Entergy

Entergy Nuclear Northeast
Entergy Nuclear Operations, Inc.
James A. Fitzpatrick NPP
P.O. Box 110
Lycoming, NY 13093
Tel 315-342-3840

Pete Dietrich
Site Vice President – JAF NPP

March 31, 2009
JAFP-09-0037

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: **Entergy Nuclear Operations, Inc.**
James A. FitzPatrick Nuclear Power Station
License No. DPR-59
Docket No. 50-333

Supplemental Response to NRC Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems"

References:

1. Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems", dated January 11, 2008.
2. Entergy Letter, Peter Dietrich to U.S. Nuclear Regulatory Commission, "Extension Request for Response to GL 2008-01," JAFP-08-0092, September 12, 2008.
3. Entergy Letter, Peter Dietrich to U.S. Nuclear Regulatory Commission, "Nine-Month Response to NRC Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems", JAFP-08-0107, October 14, 2008.

Dear Sir or Madam:

The Nuclear Regulatory Commission (NRC) issued Generic Letter (GL) 2008-01 (Reference 1) to address the issue of gas accumulation in emergency core cooling, decay heat removal, and containment spray systems. Entergy requested an extension of time to complete the actions required by Generic Letter 2008-01 (Reference 2) and agreed to submit a nine-month response to address the results of assessment and inspection activities conducted outside containment (Reference 3). Entergy also committed to providing a supplemental response that would include the results of assessment and inspection activities conducted inside containment during the fall 2008 refueling outage. The enclosure to this letter provides that supplemental response.

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There are no new regulatory commitments made in this letter.

If you have any questions, please contact Mr. Joseph Pechacek at (315) 349-6766.

I declare under the penalty of perjury that the enclosed information is true and correct.

Executed on this 31st day of March 2009.

Sincerely,

Pete Dietrich
Site Vice President

Enclosure: Entergy Engineering Report, "Summary of Activities Associated with the Resolution of GL 2008-01," JAF-RPT-08-00015, Revision 0, March 2009.

cc:

Mr. Samuel J. Collins, Regional Administrator
U.S. Nuclear Regulatory Commission, Region I
475 Allendale Road
King of Prussia, PA 19406-1415

Office of NRC Resident Inspector
James A. FitzPatrick Nuclear Power Plant
P.O. Box 136
Lycoming, New York 13093

Mr. Paul Tonko, President
New York State Energy Research and Development Authority
17 Columbia Circle
Albany, New York 12203-6399

Mr. Bhalchandra Vaidya,
Project Manager
Plant Licensing Branch
U.S. Nuclear Regulatory Commission
Mail Stop O-8-C2A
Washington, DC 20555

Mr. Charles Donaldson, Esquire
Assistant Attorney General
New York Department of Law
120 Broadway
New York, New York 10271

Mr. Paul Eddy
New York State Department of Public Services
3 Empire State Plaza
Albany, New York 12223-1350

JAFP-09-0037
ENCLOSURE

Summary of Activities Associated with the Resolution of GL 2008-01

Engineering Report No. **JAF-RPT-08-00015** Rev. **0**
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Entergy

ENTERGY NUCLEAR
Engineering Report Cover Sheet

Summary of Activities Associated with the Resolution of GL 2008-01

Engineering Report Type:

New ☒ Revision ☐ Cancelled ☐ Superseded ☐

Applicable Site(s)

IP1	☐	IP2	☐	IP3	☐	JAF	☒	PNPS	☐	VY	☐	WPO	☐
ANO1	☐	ANO2	☐	ECH	☐	GGNS	☐	RBS	☐	WF3	☐	PLP	☐

DRN (EC) No. ☐N/A; ☒ **EC 10507**

Report Origin: ☒ Entergy ☐ Vendor
Vendor Document No.:

Quality-Related: ☒ Yes ☐ No

Prepared by: Dave Kazyaka / D Kazyaka Date: 2/26/09
Responsible Engineer (Print Name/Sign)

Design Verified: Date:
Design Verifier (if required) (Print Name/Sign)

Reviewed by: Mick Baker / [signature] Date: 3/6/09
Reviewer (Print Name/Sign)

Reviewed by*: N/A Date:
ANII (if required) (Print Name/Sign)

Approved by: M.A. Dooley M.A. Dooley Date: 3/9/09
Supervisor (Print Name/Sign)

*: For ASME Section XI Code Program plans per EN-DC-120, if required

TABLE OF CONTENTS

1.0 BACKGROUND:

The NRC requested via GL 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems" that licensees evaluate their Emergency Core Cooling System (ECCS), Decay Heat Removal (DHR) system, and containment spray system licensing basis, design, testing, and corrective actions to ensure that gas accumulation is maintained less than the amount that challenges operability of these systems, and that appropriate action is taken when conditions adverse to quality are identified.

2.0 PURPOSE & SCOPE:

The purpose of this Engineering report is to document the review of the High Pressure Coolant Injection (HPCI), Core Spray (CS) and Residual Heat Removal (RHR) systems in accordance with the requirements of the NRC Generic Letter 2008-01.

The systems at JAF Nuclear Power Station that are in the scope of GL 08-01 include operating modes of the RHR system, the CS system and the HPCI system.

All susceptible piping in each of the identified systems was walked down, the pipe slope measured and recorded, and the vent locations identified. This included pump suction piping from the Condensate Storage Tank (CST) and the suppression pool and pump discharge piping up to the containment penetrations. Pump flow test lines that return to the suppression pool have been evaluated and all piping on the pump suction side, with the possibility of transporting accumulated gas to the pump suctions under postulated post-accident flow scenarios, have been evaluated. In addition, discharge piping that could either deadhead gas pockets or sweep gases into the Reactor Coolant System (RCS) or containment have also been evaluated.

The Torus Spray piping and the RHR Containment Spray piping are included in the scope of GL 2008-01 except for the portions of piping from the inboard isolation valve to the injection point which have been excluded from the scope of GL 08-01. These pipe segments are excluded on the basis that they are open to the containment atmosphere and not required to be water filled prior to system actuation. Filling of these lines on containment spray initiation is included in the system design. The Reactor Core Injection Cooling (RCIC) System, although credited in the FSAR for the loss of feed water transient, is not considered an Emergency Core Cooling System (ECCS) therefore is being excluded from the evaluation of this Generic Letter. The exclusion of this system is consistent with industry peers.

The Shutdown Cooling System is excluded from the scope of GL 2008-01 due to the fact this system is a manually initiated mode of the RHR System and is placed in service during normal shutdown and cool down, which requires manual venting and filling of the system prior to start. This ensures no voids are present.

3.0 SYSTEM DESCRIPTIONS:

High Pressure Coolant Injection (HPCI) System Description

The HPCI System provides and maintains an adequate coolant inventory inside the reactor vessel to prevent fuel clad melting as a result of postulated small breaks in the Reactor Coolant Pressure Boundary. A high pressure system is needed for such breaks because the reactor vessel depressurizes slowly, preventing low pressure systems from injecting coolant. The HPCI System includes a turbine-pump powered by reactor steam generated by residual decay heat in the core. This ensures availability of the system in case of a loss of off-site power. (FSAR Section 1.6.2.11; OP-15, Rev. 54, "High Pressure Coolant Injection")

The HPCI pump suction is normally lined up to the Condensate Storage Tanks (CST) in order to maintain the pump primed. The alternate HPCI pump suction supply takes suction from the torus. Both line-ups will supply coolant to the reactor pressure vessel (RPV) to lower RPV pressure so that low pressure coolant injection systems can supply coolant to the RPV. HPCI is normally maintained in standby and is capable of cold quick start immediately upon initiation. The HPCI turbine is driven by decay heat steam. The HPCI pump injects water from the CSTs or torus into the RPV to lower RPV pressure so that low pressure coolant injection systems can supply coolant to the RPV. HPCI includes a steam turbine driven pump, piping, valves, and controls. With the exception of HPCI Steam Supply Line Inboard Isolation 23MOV-15 and HPCI Turbine Exhaust Line Vacuum Breaker Valve 23MOV-59, which are powered by AC, all turbine controls and electric motor driven components are powered by DC. Because 23MOV-15 is normally open when HPCI is required to be operable and HPCI can operate with 23MOV-59 in the open or closed position, no AC power is normally required for HPCI operation under the conditions that exist during automatic initiation. (FSAR Section 1.6.2.11; OP-15, Rev. 54, "High Pressure Coolant Injection")

Core Spray System Description

The Core Spray (CS) system consists of two independent systems. Each system includes one 100 percent centrifugal water pump driven by an electric motor that can deliver cooling water to spray spargers directly over the core. The system is actuated by conditions indicating that a breach exists in the Reactor Coolant Pressure Boundary, but water is delivered to the core only after reactor vessel pressure is reduced. This system provides the capability to cool the fuel by spraying water onto the core. The Core Spray system is capable of preventing excessive fuel clad temperatures following a loss-of-coolant accident. Suction can also be lined up to condensate storage tanks. (FSAR Section 1.6.2.11; OP-14 Rev. 31, "Core Spray System")

Residual Heat Removal System Description

Low Pressure Coolant Injection (LPCI) is an operating mode of the Residual Heat Removal (RHR) system. The LPCI mode acts as an engineered safeguard in conjunction with the other Emergency Core Cooling Systems. LPCI uses the pump loops of the RHR system to inject cooling water at low pressure into a reactor recirculation loop. LPCI is actuated by conditions *indicating a breach in the Reactor Coolant Pressure Boundary, but water is delivered to the core only after reactor vessel pressure is reduced. LPCI operation, together with the core shroud and jet pump arrangement, provides the capability of core re-flooding following a loss-of-coolant accident in time to prevent excessive fuel clad temperatures.*

The Suppression Pool Cooling (SPC) subsystem of RHR is placed in operation to limit the temperature of the water in the suppression pool following a design basis loss-of-coolant accident. In the suppression pool cooling mode of operation the RHR pumps take suction from the suppression pool and pump the water through the RHR heat exchangers where cooling takes place. The cooled fluid is then discharged back to the suppression pool. (FSAR Section 1.6.2.11)

The Containment Spray mode is an integral part of the RHR System and is used to aid in reducing drywell pressure following a LOCA. The Containment Spray mode is initiated manually after the LPCI cooling requirements have been satisfied. An interlock is provided so that the control room operator does not inadvertently initiate containment spray before LPCI requirements are met.

As stated in Section 2.0 PURPOSE and SCOPE: "The Torus Spray piping and the RHR Containment Spray piping are included in the scope of GL 2008-01 except for the portions of piping from the inboard isolation valve to the injection point which have been excluded from the scope of GL 08-01. These pipe segments are excluded on the basis that they are open to the containment atmosphere and not required to be water filled prior to system actuation".

During containment spray operation, RHR pumps take suction from the torus and discharge through RHR heat exchangers, where heat is transferred to RHR service water. The cooled water is then diverted into either the drywell spray header or the torus spray header. The spray in the drywell condenses steam to lower drywell pressure. The water collects on the bottom of the drywell until water level reaches the suppression vent lines, it then overflows and drains back to the torus. The spray in the torus air space cools non-condensable gases. (FSAR 4.8.6.2; OP-13 Rev. 13, "Residual Heat Removal System")

4.0 LICENSING BASIS EVALUATION:

Discuss the review of: Tech Specs (TS) and Bases, UFSAR, Licensee controlled documents and Bases, Responses to NRC Generic Communications, Regulatory Commitments. Summarize the changes to the licensing basis.

4.1 Identify and review the Current Licensing Basis with respect to gas accumulation for the systems to be evaluated, including periodic venting requirements based on a review of, for example, the TS, TS Bases, UFSAR, Licensee Controlled Documents (e.g., Technical Requirements Manual (TRM) and TRM Bases), docketed correspondence, Licensing Commitments, and License Conditions.

The licensing basis documents that were reviewed for venting requirements were the Operating License (OL), Technical Specifications (TS), Updated Final Safety Analysis

Report (UFSAR), TRM and plant specific regulatory commitments. An electronic search was performed of these documents using the words "air", "gas", "vent" and "void".

Operating License (OL)

The OL does not contain any license conditions that specifically address gas accumulation.

Technical Specifications (TS)

- *Limiting Condition of Operation (LCO) 3.5.1 states "Each ECCS injection/spray subsystem and the Automatic Depressurization System function of six safety/relief valves shall be OPERABLE.*
    - *SR 3.5.1.1 states, "Verify, for each ECCS injection/spray subsystem, the piping is filled with water from the pump discharge check valve to the injection valve. Frequency-31 days.*
    - *The bases for Surveillance Requirement (SR) 3.5.1.1 states, "The flow path piping has the potential to develop voids and pockets of entrained air. Maintaining the pump discharge lines of the HPCI System, CS System, and LPCI subsystems full of water ensures that the ECCS will perform properly, injecting its full capacity into the RCS upon demand. This will also prevent a water hammer following ECCS initiation signal. One acceptable method of ensuring that the lines are full is to vent at the high points and observe water flow through the vent. Another acceptable method is to verify that the associated "keep full" level switch alarms are clear. The 31 day frequency is based on the gradual nature of void buildup in the ECCS piping, the procedural controls governing system operation, and operating experience.*
- *LCO 3.5.2 states "Two low pressure ECCS injection/spray subsystems shall be OPERABLE.*
    - *SR 3.5.2.3 states, "Verify, for each ECCS injection/spray subsystem, the piping is filled with water from the pump discharge check valve to the injection valve. Frequency-31 days.*
    - *The bases for SR 3.5.2.3 states, "The flow path piping has the potential to develop voids and pockets of entrained air. Maintaining the pump discharge lines of the HPCI System, CS System, and LPCI subsystems full of water ensures that the ECCS will perform properly, injecting its full capacity into the RCS upon demand. This will also prevent a water hammer following ECCS initiation signal. One acceptable method of ensuring that the lines are full is to vent at the high points and observe water flow through the vent. Another acceptable method is to verify that the associated "keep full" level*

switch alarms are clear. The 31 day frequency is based on the gradual nature of void buildup in the ECCS piping, the procedural controls governing system operation, and operating experience.

<u>*Updated Final Safety Analysis Report*</u>

The UFSAR was searched for any reference to gas accumulation or periodic venting and the following statement concerning the operation of the Core Spray pump was identified. No discussion concerning gas accumulation or periodic venting associated with HPCI or RHR was found in the UFSAR.

> *Operation of a Core Spray pump, other than in performance of its accident mitigation function, is performed with that pump train declared inoperable. Analysis performed in support of the ECCS suction strainer replacement, during the 1998 refueling outage, identified a potential for gas entrainment into a Core Spray pump if a LOCA were to occur while the pump was operating. The limiting conditions for operation ensure that the minimum complement of ECCS subsystems are available in the event the operating Core Spray pump is degraded when the LOCA downcomers clear. (UFSAR 6.6)*

<u>*Technical Requirements Manual*</u>

The TRM was searched and the following statement concerning the Emergency Core Cooling System (ECCS) Discharge Line Keep Full Alarm Instrumentation was identified. (TRS 3.3.E)

- *Perform a CHANNEL FUNCTIONAL TEST of the Core Spray and RHR System discharge line keep full alarm instrumentation on a frequency of 92 days.*

<u>*Docketed Correspondence, Licensing Commitments and License Conditions*</u>

JAF's docketed correspondence, licensing commitments and licensing conditions were searched and the following commitments were identified:

- *A-1273 NRC Inspection 50-333/75-04*

  <u>*Summary:*</u> *During routine plant inspection, found damaged pipe restraints and broken snubber on containment spray line. Probable cause was due to operating the RHR system with the discharge piping not full of water. Operating only one side of RHR in shutdown cooling mode, the keep full system was not available to the other side.*

  <u>*Action:*</u> *Add a keep full system to the "A" RHR System.*

- *A-1485 Damaged Containment Spray Line Pipe Support*

<u>Summary:</u> During routine plant inspection, found damaged pipe restraints and broken snubber on containment spray line. Probable cause was due to operating the RHR system with the discharge piping not full of water. Operating only one side of RHR in shutdown cooling mode, the keep full system was not available to the other side.

<u>Action:</u> Modify RHR System to provide a keep full system to avoid water hammer.

- *A-2232 Proposed change to Technical Specifications*

  <u>Summary:</u> Added level switches to the discharge piping of the Core Spray and RHR Systems to monitor the discharge piping.

