May 25, 2010

GUIDANCE TO NRC/NRR/DSS/SRXB REVIEWERS FOR WRITING TI SUGGESTIONS FOR THE REGION INSPECTIONS

This is Revision 8 of this document. It is an interim version that is to be discussed during the June 2, 2910 meeting with NEI and industry representatives. Yellow bold is used for changes from the Revision 5 that was commented on by industry and to identify items that need to be discussed in the June 2 meeting. A Revision 9 will be developed and transmitted to the NRC regions and to NEI following the meeting for use by the NRC inspectors.

Blue is used for comments and guidance in preparing the communication to the Regions. Material in black may be used "as is" or you may modify it. Choose from material in Red as appropriate, modify it, or add anything else that you believe is needed. Green is used for licensee-specific information. This means that a color printer should be used if you want a hard copy of this communication.

The following should be a memo from Anthony Ulses, the SRXB Branch Chief as of April12, if to Region II and an attachment to an email from Anthony Ulses if to Regions I, III, or IV. Addressees are:

I Michael Balazik

II Binoy Desai, Chief, Engineering Branch 1, Division of Reactor Safety, Region II, cc to Robert Berryman, Senior Reactor Inspector, Engineering Branch 1, Division of Reactor Safety, Region II

III Ann Marie Stone, cc to Caroline Tilton, Nestor Feliz-Adorno,

IV Thomas Farnholtz, cc to Matthew Young,

Warren Lyon, Diana Woodyatt, Dave Beaulieu, the Project Manager (PM), and the PM's Branch Chief should be on cc for all communications.

Subject: TI 2515/177 Inspection of plant name

The attachment provides the NRR Reactor Systems Branch (SRXB) suggestions for the inspection of plant name using the guidance provided in Temporary Instruction (TI) 2515/177, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems, (NRC Generic Letter 2008-01)"

ATTACHMENT

OFFICE OF NUCLEAR REACTOR REGULATION (NRR) REACTOR SYSTEMS BRANCH (SRXB) SUGGESTIONS FOR THE PLANT NAME INSPECTION USING THE GUIDANCE PROVIDED IN TEMPORARY INSTRUCTION (TI) 2515/177 (REFERENCE 1)

1 BACKGROUND

Section 1 summarizes the SRXB review approach and provides information inspectors may find useful for inspections.

1.1 SRXB Review Approach

Reference 2 described the coverage the NRC staff expected licensees to provide in their responses to Generic Letter (GL) 2008-01 (Reference 3). The initial SRXB review approach was to address all shortcomings via in-depth Requests for Additional Information (RAIs) followed by recommendations to the Regions to supplement Regional plans for TI inspection coverage. However, based on feedback from the Regions and other stakeholders, we modified the review process to focus on information needed to ensure plant operability with respect to finding and addressing voids (Reference 4). This should reduce regulatory burden and appropriately utilize Regional inspector practices and knowledge. Reference 2 continues to apply and may be used for guidance in conducting TI inspections,

We focused on the following when preparing RAIs:

a. Technical Specifications (TSs) and planned response to Technical Specifications Task Force (TSTF) documentation,
b. Surveillance requirements,
c. Procedures, and
d. Corrective action program (CAP).

This was done with the intent of establishing that any remaining issues are confirmatory and the Regions can select issues to be examined further via the TI inspection.

1.2 Operability Determination

Our review and the inspections are based on guidance provided in References 5 - 7 for assessing subject system operability. The objective is to "reasonably ensure that subject system operability" is achieved and a "reasonable expectation" test applies. This means that a high degree of confidence applies but absolute assurance is not necessary. The determination can be based on analyses, test or partial test, experience, and/or engineering judgment. This is particularly applicable to void transport, pump response to voids, and vortexing, as discussed in Sections 1.4 and 1.5, below, where sufficient information is not available for providing in-depth generic guidance. Consequently, a strong reliance on engineering judgment will be necessary to support an interim finding regarding operability for these issues until improved generic guidance can be developed. Final findings regarding operability will be more solidly based on analyses and tests and the need for engineering judgment will be diminished although there will likely remain circumstances where solidly based engineering judgment is acceptable.

1.3 The Meaning of "Full of Water"

There have been issues related to the meaning of "full of water" in TSs. Reference 8 concluded that "if the licensee can conclude through an operability determination that there is a reasonable expectation that the system in question can perform its specified safety function, the system piping can be considered filled with water such that the surveillance requirement is met." A condition where there is no void is described by such words as gas-free, free-of-gas, or water-solid.

