Dominion Energy Kewaunee, Inc.
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October 14, 2008

Attention: Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555-0001

Serial No.	08-0013D
NL&OS/CDS	R2
Docket No.	50-305
License No.	DPR-43

DOMINION ENERGY KEWAUNEE, INC.
KEWAUNEE POWER STATION
NINE-MONTH RESPONSE TO NRC GENERIC LETTER 2008-01, MANAGING GAS ACCUMULATION IN EMERGENCY CORE COOLING, DECAY HEAT REMOVAL, AND CONTAINMENT SPRAY SYSTEMS

The Nuclear Regulatory Commission issued Generic Letter (GL) 2008-01 (reference 1) on January 11, 2008 to request that each licensee evaluate the licensing basis, design, testing, and corrective action programs for the Emergency Core Cooling Systems, Residual Heat Removal system, and Containment Spray 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 specified that each licensee submit a written response in accordance with 10 CFR 50.54(f) within nine months of the date of the GL to provide the following information:

(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 you determine were 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 of the GL; and,

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

The attachment to this letter contains the Dominion Energy Kewaunee, Inc. (DEK) nine-month response for information requested in GL 2008-01.

In summary, DEK has concluded that the systems discussed above are in compliance with the Kewaunee Power Station (KPS) Technical Specification definition of Operability (i.e., capable of performing their intended safety function), and that KPS is currently in compliance with 10 CFR 50, Appendix B, Criterion III, V, XI, XVI and XVII, with respect to the concerns outlined in GL 2008-01 regarding gas accumulation in the applicable systems.

Please contact Mr. Craig D. Sly at (804) 273-2784 if you have any questions or require additional information.

Sincerely,

J. Alan Price
Vice President – Nuclear Engineering
Dominion Energy Kewaunee, Inc.

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by J. Alan Price, who is Vice President - Nuclear Engineering, Dominion Energy Kewaunee, Inc. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of his knowledge and belief.

GINGER LYNN ALLIGOOD
Notary Public
Commonwealth of Virginia
310847
My Commission Expires Apr 30, 2009

Acknowledged before me this 14th day of October, 2008.

My Commission Expires: 4/30/09.

Ginger L Alligood
Notary Public

Attachment:

Nine-Month Response to Generic Letter 2008-01 for Kewaunee Power Station

References:

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

Commitments made in this letter:

As detailed in Attachment 1, Section III.B.

cc:

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Attachment 1

NINE-MONTH RESPONSE TO GENERIC LETTER 2008-01 FOR KEWAUNEE POWER STATION

DOMINION ENERGY KEWAUNEE, INC.
KEWAUNEE POWER STATION

NINE-MONTH RESPONSE TO GENERIC LETTER 2008-01 FOR KEWAUNEE POWER STATION

This attachment contains the Kewaunee Power Station (KPS) 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 description of the results of evaluations that were performed pursuant to the requested actions (see Section I of this Attachment),
- 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 II of this Attachment),
- A summary regarding which corrective actions have been completed, the schedule for the corrective actions not yet complete, and the basis for that schedule (see Section III of this Attachment), and
- A summary of licensing basis references reviewed pursuant to the requested actions (see Section IV).

The following KPS systems were determined to be within the scope of GL 2008-01:

- Safety Injection (SI) System,
- Residual Heat Removal (RHR) System, and
- Internal Containment Spray (ICS) System.

The Safety Injection (SI) and Residual Heat Removal (RHR) systems perform the Emergency Core Cooling System functions of High Head Safety Injection (HHSI) and Low Head Safety Injection (LHSI). The Residual Heat Removal (RHR) system also performs the Decay Heat Removal function. The Internal Containment Spray (ICS) system, including the injection portion of the Caustic (Spray) Additive subsystem, performs the Containment Spray function.

As used within the context of this attachment, the phrase *"subject systems"* refers to those systems identified as within scope of GL 2008-01 as described above.

I. EVALUATION RESULTS

A. Licensing Basis Evaluation

The Kewaunee Power Station licensing basis was reviewed with respect to gas accumulation in the subject systems. This review included the Technical Specifications (TS), TS Bases, Updated Safety Analysis Report (USAR), the Technical Requirements Manual (TRM), TRM Bases, and responses to NRC generic communications, regulatory commitments, and license conditions.

1. Summarize the results of the review of these documents:

The above documents were reviewed with respect to gas accumulation in the subject systems with the following results.

a. Technical Specifications/Technical Specifications Bases (reference 1):

- The KPS TS do not establish Limiting Conditions for Operation (LCO) requirements for the size of gas accumulation/voids in the subject systems, nor are there any Surveillance Requirements (SR) for monitoring/venting of gas accumulation/voids from the subject systems.
- KPS TS 3.3.b.1.A states that the reactor shall not be made critical unless two trains of the SI and RHR systems are operable. KPS TS 3.3.c.1.A.1 states that the reactor shall not be made critical unless two trains of the ICS system are operable. KPS TS 3.3.c.2 states that the reactor shall not be made critical unless valves and piping are capable of adding sodium hydroxide (NaOH) from the additive tank to a containment spray system. These TS contain no criteria regarding gas accumulation/voids in the subject systems as a condition of system operability.
- The KPS TS definition of OPERABLE (TS 1.0.e) does not establish a requirement for venting of the subject systems or for a permissible level of gas accumulation that may exist in the subject systems. However, the definition of OPERABLE does specify that a system or component must be *"capable of performing its intended function within the required range."* This implies that each system or component required to be operable by the KPS TS must function within a given range of operation to support the KPS accident analyses. This would include consideration of gas accumulation in the subject systems.
- KPS TS 4.5.a.1 provides the SR for the SI system. KPS TS 4.5.a.2 provides the SR for the ICS system. KPS TS 4.5.b.1 provides the SR for the SI, RHR and ICS pumps. These SR contain no requirements for monitoring/venting of gas voids in the subject systems.

- No information is contained in the KPS TS Bases regarding permissible levels of gas accumulation in the subject systems or system venting requirements.

b. Updated Safety Analysis Report (USAR) (reference 2):

- KPS USAR section 6.2, Safety Injection System, describes the ECCS (including both HHSI (SI) and LHSI (RHR) systems). During original licensure of KPS, the Atomic Energy Commission (AEC) asked Wisconsin Public Service Corporation (WPSC) to demonstrate the ability of safety related systems, including core cooling systems, to withstand the potential hydraulic forces that could result from system actuation with the pump discharge lines not completely filled with fluid or from rapid closure in an operating line (reference 3). WPSC replied (reference 4), in part, with the following statement:

  "The design of the safety-related systems incorporates features that preclude hydraulic forces such as water hammer and steam compression. ... With the exception of the containment spray piping inside containment all lines are kept full of ambient temperature fluid at all times."

  No further elaboration of this statement is made in the USAR. This information currently resides in the KPS USAR, section 6.2.2.3, *"Protection Against Dynamic Effects,"* and also states in part:

  "With the exception of the containment spray piping inside containment all lines are kept full of ambient temperature fluid at all times (except the piping between sump suction valves SI-350A/B and SI-351A/B, which is normally maintained empty to preclude pressure locking concerns as required by Generic Letter 95-07)."

- USAR section 6.2.2.1.1, *"Injection Phase,"* describes the SI system function during the injection phase after a receipt of a SI signal. In this USAR section the following statement is made:

  "Because the injection phase of the accident is terminated before the refueling water storage tank is completely emptied, all pipes are kept filled with water before recirculation is initiated (except the piping between sump suction valves SI-350A/B and SI-351A/B, which is normally maintained empty to preclude pressure locking concerns as required by Generic Letter 95-07)."

- USAR section 6.2.2.1.1 further discusses that adequate time and instrumentation are available to alert the operator to terminate the SI injection mode. USAR section 6.2.3.10, *"Safety Injection Pumps,"* discusses that adequate net positive suction head (NPSH) is available in the refueling water storage tank to support pump operation prior to termination of the injection phase by the operator.