  <u>Action:</u> Add level switches to Core Spray and RHR Keep Full Systems

- *A-2583 NRC Inspection 50-333/78-19*

  <u>Summary:</u> On August 6, 1978, when the High Pressure Coolant Injection (HPCI) system became inoperable due to a failed suction valve, the system was not declared inoperable and the required operability demonstrations of the other core cooling systems were not performed.

  <u>Action:</u> To prevent a similar occurrence on the RHR System, procedures were revised to assure that the RHR Keep Full System was, in fact, kept full.

- *A-5408 NUREG-0737 Item II.B.1 – NYPA Response to NRC Question*

  <u>Summary:</u> NUREG- 0737 Item 11.B.1

  <u>Action:</u> Venting of the RHR heat exchanger is accomplished through two safety related motor operated valves, installed in series and operated from the control room. Operating procedures provide the operator with guidance for venting the heat exchanger to prevent accumulation of noncondensible gases.

- *A-11262 Proposed Change to Technical Specifications*

  <u>Summary:</u> The proposed amendment to the JAF Technical Specifications updates tables 3.7-1 ("Primary Containment Isolation Valves") and 4.7-2 ("Exception to Type C Tests") to reflect the Containment Isolation Valves in the RHR and Core Spray keep-full systems.

  <u>Action:</u> The RHR Keep Full System will be installed during the 1990 refueling outage and will not be declared operational until this proposed Technical Specification change has been issued by the NRC Staff. Until then, the RHR Keep Full minimum flow discharge lines will remain isolated and active equipment will be de-energized.

4.2 Determine if changes to the Current Licensing Basis, e.g. UFSAR, TS, TS Bases, TRM or TRM Bases, are required for each system being evaluated.

4.2.1 The GL states that TS Surveillance Requirements (SR)s should be complete and address both the suction and discharge piping, when applicable.

TS 3.5.1, SR 3.5.1.1 and TS 3.5.2, SR 3.5.2.3 have a requirement to ensure for each ECCS injection/spray system, the pump discharge piping is filled with water from the pump discharge check valve to the injection valve on a 31 day frequency. Entergy is aware that the NRC is working with the industry to establish SR requirements and will commit to consider these changes once staff has approved the proposed approach.

Entergy does not consider the lack of SRs on pump suction piping to be a safety issue since the suction piping from the Torus and CST creates a positive pressure up to the pump. There is minimal potential for gas intrusion once the suction lines are shown to be full of water and free of voids. JAF recognizes that there is a vulnerability that the suction piping, pump casing and the discharge piping from the pump up to the discharge check valve may have a potential for gas voiding. However, based on the results of the walkdowns performed by ABS, seven potential void areas were identified in suction side piping. A UT was performed at each of these seven locations and no voids were identified. (ABS Report 1924850-R-001, Revision 1, Section 4.2, Table 4-1).

During normal power operation conditions the pump / system ST and operation have not exhibited any adverse operational characteristics indicative of air intrusion (such as pump cavatation, water hammer or vapor bound heat exchangers where applicable, etc.).

4.2.2 The Bases for the TS Surveillance Requirement(s) should be written to ensure the systems are "sufficiently full of water" vs. "full of water" (see GL, page 6, paragraph 2 of the Discussion Section).

The Bases for the SR currently states that the flow path piping has the potential to develop voids and pockets of entrained air. Maintaining the pump discharge lines of HPCI, CS, and LPCI systems full of water ensures that the ECCS will perform properly, injecting its full capacity into the RCS upon demand. This will also prevent a water hammer following an ECCS initiation signal. One acceptable method of ensuring that the lines are full is to vent at the high points and observe water flow through the vent. Another acceptable method is to verify that the associated "keep full" level switch alarms are clear. The 31 day Frequency is based on the gradual nature of void buildup in the ECCS piping, the procedural controls governing system operation and operating experience.

The subject TS Surveillance Requirement does not address the suction side, or the section of discharge piping from the pump to the discharge check valve, including the pump casing. JAF does recognize that there is a vulnerability that the suction piping, pump casing and the discharge piping from the pump up to the discharge check valve may have a potential for gas voiding. The current wording in the Bases is nonconservative in ensuring that the system has been properly vented. This was addressed in ABS evaluation. (Reference ABS Report 1924850-R-001, Revision 1, Section 3.3.9 Potential Voids at Component and Piping Configuration Locations).

4.2.3 Revise the Bases for the Tech Spec SR(s) and consider adding or revising TRM requirements for these systems to address periodic monitoring due to gas accumulation vulnerabilities, if required.

The discussion on revising the Bases and the TS Surveillance Requirements is discussed above. JAF will commit to a long-term action to determine the need to ensure proper venting of the suction piping, the pump casings and the discharge piping from the pump up to the discharge check valve. Based on these evaluations, further actions may be defined. This was addressed in ABS evaluation. (Reference ABS Report 1924850-R-001, Revision 1, Section 3.3.9 Potential Voids at Component and Piping Configuration Locations).

4.3 Identify Current Licensing Basis changes resulting from the evaluation performed in Section 4.2 above.

- *JAF will revise TS Bases to specify that the subject systems are "sufficiently full of water" vs. "full of water". Included in this commitment will be an evaluation of the need to vent on a specified frequency to ensure subject systems are sufficiently full.*
- *JAF will revise commitment A-5408 for venting of the RHR heat exchangers. The revised commitment will vent through the existing high point vents in conjunction with the two safety-related motor operated valves (MOVs). Use of the high point vents in conjunction with the MOVs will reduce stay time and ensure adequate venting.*

4.4 State that changes proposed by the Technical Specification Task Force (TSTF) will be considered for implementation following NRC approval.

Entergy is aware that the NRC is working with the industry to establish TS Surveillance Requirements and will commit to implement these changes once staff has approved the proposed approach.

4.5 Enter applicable changes that were identified as part of the Current Licensing Basis review in the Corrective Action Program (CAP).

- ***LO-LAR-2008-00020***

  JAF will revise TS Bases to specify that the subject systems are "sufficiently full of water" vs. "full of water". Included in this commitment will be an evaluation of the need to vent on a specified frequency to ensure subject systems are sufficiently full.

- ***LO-LAR-2008-00020***

  JAF will revise commitment A-5408 for venting of the RHR heat exchangers. The revised commitment will vent through the existing high point vents in conjunction with the two safety-related motor operated valves (MOVs). Use of the high point vents in conjunction with the MOVs will reduce stay time and ensure adequate venting.

4.6 Document the results of the Current Licensing Basis review and summarize the changes that will be implemented and the schedule for implementation of the changes.

Based on the review of the Current Licensing Basis as requested by GL-2008-01, JAF has determined the following changes will be required.

- *JAF will revise TS Bases to specify that the subject systems are "sufficiently full of water" vs. "full of water". Included in this commitment will be an evaluation of the need to vent on a specified frequency to ensure subject systems are sufficiently full.*

  This action will be completion within 90 days following NRC publication of the Notice of Approval of the TSTF Traveler in the Federal Register.

- *JAF will revise commitment A-5408 for venting of the RHR heat exchangers. The revised commitment will vent through the existing high point vents in conjunction with the two safety-related motor operated valves (MOVs). Use of the high point vents in conjunction with the MOVs will reduce stay time and ensure adequate venting.*

  This action will be completed on or before 04/30/09.

4.7 The Current Licensing Basis review activities discussed in sections 4.1 and 4.2 will be completed by October 11, 2008. However, the need for additional changes to Current Licensing Basis documents may be identified during activities that occur after October 11, 2008 (e.g., piping walkdowns performed during a refueling outage and the results from any industry testing and analytical programs).

The Licensing Basis review activities discussed in sections 4.1 and 4.2 have been completed.

A walkdown of piping, both non-insulated and insulated, inside and outside of containment, has been completed with the exception of the inaccessible pipe identified below:

- *HPCI suction piping from CST Pit to Reactor Building Wall – Buried*
- *RCIC suction piping from CST Pit to Reactor Building Wall – Buried*
- *CS suction piping from CST Pit to Reactor Building Wall – Buried*
- *CS suction piping from CST in East Crescent – inaccessible without scaffolding*
- *Portion of RHR Train B Containment Spray line overhead at 300' RX BLD NE – inaccessible without scaffolding*
- *Portion of RHR Trains A to LPCI in West Crescent – inaccessible without scaffolding*
- *Portion of RHR Trains B to LPCI in East Crescent – inaccessible without scaffolding*

A tabletop review was conducted with Engineering, Operations, PS&O, Maintenance, and RP which reviewed system isometric drawings for the inaccessible piping areas. It was determined through drawing reviews during the tabletop mulit-departmental reviews that the above locations did not cite any areas for the potential to exhibit any gas intrusion. Also, due to the satisfactory results of the piping that was accessed for the walkdown and the history of few air voiding events at JAF, included with the table top reviews, it is not necessary to perform walkdowns of the inaccessible sections of this piping. The aforementioned review conclusion performed by JAF was corroborated by the ABS evaluation which did not require additional walkdowns and void testing of the piping that was not walked down. System walkdowns is further discussed in Section 5.3.

4.8 Determine if any corrective actions will be completed after October 11, 2008 and identify as licensee commitments that will not be completed within the 9-month GL response date.

- *JAF will revise TS Bases to specify that the subject systems are "sufficiently full of water" vs. "full of water". Included in this commitment will be an evaluation of the need to vent on a specified frequency to ensure subject systems are sufficiently full. (LO-LAR-2008-00020, CA-14)*
- *JAF will revise commitment A-5408 for venting of the RHR heat exchangers. The revised commitment will vent through the existing high point vents in conjunction with the two safety-related motor operated valves (MOVs). Use of the high point vents in conjunction with the MOVs will reduce stay time and ensure adequate venting. (LO-LAR-2008-00020, CA-12)*

5.0 DESIGN EVALUATION:

Discuss the review of Design Basis Documents (Calculations, Isometric drawings, P&IDs, etc), gas intrusion mechanisms and acceptance criteria. Summarize the changes to the design basis.

5.1 DESIGN BASIS DOCUMENTS REVIEW

Include Calculations and Engineering Evaluations and Vendor Technical Manuals, with respect to gas accumulation for the systems to be evaluated.

Examples of relevant Design Basis documentation include:

- System periodic venting requirements.

  Tech Spec SR 3.5.1.1 states, "Verify, for each ECCS injection/spray subsystem, the piping is filled with water from the pump discharge check valve to the injection valve." The frequency for this SR is 31 days.

- Statements regarding system keep-fill designs and requirements, if installed.

  RHR System

  The RHR Keep-full pumps keep the RHR System discharge piping full of water during the Standby mode of operation. Whenever an RHR pump is running, the keep-full pump in the associated operating loop should be secured.

  Requirement: The RHR Keep-Full Subsystem and instruments for maintaining and monitoring the RHR discharge piping in a filled condition must be adequate. Section 4.5.6 of the RHR system design specification 22A1472 states that, "A means such as a pressurized water supply must be provided to insure that the discharge piping remains full of water." RHR keep-full pumps were installed under modification F1-75-253.

  Reason: The RHR pump discharge piping is required to be maintained full of water to avoid water hammer and delay of LPCI injection flow. Based on experience in operating BWRs, the NRC had a concern that it may be difficult to maintain the ECCS pump discharge piping full of water. This NRC concern was realized in the following event at JAF.

  During a shutdown cooling operation in 1975, the 'A' Containment Spray line was found to be damaged due to water hammer. The cause was identified to be the 'A' RHR loop piping not being kept full by the Keep-Full Subsystem during the SDC operation. The cause was attributed to the improper design of the Keep-Full Subsystem. The Keep-Full Subsystem was connected only to the 'B' RHR loop piping. During power operation, the Keep-Full Subsystem charges both RHR loops via RHR loops cross-tie line. During the SDC mode, the cross tie line isolation valve 10MOV-20 was closed causing 'A' RHR loop piping to be isolated from the 'B' loop and the Keep-Full Subsystem.

<u>Design Feature:</u> As a result of the LPCI fix, the RHR discharge header is isolated from the originally installed Keep-Full Subsystem by 10MOV-20 which is closed when the RHR system is in the standby mode. Under the two identical modifications, F1-74-052 and F1-75-13 a line was installed from the existing Keep-Full Subsystem header to RHR loops 'B' and 'A' respectively. A new Keep-Full pumping subsystem using the Keep-Full pumps 10P-2A, B was added by Modification F1-75-253 to maintain the RHR piping full of water. The replacement pump installed for the Keep-Full Subsystem was evaluated to confirm its adequacy.

<u>Source:</u> Design Basis Document (DBD)-010, "Design Basis Document for the Residual Heat Removal System".

Modification JD-03-005 (ER-02-0031) replaced previously used strap-on ultrasonic level detectors mounted external to piping and used to monitor high points in the RHR and core spray systems for water filled condition with thermal dispersion level detectors which place the sensor in the monitored fluid to ensure high points in the piping are filled with water. This change was made to correct previous performance deficiencies with the external ultrasonic detectors and have performed successfully for a number of years.

<u>Core Spray System</u>

The CS Keep-Full Subsystem is provided to maintain the CS system discharge piping in a full condition. The subsystem consists of a hold pump and associated piping, valves, instrument and controls.

<u>Requirement:</u> Provisions must be made to assure the CS system piping is full of water to avoid water hammer on pump start. Section 4.5.5 of the core spray design specification 22A1435 states that, "Provision shall be made to keep the core spray discharge continuously full of water to avoid time delays in filling the lines and to avoid hydraulic hammer." Section 4.4.3.1 of the core spray design specification 22A1435 states that, "A check valve shall be provided in the pump discharge line below the water level in the suppression pool. This valve shall cause the line downstream of the valve to remain filled with water."

<u>Reason:</u> Based on experience in operating BWRs, the NRC had a concern that it may be difficult to maintain the ECCS pump discharge piping full of water. In 1975, damage to the RHR system piping due to water hammer occurred at JAF when the RHR pump was started for the shutdown cooling function. The CS system was considered to have the same potential problem on pump start. Core spray keep full pumps appear to have been included in the initial plant design and were purchased under APO-73B.

<u>Design Features:</u> A Core Spray (CS) Hold Pump in each CS system loop normally operates to maintain the CS pump discharge piping up to the isolation valves full of water. The Condensate Transfer Pump has the capability to provide backup to the hold pumps if needed through a normally closed gate valve. A modification improved the power supplies to the hold pumps to assure pump operation in the event of a loss of offsite power (LOOP) event. Level switches and control room alarms are used to monitor the CS pump discharge piping and alert the operator of piping not full condition. Modification JD-03-005 (ER-02-0031) replaced previously used strap-on ultrasonic level detectors mounted external to piping and used to monitor high points in the RHR and core spray systems for water filled condition with thermal dispersion level detectors which place the sensor in the monitored fluid to ensure high points in the piping are filled with water.

<u>Source:</u> Design Basis Document (DBD)-014, "Design Basis Document for the Core Spray System".

<u>HPCI System</u>

The HPCI system at JAF's has no keep full system. A keep full system is not required since the CST level is maintained above the elevation of the discharge check valves.

- System designs that include voided pipes (e.g. drywell spray piping inside containment).

<u>RHR System</u>

A mode of operation for the RHR system is Drywell Spray during a LOCA. This flow path is through a normally closed out-board isolation valve into an open spray header. The Drywell Spray nozzles and inboard piping are voided by design, as the lines are open ended in the vessel.

<u>Core Spray System</u>

The Core Spray sparger and incore piping is voided by design, as the lines are open ended in the vessel.

<u>HPCI System</u>

The HPCI System at JAF has no voided pipe by design. This system does not have a keep-full system due to the fact that HPCI is normally lined up to take suction from the CST and the CST level is above the HPCI discharge check valves. This configuration ensures the piping is full of water.

- System realignments during Design Basis actuations and how the system remains full.

For RHR and CS, experience at similar plants has shown a tendency for leakage to develop through the pump discharge check valves. A Keep Full pump is provided *for each RHR and CS loop. The Keep Full pumps will re-circulate torus water around the discharge check valves should any leakage occur. The Keep Full pump is not essential to maintaining the line full of water, but eliminates the flow of condensate storage tank water to the torus. (UFSAR Section 6.4.5)*

The HPCI system requires no fill-line arrangement, since the required valves are normally open, and the piping is located below the reserve water level of the CSTs. (UFSAR Section 6.4.5)

HPCI also has a second source of water, an automatic transfer to the Torus suppression pool occurs when the CSTs reach low level. (UFSAR Section 16.6.1)

The suction piping is located below the reserve water level of the condensate storage tank and the minimum water level of the suppression pool.