1.4 Void Transport and Pump Response

There are numerous issues related to void size, void transport and pump response to voids. Reference 9 provides guidance that we will accept without further justification. This is intended to be conservative and an update is planned but we are waiting for information based on industry testing and analysis development activities. In the meantime, we suggest you use the following in place of the applicable information in Reference 9:

Assessing operability requires addressing all aspects of the behavior. This includes but is not necessarily limited to:

1. Variation in pump flow rate and discharge head encountered.
2. Suction transport.
3. Pump ingestion.
4. Discharge effects
5. Behavior within the reactor coolant system including delay in delivery of water.

At low flow rates, gas may be assumed to not move in a pipe if the Froude Number, N_{FR}, is ≤ 0.31 and the average void fraction in a plane perpendicular to the pipe centerline, Φ, is ≤ 0.2, where:

$$N_{FR} = \frac{V}{\sqrt{\frac{Dg_c(\rho_L - \rho_g)}{\rho_L}}}$$

D = pipe diameter
V = liquid velocity based on total pipe flow area
g_c = gravitational constant
ρ = density
subscript L indicates liquid
subscript g indicates gas

At higher flow rates, some gas may be transported at N_{FR} ≤ 0.65 and all gas will be carried out of a pipe with the flowing water if N_{FR} ≥ 2.0. Time to clear gas from a pipe for 0.8 < N_{FR} < 2.0 is a function of flow rate and dynamic venting may not be assumed effective for N_{FR} < 0.8. Time to clear gas as a function of time will be addressed in the June 2 meeting.

Interim criteria we will accept without further justification for not jeopardizing operability of a subject system pump are:

Condition	Typical BWR Pumps Allowable Φ, %	Typical PWR Pumps Allowable Φ, %		
		Single Stage	Multi-Stage Stiff Shaft	Multi-Stage Flexible Shaft
Steady state (> 20 seconds), 40% ≤ Q/Q_{BEP} ≤ 120%	2	2	2	2
Steady state (> 20 seconds), Q/Q_{BEP} < 40%	1	1	1	1

Condition	Typical BWR Pumps Allowable Φ, %	Typical PWR Pumps Allowable Φ, %		
		Single Stage	Multi-Stage Stiff Shaft	Multi-Stage Flexible Shaft
or >120%				
Transient ≤ 5 seconds, 70% ≤ Q/Q_{BEP} ≤ 120%	10	7	20	10
Transient ≤ 5 seconds, Q/Q_{BEP} < 70% or >120%	5	5	5	5
Transient ≤ 20 seconds, 70% ≤ Q/Q_{BEP} ≤ 120%	4	4	20	5
Transient ≤ 20 seconds, Q/Q_{BEP} < 70% or >120%	3	3	5	5

The last two lines of the single stage pump entries were 5% in the industry table and we have changed them to 4% and 3% on the basis of judgment that the allowable void volume should decrease as the stated conditions change. We suggest discussing this in the June 2 meeting.

where: Q = water volumetric flow rate
BEP = best efficiency point
Transient Φ is averaged over the specified time span
Instantaneous Φ < 1.5 times the listed value

The pipe void criteria are applicable when the upstream suction piping has a circular cross section and either:

1. the velocity is parallel to the pipe centerline or

2. the suction pipes contain elbows that connect between horizontal and long vertical pipes without other close-by connections, such as Tees

unless acceptable qualifications are provided.

Reference 9 also discusses net positive suction head (NPSH) considerations. These are no longer necessary for transients since meeting the above requirements should also result in meeting NPSH requirements. NPSH considerations continue to apply for steady state operation. We have received feedback from other NRC personnel that may change our conclusion that NPSH considerations are no longer necessary, a conclusion we reached based upon industry comments. We plan to address this during the June 2 meeting.

Licensees have provided plant-specific responses to address issues when gas was discovered that potentially rendered systems inoperable. Some of these involved extensive RELAP 5 analyses and scaled system mockup tests where we provided assessments to Regional / Resident Inspectors while not finding that the responses were generically acceptable. For example, Region I personnel, the licensee, and Fauske Associates did an in-depth evaluation of a void issue at Millstone 3 that provided sufficient information for the Region to conclude that historic operability had been acceptably confirmed. References 10 and 11 describe two phase, two component tests and RELAP 5 analyses of the tests, respectively. Fauske Associates and the licensee also used RELAP 5 to calculate behavior in the emergency core cooling system (ECCS) flow path at Millstone 3, but these reports are not readily available. We suggest contacting Wayne Schmidt (610-337-5315) at Region I if you need additional information. RELAP 5 has also been used to calculate two phase, two component behavior in the subject systems at other facilities. There are at least seven cautions to observe in considering this approach:

1. RELAP 5 modeling is strongly influenced by the modeler who must have a demonstrated capability to fully understand the code and the necessary nodalization.

2. RELAP 5 does not correctly model such phenomena as the kinematic shock (waterfall) that may occur downstream of the elbow from a horizontal pipe to a vertical pipe and any conclusions must consider such inadequacies.