- USAR section 6.2.2.2.6, *"Motor Operated Valves,"* describes the construction and operation of SI system motor operated valves. In this USAR section, the following statement is made:

  "Plant procedures require cycling of valves SI-350A/B after any condition that could potentially fill the piping with water. This maintains the piping between SI-350A/B and SI-351A/B essentially dry, preventing pressure locking. Additionally, the containment sump water level is periodically confirmed to be below the level of the suction pipe."

c. **Technical Requirements Manual/Technical Requirements Manual Bases** (reference 5):

The KPS TRM and TRM Bases do not establish administrative limiting conditions for operation (ALCO) requirements for the size of gas accumulation/voids in the subject systems, nor are there any administrative surveillance requirements (ASR) for monitoring/venting of gas accumulation/voids in the subject systems.

d. **Responses to NRC generic communications, NRC Commitments, and License Conditions:**

The following NRC generic communications described licensing bases criteria for the subject systems relative to gas accumulation within the scope of Generic Letter 2008-01.

<u>Generic Letter 88-17</u>

Generic Letter (GL) 88-17, "Loss of Decay Heat Removal," (reference 6) requested Pressurized Water Reactor licensees to describe procedures, hardware, and training in the areas of; (1) prevention of accident initiation, (2) mitigation of accidents before they potentially progress to core damage, and (3) control of radioactive material if a core damage accident should occur during non-power operation.

The WPSC responses to GL 88-17 (references 7, 8 and 9) provided assurance that decay heat removal is available at non-power operation conditions. The venting and system lineup configurations described in the WPSC response to GL 88-17 are applicable only during non-power operation conditions. As such, these conditions would be followed by filling and venting operations that are designed to assure that systems are sufficiently full of water to address voiding concerns. Review of this response did not identify any additional licensing bases conditions that are pertinent to the response to GL 2008-01.

Generic Letter 95-07

Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," (reference 10) requested licensees to perform or verify performance of certain evaluations and analyses and to perform corrective actions as needed to ensure that safety-related power-operated gate valves could perform their required safety functions.

Pressure locking occurs when fluid becomes pressurized within the valve bonnet (e.g., for flexible wedge and double disk gate valves) and the actuator is not capable of overcoming the additional thrust requirements resulting from the differential pressure created across the valve disk(s) by the pressurized fluid in the valve bonnet. The WPSC analysis determined that specific portions of the RHR system were susceptible to pressure locking.

Specifically, WPSC stated in a July 18, 1996 letter to the NRC (reference 11) that containment sump suction valves SI-350A and SI-350B were susceptible to pressure locking should their valve bonnets be filled with water. To ensure that pressure locking would not occur, WPSC concluded that the RHR suction piping from Containment Sump B between containment sump suction valves SI-350A/B and SI-351A/B (reference USAR Figure 6.2-1) should be air filled. The July 18, 1996 letter also stated that the remainder of the RHR system is isolated from this dry section of piping by the SI-351A/B valves and is water filled.

The NRC reviewed and approved this position in a safety evaluation sent by letter dated January 13, 1998 (reference 12). In the safety evaluation the NRC stated:

> *"The staff finds that maintaining the piping that contains valves SI-350A,B in a dry condition eliminates the susceptibility of the valves to thermal-induced pressure locking and is thus acceptable."*

During an NRC Supplemental Inspection of KPS (reference 13), NRC inspectors reviewed site documentation concerning the effects of air entrainment in ECCS pumps. The void described above and its affect on RHR pump operability is the subject of NRC unresolved item (URI) 05000305/2007011-04 (reference 13). Further discussion regarding this condition is provided in the design evaluation portion of this response (see Section I.B).

Generic Letter 96-06, including Supplement 1

Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," (references 14 and 15) requested licensees to determine:

- If containment air cooler cooling water systems are susceptible to either waterhammer or two-phase flow conditions; and,
- If piping systems that penetrate the containment are susceptible to thermal expansion of fluid so that over-pressurization of piping could occur.

If systems were found to be susceptible to the conditions identified, licensees were expected to assess operability of the affected systems and to take corrective action as appropriate.

Pressurization of isolated piping systems results from the release of heat from the accident and can impact the safety function of motor-operated valves and the integrity of pressure boundary components.

WPSC stated in a November 20, 1997 response to the NRC (reference 16) that seventeen penetrations were identified as being susceptible to the conditions identified in GL 96-06. Specifically, as it relates to the subject systems, penetration 9 (RHR normal cooldown alignment from the RCS) and penetration 35 (SI Accumulator check valve test line) were identified as being susceptible. WPSC stated that these systems were modified to include overpressure protection.

The remaining subject system penetrations were not identified as being susceptible and no basis for the exclusion of penetrations is provided in the response. In particular, penetrations 30E and 30W (RHR Containment Sump B recirculation) were excluded from the response because the piping upstream of the containment sump suction valves SI-351A/B is maintained dry.

The NRC reviewed the WPSC response and closed the licensing actions associated with GL 96-06 by a letter dated September 22, 2004 (reference 17).

Generic Letter 97-04

Generic Letter 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," (reference 18) requested licensees to confirm the adequacy of the net positive suction head (NPSH) available for emergency core cooling (including core spray and decay heat removal) and containment heat removal pumps.

The WPSC response to GL 97-04 (reference 19) concluded that sufficient NPSH is available for the RHR, ICS and SI pumps. The response provided the methodology for calculating the NPSH available for these pumps as well as assumptions for friction losses, losses due to strainers, and losses due to system components. The response also provided the bases for ensuring the calculated NPSH available met the required NPSH under all evaluated accident conditions. Review of this response did not identify any licensing bases conditions that are pertinent to the response to GL 2008-01.

Generic Letter 2004-02

Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors," (reference 20) requested licensees, in part, to perform an evaluation of the ECCS and Containment Spray recirculation functions in light of potential debris-induced loss of NPSH margin during sump recirculation.

Debris-induced loss of NPSH margins can occur following severe Loss of Coolant Accidents (LOCA) as a result of energetic pressure waves and fluid jet stream impingement upon materials in the vicinity of the break location. Debris can also be generated from secondary mechanisms such as severe post-accident temperature and humidity, flooding of the lower containment, and impact of containment spray droplets.

The DEK supplemental response to GL 2004-02 (reference 21) provides information concerning the status of commitments for design changes and analysis and testing activities to confirm that the ECCS and Containment Spray recirculation systems are capable of providing their post-LOCA safety functions. The response provided the bases to ensure that these safety functions are maintained under applicable design basis accident conditions. The summary description of supporting calculations, and testing and analysis results, provide assurance of adequate NPSH margins and mitigation of air ingestion into the pump suction piping.

e. Regulatory Commitments and License Conditions

The KPS Regulatory Commitments and License Conditions contain no explicit requirements for monitoring or removal of gas accumulation in the SI, RHR or ICS systems.

2. **Summary of changes to licensing basis documents (Corrective Actions):**

No changes to the licensing basis documents have been completed to date as a result of this evaluation.

3. **Detailed list of items that have not been completed, a schedule for their completion, and the basis for that schedule.**

The following actions are planned to enhance the applicable KPS licensing basis documents:

a. DEK will develop and implement a TRM and TRM Bases section similar to NUREG-1431 SR 3.5.2.3 and LCO 3.6.6. This TRM section will require that the applicable portions of the subject systems are maintained sufficiently full of water to reliably perform their intended safety function and accessible portions of the subsystems susceptible to gas intrusion are verified sufficiently full of water on a quarterly basis.

Schedule: This action will be complete by January 30, 2009.

Basis: Technical evaluations and field verification activities performed in support of the GL 2008-01 response have demonstrated system operability and monitoring actions are in place where required. The timeframe for completion of these additional licensing basis requirements is consistent with the proposed surveillance frequency.

