WOLF CREEK
NUCLEAR OPERATING CORPORATION

Terry J. Garrett
Vice President, Engineering

October 10, 2008
ET 08-0045

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

Subject: Docket No. 50-482: Nine-Month Response to NRC Generic Letter 2008-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems"

Gentlemen:

Pursuant to 10 CFR 50.54(f), this letter provides the Wolf Creek Nuclear Operating Corporation (WCNOC) nine-month response to Generic Letter 2008-01. Generic Letter 2008-01 requests that WCNOC evaluate the licensing basis, design, testing, and corrective action programs for the Emergency Core Cooling Systems (ECCS), Residual Heat Removal (RHR) System, and Containment Spray (CS) System, 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.

Generic Letter 2008-01 requests WCNOC to submit a written response in accordance with 10 CFR 50.54(f) within nine months of the date of the generic letter to provide the information summarized below:

(a) A description of the results of evaluations that were performed pursuant to the requested actions;

(b) A description of all corrective actions, including plant, programmatic, procedure, and licensing basis modifications that were determined to be necessary to assure compliance with the quality assurance criteria in Sections III, V, XI, XVI, and XVII of Appendix B to 10 CFR Part 50 and the licensing basis and operating license as those requirements apply to the subject systems; and,

(c) A statement regarding which corrective actions were completed, the schedule for completing the remaining corrective actions, and the basis for that schedule.

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Attachment I to this letter contains WCNOC's nine-month response to Generic Letter 2008-01. Attachment II lists commitments made to the NRC by this letter. If you have any questions concerning this matter, please contact me at (620) 364-4084, or Mr. Richard Flannigan at (620) 364-4117.

Sincerely,

Terry J. Garrett

TJG/rlt

Attachments: I Generic Letter 2008-01 Nine-Month Response
II List of Regulatory Commitments

cc: E. E. Collins (NRC), w/a
V. G. Gaddy (NRC), w/a
B. K. Singal (NRC), w/a
Senior Resident Inspector (NRC), w/a

STATE OF KANSAS)
) SS
COUNTY OF COFFEY)

Terry J. Garrett, of lawful age, being first duly sworn upon oath says that he is Vice President Engineering of Wolf Creek Nuclear Operating Corporation; that he has read the foregoing document and knows the contents thereof; that he has executed the same for and on behalf of said Corporation with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By________________________
Terry J. Garrett
Vice President Engineering

SUBSCRIBED and sworn to before me this tenth day of Oct., 2008.

Jolene C Vannocker
Notary Public

JOLENE C. VANNOCKER
NOTARY PUBLIC
OFFICIAL SEAL
STATE OF KANSAS
MY COMMISSION EXPIRES
July 31, 2012

Expiration Date 7-31-2012

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

This Attachment contains the Wolf Creek Nuclear Operating Corporation (WCNOC) nine-month response to NRC Generic Letter (GL) 2008-01 "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems," dated January 11, 2008. In GL 2008-01, the NRC requested "that each addressee evaluate its ECCS, 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."

The following information is provided in this response:

a) A description of the results of evaluations that were performed pursuant to the requested actions (see Section A of this Attachment),

b) A description of the corrective actions determined necessary to assure compliance with the quality assurance criteria in Sections III, V, XI, XVI, and XVII of Appendix B to 10 CFR Part 50 and the licensing basis and operating license with respect to the subject systems (see Section B of this Attachment), and

c) A statement regarding which corrective actions have been completed, the schedule for the corrective actions not yet complete, and the basis for that schedule (see Section C of this Attachment).

The following systems were determined to be in the scope of GL 2008-01 for Wolf Creek Generating Station (WCGS):

- Chemical and Volume Control System (CVCS) (ECCS interface only) (System designator – BG)
- Borated Refueling Water Storage System (ECCS interface only) (System designator – BN)
- Residual Heat Removal (RHR) System (System designator – EJ)
- Safety Injection (SI) System (System designator – EM)
- Containment Spray (CS) System (System designator – EN)
- Accumulator Safety Injection System (System designator – EP)

<u>Background</u>

In January 2008 WCGS experienced a gas accumulation event in the Emergency Core Cooling System (ECCS) piping. Accumulated nitrogen was discovered in the Safety Injection (SI) System discharge piping. The source of the nitrogen was subsequently identified as gas coming out of solution from nitrogen saturated water leaking into ECCS piping from the safety injection accumulators. In addition, air was discovered in ECCS pump suction line piping. The air was trapped as a result of the slope of a nominally horizontal pipe, resulting in trapped air at an elevation above the installed vent in the nominally horizontal pipe. This event affected both safety trains and led to a forced shutdown of the plant. NRC GL 2008-01 was issued almost simultaneously with this WCGS gas accumulation event.

WCNOC took corrective actions and performed evaluations relative to gas accumulation in early January 2008 in response to the event described above. Additional actions and evaluations were completed in conjunction with, and as a result of, the NRC special inspection conducted from January 16, 2008 to March 13, 2008 (Reference 1) on gas accumulation issues at WCGS. Some actions and evaluations were completed prior to, or coincident with, issuance of GL 2008-01. This Attachment includes relevant descriptions associated with the January 2008 WCGS event described above as well as additional actions and evaluations taken in response to GL 2008-01.

Format

The format of this Attachment is consistent with the industry-supplied template for this generic letter response. When descriptions in this Attachment refer to all of the systems within the scope of GL 2008-01 identified above, the terms "systems within the scope of GL 2008-01" or "GL 2008-01 systems" will be used. Otherwise the descriptions will refer to the individual system or systems.

A. EVALUATION RESULTS

A.1. LICENSING BASIS EVALUATION

The WCGS licensing basis was reviewed with respect to gas accumulation in the systems within the scope of GL 2008-01. This review included the Technical Specifications (TS), TS Bases, Updated Safety Analysis Report (USAR), the Technical Requirements Manual (TRM) and TRM bases, responses to NRC generic communications, WCNOC regulatory commitments, and operating license conditions.

A.1.1. Results of the review of licensing basis documents

The above documents and regulatory commitments were evaluated for compliance with applicable regulatory requirements. Provided below is a summary of the evaluation.

a) ECCS piping (including RHR System piping)

TS Surveillance Requirement (SR) 3.5.2.3 requires the ECCS piping be verified full of water. Prior to May 1, 2008, the TS SR 3.5.2.3 Bases specified that the SR is satisfied by verifying that RHR and Safety Injection (SI) pump casings and accessible ECCS discharge piping high point vents are full of water by venting and/or ultrasonic testing. The TS SR 3.5.2.3 Bases further indicated that the Frequency for this SR takes into consideration the gradual nature of gas accumulation in the ECCS piping and the procedural controls governing system operation. The evaluation concluded that the suction piping should also be addressed in this Bases section as well as additional information related to verifying the piping to be full of water.

USAR Section 6.3.2.2 provides descriptions of the ECCS equipment and components. This section indicates that the ECCS discharge piping is water solid during plant operation thereby precluding water hammers in the injection line. The evaluation concluded that the statement that the piping is water solid is not consistent with operating experience and a USAR change was required.

b) Containment Spray System piping

A review of the WCGS licensing basis documents did not identify specific requirements with respect to gas accumulation. Specifically, the TS and TRM do not include a SR for verifying containment spray piping full of water. Refer to Section A.1.3 below for additional information.

A.1.2. Summary of changes to licensing basis documents

a) The TS SR 3.5.2.3 Bases were revised on May 1, 2008, (item 1 in Table 3 below) to include verification of accessible ECCS suction piping high point vents and to clarify that the piping is sufficiently full of water to ensure that the subsystems can reliably perform their intended safety function.

b) USAR Section 6.3.2.2 was revised on October 3, 2008 to delete discussion of water solid piping and to reflect that the ECCS piping must be sufficiently full of water to ensure that the subsystems can reliably perform their intended safety function under LOCA and non-LOCA conditions that require injection into the reactor coolant system (RCS).

c) No changes were made to WCGS licensing basis documents related to Containment Spray System piping. However, on April 29, 2008, WCNOC implemented a surveillance procedure for verifying Containment Spray System operability (with respect to gas accumulation) by ensuring the applicable system piping is sufficiently full of water. This procedure is currently performed on a frequency consistent with the Frequency of SR 3.5.2.3.