3. If pump modeling is an important component of the analysis, then pump modeling may be inadequately addressed.

4. There are questions regarding the correct modeling of vortex behavior associated with water level approaching the level of a drain pipe from a tank or the connection between a large pipe and a smaller suction pipe (see Section 1.5, below).

5. The wide variation of pipe geometries and the above considerations may necessitate that tests be conducted and compared to RELAP 5 calculations unless previously applicable comparisons have been performed.

6. Older versions of RELAP 5 do not have a two component (gas-liquid) analysis capability.

7. RELAP 5 predictions should be assessed with respect to basic behavior as addressed by such approaches as use of Froude number, bubble rise velocities, and, in some cases, tests that include applicable configurations.

Application of other codes, such as GOTHIC, TRAC, and TRACE, may also be acceptable when the codes have been shown to have a two-phase, two component capability via built-in modeling capability that is substantiated by processes such as discussed above for RELAP 5.

With respect to the need for substantiation of a code for such applications as opposed to a comment that it is not necessary since engineering judgment is sufficient, we disagree. Engineering judgment must be based upon a reasonable basis and applying a code that does not have such a basis is not acceptable. This was clearly shown in the RELAP 5 work described above where the test data and associated analyses established what aspects of RELAP 5 could be applied and which were not appropriate. With respect to the time required to perform a validation test and the need to shut down in the event of a problem since insufficient time would be available, the first requirement is a reasonable substantiation of operability. This can differ with respect to the time when in-depth substantiation becomes available. For example, continued operation for a short time while a code application is substantiated for justification of long term operation may be acceptable.

Industry is developing a simplified conservative methodology to address gas movement that should cover the majority of cases of concern and reduce reliance on use of such codes as

RELAP 5 and GOTHIC. This is scheduled for completion during calendar year 2010 and we will update our guidance following acceptance of the methodology.

At present, there is no acceptable generic methodology for assessing void size, transport behavior, and pump response to voids other than Reference 9 with the above modifications, and any extrapolations to conditions not addressed by this information should be addressed on a plant-specific basis. Many licensees reference industry documentation that is inconsistent with the above information and such references may not be acceptable for operability or operating considerations. In conclusion, the best approach is one in which voids are prevented and, when voids are found, they should clearly be much smaller than a void that could challenge operability, and generally should be removed unless removal is impractical. Further, any void that challenges operability must be removed or reduced so that it is no longer a concern.

1.5 Vortexing

NRC inspectors are often encountering plant conditions where vortexing may result in entrainment of gas into systems that are required for plant operation or to respond to accident conditions. In assessing these conditions, they are finding that licensees may be relying on non-conservative analysis methodologies, yet the inspectors have little guidance upon which to base their assessments. Instead, they have found that several methodologies exist to determine whether a vortex will form and contradictory results have been obtained from the different testing methods, configurations evaluated, and interpretation and extrapolation of results. Likewise, inspectors have a difficult time in determining the amount of air entrainment due to vortexing and the effect on pumps. This has led to such situations as inconsistent assessment of vortices, challenging of previously reviewed vortex analyses, potential inappropriate selection of which methodology to use, and questions regarding the impact on pump operability.

Industry has commented that vortices are categorized as Types 1 through 6 with Type 1 being a surface dimple and Type 6 having a continuous gas core tha t extends into the suction port. To obtain a 1% void fraction in the suction flow, the diameter of the gas core needs to be at least 10% of the suction port diameter. This is only obtained with a Type 6 vortex. Much of the confusion arises because it is not clear that only a Type 6 vortex of this scale would challenge pump operation. This vortex guidance must be consistent with the NEI/NRC guidance on the allowable pump inlet gas volume fraction. We welcome additional information and specific references during the June 2 meeting.

We plan to develop a formal position and generic guidance regarding vortex formation and acceptable analytical methods for assessing vortex formation by December, 2010, (TAC ME1306). In conclusion, the best approach is one in which plant operation prevents approaching conditions where vortexing can result in gas ingestion.

1.6 Recent Nuclear Energy Institute (NEI) Guidance

NEI recently published Reference 12, “Guidelines for Effective Prevention and Management of System Gas Accumulation,” ML093130090. Although it does not provide significant information regarding gas movement and pump response to gas, it provides excellent coverage of many aspects of the issues addressed by GL 2008-01 and extends industry guidance to cover all systems where gas accumulation may be a concern. We recommend you read this document for background information before conducting the TI inspection.

NEI plans to revise Reference 12 by the end of December, 2010, and will include void criteria and guidance. We are working with NEI and industry to achieve criteria that we will accept and, if successful, will replace the need for a separate NRC void criteria document. We also are pursuing endorsing the revised document, assuming it is acceptable, by issuing a regulatory guide in 2011. We'll keep you informed of progress in this area.

