potential common cause operability impact on the RHR, SI and charging pumps following a LLOCA. Several deterministic criteria were met and the risk assessment estimated the increase in conditional core damage probability (ICCDP) to be in the low E-6 per year range. The risk assessment assumed that given a LLOCA, all RHR, SI and charging pumps would be damaged due to the entrained void fraction. Using these assumptions if a LLOCA (low E-6/year initiating event frequency) happened there would be core damage. A special inspection was recommended and approved by NRC management on November 20, 2008.

This SIT is chartered to assess the as-found conditions to determine their impact on the accident mitigation functions of the Emergency Core Cooling System. Also, the team will review

[3] At MS3, RHR supplies the low pressure safety injection and SI and charging supply high pressure safety injection.

the timeliness and effectiveness of the licensee's corrective actions for this and any prior similar events related to voiding in safety related piping systems. The team shall also determine if there are generic safety implications associated with voiding of the suction piping beyond those already described in GL 2008-01.

B. Scope

The team is expected to address the following:

1. Develop a complete sequence of events related to the discovery of the voided condition and follow-up actions taken by the licensee;

2. Compare operating experience involving gas voiding of emergency core cooling system suction piping to actions implemented at Millstone. Determine if there are any generic issues related to the design and operation practices that resulted in the voiding of the ECCS suction piping beyond those already described in GL 2008-01. Promptly communicate these issues to NRC regional management;

3. Review the licensee's determination of the cause of voiding including any design deficiencies and/or operating practices that allowed the voiding condition to exist. Independently verify key assumptions and facts in their root cause assessment. Determine if the licensee's root cause analysis and corrective actions have addressed the extent of condition for gas voiding for this and any other safety systems. Assess the licensee's extent of condition reviews for any previous voiding events;

4. Determine if the Technical Specifications were met for the gas voided condition and following the implementation of compensatory measures;

5. Review the calculations the licensee used to evaluate the voided condition. Assess the key factors associated with the total volume of trapped gas, the expected flow rates of the ECCS pumps, the size and orientation of the sump suction pipe, and the impact on pump operability. Consider the potential for void migration and its potential effects on pump operability;

6. Collect data necessary to refine the existing risk analysis. Specifically obtain information associated with the degree to which the ECCS pumps were affected, the ability to recover failed pumps, and the dominant accident sequences.

C. Guidance

Inspection Procedure 93812, "Special Inspection", provides additional guidance to be used by the Special Inspection Team. Your duties will be as described in Inspection Procedure 93812. The inspection should emphasize fact-finding in its review of the circumstances surrounding the event. It is not the responsibility of the team to examine the regulatory process. Safety concerns identified that are not directly related to the event should be reported to the Region I office for appropriate action.

ATTACHMENT C

The Team will report to the site, conduct an entrance meeting, and begin inspection no later than December 15, 2008. The inspection will include a review of the licensee's calculations associated with the transportability of the gas pocket. This may not be completed until after the team's initial visit. While on site, you will provide daily briefings to Region I management, who will coordinate with the Office of Nuclear Reactor Regulation, to ensure that all other parties are kept informed. A report documenting the results of the inspection should be issued within 45 days of the completion of the inspection.

This Charter may be modified should the team develop significant new information that warrants review. Should you have any questions concerning this Charter, contact me at (610) 337-5229.