March 13, 2009

Mr. Peter P. Sena, III
Site Vice President
FirstEnergy Nuclear Operating Company
Beaver Valley Power Station
Mail Stop A-BV-SEB1
P. O. Box 4, Route 168
Shippingport, PA 15077

SUBJECT: BEAVER VALLEY POWER STATION, UNIT 1 - NRC SPECIAL INSPECTION TEAM REPORT 05000334/2008009

Dear Mr. Sena:

On November 12-14, 2008 and January 27-29, 2009, the U.S. Nuclear Regulatory Commission (NRC) conducted the onsite portions of a special inspection at Beaver Valley Power Station, Unit 1. In-office inspection reviews were conducted in the intervening weeks. The enclosed report documents the inspection team's findings and observations which were discussed with Mr. Mark Manoleras and others of your staff on January 29, 2009.

The special inspection was conducted in response to FirstEnergy Nuclear Operating Company's (FENOC) discovery of air voids in the recirculation sump suction piping to the low head safety injection pumps on September 23, 2008. The NRC's initial evaluation of this condition satisfied the criteria in NRC Management Directive 8.3, "NRC Incident Investigation Program," for conducting a special inspection. The basis for initiating this special inspection is further discussed in the inspection team's charter that is included in this report as Attachment B.

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, observed activities, and interviewed personnel. Based on the results of this inspection, one NRC-identified finding of very low safety significance (Green) was identified.

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.: 50-334
License No: DPR-66

Enclosures: Inspection Report 05000334/2008009
w/Attachment A: Supplemental Information
w/Attachment B: Special Inspection Charter
w/Attachment C: Independent Operability Evaluation

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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REGION I

Docket No.	50-334
License No.	DPR-66
Report No.	05000334/2008009
Licensee:	FirstEnergy Nuclear Operating Company (FENOC)
Facility:	Beaver Valley Power Station, Unit 1
Location:	Post Office Box 4 Shippingport, PA 15077
Dates:	November 12-14, 2008 and January 27-29, 2009
Inspectors:	W. Cook, Senior Reactor Analyst, Division of Reactor Safety (DRS) F. Arner, Senior Reactor Inspector, DRS P. Cataldo, Senior Resident Inspector, Division of Reactor Projects W. Lyon, Senior Reactor Systems Engineer, Office of Nuclear Reactor Regulations J. Staudenmeier, Senior Reactor Engineer, Office of Nuclear Regulatory Research
Approved by:	Lawrence T. Doerflein, Chief Engineering Branch 2 Division of Reactor Safety

SUMMARY OF FINDINGS

IR 05000334/2008009; 11/12-14/2008 and 01/27-29/2009; Beaver Valley Power Station, Unit 1; Special Inspection Team Report.

The report covered two on-site inspection visits by a special inspection team consisting of a Senior Reactor Analyst, Senior Reactor Engineer, and a Senior Resident Inspector, with part-time assistance of two headquarters technical reviewers. One finding of very low safety significance (Green) was identified. The significance of most findings is indicated by its color (Green, White, Yellow, or Red) using Inspection Manual Chapter 0609, "Significance Determination Process." Findings for which the significance determination process does not apply may be Green or be assigned a severity level after NRC management review. The NRC 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

- Green: A finding of very low safety significance was identified based upon FENOC not performing adequate extent-of-condition evaluations for voiding events that occurred on-site and for external voiding events evaluated within the corrective action program. This finding is based upon the identification of air voids in September 2008, which were located in accessible portions of both low head safety injection pumps' suction piping utilized during accident conditions for recirculation from the containment sump.

  The finding was determined to be more than minor, because it was associated with the equipment performance attribute of the Mitigating Systems Cornerstone, and affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences. This finding was evaluated for safety significance using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process," Attachment 4, "Phase 1 - Initial Screening and Characterization of Findings," and determined to be of very low safety significance (Green). The finding screened to Green because the as-found condition constitutes a design or qualification deficiency confirmed not to result in a loss of operability or functionality. The team verified that the voids were effectively removed, periodic ultrasonic testing acceptance criteria for these locations were established, and an extensive analysis that supported past operability was performed. The team also reviewed licensee corrective actions to prevent recurrence which involved initiation of a Condition Report and follow-up using a prepared questionnaire and data sheet of any external operating experience involving emergency core cooling system (ECCS) piping voids. (Section 3.2)

B. Licensee-Identified Violations

None.

REPORT DETAILS

1. INTRODUCTION

1.1 Background

In September 2008, FENOC was conducting ultrasonic testing (UT) of emergency core cooling system piping, in response to Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems," dated January 11, 2008, when the responsible staff identified air voids in the Unit 1 containment sump suction piping to the low head safety injection (LHSI) pumps. The air voids were found in the 12-inch diameter stainless steel suction piping to both trains of LHSI on September 23, 2008. The approximate size of the air voids were 4.1 cubic feet in train A and 3.9 cubic feet in train B. In both trains, the air voids displaced approximately one-half of the water volume in the piping, located in a horizontal length of piping upstream of the sump suction containment isolation valves (MOV-1SI-860A and 860B) and downstream of the sump suction inlet. Upon confirmation of the air voids, the control room operators were notified and per procedure NOP-OP-1009, "Immediate and Prompt Operability Determination," an operability determination was initiated by the engineering staff. The initial operability determination concluded that the LHSI pumps would remain operable in the event of a loss-of-coolant accident and subsequent swap-over to containment sump recirculation. The FENOC design engineering staff concluded there was reasonable assurance that the LHSI pumps would remain operable because it was judged that a large percentage of the air void swept into the pump suction would escape upward into the pump suction casing and not be ingested into the pump impellers. Subsequent engineering analysis confirmed the initial operability determination (see Section 3.5 for further details).