1.7 Accessible Versus Non-Accessible Locations and Surveillance Requirements

All locations are considered to be accessible unless actual environmental conditions constitute a hazard to personnel or are such that conducting the surveillance in the specific locations to be surveyed will result in an unacceptable dose. Surveillance locations in a posted high radiation area are considered to be accessible if the surveillance(s) are not in actual locations of significantly elevated radiation or surveillances in the posted area can be conducted without exceeding an acceptable dose. For example, suppose six locations are in a high radiation area, but only one location would result in an excessive dose and the other five can be completed with a minimal exposure to radiation. Then, the one location would be considered to be non-accessible and the other five would be accessible. Consideration of such aspects as high environmental temperatures or local high temperatures that constitute a burn hazard also apply to determination of non-accessibility.

Surveillance is required for all locations of concern unless it is acceptably determined that the surveillance is not necessary to reasonably ensure operability. However, the NRC staff will allow more flexibility in determination of operability for non-accessible locations with respect to consideration of such aspects as the likelihood that gas can accumulate in the locations of concern in contrast to the impact of gas at those locations.

1.8 Surveillance Frequency and Requirements

The NRC staff is studying general surveillance requirements as part of the TSTF evaluation but, for now, the scheduled surveillance frequency should be every 31 days unless a greater surveillance frequency has been justified. Typical considerations for a greater surveillance frequency could include such items as:

1. All potential sources of gas are monitored and trended and applicable parameters remain within specified limits. Potential monitoring may include but not be limited to such items as accumulator level and pressure, reactor coolant system (RCS) leakage, ECCS and residual heat removal (RHR) system piping pressure, RHR temperature versus saturation temperature when RHR is initiated or suction sources are changed, volume control tank pressure for unanticipated pressure drops, reactor coolant pump seal return flow rate for unanticipated increases, and level in tanks (if any) that are provided to accumulate gas from piping high points. Further, monitoring of locations where outgassing may occur when liquid passes from a high pressure region to one at lower pressure should be considered.

2. The piping is maintained at a pressure higher than that of any potential source of gas in-leakage, such as some of the ECCS discharge piping in some Westinghouse designs that are maintained at pressures greater than the RCS pressure, and no locations exist where outgassing may cause gas to accumulate during operation

Potential sources of gas that should also be considered may include failure of level instruments to indicate correct level, leakage through one or a series of closed valves, vortexing, design deficiencies that may result in gas intrusion during accidents, keep-full system malfunctions, leaks in hydraulic dampeners, and cooling of an isolated section of piping that may cause a pressure decrease.

Any location that has the potential for a gas volume to be formed should be assumed to have an acceptance criterion of zero gas unless a criterion has been specifically determined for that location.

Monitoring is not required for those potential void locations (vented or unvented) where the maximum potential accumulated gas void volume has been evaluated and determined to not challenge system operability based on the maximum acceptable void volume, location, Froude number, or other technical basis. Further, Monitoring is not required for a potential void location that communicates with a bounding monitored potential void location in the same piping segment when the second location will show a void when the first location is full. However, any potential gas volume in unmonitored locations must be acceptably evaluated with respect to its potential contribution to the overall system response if gas accumulates in other locations. The evaluation must be documented and the total potential gas volume from such a location reduces the overall system acceptance criteria for that pipe segment. The process could require additional monitoring for these locations if gas is found at the bounding monitored potential void location. (Most material taken from Reference 12, which provides excellent insights for addressing gas concerns.)

The monitoring methodology should be documented. The documentation should include an assessment of the monitoring methodology accuracy and a justification of why the accuracy is sufficient to support a determination of operability. Note that in the case of UT, if the measurement methodology involves a relatively precise process such as determining the water level in a horizontal pipe from one side and from the other side accompanied by a circumferential measurement and suitable calculations, measuring the level in a vertical pipe, or using a widely acceptable method of measurement from the bottom or top of a horizontal pipe, then an accuracy determination and justification is not necessary because these processes are expected to provide more than sufficient accuracy when compared to the uncertainty associated with the void criteria.

Failure to meet a gas volume acceptance criterion shall require (1) immediate entry into the CAP, (2) an immediate operability determination, and (3) a decreased scheduled surveillance frequency that is sufficiently short to ensure that the affected locations will remain within acceptance criteria until the cause of the failure is corrected.

1.9 Surveillances Associated with Outage and Maintenance

Any system maintenance activity that will result in a reduction in fluid inventory of a fluid system in the scope of gas accumulation management should be evaluated to determine the required fill, vent and verification inspection. The work processes should include provision for engineering review and evaluation of such evolutions. If the specific evolution has been previously evaluated and the fill, vent, and verification requirement identified, then engineering review could be limited to verifying applicability.