A.1.3. List of licensing basis evaluation items that have not been completed.

a) The Technical Specifications Task Force (TSTF) is addressing TS improvements. The TSTF is tasked with developing and submitting to the NRC a TSTF traveler related to the potential for unacceptable gas accumulation. WCNOC is continuing to support the industry and Nuclear Energy Institute Gas Accumulation Management Team activities regarding the resolution of generic TS changes via the TSTF traveler process. WCNOC will monitor the resolution of the TS issues and submit a license amendment request, as appropriate, within one year following NRC approval of the TSTF or the CLIIP Notice of Availability. Associated TS Bases changes, as appropriate, would be made consistent with the TSTF and implemented with the issuance of a license amendment for the TS changes.

b) Corrective action (item 2 in Table 3 below) has been initiated to address the following issue. Recent discussions with the industry and the NRC addressed a potential TS Bases change to clarify the TS SR wording of "full" or "filled" as something other than 100%. During the discussion, it was stated that this type of change should possibly be considered a change to the TS and therefore should not be implemented as a change to the TS Bases. The purpose of this corrective action is to identify that WCNOC implemented a change to the TS Bases on May 1, 2008 that may be contrary to a future NRC determination. WCNOC will resolve this corrective action consistent with completion of the activities in paragraph a) above regarding the resolution of generic TS changes via the TSTF traveler process.

A.2. DESIGN EVALUATION

The WCGS design basis was reviewed with respect to gas accumulation in systems within the scope of GL 2008-01. This review included the design basis documents, calculations, engineering evaluations, and vendor technical manuals.

A.2.1. Results of the review of the design basis documents.

The only WCNOC design basis document identified that addresses the acceptability of the presence of gas in GL 2008-01 systems piping is the design calculation for qualification of the Containment Spray (CS) System discharge piping for the impulse of a water hammer at the commencement of system flow. CS System discharge piping is not required to be filled with water during normal plant operation. No deficiencies were identified in the review of this calculation.

No other design basis document, calculation, engineering evaluation, or vendor technical manual for GL 2008-01 systems was identified that addresses the acceptability or impact of gas accumulation in affected piping. However, a review of engineering procedures and other non-design basis engineering documents has identified two issues that require resolution. Associated corrective actions are described in Section A.2.3 below.

- WCNOC uses an "Engineering Screening Form" in the design process. This form is a checklist that prompts the developer of the design change package to consider, and possibly take additional action on, numerous issues associated with the WCGS design and licensing bases. This screening form did not directly address the potential impact of gas accumulation issues.
- A review of non-design basis engineering evaluation calculations in the WCNOC document system concluded that the wording in some calculations could be interpreted as allowing accumulated gas to be present as a design condition.

The WCGS design bases documents reviewed do not explicitly address the possibility of gas accumulation in systems within the scope of GL 2008-01. The system descriptions reflect the implicit design assumption that the GL 2008-01 systems are sufficiently full of water because no evaluations were identified that quantify the effects of gas accumulation on system performance. Calculations are based on pump performance data and flow delivery from the system that assume the piping to be filled. For example, the time delays estimated for delivery of flow for the various ECCS functions are based on pump start times and valve opening times. No additional allowance for the effects of gas accumulation is included in the calculations reviewed. Assumed delays due to pump start and valve actuation are conservative, which may provide margin for the effects of gas accumulation, but no explicit allowance for this purpose was identified in calculations reviewed. With the exception of CS System discharge piping, stress calculations to evaluate the pressure pulsations and/or water hammer pressures and forces were not identified in piping stress analyses.

A.2.2. Gas volume acceptance criteria

As discussed above, WCNOC began conducting reviews and performing evaluations relative to gas volume acceptance criteria beginning in early January 2008, prior to the start of more recent industry efforts to address acceptance criteria. The WCNOC gas accumulation acceptance criterion was developed in response to issues identified by

WCNOC personnel and by NRC inspection personnel during the ongoing NRC Special Inspection (Reference 1). The discussion below describes the results of this acceptance criterion development effort. Actions supporting development of WCNOC's current acceptance criterion, as well as all identified associated corrective actions implementing this acceptance criterion, are complete.

The acceptance criterion for the WCGS systems within the scope of GL 2008-01 is "full." The term "full," as used in this section, as well as the reminder of this Attachment, is clarified by the implementation of TS SR Bases 3.5.2.3 to mean sufficiently full of water to ensure that the subsystems can reliably perform their intended safety function. This usage of the term is integrated into the surveillance procedure implementing the requirement of TS SR 3.5.2.3 as well as other procedures and processes described in this Attachment impacting operability of GL 2008-01 systems.

Gas accumulation in systems within the scope of GL 2008-01 is considered to be a degraded condition that requires appropriate corrective action including assessing impact on system operability. Gas accumulation that is discovered is evaluated for its potential effects on the function of the GL 2008-01 systems to determine whether the systems and components can continue to perform their specified safety functions. If functionality is retained, the system is determined to be operable but degraded. The degraded condition is tracked by the corrective action program until it is corrected.

WCNOC has determined from review of design basis documentation for systems within the scope of GL 2008-01 that the design is based on the tacit assumption that the piping system is full. There are no identified design level acceptance criteria to allow accumulated gas to remain in the system as a long term or permanent condition. WCNOC has reviewed available information in the technical literature (e.g., NUREG/CR-2792 (Reference 2) and other published papers and reports) regarding the effects of gas accumulation on pump performance. At the time WCNOC performed the acceptance criterion evaluation, WCNOC believed the objective evidence available on the effects of gas ingestion on pump performance at high and low flow rates was insufficient for WCNOC to justify acceptance of accumulated gas in suction piping. WCNOC also believed that test results and analysis techniques for transport of gas from a starting location to a pump inlet were insufficient at that time to support development of acceptance criteria. Gas transport analyses are required to establish the inlet conditions that the pumps must tolerate to perform their specified safety functions based on an initial gas accumulation volume. Because of these deficiencies in test data and analytical techniques, WCNOC did not consider it possible, at that time, to develop acceptance criteria to allow gas accumulation as a permanent condition in piping systems within the scope of GL 2008-01. Therefore, the current design acceptance criterion for GL 2008-01 systems at WCGS is full.

WCNOC considers the accumulation of small amounts of gas at high points to be an expected condition following a system drain down and refill evolution. Consistent with guidance described in Section C.4 of Regulatory Information Summary 2005-20 (References 3 and 4), WCNOC has developed technical criteria using alternate evaluation criteria for assessing the potential impact of accumulated gas on TS operability, until corrective actions can be completed to remove the gas. The bases for these technical criteria are documented in an engineering document (referred to as a basic engineering disposition) developed as ongoing corrective action for GL 2008-01 issues. If gas accumulation in GL 2008-01 systems piping is discovered, this engineering disposition provides guidance regarding continued capability of the degraded affected system to perform its safety function. Therefore, this disposition may be used by the on-duty licensed Senior Reactor Operators (SROs) to support a "degraded but operable" operability decision.

Industry Reports Addressing Gas Accumulation Acceptance Criteria

Following WCNOC's implementation of the gas volume acceptance criterion described above, several industry reports have become available addressing gas accumulation issues. As with other engineering evaluations using industry reports, WCNOC's assessment of the applicability of the industry report to the situation being evaluated includes an assessment of the impact of assumptions, initial conditions, and limitations documented in the industry report. The discussions in the following paragraphs are consistent with WCNOC's implementation of the gas volume acceptance criterion described above.

a) Pump Suction Piping

The WCGS design basis for GL 2008-01 systems is that both suction and discharge piping are full. Physical plant changes (e.g., installation of additional vent valves) and procedure improvements have been implemented to provide confidence that the full condition can be maintained. WCNOC guidance developed for evaluation of the functional effects of accumulated gas identified by surveillance procedures is based on maintaining a high level of assurance that gas void volume fractions at pump inlets will be less than 2% even for short term transients. In developing the guidance, the effects of gas ingestion on pump and system performance were evaluated. For portions of systems where pump developed head degradation or increased pump suction pressure requirements were of particular concern, additional restrictions were incorporated in the functional evaluation guidance to assure that there is a high degree of confidence that GL 2008-01 systems can perform all specified safety functions.

WCNOC continues to follow industry activities to pursue testing of gas transport in ECCS piping and development of models and correlations to apply the test results to plant specific analyses.

b) Pump discharge piping which is not susceptible to water hammer or pressure pulsation following a pump start

The design basis of WCGS includes a calculation of the force imbalances during the filling of the containment spray discharge header that shows the resultant force imbalances to be within the margin of the pipe hangers.

Based on WCNOC engineering analyses performed for accumulated gas at specific locations in ECCS discharge piping upstream from throttle valves and flow restricting orifices, WCNOC considers that small gas void volumes (e.g., less than 0.25 cubic feet) are not likely to produce excessive pressure pulsations or water hammer that could affect the system functions.

c) RCS Allowable Gas Ingestion

WCNOC procedures provide assurance that the gas accumulation in any portions of the GL 2008-01 systems will be minimal so that the systems are maintained functionally full. Based on the guidance used for evaluating the capability of the systems to perform their required safety functions in an operable but degraded condition with small gas void volumes present, it is expected that the potential cumulative total volume of gas that may be injected to the RCS under accident conditions would be less than 10 cubic feet (standard temperature and pressure), which has been evaluated for WCGS and determined to be acceptable (item 3 in Table 3 below). Exceeding 10 cubic feet within the guidance would require many small void volumes at many different locations or an undetected intrusion event. WCNOC surveillance procedures and other processes addressing gas accumulation provide a high degree of assurance that such conditions will not occur.