1.2 Special Inspection Scope

The NRC conducted this inspection to gain a better understanding of the circumstances involving FENOC's identification of trapped volumes of air between the containment sump and the LHSI pump sump suction containment isolation valves. Between October 4 and 5, FENOC took action to vent and fill the approximate four cubic foot air voids in each sump suction line and eliminated the potential for any adverse impact on LHSI pump operability.

The inspection team used NRC Inspection Procedure 93812, "Special Inspection," as a guide to complete their review. Additional inspection and review activities were outlined in the special inspection team charter, provided as Attachment B. The special inspection team reviewed procedures, corrective action documents, work requests, engineering calculations and analyses, and the root cause evaluation prepared by FENOC. 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.

1.3 Preliminary Conditional Risk Assessment

Using Inspection Manual Chapters (IMC) 0309, "Reactive Inspection Decision Basis for Reactors," IMC 0609, "Significance Determination Process," and the Beaver Valley Unit 1 Standardized Plant Analysis Risk (SPAR) model in conjunction with the Graphical

Evaluation Module (GEM), the Region I Senior Reactor Analyst (SRA) evaluated the increase in conditional core damage probability for the voided sump suction piping and postulated impact on LHSI pump operability. Although the immediate operability determination prepared by FENOC concluded that the LHSI pumps would remain functional, if the air voids were ingested with recirculation sump flow, the NRC staff judged that the presence of the air voids, absent more definitive examination and engineering evaluation, may result in both LHSI pumps being rendered inoperable and non-recoverable.

The SRA made the following assumptions to estimate the increase in conditional core damage probability (CCDP): the condition duration was one full year (maximum exposure time); the containment sump recirculation mode of LHSI pumps fail upon ingestion of the air voids (SPAR model event <LPR-MOV-CF-SI860AB>, common cause failure of sump isolation valve SI-860A/B, set to TRUE); calculation truncation was set at 1E-13; an uncertainty factor of 1 in 10 (10 percent) assigned to the failure of the LHSI pumps due to the void ingestion; and, all other model events were set to nominal values. The results of the GEM evaluation, with the 10 percent LHSI pump failure probability, was an increase in CCDP value in the low 1E-5 range. The dominant core damage sequences involved medium break loss-of-coolant accidents, which are dependent upon the recirculation mode of the LHSI pumps to provide continued core cooling and containment heat removal. Based upon this conservative CCDP value, and having satisfied an IMC 0309 deterministic criterion, this degraded LHSI pump condition fell within the Special Inspection to Augmented Inspection Team overlap range for reactive inspections.

2. EVENT DESCRIPTION

On September 23, 2008, FENOC detected voids in the suction lines for both trains of LHSI at Beaver Valley Unit 1. FENOC's review was being done to complete commitments made in response to Generic Letter (GL) 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems." Approximately four cubic feet of air were detected in each sump suction line by ultrasonic testing (UT) measurement. On September 26, FENOC completed a prompt operability evaluation for this void condition. This operability determination (OD) was reviewed by the resident inspectors and forwarded to the NRC Region I Office on September 30, 2008. NRC regional staff was engaged and had an initial call with the licensee on October 1. Technical questions were developed and asked of FENOC. The questions and other related issues were discussed on a subsequent October 3 conference call. During the call, FENOC acknowledged that they were not able to fully address all of the staff's questions, and initiated action to have the pump vendor conduct a formal analysis of the impact of the voids on LHSI pump operability. The consensus view of the NRC staff was that there was enough uncertainty in FENOC's prompt OD to question the LHSI pumps' ability to operate in the low pressure recirculation mode. After follow-up discussions between FENOC and NRC management on October 3, FENOC vented and vacuum filled both LHSI loops, effectively eliminating the voids and resolving any potential safety and operability concerns.

3. SPECIAL INSPECTION AREAS

3.1 Sequence of Events

a. Inspection Scope

The team developed a complete sequence of events related to FENOC's discovery of the voided piping and their follow-up actions to address the condition.

b. Condition Identification and Resolution Chronology

The team, with FENOC input, developed the following chronology of events associated with the discovery and removal of the air voids in the LHSI pump suction lines:

June – September 2008	Beaver Valley Operations and Engineering staff conduct an intensive review of emergency core cooling system (ECCS) piping configurations in response to GL 2008-01.
September 23, 2008	Non-Destructive Examination staff conducted ultrasonic examinations of the low head safety injection pump suction piping. Condition Report 08-46771 initiated, identifying the two sections of LHSI pump suction piping from the Unit 1 containment sump having potentially entrapped air voids. Shift Manager notified by the engineering staff and the immediate operability assessment concluded the LHSI pumps were still operable.
September 26, 2008	Engineering completed a Prompt Operability Determination (POD) per NOP-OP-1009, "Immediate and Prompt Operability Determination," concluding that the LHSI pumps would remain operable during and following ingestion of the air voids. Engineering provided approved POD to the on-watch Shift Manager.
October 1, 2008	Conference call conducted between FENOC and Region I representatives to discuss the POD, dated 9/26/09.
October 3, 2008	Follow-up conference call between FENOC, Region I, and Office of Nuclear Reactor Regulation (NRR) staffs to discuss details of the operability determination. Discussions between Region I management and Beaver Valley Site Vice President pertaining to the uncertainties associated with LHSI pump operability with the air voids remaining in the recirculation sump suction piping.

October 4-5, 2008	Plant Operations and Engineering personnel conducted a vent and vacuum fill to remove air voids in sump suction piping using available local leak rate connections.
October 6, 2008	FlowServe (pump vendor) documents their evaluation of the impact of air voids on LHSI pump operability.
October 14, 2008	FENOC submitted response to Generic Letter 2008-01.
November 2008	Mancini Consulting Services provided summary of LHSI pump air entrainment analysis to FENOC.
November 12, 2008	Commenced on site Special Inspection Team review at Beaver Valley Power Station.
November 14, 2008	Conducted team debrief with station management
December 2008	MPR Associates, Inc. provided Revision 2 of their Beaver Valley Unit 1 LHSI Pump Past Operability Analysis to FENOC.
January 27-29, 2009	Completed on-site inspection activities and conducted exit meeting.