Some of the potential sources of gas that are of concern with outage and maintenance practices are the same as identified in Section 1.8, above. Others that should be considered include procedure errors, failure to follow procedures, ineffective fill and vent, system draining, and realignments, Locations potentially affected by outages or maintenance operations are to be purged of gas and/or surveyed immediately upon completion of the activity and established to have no gas volumes that exceed gas volume acceptance criteria. A follow-up complete independent surveillance of potentially affected locations and adjoining locations should be accomplished within 31 days if the scheduled surveillance frequency is greater than 31 days to ensure that the post-outage or maintenance potential impacts have been addressed. The acceptance criteria for this second surveillance should be that no gas volume acceptance criteria will be exceeded and no significant gas accumulation will have occurred since the first surveillance that was conducted upon completion of the activity. Startup of selected pumps and observation of the transient discharge pressure is an acceptable second surveillance of pump discharge piping if (1) at least one week has passed since the first test, (2) this test was conducted previously with verification that the observed transient was consistent with the previously determined volume, (3) the second surveillance established, within the sensitivity of the test, that no gas accumulated since the first test, and (4) gas volumes are less than half the gas volume acceptance criteria. - Dicsuss during June 2 meeting.

1.10 Gas Volume Acceptance Criteria

If there is no specified gas volume acceptance criterion for a location where gas may potentially exist, then the acceptance criterion is that a water-solid condition shall exist.

As discussed in Section 1.4, above, gas volume acceptance criteria are of five types:

1. Pump Inlet void fractions
2. Criteria applicable to piping upstream of pumps that may result in voids entering a pump
3. Criteria applicable to water hammer and related issues
4. Criteria applicable to RCS behavior due to injected gas
5. Criteria applicable to containment response

Water hammer effects due to potential accumulated gas or vapor must be shown to be limited to a value that does not damage piping, pipe supports, or other system components. Further, the pressure surge associated with pump starts must not result in lifting of relief valves where system pressure exceeds reseat pressure and should not result in lifting relief valves. Several industry reports have been received that address water hammer under various conditions and the NRC staff is considering the available information.

RCS response to injected gas generally entails consideration of the potential delay in injecting water upon demand and the effect of the injected gas on RCS behavior. The potential delay is generally small with respect to other delays associated with initiation of injection and the amount of injected gas is often small in comparison to the voids that exist due to other causes. In such cases, a qualitative evaluation is often sufficient to establish operational acceptability. No generic guidance is anticipated to be necessary to address Item 4.

The same conclusions generally apply to Item 5.

1.11 Corrective Action Program (Taken in part from Reference 12)

The CAP should be used to resolve identified deficiencies in procedures. The final system condition should be verified to meet acceptance criteria or to be resolved by appropriate corrective action. Any voids found following completion of fill and vent activities should be recorded, tracked, and trended for evaluation of gas intrusion management effectiveness. If the CAP is entered because of failure to meet an acceptance criterion, an immediate review should be conducted to identify other locations that are potentially affected by the observed gas intrusion mechanism and inspections should be performed at the locations identified by the review. Locations where gas continues to accumulate should be evaluated for possible remedies which could prevent or minimize future gas intrusion. This could be through plant modification or operating procedure and practice changes. An important aspect of correcting such conditions is to have a clear understanding of the gas intrusion mechanism. If changes cannot be made immediately to remedy these locations, then enhanced monitoring shall be implemented to identify early onset of gas accumulation.

1.12 **Procedures** (Taken from Reference 12 with modifications)

Operating, testing, and maintenance procedures should include warnings about potential gas intrusion and / or accumulation for those evolutions that have been identified during the evaluations of the plant systems. For precursor conditions that are monitored, criteria for when action is required to evaluate gas intrusion should be included in procedures.

1.12.1 Fill and Vent Procedures

Fill and vent procedures should contain guidance on filling and venting methods to restore the systems as full based on the system configuration. Venting methods may include static venting through a valve, dynamic (flow induced) venting, and vacuum venting. Verification that the system piping is full of water following fill and vent is necessary.

Fill and vent procedures should:

1. Specify vent locations to support operating and maintenance activities, the venting method, and the criteria to determine when adequately filled.

2. Specify adequate steps that ensure the subject systems are free of accumulated gas and will perform their intended functions.

3. Be revised as necessary to incorporate operating experience and to control gas voids that may be introduced by maintenance and / or operational activities.

4. Be specific for the condition and alignment of the system at the time of the activity and any limitations on available vents from isolation boundaries.