This TRM section will be deleted if KPS Technical Specifications are amended in the future to address this requirement.

b. The KPS USAR will be revised to reflect that the applicable portions of the subject systems must be verified sufficiently full of water following the opening of the systems for maintenance or testing, and by periodic monitoring of the accessible portions of the subject systems susceptible to gas intrusion, consistent with the guidance of GL 2008-01 and the supporting analysis.

Schedule: This action will be complete within 6 months of the next KPS refueling outage KR 30 (Fall of 2009).

Basis: The recent evaluations and actions performed in support of the GL 2008-01 response have demonstrated system operability. Changes to the USAR clarify licensing basis requirements and should be accomplished in an orderly manner consistent with the applicable USAR update cycle.

c. The USAR will be revised following the completion of the evaluation to change the design or operating practices to maintain the containment sump suction piping between valves SI-350A/B and SI-351A/B sufficiently full of water, consistent with the guidance of GL 2008-01 and the supporting analysis, if applicable design basis are changed.

Schedule: This action will be complete within 6 months of the next KPS refueling outage KR 30 (Fall of 2009).

Basis: Incorporation of design changes into the USAR is a programmatic requirement contained within the design change program. Anticipated design changes will require KPS to be in a shutdown condition. Associated changes to the USAR should be accomplished in an orderly manner consistent with the applicable USAR update cycle.

d. DEK will monitor the status of the industry/NRC Technical Specifications Task Force (TSTF) Traveler to be developed as a follow-up to GL 2008-01. Following NRC approval of this TSTF, DEK will evaluate adopting it.

Schedule: The completion date for this action is dependent on NRC approval of the TSTF. DEK evaluation of the TSTF and any subsequent TS submittal to supplement or replace the current TS or TRM will be completed within twelve months of NRC approval of the TSTF.

Basis: The completion date for this action is dependent on the NRC approval of the TSTF. This action will require significant effort by both the industry and NRC. Until the TSTF is approved no specific target date for completion can be made.

e. DEK will monitor the results of industry testing and analytical programs related to gas accumulation and pump suction acceptance criteria to determine if any changes to KPS licensing basis documents are required.

Schedule: The completion date for this action is dependent on completion of the industry testing and analytical programs, which are not presently defined.

Basis: Completion of the industry testing and analytical programs will require an extended period and significant industry funding. While the programs may provide additional information, the existing acceptance criteria in place for Kewaunee are considered conservative. The acceptance criteria are based on historical results and empirical testing that has been documented as meeting the design requirements.

B. Design Evaluation

1. Results of the review of the design basis documents.

The Kewaunee Power Station design basis was reviewed with respect to gas accumulation in the High Head Safety Injection (HHSI, SI), Low Head Safety Injection (LHSI, RHR), and Internal Containment Spray (ICS) systems (including the chemical addition subsystem). This review included the applicable Design Basis Documents, Calculations, Engineering Evaluations, and Vendor Technical Manuals as well as the design and operation of the systems.

As discussed in the Licensing Basis Evaluation above, these systems are required to be maintained filled with water, except a portion of the containment spray piping inside containment and the suction piping from the Containment Sump to the second isolation valve. Internal Containment Spray piping inside containment was originally designed to not be full of water. The Containment Sump piping was designed to remain essentially empty up to the second isolation valve, which was credited to address GL 95-07 issues. Beyond these examples, there are no specific design basis analyses or calculations that specify acceptance criteria for allowable gas volumes in these systems.

a. During the initial injection phase, both trains of the SI, RHR and ICS pumps may take suction from the RWST. A calculation was performed that determined the minimum required submergence of the SI, RHR and ICS pump suction piping from the RWST. The calculation considers the potential for air entrainment due to vortex formation at the tank's suction nozzles. The calculation approach was based on testing of an actual configuration similar to that of Kewaunee. The results showed that at minimum RWST level, slight vortexing may occur but no air entrainment is expected.

b. During the containment sump recirculation phase, the Residual Heat Removal pumps (LHSI) take suction from the containment floor/sump. Foreign material is prevented from entering the containment sump by a passive Sure-Flow® strainer. The strainer is fully submerged at the onset of recirculation. As part of the qualification report for the strainer, the results of various testing program documents were reviewed and calculations were performed. One of the calculations analyzed vortex formation and air entrainment/ingestion and concluded that vortex formation is precluded and air ingestion will not occur.

2. Development of New Gas Volume Acceptance Criteria for Operability Determination.

To allow assessment of potential gas volumes found during evaluations for Generic Letter 2008-01, DEK developed interim acceptance criteria for KPS system operability. These interim acceptance criteria have been used and will be used in the future to assess operability of the HHSI, LHSI (RHR) and ICS systems when gas accumulations are found. These criteria are not considered design basis acceptance criteria.

a. Pump Suction Piping

The interim allowable gas accumulation in the pump suction piping is based on limiting the gas entrainment to the pump after a pump start. A Pressurized Water Reactors Owners Group (PWROG) program established interim pump gas ingestion limits to be employed by the member utilities. The interim criteria address pump mechanical integrity only and are as follows:

	Single-Stage	***Multi-Stage***	***Multi-Stage***
		Stiff Shaft	Flexible Shaft
Steady-State	2%	2%	2%
Transient*	5% for 20 sec.	20% for 20 sec.	10% for 5 sec.
$Q_{B.E.P.}$ Range	70%-120%	70%-140%	70%-120%
Pump Type (transient data)	WDF	CA	RLIJ, JHF
* The transient criteria are based on pump test data and vendor supplied information.			

At KPS, the ICS and LHSI (RHR) pumps are single-stage, so the first column criteria are applicable. The HHSI (SI) pump is a multi-stage, flexible shaft pump, so the third column criteria are applicable.

Guidance on the impact of gas entrainment on pump performance is presented in NUREG/CR-2792, "An Assessment of Residual Heat Removal and Containment Spray Pump Performance Under Air and Debris Ingesting Conditions" (reference 22). This information was used for pump performance (NPSH and developed head) acceptance criteria.

b. Pump discharge piping susceptible to pressure pulsation after a pump start

LHSI (RHR) and ICS Pump discharge piping

The PWROG program evaluated pump discharge piping gas accumulation. Gas accumulation in the piping downstream of the pump to the first closed isolation valve or the RCS pressure boundary isolation valves will result in amplified pressure pulsations after a pump start. This pressure pulsation may cause relief valves in the subject systems to lift, or result in unacceptable pipe loads, i.e., axial forces that are greater than the design rating of the axial restraint(s). The PWROG program establishes a method to determine the limit for discharge line gas accumulation to be utilized by the member utilities.

The method uses plant specific information for piping restraints and relief valve set points in the subject systems to determine the acceptable gas volume accumulation such that relief valve lifting in the subject systems does not occur and pipe loading is within acceptable limits, i.e., axial forces that are less than the design rating of the axial restraint(s).

DEK has implemented this methodology for KPS and established the applicable limits for gas accumulation in the discharge piping of the LHSI (RHR) and ICS systems. For the ICS system, this methodology is applied up to the normally closed pump discharge valves. For the LHSI (RHR) pumps, the methodology is applied to the RCS connection.

HHSI (SI) Pump discharge piping susceptible to pressure pulsation after a pump start

A transient thermal hydraulic analysis of the SI system piping with postulated voids in the SI pump discharge piping was performed to determine the maximum dynamic loading that would occur in the piping system following a pump start. A hydraulic transient computer analysis was used to calculate the detailed force time histories on the piping. The analysis considered the pump head flow curve, time for the pumps to reach full speed after start, check valve opening characteristics, system resistance and configuration, location of the gas void, volume of the gas void, and the piping geometry. The computer analysis was required to appropriately capture all of these effects and to predict the worst-case dynamic loads on the piping.

A number of cases with gas accumulations at various combinations of locations were performed to identify acceptable transient responses. This analysis was used to establish location specific limits on allowable gas accumulations. These limits were used to determine system operability with postulated gas accumulations at various locations. The limits vary, dependent on the location of the void and the existence of other voids in the system.

c. ICS Pump discharge piping downstream of the pump discharge isolation valves (piping which is not susceptible to water hammer or pressure pulsation following a pump start).