A.2.3. Summary of changes to design basis documents

Corrective actions associated with WCNOC's review of design basis documents associated with GL 2008-01 systems are complete.

The "Engineering Screening Form" used in WCNOC's design change process was revised to address gas accumulation issues and an additional checklist item was added to addresses the potential increased probability of creating gas accumulation or increasing potential for gas intrusion. If the check list question is answered "yes", an engineering evaluation of the design change package by cognizant engineers and/or subject matter experts to address gas accumulation issues in the ECCS and CS System is required (item 4 in Table 3 below).

Evaluation calculations in the WCNOC document system that could be interpreted as allowing accumulated gas to be present as a design condition were voided and removed from the documentation system (items 5 and 6 in Table 3 below).

A.2.4. Results of the system P&ID and isometric drawing reviews to identify all system vents and high points

No discrepancies between the as-built plant configuration and the P&ID and isometric drawings were identified from the drawing reviews.

Description of High Points

WCNOC activities to assess the potential for gas accumulation, including drawing reviews, have considered all identified system configurations that can result in accumulation of gas during normal plant operation and other plant evolutions. These configurations are considered to be the definition of the term "high points" at WCGS. High point configurations include the following:

Highest Elevation Pipes: For any portion of the piping, the pipe run that is the highest elevation is an obvious gas accumulation point. There may be several highest elevation pipe runs in a system because piping is often required to go up and down to connect the various components in the system. A pipe run is a highest elevation pipe if the pipe runs connecting to each end go downward. The highest elevation designation is based on nominal elevation shown on drawings.

Local Horizontal Run High Points: Because the tolerance on elevation used for erection of most piping in GL 2008-01 systems was within plus or minus 1.0 inch of nominal elevation, it is possible that pipes have local high points. Local high points can be present on "highest elevation" pipes if portions of the pipe are at an elevation higher than that at the location of the design vent. Local high points can also occur in pipes at lower elevations if the pipe does not slope toward an upward going vertical run.

Traps Created by Valve Configuration: Some traps allowing gas accumulation in GL 2008-01 systems are created by valve arrangements. These types of traps are created when there are two valves in sequence on a horizontal run with no vent between them or with a vent that does not adequately vent the pipe between the valves. The most common example of this configuration is an isolation valve and a check valve in series.

Normally Closed Valves (Isolated Branch Connections): Isolation valves that are normally closed in GL 2008-01 systems while in standby lineup can create local gas accumulation traps. This includes check valves.

Local High Points in Components: Local high points that can trap or accumulate gas may be found in components that are part of systems within the scope of GL 2008-01. The components that have been identified as creating local high points are heat exchanger tube bundles, valve bodies, and vertical small bore piping to relief valves.

Tube bundles in heat exchangers in the GL 2008-01 systems (i.e., RHR heat exchanger and the reactor coolant pump seal water return heat exchanger) and attached systems are unventable gas traps. When the heat exchangers have been drained and the system is refilled, removal of air by dynamically flushing is the normal method of removing the trapped air.

The valves in the GL 2008-01 systems are either gate valves, globe valves or check valves. All types of valves identified have portions of the cavity in the valve body that are above the elevation of the connected pipes. Therefore, valve bodies are local high points.

Gas trapped in the bonnet region of gate valves is not considered to be a concern for operation of systems within the scope of GL 2008-01. As the system is filled and system pressure increases, gas in a gate valve body above the top of the run pipe will compress and will not be removed. Even with a dynamic filling operation most of the gas in a gate valve bonnet will remain trapped, because most of the opening between the flow path and the bonnet region is blocked by the withdrawn disk. Since there is no significant flow into the bonnet region to remove the gas, the trapped gas is not a concern with regard to entrainment. Void volumes trapped in gate valve bonnets are also considered too small to create a concern with excessive pressure overshoot or pulsations when the system is pressurized by starting a pump or opening a valve.

The vertical standpipes leading to relief valves can trap gas. These standpipes cannot be vented without lifting the relief valves or loosening the joint. However, for similar reasons described above for gate valve bonnet regions gas that is trapped in these standpipes is out of the flow path and is compressed by the system pressure so that the gas/water interface is above the entrance to the pipe. Therefore, small amounts of gas accumulated in relief valve standpipes will not be transported to pump inlets and the volume is too small for the pressure fluctuations to be significant.

Check valve bonnet regions are considered to be local high points in the GL 2008-01 systems that can trap gas in a location where it is likely to be mobilized when flow is increased in that portion of the system. The portion of a check valve body above the elevation of the top of attached pipes is a shallow trap for gas. If a dynamic flush with flow through the check valve is used for system fill, it is likely that the gas will be removed. However, if the fill is static or if the pipe is filled from the direction that closes the valve, it is likely that gas will be trapped.

Globe valve bonnets can be considered local high points. These valves are not typically found in the GL 2008-01 systems but can back feed into ECCS piping from the CVCS normal charging piping (non-ECCS) from the charging pumps that remain in service following a SI System actuation. The potential void volume size would typically be smaller than a similar size check valve. These control valves are required to operate generally on at least a monthly basis for pump or check valve surveillance testing or charging pump boron equalization. If any gas were to collect during normal operation, charging flow velocities would easily flush accumulated gas into the normal charging header that has a free path to the RCS. Therefore gas accumulated in the globe type valves in systems that connect to the ECCS (two valves maximum) is not considered to be a concern.

<u>Pipe Diameter Changes</u>: If a pipe diameter change occurs in a horizontal run, the elevation of the inner diameter of the larger pipe will be above that of the smaller pipe unless an eccentric reducer is used. This can prevent gas in the larger pipe from moving to an escape path (vent, branch, or upward pipe at end of horizontal run) in the smaller diameter pipe.

<u>Flow Orifices</u>: Flow orifice plates in horizontal pipes may prevent gas from moving to an escape path (vent, branch, or upward pipe at the end of a horizontal run). Flow orifices were considered in conjunction with the evaluation of pipe metrology to identify local high points. Flow orifices in vertical pipes may cause dissolved gas to come out of solution in the low-pressure region down stream from the orifice.

A.2.5. New vent valve locations, modifications to existing vent valves, or utilization of existing vent valves, based on the drawing review, and summary of corrective actions

Refer to section A.2.7 below for a complete description of new vent valve locations, modifications to existing vent valves, or utilization of existing vent valves.

Required corrective action was identified in one location where a vent is located on the smaller diameter pipe in a horizontal run creating a gas trap in the larger piping. This potential gas accumulation issue will be corrected by installation of an additional vent prior to startup following Refueling Outage 17. Refer to Section A.2.12 below for a complete description of vent locations planned for future installation, which includes this valve as item number 18 in Table 2.

A.2.6. Results of the system confirmation walkdowns that have been completed

<u>Introduction</u>

Following the January 2008 WCGS gas accumulation events described in the background section above and to provide information for the requested actions of GL 2008-01, WCNOC performed extensive surveying to determine the actual slopes of nominally horizontal GL 2008-01 systems piping and to identify local high points on horizontal piping runs. The method chosen for surveying the piping was laser metrology. Using the results of the laser metrology, determination of the local slopes of horizontal runs of pipes allowed quantification of pipe volumes above vents or other escape paths where gas could accumulate.

Piping in rooms and other locations containing GL 2008-01 system piping, including pipe chases and the containment building, was scanned to obtain data on selected horizontal piping runs. The laser metrology measurements were successful in obtaining data for more than 90% of the GL 2008-01 pipe runs meeting the laser metrology selection criteria. For pipes where no data were obtained or the laser metrology data were insufficient to characterize the pipe, field measurements with levels and scales were used to acquire the information.

In addition, a walkdown of existing GL 2008-01 system vents installed prior to the end of Refueling Outage 16 was completed in order to verify that each vent was actually installed and was configured as shown on the associated design drawings. The configuration of vent valves installed during Refueling Outage 16 was verified as part of the installation process. Using a tape measure, or by estimation in inaccessible areas, the distance on the pipe from centerline of a nearby fitting (elbow, tee, etc.) to the centerline of vent valve pipe was measured. The acceptance criterion for identifying discrepancies from the design drawings was plus or minus one inch. In addition, a visual examination (no direct measurement) was performed to determine if each vent was located at the top center of the pipe. No discrepancies in installed vents were identified from the drawing walkdown.