5. Include the following:

    a. Use the appropriate fill source and fill location.

    b. Provide the proper sequencing of valve operations to maximize gas void removal. Vent sequencing from lower high points to the higher elevation high points should be accomplished unless a determination has been made that it is not necessary.

    c. Provide specific acceptance criteria for venting based on potential void locations and the duration of flow required for transfer of the void to the vent location.

d. Include filling or backfilling instrumentation lines when applicable.

e. Provide instructions related to system alignment and the minimum required flow rate to perform dynamic venting if necessary.

f. Provide verification after fill and venting, and re-verification if additional venting is required, so that the piping is sufficiently full.

g. Document void identification and quantification information, including no void present.

h. Use the CAP if verification identifies weaknesses in prior fill and vent activities.

1.12.2 Dynamic Venting

Use of dynamic venting is an effective means to remove gas from local high points and traps in piping. It involves pumping water through the system to force accumulated gas to a location that can be vented or removed. When static fill and vent efforts are not effective in removing all trapped gas during system restoration, procedures should provide for use of dynamic venting when it is allowed by the system configuration. Dynamic venting should be performed in accordance with written procedures that consider the following:

1. Acceptability of the location to which the gas will be transported

2. Effect of transporting voids through pumps

3. Required flow rate (Froude Number) to sweep the gas from the high point

4. Time that flow should be maintained to ensure sweeping the gas

1.12.3 Vacuum Fill

Vacuum filling may be an effective method for removal of trapped gas. Vacuum fill should be done in accordance with written procedures and appropriate evaluations of the effect of vacuum on the system should be performed and documented.

1.12.4 Verification

Fill and vent procedures should include requirements for verification of effectiveness and should include quantification of any remaining gas found. If the fill and vent is performed for system restoration following maintenance on an isolated portion of the system, verification should include quantitative inspection to find gas accumulation that may be transported outside the isolation boundary once the system is restored.

1.13 Applicable systems

Select the PWR or BWR list as appropriate:

For pressurized water reactors, applicable systems will typically include:

1. Safety Injection (SI) System or ECCS. This typically includes charging pumps, high pressure coolant injection (HPCI) system, low pressure injection (LPI) system, and SI accumulators where different licensees use different nomenclature that is not listed in this report for the same function.

2. RHR, DHR, or Shutdown Cooling (SDC) System. Different licensees use different designations. Configurations typically include reactor vessel (RV) cold leg and hot leg injection, suction from the RCS, and the containment emergency sump.

3. Containment Spray (CS) System.

4. Borated Refueling Water Storage System or its equivalent with respect to potential interactions with the ECCS. (Different licensees use different designations.)

5. Chemical and Volume Control System with respect to potential interactions with the ECCS.

For boiling water reactors, this will typically include:

6. Core Spray.

7. High Pressure Coolant Injection (HPCI).

8. RHR. Functions typically include suppression pool cooling, shutdown cooling, core spray, containment cooling, decay heat removal, alternate decay heat removal, drywell / wetwell spray, suppression pool spray, ECCS keepfill system, torus spray, and low pressure core spray, depending upon the plant and the licensee's designation of the system functions.

9. Other components of the ECCS.

2 INSPECTION GUIDANCE

The licensee has provided a response to GL 2008-01 that satisfies the GL objectives. (References 13, 14, etc) There are no open items that necessitate additional NRR/SRXB follow-up although SRXB plans to provide consultation to Regional or Resident Inspectors upon request. A confirmatory inspection that uses the guidance provided in Temporary Instruction (TI) 2515/177 is the only item that remains.

Selection of inspection items and the inspection depth is a Regional decision since Regional personnel have insights and knowledge that we do not possess at Headquarters, and the TI has been written to provide this flexibility. Our suggestions are based on a selective review of the licensee's responses to the GL and those responses may not fully cover the licensee's capabilities. Our suggestions are provided for your consideration and we have not attempted to cover all aspects of the TI. You should treat the suggestions as supplementary information that may not be necessary in light of your knowledge of the actual plant condition, and you should follow the TI in whatever depth you believe is appropriate.

In general, we suggest that your inspection in response to the TI

Select one of the following three or provide your own suggestion:

be minimal since the licensee has provided an in-depth response to the GL that addresses the issues.

or

be an in-depth inspection because the licensee's response to the GL resulted in many confirmatory items that need to be addressed. We suggest that most aspects of the TI be covered with consideration of the suggestions we provide below.

or

be based on selections from the TI guidance that you believe appropriate with consideration of the suggestions we provide below.

Based upon the information we have reviewed, we suggest you consider including the following when planning the TI 2515/177 inspection:

The following should be included in all inspection suggestions documents unless there are no commitments:

- Verify that the licensee has completed or has acceptable plans for addressing commitments identified in the GL responses. We suggest that you plan to follow up to reasonably ensure outstanding commitments are acceptably addressed.