The PWROG developed a methodology for Containment Spray systems that evaluates the piping response as the Containment Spray header is filled and compares the potential force imbalances with the weight of the piping. The net force resulting from the pressurization of the Containment Spray header during the filling transient is a small fraction of the dead weight of the filled piping, and therefore the filling transient is well within the margin of the pipe hangers. At KPS, the Internal Containment Spray System discharge header piping was evaluated using the PWROG methodology and it was determined that the force imbalances on the Internal Containment Spray System discharge header piping are well within the margin of the pipe hangers.

d. RCS Allowable Gas Ingestion

The PWROG qualitatively evaluated the impact of non-condensable gases entering the RCS on the ability on the post-accident core cooling functions of the RCS. This evaluation assumed that 5 cubic feet of non-condensable gas at 400 psia was present in the HHSI discharge piping concurrent with 5 cubic feet of non-condensable gas at 100 psia in the LHSI discharge piping. The qualitative evaluation concluded that these quantities of gas will not prevent the ECCS from performing its core cooling function.

KPS evaluations and procedures will provide assurance that gas accumulation in the KPS LHSI system reactor vessel injection piping is less than 5 cubic feet of non-condensable gas at 100 psia at any location. KPS evaluations and procedures will also provide assurance that the gas accumulation in the KPS HHSI cold leg injection piping is less than 5 cubic feet of non-condensable gas at 400 psia at any location.

3. Changes to the design basis documents (Corrective Actions) and the schedule for completion of the Corrective Actions

In general, DEK intends to maintain the current design basis condition for the subject systems as sufficiently full of water, with the exception of containment spray piping inside containment. Design changes are being considered to allow maintaining the portion of the containment sump piping that is currently kept drained, sufficiently full of water. An action to further address this condition is provided in section I.B.7.

In the future, DEK may choose to revise design basis documents to establish allowable design basis limits on gas accumulation.

The following changes have been implemented or are being implemented to enhance the applicable KPS design basis documents:

a. A calculation was developed to support the evaluation of GL 2008-01. This calculation identified the maximum potential void volumes at local high point locations and in valve bonnets in the SI, RHR and ICS systems. This calculation used measured piping slopes, existing vent valve locations, and valve design information to determine maximum potential void volumes after static venting. This information was used as an input to analyses and evaluations performed for this generic letter and will be used in planning future modifications. This calculation is complete.

b. The existing design basis calculations for assuring adequate NPSH margin for the SI, RHR and ICS pumps during alignment to the RWST do not include consideration of air ingestion effects resulting from pump recirculation flows. The existing calculations may require revision to document the potential effects of air ingestion from recirculation flows into the RWST.

   Schedule: Complete by January 30, 2009.

   Basis: The completion of this activity is dependent on identification and analysis of sufficient test data to adequately characterize the hydraulic behaviors and determine if NPSH or vortexing would be impacted. Sufficient time is required to research this condition, and, if necessary, develop and approve a safety related calculation to document the results.

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

The ICS, RHR and SI system P&IDs were reviewed to determine those portions of piping within the scope of GL 2008-01. Small portions of the systems where gas accumulation would have no impact on system operation were excluded. ICS system scope included piping from the caustic additive system. RHR system scope included both the portion used for low head safety injection and the portion used for normal RHR decay heat removal. Piping isometrics from all affected portions of piping were reviewed. Potential system high points identified included branch lines, valve bonnets, and as-installed piping. In addition, pipe diameter transitions in horizontal lines that could trap gas such as pipe reducers and orifices were identified.

The review of piping system arrangements found the following:

- The systems were typically found to have vent valves properly installed in key locations. The vents are typically located at the highest elevation of the piping runs.
- The KPS piping isometric drawings do not contain sufficient slope detail to determine if the vent valves were in the correct location along horizontal runs of piping.
- Horizontal piping sections not at the highest point in the system may not contain vent valves. It could not be determined from drawings if these sections were properly sloped to allow venting through the existing vent valves.
- The RHR pump suction piping from the RCS did not contain sufficient vents to facilitate planned maintenance. As a result, maintenance was rescheduled and an emergent modification was performed. See Section I.B.5 for details.
- High points in piping without vent valves were found in the SI test line piping inside containment, the RHR mini-flow recirculation piping, and the SI suction piping.

Since it could not be ascertained from the piping isometrics that all piping was properly sloped, in-scope horizontal piping was included as part of the detailed walkdown scope.

During review of the drawings a preliminary determination was made of piping that might be subject to gas accumulation during operation. A representative sample of high points without vents was selected for Ultrasonic Testing (UT) examination at the start of the KPS spring 2008 refueling outage (KR 29) to check for the presence of gas voids. The UT examinations resulted in the discovery of a void at one location. This location was in the RHR suction piping from the Reactor Coolant loop, between the first and second isolation valves (RHR-1A and RHR-2A). This location was filled and vented prior to placing the RHR system in operation for KR 29. Monitoring is being performed at this location. (see Section I.C.3).

In addition, during the drawing review, it was recognized that leakage of both check valves in each HHSI injection line could result in gas accumulation in the HHSI piping. A test procedure was developed and performed to measure leakage of both check valves in series in each injection line. The results of this test were inconclusive, so additional actions were planned to assess potential leakage through these valves, as discussed in Section I.B.6.

Instrument lines were reviewed and found not to represent a source of gas intrusion. Any gas in the lines would be small in volume and would not be swept into the main flow path. Additionally, these lines are required to be kept full by instrumentation calibration procedures.

5. **New vent valve locations, modifications to existing vent valves, or utilization of existing vent valves based on the drawing review, summary of Corrective Actions, and schedule for completion of the Corrective Actions.**

   Two new vent valves were installed on the RHR suction line from the RCS during KR 29. These vent valves were installed to facilitate filling the piping following RHR pump maintenance. No modifications to existing vent valves were performed during KR 29.

   In addition, at the location in the RHR cooldown suction piping where gas accumulation was found, actions were taken to use existing vent valves to fill the system before initiating cooldown. Corrective actions that may be required to prevent gas accumulation at this location are still in development.

6. **Results (including the scope and acceptance criteria used) of the system confirmation walkdowns that have been completed for the portions of the systems that require venting to ensure that they are sufficiently full of water.**

   Walkdowns of piping systems determined to be within the scope of GL 2008-01 have been completed. As discussed in Section I.B.4, horizontal piping was included as part of the detailed walkdown scope. Approximately 395 horizontal runs were identified for walkdown, including locations both inside and outside containment. Potential high points identified included branch lines, valve bonnets, and improperly sloped piping. In addition, pipe diameter transitions in horizontal lines that could trap gas such as pipe reducers and orifices were reviewed.

   A digital level (accurate to ± 0.1 degree) was utilized to obtain most slope information for the horizontal runs. For some difficult to access locations, an elevation reference Zip-Level® (accurate to approximately 1/8 inch for vertical measurements 10 ft or less) was used. In general, piping less than 6 inches in length could not be measured with the digital level. For these short horizontal lengths of piping, the piping slope was conservatively assumed to be 2 degrees for piping sized 4-inch NPS and larger or 3 degrees for piping sized 3-inch NPS and smaller.

   Obtaining slope data was not practical at a few locations, either due to accessibility constraints or insulation removal requirements. The potential for gas accumulation was assessed for these locations. If slope data was not obtained, the same conservative slope assumption described above was applied to determine the size of gas voids that could be present.

The field walkdowns confirmed that vent valves are installed as shown on plant drawings. The location of installed vent valves along the circumference of the pipe and piping routing configuration as depicted on the isometric drawings was confirmed. One valve was identified as a vent valve but is installed on the bottom of the pipe. The system isometric drawing correctly showed the actual location of this valve. This was entered in the corrective action system and actions are in progress to correct the plant documents. The walkdown data was collected and is documented in the KPS Work Management System.