The GL 2008-01 systems piping segments that were not considered for walk downs were CS System discharge piping segments because they are not required to be filled with water prior to system actuation. The containment spray header and nozzles are designed to withstand the impulse of a water hammer at the commencement of flow. The results of this drawing walkdown review are documented and available for review at WCGS.

Laser Metrology

Laser metrology is a method for obtaining three dimensional position information from objects that reflect pulses of laser light. The laser instrument is set up in a room and scans its field of view with laser light pulses. The instrument detects light from the pulse that is reflected from objects in the room. From the time of flight of the laser pulse and reflection and the direction of the light pulse, the instrument calculates the three dimensional position of the reflector relative to the fixed instrument location. The laser scanning of a room captures a large amount of position data that can be processed to identify reflections from pipes and determine the diameter, centerline coordinates, and lengths of pipe segments.

Survey Selection Criteria: Piping selection criteria for using laser metrology for piping surveys were as follows:

1. Any straight 10 feet or longer horizontal piping run on the same elevation.
2. Any horizontal run that had a vent in it.
3. Any horizontal run that had a reducer, reducing tee, or line size change in it on the same elevation.
4. Any 10 feet or longer horizontal run on the same level made up of segments due to elbows.

5. For any horizontal run with a horizontal tee, such that if the tee run segment lengths are added to the horizontal pipe length, the total is over 10 feet.
6. Any horizontal pipe 6 inches or greater nominal pipe size of any length.

Data Reduction: Data reduction to obtain the information to identify high points and quantify potential void volumes included the following steps:

1. The laser measurement data were imported into a proprietary three dimensional (3D) computer aided design/solid modeling computer program. Using the 3D display, the data representing a section of pipe was manually selected. The solid modeling program then generated a best fit cylinder representing the best fit through the laser reflection data points. A horizontal length of pipe was fitted either as a whole or piecewise, depending on the quality of the fit. Piecewise fits allowed local slopes to be determined for pipes that are not straight. The accuracy of determining elevation using this technique is plus or minus 0.1 inch.

2. The solid modeling program returned the dimensions (centerline elevations at the ends of the pipe segments and segment length). This information was captured by pictures of the model with dimensions displayed.

3. The pictures of the 3D solid model of pipe sections were correlated with isometric drawings. The slopes indicated by the elevations were reviewed to determine whether each pipe section sloped upward toward an escape path for accumulated gas (installed vent or upward going connecting pipe). Pipe segments that slope away from escape paths create trapping points where gas can accumulate. The trapping points are typically elbows from horizontal to vertical downward pipes, horizontal elbows that are higher than connected pipes, local high points in nominally straight horizontal runs. Local high points in straight runs are most often located at anchor supports or other rigid pipe supports. Locations of orifices that can prevent migration of gas to an escape path were considered in the process of identifying local high points.

4. For each location with an identified gas trap, the potential trapped void volume was calculated from the elevation changes and pipe diameter.

Results of the pipe metrology or supplemental surveys were tabulated for each identified measurement location and are available in a calculation for review at WCGS.

Results of Drawing Walkdowns and Laser Metrology

Some locations with significant potential gas trap volumes were corrected by installation of an additional vent during Refueling Outage 16 (March-April-May 2008). Additional vents based on metrology results and drawing reviews are scheduled for installation during Refueling Outage 17 (Fall 2009), as described in Section A.2.12 below. The impact of the remaining potential gas void volume is discussed below.

Following installation of vents planned for Refueling Outage 17, the remaining potential cumulative unventable gas void volumes created by slopes in horizontal pipes will be less than 3 cubic feet for GL 2008-01 systems discharge piping, and less than 0.5 cubic feet for GL 2008-01 systems suction piping. These potential volumes are not existing gas voids, but rather are locations where gas could accumulate. Refueling Outage 16 system fill and vent experience demonstrates that locations without installed vents can be filled with water during a system fill and vent process. Gas may accumulate over time at some of these locations, but the total accumulated volume is expected to be less than the volumes given above because a plausible mechanism for gas accumulation at many of the locations has not been identified. The gas that can accumulate at any single small local high point does not create a condition that threatens the ability of GL 2008-01 systems to perform their intended functions.

A.2.7. New vent valve locations, modifications to existing vent valves, or utilization of existing vent valves, that resulted from the confirmatory walkdowns, and summary of corrective actions

Pipe slope surveys and drawing walkdowns of GL 2008-01 systems piping at WCGS are complete.

Based on laser metrology results and drawing reviews identified above, twenty seven locations with significant potential gas accumulation volumes were corrected by installation of new vents during Refueling Outage 16 (March-April-May 2008). In addition, valves in four other locations were installed prior to the end of Refueling Outage 16 due to other gas accumulation evaluations not directly related to GL 2008-01 issues. Valves in two vent locations were installed in January 2008 during a forced outage due to discovery of gas accumulation, and valves installed in two other vent locations were planned prior to January 2008 due to actions resulting from industry operating experience. The thirty one valve locations identified above are listed in Table 1.

No previously existing vent valves were modified as a result of pipe slope surveys or drawing walkdowns. Following discovery of trapped gas in January 2008, one of the pipes was realigned by adjusting pipe supports to allow the vents to be more effective. Completed corrective actions identified in Sections A.2.9 and A.3 below have resulted in the inclusion of all identified previously installed vent locations into surveillance testing procedures and fill and vent procedures. As a result, fifty four vent locations that existed prior to January 2008, but were not directly included in surveillance procedures and fill and vent procedures, are now included.

Table 1. WCGS Vent Valves Installed Prior to End of Refueling Outage 16

Item No.	Vent Valve No.	Sys	Train (Note1)	Suction/ Disch. Vent	Vent Valve Location Description
1	BG-V0832	BG	C	Suction	Charging pump suction header
2	EJ-V0216	EJ	B	Suction	Downstream of valve EJHV8804B
3	EJ-V0217	EJ	B	Suction	In bonnet of valve EJV8969B
4	EJ-V0218/219	EJ	C	Discharge	RHR 10 inch hot leg injection header to loops 2 and 3
5	EJ-V0220/222	EJ	A	Suction	RHR pump suction from cont. sumps
6	EJ-V0221	EJ	A	Suction	In bonnet of check valve EJ8958A from refueling water storage tank (RWST).
7	EJ-V0223	EJ	B	Suction	In bonnet of check valve EJ8958B from RWST.
8	EJ-V0224/225	EJ	B	Suction	RHR pump suction from cont. sumps
9	EJ-V0226/227	EJ	A	Suction	RCS suction line from hot leg #1
10	EJ-V0228/229	EJ	A	Suction	RWST supply line to RHR
11	EJ-V0230/231	EJ	B	Suction	RCS suction line from hot leg #4
12	EJ-V0232/233	EJ	B	Suction	RHR pump suction on pump side of tee
13	EJ-V0234/235	EJ	B	Discharge	RHR pump cold leg discharge
14	EJ-V0236/237	EJ	A	Discharge	RHR A pump cold leg discharge
15	EM-V0256	EM	C	Suction	SI pump suction, (Note 2)
16	EM-V0257	EM	C	Suction	SI pump suction, (Note 2)
17	EM-V0258	EM	C	Suction	SI pump suction
18	EM-V0259	EM	C	Suction	SI pump suction
19	EM-V0260	EM	A	Suction	SI pump suction
20	EM-V0261/266	EM	A	Discharge	SI pump discharge
21	EM-V0262/267	EM	A	Discharge	SI pump discharge
22	EM-V0263/268	EM	A	Discharge	SI pump discharge
23	EM-V0264/269	EM	A	Discharge	SI pump discharge
24	EMV-0265	EM	C	Suction	SI pump suction
25	EM-V0270	EM	A	Suction	SI pump suction in SI pump room
26	EM-V0271	EM	C	Suction	SI pump suction
27	EM-V0272/273	EM	A	Discharge	Boron injection tank injection header from centrifugal charging pump A
28	EM-V0705/706	EM	B	Discharge	Boron injection tank injection header from centrifugal charging pump B
29	EM-V0707/708	EM	C	Discharge	SI pump discharge to accumulator injection cold legs
30	EN-V117/91	EN	A	Suction	CS pump A suction header (Note 3)
31	EN-V121/95	EN	B	Suction	CS pump A suction header (Note 3)

Note 1: A = A train; B = B train; C = Combined (both A and B train)

Note 2: These valves were installed in January 2008 during forced outage due to discovery of gas accumulation.

Note 3: Installation of this valve was planned prior to January 2008 due to actions resulting from industry operating experience, not as a result of walkdowns or drawing reviews.