The following should be included in all PWR inspection suggestions documents:

- Many PWR licensees have found that flashing can occur in RHR suction lines when initiating RHR while the lines are at an elevated temperature. Verify that the licensee has acceptably addressed this issue if applicable to its design and operation. Note that steam bubbles do not transport like a gas. Rather, they collapse once submerged into the flow stream if the flow stream temperature is less than the saturation temperature, a process that will be accompanied by a flow stream temperature increase. Conversely, Instant flashing due to a pressure decrease will result in a rapid temperature decrease.

Depending on the information provided in the licensee's GL response and our review, the following should be considered for inclusion in our suggestions to the Regions:

- Verify that one or more procedures (1) include acceptable methods for determining void volume, (2) acceptably address a methodology for void removal, (3) have been covered in training, and (4) ensure that the licensee enters the CAP whenever voids are discovered following refill operations. TI Sections 04.01, 04.03, Reference 2 Sections 3.3.2, 3.5.1, 3.5.2, 3.5.3, 3.5.4

- Selectively verify the acceptability of the CAP process for addressing issues pertinent to GL 2008-01 and, if applicable CAP processes have been performed, then selectively verify the acceptability of the licensee's response to the identified issues. TI Sections 04.01, 04.02, 04.03c5, 04.04; Reference 2 Sections 3.4.6, 3.6

- Verify the acceptability of the licensee's processes for monitoring and trending such parameters as void volumes, accumulator level and temperature, reactor coolant system

(RCS) leakage, and ECCS discharge pressure and temperature to ensure that pre-cursor parameters are addressed and that entry into the CAP will be accomplished if acceptable trending criteria are not met. See Sections 1.8 and 1.9, above, for guidance. TI Sections 04.01, 04.02e Exclude any items that do not apply, such as accumulators for BWRs.

- Verify the acceptability of the licensee's methodology for predicting void behavior and the impact on subject system operability. Pay particular attention to the licensee's determination of acceptable void volumes with respect to void volume, void transport, and pump response to voids. See Section 1.4, above, for guidance. The licensee should be consistent with the Reference 9 or the Section 1.4 criteria or should provide a justification for any differences. TI Sections 04.01, 04.02f, 04.03d; Reference 2 Sections 3.3.2, 3.4.3, 3.4.4

- Selectively verify the acceptability of the licensee's review relative to the plant configuration, walkdowns, and commitments for planned walkdowns. TI General Guidance, TI Sections 04.02c and d, 04.04; Reference 2 Sections 3.4.5, 3.4.6, 3.4.7

- Selectively verify that the licensee has acceptably performed hardware modifications, such as installing additional vent valves in upper pipe elevations and that the vent valve installation process reasonably ensures that the opening inside the pipe is sufficiently close to the upper elevation of the pipe to accomplish the venting purpose. TI Section 04.04, Reference 2 Section 3.4.8

- If training is acceptably addressed, but interim training is not covered, then: Training is stated to be accomplished at a future date. Verify that the existing applicable training background ensures that personnel are aware of gas-related concerns and will respond accordingly. TI Section 04.02c, Reference 2 Section 3.7.

- If TSTF information, such as a commitment date, is not adequate, then: Verify that the licensee has committed to assess the technical specification task force (TSTF) traveler and to implement appropriate changes in TSs within one year or less of the TSTF being issued. TI Section 04.01, Reference 2 Section 3.3.4

- If "accessible locations" is based on a broad statement such as containment and posted high radiation areas rather than actual radiation or thermal access considerations, then: Verify that the meaning of "accessible locations" is consistent with actual accessibility and that coverage of inaccessible locations is acceptable. TI Section 04.02c, Reference 2 Section 3.3.2

- If the licensee did not adequately identify the applicable systems, then: Verify that the licensee considers all systems that should be covered consistent with the GL. Select either the PWR or the BWR item that follows. For pressurized water reactors (PWRs) this will typically include:

    - Safety Injection (SI) System or ECCS. This typically includes charging pumps, the high pressure coolant injection (HPCI) system, the low pressure injection (LPI) system, and SI accumulators. (Different licensees use different nomenclature that is not listed in this report for the same function.)

- Residual Heat Removal (RHR), DHR, or Shutdown Cooling (SDC) System. Different licensees use different designations. Configurations typically include reactor vessel (RV) cold leg and hot leg injection, suction from the reactor coolant system (RCS), and the containment emergency sump.

- Containment Spray (CS) System.

- Borated Refueling Water Storage System or its equivalent with respect to potential interactions with the ECCS. (Different licensees use different designations.)

- Chemical and Volume Control System (CVCS) with respect to potential interactions with the ECCS.

For boiling water reactors (BWRs) this will typically include:

- Core Spray.

- High Pressure Coolant Injection (HPCI).