The walkdown results confirmed that there is some variation in the slope of horizontal piping. Horizontal piping is not always properly sloped toward the nearest vent valve, creating high points where gas may potentially accumulate and cannot be removed by static venting.

The potential volume of gas that could be accumulated at each local high point after performance of a static vent was calculated. The maximum volumes calculated are based primarily on the geometry of the piping systems assuming static venting. Potential void volumes less than 0.01 cubic feet were considered to be negligible and were not evaluated further. Approximately 140 local high points with significant potential void volumes (greater than 0.01 cubic feet) were identified from the walkdown data for the three systems. The reviewed lines and results of field walkdowns were highlighted on piping isometric drawings and documented in a calculation.

Operability acceptance criteria were developed for the areas of significant potential gas accumulation using the methods described earlier (Section I.B.2). UT examination was then used to check for gas at the accessible locations. UT examinations were performed at over 70 percent of all significant high point locations, including locations in containment where dose rates were not prohibitive. The UT examinations resulted in the detection of voids in the following areas:

- Train A ICS discharge piping near the containment penetration
- Train A ICS discharge piping branch line associated with the full flow test line
- Caustic addition branch line to the ICS suction piping
- CVCS-RHR cross-connect piping from the RHR discharge piping
- RHR-to-Spent Fuel Pool interconnection branch line from the RHR discharge piping
- Train A RHR mini-flow recirculation branch line from the RHR discharge piping
- SI test line branch from the SI discharge piping

- Suction bypass branch to the SI suction piping

A Condition Report was issued for each of these areas and an operability determination was performed in accordance with the DEK corrective action program. In each case, it was determined that the system was operable with the gas volume present. No immediate corrective actions were required. Due to the presence of a potential gas intrusion mechanism (see section I.B.10.d. "From SI Accumulator Test Line Check Valve Leakage), increased monitoring was established for the void location in the SI test line branch from the SI discharge piping.

The potential for gas accumulations in valve bonnets was evaluated for valves in the subject systems. The maximum possible gas volume that could be trapped in the bonnets of isolation valves and check valves was estimated by review of available information on valve internal configurations. Potential valve bonnet voids greater than 0.01 cubic feet were considered significant and were evaluated for potential operability impacts. The following conclusions were reached:

- Gas accumulations in valve bonnets are located above the active flow stream.
- Flow through valve bonnets is limited by the relatively small exposed flow area. The valve disc blocks a significant portion of the exposed flow area in check valves. The bonnet entrance area is smaller than the bonnet diameter in gate valves.
- Many globe, ball, and diaphragm valves within the subject systems have negligible internal volumes susceptible to gas accumulation.
- Retracted discs in gate valves reduce the bonnet volume available for gas accumulation and hinder flow within the bonnet.
- Little accumulated gas in tall bonnets such as those common on gate valves can be drawn out because there is no direct flow path through the dead space in the upper bonnet region.
- Most gas voids in valve bonnets are expected to decrease in size with time, because of venting through minor packing leakage and entry of the gas into solution. Packing generally will not seal against gas as efficiently as against water.
- There is no known method available for checking for the presence of actual voids in valve bonnets.

For valves that change position during post accident operation, the potential effects of air that could be forced out of the bonnet area into the flowstream were considered. The assessment of potential valve bonnet gas accumulations found that there are no operability concerns.

Not all significant high points could be checked for the presence of gas accumulation, including potential gas in valve bonnets. Therefore, an evaluation was prepared that considered the potential operability effects of gas accumulations of maximum calculated size at areas that could not be checked for the presence of actual voids. Consideration was also given to the potential sources of gas intrusion that might be present during plant operation. Where appropriate, consideration was given to other factors that provide additional assurance that voids are not present. These included system operations that may establish flow rates that sweep out voids, maintenance and leak testing history, and operational history.

For the High Head Injection System (HHSI) discharge piping, locations that could not be verified as full of water were assumed to contain gas accumulations. One of these areas was the HHSI piping near the RCS connections. These lines were assumed to be voided due to potential check valve leakage. UT examination of these areas was not possible because of high dose rates during operation (much of this piping is located in the Reactor Coolant Pump vaults). These high points do not currently contain vent valves.

Other high point locations in HHSI that could not be accessed for UT examination were also assumed to contain gas accumulation. In addition, as described earlier, the ¾ inch SI test line was found to be partially voided. The gas water hammer analysis was performed with these actual and assumed voids included. The results met the operability acceptance criteria described in Section I. B.2.b.2.

As described earlier, some actual gas accumulations were found in the Low Head Injection System discharge piping. In addition, some sections of piping located in containment were not accessible for UT examination and could not be confirmed to be full of water. The acceptance criteria described in Section I.B.2.b.2 might not be met when using maximum assumed gas accumulation volumes in LHSI piping. That is, peak pressures in the system might exceed the 600 psig relief valve setpoints, although it was predicted that the system would still be able to perform its safety function. Other considerations, including maintenance history and test results for check valves, provided confidence that the maximum potential gas accumulations did not exist. To confirm this conclusion, each LHSI train was tested by starting the RHR pump while discharge pressure was monitored. It was confirmed that the maximum pressure peak above the steady state discharge pressure of the pump was not excessive. Therefore, the pump start did not cause a relief valve to open. This testing confirmed that the pump would start without causing any appreciable gas water hammer in the discharge piping.

7. **New vent valve locations, modifications to existing vent valves, or utilization of existing vent valves that resulted from the confirmatory walkdowns, and a summary of Corrective Actions, and the schedule for completion of the Corrective Actions.**

   a. DEK will take actions needed to eliminate gas accumulations that were found during UT examinations of subject systems. The actions to be taken are still in development, but are expected to include some combination of installation of additional vent valves and procedure modifications to ensure systems are sufficiently filled after draining for maintenance. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation.

      The locations where gas accumulations were found that will be corrected include:

      - Train A ICS discharge piping near the containment penetration
      - Train A ICS discharge piping branch line associated with the full flow test line
      - Caustic addition branch line to the ICS suction piping
      - CVCS-RHR cross-connect piping from the RHR discharge piping
      - RHR-to-Spent Fuel Pool interconnection branch line from the RHR discharge piping
      - Train A RHR mini-flow recirculation branch line from the RHR discharge piping
      - SI test line branch from the SI discharge piping
      - Suction bypass branch to the SI suction piping
      - RHR normal cooldown suction line from RCS loop A.

      Schedule: Complete prior to the end of the next refueling outage KR 30 (Fall of 2009).

      Basis: Sufficient time is required for design change development, material procurement, and work order planning. KR 30 is the first available planned shutdown to install these vent valves. The current system has minor gas accumulation areas that are being monitored and do not represent a challenge to operability.

   b. DEK will evaluate actions to address system high points that may not have an existing vent valve. The actions to be taken are still in development, but are expected to include some combination of installation of additional vent valves or procedure modifications to ensure systems are sufficiently filled after draining for maintenance. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation.

Schedule: Complete prior to the end of the next refueling outage KR 30 (Fall of 2009).

Basis: Sufficient time is required for thorough evaluation and development of the appropriate actions, potential design change, material procurement, and work order planning. There are currently no gas accumulations known to exist at these locations, although some are not accessible for UT examination.

c. System modifications and operating practices will be evaluated to permit maintaining the containment sump suction piping between the first and second isolation valves (SI-350A/B and SI-351A/B) sufficiently full of water to prevent gas intrusion. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation or use other means to resolve the concern with gas at this location.

Schedule: Complete prior to the end of the next refueling outage KR 30 (Fall of 2009).

Basis: Sufficient time is required for thorough evaluation and development of the appropriate, potential design change, material procurement, and work order planning. Evaluations have determined that the containment sump recirculation system is operable with the current system arrangement.

