Generic Letter 2008-01 Response Guidance

SCOPE

The systems required to be evaluated by Generic Letter (GL) 2008-01 are the Emergency Core Cooling System (ECCS), Decay Heat Removal (DHR) and Containment Spray Systems (CSS).

- GL note 2 states: "DHR, residual heat removal (RHR), and shutdown cooling are common names for systems used to cool the reactor coolant system (RCS) during some phases of shutdown operation. In this GL, the NRC staff generally uses 'DHR'."

1. LICENSING BASIS

1.1. 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 Tech Specs (TS), TS Bases, UFSAR, Licensee Controlled Documents (e.g., Technical Requirements Manual (TRM) and TRM Bases), docketed correspondence, Licensing Commitments, and License Conditions.

1.2. 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.

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

1.2.2. The Bases for the TS SR(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).

1.2.3. 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.

1.3. Identify Current Licensing Basis changes resulting from the evaluation performed in Section 1.2 above.

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

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

1.6. 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.

1.7. The Current Licensing Basis review activities discussed in sections 1.1 and 1.2 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).

1.8. 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.

2. DESIGN REVIEW

2.1. Review Design Basis Documents (including 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
- Statements regarding system keep-fill designs and requirements, if installed
- System designs that include voided pipes (e.g. drywell spray piping inside containment)
- System realignments during Design Basis actuations and how the system remains full
- The potential for gas intrusion due to debris laden suction strainer geometry
- Vortex correlations used to establish minimum water level setpoints or manual actions credited in the design basis LOCA
- Allowable leakage between high pressure and low pressure interfaces
- Existing documents which evaluate void size acceptability
- How the GDCs or plant specific principle design criteria listed in GL are met or applied to the station
- Mission times for system pumps
- Fuel evaluation for acceptable air voids sent to the core during injection

2.1.1. 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.

2.1.2. Enter changes that are identified as part of the design basis review in the CAP.

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

2.1.4. The Design Basis review activities will be complete by October 11, 2008.

2.1.5. 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.

2.2. DRAWING REVIEW

2.2.1. 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 2.3 for walkdown activities related to the drawing reviews.

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

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

2.2.4. The drawing review will be completed by October 11, 2008.

2.3. SYSTEM WALKDOWNS

2.3.1. The scope should include:

- Verification that vents are in the proper location along horizontal (nominal) runs of pipe
- Verification that vents are in the proper location along circumference of the pipe
- Verification that piping is sloped in the proper direction
- Verification that horizontal (nominal) runs of pipe do not contain local highpoints
- Walkdowns should be performed on portions of the systems that would require venting to ensure the systems are sufficiently full of water. Walkdowns do not need to be performed 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.

- 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).

2.3.2. Perform system walkdowns for all piping located outside containment which is un-insulated, 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.

2.3.2.1. 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).

2.3.3. 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. These systems, or portions of the systems, will need to be identified and documented as action items in the 3-month GL response (if one is required) and 9-month GL response.

2.3.4. Develop a prioritized walkdown list of piping sections based on the configuration, pressure change potential, and source analysis (vulnerability to gas intrusion, see Section 2.4.2). In general, suction piping is more critical than discharge piping.

2.3.5. 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.

2.3.5.1. 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.).

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

2.3.5.3. 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)
- High points created by closed valves in vertical piping runs
- DHR system heat exchanger U-tubes, or other heat exchangers
- 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)
- Tees where gas contained in flowing water can pass into a stagnant pipe where it then accumulates
- Valve bonnets
- Pump casings

2.3.6. 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 2.3.3).

2.3.7. 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.

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

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

2.4. SYSTEM REVIEWS

2.4.1. Fill and Vent

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

2.4.1.1.1. 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.

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

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

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

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

2.4.1.1.6. 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.

2.4.1.1.7. 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.

2.4.1.1.8. 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.

2.4.1.1.9. 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.

2.4.1.2. 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.).

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

2.4.1.4. All unvented gas must be quantified, trended and justified through a formal Technical Evaluation or Calculation process (consistent with Section 2.4.3).

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

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

2.4.2. Gas Intrusion

2.4.2.1. 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 2.4.3) 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.

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

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

2.4.2.1.3. 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.

2.4.2.1.4. 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.
- Ensure that system response actions following a loss of the keep-fill system adequately address gas void formation and system restoration.

2.4.2.1.5. Air in-leakage can occur through system pathways which allow drainback to the system.

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

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

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

2.4.2.1.9. 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.

2.4.2.1.10. 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.

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

2.4.2.1.12. Identify other plant specific methods of gas intrusion.

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

2.4.3. Acceptance Criteria

2.4.3.1. Identify applicable acceptance criteria for allowable gas volume limits for each piping section where gas may accumulate. See Section 2.4.2 for Gas Intrusion vulnerability reviews. This will be completed by October 11, 2008.

2.4.3.1.1. 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.

2.4.3.1.1.1. Acceptance criteria should be based on industry guidance for acceptable pump performance.

2.4.3.1.1.2. 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.

2.4.3.1.1.3. 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.

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

2.4.3.1.2.1. 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.

2.4.3.2. 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.

2.4.3.3. 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.

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

3. TESTING

3.1. 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.

3.2. Review the periodic venting or gas accumulation surveillance procedure to:

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

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

3.2.3. Ensure that procedures have acceptance criteria (consistent with Section 2.4.3) for the allowable amount 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.

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

3.2.5. 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 2.4.2. Develop new procedures where none exists, ensuring that requirements in 3.2.4 are included.

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

3.3.1. 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.

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

3.5. 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.

3.5.1. 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.

3.6. 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.

3.7. All of the testing evaluations, except for procedure reviews identified in Section 3.6, will be completed by October 11, 2008.

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

4. CORRECTIVE ACTIONS

4.1. Summarize the corrective actions that have been or will be completed by October 11, 2008 as a result of the reviews identified in Sections 1 through 3.

4.2. 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 evaluations performed in Sections 1 through 3. Note: The GL specifically requests a basis be provided for the schedule of future corrective actions.

4.3. General Corrective Action Process

4.3.1. Describe how gas voids are trended, documented and dispositioned, if found on any of the subject systems. This item may be covered in Section 3.2.4.

- 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.

4.4. Summary of as-found conditions

4.4.1. 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 1 through 3.

5. ONGOING INDUSTRY ACTIVITIES

5.1. Discussions are being held with the Owner's Groups to fund the following activities:

- Pump void limits
- Gas transport processes
- Methodology for evaluating water hammer
- Best practices for fill and vent surveillances
- Evaluation of gas injection effects on safety analysis
- UT best practices
- Guidance for vent locations
- Guidance for potential sources of gas
- Guidance on avoiding gas intrusion due vortex formation
- Procedure for quantification of venting

As these activities are completed, the results of these activities should be reviewed to determine whether any of the previously identified review conclusions, acceptance criteria, and corrective actions should be revised, as applicable. These enhancements and corrective actions may not be completed by October 11, 2008.

6. TRAINING

6.1.1. 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**.

6.1.1.1. 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