A.2.8. Results of the fill and vent activities and procedure reviews

Administrative controls for initial fill and partial system restoration venting activities for systems within the scope of GL 2008-01 were contained in seven system-specific WCNOC procedures and one multiple-system procedure (tagging procedure) that contains controls for system restoration after maintenance is performed while impacted systems are in-service. The seven fill and vent procedures were reviewed against system isometric drawings to ensure the procedure included all identified installed vent locations. The fill and vent procedures review concluded that the procedures generally included effective sequencing of steps, and adequate fill and venting instructions. However, required corrections and enhancements to the procedures were identified in the following areas:

- The WCNOC fill and vent procedures did not include all identified installed vent locations identified on associated GL 2008-01 system isometric drawings.
- The WCNOC restoration process did not address the potential for gas migration during system restoration.
- The WCNOC system restoration process did not provide specific requirements to verify that the piping was full in accordance with approved surveillance procedures.

Pressure sensing instrument line designs and arrangements for GL 2008-01 systems were reviewed to evaluate the potential necessity for venting or back filling the instrument lines following an activity that included draining the piping segment associated with the instrument. The majority of WCGS instrument lines do not require venting or back filling the instrument lines following a draining activity. However, some exceptions were identified. The instruments identified below required administrative controls for filling and/or venting activities.

- Flow indicating switch for RHR mini-flow
- Flow transmitter for boron injection tank
- Flow indicator for SI System combined recirculation flow to the RWST
- Flow indicating switch for normal charging pump low recirculation flow (non-ECCS)
- Flow transmitter for normal charging header flow (non-ECCS)

No fill and vent procedures were identified at WCGS that allow vacuum filling for specific portions of GL 2008-01 systems.

A.2.9. Procedure revisions, or new procedures resulting from the fill and vent activities and procedure reviews, and summary of corrective actions

Corrective actions associated with WCNOC's review of fill and vent activities and WCNOC's review of fill and vent procedures associated with GL 2008-01 systems are complete. Corrective actions taken following the WCGS gas accumulation event in January 2008 included reviewing WCNOC fill and vent procedures against system isometric drawings to validate that installed vent locations were included in the fill and vent procedures (item 7 in Table 3 below).

No new fill and vent procedures were identified as being required to be created to address gas accumulation issues. Each of the WCNOC procedures used for filling and venting systems within the scope of GL 2008-01 has been revised. Revisions include:

- Each fill and vent procedure was revised to include controls for all identified valves installed in the systems within the scope of each procedure (item 8 in Table 3 below).
- The procedure controlling system restoration following in-service maintenance was revised to address the potential for gas migration during restoration. This procedure now requires a manual vent or a confirmatory ultrasonic test (UT) of the next high point location of the system to ensure additional portions of the piping are full (item 9 in Table 3 below).
- The procedure controlling system restoration following in-service maintenance was revised to provide specific requirements to verify that the piping was full in accordance with approved surveillance procedures (item 9 in Table 3 below).
- Fill and vent procedures covering systems with the following instrumentation were modified to require venting or back filling the instrument lines following a draining activity:
    - Flow indicating switch for RHR mini-flow
    - Flow transmitter for boron injection tank
    - Flow indicator for SI system combined recirculation flow to the RWST
    - Flow indicating switch for normal charging pump low recirculation flow (non-ECCS)
    - Flow transmitter for normal charging header flow (non-ECCS)

A.2.10. Potential gas intrusion mechanisms

Nitrogen-saturated water from the Safety Injection Accumulators is maintained at approximately 650 psig. If leakage through closed valves or check valves occurs, the process fluid has the potential to migrate to a lower pressure section allowing the nitrogen to come out of solution. Corrective action from the January 2008 WCGS gas intrusion event includes monitoring of the accumulator levels by the System Engineer from the plant computer (item 10 in Table 3 below). Additionally, a deviation alarm has been established such that if the level decreases or increases by a pre-defined amount, an email alert is sent to the System Engineer.

Another high-pressure source is leakage past the first-off and second-off check valves from any of the RCS cold leg and hot leg injection lines. This source, like the accumulators, can leak past check valves and depressurize causing hydrogen gas to come out of solution.

The safety injection test header is inter-connected to the cold leg and hot leg injection lines. While these flow paths are normally isolated with closed air operated valves, leakage past closed valves has been identified. If the second-off check valves are leak tight then the pressure between the first-off and second-off valves will increase to RCS pressure and hydrogen gas will not accumulate. However, if leakage occurs past the second-off check valves, and the air operated isolation valves are not leak tight, then this water can further depressurize and hydrogen gas could accumulate.

Due to the adverse impact of gases coming out of solution from migration of higher-pressure fluids to lower pressures, the safety injection test header is normally maintained in the isolated position through administrative controls. These controls mitigate a potentially continuous and un-monitored build up of gases in the discharge piping. With the test header isolated, any in-leakage will cause the pressure to increase and will be identified through monitoring of the safety injection discharge header pressure indicators.

Leakage from the RCS through this path can be detected by observing an increase in safety injection accumulator level, an increase in safety injection pump discharge header pressure and/or an increase in residual heat removal discharge header pressure.

WCGS configurations in the GL 2008-01 systems where dissolved gas could come out of solution due to a pressure reduction such as through control valves, orifices, or piping diameter changes were identified by drawing reviews and were evaluated. It was determined that the possibility of gas accumulation in such locations is appropriately addressed by surveillance procedures and that appropriate vents for removal of any accumulated gas are available.

The containment emergency recirculation sump screens were replaced with strainer assemblies in Refueling Outage 15 to increase the surface area. The piping from the sumps to the RHR and CS System pumps is sloped downward towards the pumps. Thus if any gas were to come out of solution, it would migrate back out to the sump itself. The modified sump strainers installed in Refueling Outage 15 have been analyzed to show that a vortex will not form in the sump to entrain air through the strainers. This is true even with maximum debris loading on the strainers, which can increase local velocity. Without a vortex, air entrainment through the sump strainers is not possible. Steam may form in the fluid from the sump as it passes through the strainers if it is at saturation pressure. However, the calculation for the strainers shows that these steam voids will collapse before they exit the sump through the discharge pipe. By the time the fluid from the sump reaches the pump inlets, it will be sub-cooled because of the static head from the sump to the pump.

Failure of level instruments to indicate the correct level for tanks used as a pump suction source can potentially result in gas intrusion, even though plant design and use of redundant instruments minimizes this risk. The tanks used for the GL 2008-01 systems are: RWST, volume control tank (VCT), spray additive tank (SAT), and the containment recirculation sumps.

The RWST is the primary source of water for the ECCS and CS pumps during the injection phase of an accident. The RWST has four separate safety related level transmitters associated with it. Additionally, the level transmitters have independent reference legs, preventing a common mode failure. WCNOC calculations for water transfer rates from the RWST to containment, and evaluations of times available for operator actions to manually transfer the suctions of the containment spray pumps from the RWST to the containment recirculation sumps, demonstrate that sufficient submergence of the RWST outlet pipe will be maintained to prevent formation of a vortex leading to gas entrainment in the flow from the tank. The evaluations are based on a conservative bounding correlation of test data from a scale model tank that was geometrically similar to the WCGS RWST. The calculations allow for maximum instrument uncertainty for tank level indications and setpoints.

The VCT is the normal suction source for the normal charging pump (NCP) and centrifugal charging pumps (CCP) during non-accident conditions. Indication of an accident condition will open the suction valves off of the RWST and close the VCT outlet valves. The VCT has two safety related level instruments with independent reference legs.

The SAT contains a sodium hydroxide solution that is sprayed into containment during accident conditions when the containment pressure is high. The tank has two sets of safety related level instruments powered from two separate safety related power sources. Each set of these instruments has an independent reference leg.

Each containment emergency recirculation sump has a single level instrument, with each instrument being powered from a separate safety-related power supply. The level instruments can be monitored from the control room, but do not provide any automatic actions. Design calculations verify that sufficient water has been transferred from the RWST to the containment during accident scenarios prior to the automatic transfer of the RHR pump suctions from the RWST to the sumps to assure that the sumps are full and that there is sufficient suction pressure available for the pumps.

Leakage through isolation valves or through check valves could potentially result in gas transport from the intrusion location to other locations in GL 2008-01 systems. Multiple monitoring points are available to assist in determining when leakage is occurring. Ultrasonic testing or manual venting is performed at suspected gas accumulation locations and ultrasonic leak detection is performed at suspected potential leaking isolation points. The safety injection pump discharge header pressure and the RHR pump discharge header pressure are monitored for increasing pressures. Cautions included in system procedures address the potential adverse impact of leakage through closed isolation valves and check valves.

While leakage through vent valves could potentially occur when the local system pressure is less than the nominal atmospheric vent pressure, the CVCS, RHR and SI Systems are always slightly pressurized compared to atmospheric pressure by the static head of the RWST.