8. Results of the review of fill and vent activities and procedures for each system. (Note that routine periodic surveillance testing is addressed in the "Testing Evaluation" section of this document).

The following system fill and vent procedures were reviewed as part of this evaluation to provide assurance that corresponding systems were sufficiently full.

- OP-KW-MOP-SI-002, "Safety Injection System Fill and Vent Following Maintenance"
- OP-KW-MOP-RHR-005, "Residual Heat Removal System Extended Boundary Isolation for Maintenance"
- OP-KW-MOP-RHR-001A, "Residual Heat Removal Pump A Maintenance"
- N-ICS-23A, "Fill and Vent of ICS"
- OP-KW-MOP-ICS-004, "ICS Suction OOS"

Based upon a review of the system vent design and the venting procedures, the current procedures provide an adequate fill of the piping with some exceptions. Some system locations do not have high point vents and are not capable of developing sufficient flow velocity during static venting to sweep a void from the system. Where possible, UT inspections were performed to determine if these questionable locations were full of water. With a few exceptions, which are documented by the UT results, the piping in question was full. For the RHR system, a RHR pump discharge piping pressurization test was conducted on each train. The test results indicated that the possible voids in the system were not of sufficient size to impact operability.

The systems were operated following fill and vent to perform operations such as reactor cavity fill and subsequent draining, filling accumulators, and operating the residual heat removal system in the cooldown mode to dynamically sweep gas from the system. Also, the performance of system quarterly IST testing dynamically sweeps portions of the respective systems.

Several new vent locations have been recommended to further facilitate the return of equipment to service. Additional areas of improvement were noted that include the addition of confirmatory testing to the fill procedures, the addition of acceptance criteria for initial fill of the piping, and revision of system Inservice Test procedures to provide dynamic sweeping of the systems.

9. **Procedure revisions, or new procedures that need to be developed, resulting from the review of fill and vent activities and procedures. Summary of Corrective Actions, and schedule for completion of the Corrective Actions. (Note that routine periodic surveillance testing is addressed in the "Testing Evaluation" section of this document).**

   a. DEK will revise current fill and vent procedures to provide a means and acceptance criteria to ensure that piping is sufficiently full after system fill and vent. This may include confirmation by UT or other appropriate means.

      Schedule: Complete by October 1, 2009.

      Basis: This due date will ensure the revised procedures are available for their next scheduled use during the refueling outage in 2009.

   b. DEK will revise current inservice test procedures to provide dynamic sweeping as part of the filling of the systems where needed to ensure systems are sufficiently full.

      Schedule: Completed prior to October 1, 2009.

Basis: The addition of dynamic sweeps will further assure that the systems are sufficiently full prior to operation. This due date will ensure the revised procedures are available for use during the refueling outage in 2009.

10. Potential gas intrusion mechanisms into each system for each piping segment that is vulnerable to gas intrusion.

There is one potential gas intrusion mechanism common to all piping segments. This mechanism is inadequate post-maintenance fill and vent activities. Gas could potentially collect at localized high points in various piping segments as a result of inadequate post maintenance fill and vent activities. In addition, potential sources of gas intrusion specific to certain piping sections are discussed in detail below. As described earlier, some sections of piping were found by UT examinations to not be full of water. Of these, the following are suspected to have been caused, at least in part, by inadequate post maintenance filling of the system:

- Train A ICS discharge piping near the containment penetration
- Train A ICS discharge piping branch line associated with the full flow test line
- Caustic addition branch line to the ICS suction piping
- RHR-to-Spent Fuel Pool interconnection branch line from the RHR discharge piping
- SI test line branch from the SI discharge piping
- Suction bypass branch to the SI suction piping

a. HHSI Suction Piping

The following potential gas intrusion mechanisms into the HHSI Suction Piping were identified:

From the Charging Pump Cross-Connection to the RWST

This is a back-up, normally isolated, supply. It is possible for VCT pressure to be greater than RWST static head pressure, although this is not normally the case. Since water in the VCT is gas saturated, leakage past the isolation valves into the common HHSI/LHSI suction pipe could result in gas intrusion into the common suction line.

The Charging Pump cross-connect line was found to be completely filled with water, providing assurance that no leakage through this path is present at this time. It will be considered for inclusion in the monitoring program to be developed.

From the RHR System during Quarterly IST Pump Testing

During quarterly IST pump testing, the LHSI system is cross-connected to the ICS system, allowing use of the ICS full flow test line to achieve high flowrates. The ICS full flow test line return to the RWST is connected to the common HHSI suction line. During the LHSI quarterly test, the LHSI pump is taking its suction through this line. Consequently, any air in the flowing portions of the LHSI or ICS systems may be carried back into the common HHSI suction line.

No gas was found in high points in the SI common suction pipe, indicating that gas is not currently being deposited in this line during the quarterly RHR pump testing. Key locations where gas would collect will be considered for inclusion in the monitoring program to be developed. Modifications are being investigated that would eliminate this intrusion source.

From Gas Voids Left in the Bonnets of Larger Check Valves after System Filling

Since all valves in the RWST injection path are normally aligned open, only the voids contained in check valves would potentially create a gas intrusion mechanism. Trapped gas in check valve bonnets could be displaced when flow is initiated. However, there are no check valves in the HHSI suction piping.

b. LHSI Suction Piping

The following potential gas intrusion mechanisms into the LHSI Suction Piping were identified:

From the Charging Pump Cross-Connection to the RWST (same source as for HHSI suction piping).

This is a back-up, normally isolated, supply. It is possible for VCT pressure to be greater than RWST static head pressure, although this is not normally the case. Since water in the VCT is gas saturated, leakage past the isolation valves into the common HHSI/LHSI suction pipe could result in gas intrusion into the common suction line.

The Charging Pump cross-connect line was found to be completely filled with water, providing assurance that no leakage through this path is present at this time. It will be considered for inclusion in the monitoring program to be developed.

From Gas Voids Left in the Bonnets of Larger Check Valves after System Filling

Trapped gas in check valve bonnets could be displaced when flow is initiated. Since all valves in the RWST injection path are normally aligned open, only the voids contained in check valves would potentially create a gas intrusion mechanism.

The potential effects of this gas were considered in the assessment of RHR pump operability. It was concluded that the small amount of gas that might be introduced would not exceed the acceptance criteria. Modifications are being investigated that would eliminate this intrusion source.

From the Containment Sump Recirculation Line

Portions of the containment sump suction piping at KPS are intentionally maintained empty. The portion of the piping from the sump to the first isolation valve will fill as the containment sump fills. This piping is properly sloped to allow gas to escape to the sump, so there is no concern for gas entrainment.

However, the piping between the first and second isolation valves (SI-350A/B and SI-351A/B) is kept drained to prevent concerns for pressure locking of a gate valve in this path (GL 95-07) and to prevent over-pressurization of the piping (GL 96-06), as discussed in the licensing basis review section. Although most of this air is expected to escape to the containment sump before the RHR pump is started, this could not be proved by analysis. Therefore, an assessment was done that assumed all of the air contained between these valves was entrained to the RHR pump when containment sump recirculation is initiated. The results of this analysis showed that the resulting air entrainment would be within the transient limits discussed in section I.B.2.a. This condition is the subject of NRC unresolved item (URI) 05000305/2007011-04 as described in Section I.A.1.d under Generic Letter 95-07.

Modifications are being evaluated to eliminate this gas intrusion source by maintaining the piping section between the first and second isolation valves sufficiently full of water.

From RCS Isolation Valve Leakage

The RHR system takes suction from the RCS hot legs for normal cooldown. The flowpath from the RCS is isolated by two closed gate valves in each train during normal operation, when the RHR system is aligned for LHSI. Leakage from the RCS through the closed isolation valves could result in gas collection in the RHR system. Gas would first collect in the piping in containment between the two isolation valves. Eventually, gas could intrude to the common pipe near the containment penetration. If the gas intrusion were to go unnoticed, the piping could eventually be voided all the way to the connection between the normal cooldown piping and the LHSI suction piping.