3.2 Review of Operating Experience

a. Inspection Scope

The team reviewed operating experience involving air voiding of emergency core cooling systems (ECCS) and actions taken by the Beaver Valley Power Station (BVPS) staff to identify and address these types of conditions. The team examined the specific issues associated with FENOC's recent void discoveries to assess any new generic issues of industry interest for prompt communication and dissemination.

b. Findings and Observations

Based upon the team's review, no new generic issues were identified pertaining to BVPS air void discovery. However, the team's review of the BVPS Operating Experience Program implementation did identify one finding, as discussed below.

Introduction. A finding of very low safety significance (Green) was identified based upon FENOC not having performed adequate extent-of-condition evaluations for voiding events that occurred on-site (at Unit 2), and not having identified similar ECCS suction piping voiding vulnerabilities from external events evaluated within the BVPS Corrective Action Program.

Description. The team identified that from August 2002 to September 2008, FENOC did not evaluate ECCS piping utilized during post-accident long-term recirculation for susceptibility to air or gas voids. In particular, accessible portions of the low head safety injection (LHSI) pump suction piping, located between the pumps and the Unit 1

containment sump, were excluded from consideration during numerous Operating Experience Program evaluations performed by station staff. The team reached this conclusion following an extensive review of Corrective Action Program (CAP) documents to ascertain the scope and adequacy of FENOC's review of the generic communications and industry events that involved ECCS piping gas and air voids.

The team identified a number of missed opportunities by FENOC to identify the subject LHSI pump suction piping air void condition. For example, NRC Information Notice 2006-21, "Operating Experience regarding Entrainment of Air into Emergency Core Cooling and Containment Spray Systems," described events that highlight the need for licensees to understand how changes in plant configuration, such as transitioning from the injection phase to the recirculation phase during a design basis loss-of-coolant accident (LOCA), and the performance of proper engineering analyses, relative to "suction supply lines" of ECCS pumps, are critical to identifying latent plant design and operating vulnerabilities.

The team noted that between 2004 and 2006, multiple ECCS pump voiding events occurred at various United States nuclear power plants and these events were communicated to the industry via various Operating Experience (OE) networks. As described in Section 3.3, FENOC utilized these networks and other similar methods to disseminate information regarding internal events to the industry. FENOC review of external operating events, including NRC generic communications, was captured within the BVPS CAP, evaluated for applicability, and if applicable, corrective actions were established and implemented to address identified adverse conditions or trends. One operating event in particular, the Palo Verde Nuclear Station voided containment suction piping condition, was received via an industry information source, entered into the CAP under Condition Report (CR)-05-02979, and determined to be non-applicable, based in part, on actions already performed or considered resolved by the station. The team viewed FENOC's failure to have more thoroughly examined the lessons learned from this Palo Verde OE as another missed opportunity.

In another example, a gas void was identified in ECCS piping at BVPS Unit 2, in August 2002. The team identified that while FENOC addressed a number of issues regarding the identified gas void at Unit 2, the evaluation did not adequately address the extent-of-condition and potential for voiding of ECCS suction piping at Unit 1. In particular, the team determined that while appropriate standards for evaluation of the voids were identified within the CAP (detailed in CR-02-06831 and the associated root cause evaluation), the extent-of-condition evaluation for Unit 1 was inadequate in one important aspect. Specifically, accessible portions of the low head safety injection (LHSI) pump suction piping located between the pump and the containment sump were not evaluated. While FENOC was aware that the piping was utilized during the recirculation phase of a LOCA, the focus of the evaluation was limited to similar sections of piping between the LHSI pump discharge cross-connect piping to the high head safety injection pumps. FENOC was also focused on the issue of piping elevations and high points that would be susceptible to the accumulation of air and gas voids. The team found that FENOC staff only verified the acceptability of existing ultrasonic testing (UT) points for sections of piping that were listed in the void check procedure 3BVT-02.11.01. FENOC did not expand that review. Accordingly, the team considered this event another missed opportunity to have identified the accessible portions of the LHSI system containment sump suction piping. The team noted that FENOC's 2002 evaluation included isometric

drawing reviews to verify that UT points identified in the void check procedure were located at the high points of particular piping sections. FENOC's discovery of the air voids on September 23 was based, in part, upon the identification of piping elevation differences initially identified by review of isometric drawings as part of the actions needed to respond to Generic Letter 2008-001.

The team noted that procedure NOP-LP-2100, "Operating Experience Program," provides guidance on the review, analyses and dissemination of OE at BVPS. The team determined that between August 2002 and September 2008, FENOC did not perform adequate extent-of-condition evaluations for voiding events that occurred on-site. In addition, FENOC did not identify, via external events evaluated within the BVPS Corrective Action Program, the presence of voids in the Unit 1 LHSI system recirculation sump suction piping. The team determined that these missed opportunities, which culminated in the discovery of air voids in accessible portions of the LHSI pumps' suction piping on September 23, 2008, was a performance deficiency.

Evaluation. The team determined that this finding was more than minor, because it was associated with the equipment performance attribute of the Mitigating Systems Cornerstone, and affected the cornerstone objective of ensuring the availability, reliability and capability of systems that respond to initiating events to prevent undesirable consequences. The team determined that there was a reasonable doubt regarding LHSI pump operability with the air voids in the pump suction lines pending engineering analysis, and it resulted in unanticipated unavailability and inoperability for approximately three-and-one-half hours to resolve the identified voids, which were removed approximately 11 days following the initial identification of the air voids. This finding was evaluated for safety significance using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process," Attachment 4, "Phase 1 - Initial Screening and Characterization of Findings," and determined to be of very low safety significance (Green). The finding screened to Green because the as-found condition constitutes a design or qualification deficiency confirmed not to result in a loss of operability or functionality. The team noted that the identified void was effectively removed, ultrasonic testing acceptance criteria for these suction piping sections was established, and an extensive analysis that supported operability was performed. In addition, a prepared follow-up questionnaire was developed to ensure any future industry operating experience involving ECCS piping voids is appropriately examined for applicability to BVPS and properly resolved.