Gas could potentially be introduced from the RWST due to formation of air entraining vortices or by not isolating the suction source before the RWST is completely drained. Design calculations validate that sufficient submergence is maintained in the RWST until all pump suctions have been transferred to recirculation mode water sources to prevent formation of a vortex and air entrainment at the tank outlet pipe. The suctions for the RHR pumps are automatically transferred to the recirculation sumps when the RWST reaches the first low level setpoint. At that point, there is ample submergence of the discharge pipe to prevent vortex formation with the maximum flow rate for all pumps and accounting for maximum level instrument uncertainty. Once the RHR pump suctions have been transferred to the sumps, the flow rate from the RWST is reduced, and the submergence required to prevent a vortex is also reduced. The suctions for the SI pump and CCP are transferred manually after the RHR pump suctions have been transferred. The containment spray pump suctions are manually transferred to the containment sumps when the RWST level reaches the second low level setpoint. Calculations for timing of operator actions confirm that these transfers will be completed before a vortex can form. Should there be an unexpected delay in transferring the containment spray pump suctions to the sumps, another RWST level alarm will alert operators to secure the pumps to prevent air entrainment into the containment spray system.

Air operated valves in GL 2008-01 systems have a design such that leakage of pressurized air from the valve operator is to the surrounding environment and air does not directly interface with the process fluid. The only identified method for air inleakage is either through the packing or through the packing leakoff lines from the ambient environment. However, the CVCS, RHR and SI Systems are always slightly pressurized by the static head of the RWST.

A.2.11. Ongoing Industry Programs

Ongoing industry programs are planned in the following areas which may impact the conclusions reached during the design evaluation of WCGS relative to gas accumulation. The activities will be monitored to determine if additional changes to the WCGS design may be required or desired to provide additional margin.

- Gas Transport in Pump Suction Piping

  The Pressurized Water Reactor Owners Group (PWROG) has initiated testing to provide additional knowledge relative to gas transport in large diameter piping. One program performed testing of gas transport in 6-inch and 8-inch piping. Another program will perform additional testing of gas transport in 4-inch and 12-inch low temperature systems and 4-inch high temperature systems. This program will also integrate the results of the 4-inch, 6-inch, 8-inch and 12-inch testing.

- Pump Acceptance Criteria

  Long-term industry tasks were identified that will provide additional tools to address GL 2008-01 with respect to pump gas void ingestion tolerance limits.

A.2.12. List of items from the design evaluation that have not been completed

1. WCNOC will install twenty three additional vents based on metrology results and drawing reviews prior to startup following Refueling Outage 17 (currently scheduled for Fall 2009) (item 11 in Table 3 below). Table 2 below provides relevant information and justification for deferral of installation until Refueling Outage 17. Changes to drawings, procedures and other documents associated with design and installation of additional vents are implemented in accordance with WCNOC procedure controls associated with the design and installation processes.

All other identified corrective actions associated with GL 2008-01 design evaluations are complete.

Table 2. WCGS Vent Valves Scheduled for Fall 2009 Installation

Item	Location	Suction/ Disch.	Overall Assessment
1	On bonnet of check valve BG8546A	Suction	The probability that a void will be collected in this check valve prior to Refueling Outage 17 is low. Gas can be removed from the valve bonnet area during an outage by a dynamic flush through the line. Once filled, there is no plausible mechanism for gas to accumulate in the valve body during plant operation. The valve is on a local low point pipe, so gas cannot enter the pipe from below. There is a very low probability that maintenance would require the pipe run or the valve body to be drained for maintenance during the operating cycle. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
2	Between valves BG8546A and BNLCV0112D	Suction	This pipe is a low point pipe. There are upward vertical pipes at both ends of this horizontal run so gas can migrate to vents at higher elevations on the piping system. A vent is required on this line only to facilitate post maintenance restoration if the pipe must be isolated and drained at power. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
3	On bonnet of check valve BG8546B	Suction	The probability that a void will be collected in this check valve during operating cycle 17 is low. Gas can be removed from the valve bonnet area during an outage by a dynamic flush through the line. Once filled, there is no plausible mechanism for gas to accumulate in the valve body during plant operation. The valve is on a local low point pipe, so gas cannot enter the pipe from below. There is a very low probability that maintenance would require the pipe run or the valve body to be drained for maintenance during the operating cycle. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
4	Between valves BG8546B and BNLCV0112E	Suction	This pipe is a low point pipe. There are upward vertical pipes at both ends of this horizontal run so gas can migrate to vents at higher elevations on the piping system. A vent is required on this line only to facilitate post maintenance restoration if the pipe must be isolated and drained at power. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
5	Upstream of tap for valve BGV0089	Suction	This horizontal run is at an intermediate elevation above CCP A. Metrology shows a very small volume local high point (less than 0.008 cubic feet) on this horizontal run. If it were necessary to isolate this pipe for pump maintenance and drain the line, any gas that could not be vented could be allowed to escape to higher elevation pipes and removed from high point vents following system restoration. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.

Table 2 (Continued). WCGS Vent Valves Scheduled for Fall 2009 Installation

Item	Location	Suction/ Disch.	Overall Assessment
6	Between the pipe taps for valves BGV0357 & BGV0090	Disch.	This horizontal pipe is a local high point without a vent line. The line has a horizontal tap for instrumentation that has been used for venting. The horizontal tap location is such that air in the line cannot be completely vented, so dynamic flushing of the line is required to completely remove trapped air. The pipe volume above the horizontal tap is approximately 0.37 cubic feet. When that volume of trapped gas is pressurized to volume control tank pressure plus static head pressure, it will have a volume of approximately 0.1 cubic feet. Engineering evaluations indicate this small volume would not affect ability of the ECCS to perform its safety function. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
7	Downstream of tap for valve BGV0093	Suction	Metrology shows a very small volume local high point on this horizontal run. If it were necessary to isolate this pipe for pump maintenance and drain the line, any gas that could not be vented could be allowed to escape to higher elevation pipes and removed from high point vents following system restoration. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
8	Between the pipe taps for valves BGV0358 & BGV0094	Disch.	This horizontal pipe is a local high point without a vent line. The line has a horizontal tap for instrumentation that has been used for venting. The horizontal tap location is such that air in the line can not be completely vented, so dynamic flushing of the line is required to completely remove trapped air. The pipe volume above the horizontal tap is approximately 0.34 cubic feet. When that volume of trapped gas is pressurized to volume control tank pressure plus static head pressure, it will have a volume of approximately 0.1 cubic feet. Engineering evaluations indicate this small volume would not affect ability of the ECCS to perform its safety function. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
9	RHR A discharge line on horizontal section of top elbow on vertical line	Disch.	There are existing vents on this high point piping, but there are local high point volumes away from the existing vents that could trap gas. Gas in these local high points can be removed by dynamic fill and vent. The additional vent is to be installed to assure that any gas found in this location can be removed even if it is not possible to dynamically flush the system. The vent location is monitored for gas accumulation until the vent is installed. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.

Table 2 (Continued). WCGS Vent Valves Scheduled for Fall 2009 Installation

Item	Location	Suction/ Disch.	Overall Assessment
10	Between valves BNHV8806A and EM8926A	Suction	The portion of piping between the isolation valve and check valve is difficult to fill and vent if the piping must be isolated and drained locally. Under outage conditions, the fill path can be such as to allow water to enter this portion of the system and for gas to escape. Dynamic fill and vent can also be used to assure that gas is removed from this line. The vent is required only to support maintenance at power. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
11	On top of check valve EM8926A	Suction	The bonnet region of this check valve is a local high point where gas can be trapped during a static fill and vent. The trapped gas can be flushed from the valve body by flow through the system. However, the vent facilitates removal of trapped air from the check valve following maintenance when plant conditions do not allow for high velocity flushing of the pipe. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
12	Between valves BNHV8806B and EM8926B	Suction	The portion of piping between the isolation valve and check valve is difficult to fill and vent if the piping must be isolated and drained locally. Under outage conditions, the fill path can be such as to allow water to enter this portion of the system and for gas to escape. Dynamic fill and vent can also be used to assure that gas is removed from this line. The vent is required only to support maintenance at power. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
13	On top of check valve EM8926B	Suction	The bonnet region of this check valve is a local high point where gas can be trapped during a static fill and vent. The trapped gas can be flushed from the valve body by flow through the system. A vent is to be installed to facilitate removal of trapped air from the check valve following maintenance that requires the valve and a small part of the system piping to be drained under plant conditions that do not allow for high velocity flushing of the pipe. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
14	Between valves EJHV8804A and EJ8969A	Suction	The portion of piping between the isolation valve and check valve is difficult to fill and vent if the piping must be isolated and drained locally. Under outage conditions, the fill path can be such as to allow water to enter this portion of the system and for gas to escape. Dynamic fill and vent can also be used to assure that gas is removed from this line. The vent is required only to support in-service maintenance. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.