Gas was found in the RHR pump suction from RCS hot leg A, indicating leakage of the isolation valves. Repairs to one isolation valve during the recent refueling outage have not eliminated this gas accumulation. Additional corrective actions are being developed.

The size of the gas accumulation is being monitored periodically and controlled as needed by filling and venting the piping section. Monitoring at this location and at downstream locations will be considered for inclusion in the monitoring plan to be developed to provide assurance that the gas void cannot impact the LHSI function of the RHR pumps.

From Trapped Gas in the Mini-Flow Recirculation Line

Each RHR train contains a mini-flow recirculation line, which connects to the top of the LHSI injection discharge header, rises vertically, then descends and connects to the pump suction line. There is no vent valve provided in the high point of the mini-flow recirculation line. Therefore, some gas would always be trapped there after system fill. In addition, any gas introduced into the LHSI header would tend to rise into the mini-flow line high point and collect there.

Gas was found in this location in RHR train A. This condition was entered into the corrective action program and found to not affect system operability. Corrective actions have not yet been developed.

Monitoring at this location will be considered for inclusion in the monitoring plan to be developed, if needed to provide assurance that the gas void cannot impact the LHSI function of the RHR pumps.

c. LHSI Discharge Piping

The following potential gas intrusion mechanisms into the LHSI Discharge Piping were identified:

From the Letdown Cross-Connection to the RHR system

A branch line off the LHSI header connects to the Letdown system. This branch line allows flow from the RHR system to letdown during RHR cooldown operation. During normal plant operation, the RHR system is aligned for LHSI injection and is pressurized to RWST static head pressure, while the letdown system is in operation and is pressurized to approximately 250 psig. Therefore, leakage from the letdown system into the RHR/LHSI header can occur, releasing gas as the water depressurizes.

The Letdown to RHR cross–connect branch line was found to be completely voided, indicating leakage through this path may be present. This condition was entered into the corrective action program and found to not affect system operability. Corrective actions have not yet been developed.

Monitoring at this location or at downstream locations will be considered for inclusion in the monitoring plan to be developed, if needed to provide assurance that the gas void cannot impact the LHSI function of the RHR pumps.

In addition, performance of the RHR pump discharge pressure test described earlier provides assurance that no appreciable gas water hammer would occur in the LHSI discharge piping. Periodic performance of the RHR pump discharge pressure test is being considered for inclusion in the monitoring plan to be developed.

From RCS Check Valve Leakage

Each LHSI injection line is isolated from the RCS by two check valves. Leakage past either pair of check valves would result in gas being released in the LHSI piping.

Although these locations could not be fully accessed for UT examination, review of other indicators provides assurance that leakage through these paths is not present. In addition, performance of the RHR pump discharge pressure test described earlier provides assurance that no appreciable gas water hammer would occur in the LHSI discharge piping.

Periodic performance of the RHR pump discharge pressure test is being considered for inclusion in the monitoring plan to be developed. In addition, modifications are being investigated that would improve the monitoring capability.

From SI Accumulator Leakage

The LHSI A train also serves as the normal return for RHR to the RCS cold leg loop B. The LHSI piping is connected to SI accumulator B injection piping between the SI accumulator and RCS cold leg B. During power operation, a normally closed gate valve isolates the LHSI header from the SI accumulator injection piping. The accumulator injection piping is normally pressurized to full accumulator pressure, at least 700 psig. This water is also gas saturated. Therefore, leakage of the single gate valve could result in the release of gas into the LHSI piping. In addition, leakage of the first check valve in the accumulator injection line (nearest to the RCS) could result in pressurizing the accumulator injection piping to full RCS pressure, which would then be against the single gate valve isolating the accumulator piping from LHSI train A.

This location was checked for the presence of gas by UT examination at the end of the last operating cycle and none was found. Also, no abnormal accumulator leakage has been detected. These indications provide assurance that no leakage is occurring through this source. Because of piping arrangements, gas introduced by leakage from this source would rise quickly to the RHR-to-Letdown cross-connection where gas was found. As described above, monitoring at this location or at downstream locations will be considered for inclusion in the monitoring plan to be developed, if needed to provide assurance that the gas void cannot impact the LHSI function of the RHR pumps.

In addition, performance of the RHR pump discharge pressure test described earlier provides assurance that no appreciable gas waterhammer would occur in the LHSI discharge piping. Periodic performance of the RHR pump discharge pressure test is being considered for inclusion in the monitoring plan to be developed.

d. HHSI Discharge Piping

The following potential gas intrusion mechanisms into the HHSI Discharge Piping were identified:

From SI Accumulator Leakage

The accumulators are pressurized with nitrogen to at least 700 psig. As a result, gas can be released if leakage into the HHSI system is present. Each accumulator is filled from the HHSI system and a single valve isolates each accumulator from the HHSI header.

UT examination found the fill lines for both SI accumulators to be full of water, providing assurance that leakage is not occurring through this source.

Periodic monitoring for gas at these locations will be considered for inclusion in the monitoring program to be developed.

From SI Accumulator Test Line Check Valve Leakage

There are also two normally closed test line isolation valves for each SI accumulator injection line. Each of these valves isolates the accumulator injection line from the SI test line, which is used for testing of the SI accumulator injection check valves. Leakage of any of the test line isolation valves would release gas into the ¾ inch test line.

Gas was found in the accumulator test line during UT examinations. This condition was entered into the corrective action program and found to not affect system operability. Corrective actions have not yet been developed. Monitoring at this location has been established both on a periodic basis and on indication of SI accumulator level change.

From RCS Check Valve Leakage

The HHSI system is isolated from each RCS cold leg by two check valves. Leakage past either pair of check valves would result in gas being released in the HHSI piping.

Although the piping location adjacent to the first RCS check valve where the gas accumulation would be expected could not be accessed for UT examination, UT at other locations provides assurance that leakage through these paths is not occurring. In addition, gas was assumed to be present in this location during assessment of the potential operability effects. It was concluded that the system would be operable even if gas were present in this location.

Modifications are being considered that would allow monitoring for gas accumulations due to leakage through these paths.

From Reactor Vessel Check Valve Leakage

The HHSI system also contains connections to the reactor vessel. These connections are shared with the LHSI piping. Therefore, the first isolation from the reactor vessel is the LHSI check valve. The HHSI piping contains a second check valve and a normally closed globe valve, since this flowpath is not used in any post-accident condition. The presence of two check valves and a closed isolation valve in each injection line makes it unlikely that leakage through this path will occur.

Although the piping location adjacent to the first RCS check valve where the gas accumulation would be expected could not be accessed for UT examination, UT at other locations provides assurance that leakage through these paths is not occurring. In addition, gas was assumed to be present in this location during assessment of the potential operability effects. It was concluded that the system would be operable even if gas were present in this location.

Modifications are being considered that would allow monitoring for gas accumulations due to leakage through these paths.

e. ICS Suction and Discharge Piping

The following potential gas intrusion mechanisms into the ICS suction and discharge piping were identified:

From the RHR System during Quarterly IST Pump Testing

The RHR discharge is aligned to the ICS pump suction for quarterly testing. This allows use of the ICS full flow test line to achieve higher RHR pump flowrates. If gas were present in the RHR system, it would be swept into the ICS suction and discharge piping.

Gas was found in the ICS Train A discharge piping. This gas is suspected to be left from incomplete venting after the system was drained for maintenance, but may also be partially due to transport of gas to this location during the RHR pump quarterly test. This condition was entered into the corrective action program and found to not affect system operability. Corrective actions have not yet been developed.

Periodic monitoring for gas at these locations will be considered for inclusion in the monitoring program to be developed. Modifications are being investigated that would eliminate this intrusion source.