- The potential for gas intrusion due to debris laden suction strainer geometry.

  NRC Bulletin 96-03 imposed requirements on BWR licensees to address the impact of debris generation in the drywell on ECCS pump NPSH following a design basis LOCA. The Bulletin cited industry experience and NRC study data in its conclusion that there was a high probability that the available NPSH margin for the ECCS pumps would be inadequate following dislodging of insulation and other debris caused by a LOCA and transport of the debris to the suppression pool suction strainers.

  In response to the issues raised in the NRC Bulletin, modification F1-97-031 was implemented in 1998, during Refueling Outage 13, to install larger, high capacity suppression pool suction strainers for both Core Spray loops. The new strainers were designed to ensure adequate NPSH would be available to the pumps assuming the maximum quantity of debris that could be generated and transported to the suppression pool as a result of a design basis LOCA and the peak pool temperature postulated for the accident.

  In additions to ensuring adequate NPSH to the ECCS pumps, installation of the larger, high capacity, suppression pool suction strainers makes the potential for gas intrusion associated with debris less likely.

- Vortex correlations used to establish minimum water level set points or manual actions credited in the design basis LOCA.

  <u>HPCI System</u>

  Duke Engineering & Services Calculation No. A384.F02-03, "RHR, CS, HPCI and RCIC Suction Strainer Vortex/Minimum Submergence", Rev. 1 concluded that the new suction strainers require only partial submergence to prevent vortexing. The Technical Specification minimum suppression pool water level is well above the level required to prevent vortex conditions. The elevations at the top of the debris *postulated to accumulate on the strainers following a design basis LOCA are below the Technical Specification minimum suppression pool water level. (DBD-023)*

CS System

Duke Engineering & Services Calculation No. A384.F02-03, "RHR, CS, HPCI and RCIC Suction Strainer Vortex/Minimum Submergence", Rev. 1 concluded that the new suction strainers require only partial submergence to prevent vortexing. The Technical Specification minimum suppression pool water level is well above the level required to prevent vortex conditions. The elevations at the top of the debris postulated to accumulate on the strainers following a design basis LOCA are below the Technical Specification minimum suppression pool water level. (DBD-014)

RHR System

Duke Engineering & Services Calculation No. A384.F02-03, "RHR, CS, HPCI and RCIC Suction Strainer Vortex/Minimum Submergence", Rev. 1 concluded that the new suction strainers require only partial submergence to prevent vortexing. The Technical Specification minimum suppression pool water level is well above the level required to prevent vortex conditions. The elevations at the top of the debris postulated to accumulate on the strainers following a design basis LOCA are below the Technical Specification minimum suppression pool water level. (DBD-010)

- Allowable leakage between high pressure and low pressure interfaces.

  The allowable high to low pressure leakage is bounded by the Containment Isolation Valve Local Leak Rate Testing Program.

  CS and RHR are both equipped with alarming pressure instrumentation to alert the operating staff to a potential high to low pressure interface leakage path. The alarms are set at 450 psig for the systems and are provided by pressure switches 10PS-122A, 10PS-122B, 14PS-47A and 14PS-47B should the respective system discharge containment isolation valves exhibit back-leakage. Station Annunciator Response Procedures (ARPs) 09-4-3-23, 09-3-1-11 and 09-3-2-11 provide the operating staff with the procedural mitigation actions.

  HPCI by design is not provided with similar instrumentation as discussed above for CS and RHR since HPCI piping downstream of the pump is designed for high pressure. The HPCI discharge is isolated from the high pressure source by two normally closed check valves and one normally closed motor operated valve (23MOV-19). Triple valve isolation mitigates the likelihood of a high to low pressure interface condition and therefore alarming pressure instrumentation is not required.

- Existing documents which evaluate void size acceptability.

ECCS Suction Voiding:

Based on evaluation of the gas intrusion data that was reviewed by the BWROG and GEH applicable to the performance of centrifugal pumps, a bounding 2% by volume continuous suction gas void fraction is acceptable. It could cause increased wear of the pump, but will not cause pump operability problems. Although, test data is available for fractions up to 4% having minimal effects on pump performance, other test data shows performance degradation (although minor) under certain conditions, such as low flow and flow beyond the Best Efficiency Point (BEP), beginning at about 2%. Due to the large number of variables and pump types that can affect pump performance while ingesting gas, a bounding 2% void fraction is considered appropriate and conservative for continuous pump operation. However, due to the lack of test data or operating experience of pump operation above 120% of the BEP, it is recommended that pumps which operate above this point be limited to a 1% allowable continuous void fraction. System operability would still need to be assessed for either limit above, including such factors as required NPSH versus available NPSH, duration of gas flow, and transients for which the system is credited.

Gas accumulation in the suction lines of BWR ECCS systems is not expected to occur. If a gas void is found in a suction line it will be a fixed volume and will not cause a continuous gas void flowing through the pump. As such it is overly conservative to apply the above void criteria to these types of voids. To evaluate pump and system effects of a void of a known volume, it is appropriate to use the guidance that an average void fraction less than 10% can be tolerated by the pump and system for a period of no greater than 5 seconds.

To evaluate pump and system effects of a void of a fixed known volume, it is appropriate to use the guidance developed by GEH and the BWROG, that an average void fraction less than 20% can be tolerated by the pump for a period of 5 seconds. However, since this criterion is qualitative in nature, a more conservative guideline of an average 10% void fraction for no greater than 5 seconds is recommended for use. This assumes that the void is not initially located in the pump during a pump start. Proposing an acceptance criterion of 10% void fraction over no greater than 5 seconds to evaluate pump and system operability acknowledges the qualitative nature by which the limit was developed. Additionally, this limit more closely aligns with similar limits that Westinghouse is developing. Also, bubble surges during transport will result in a varying void fraction that will likely peak over 10%, but should average less than 10%. The actual gas volume this constitutes will depend on pump suction line diameter, flow rate, and pressure.

Although no specific test data was located which empirically validates this guidance, it is considered bounding and appropriate for the following reasons:

- *At the pump BEP or rated speed, a gas void present in a suction line would be swept through the pump due to system flow inertia as bubbly flow in a short amount of time (seconds).*
- *The flow of entrained gas through the pump would occur for a short duration (seconds), during which, a small reduction in flow may occur, but will not compromise system performance. As such, recalculation of pump NPSHr should not be required.*
- *As noted above, a small reduction in flow may occur for several seconds.*
- *Although it difficult to quantify the short duration reduction in flow, it is more than offset by conservative accident analysis assumptions, such as not crediting ECCS flow until the time the injection valve is assumed full open. In reality, significant flow occurs early in the opening stroke, before flow is actually credited.*
- *If gas was present in an ECCS pump suction line, ingestion by the pump would be expected to occur early in an event when NPSHa is higher, rather than later in an event.*
- *A pump vendor's review of an event with a similar amount of voiding, averaging 15% void fraction over 5 seconds, indicated that the pump will continue to operate, and the pump will return to its pre-transient flow as the voiding clears.*
- *BWROG/GEH Test documentation found that after air injection was increased to the point that flow collapsed or totally ceased, air injection was switched off and the head and flow normalized in a few seconds back to the original values, with one exception. With the smallest flow rate (200 gpm or approximately 20% of rated flow), it took about 30 seconds for the pump head to normalize.*
- *Due to the short duration of time (generally minutes) that pumps are expected to run on minimum flow, accumulation of sufficient gas to cause pump binding is not expected. Additionally, flow velocities on minimum flow are not high enough to push minor voiding into the pump suction. As such, time restrictions for minimum flow operation are not recommended.*
- *The criteria chosen assumes all of the void volume in the suction line is transported through the pump. Depending on the suction flow rate, a lower percent of this volume will be transported through the pump (lower flow yields a lower Froude number).*

This guidance is generic and conservative. It is intended for evaluating short term system operability due to a void found in the ECCS suction piping and not for long term design basis. A plant specific evaluation of any voiding discovered in the suction piping is not precluded and may provide a larger acceptable void fraction. If voiding near, or exceeding, the acceptance limit established in this report is *identified in an ECCS suction line, it is recommended that the pump vendor also be consulted to ensure that the pump is not an outlier relative to any of the generic assumptions made.*

ABS Calculation 1924850-C-002, Revision 1, Titled "Generic Letter GL2008-01: Evaluation of Acceptable Void Sizes in ECCS, Decay Heat Removal, and Containment Spray Systems" determined acceptable void sizes that could potentially be found in pump suction piping in the ECCS and determined the maximum pressure and pipe segment pressurization rate that could result from void compression following pump start. These systems included RHR, HPCI and CS.

The maximum acceptable gas accumulation for the sum of the suction and discharge piping is limited. Based on guidance provided the BWROG by GE/Hitachi, an evaluation based on the delay in ECCS function of up to 4 seconds demonstrated that peak cladding temperature was maintained within 50°F of analyzed conditions and therefore is within the plant's licensing basis.

The maximum void that can be pumped into the vessel is the sum of the acceptable suction void and discharge void. Therefore, the upper limit on discharge side voids is the difference between the vessel acceptable void and the suction acceptable void. In this evaluation, 87.5% of the pump flow over 4 seconds was used. The 87.5% value is based on the consideration that the suction side can be voided 10% for 5 seconds, which is equivalent to 12.5% over 4 seconds.

This volume is also adjusted for voids that occur in piping downstream of the closed isolation valve on the path to the reactor. This is required if the void is exposed to reactor pressure during operation and a lower pressure under ECCS injection. Under accident conditions, the vessel pressure would drop and the void would expand and could occupy more volume. To adjust for measurements made during operation, the void volume is lowered by the ratio of the pump head to the reactor pressure.

ABS Consulting Report 1924850-R-001 Revision 1
Table 4-1: Acceptable Suction Side Voids

Numbers shown (X), refer to notes following table.

Pump	Volume (ft^3) (1)	Volume (ft^3) (2)
HPCI	4.2	4.7
RCIC	0.42	0.46
RHR	7.7	9.1
CS	4.7	5.6

Notes:

1. *Based on 10% flow for 5 seconds or 5% flow for 20 seconds.*
2. *For void at elevation > 10 feet above pump.*

ECCS Discharge Piping:

A significant flow transient can result when a water mass is accelerated into a non-condensable gas volume as the result of a pump start or the opening of a valve. This acceleration is due to a pressure difference acting on the available water mass with the subsequent motion compressing the gas volume thereby increasing the pressure. Eventually, the gas volume pressure exceeds the pump shutoff head pressure or the stagnation pressure of the water upstream of the valve and the water begins to decelerate. If this deceleration process occurs faster than the resulting compression pressure waves caused by the continued compression of the gas volume, the hydrodynamic process is essentially governed by the acoustic transmission of these pressure waves through the water in the piping. Consequently, this evolves into a gas-water water hammer event and the accompanying force imbalances on the piping segments can be sufficient to challenge the piping supports and restraints.

The BWROG and GEH work demonstrates that any voids for the sections of piping downstream of the first normally closed motor operated isolation valve will not create a water hammer that could challenge the operability of those systems when required to mitigate any postulated events. A portion of piping that discharges into the vessel, or lines directly connected to the vessel, will void (due to flashing) during vessel de-pressurization and are designed accordingly. Any pressure transients occurring due to voids are accounted for in the original piping design margin. Piping design philosophy is to design piping to preclude severe water hammer events. Part of this philosophy is to include hard pipe vents on piping sections where void formation is detrimental. For the piping downstream of the normally closed isolation valve, vents may be installed between the isolation and downstream check valve. These vents can be used to ensure that the piping is vented after a drain down or maintenance in a plant outage but usage at power needs to be carefully evaluated. Generally, the water in this section of piping can be above the saturation temperature at atmospheric pressure, so venting with the system above 212 °F will void the pipe. It will not vent non-condensables.

Given the above, the concerns of GL 2008-01 are addressed for the LPCI, HPCI and CS systems. Containment Spray systems are designed to be voided in standby. No further actions in verifying the piping's actual configuration are necessary to address GL 2008-01 for the discharge piping downstream of the isolation valve.

ABS Consulting Report 1924850-R-001 Revision 1
Table 4-2 Acceptable Discharge Side Voids for Vessel Injection

Numbers shown (X) refer to notes following table.

Discharge Void	***Max Void (Pump Side) ft^3 (1)***	***Max Void (Vessel Side) ft^3 (2)***
HPCI	*36.4*	*36.4*
RCIC	*3.5*	*3.5*
RHR	*132.1*	*34.8*
CS	*40.7*	*13.8*

Notes:

1. *Pump side = from pump to first isolation valve.*
2. *Vessel side = from first isolation valve to vessel.*

- How the GDCs or plant specific principle design criteria listed in GL are met or applied to the station.

DRAFT AEC Criterion 38 - Reliability and Testability of Engineered Safety Features

All engineered safety features shall be designed to provide high functional reliability and ready testability. In determining the suitability of a facility for a proposed site, the degree of reliance upon and acceptance of the inherent and engineered safety afforded by the systems, including engineered safety features, will be influenced by the known and the demonstrated performance capability and reliability of the systems, and by the extent to which the operability of such systems can be tested and inspected where appropriate during the life of the plant.

UFSAR 16.6.2.4 Group IV: Fluid systems (Criteria 30-46)

***Interpretation and Conclusion**:*

The criteria of Group IV are intended to:

(1) Identify those nuclear safety systems within the general category of fluid systems;

(2) Examine each one for capability, redundancy, testability, and inspect ability; and

(3) Assure that each safety feature's capability-scope encompasses all the anticipated and credible phenomena associated with the operational transients or design basis accidents.

In addition, the criteria in Group IV are intended to establish the design requirements for the Reactor Coolant Pressure Boundary (RCPB) and to identify the means for satisfying these design requirements. It was concluded that the JAF Nuclear Power Plant conformed with the intent of the AEC General Design Criteria for Nuclear Power Plants to the maximum extent possible consistent with the state of design and construction at the time of issuance of these criteria.

Further this section of the UFSAR states:

The plant is provided with a Residual Heat Removal System to transfer fission products and other residual heat from the reactor core at a rate such that specified acceptable fuel design limits and the design conditions of the RCPB are not exceeded (Criterion 34). The Emergency Core Cooling Systems (ECCS) are designed to prevent excessive fuel cladding temperatures over the entire spectrum of postulated design basis Reactor Coolant System (RCS) breaks. Such capability is available concurrent with loss of all off-site power. The ECCS themselves are designed to various levels of component redundancy to prevent a single active component failure, in addition to the accident, from negating the required core cooling capability (Criterion 35). To assure that the ECCS functions properly, specific provisions are made for testing the sequential operability and functional performance of each individual system (Criterion 37). Design provisions have also been made to enable physical and visual inspection of the ECCS components to the degree practicable (Criterion 36). Provisions are made for the removal of heat from within the primary containment for as long as is necessary to maintain the integrity of the containment following the various postulated design basis accidents (Criterion 38). The capability to test the functional performance and to inspect the containment heat removal system is provided.

- Mission times for system pumps.

  The IPE mission times for the Core Spray, RHR and HPCI pumps is determined to be 24 hours. These values are described in Appendix L, "Success Criteria" from report JAFRPT-MULT-02107, "James A. FitzPatrick Nuclear Power Station IPE Update," Rev. 2. The considerations that have dominated the choice of the mission time are as follows:

  - *After approximately 1 hour, the Technical Support Center (TSC) and Emergency Offsite Facility (EOF) would be manned and additional expertise and support could be available by phone or transported to these facilities.*
  - *For times greater than 24 hours, it is considered highly likely that offsite resources (i.e., equipment, power, vehicles, etc) would be available for recovery actions.*
  - *From a risk perspective, actual data from natural and man-caused disasters have indicated that public evacuations can be effectively carried out in time frames of less than 24 hours.*

Based on the above considerations, it has been considered in past IPEs (including NUREG-1150) appropriate to use equipment mission time of 24 hours if conditions at that time are stable.

This consideration dictates the use of equipment "run" failure rates (per hour) coupled with a 24 hour mission time to calculate the "run" failure probability of equipment. This calculated "run" failure probability is then sometimes treated conservatively by assuming this failure occurs at time zero.

- Fuel evaluation for acceptable air voids sent to the core during injection.