Table 2 (Continued). WCGS Vent Valves Scheduled for Fall 2009 Installation

Item	Location	Suction/ Disch.	Overall Assessment
15	On bonnet of check valve EJ8969A	Suction	The bonnet region of this check valve is a local high point where gas can be trapped during a static fill and vent. The trapped gas can be flushed from the valve body by flow through the system. A vent is to be installed to facilitate removal of trapped air from the check valve following maintenance that requires the valve and a small part of the system piping to be drained under plant conditions that do not allow for high velocity flushing of the pipe. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
16	Normal charging pump suction line	Suction	This location is on the suction flow path for the normal charging pump. It is not part of the ECCS, but this system includes both the normal charging pump and the centrifugal charging pumps and the piping is interconnected. While it is possible for gas to collect at this location and migrate to the ECCS, it is not likely. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
17	On the horizontal section of chemical and volume control system	Disch.	This unvented high point pipe is the flow path from centrifugal pump B to the charging system. It is not part of the ECCS injection flow path. However for some accident scenarios, when the normal charging pump remains operating after initiation of safety injection, gas from this line could migrate to the charging pump discharge flow path. Accumulation of gas in this line is unlikely because it is used monthly when centrifugal pump B is operated as a charging pump. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
18	Upstream of the reducer in chemical and volume control system line	Disch.	This unvented high point pipe is the flow path from the centrifugal pumps to the charging system. It is not part of the ECCS injection flow path. However for some accident scenarios, when the normal charging pump remains operating after initiation of safety injection, gas from this line could migrate to the charging pump discharge flow path. Accumulation of gas in this line is unlikely because it is used monthly when the centrifugal pumps are operated as charging pumps. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
19	On RHR line elbow	Disch.	This is a local high point on the hot leg recirculation discharge piping identified metrology. The high point was filled by a dynamic fill and vent and verified to be full of water. It is unlikely that this location will be drained during an operating cycle or that it will accumulate significant gas. The vent location is monitored for gas accumulation until a vent can be installed. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
20	On centrifugal charging pump suction line	Suction	For gas to accumulate at this local high point, it should also accumulate at a higher location with an installed vent. This higher vent was installed in Refueling Outage 16 and has been monitored since the outage and no gas accumulation has been found. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.

Table 2 (Continued). WCGS Vent Valves Scheduled for Fall 2009 Installation

Item	Location	Suction/ Disch.	Overall Assessment
21	Between valves EM8922A and EMV8921A	Disch.	The potential void volume is small. Metrology does not show a high point in this pipe, but for a local system restoration following maintenance, it is difficult to refill piping between an isolation valve and a check valve. However, there are no planned maintenance activities that affect this pipe run. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
22	Between valves EM8922B and EMV8921B	Disch.	The potential void volume is small. Metrology does not show a high point in this pipe, but for a local system restoration following maintenance, it is difficult to refill piping between an isolation valve and a check valve. However, there are no planned maintenance activities that affect this pipe run. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.
23	On elbow to the vertical downward run of safety injection suction piping	Suction	Metrology shows an unventable high point at this location. The pipe can be filled by a dynamic flush, but removal of a void would be difficult at power following maintenance when it is not possible to run full flow through the pipe. However, there are no planned maintenance activities that affect this pipe run. Therefore, deferral of installation of this vent until Refueling Outage 17 is acceptable.

A.3. TESTING EVALUATION

A.3.1. Results of the periodic venting or gas accumulation surveillance procedure review

Administrative controls for surveillance activities for systems within the scope of GL 2008-01 were contained in three WCNOC procedures prior to January 2008. The surveillance procedures review concluded that the procedures generally included (1) requirements to use UT measurements if possible or venting, (2) the requirement to re-perform UT/vent to verify gas was removed, and (3) acceptance criteria consistent with technical specification surveillance requirements. However, required corrections and enhancements to the surveillance procedures were identified in the following areas:

- The WCNOC surveillance procedures did not include numerous installed vent locations identified on associated GL 2008-01 system isometric drawings.
- No specific controls were identified to connect discovery of failure to meet the acceptance criteria to the technical specifications operability process.
- No administrative controls were identified to require the discovery of failure to meet the acceptance criteria to be entered into the corrective action process.
- Administrative controls did not include actions or direction for information gathering required for trending void volume growth.
- Administrative controls did not include actions for sampling and chemical analysis of accumulated gas.
- Administrative controls did not include requirements to quantify or document the amount of accumulated gas discovered.
- Administrative controls did not include requirements to inform system engineering group or to address trending of accumulated gas.
- Several installed vent locations were considered inaccessible; however additional reviews determined that several locations should have been considered accessible based on actual conditions at the time of the surveillance.

A.3.2. Procedure revisions, or new procedures resulting from the periodic venting or gas accumulation surveillance procedure review that need to be developed, and summary of corrective actions

Corrective actions associated with WCNOC's review of surveillance procedures associated with GL 2008-01 systems are complete.

Three new surveillance procedures and one new sample procedure were required to be created to address gas accumulation issues. The four new procedures created administrative controls similar to the revised ECCS controls for the CS System, the RHR System and the normal charging portion of the CVCS. The new sample procedure was generated to create consistent administrative controls and instructions for system vent sampling when accumulated gas is detected. The revised and created WCNOC procedures used for surveillance activities within the scope of GL 2008-01 include:

- Controls for all identified valves installed in the systems within the scope of each procedure (item 8 in Table 3 below).

- Requirements to contact the control room senior licensed operators upon discovery of failure to meet the acceptance criteria (item 12 in Table 3 below).
- Requirements to initiate corrective action process documentation when accumulated gas is discovered (item 12 in Table 3 below).
- Requirements to contact the engineering group when accumulated gas is discovered (item 12 in Table 3 below).
- Controls for information gathering required for trending void volume growth (item 12 in Table 3 below).
- Instructions for potential sampling and chemical analysis of accumulated gas (item 12 in Table 3 below).
- Controls to quantify and document the amount of accumulated gas discovered (item 12 in Table 3 below).
- Controls addressing valve accessibility criteria based on potential radiological dose to the test performer and potential heat stress hazard to the test performer based on temperature and humidity (item 13 in Table 3 below).

A.3.3. Procedures that address the manual operation of the RHR system in its decay heat removal mode of operation.

Approved procedures are used to conduct fill and vent activities for the RHR piping associated with decay heat removal. The surveillance procedures described in Section A.3.2 above include high point vents in the portion of the RHR System used in the decay heat removal mode of operation. This procedure is performed frequently upon securing RHR from shutdown cooling mode and into ECCS mode. This same procedure is performed periodically to monitor the decay heat removal piping.

To ensure RHR remains capable for decay heat removal in reduced RCS inventory, detailed administrative controls have been established and pump operation is closely monitored by plant operators using approved procedures:

- When the RCS is in reduced inventory conditions and fuel is installed in the vessel, at least two independent, continuous RCS water level indicators are available.
- At least two independent coolant temperature indicators that are representative of the core exit conditions are available.
- The following indications of RHR pump cavitation are monitored continuously:
    - RHR pump current
    - RHR pump flow
- Main control board annunciators for both high and low RCS loop level are available.
- A graph of RCS level vs. RHR flow is available for use to prevent vortex in RHR suction pipe.
- A method is established to determine minimum RHR flow versus days after shutdown for various cooling water inlet temperatures to RHR heat exchangers.

A.3.4. Summary of the results of the procedure reviews performed to determine that gas intrusion does not occur as a result of inadvertent draining due to valve manipulations specified in the procedures, system realignments, or incorrect maintenance procedures.

Corrective actions identified as a result of the procedure reviews discussed in this section are complete. Measures are in place to guard against gas intrusion because of inadvertent draining, system realignments, incorrect maintenance procedures or other evolutions, as described below.

Draining activities during outage or on-line are required to be performed under a clearance order, which is an administrative process that establishes boundaries using a tagging system to effectively isolate the portions of systems that are impacted by the maintenance activity. Filling and venting activities for restoring systems from these draining activities are controlled through approved procedures. To address the potential for gas migration during restoration, a manual vent or a confirmatory UT at the next high point location of the system beyond the clearance order boundary ensures additional portions of associated piping are full (item 9 in Table 3 below). Administrative controls also require that restoration includes appropriate piping full verifications in accordance with approved surveillance procedures.