Enforcement. This finding did not involve a violation of regulatory requirements. FENOC has documented this finding and addressed corrective actions to prevent recurrence in BVPS Condition Report CR-08-49518. **(FIN 05000334/2008009-01: Inadequate extent-of-condition and applicability review of Operating Experience involving ECCS pump and piping voids)**

3.3 Review of Root Cause and Extent-of-Condition

a. Inspection Scope

The team examined the licensee's root cause determination for the LHSI system air voids and assessed the condition for evidence of inadequate design and/or system operations. The team independently evaluated plant drawings, procedures, and

associated system modifications, including a detailed field inspection of the piping found to be voided and actions taken by FENOC to remove the air voids. The team also examined the licensee's efforts to assess the extent-of-condition (including Unit 2) and their self-critique of prior opportunities to have identified this condition.

b. Findings and Observations

No findings of significance were identified.

The team reviewed FENOC's assessment of the potential generic implications regarding the voids identified in September 2008, as detailed in CR 08-46771. The team noted that the potential generic implications were adequately assessed, consistent with station guidance contained in NOBP-LP-2011, "FENOC Cause Analysis," Revision 7. The team noted that FENOC had initiated a corrective action to communicate their ECCS void issue and associated consequences to the industry via existing OE networks.

As documented in CR-08-46771, the design and construction of the LHSI recirculation sump suction piping provides a piping configuration that would result in the formation or entrapment of air voids. With the exception of the 12-inch diameter stainless piping exiting the containment wall in the 687-foot elevation valve pit room, the remaining upstream suction piping to the sump is embedded in concrete. In this embedded section of suction piping, a six-inch elevation rise is clearly depicted in the architect-engineering fabrication and welding isometric drawing (No. 11700-6.24-83 Sheet 1-2). Because of the 6-inch upward slope of the 12-inch diameter suction piping, there is no natural vent path back to the containment sump for air to escape. Also, since the issue involves a specific ECCS alignment during a LOCA, it could not manifest itself during routine operations or surveillance testing. As previously discussed, FENOC used a vacuum fill process to remove the air, via the down stream containment isolation valve local leak rate testing connections. No documented explanation could be found by the FENOC staff for this 1971 design configuration/decision. A review of the Unit 2 isometric drawings identified that this piping design vulnerability does not exist. Additional details of FENOC's Unit 2 review and results are documented in their GL 2008-01 response, dated October 14, 2008.

The team concluded that FENOC's historical review and root cause evaluation of this condition was appropriate and thorough.

As required by the Special Inspection Team charter, the team also assessed FENOC's extent-of-condition reviews for previous voiding events and observed that FENOC had numerous Condition Reports (CRs) populated within the station CAP that detailed their assessments of industry operating experience (OE), as well as generic communications from the industry and the NRC. With the exception of the issues discussed in section 3.2, the team observed that the OE program, as detailed in NOP-LP-2100, "Operating Experience Program," was generally effective in evaluating the potential impact of specific events and information regarding gas accumulation and voiding in ECCS pumps and piping. The team noted that, to the extent practicable, there was an appropriate interface between the OE program and the station CAP to identify and resolve issues.

Specifically, the team reviewed FENOC's assessment of industry events that involved gas intrusion of safety-related systems, as detailed in CR 05-02979. This CR utilized

attributes of the OE program and requested an "in-depth and thorough evaluation" for applicability of these types of industry events to BVPS. The team determined that, while the evaluation performed under CR 05-02979 was generally effective, missed opportunities were identified that may have led to an earlier identification of the gas voids that were the subject of this special inspection. For example, the engineering staff reviewed selected systems for possible gas intrusion mechanisms and noted that procedures had been developed to ensure the BVPS staff utilized techniques to control gas accumulation. The engineering staff concluded that procedure revisions were not necessary as a result of these existing gas control measures. However, the team found that 3BVT 02.11.01, "Void Monitoring Test Procedure," contains a list of piping segments for performance of void checks, and does not inspect piping utilized for long-term recirculation following the design basis LOCA at either unit.

3.4 Review of Technical Specification Compliance

a. Inspection Scope

The team reviewed station operator compliance with applicable Technical Specifications upon discovery of the sump suction piping voids and through subsequent air void removal activities.

b. Findings and Observations

No findings of significance were identified. Based upon the team's review of the chronology of events and interviews with plant staff, no discrepancies were noted with respect to control room staff compliance with the Unit 1 Technical Specifications.

3.5 Independent Review of Engineering Calculations and Operability Determination

a. Inspection Scope

The team reviewed FENOC's analyses that support their past operability determination for both LHSI pump trains. The team independently evaluated the available plant data and used insights from the FENOC analyses to develop an independent assessment of LHSI pump impact due to suction piping air voids.

b. Findings and Observations

The team observed that FENOC contacted the pump vendor and two independent engineering consulting firms (contractors) to aid in evaluating the potential impact of the as-found air voids on LHSI pump past operability. One of the contractors performed a complex transient thermal-hydraulic analysis to determine the void transport mechanism to the LHSI pumps. This transient analysis included the modeling of the alignment of the pump suction from the refueling water storage tank (RWST) to the containment sump, including the opening of the sump isolation valve and closing of the RWST isolation valve. This modeling characterizes the transition of water flow from the RWST to the containment sump based on the change in system resistance associated with these different suction paths. This analysis also used time dependent assumptions for worst case sump temperature, along with containment pressure, as inputs in calculating/predicting the affect on the air voids found in the sump suction piping. An

additional analytical program for air transport mechanisms was used to estimate the transport of the air voids to the pump inlet and then through the pump casing into the pump impeller. This program used theoretical and experimental correlations to determine the movement of the air through the piping and pump suction can, accounting for piping geometry, bubble buoyancy, flow velocities, and the associated Froude numbers (i.e., ratio of inertial to gravitational forces).