  The BWR Owners Group draft document on the "Potential Effects of Gas Accumulation on ECCS Analysis as Part of GL 2008-01 Resolution" has provided information that supports that there are no adverse effects of an air void being injected into the reactor. In summary, three main factors would determine why air bubbles (i.e., gas voids) passing through a BWR core do not pose an additional safety concern: (1) unlikely path for air to get into the core, (2) high void conditions already present in the core during a LOCA, and (3) air that does enter the core does not accumulate there, but passes through into the upper plenum and upper parts of the vessel.

From the survey of the BWROG and GEH, the most limiting heatup rate is determined as 12 °F/s. For small amount of delay in actuation of the most effective ECCS component, the anticipated Peak Cladding Temperature (PCT) impact on plant LOCA analyses is provided below:

LOCA PCT Impact for Hypothetical ECCS Delay Amounts.

Delay in ECCS	***PCT Impact***
1 Seconds	*12 °F*
2 Seconds	*24 °F*
3 Seconds	*36 °F*
4 Seconds	*48 °F*
>4 Seconds	*Must Be Analyzed*

The delays indicated are assumed to be the delay in actuation of the ECCS component most effective in mitigating LOCA. For example, for a large-break LOCA, this would be LPCI or CS, for a small-break LOCA, this would be HPCI. Automatic Depressurization System (ADS) is not considered to be impacted by the gas intrusion issue. If the delay in multiple components is to be assumed, the combined effect would be less severe than simple addition of the impact given in the identified delay times. From the initial injection rates of low-pressure systems, a four-second delay would be *equivalent of approximately 25ft^3 of coolant displaced by gas intrusion in the ECCS line.*

Any change greater than 50°F in plant's licensing basis PCT is considered a significant change and requires further action in accordance with10CFR50.46 (a)(3). Therefore, a delay in ECCS greater than 4 seconds cannot be supported by the BWROG/GEH evaluation.

A survey of BWR LOCA analyses was conducted and a limiting LOCA PCT heatup rate of 12 °F/s is determined for the entire U.S. BWR fleet. Using this heatup rate, 48 °F of PCT impact is assessed with a maximum of 4-second delay in the ECCS actuation. The validity of this assessment is confirmed using representative calculations with high heatup rate cases and cases with high PCT. This evaluation is provided as a conservative "worst case" scenario; the majority of the units would benefit from plant-specific evaluations or analyses.

An assessment on the potential impact of gas voids passing through the core was performed by the BWROG and GEH. This assessment justified that gas voids passing through the core do not cause an additional safety concern mainly because of the unlikely path for air to get into the core and high void conditions in the core present during LOCA. Assessments on the Loss of Feedwater (LOFW) and Anticipated Trip Without a Reactor SCRAM (ATWS) events concluded that a delay of 5 seconds in ECCS flow would affect the analysis results insignificantly and have no impact on meeting the acceptance criteria. The evaluation of station blackout events indicates that a delay of 10 seconds would not impact the ability of the water makeup system to maintain the vessel water level above the top of active fuel. Similarly, it is concluded that a delay of 10 seconds would have an insignificant impact on meeting the acceptance criteria in Appendix R fire safe shutdown analysis.

Currently the JAF Core Reload Analysis shows the ECCS response times for injection is analyzed to be 36 seconds for CS, 62 seconds for LPCI and 60 seconds for HPCI. (GEH-EPIWXIWZ-015, "ECCS-LOCA EVAL" and EC 8182 "ECCS LOCA Analysis SAFER/GESTR (T0407) Evaluation). Credit for injection time is taken from the time the injection valve is full open.

5.1.1 Review the design control program and ensure that the design change review checklists have an explicit line item to determine if the design change introduces or increases the potential for gas accumulation beyond established acceptance criteria.

EN-DC-115, 117, 136 and 141 all were found to not address the above review attribute. It is recommended to consider the procedures for improvement pursuant to the Entergy review Criteria to promulgate the requirements pursuant to GL 2008-01.

EN DC-115, "Engineering Change Development"

- *Attachment 9.3, "Impact Screening Summary" does not contain an explicit line item to determine if the design change introduces or increases the potential for gas accumulation beyond established acceptance criteria.*

EN-DC-117, "Post Modification Testing and Special Instructions"

- *Attachment 9.1, "Mechanical Component Test Guide", does not contain an explicit line item to define the testing methodologies of a design change to ensure that it does not introduce or increase the potential for gas accumulation beyond established acceptance criteria*

- *Attachment 9.4, "Post Modification Test Plan Form", does not contain an explicit line item to determine if the design change introduces or increases the potential for gas accumulation beyond established acceptance criteria.*

    - *The PMTP identifies the testing required (Construction, Functional, EC Assumptions, Operations, Post Return to Service). The PMTP documents all tests or series of tests that will be performed to comply with any code requirements for construction testing as well as those that will be performed to demonstrate component and system functionality after completion of the modification. This will include any existing surveillance tests, maintenance tests, or ECTs developed specifically for the modification.*

EN-DC-136, "Temporary Modifications"

- *The procedure content does not contain an explicit line item to determine if the design change introduces or increases the potential for gas accumulation beyond established acceptance criteria.*

EN-DC-141, "Design Inputs"

- *Attachment 9.3, "Impact Screening Summary", does require the Engineer to consider vent paths under Mechanical Considerations, step 43j. However, this line item does not explicitly pertain to determining if the design change introduces or increases the potential for gas accumulation beyond established acceptance criteria. It is suggested to prescribe input activities such as considering proposed isometric configuration or equipment to assure that vents are located at high points or that inverted loops are ventable.*

5.1.2 Enter changes that were identified as part of the design basis review in the CAP.

EN-DC-115, 117, 136 and 141 all were found to not address the above review attribute. It is recommended to consider the procedures for improvement *pursuant to the Entergy review Criteria to promulgate the requirements pursuant to GL 2008-01. (CR HQN-2008-00880, CA-1 & CA-2)*

- <u>*EN DC-115, "Engineering Change Development"*</u>

  Attachment 9.3, "Impact Screening Summary" does not contain an explicit line item to determine if the design change introduces or increases the potential for gas accumulation beyond established acceptance criteria.

- <u>*EN-DC-117, "Post Modification Testing and Special Instructions"*</u>

  Attachment 9.1, "Mechanical Component Test Guide", does not contain an explicit line item to define the testing methodologies of a design change to ensure that it does not introduce or increase the potential for gas accumulation beyond established acceptance criteria.
  Attachment 9.4, "Post Modification Test Plan Form", does not contain an explicit line item to determine if the design change introduces or increases the potential for gas accumulation beyond established acceptance criteria.

  The PMTP identifies the testing required (Construction, Functional, EC Assumptions, Operations, Post Return to Service). The PMTP documents all tests or series of tests that will be performed to comply with any code requirements for construction testing as well as those that will be performed to demonstrate component and system functionality after completion of the modification. This will include any existing surveillance tests, maintenance tests or ECTs developed specifically for the modification.

- <u>*EN-DC-136, "Temporary Modifications"*</u>

  The procedure content does not contain an explicit line item to determine if the design change introduces or increases the potential for gas accumulation beyond established acceptance criteria.

- <u>*EN-DC-141, "Design Inputs"*</u>

  Attachment 9.3, "Impact Screening Summary", does require the Engineer to consider vent paths under Mechanical Considerations, step 43j. However, this line item does not explicitly pertain to determining if the design change introduces or increases the potential for gas accumulation beyond established acceptance criteria. It is suggested to prescribe input activities such as considering proposed isometric configuration or equipment to assure that vents are located at high points or that inverted loops are ventable.

5.1.3 Summarize and document the results of this design basis document review.

Based on the information reviewed including the work by the BWROG, GEH, and ABS, JAF adequately meets the design basis as well as the intent of the AEC General Design Criteria for Nuclear Power Plants to the maximum extent possible consistent with the state of design and construction at the time of issuance of these criteria. Further the plant testing and operation has demonstrated compliance with the design requirements in that there have been no documented evidence of inoperable safety systems due to gas accumulation issues.

Based on the reviews performed to respond to GL 2008-01 JAF has identified areas of improvements to processes to ensure further compliance with the requirements by identifying procedural and program revisions to identify potential voiding issues in ECCS and other fluid systems.

5.1.4 The Design Basis review activities were complete by October 11, 2008.

All design basis review activities have been completed.

5.1.5 Determine if any corrective actions will be completed after October 11, 2008 and identify as licensee commitments that will not be completed within the 9-month GL response date.

Entergy is evaluating the enhancement to the engineering processes and procedures as outlined in Section 5.1.2 to ensure that future modifications are adequately developed to ensure gas accumulation in fluid systems is evaluated. (CR HQN-2008-00880, CA-1 & CA-2, Due 07/30/09)

5.2 <u>DRAWING REVIEW</u>

5.2.1 Review the system P&IDs and isometrics drawings.

Note: SER 2-05, Rev. 1 recommends that simple one-line isometrics be developed for each system to aid the personnel performing the drawing reviews and subsequent venting/verification activities on the systems.

Document the review of the drawings and identify all system vents and high points. System high points include all areas where gas can accumulate in the system, including isolated branch lines, valve bodies, heat exchangers, improperly sloped piping, or located upstream of components in horizontal lines. See Section 5.3 for walkdown activities related to the drawing reviews.

The walkdown drawings for RHR, CS, and HPCI are included in an attachment to ABS Report 1924850-R-001, Revision 1, to aid personnel performing the reviews. The grade elevation drawings were developed using the support stress *isometrics, P&IDs and walkdown data. They show the component and pipe elevation relative to the system flow path, reactor, CST and Torus.*

5.2.2 Summarize new vent valve locations identified as a result of the drawing review.

No new vent valve locations were identified as a result of the drawing review.

5.2.3 Enter the changes that are identified as part of the drawing review in the CAP.

No changes were identified as a result of the drawing review.

5.2.4 Drawing reviews will be completed by October 11, 2008.

All drawing reviews have been completed.

5.3 <u>SYSTEM WALKDOWNS</u>

5.3.1 The scope should include:

- Verification that vents are in the proper location along horizontal (nominal) runs of pipe.

  Based on a review of ABS Report 1924850-R-001, Revision 1 and the ABS generated isometrics, there are eleven locations identified where no vent is available and the potential for void formation exist. These eleven locations are indentified in Table 4-4 of the report. UT examinations of the eleven potentially void locations were performed and all locations were found to be full of water with no evidence of air voiding. Based on the UT results, no additional vents are needed at these locations.

- Verification that vents are in the proper location along circumference of the pipe.

  Based on a review of ABS Report 1924850-R-001, Revision 1 and the ABS generated isometrics, all vents were found to be located properly along the circumference of the pipe.

- Verification that piping is sloped in the proper direction.

  The subject system piping was either verified to have proper slope, or UT inspections were performed on suspect pipe sections. UT examinations are complete and the pipe sections were found to be full of water. Based on the UT results, the slope of the subject piping is determined to be acceptable.

- Verification that horizontal (nominal) runs of pipe do not contain local highpoints.

UT examinations were performed on pipe sections shown to have a local highpoint. No evidence of air voiding was found, as the pipe sections were found full of water. Based on these results, the horizontal pipe runs do not contain local highpoints that would contribute to air accumulation in these locations.

- Walkdowns should be performed on portions of the systems that would require venting to ensure the systems are sufficiently full of water. Walkdowns are not required on portions of the systems that do not require venting to ensure the systems are sufficiently full of water. For example, the containment spray system piping from the containment spray isolation valves to the spray headers is not designed to ensure that the system is sufficiently full of water for some plants. Therefore, these sections of the system do not need to be walked down.

  Walkdowns to measure pipe slope of ECCS piping both outside and inside containment has been completed.

  The following is a brief summary of the pipe slope results from ABS Report 1924850-R-001, Revision 1, Attachment B.

  HPCI

  Sum segment length of piping - 357.4'/ Max total slope w/ error - (-2.35") 47 records.

  CS "A"

  Sum segment length of piping – 93.7'/ Max total slope w/ error - (1.60") 17 records.

  CS"B"

  Sum segment length of piping – 223.6'/ Max total slope w/ error - (2.13") 32 records.

  RHR "A"

  Sum segment length of piping – 270.6'/ Max total slope w/ error - (3.40") 36 records.

  RHR "B"

  Sum segment length of piping – 250.8'/ Max total slope w/ error - (2.11") 37 records.

- Analytical based assessments may result in refining the scope and level of detail of the walkdown (e.g., an analytical assessment may be used to demonstrate that worst case gas accumulation volumes are acceptable in the pump discharge piping).

A walkdown of piping, both non-insulated and insulated, inside and outside of containment, has been completed with the exceptions listed in section 5.3.2.1. Based on the evaluations documented in ABS Report 1924850-R-001, Revision 1 no additional walkdowns and void testing was determined to be necessary of the piping that was not walked down.

5.3.2 Perform system walkdowns for all un-insulated piping located outside containment that does not require scaffolding to access it, and is not located in high radiation areas. These walkdowns will be completed by October 11, 2008.

5.3.2.1 A walkdown of piping which is located outside of containment and not in a high radiation area but is insulated will be performed by October 11, 2008 to gather information which can be reliably obtained without removing the insulation (e.g., high point vent location or correct piping slope).

A walkdown of piping, both non-insulated and insulated, inside and outside of containment, has been completed with the exception of the inaccessible pipe identified below:

- *HPCI suction piping from CST Pit to Reactor Building Wall – Buried*
- *RCIC suction piping from CST Pit to Reactor Building Wall – Buried*
- *CS suction piping from CST Pit to Reactor Building Wall – Buried*
- *CS suction piping from CST in East Crescent – inaccessible without scaffolding*
- *Portion of RHR Train B Containment Spray line overhead at 300' RX BLD NE – inaccessible without scaffolding*
- *Portion of RHR Trains A to LPCI in West Crescent – inaccessible without scaffolding*
- *Portion of RHR Trains B to LPCI in East Crescent – inaccessible without scaffolding*

A tabletop review was conducted with Engineering, Operations, PS&O, Maintenance, and RP which reviewed system isometric drawings for the inaccessible piping areas. It was determined through drawing reviews during the tabletop mulit-departmental reviews that the above locations did not cite any areas gas intrusion may be of concern. Also, due to the satisfactory results of the piping that was accessed for the walkdown and the history of few air voiding events at JAF, included with the table top reviews, it is not necessary to perform walkdowns of the inaccessible sections of this piping. The aforementioned review conclusion performed by JAF was corroborated by the ABS evaluation which did not require additional walkdowns and void testing of the piping that was not walked down.

5.3.3 Portions of systems that are in containment, in high radiation areas, insulated, or require scaffolding to access it may require a refueling outage for proper access and sufficient planning time in advance of the refueling outage and thus may not be walked down by October 11, 2008. Document the walkdown schedules (e.g., refueling outage) and the basis (e.g., in containment, in high radiation areas, insulated, or require scaffolding to access it) for these portions of the systems.

A walkdown of piping inside containment, both insulated and non-insulated, was completed during RO18 in September, 2008.

5.3.4 Develop a prioritized walkdown list of piping sections based on the configuration, pressure change potential, and source analysis (vulnerability to gas intrusion, see Section 5.4.2). In general, suction piping is more critical than discharge piping.

A prioritized walkdown list of piping sections was developed based on the Core Damage Frequency number assigned by the site specific PRA. All walkdowns have been completed per project plan documented in LO-LAR-2008-00020. No further walkdowns are scheduled.

5.3.5 Document the results of the walkdown, including any deficiencies and concerns. The piping sections and the applicable drawing numbers should be included in the review documentation. Descriptions should include the scope of the walkdowns and any basis for excluding portions of the system from detailed walkdowns.

All aspects of the walkdown activities are documented in ABS Report 1924850-R-001, Revision 1. A walkdown of piping outside and inside containment, both insulated and non-insulated, was completed prior to or during RO18, with the exception of the inaccessible pipe located outside containment:

- *HPCI suction piping from CST Pit to Reactor Building Wall – Buried*
- *RCIC suction piping from CST Pit to Reactor Building Wall – Buried*
- *CS suction piping from CST Pit to Reactor Building Wall – Buried*
- *CS suction piping from CST in East Crescent – inaccessible without scaffolding*
- *Portion of RHR Train B Containment Spray line overhead at 300' RX BLD NE – inaccessible without scaffolding*
- *Portion of RHR Trains A to LPCI in West Crescent – inaccessible without scaffolding*
- *Portion of RHR Trains B to LPCI in East Crescent – inaccessible without scaffolding*

Due to the satisfactory results of the piping that was accessed for the walkdown and the history of few air voiding events at JAF, it is not necessary to perform walkdowns of the inaccessible sections of this piping. In addition, collegial reviews of systems piping diagrams did not cite areas where gas intrusion may be of concern in the piping that was not walked down. The aforementioned review conclusion was corroborated by the ABS evaluation which did not require additional walkdowns and void testing of the piping that was not walked down.