During maintenance activities, any change to the maintenance work scope requires a revision to the work instruction package controlling the activity. Before work can recommence, licensed SROs must review and reauthorize the revised work instruction package. Reviews of revisions to work instruction packages are based on the total maintenance work scope. This includes a review of the adequacy of the tagging boundary, any of the system restoration procedures including fill and vent, and post-maintenance test requirements. Required changes to these documents are prepared to reflect the revised work scope. In some cases, the development of new temporary procedures (e.g., a fill and vent procedure) may be necessary depending on the scope and complexity of the restoration.

When the work is complete a licensed senior reactor operator analyzes and approves the restoration sequence performed in accordance with the clearance order procedure and plant operators implement the restoration process, including the fill and vent procedures.

Corrective action has been completed addressing ECCS operability when transferring RHR suction from the RCS to RWST in operational modes 3 and 4 (item 14 in Table 3 below). A potential line-up configuration exists during plant cool down and heatup such that the RHR pump suction piping and fluid could be at an elevated temperature for some period of time after entering operational mode 4 during cool down and after entering operational mode 3 during heatup. Steam binding of the RHR pumps could result should a loss of coolant accident or other event occur during this period of high temperature, requiring re-alignment of the RHR pump suction from the reactor coolant system to the RWST for injection during operational mode 4 or resulting in the automatic start of the RHR pumps during operational mode 3. Corrective action changes include implementing procedure controls to prevent the undesirable RHR System configuration (Reference 5).

A.3.5. Description of how gas voids are documented, dispositioned, and trended, if found in any of the subject systems.

The GL 2008-01 system surveillance procedures ensure that gas has been removed using UT and manual venting verification methods. Current surveillance acceptance criteria requires the systems to be full of water, therefore any gas discovered at the high points renders the system degraded and the condition requires entry into the operability determination process and entry into the corrective action program.

WCNOC has developed technical criteria for assessment of the degraded function of GL 2008-01 systems with small amounts of gas. Operators and engineers use these criteria as an aid during the immediate operability determination process.

System Engineering processes implement an ECCS and CS System void volume tracking, trending and monitoring process, which contains guidance on the selection of system/component parameters to be trended.

The processes for addressing gas accumulation are summarized below. While the actual process used for each discovery of accumulated gas may follow a unique set of administrative controls, the processes described below summarize the impact of the completed corrective actions covering several inter-related procedures and processes for addressing gas accumulation at WCGS.

- If gas is identified:
  - determine gas volume, and
  - notify the on-duty licensed Senior Reactor Operators, and
  - initiate a corrective action document and notify Engineering
- If gas volume is within pre-determined acceptable volume for that location:
  - system remains operable but degraded
  - vent gas
- If gas volume is greater than pre-determined acceptable volume for that location:
  - enter TS Condition/Required Action for inoperable system
  - vent gas and/or take other measures to re-establish operability or comply with TS
- Engineering addresses gas accumulation, including:
  - sampling/analyzing, and/or
  - determine source of gas, and/or
  - determine fix for source of gas, and/or
  - track and trend accumulated gas, and/or
  - determine any change of frequency of inspection

A.3.6. List of items from the testing review that have not been completed

Corrective actions associated with WCNOC's evaluation of testing activities associated with GL 2008-01 systems are complete.

A.4. CORRECTIVE ACTIONS EVALUATION

A.4.1. Results of reviews regarding how gas accumulation has been addressed at your site.

Following the WCGS gas accumulation event in January 2008 described above and following the issuance of GL 2008-01, WCNOC conducted numerous reviews of corrective action activities as well as past gas accumulation evaluations conducted within the corrective action program. In addition, while performing reviews of procedures and processes described elsewhere in this Attachment, WCNOC also addressed the adequacy of administrative controls related to use of the corrective action program as well as other programs to address gas accumulation issues. Weaknesses requiring correction were identified in the following areas:

- Specific administrative controls for entry into the corrective action program, as well as entry into the operability determination process, were absent or inadequate in existing procedures (item 12 in Table 3 below).
- While some industry operating experience evaluations resulted in recommended changes by the engineering group, the changes were not always implemented in the plant (item 15 in Table 3 below).
- Indications of SI System accumulator leakage were not recognized or assessed in a timely manner (item 10 in Table 3 below).

A.4.2. List of items from the corrective action evaluation that have not been completed

Corrective actions associated with WCNOC's evaluation of corrective action processes associated with assessment of gas accumulation in GL 2008-01 systems are complete.

B. DESCRIPTION OF CORRECTIVE ACTIONS

Table 3 is a listing of corrective actions taken at WCGS to address gas accumulation issues described in GL 2008-01. It includes corrective actions that were determined to be necessary to assure compliance with the applicable regulations, as well as other corrective actions related to gas accumulation in GL 2008-01 systems.

Table 3. Corrective Actions Taken at WCGS to Address Gas Accumulation Issues Described in GL 2008-01

Item No.	Document Number	Document Description
1	CR 2008-000091 (Action # 3691)	Revise TS SR 3.5.2.3 Bases.
2	CR 2008-004492	Track future NRC determination to assess impact on TS SR 3.5.2.3 Bases change.
3	CR 2008-000854	Design input had not received independent review.
4	CR 2008-003323	Revise Engineering Screening Form.
5	CR 2008-000515	Insufficient evidence to validate calculation conclusions.
6	CR 2008-000516	Insufficient review and acceptance of calculation.
7	CR 2008-000091 (Action # 3694)	Validate all installed vent locations.
8	CR 2008-000091 (Action # 3685)	Add all installed vent locations to surveillance procedures.
9	CR 2008-004006 (Action # 4834)	Revise clearance order procedure to add void checks inside and outside CO boundary.
10	CR 2008-000849	Failure to identify and take corrective action in a timely manner.
11	CR 2008-000091 (Action # 3689)	Determine if any new vents need to be installed in RF17.
12	CR 2008-000091 (Action # 3688)	Incorporate required acceptance criteria into surveillance procedures.
13	CR 2008-000859	Inappropriate classification of inaccessible vent locations.
14	CR 2008–003810	ECCS operability in Modes 3 and 4.
15	CR 2008-000855	Vent added in plant but not used in surveillance.

C. CORRECTIVE ACTION SCHEDULE

C.1. Summary of the corrective actions that have been completed as a result of the evaluations discussed above.

Corrective actions listed in Table 3 in Section B above are complete, with the exception of item 2, CR 2008-004492, which is addressed in Section C.2 below.

C.2. Summary of the corrective actions to be completed including the scope, schedule, and a basis for that schedule.

WCNOC will resolve the adequacy of WCNOC's implementation of a change to the Bases for TS SR 3.5.2.3. The resolution of this change is dependent on the NRC/industry effort addressing generic TS changes via the TSTF traveler process.

WCNOC will install twenty three additional vents based on metrology results and drawing reviews prior to the end of Refueling Outage 17. The description of the vent locations and the basis for the schedule is included in section A.2.12 above.

REFERENCES

1. Letter from USNRC to R. A. Muench, WCNOC, dated April 24, 2008, "Wolf Creek Generating Station - NRC Special Inspection Report 5000482/2008007"
2. NUREG/CR-2792, "An Assessment of Residual Heat Removal and Containment Spray Pump Performance Under Air and Debris Ingesting Conditions," Creare, Inc., Hanover, New Hampshire, September 1982
3. RIS 2005-20, "Revision to Guidance Formerly Contained in NRC Generic Letter 91-18, 'Information to Licensees Regarding Two NRC Inspection Manual Sections on Resolution of Degraded and Nonconforming Conditions and on Operability,'" dated April 16, 2008
4. NRC Inspection Manual Part 9900, Technical Guidance, "Operability Determinations & Functionality Assessments for Resolution of Degraded and Nonconforming Conditions Adverse to Quality or Safety," dated April 16, 2008
5. Letter from M. W. Sunseri to USNRC dated October 3, 2008, "Licensee Event Report 2008-008-00, Potential for Residual Heat Removal Trains to be Inoperable during Mode Change"

Regulatory Commitments

The following table identifies actions committed to by Wolf Creek Nuclear Operating Corporation in this letter. Any other statements in this letter are provided for information purposes and are not considered to be regulatory commitments. Please direct questions regarding these commitments to Mr. Richard Flannigan, Manager Regulatory Affairs at Wolf Creek Generating Station, (620) 364-4117.

Regulatory Commitment	Due Date
WCNOC will monitor the industry resolution of the gas accumulation Technical Specification issues and submit a license amendment request, as appropriate, within one year following NRC approval of the TSTF or the CLIIP Notice of Availability.	One year following NRC approval of TSTF or CLIIP Notice of Availability
WCNOC will resolve the adequacy of implementation of a change to the Bases for TS SR 3.5.2.3 consistent with resolution of generic TS changes via the TSTF traveler process.	One year following NRC approval of TSTF or CLIIP Notice of Availability
WCNOC will install twenty three additional vents based on metrology results and drawing reviews.	Prior to startup following Refueling Outage 17