The team determined that key design inputs used within the contractor's model were generally conservative; in particular, the maximum expected pump flow rate, which has a direct impact on the movement of the air void to the inlet of the pump. The team found that parameters assumed for containment sump temperature and pressure, RWST level, and closing time assumed for the RWST isolation valve were conservative and reasonable. With respect to the assumed flow rate, the team noted that the maximum flow value was conservative, since it accounts for only one LHSI pump in operation vice both pumps. This modeling assumption has the affect of increasing overall system flow rates and the calculated transport of the air void through the pump.

The LHSI pumps at Unit 1 are two-stage, vertically mounted, deep-well, centrifugal pumps. The LHSI pump bowls and impellers are located near the bottom of the pump casing, with the casing inlet approximately six feet above the first stage impeller inlet. The configuration is such that after the flow enters the casing inlet, it is directed downward by turbulence flow (swirl limiter) vanes. From the exit of the swirl limiter, the flow continues downward around the pump discharge column and two impeller bowls to the first stage impeller inlet. The contractor's model calculated that, while a 30% void fraction may enter the pump casing, only a nominal 4% void fraction would travel to the pump impellers. This was based on the vertical configuration and velocity profiles calculated for the pump suction casing flow path. The contractor's model shows that a majority of the air void would travel up through an inner annulus area, between the swirl limiter and the pump discharge column, and not travel down to the pump impeller. This is the predicted consequence of the relative air bubble buoyancy velocities and the associated Froude numbers calculated from downward water velocity profiles. Based on this modeling, the contractor and FENOC concluded that the pumps would have always remained operable during and after the ingestion of the air voids.

The team noted that, while the inputs to the model were determined to be reasonable, the team had concerns relative to the accuracy and uncertainty involved with the determination of the air transport mechanism within the pump suction casing. Specifically, the team was concerned that air transport within the pump may have inaccuracies associated with it based on the unknown configuration of the pocket of air as it progresses through the inlet of the pump, through the swirl limiters, and into the annulus area below. The team noted that bubble transport phenomenon in the vertical direction is, in part, a function of bubble size, which impacts bubble velocity in the upward direction (buoyancy). The contractor's analysis acknowledges that the precise size and distribution of the air void/bubbles ingested through the pump casing are not specifically known, but are predicted based upon engineering judgment. Accordingly, the Froude number criteria used in the analysis for vertical transport of air through the pump will propagate the uncertainty of this prediction through the remainder of the analysis. Notwithstanding, the team noted that FENOC's approach to evaluating the issue was not unreasonable and did provide an evaluation of the thermal hydraulics and assumed air transport through the LHSI pumps. However, because of the potential

uncertainty involved with the determination of the void fraction transport mechanism within the pump casing and the inherent uncertainty of any analytical model, the team performed an independent bounding analysis to evaluate the air void impact on past operability of the LHSI pumps. The team's results were in general agreement with FENOC's past operability determination. A summary of the team's bounding analysis is documented in Attachment C.

No findings of significance were identified.

3.6 Risk Assessment of the As-Found Condition

a. Inspection Scope

Prior to the initiation of the Special Inspection Team, the Region I Senior Reactor Analyst (SRA) performed a conditional core damage probability (CCDP) assessment which conservatively bounded the potential risk significance of the degraded condition, assuming the as-found air voids may render both LHSI pumps inoperable following swap-over to the containment sump recirculation phase. The initial CCDP estimate was performed in accordance with Inspection Manual Chapter (IMC) 0309, "Reactive Inspection Decision Basis for Reactors." The SRA used the Beaver Valley Unit 1 Standardized Plant Analysis Risk (SPAR) model and associated Graphical Evaluation Module (GEM) to evaluate the potential risk significance of this condition. The results of the IMC 0309 assessment are documented in report section 1.3 above.

b. Final Risk Estimate

Following team review and independent verification of the impact of the air voids on LHSI pump operability, the team concluded that the LHSI pumps would have remained operable had the air voids been ingested via initiation of sump recirculation flow. Consistent with IMC 0609 conditional core damage probability assessment methodology, this LHSI system design deficiency did not result in a loss of operability or safety function, and therefore was of very low (less than 1E-6) safety significance. Accordingly, the identified condition (containment sump suction piping air voids) did not result in any appreciable increase in risk to core damage for postulated design basis events.

4. OTHER ACTIVITIES

4OA6 Meetings, Including Exit

On November 14, 2008, the team conducted a debrief meeting with Mr. Peter Sena and other members of his staff to discuss the status of the team's inspection activities, to date. On January 29, 2009, the team presented the inspection results to Mr. Mark Manoleras and other members of the BVPS staff. Proprietary information that was reviewed during the inspection was returned to FENOC.

ATTACHMENT A

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee personnel:

Rich Bologna	Manager, Plant Engineering
Gary Cacciani	Staff Nuclear Engineer
Sam Checketts	Manager, Site Operations
Kim DeBerry	Staff Nuclear Engineer
Bill Etzel	Senior Consultant
Ken Frederick	Senior Consultant
Steve Hovanec	Supervisor, Nuclear Supply System Engineering
Colin Keller	Manager, Regulatory Compliance
Carmen Mancuso	Manager, Design Engineering
Mark Manoleras	Director, Site Engineering
Jim Mauck	Regulatory Compliance Specialist
Dan Mickinac	Advanced Nuclear Specialist
Katie Mitchell	Senior Nuclear Engineer
Dave Price	Supervisor, Nuclear Mechanical Engineering
Mike Ressler	Supervisor, Nuclear Engineering Analysis
Brian Sepelak	Regulatory Compliance Supervisor
Phil Slifkin	Staff Nuclear Engineer
George Storolis	Nuclear Shift Manager

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened/Closed

05000334/2008009-01	FIN	Inadequate extent-of-condition and applicability review of Operating Experience involving ECCS pump and piping voids.