5.3.5.1 Identify any discrepancies between as-built field conditions and the drawings relevant to gas accumulation issues (e.g. vent not installed, pipe slope not as identified, etc.).

Based on a review of ABS Report 1924850-R-001, Revision 1, all vent valves were found to be installed as shown on the drawings.

5.3.5.2 Verify vent locations, including the location on the pipe (circumferentially, as well as the location along the length of pipe).

Based on a review of ABS Report 1924850-R-001, Revision 1 and the ABS generated isometrics, all vents were found to be located properly along the length of the piping sections and around the circumference of the pipe.

5.3.5.3 Identify additional high points (all areas vulnerable to gas accumulation). The GL includes the following areas for consideration:

- High points in pipe runs, including elevation variation in nominally horizontal pipes (e.g. improperly sloped piping).

  ABS Report 1924850-R-001, Revision 1, Table 4.4 identified 15 areas of potential concern for gas voiding. These 15 locations were subsequently UT inspected. No potential concerns were identified.

- High points created by closed valves in vertical piping runs.

  Valves 10MOV-27 A & B were identified by ABS (see ABS Report 1924850-R-001, Revision 1). These valves are listed in Table 4.5 of this report as ID numbers 8 and 9. UT examinations demonstrated that these areas were full of water and are therefore no longer a potential concern.

- DHR system heat exchanger U-tubes, or other heat exchangers

  The RHR heat exchangers are lower than the system high point vent valves. Entrained air within the shell side of the RHR heat exchangers will migrate out of the heat exchanger to the high point vent valves due to elevation difference. The RHR heat exchangers *have vent valves to vent air voids from the shell side; however, sufficient procedural guidance does not exist to address system / equipment venting following maintenance activities and on a prescribed frequency during normal plant operation.*

OP-13D was enhanced in September 2008 to include RHR HX vents (10RHR-451A &B) to ensure system venting to lessen the likelihood of a Shutdown Cooling System trip on pump start due to hydraulic transient. The 'A' and 'B' heat exchangers was vented and found full of water (no air).

- Horizontal pipe diameter transitions that introduce traps at the top of the larger piping or piping upstream of components (including orifice plates, reducers, and backing rings)

  This attribute was addressed and bounded by ABS evaluation (ABS Report 1924850-R-001, Revision 1, Section 3.3.9 Potential Voids at Component and Piping Configuration Locations).

- Tees where gas contained in flowing water can pass into a stagnant pipe where it then accumulates

  This attribute was addressed and bounded by ABS evaluation (ABS Report 1924850-R-001, Revision 1, Section 3.3.9 Potential Voids at Component and Piping Configuration Locations).

- Valve bonnets

  This attribute was addressed and bounded by ABS evaluation (ABS Report 1924850-R-001, Revision 1, Section 3.3.9 Potential Voids at Component and Piping Configuration Locations).

- Pump casings

  This attribute was addressed and bounded by ABS evaluation (ABS Report 1924850-R-001, Revision 1, Section 3.3.9 Potential Voids at Component and Piping Configuration Locations).

5.3.6 If previous walkdowns will be relied upon in the GL response, ensure that they were performed in a manner sufficient to address the intent of the GL. Document previous walkdowns or validations performed, assess their adequacy and develop a plan (scope/ schedule/ responsible groups) for future walkdowns, if needed. Document corrective actions and the schedules for future walkdowns that will be performed after October 11, 2008 (See Section 5.3.3).

Walkdowns were performed for the GL 08-01 response; no previous walkdowns were relied upon.

5.3.7 Document the location of inaccessible areas (e.g. buried piping), the basis for its exclusion from the walkdowns, and the justification for acceptable system operation without walkdown data. The evaluation and justification of this piping should be completed by October 11, 2008.

A walkdown of piping, both non-insulated and insulated, inside and outside of containment has been completed with the exception of the inaccessible pipe identified below:

- *HPCI suction piping from CST Pit to Reactor Building Wall – Buried*
- *RCIC suction piping from CST Pit to Reactor Building Wall – Buried*
- *CS suction piping from CST Pit to Reactor Building Wall – Buried*
- *CS suction piping from CST in East Crescent – inaccessible without scaffolding*
- *Portion of RHR Train B Containment Spray line overhead at 300' RX BLD NE – inaccessible without scaffolding*
- *Portion of RHR Trains A to LPCI in West Crescent – inaccessible without scaffolding*
- *Portion of RHR Trains B to LPCI in East Crescent – inaccessible without scaffolding*

Due to the satisfactory results of the piping that was accessed for the walkdown and the history of few air voiding events at JAF, it is not necessary to perform walkdowns of the inaccessible sections of this piping. In addition, collegial reviews of systems piping diagrams did not cite areas where gas intrusion may be of concern in the piping that was not walked down. The aforementioned review conclusion was corroborated by the ABS evaluation which did not require additional walkdowns and void testing of the piping that was not walked down.

5.3.8 Summarize new vent valve locations identified as a result of the walkdowns.

No new (undocumented) vent valve locations were identified as a result of the walkdowns.

5.3.9 Enter the changes that are identified as part of the system walkdowns in the CAP.

No needed changes were identified by the system walkdowns.

5.4 SYSTEM REVIEW

All reviewed procedures must be listed, the responsible department identified and the title/brief description included. Any required changes are to be described along with the reason for change or state if no changes are required. Provide a status for the change: state if complete, or provide a tracking number and a reason why it is acceptable and why it can't be completed prior to October 11, 2008.

5.4.1 Fill and Vent

5.4.1.1 For each system (including branch lines), review the process used for filling and venting each section of piping, including all applicable procedures.

A review of JAF procedures for filling and venting determined that adequate procedural guidance is in place to ensure that the subject systems are sufficiently full with water. This determination was validated by the results of UT exams conducted during R18 which demonstrated that the subject systems remain sufficiently full with water

Procedural changes were identified to further enhance existing plant methods and processes. These include enhancements which ensure the filling and venting of piping systems where gas may accumulate.

5.4.1.1.1 Review and verify that all venting activities are controlled by an approved operating procedure. This includes a review of existing procedures to identify any required revisions, as well as identifying the need for the creation of new procedures to address venting.

A review of procedures was conducted. Based upon the review of these procedures, guidance for filling and venting was found.

The following procedures were reviewed:

- *OP-13, RHR System Operating Procedure*
- *OP-13E, RHR System Keep-Full Operating Procedure*
- *OP-14, CS System Operating Procedure*
- *OP-15, HPCI System Operating Procedure*
- *EN-OP-102, Revision 10, Protective and Caution Tagging*
- *EN-OP-102-01, Revision 4, Protective and Caution Tagging Forms & Checklist*
- *ST-3AA, Core Spray loop A Monthly Operability Test*

- *ST-3PA, Core Spray loop A Quarterly Operability Test*
- *ST-3AB, Core Spray loop B Monthly Operability Test*
- *ST-3PB, Core Spray loop B Quarterly Operability Test*
- *ST-2AN, RHR Loop A Monthly Operability Test*
- *ST-2AL, RHR Loop A Quarterly Operability Test*
- *ST-2AO, RHR Loop B Monthly Operability Test*
- *ST-2AM, RHR Loop B Quarterly Operability Test*

5.4.1.1.2 Verify that procedures exist to vent all locations where gas may accumulate using existing vent valves.

A review of procedures was conducted. Based upon the review of these procedures, guidance for filling and venting was found. There are some high point vents that are not currently used for venting however; procedural enhancements are being made to correct this issue. (LO-LAR-2008-00020, CA-15 & CA-20)

5.4.1.1.3 Ensure venting procedures and practices utilize the effective sequencing of steps, adequate venting durations, and acceptance criteria for the completion of venting.

A review of procedures was conducted. Based upon the review of these procedures, guidance for filling and venting was found. However, the sequencing of steps, adequate venting durations and acceptance criteria were found to be inadequate. Procedural enhancements will be made. (LO-LAR-2008-00020, CA-15 & CA-20)

5.4.1.1.4 Ensure that venting of instrument lines, including the backfilling of level and flow transmitters, is included in system venting procedures.

A review of procedures was conducted. Based upon the review of these procedures, guidance for filling and venting of instrument lines was found. However, procedural enhancements were identified and will be made. (LO-LAR-2008-00020, CA-15 & CA-20)

5.4.1.1.5 Demonstrate the effectiveness of dynamic venting methods for all locations where dynamic venting is used (adequate flow rates/fluid velocities). Revise procedures as necessary to ensure that dynamic venting is adequately implemented.

JAF, currently, has no plans to utilize dynamic venting methods for the subject systems.

5.4.1.1.6 Discuss if vacuum fill operations are used for piping sections which are difficult to fill and vent following maintenance. This activity will be completed by October 11, 2008.

Utilizing vacuum filling methodology is not being considered due to the limited amount of air voiding evidenced in the subject systems.

5.4.1.1.7 Evaluate the use of vacuum fill operations for piping sections which are difficult to fill and vent following maintenance. Implementation of vacuum fill may require plant modifications, changes to procedures, and personnel training. This activity may not be completed by October 11, 2008

Not applicable based on 5.4.1.1.6 above.

5.4.1.1.8 Ensure that fill and vent procedures provide instruction to modify restoration guidance to address changes in maintenance work scope or to reflect different boundaries from those assumed in the procedure.

Procedures EN-OP-102 and EN-OP-102-1 were reviewed. The procedure was reviewed. Direction to assure that filling and venting each section of piping is required in the development of Tagout Restoration but was not found. As such, compiling the restoration section of the tagout becomes a knowledge base task reliant upon use of a previously compiled tagout template. Procedural enhancements were identified and will be made. (LO-LAR-2008-00020, CA-15 & CA-20)

5.4.1.1.9 Review and revise the procedures to ensure they incorporate verification techniques to validate that systems are sufficiently full of water following fill and vent, based on quantification of any remaining gas void against the established acceptance criteria.

Current procedures as referenced in 6.1, were revised to ensure that "any" air noticed during venting operations gets documented per a condition report. Actual volume is not determined since air quantities currently cannot be accurately measured in an effective and cost efficient manner.

While no acceptance criteria have been established to quantify gas volume, procedure ST-4B, Revision 56, "HPCI Monthly Operability Test" does require a determination of the amount of air released during venting. The amount of air must be characterized as either "significant" or "insignificant" based on the following definition. A significant amount of air is defined as requiring more than 1 minute to obtain a solid stream of water from hose.

JAF will continue to monitor this issue with the industry as they determine the best means available for performing this task. If acceptance criteria redeveloped along with measurement means, JAF will revise the venting procedures at that time to incorporate the standards.

A review of procedures was conducted. Based upon the review, procedures were not found to validate that the subject systems are sufficiently full of water following filling and venting.

5.4.1.1.10 For any high points without adequate vents, dynamic venting justification, or venting verification (including improperly sloped piping or located upstream of components in horizontal runs), initiate corrective actions to modify the system to install any required vents and utilize the new vents in process documents (e.g. venting procedures, work orders, etc.).

There are no known high point locations that do not currently contain vents. There are some high point vents that are not currently used for venting however; procedure enhancements will be performed to correct this issue. (LO-LAR-2008-00020, CA-15 & CA-20)

5.4.1.2 Summarize the new vent valve locations identified as a result of the system review.

Based on the system reviews performed and documented in this report, there were no locations identified that required installation of new vent valves.

5.4.1.3 All unvented gas must be quantified, trended and justified through a formal Technical Evaluation or Calculation process (consistent with Section 5.4.3).

A technical evaluation of CS, HPCI and RHR unvented gas was evaluated by ABS Report 1924850-R-001, Revision 1. The results of the ABS report are detailed later in Section 5.4.3 of this report.

5.4.1.4 Review of the fill and vent activities and the identification of procedure changes and corrective actions will be completed by October 11, 2008.

A review of the fill and vent activities, identification of procedure changes, and initiation of corrective actions has been completed.

5.4.1.5 Enter the changes that are identified as part of the fill and vent activity review in the CAP.

CR-HQN-2008-00882, Generic Letter 2008-01 Issue

Entergy review criteria for GL 2008-01 indicates to review the process used for filling and venting each section of in-scope ECCS piping, including all applicable procedures.

EN-OP-102 and EN-OP-102-01 were found not to address the above review attribute. It is recommended to consider improving the procedures per the Entergy review Criteria to promulgate the GL 2008-01 requirements.

- <u>*EN-OP-102, "Protective and Caution Tagging"*</u>
  The procedure was reviewed. Direction to assure that filling and venting each section of piping is required in the development of Tagout Restoration but was not found. As such, compiling the restoration section of the tagout becomes a knowledge base task reliant upon use of a previously compiled tagout template. Without clear procedure direction, improper system venting during restoration can and has occurred. It is recommended to provide direction to the use of the system's filling and venting procedure when clearing the Tagout to assure filling and venting each section of piping.

- <u>*EN-OP-102-01, "Protective and Caution Tagging Forms & Checklist"*</u>
  The procedure was reviewed. Attachment 9.17, "Protective and Caution Tagging Forms & Checklists" does provide a Pre and Post-job briefing checklists for clearing a Tagout. The Pre-job briefing checklist form contains a line item to discuss how a system will be filled and vented. The Post-job briefing checklist contains a line item asking if the system is completely filled and vented and if additional actions are required.

EN-OP-012 and EN-OP-102-01 were developed to work in consort with each other. In the absence of providing direction (system venting procedure) to assure that filling and venting each section of piping is required in the development of Tagout Restoration, the Pre-job and Post-job checklists for Tagout Restoration are not set-up to assure adequate system filling and venting.

LO-LAR-2008-00020, CA-15 & CA-20, Generic Letter 2008-01 Issue

Entergy review criteria for GL 2008-01 (in-scope ECCS systems) indicated to review the process used for filling and venting each section of piping, including all applicable procedures.

A review for processes and or procedures was conducted. Based upon the review, processes and or procedures were not found for filling and venting each section of piping. The following items should be considered for improving current procedural guidance:

- *All system vent locations were not found to be periodically vented. System venting via installed system vents should be considered to enhance current procedural guidance. Consideration of venting at installed system vent locations could be an enhancement to the surveillance test (which would address frequency of performance).*
- *Procedural guidance should be considered to be developed for filling / venting systems following maintenance activities.*

CR-HQN-2008-00881, Generic Letter 2008-01 Issue

Entergy review criteria for GL 2008-01 indicates to review the process used for filling and venting each section of in-scope ECCS piping, including all applicable procedures.

Based upon Section 5.4 of the scope and recommendations contained within the Entergy Template for addressing Engineering / Operating and Maintenance type procedures for ensuring systems are designed, operated and maintained in such a manner as not to introduce or increase the potential for gas accumulation beyond established acceptance criteria. It is recommended to consider Operational procedural development pursuant to the Entergy review Criteria to promulgate the requirements pursuant to GL 2008-01.

5.4.2 Gas Intrusion

5.4.2.1 Identify all areas of potential gas intrusion into each system and each system segment vulnerable to subsequent gas accumulation. Assess the system against all potential areas of intrusion/accumulation identified in GL 2008-01 and listed below. The evaluation of gas intrusion prevention, monitoring, evaluation, and acceptance criteria (consistent with Section 5.4.3) should be included, as applicable, for each system piping segment determined to be vulnerable to gas intrusion and accumulation in any of the areas listed below.

5.4.2.1.1 Leakage from accumulators or other high-pressure sources can result in gases coming out of solution.

Accumulators are not utilized in the RHR, CS or HPCI systems.

5.4.2.1.2 Leakage from the RCS can result in the formation of steam pockets or hydrogen coming out of solution.

Any leakage coming from the RHR or CS systems will not form a steam pocket or hydrogen coming out of solution. Any system leakage does not create a drop in system pressure since the pressurized keep full supply constantly pressurizes the systems. Additionally, any leak path from RHR or CS would be discovered during Operations and system engineering walkdowns.

5.4.2.1.3 Dissolved gas can come out of solution due to a pressure reduction such as through control valves, orifices, and ECCS sump screens, or because of elevation changes or venting.