- Residual Heat Removal (RHR). Functions typically include suppression pool cooling, shutdown cooling, core spray, containment cooling, decay heat removal, alternate decay heat removal, drywell / wetwell spray, suppression pool spray, ECCS keepfill system, torus spray, and low pressure core spray, depending upon the plant and the licensee's designation of the system functions.

- Other components of the ECCS.

TI General Guidance, Reference 2 Section 3.1

- With respect to surveillance frequency and requirements, see Sections 1.8 and 1.9, above, for guidance. If the licensee did not adequately address surveillances, then: Verify that areas not covered by TSs and TS Bases, such as not providing surveillance requirements (SRs) for ECCS suction piping and not ensuring a void assessment at high points that are not equipped with a vent, are identified and the process of ensuring adequate coverage is identified. See Sections 1.8 and 1.9, above, for guidance. And / or, if the licensee uses a surveillance frequency that is greater than every 31 days and it is not acceptably justified, then: Since the licensee uses a surveillance frequency of greater than 31 days, verify that the surveillance frequency is acceptably justified. See Sections 1.8 and 1.9, above, for guidance. TI Section 04.01, Reference 2 Section 3.3.2

- If the licensee did not adequately identify potential gas intrusion mechanisms, then: Verify that the licensee has addressed the potential gas intrusion mechanisms. Depending on the plant, these typically include such items as SI accumulators, the RCS, dissolved gas coming out of solution, gas issues associated with the containment emergency sump, the refueling water storage tank, gas issues that may be caused by level instrumentation error, valve leakage, and operations such as shutdown, restart, and maintenance. TI Section 04.02e, Reference 2 Section 3.4.2 Exclude any items that do not apply, such as accumulators for BWRs.

3 REFERENCES

3.1 General References

1. **The Temporary Instruction:** "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Contain Spray Systems (NRC Generic Letter 2008-01)," Temporary Instruction 2515/177, ML082950666, June 9, 2009.

2. **NRR expectations for licensee GL responses:** Ruland, William H., "Preliminary Assessment of Responses to Generic Letter 2008-01, 'Managing Gas Accumulation in emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems,' and Future NRC Staff Review Plans," NRC letter to James H. Riley, Nuclear Energy Institute, ML091390637, May 28, 2009.

3. **The Generic Letter (GL):** "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems," NRC Generic Letter 2008-01, ML072910759, January 11, 2008.

4. **Guidance for NRR Reactor Systems Branch (SRXB) reviews:** "July 2009 Review Guidance Update," ML092460591, July 17, 2009.

3.2 Guidance for assessing operability

5. "NRC Regulatory Issue Summary 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,'" ML052020424, September 26, 2005.

6. "NRC Regulatory Issue Summary 2005-20, Rev. 1, Revision to NRC Inspection Manual Part 9900 Technical Guidance, 'Operability Determinations & Functionality Assessments for Resolution of Degraded or Nonconforming conditions Adverse to Quality or Safety,'" ML073440103, April 16, 2008.

7. "Operability Determinations & Functionality Assessments for Resolution of Degraded or Nonconforming conditions Adverse to Quality or Safety," NRC Inspection Manual, Part 9900: Technical Guidance, Attachment to Reference 6, April 16, 2008.

8. **The Technical Specification meaning of "full:"** "Task Interface Agreement - Emergency Core Cooling Systems (ECCS) Voiding Relative to Compliance with Surveillance Requirements (SR) 3.0.1.1, 3.5.2.3, and 3.5.3.1 (TIA 2008-03)," ML082560209, October 21, 2008.

9. **Void criteria the NRC staff will accept without further justification:** "Revision 2 to NRC Staff Criteria for Gas Movement in Suction Lines and Pump Response to Gas," ML090900136, March 26, 2009. Note that acceptable modifications are discussed in Section 1.4, above, and revisions are expected as additional information is obtained by industry and made available to NRR.

3.3 Additional references for void transport behavior

10. "Test Results for the Millstone-3 Gas-Water Transport Tests," Fauske Associates, LLC, FAI/09-22, ML091170150, March, 2009.

11. “Post-Test Analysis of the FAI Millstone 3 RWST ¼ Scale Gas Entrainment Test,” Fauske Associates, Inc., FAI/09-44, Rev. 0, ML091910460, March 13, 2009.

3.4 Additional NEI guidance

12. Riley, James H., “Issuance of NEI 09-10, Revision 0, Guidelines for Effective Prevention and Management of System Gas Accumulation,” Communication from NEI Director of Engineering, ML093130090, October 30, 2009.

13. NEI APC letter 09-20, June 2009. Is this the June 18 Riley letter?

3.5 Plant-Specific References

14…. GL 2008-01 licensee responses and any other applicable documents