LIST OF DOCUMENTS REVIEWED

In addition to the documents identified in the body of this report, the inspectors reviewed the following documents and records:

Procedures

1OST-11.14A, “LHSI Full Flow Test,” Revision 19
1OM-53A.1.1-G(ISS1C), “Cold Leg Recirculation Actuation,” Revision 1
1OM-53A.1.ES-1.3(ISS1C), “Transfer to Cold Leg Recirculation,” Revision 6
1OM-53A.1.E-1(ISS1C), “Loss of Reactor or Secondary Coolant,” Revision 12

Documents Reviewed

3BVT01.11.04, "Void Monitoring," Revisions 0 and 1
1BVT 1.47.11, "Safety Injection and Charging System Containment Penetration Valve Integrity Test," Revision 18
1OST-1.47.2, “Containment Integrity Verification,” Revision 0
1MSP-9.04-M, “Containment Sump Inspection,” Revision 8
1MSP-13-RS Sump-1M, “Containment Sump Inspection,” Revision 0
1OST-47.2B, “Containment Closeout Inspection,” Revision 8
1BVT 1.13.5, “Inside Recirculation Spray Pump Test,” Revision 19
10M-53A.1.ES-1.3(ISS1C), “Transfer to Cold Leg Recirculation,” Revision 6
NOP-LP-2100, “Operating Experience Program,” Revision 3

Condition Reports (CRs)

02-01901	02-06976	02-06992	04-09637	05-01465	05-03260
05-04024	06-7199	06-9492	07-14796	07-19244	08-49413
08-08185	08-40279	08-45988	08-46113	08-47436	08-46084
08-49371	08-49395	08-49396	08-34455	08-49096	08-38738
08-49392	08-49393	08-49101	09-52768	09-52770	

Other Documents

Nine Month Response to NRC Generic Letter 2008-01, “Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems,” (TAC Nos. MD7795 and MD7796), No. L-08-313, dated October 14, 2008
MPR Associates, Inc., “Beaver Valley Unit 1 Low Head Safety Injection pump Past Operability Analysis,” Revision 2, dated December 2008
Mancini Consulting Services, “Low Head safety Injection Pump – Air Entrainment Analysis,” dated November 2008
Nuclear Products Operation FlowServe Pump Division letter, dated October 6, 2008
LaSalle Hydraulic Laboratory Technical Report LHL-725, dated April 1, 1978
Flowserve Pump Division, Nuclear Products Operation letter, Pump Style 25APK-2 Low Head Safety Injection, dated October 6, 2008

LIST OF ACRONYMS

BVPS	Beaver Valley Power Station
CAP	Corrective Action Program
CCDP	Conditional Core Damage Probability
CR	Condition Report
DRP	Division of Reactor Projects
DRS	Division of Reactor Safety
ECCS	Emergency Core Cooling System
FENOC	FirstEnergy Nuclear Operating Company
GEM	Graphical Evaluation Module
GL	Generic Letter
IMC	Inspection Manuel Chapter
LHSI	Low Head Safety Injection
LOCA	Loss of Coolant Accident

NRC	Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation
OD	Operability Determination
OE	Operating Experience
PARS	Publicly Available Records
SDP	Significance Determination Process
SPAR	Standardized Plant Analysis Risk
UT	Ultrasonic Testing

ATTACHMENT B

SPECIAL INSPECTION TEAM CHARTER

November 6, 2008

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

William A. Cook, Leader
Special Team Inspection

FROM: James W. Clifford, Director (Acting) **/RA/**
Division of Reactor Projects

Marsha K. Gamberoni, Director **/RA by Darrell Roberts**
Division of Reactor Safety **Acting for/**

SUBJECT: SPECIAL INSPECTION CHARTER TO EVALUATE BEAVER VALLEY UNIT 1 VOIDED CONDITION IN THE LOW HEAD SAFETY INJECTION SUCTION PIPING FROM THE CONTAINMENT SUMP

In response to the identification of a trapped volume of air between the containment sump and the low head safety injection (LHSI) pump suction line isolation valves discovered in September 2008, a Special Inspection Team (SIT) is being chartered. The special inspection will expand on the inspection activities started by the resident inspectors immediately after the significant operational condition was discovered, and will review FirstEnergy Nuclear Operating Company's (FENOC) 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 FENOC's calculation of the void condition and its effect on LHSI pump operability.

This special team inspection was initiated in accordance with NRC Management Directive (MD) 8.3, "NRC Incident Investigation Program," and Inspection Manual Chapter (IMC) 0309, "Reactive Inspection Decision Basis for Reactors." The decision to conduct this special inspection was based on deterministic criteria in MD 8.3, and the risk associated with the potential for the voids to adversely affect LHSI pump operability. The Special Inspection Charter for the inspection team is attached.