All the ECCS systems typically are in standby and depressurized condition. The only areas of a High / Low pressure interface in the ECCS systems are exhibited at the interaction from reactor vessel pressure to the RHR injection piping at the normally closed injection valve. All the keep full systems are a Low / Low pressure interface. Any gas that comes out of solution as a result of a pressure drop due to orifice, control valve, screen geometries, would be due to flow and will be swept away.

5.4.2.1.4 Inadvertent draining, system realignments, and incorrect maintenance and testing procedures can result in gas intrusion.

- Verify that discharge low-pressure alarms are set conservatively on keep-fill systems, if installed.

Level switches are used instead of low pressure alarms

In an effort to verify keep-full level switches were in calibration, it was discovered that RHR keep-full level switch

10LS-101 does not have a calibration PM posted against it, and the calibration frequency and basis for the RHR and Core Spray keep-full level switches does not meet Entergy PM template standards. REF: CR-JAF-2008-03373.

- Ensure that system response actions following a loss of the keep-fill system adequately address gas void formation and system restoration.

Reviewed ARP 09-3-1-18 (RHR A or B Disch Line Not Full and ARP 09-3-1-10 (Core Spray A or B Disch Line Not Full). Both documents give guidance on system restoration after air intrusion into system, with adequate warnings on water hammer issues.

5.4.2.1.5 Air in-leakage can occur through system pathways which allow drain back to the system.

Air in-leakage through system pathways which allow drain back to the system would not occur unless a leak was present. The suction piping for the RHR and CS are pressurized from the torus. The discharge piping is continuously pressurized with a keep-full system. The HPCI suction and discharge piping is pressurized from the CST. Should a leak occur that could cause air in leakage, this would be noticed by operator rounds or by level indications in the Torus or the CST.

5.4.2.1.6 Failure of level instruments to indicate the correct level for tanks used as a pump suction source can result in gas intrusion.

The table below reflects the annunciator Response Procedures (ARP) for Condensate Storage Tank Level Instrument Alarm Actions for the HPCI and RCIC Systems. Understanding that RCIC is not within the scope of the Generic Letter, the table illustrates instrumentation redundancy for each system (HPCI and RCIC) as well as a tertiary tank level indication independent of these two systems. While there is a potential for a singular level instrument failure to occur, the likelihood of a total loss of CST level indication is unlikely. Therefore, gas intrusion due to a failure of CST level indication is not probable.

Annunciator Response Procedures (ARP) for Tank Level Instrument Alarm Actions for HPCI and RCIC Systems

ARP Procedure No.	Annunciator Legend	Device	Setpoint	Cause
09-3-3-07	HPCI CST A LVL LO	23LS-74A, 23LS-75A, 23PNS-101A	60 inches and 23HPI-01A not full open	Low water level in 33TK-12A (condensate storage tank A) due to loss of inventory from tank or HPCI and RCIC usage
09-3-3-08	HPCI CST B LVL LO	23LS-74B and 23LS-75B	60 inches and 23HPI-01b not full open	Low water level in 33TK-12B (condensate storage tank B) due to loss of inventory from tank or HPCI and RCIC usage
09-4-0-28	RCIC CST A LVL LO	13LS-76A (condensate storage tank A RCIC logic level switch	59.5 inches	CST level less than 59.5 inches
09-4-0-29	RCIC CST A LVL LO	13LS-76B (condensate storage tank B RCIC logic level switch	59.5 inches	CST level less than 59.5 inches
09-6-2-10	CST A OR B LVL HI OR LO	33LS-101 (Cond Storage TK-12A&B HI and Lo Level Switch)	Low: 238-19 inches High 350.81 inches	Low: Hotwell level control failure

5.4.2.1.7 Leakage through isolation valves or through check valves can result in gas transport from the intrusion location to other locations in the ECCS.

Air in-leakage through system pathways which allow drain back to the system would not occur unless a leak was present. The suction piping for the RHR and CS are pressurized from the torus. The discharge piping is continuously pressurized with a keep-full system. The HPCI suction and discharge *piping is pressurized from the CST. Should a leak occur that could cause air in leakage, this would be noticed by operator rounds or by level indications in the Torus or the CST.*

5.4.2.1.8 Leakage through vent valves can occur when the local system pressure is less than the nominal atmospheric vent pressure.

The local system pressure will not be less than nominal atmospheric pressure, as the RHR & Core spray suction is pressurized to Torus head of water and the discharge is pressurized to keep full system pressure.

5.4.2.1.9 Temperatures at or above saturation temperature can occur due to heat conduction through piping connected to the RCS or due to leakage of RCS fluid through isolation valves.

- Verify that any discharge thermocouple monitoring thresholds are set conservatively, if applicable.

  CS, HPCI and RHR were reviewed for discharge thermocouple configurations. Thermocouple applications were not found during this review. Of note, CIVs are normally closed which provides a thermal barrier between the subject systems and RCS.

5.4.2.1.10 Gas can be introduced from suction sources due to formation of air entraining vortices or by not isolating the suction source before it is completely drained.

The potential for a vortex to form, while HPCI, RHR or CS is aligned to take suction from the Torus suppression pool, was evaluated by calculation A384.F02-03. This calculation concluded that a vortex would not develop at the HPCI, RHR or CS suction strainers since the minimum water level in the suppression pool is well above the water level where conditions would support the formation of a vortex.

HPCI has two suction sources, the Torus suppression pool as addressed above, and the CSTs. The potential for a vortex to form while HPCI is taking suction from the CSTs was evaluated by calculation JAF-CALC-07-00032. This calculation concluded that there was sufficient submergence depth to prevent the formation of a vortex.

5.4.2.1.11 Review air-operated valve designs for potential air leakage into the system.

CS, HPCI and RHR were reviewed for Air Operated Valve (AOV) design configurations (i.e., Flow Control Valve, Pressure Control Valve, and Air Operated Valve) where the associated air operator may provide a potential air in-leakage path. AOV type applications were identified in the review however none were noted as providing a air in-leakage communication path from the air operator to the fluid side of the system.

5.4.2.1.12 Identify other plant specific methods of gas intrusion.

Off-gassing of non-deoxygenated water used during system filling and venting following maintenance activities (given enough time) will provide a gas intrusion mechanism. This concept is thought to be equally applicable following system operation in support of plant operations or surveillance testing. For these reasons, the recommendation for consideration of conducting periodic system venting was developed (LO-LAR-2008-00020, CA-15 & CA-20).

Otherwise, there are no other methods of gas intrusion that have not already been identified.

5.4.2.1.13 Enter changes that were identified as part of the gas intrusion review.

LO-LAR-2008-00020, CA16, Generic Letter 2008-01 Issue

Entergy review criteria for GL 2008-01 (in-scope ECCS systems) indicate to identify all areas of potential gas intrusion into each system and each system segment vulnerable to subsequent gas accumulation. Assess the system against all potential areas of intrusion/accumulation identified in GL 2008-01 and in the Entergy Engineering Template for addressing the GL.

RHR system heat exchangers (10E-2A and 10E-2B, referred to hereafter as 'HX') inlet piping configuration inherently provides a system high point at each HX inlet piping manifold. This piping configuration provides an area vulnerable to gas accumulation. This piping is provided with high point vent locations (10RHR-451A / B) that are not currently vented from at any frequency due to the valves location in a High Radiation Area.

Pursuant to Licensing commitment A-5408, NUREG-0737 Item II.B.1 – NYPA Response to NRC Question, JAF has committed to the following.

"Venting of the RHR heat exchanger is accomplished through two safety related motor operated valves, installed in series and operated from the control room. Operating procedures provide the operator with guidance for venting the heat exchanger to prevent accumulation of noncondensible gases."

The licensing discrepancy is cited in LO-LAR-2008-00020, CA-12. It is recommended that in addition to venting from 10MOV-166A (B) and 10MOV167A (B) as per the Licensing Commitment that the HX's be fully vented by use of 10RHR-451A (B). If the HX was drained, using the MOV's will fill the HX most of the way and then could be fully vented using 10RHR-451A / B. This approach to venting will reduce area stay time and dose accrual.

LO-LAR-2008-00020, CA-15 & CA-20, Generic Letter 2008-01 Issue

Entergy review criteria for GL 2008-01 (in-scope ECCS systems) indicated to review the process used for filling and venting each section of piping, including all applicable procedures.

A review for processes and or procedures was conducted. Based upon the review, processes and or procedures were not found for filling and venting each section of piping. The following items should be considered for improving current procedural guidance:

- *All system vent locations were not found to be periodically vented. System venting via installed system vents should be considered to enhance current procedural guidance. Consideration of venting at installed system vent locations could be an enhancement to the surveillance test (which would address frequency of performance).*
- *Procedural guidance should be considered to be developed for filling / venting systems following maintenance activities.*

LO-LAR-2008-00020, CA17, Generic Letter 2008-01 Issue

Entergy review criteria for GL 2008-01(in-scope ECCS systems) indicate to identify all areas of potential gas intrusion into each system and each system segment vulnerable to subsequent gas accumulation. Assess the system against all potential areas of intrusion/accumulation identified in GL 2008-01 and in the Entergy Engineering Template for addressing the GL.

RHR system heat exchangers (10E-2A and 10E-2B, referred to hereafter as 'HX') inlet piping configuration inherently provide a system high point at each HX inlet piping manifold. This piping configuration provides an area vulnerable to gas accumulation.

This piping is provided with high point vent locations (10RHR-451A / B) that are not currently vented from at any frequency due to ALARA concerns. Presented with this system vulnerability, a system design enhancement evaluation pursuant to GL 2008-01 should be considered to enhance the installation of vent valve 10RHR-451A / B effluent routing configuration in such a manner as to allow venting of the switches from an accessible – low dose area

In addition, this piping is provided with high point vent locations (10RHR-451A / B) that are not currently vented from at any frequency due to ALARA concerns. Presented with this system vulnerability, a system design enhancement evaluation pursuant to GL 2008-01 should be considered for the installation of level instrumentation / switches for continuous monitoring capability to assure the system HX's remain full. Such level switches are currently installed elsewhere in the RHR system for this very function (reference: 10LS-100, 101, 102, 103,& 104).

Should level switches be installed at the HX high points, consideration should be given to evaluate the following as a part of the design / operation:

- *Periodic level switch venting is recommended to corroborate switch functionality.*
- *The level switch piping / tubing / vent valve routing configuration should be configured in such a manner as to allow venting of the switches from an accessible – low dose area.*

5.4.2.2 All of the gas intrusion review activities will be completed by October 11, 2008.

All gas intrusion review activities have been completed.

5.4.3 Acceptance Criteria

5.4.3.1 Identify applicable acceptance criteria for allowable gas volume limits for each piping section where gas may accumulate. See Section 5.4.2 for Gas Intrusion vulnerability reviews. This will be completed by October 11, 2008.

5.4.3.1.1 Verify that the acceptance criteria for pump suction piping gas volume limits are sufficient to ensure the gas volume fraction at the pump suction is acceptable under flowing conditions.

The suction side piping was evaluated to determine acceptable size voids to meet the acceptance criteria as outlined in Section 3.3 of ABS Report 1924850-R-001, Revision 1. The resulting acceptable suction side voids, based on the evaluation contained in calculation 1924850-C-002 are outlined in Table 4-1.

Table 4-1: Acceptable Suction Side Voids
ABS Consulting Report 1924850-R-001 Revision 1

Numbers shown (xx), refer to notes following table.

Pump	*Volume (ft^3) (1)*	*Volume (ft^3) (2)*
HPCI	*4.2*	*4.7*
RCIC	*0.42*	*0.46*
RHR	*7.7*	*9.1*
CS	*4.7*	*5.6*

Notes:

1. *Based on 10% flow for 5 seconds or 5% flow for 20 seconds*
2. *For void at elevation > 10 feet above pump.*

- In lieu of specific pump testing results, acceptance criteria should be based on industry guidance for acceptable pump performance.

The acceptance criteria referenced in ABS Report 1924850-R-001, Revision 1, is based on guidance provided the BWROG by GE/Hitachi.

- Acceptance criteria should correlate the allowable accumulated gas volume with the allowable rate of transport to the pump under flow conditions. The range of flow conditions evaluated should be consistent with the full range of design base flow rates for various break sizes and locations.

  ABS Report 1924850-R-001, Revision 1, Section 3.3.1, states ECCS pumps are expected to remain operable with an average continuous void fraction and limited time void fraction. Based on guidance provided the BWROG by GE/Hitachi., the following criteria can be applied to any void in the suction piping:

  - *Continuous void fraction at the pump of 1 %*
  - *Limited time void fraction passing the pump of 10% for 5 seconds*

  Most testing performed for gas intrusion effects was at the Best Efficiency Point (BEP) for the pump. However, there are concerns on the effects of gas intrusion during lower and higher flow scenarios. During most BWR accident scenarios, HPCI and/or RCIC will start and inject immediately. RHR and CS may run on minimum flow for a period of time before low pressure permissives for injection are satisfied. Minimum flow is generally at approximately 10% of peak efficiency flow on the pump curve and is provided to ensure the pump does not overheat.

  The report further states that it is overly conservative to apply a continuous void fraction to BWR suction line voiding. The most probable event in a BWR will involve a shorter duration flow of gas after pump start because of gas trapped in the suction line due to inadequate venting following maintenance activities.

- Acceptance criteria should consider the prevention of pump air binding, limit pump wear to within the acceptable mission time of the pump, and limit the hydraulic performance reduction in the pump to limits defined by the safety analyses.

Based on evaluation of the gas intrusion data that was incorporated into ABS Report 1924850-R-001, Revision 1 Section, 3.3.1 and guidance provided the BWROG by GE/Hitachi, a bounding 2% by volume continuous suction gas void fraction is acceptable for continuous pump operation. It could cause increased wear of the pump, but will not cause pump operability problems. However, due to the lack of test data or operating experience of pump operation above 120% of the BEP, it is recommended that pumps which are operated above this point be limited to a 1% allowable continuous void fraction.

5.4.3.1.2 Ensure the acceptance criteria for pump discharge side voiding address water hammer.

- Acceptance criteria should consider force loads on pipes and hangers, peak pressure pulses, relief valve opening and reclosing, secondary water hammer due to check valve slamming, and delays or reduction in flow delivery.

  Longitudinal pipe stresses as a result of the discharge side pressure transients were screened as outlined in Section 4.6.2 of ABS Report 1924850-R-001, Revision 1 and evaluated in calculation 1924875-C-001. The results of this evaluation are summarized in Table 4-8 of the same ABS Report.

  The acceptance criteria are met for all cases.

5.4.3.2 Develop acceptance criteria for allowable gas volume limits for each location where gas may accumulate, if it does not exist. This will be completed by October 11, 2008.

Acceptance criteria for allowable gas volume limits were calculated by ABS and provided in ABS Report 1924850-R-001, Revision 1.

5.4.3.3 Follow industry activities related to the development of acceptance criteria on allowable gas volume limits for pumps and piping. Determine the need for revised acceptance criteria as new information becomes available. This will not be completed by October 11, 2008.

Allowable gas volume limits were calculated by ABS and provided in ABS Report 1924850-R-001, Revision 1. JAF will utilize all resources *available, such as BWROG, to keep abreast of new developments, research, and information, and incorporate into processes and procedures as it becomes available. This will be an ongoing process and will not be completed by 10-11-08.*

5.4.3.4 Enter the changes that are identified as part of the acceptance criteria review in the corrective action program.

The acceptance criteria is detailed in ABS Report 1924850-R-001, Revision 1. There were no changes required.

6.0 TESTING EVALUATION:

All reviewed procedures (and WOs) must be listed, the responsible department identified and the title/brief description included. Any required changes are to be described along with the reason for change, or state if no changes are required. Provide a status for the change: state if complete, or provide a tracking number and a reason why it is acceptable and why it can't be completed prior to October 13, 2008.

6.1 Identify periodic venting (e.g., the Tech Spec 31-day venting surveillance) or gas accumulation surveillance (e.g., ultrasonic testing) procedures that are performed on each system.