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 November 11, 2008. The following personnel have been assigned to this effort:

Manager:	Lawrence Doerflein, Branch Chief, Engineering Branch 2, Division of Reactor Safety (DRS), Region I
Team Leader:	William Cook, Senior Reactor Analyst, Division of Reactor Safety (DRS), Region I
Full Time Members:	Frank Arner, Senior Reactor Inspector, Engineering Branch 2, Division of Reactor Safety (DRS), Region I
	Paul Cataldo, Senior Resident Inspector, Indian Point 3 Division of Reactor Projects, Region I
Part Time Members:	Joseph Staudenmeier, Senior Reactor Engineer, Office of Research, Headquarters
	Warren Lyon, Senior Reactor Systems Engineer, Office of Nuclear Reactor Regulation, Headquarters

Attachment: Special Inspection Charter

Special Inspection Charter
Beaver Valley Unit No. 1
Voiding in Low Head Safety Injection (LHSI) Piping

A. Background

On September 23, 2008, FirstEnergy Nuclear Operating Company (FENOC) detected voids in the suction lines for both trains of LHSI at Beaver Valley Unit 1. The licensee's inspection was being done to complete commitments made in response to Generic Letter (GL) 2008-01, Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems. Approximately 4 cubic feet of void were detected in each loop by ultrasonic testing (UT) measurement. On September 26, FENOC completed an operability evaluation for this voiding condition. This operability determination (OD) was reviewed by the resident inspectors and forwarded to the NRC Region I office on September 30, 2008. NRC Regional staff was engaged and had an initial call with the licensee on October 1. Technical questions were developed and asked of FENOC. The questions and other related issues were discussed in an October 3 conference call. During the call, FENOC acknowledged that they were not able to address the staff's questions, and initiated action to have the pump vendor conduct a formal analysis of the impact of the voids on the LHSI pumps. The consensus view of the NRC was that there was enough uncertainty in the licensee's OD to question the licensee's confidence in the LHSI pumps' ability to operate in the low pressure recirculation (LPR) mode. After follow up discussions between FENOC and NRC management on October 3, FENOC took additional action by filling and venting both LHSI loops on October 4 and October 5, effectively eliminating the voids and addressing the immediate safety concern. A risk assessment for the original voided condition was performed per Inspection Manual Chapter 0309 and a special inspection was recommended and approved by NRC management on October 15, 2008.

This SIT is chartered to assess the as-found conditions to determine their impact on the long term cooling functions of the LHSI system and any licensing basis requirements for the containment sump. Also, the team will review 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 air voiding of emergency core cooling system suction piping to actions implemented at Beaver Valley. Determine if there are any generic issues related to the design and operation practices that resulted in the voiding of the LHSI 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 air 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 air 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 air, the expected flow rates of the LHSI 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 LHSI 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.

The Team will report to the site, conduct an entrance meeting, and begin inspection no later than November 14, 2008. The inspection will include a review of the licensee's calculations associated with the transportability of the air 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) 337-5080.

ATTACHMENT C

NRC Special Inspection Team Independent Operability Assessment

Based upon the information gathered during the inspection, review of design documentation and drawings, and insights garnered from FENOC's past operability analysis, the team independently evaluated the postulated impact of the air voids on the operability of the low head safety injection (LHSI) pumps. The team's approach was to develop a bounding analysis with best estimates as to the characterization of the air/water interactions.

Supporting Data:

Using Drawings 11700-6.24-83 sheet 1-2, and D-25-2APK86X3, the team calculated approximate cross-sectional areas and volumes of the LHSI pump suction can and associated piping, and summarized pertinent system performance data, as follows:

Maximum pump flow rate: 3400 gpm (7.575 cu ft/sec through 12-inch diameter pipe)

Pump Suction Piping: 12-inch I.D. (12.75-inch O.D.)

Pump Suction Piping Air Void: 4.1 cubic feet (FENOC estimate, determined to be reasonable by the team)

LHSI Pump Suction Can Swirl Limiter Cross-Sectional Area:

Swirl Limiter O.D. – 26.75-inch
Swirl Limiter I.D. – 19.5-inch
Effective Area = 263 sq. inches (equivalent pipe diameter = 18.3-inch)

LHSI Pump Suction Can Cross-Sectional Area Below the Swirl Limiter:

Suction Can – 27.25-inch I.D.
Discharge Column – 10.75-inch O.D.
Effective Area = 492 sq. inches (equivalent pipe diameter = 25-inch)

Volume of water (approximate) in LHSI Suction Can below Swirl Limiter:

(Effective Area) X (Height) = 3.42 x 5.1 = 17.4 cu.ft

Calculated Flow Rates:

12-inch suction piping – 9.64 feet per second (fps)
Swirl limiter – 4.15 fps
Suction Can – 2.22 fps

Void Fraction = Volume of Air Void / Volume of Water – Volume of Air Void (displacing water)

Note: The calculated flow velocities are based upon an assumed maximum pump flow rate of 3400 gpm (RWST water temperature equal to 65 degrees F) which represents a bounding flow rate at the time flow initiates from the sump suction piping, with the temperature of the water at

the discharge venturi initially at the RWST temperature. The calculational method was obtained from an on-line source: http://www.pipeflowcalculations.com/flowrate. The flow rates within the pump suction can are approximations based upon calculated effective cross-sectional areas.

Analysis Assumptions:

The team made the following assumptions to characterize air void entrainment and air-water mixture flow through the LHSI pump:

1. The entire 4.1 cubic foot air void would be swept from the sump suction piping within approximately 4 seconds and into the pump suction can. Based upon FENOC data and system response, once the sump check valve opens, flow rapidly accelerates and achieves full flow within approximately 5 seconds. With an accelerating flow velocity terminating at ~9.64 fps, the associated Froude numbers ensure the air void is rapidly entrained into the pump suction flow and completely swept to the pump inlet.

2. Because of the rapid sweep of the air void (~4 seconds) into the suction flow, it is assumed that the flow regime will be a mixture of bubble/plug and slug flow. [engineering judgment]

3. For this bounding analysis, it is assumed that the 4.1 cubic feet of air is entrained uniformly over the ~4 second time interval. Accordingly, the air entrainment rate may be approximated at 1.0 cubic feet per second (fps). Based upon the expected water flow rate at the time of the RWST-to-sump swapover (3400 gpm or 7.6 cubic feet per second), the assumed air entrainment rates equate to air void fraction of approximately 15 percent.