- The following Operating procedures / surveillances were reviewed:
  - *OP-13, RHR System Operating Procedure*
  - *OP-13E, RHR System Keep-Full Operating Procedure*
  - *OP-14, CS System Operating Procedure*
  - *OP-15, HPCI System Operating Procedure*
  - *EN-OP-102, Revision 10, Protective and Caution Tagging*
  - *EN-OP-102-01, Revision 4, Protective and Caution Tagging Forms & Checklist*
  - *ST-3AA, Core Spray loop A Monthly Operability Test*
  - *ST-3PA, Core Spray loop A Quarterly Operability Test*
  - *ST-3AB, Core Spray loop B Monthly Operability Test*
  - *ST-3PB, Core Spray loop B Quarterly Operability Test*
  - *ST-2AN, RHR Loop A Monthly Operability Test*
  - *ST-2AL, RHR Loop A Quarterly Operability Test*
  - *ST-2AO, RHR Loop B Monthly Operability Test*
  - *ST-2AM, RHR Loop B Quarterly Operability Test*

If air flow was observed during the venting process, a CR is required to be initiated. Procedure ST-4B, HPCI Monthly Operability Test, provides the actions to vent piping and further defines the measurement of the gas / air discharge. This test defines a *"significant amount of air / gas" as that requiring more than a minute to obtain a steady flow of water. If this amount is exceeded, then a CR would be initiated.*

6.2 Review the periodic venting or gas accumulation surveillance procedure to:

6.2.1 Ensure consistent and adequate processes are used to verify the effectiveness of periodic venting and surveillance procedures.

All system vent locations were not found to be periodically vented. System venting via installed system vents should be considered to enhance current procedural guidance. Consideration of venting at installed system vent locations could be an enhancement to the surveillance test (which would address frequency of performance).

6.2.2 Ensure that procedures identify the quantity of gas present or vented during surveillances.

Current procedures as referenced in 6.1, were revised to ensure that "any" air noticed during venting operations gets documented per a condition report. Actual volume is not determined since air quantities currently cannot be accurately measured in an effective and cost efficient manner.

While no acceptance criteria have been established to quantify gas volume, procedure ST-4B, Revision 56, "HPCI Monthly Operability Test" does require a determination of the amount of air released during venting. The amount of air must be characterized as either "significant" or "insignificant" based on the following definition: "A significant amount of air is defined as requiring more than 1 minute to obtain a solid stream of water from hose".

JAF will continue to monitor this issue with the industry as they determine the best means available for performing this task. If acceptance criteria are developed along with measurement means, JAF will evaluate revising the venting procedures at that time to incorporate the standards.

6.2.3 Ensure that procedures have acceptance criteria (consistent with Section 5.4.3) for the allowable of gas at each location which is periodically vented or verified by surveillance procedures, including an allowance for measurement uncertainty (where required). If acceptance criteria are not included, then require it to be entered into the CAP when a void is detected.

Current procedures as referenced in 6.1, were revised to ensure that "any" air noticed during venting operations gets documented per a condition report. Actual volume is not determined since air quantities currently cannot be accurately measured in an effective and cost efficient manner.

While no acceptance criteria have been established to quantify gas volume, procedure ST-4B, Revision 56, "HPCI Monthly Operability Test" does require a *determination of the amount of air released during venting. The amount of air must be characterized as either "significant" or "insignificant" based on the following definition: "A significant amount of air is defined as requiring more than 1 minute to obtain a solid stream of water from hose."*

JAF will continue to monitor this issue with the industry as they determine the best means available for performing this task. If acceptance criteria are developed along with a measurement means, JAF will evaluate revising the venting procedures at that time to incorporate the standards.

6.2.4 Ensure that procedures require entry into the CAP when gas accumulation in excess of the acceptance criteria is identified

Current procedures as referenced in 6.1, ensure that "any" air noticed during venting operations gets documented per a condition report. No acceptance criteria have been established to quantify what amount is acceptable. Vented air quantities currently cannot be accurately measured in a cost efficient manner.

JAF will continue to monitor this issue with the industry as they determine the best means available for performing this task. If acceptance criteria are developed along with a measurement means, JAF will evaluate revising the venting procedures at that time to incorporate the standards.

6.2.5 Ensure that a procedure exists to verify that the piping is sufficiently full of water for each system and for each source of gas intrusion identified in Section 5.4.2. Develop new procedures where none exists, ensuring that requirements in 6.2.4 are included.

- *ST-2AL, ST-2AM, ST-2AN, and ST-2A0 (RHR Quarterly and Monthly Operability Test)*
- *ST-3AA, ST-3AB, ST-3PA, and ST-3PB (CS Quarterly and Monthly Operability Test)*
- *ST-4B (HPCI Monthly)*

These procedures were revised to ensure that any air noticed during venting operations is required to be documented per a condition report. RHR and CS system are not vented if the level switches are verified to be working. The HPCI system is vented since there are no level switches installed on the system.

6.3 Review current procedures that address periodic venting or gas accumulation surveillance requirements.

6.3.1 Verify that the system is not pre-conditioned by other surveillance procedures such that the system is filled by the previous testing activity prior to the venting surveillance.

No such precautions currently exist. Revise surveillance procedures to add a prerequisite to verify that the system has not been pre-conditioned. (CR-HQN-2008-0881)

6.4 Identify revisions required to current periodic venting or gas accumulation surveillance procedures, and any new procedures required, and enter them into the CAP.

LO-LAR-2008-00020, CA-15 & CA-20, Generic Letter 2008-01 Issue

Entergy review criteria for GL 2008-01 (all in-scope ECCS systems) indicate to review the process used for filling and venting each section of piping, including all applicable procedures.

A review for processes and or procedures was conducted. Based upon the review, processes and or procedures were not found for filling and venting each section of piping. The following items should be considered for improving current procedural guidance:

- *All system vent locations were not found to be periodically vented. System venting via installed system vents should be considered to enhance current procedural guidance. Consideration of venting at installed system vent locations could be an enhancement to the surveillance test (which would address frequency of performance).*
- *Procedural guidance should be considered to be developed for filling / venting systems following maintenance activities.*

6.5 Trend periodic venting results to confirm that the systems are sufficiently full of water and that the venting frequencies are adequate. Records on the quantity of gas at each location should be maintained and trended as a means of preemptively identifying degrading gas accumulations.

JAF will evaluate the need to develop a program to monitor and trend gas accumulation in ECCS systems within the scope of this report. The intent of the program would be to conduct monitoring and could be suspended if trending indicates no issues have developed in the specific systems. (LO-LAR-2008-00020, CA-19)

6.5.1 Ensure gas is sampled for any unexpected void to identify the type of gas to assist in determining the source and required monitoring and control actions, as necessary.

When performing venting operations in the plant, a sample is not collected for determining the source. This is due to the fact that the gas vented is assumed to be air based on no other gas being introduced into the system.

6.6 Review the procedures to verify that gas intrusion does not occur as a result of inadvertent draining, system realignments, or incorrect maintenance procedures. For example, these activities may include the following:

- Maintenance activities
- Quarterly pump testing (including restoration to standby conditions)
- Suction source changes (e.g. tank to suppression pool, or RWST to containment sump, etc.)
- Testing evolutions
- Idle train startup activities

Identify the schedule to complete this procedure review.

According to section 6.7 below, procedure reviews identified in this section are not required to be completed by the October 11, 2008 deadline. JAF will review the associated procedures and initiate corrective actions for any deficiencies identified or where procedural enhancements are needed. JAF will commit to performing these procedure reviews by April 11, 2009. (LO-LAR-2008-00020, CA-15 & CA-20)

6.7 All of the testing evaluations, except for procedure reviews identified in Section 6.6, will be completed by October 11, 2008.

Based on a review of ABS Report 1924850-R-001, Revision 1 and the ABS generated isometrics, there are eleven locations identified where no vent is available and the potential for void formation exist. These eleven locations are indentified in Table 4-5 of the report. UT examinations of the eleven potentially void locations were performed and all locations were found to be full of water with no evidence of air voiding. Based on the UT results, no additional vents are needed at these locations.

6.8 Enter the changes that are identified as part of the testing review in the CAP.

LO-LAR-2008-00020, CA-15 & CA-20, Generic Letter 2008-01 Issue

Entergy review criteria for GL 2008-01 (all in-scope ECCS systems) indicate to review the process used for filling and venting each section of piping, including all applicable procedures.

A review for processes and or procedures was conducted. Based upon the review, processes and or procedures were not found for filling and venting each section of piping. Current procedural guidance should be considered for enhancement for the periodic venting of installed system level switches.

- *In addition to the Level Switch venting recommendation, installed system vent locations were not found to be periodically vented. System venting via installed system vents should be considered to enhance current procedural guidance.*

Consideration of venting at installed system vent locations could be an enhancement to the surveillance test (which would address frequency of performance).

- *Procedural guidance should be considered to be developed for filling / venting systems following maintenance activities. (LO-LAR-2008-00020, CA-15 & CA-20)*

7.0 CORRECTIVE ACTIONS:

7.1 Summary of as-found conditions

7.1.1 Summarize the results of any non-conforming, as-found gas accumulations and the correction actions that were identified as a result of the reviews identified in Sections 4 through 6.

UT examinations were performed on the eleven areas identified in ABS Report 1924850-R-001, Revision 1, Section 4.0 and are listed in Table 4.4. No as-found, non-conforming gas accumulations were discovered as a result of these reviews.

7.2 Summarize the corrective actions that have been or will be completed by October 11, 2008 resulting from the Licensing Basis, Design, and Testing Evaluations.

No immediate corrective actions are required based on the evaluation performed for GL-2008-01. Walkdowns identified potential void areas that were verified to be full of water or analyzed as acceptable. No Plant damage has been identified as attributable to gas accumulation.

7.3 For the follow-up actions that will not be completed by October 11, 2008, summarize the scope and schedule (and basis for the schedule) for any follow-up actions and corrective actions resulting from the Licensing Basis, Design, and Testing Evaluations. Note: The GL specifically requests a basis be provided for the schedule of future corrective actions.

Procedural revisions are required to enhance future compliance with the management of gas accumulation issues. These procedures include Operations and Engineering. No additional vent locations were identified however, additional training in filling and venting of systems is recommended. The remaining required corrective actions will be completed on or before 10/11/2009.

7.4 General Corrective Action Process

7.4.1 Describe how gas voids are trended, documented and dispositioned, if found on any of the subject systems. This item may be covered in Section 6.2.4.

- The site CAP is the primary program that is used, however other details related to void specific disposition should also be discussed here. Gas intrusion/accumulation issues should be documented as nonconforming conditions and should be trended to determine if increased or alternate monitoring is required. Previous OE can be used to demonstrate program effectiveness.

JAF will evaluate the need to develop a program to monitor and trend gas accumulation in ECCS systems within the scope of this report. The intent of the program would be to conduct monitoring and could be suspended if trending indicates no issues have developed in the specific systems. (LO-LAR-2008-00020, CA-19)

8.0 TRAINING:

8.1 SER 2-05, Rev 1 recommends that training be provided to plant personnel on Gas Intrusion/Accumulation issues as described below. Note that a description of training activities is not requested by the GL.

8.1.1 Provide initial and continuing training on gas intrusion to personnel responsible for the design, performance monitoring, operation, and maintenance of safety systems susceptible to gas intrusion or systems and components that may cause gas intrusion in safety systems. Train personnel who plan and perform fill and vent evolutions and who develop work instructions or procedures on these systems. This training should address the following:

- Reviews of site and industry gas intrusion events, including actual and potential consequences and lessons learned.
- Causal factors and conditions for gas intrusion—design characteristics, operating practices, and equipment performance problems.
- Plant-specific actions and strategies for the identification, prevention, and mitigation of gas intrusion.
- Association of the void location in pump suction piping or pump discharge piping with the physical phenomenon it causes and the part of the design basis adversely affected (e.g., reduction in core and containment cooling, lower $NPSH_A$, air binding, flow reduction, delay in flow, pressure pulse, relief valve opening and re-closing, force loads on hangers and piping).
- Location of each system's void acceptance criteria and trending records.

JAF-TEAR #624

Title: Generic Letter 2008-01 Issue: JAF- Training Enhancements

Entergy review criteria for GL 2008-01 (in-scope ECCS systems) recommends that pursuant to SER 2-05, Rev 1, training be provided to plant personnel on Gas Intrusion/Accumulation issues as described below. Note that a description of training activities is not requested by the GL. A training review was conducted. Based upon this review, it is recommended to provide initial and continuing training on gas intrusion to personnel responsible for the design, performance monitoring, operation, and maintenance of safety systems susceptible to gas intrusion or systems and components that may cause gas intrusion in safety systems. Train personnel who plan and perform fill and vent evolutions and who develop work instructions or procedures on these systems. This training should address the criteria outlined in 8.1.1 of this report.

9.0 SUMMARY OF INTERNAL OE REVIEW:

9.1 Summarize the review of internal OE and corrective actions for gas intrusion, Water hammer or air entrapment. Include details in attachment 12.3.

A review of internal and external OE was completed. Keyword searches related to the ECCS systems and factors related to gas accumulation were run to identify any previous or current problems related to gas accumulation and its effects. Keywords used in this search included combinations of the following:

- *Emergency Core Cooling System or ECCS*
- *Residual Heat Removal or RHR*
- *Low Pressure Core Spray or LPCS*
- *High Pressure Core Spray or HPCS*
- *High Pressure Coolant Injection or HPCI*
- *Low Pressure Core Injection or LPCI*
- *Core Spray*
- *Gas intrusion; Gas accumulation; Gas binding*
- *Binding; Pump binding*
- *Water hammer*
- *Void; Voiding*
- *Venting*

The majority of OE, reviewed, dealt with the issue of inadequate, or lack of proper venting during maintenance and or testing evolutions. These OE pointed to the critical aspect of proper venting methods being utilized to ensure system availability. There has not been any incident where damage due to the existence of air or gas in these systems *has impaired the systems in a way that would keep them from performing their safety function.*

The review of external operating experience (OE) also confirms and supports the conclusions of this report. Most of the lessons learned in the external operating experience search have already been incorporated into current JAF practices. Those practices that have not yet been incorporated, such as dynamic venting, enhancements to post maintenance / outage operability testing of ECCS systems and revisions to current testing procedures to enhance acceptance criteria, will be incorporated through the CR process as outlined in Section 7.0.

10.0 CONCLUSIONS:

Based on the evaluations completed and documented herein and completion of identified corrective actions the JAF plant concludes that the evaluated systems are in compliance with the current licensing basis and design basis and applicable regulatory requirements. Upon completion of the identified corrective actions, suitable design, operational and testing control measures are or will be in place for maintaining this compliance.

It should be noted that additional industry activities are under consideration (e.g. pump testing for void limits, gas transport processes, procedure for quantification of venting, best practices for fill and vent surveillances, etc.). As these activities are completed, the results of these activities should be reviewed for relevance and applicability.

11.0 REFERENCES

11.1 NRC Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems", Dated 01/11/2008.

11.2 INPO Significant Event Report SER 2-05, "Gas Intrusion in Safety Systems", Dated 01/09/2008.

11.3 NEI Letter to Nuclear Strategic Issues Advisory Committee, "Response to GL 2008-01, Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems", Dated 07/24/2008.

11.4 NRC Letter to NEI Summarizing NRC Requirements for the GL 2008-01 Response, Dated 07/08/2008.

11.5 Westinghouse Electric Co., SEE-III-WP-08-01 Rev 0, "Walkdown Procedure for Gas Accumulation Evaluation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems".

11.6 Westinghouse Electric Co., WCAP-16631-NP Rev 0 Volumes 1 & 2, "Testing and Evaluation of Gas Transport to the Suction of ECCS Pumps", Dated October 2006.

11.7 GE- Hitachi Nuclear Energy, GEH-EPIWXIWZ-015, "ECCS LOCA Evaluation".

11.8 *EC 8182, ECCS/LOCA Analysis Input Parameters, SAFER/GESTR (T0407) Evaluation*

11.9 *ABS Consulting Report 1924850-R-001 Revision 1, "Summary Report Associated with NRC Generic Letter (GL) 2008-01 Managing Gas Accumulation in ECCS, Decay Heat and Containment Spray Systems" Dated October 2008.*

11.10 *ABS Consulting Report 1924850 –R-003, Rev. 0, "Walkdown Report Associated with GL 2008-01 Managing Gas Accumulation in ECCS, Decay Heat and Containment Spray System".*

11.11 *ABS Consulting Report 1924850-C-001, Rev. 1, "GL 2008-01: Structural Screening of Fluid Transient Effects" Dated September 2008.*

11.12 *ABS Consulting Report 1924850 –C-002, Rev. 2, "GL 2008-01: Evaluation of Acceptable Void Sizes in ECCS, Decay Heat, and Containment Spray Systems" Dated September 2008.*

11.13 *ABS Consulting Report 1924850-P-002, Revision 0, "Field Walkdown and Data Recording Associated with Managing Gas Accumulation in Emergency Core Cooling, Decay Heat and Containment Sprays Systems, James A. Fitzpatrick".*

11.14 *ABS Consulting Walkdown Drawings*

11.14.1 *1924850-D-001, Revision, "GL2008-01 Walkdown Data Points - ECCS All"*

11.14.2 *1924850-D-002, Revision 0, "GL2008-01 Piping Segment Elevation Data for HPCI System, JAF Station".*

11.14.3 *1924850-D-004, Revision 0, "GL2008-01 Piping Segment Elevation Data for CS System, JAF Station".*

11.14.4 *1924850-D-005, Revision 0, "GL2008-01 Piping Segment Elevation Data for RHR System, JAF Station".*

11.15 *Letter from NYPA, concerning JAF CST Vortexing during HPCI/RCIC Operation, Letter # CM-JAF-93-016, Dated January 27, 1993.*

11.16 *Report JAFRPT-MULT-02107, "James A. Fitzpatrick Nuclear Power Station IPE Update, Revision 2".*

11.17 *Duke Engineering & Services Calculation No. A384.F02-03, "RHR, CS, HPCI and RCIC Suction Strainer Vortex/Minimum Submergence, Rev. 1".*

11.18 *JAF Updated FSAR*

11.19 *JAF Technical Specifications*

11.20 *JAF Technical Specifications Bases*

11.21 *JAF Technical Requirements Manual*

11.22 *NRC Bulletin 96-03, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors".*

11.23 *NUREG-0737, "Clarification of TMI Action Plan Requirements, 1980".*

11.24 *NUREG-1150, "Severe Accident Risks: An Assessment for Five US Nuclear Power Plants, 199".*

11.25 *Calculation:*

11.25.1 *A384.F02-03, Revision 0, "RHR, CS, HPCI, and RCIC Suction Strainer Vortex / Minimum Submergence".*

11.25.2 *JAF-CALC-07-00032, "Required Level to Prevent Air-entraining Vortices at HPCI & RCIC CST Suction".*

11.26 *Modifications:*

11.26.1 *F1-74-052*

11.26.2 *F1-75-13*

11.26.3 *F1-75-253, "RHR Keepfull Pump Installation".*

11.26.4 *JD-03-005 (ER-02-0031).*

11.27 *Design Basis Documents:*

11.27.1 *DBD-010, Revision 12, "Residual Heat Removal System".*

11.27.2 *DBD-014, Revision 10, "Core Spray System".*

11.27.3 *DBD-023, Revision 11, "High Pressure Coolant Injection System".*

11.28 *Design Specifications:*

11.28.1 *22A1435, Revision 1, "Core Spray System Design".*

11.28.2 *22A1472, Revision 1, "GE Design Specification Residual Heat Removal System (with Steam Condensing)".*

11.29 *Procedures:*

11.29.1 *ARP-09-3-1-10, Revision 3, "Core Spray A and B Discharge Line Not Full".*

11.29.2 *ARP-09-3-1-11, Revision 4, "Core Spray Sys. A Hi Press Valve Leakage".*

11.29.3 *ARP-09-3-1-14, Revision 6, "Torus Bulk Temp Hi or RTD Failure".*

11.29.4 *ARP-09-3-1-18, Revision 5, "RHR A or B Disch Line Not Full".*

11.29.5 *ARP-09-3-2-11, Revision 4, "Core Spray Sys B Hi Press Vlv Leakage".*

11.29.6 *ARP-09-3-2-14, Revision 5, "RHR HX A or B Inlet WTR Temp Hi".*

11.29.7 *ARP-09-3-3-07, Revision 4, "HPCI CST A LVL LO".*

11.29.8 *ARP-09-3-3-08, Revision 3, "HPCI CST B LVL LO".*

11.29.9 *ARP-09-4-0-28, Revision 5, "ADS Timers Actuation".*

11.29.10 *ARP-09-4-0-29, Revision 5, "RX Bldg Equip Sump A LVL HI".*

11.29.11 *ARP-09-4-3-23, Revision 2, "RHR HX A or B PRESS HI".*

11.29.12 *ARP-09-6-2-10, Revision 5, "CST A OR B LVL HI OR LO".*

11.29.13 *ARP-09-6-3-10, Revision 2, "TURB BLDG EQUIP SUMP VAC DRAG VLV OUT OF AUTO".*

11.29.14 *EN-DC-115, Revision 5, "Engineering Change Development".*

11.29.15 *EN-DC-117, Revision 1, "Post Modification Testing and Special Instructions".*

11.29.16 *EN-DC-136, Revision 3, "Temporary Modifications".*

11.29.17 *EN-DC-141, Revision 5, "Design Inputs".*

11.29.18 *EN-OP-102, Revision 10, "Protective and Caution Tagging".*

11.29.19 *EN-OP-102-01, Revision 4, "Protective and Caution Tagging Forms & Checklist".*

11.29.20 *OP-13, Revision 93, "Residual Heat Removal System".*

11.29.21 *OP-13D, Revision 20, "RHR Shutdown Cooling".*

11.29.22 *OP-13E, Revision 4, "RHR-Keep-Full".*

11.29.23 *OP-13F, Revision 10, "RHR System Operations".*

11.29.24 *OP-14, Revision 31, "Core Spray System".*

11.29.25 *OP-15, Revision 54, "High Pressure Coolant Injection".*

11.29.26 *ST-2AL, Revision 27, "RHR Loop A Quarterly Operability Test (IST)".*

11.29.27 *ST-2AM, Revision 26, "RHR Loop B Quarterly Operability Test (IST)".*

11.29.28 *ST-2AN, Revision 13, "RHR Loop A Monthly Operability Test (IST)".*

11.29.29 *ST-2AO, Revision 13, "RHR Loop B Monthly Operability Test (IST)".*

11.29.30 *ST-3AA, Revision 8, "Core Spray Loop A Monthly Operability Test (IST)".*

11.29.31 *ST-3AB, Revision 8, "Core Spray Loop B Monthly Operability Test (IST)".*

11.29.32 *ST-3PA, Revision 11, "Core Spray Loop A Quarterly Operability Test (IST)".*

11.29.33 *ST-3PB, Revision 12, "Core Spray Loop B Quarterly Operability Test (IST)".*

11.29.34 *ST-4B, Revision 56, "HPCI Monthly Operability Test".*

11.30 *Licensing Commitments:*

11.30.1 *A-1273, "NRC Inspection 50-333/75-04".*

11.30.2 *A-1485, "Damaged Containment Spray Line Support".*

11.30.3 *A-2232, "Proposed Change to Technical Specifications".*

11.30.4 *A-2583, "NRC Inspection 50-333/78-19".*

11.30.5 *A-5408, "NUREG 0737 Item II.B.1 – NYPA Response to NRC Question".*

11.30.6 *A-1126, "Proposed Change to Technical Specifications".*

12.0 ATTACHMENTS:

12.1 *Operational Experience Reviews.*

12.2 *ABS Project Deliverables Listing.*

12.3 *12.3 ABS Consulting Report 1924850-R-001 Revision 0, "Summary Report Associated with NRC Generic Letter (GL) 2008-01 Managing Gas Accumulation in ECCS, Decay Heat and Containment Spray Systems" Dated October 2008. (See EC-10507 attachment in INDUS)*

ATTACHEMENT 12.1

OPERATIONAL EXPERIENCE REVIEWS

DATE	OE NUMBER	OE TITLE	LESSONS LEARNED
09/12/2007	CR-JAF-2007-03221	Shutdown cooling isolated two times on high RPV pressure with RPV pressure at less than 5 psig	▪ The system / pump trip was due to a high pressure system isolation signal when Reactor Pressure was less than 5 psig (well below the isolation signal setpoint of 102 - 108 psig). ▪ The investigation attributed this failure to the collapse of gas (air) voids within the system suction and / or discharge piping. ▪ Voids were determined present within the system due to inadequate system venting and system flushing.
09/14/2008	CR-JAF-2008-02933	Shutdown cooling isolated two times on high RPV pressure with RPV pressure at less than 5 psig.	▪ The system / pump trip was due to a high pressure system isolation signal when Reactor Pressure was less than 5 psig (well below the isolation signal setpoint of 102 - 108 psig). ▪ The event was similar to CR-JAF-2007-03221. However, following the CR-JAF-2007-03221 investigation / corrective actions coupled with the ongoing GL 2008-01 review, the CR-JAF-2008-02933 event yielded consideration of a cause other than inadequate venting. ▪ Actions are being developed to address the latent error to prelude future occurrence.

DATE	OE NUMBER	OE TITLE	LESSONS LEARNED
01/9/2008	SER 2-05	Gas Intrusion in Safety Systems	▪ Review safety system configurations for the susceptibility to gas intrusion. ▪ Enhance the effectiveness of venting by reviewing procedures, vent locations etc. ▪ Give a high priority to known equipment deficiencies that contribute to air intrusion into safety systems. ▪ Provide training to personnel on air intrusion. ▪ Provide guidance in procedures (operating, tests and maintenance) regarding activities that could result in air intrusion in safety systems. ▪ Review maintenance procedures and preventative maintenance programs that involve safety related systems for establishing adequate system operability following maintenance activities.
01/29/1998	SEN 179	Long Standing Design Weakness and Ineffective Corrective Actions Cause Gas Binding Failures of High Head Safety Injection Pumps	▪ Industry OE not used to resolve problem of gas binding. ▪ The pump manufacturer did not notify stations of updated information on orifice design that were found to eliminate generation of gas in the system. ▪ Venting of pump to purge accumulated suction piping voids was proceduralized and was not considered an operator workaround thus delaying implementation of corrective actions.
09/11/2003	SEN 243	Airbound Containment Spray Pumps	▪ The operating procedure for performing a static fill and vent was inadequate to eliminate voids in the pump casing. ▪ Operating procedures did not incorporate guidance for dynamic venting. ▪ Surveillance procedures specified the normal and expected values for pump discharge pressure and spin-up time, but did not specify values for pump motor amperage and flow rate as a reference for the operators to verify proper pump operations.
08/11/2008	OE27271	Gas Accumulation Discovered in RHR System (Vogtle)	▪ The procedure for ECCS flow path verification did not include venting the high point inside containment.

DATE	OE NUMBER	OE TITLE	LESSONS LEARNED
08/11/2008	OE27270	Gas Intrusion in Safety Related System as a Result of Maintenance and Safety Tagging Activities (Calvert Cliffs)	▪ Maintenance activities required the pumps to be isolated drained. When returning the pump to service, venting involved opening suction valve, venting pump casing and opening discharge valve. ▪ This did not account for small amounts of gas voids created within the safety tagging boundaries migrating to high points of the system against the filling flow direction at the beginning of the restoration steps. (allow for migration of air bubbles outside the tagged boundaries)
08/13/2008	OE27287	Gas Accumulation in Suction Piping for Standby Makeup Pump (Catawba)	▪ Cause was packing leak on pump. Corrective actions included possibly further enhancement to the preventative maintenance performed on these pumps and/or monitoring leakage after pumps are shut down upon completion of testing
01/13/2008	OE26090 / LER 482-08001	Preliminary-T/S 3.0.3 Entry Due to Both CPP's and Both SIP's Being Declared Inoperable Due to Gas Voiding. (Wolf Creek)	▪ Voids were vented, this is still being evaluated further.
08/12/2008	OE27279	HPCI Main pump seal fails due to inadequate venting	▪ Inadequate instructions provided by system engineer which were included in Clearance Special Instructions. ▪ Revise HPCI operating procedure to include a sequence of steps required to properly vent the system.
03/19/2008	OE26474	DHS Voiding due to Inadequate Restoration from Maintenance	▪ Inadequate venting procedures when returning from maintenance. Review fill and vent procedure for adequacy.

DATE	OE NUMBER	OE TITLE	LESSONS LEARNED
02/01/2005	OE19931	Decision Making with Air Entrainment in Millstone 3 RHR system (Updated by OE20979)	▪ There was a lack of important information contained in the surveillance criteria associated with the as-found conditions of the RHR system not being full of water. ▪ Contrary to the requirements of the procedure, "A" RHR train was not swept to remove entrained gases. ▪ Key internal and external OE information was missed. ▪ OE explained the need for sweeping and venting the RHR system and provided detailed guidance on methods to determine impacts on operability and reportability for gas voids found in the system.
07/17/2008	OE27319	Gas Accumulation is suction piping for the centrifugal charging pumps	▪ Collection of gases in vertical runs of pipe – part of the minimum flow path. ▪ Procedures are to be revised to preclude the use of minimum flow alignment to the centrifugal charging pump suction.
3/06/2001	OE11969	Unexpected Buildup of N2 Gas in Decay Heat Closed Cooling System 4 at TMI Unit 1	▪ Gas pocket was detected in decay heat closed cooling system train A. During the venting process the gas was sampled and determined to be primarily nitrogen gas. ▪ The source of the nitrogen is microbiological activity in the closed cooling systems. ▪ Denitrifying bacteria produce gas through the consumption of sodium nitrite which is used as a system corrosion inhibitor.
2/23/1998	OE8801	ECCS Discharge Piping Venting (Seabrook Station)	▪ Corrective actions include recording whether or not air is observed during venting. ▪ Provide direction to write a CR if an unusual amount of gas is present.
09/14/1999	OE10248	System Configuration and Inadequate Flushing Lead to ECCS Void Formation	▪ Enhancement of post outage and maintenance venting, installing new vents, modifying existing vents and adding certain vent valves to the monthly ECCS venting procedure to reduce the potential for the presence of small voids.

DATE	OE NUMBER	OE TITLE	LESSONS LEARNED
11/06/2003	OE17226	ECCS system Design Configuration Render Systems Susceptible to Gas Binding Events	▪ Inadequate venting procedures to demonstrate the operability of the keepfill portion of the system. ▪ High point vent valves were not included in initial ECCS system Fill and Vent procedures. ▪ Venting practices were of an inadequate duration to eliminate bubbles from long horizontal piping runs. ▪ System elevation difference between waterleg pump discharge and dead leg piping allowed a head pressure drop that reduced re-absorption of gasses. ▪ Suppression pool conditions (SRV discharge, suppression pool cooling, suppression pool temperatures LPCS operation) increased aeration of the process fluid resulting in increased rates of gas accumulation.
02/28/2008	LER2007-002	DHR Discharge Piping Void Due to Inadequate procedure for Venting Following Maintenance	▪ Systems will be reviewed and venting procedures will be revised.

ATTACHEMENT 12.2
ABS PROJECT DELIVERABLES

ITEM	ABS CONSULTING DOCUMENT NO.	REV	DOC TYPE	DOCUMENT TITLE
1	1924850-O-006	2/9/09	Transmittal	Transmittal of Project Deliverables - Engineering Support Services Associated with US NRC GL 2008-01 Fitzpatrick Station
2	1924850-R-001	1	Report	Summary Report Associated with NRC Generic Letter (GL) 2008-01 Managing Bas Accumulation in ECCS, Decay Heat and Containment Spray Systems
3	1924850-R-002	1	Report	Calibration of ZipLevel ID: ABS-ZIP-3 & 4
4	1924850-R-003	0	Report	Walkdown Report Associated with NRC GL 2008-01 Managing Bas Accumulation in ECCS, Decay Heat and Containment Spray Systems
5	1924850-R-004	0	Report	Evaluation of Elevation Measurement Taken on Insulated Pipes (in support of GL 2008-01)
6	1900039-R-004	0	Report	Piping Structural Screening Methodology for NRC GL 2008-01 Associated ECCS, Decay Heat and Containment Spray Systems
7	1924850-C-001	1	Calculation	GL 2008-01: Structural Screening of Fluid Transient Effects
8	1924850-C-002	2	Calculation	GL 2008-01: Evaluation of Acceptable Void Sizes in ECCS, Decay Heat, and Containment Spray Systems
9	1924850-P-002	0	Procedure	Field Waldown & Data Recording – Engineering Support Associated with NRC Generic Letter GL 2008-01
10	1924850-D-001	0	Drawing	GL 2008-01 Walkdown Data Points – ECCS All (1 sheet)
11	1924850-D-002	0	Drawing	GL 2008-01 Walkdown Data Points – HPCI System (2 sheets)
12	1924850-D-003	0	Drawing	GL 2008-01 Walkdown Data Points – RCIC (1 sheet)
13	1924850-D-004	0	Drawing	GL 2008-01 Walkdown Data Points – CS (2 sheets)
14	1924850-D-005	0	Drawing	GL 2008-01 Walkdown Data Points – RHR (4 sheets)