4. Upon air-water mixture entry into the swirl limiter, the mixture will lose flow velocity (twice cross-sectional area as the 12-inch diameter suction piping - calculated flow velocity of 4.15 fps) and there is expected to be some head loss due to the swirl limiter design (reference LaSalle Hydraulic Laboratory Technical Report LHL-725, dated 4/1/1978). The impact of the swirl limiter on the air-water mixture is not specifically known. The swirl limiter may cause further homogeneous mixing of the air and water or may contribute to separation of the air-water mixture as it is diverted from a horizontal to a vertical (downward) flow regime.

5. Flow velocity in the pump suction can, below the swirl limiter, is again reduced due to the larger cross-sectional area in this portion of the suction can (calculated average flow velocity of 2.22 fps). Based upon: a) the design (annulus between the swirl limiter and discharge column); b) unknown quality of the air-water mixture exiting the swirl limiter; and c) air bubble buoyancy; a precise characterization of the flow regime in this area would be speculative. However, the team does assume, based upon the lower average downward flow velocities in this region, that some upward (buoyancy) bubble velocities will exceed downward flow velocities and some of the air will escape to the top of the suction can (via the annulus). Calculated Froude numbers for the expected flow velocity profile in this region support this assumption. However, the absence of any actual system data or laboratory testing results leaves this quantity of air loss/escape unknown and a source of analytical uncertainty.

6. The calculation for effective cross-sectional area (equivalent pipe radius) for the region immediately below the swirl limiter is lower than the effective cross-sectional areas further down the suction can (not calculated). The larger diameter pump suction bells and associated flanges lower in the suction can effectively reduce the cross-sectional areas and result in increased bulk flow velocities (and associated Froude numbers).

7. The air-water mixture transit time through the lower pump suction can area is assumed to be greater than 4 seconds. This longer transit time is based upon the relative speed of the entrained air bubbles (upward bubble buoyancy velocity opposing downward water flow velocity). The result of this longer transit time is that the void fraction ingested by the pump impellers will be smaller. Assuming an average bubble buoyancy velocity of 1.0 fps (opposing downward water flow velocity of ~2.2 fps), the expected transit time of the remaining ingested air volume would be doubled (8 seconds). This longer air transit time effectively reduces the air void fraction to the impellers by one-half or 7.5 percent (not accounting for any air loss/escape via the annulus).

8. The assumed RWST water temperature of 65 degrees F results in maximum initial flow rates and associated Froude numbers. Based upon the design of the containment quench spray system and the delay prior to initiation of recirculation flow from the sump, the increasing temperature effect on the void size was considered to be negligible.

Bounding Analyses:

The entire air void (4.1 cubic feet) is entrained in a 4 second time interval and the entire air-water mixture transits to the pump impeller in approximately 8 seconds. This case assumes no air loss/escape via the swirl limiter annulus.

This best estimate average void fraction to the LHSI pump impeller would be approximately 7.5%, ingested at this concentration over an 8-second time interval. For this void fraction, a September 1982 study sponsored by the NRC suggests that pump degradation due to air ingestion between 3% and 15% by volume may result, but damage is dependent upon operating conditions and pump design. NUREG/CR-2792, “An assessment of Residual Heat Removal and Containment Spray Pump Performance Under Air and Debris Ingesting Conditions,” states that “…for ingestion greater than about 15%, most centrifugal pumps are fully degraded.” More recently developed void fraction acceptance criteria has been prepared by an industry working group, drafted in a revision to Generic Letter 2008-01, “NRC Staff Criteria for Gas Movement in Suction Lines and Pump Response to Gas,” (ML083250536). The applicable draft criteria suggest that centrifugal pump operability would not be jeopardized for ingestion rates of up to 10% void fraction, over a maximum duration of 5 seconds. The team considers the estimated 7.5% void fraction bounded by this criteria. The team’s assumption of uniform entrainment of the air void over the approximate 4-second interval may be non-conservative and introduces an element of unquantifiable uncertainty. Specifically, the air entrainment per unit time distribution may more realistically be represented by a parabolic distribution curve, with a higher peak value and relatively short tail values. The resultant air void fraction may be slightly higher over a shorter ingestion time interval. Notwithstanding, the team’s bounding analysis does not credit any air loss/escape via the swirl limiter annulus and it is the team’s engineering judgment that some percentage of air will escape via the annulus. Therefore, the bounding analysis result (7.5%) is a conservatively higher void fraction than expected to be ingested for this specific LHSI pump design configuration.

The team notes that FENOC engaged the LHSI pump vendor (FlowServe) to evaluate the as-found sump suction void condition and was provided a pump operability impact assessment, dated October 6, 2008. FlowServe's assessment concluded that for short durations (less than 10 seconds) air ingestion over 15%, should "not be a problem." The vendor's basis for this determination is that the pump design (carbon bearings that have the ability to run dry) and the pump's orientation (vertical), if subjected to the stated range of void fractions, may cause the pump to loose prime and stop pumping, but the air within the suction approach area would self-clear and permit re-priming and resumption of pump head and flow.

Conclusions:

Based upon the team's review of associated industry information/guidance and the insights gained from FENOC's past operability analysis (in particular, the thermal-hydraulic and computation fluid analyses), the team concluded that some percentage of the air void would likely escape via the swirl limiter annulus region. Due to inherent modeling uncertainty (with regards to the transport of air through the pump can), the team had questions regarding FENOC's determination that only 20% of the as-found air volume would be transported to the impeller of the LHSI pumps. Based upon this 20% value, FENOC estimated that the resultant worst case void fraction ingested by the pumps would be approximately 4%. Notwithstanding, the team acknowledges that some percentage of the air would likely migrate up through the annulus between the swirl limiter and discharge column due to the expected lower flow velocities in this region of the pump suction can. This pump suction can design attribute would act to mitigate any air entrainment to the suction of the LHSI pumps. The team did not discount the licensee's operability determination, but believes that a bounding analysis, using conservative assumptions for the air-water flow interactions, provides additional confidence in concluding LHSI pump past operability. Based upon the team's bounding analysis, the team concurs with the licensee's past operability determination for the as-found condition.