11. Ongoing Industry Programs

Ongoing industry programs are planned in the following areas that may impact the conclusions reached during the Design Evaluation of KPS relative to gas accumulation. The activities will be monitored to determine if additional changes to the KPS licensing or design basis may be required or desired to provide additional margin.

a. Gas Transport in Pump Suction Piping

The 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.

b. 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. KPS will monitor the results of industry testing and analytical programs related to gas accumulation. This effort will evaluate the results of the industry testing and analytical efforts to determine if any additional changes to any licensing basis documents are required. The completion date for this NRC commitment is dependent on the completion of the industry testing and analytical programs that will not be completed prior to October 14, 2008.

12. Detailed list of items that have not been completed, a schedule for their completion, and the basis for that schedule.

a. The existing design basis calculations for assuring adequate NPSH margin for the SI, RHR and ICS pumps during alignment to the RWST do not specifically include consideration of air ingestion effects resulting from pump recirculation flows. The existing calculations may require revision to document the potential effects of air ingestion from recirculation flows into the RWST.

Schedule: Complete by January 30, 2009.

Basis: The completion of this activity is dependent on identification and analysis of sufficient test data to adequately characterize the hydraulic behaviors and determine if NPSH or vortexing would be impacted. Sufficient time is required to research this condition, and, if necessary, develop and approve a safety related calculation to document the results.

b. A manual RHR system valve was identified as a vent valve on the P&ID and equipment database, but is installed on the bottom of the pipe. The system isometric drawing correctly showed the actual location of this valve. This was entered in the corrective action system and actions are required to correct the associated documents, databases and labels as applicable.

   Schedule: Complete by January 30, 2009.

   Basis: The completion of this activity has no significant impact to the operation of the facility. The proposed date provides sufficient time for processing the changes.

c. DEK will take actions needed to eliminate gas accumulations that were found during UT examinations of subject systems. The actions to be taken are still in development, but are expected to include some combination of installation of additional vent valves and procedure modifications to ensure systems are sufficiently filled after draining for maintenance. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation. The locations where gas accumulations were found that will be corrected include:

   - Train A ICS discharge piping near the containment penetration
   - Train A ICS discharge piping branch line associated with the full flow test line
   - Caustic addition branch line to the ICS suction piping
   - CVCS-RHR cross-connect piping from the RHR discharge piping
   - RHR-to-Spent Fuel Pool interconnection branch line from the RHR discharge piping
   - Train A RHR mini-flow recirculation branch line from the RHR discharge piping
   - SI test line branch from the SI discharge piping
   - Suction bypass branch to the SI suction piping
   - RHR normal cooldown suction line from RCS loop A.

   Schedule: Complete prior to the end of the next refueling outage KR 30 (Fall of 2009).

   Basis: Sufficient time is required for design change development, material procurement, and work order planning. KR 30 is the first available planned shutdown to install these vent valves. The current system has minor gas accumulation areas that are being monitored and do not represent a challenge to operability.

d. DEK will evaluate actions to address system high points that may not have an existing vent valve. The actions to be taken are still in development, but are expected to include some combination of installation of additional vent valves or procedure modifications to ensure systems are sufficiently filled after draining for maintenance. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation.

   Schedule: Complete prior to the end of the next refueling outage KR 30 (Fall of 2009).

   Basis: Sufficient time is required for thorough evaluation and development of the appropriate actions, potential design change, material procurement, and work order planning. There are currently no gas accumulations known to exist at these locations, although some are not accessible for UT examination.

e. System modifications and operating practices will be evaluated to permit maintaining the containment sump suction piping between the first and second isolation valves (SI-350A/B and SI-351A/B) sufficiently full of water to prevent gas intrusion. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation or use other means to resolve the concern with gas at this location.

   Schedule: Complete prior to the end of the next refueling outage KR 30 (Fall of 2009).

   Basis: Sufficient time is required for thorough evaluation and development of the appropriate, potential design change, material procurement, and work order planning. Evaluations have determined that the containment sump recirculation system is operable with the current system arrangement.

f. DEK will revise current fill and vent procedures to provide a means and acceptance criteria to ensure that piping is sufficiently full after system fill and vent. This may include confirmation by UT or other appropriate means.

   Schedule: Complete by October 1, 2009.

   Basis: This due date will ensure the revised procedures are available for their next scheduled use during the refueling outage in 2009.

g. DEK will revise current inservice test procedures to provide dynamic sweeping as part of the filling of the systems where needed to ensure systems are sufficiently full.

Schedule: Completed prior to October 1, 2009.

Basis: The addition of dynamic sweeps will further assure that the systems are sufficiently full prior to operation. This due date will ensure the revised procedures are available for use during the refueling outage in 2009.

C. Testing Evaluation

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

Because KPS does not have a Technical Specification requirement for periodic venting or gas accumulation surveillances, there are currently no associated procedures. Because it had previously been recognized that small amounts of leakage from SI accumulators could result in significant gas accumulation in HHSI system piping, routine monitoring of SI accumulator level was implemented several years ago. The surveillance procedure requires daily tracking of accumulator level. If combined accumulator level decreased by two percent of indicated level, the procedure requires performance of venting or UT examination of the SI pump discharge piping. This ensures that gas is not introduced into either SI pump. Note that as a result of assessments performed for this generic letter, the requirement for monitoring was changed to 1% level change on any indicated SI accumulator level, and additional monitoring locations were added.

During this evaluation a number of UT examinations were performed to verify that systems were full. As discussed earlier, gas voids were found in some locations and were entered into the corrective action program. Where needed, periodic monitoring has been established at those locations to ensure gas volumes stay within operability limits. Repetitive performances of these examinations are administratively controlled by the maintenance scheduling program.

DEK recognizes the need to establish a program for periodic surveillance to ensure that the systems are maintained essentially full. This is discussed further in section 2, below.

2. Procedure revisions, or new procedures that need to be developed resulting from the review of periodic venting or gas accumulation surveillance procedures.

DEK plans to establish requirements for periodic monitoring for gas accumulation. Accessible locations to be monitored will be those that have been identified as having the potential for gas intrusion and accumulation during normal operation. The exact locations to be monitored, the methods to be used, and appropriate procedures will be developed and implemented before January 30, 2009. Monitoring will be performed quarterly.

All of the systems within the scope of Generic Letter 2008-01 will be included in the monitoring program. Wherever possible, monitoring will employ UT of piping to confirm it is full and to determine the size of any voids found. Any voids found that are not consistent with the approved licensing and design basis will be entered into the corrective action program and will be considered non-conforming with the KPS USAR requirement to maintain the system full of water. Where possible, the gas will be eliminated. If not possible to eliminate the gas, operability will be assessed using the methods described earlier.

With current system design and arrangement, some locations where gas might collect cannot be vented or monitored due to radiation levels or inaccessibility. Therefore, alternate means of monitoring may be employed. For HHSI discharge piping, preliminary water hammer analysis has shown that significant voids can be tolerated at certain inaccessible locations as long as void size is limited at other accessible locations. Therefore, interim monitoring will ensure that voids in accessible locations are detected and controlled. Modifications will be investigated that would allow monitoring in the locations that are currently inaccessible or other long term solutions will be pursued.

For LHSI, there are also locations in piping in containment that are not currently accessible where gas might collect. The effects of potential voids at these locations has been analyzed and found to be within operability limits. This was confirmed by performance of a test that monitored pump discharge pressure during a pump start. By observing the peak pressure and rate of pressure increase, it was verified that total gas voids in the LHSI discharge piping are within allowable limits. To ensure that total gas void volumes stay within allowable limits, interim monitoring may include periodic performance of this testing. Modifications will be investigated that would allow monitoring at the locations that are currently inaccessible or other long term solutions will be pursued.

Other monitoring methods may also be employed to supplement UT examinations. Trending of the rate of change of RWST level may be used as an indicator of increased RCS leakage into the LHSI or HHSI systems. As stated earlier, monitoring of SI accumulator level is already in place. This monitoring may be revised or enhanced, if appropriate. Other monitoring methods will be considered, including trending of SI and RHR system pressure for evidence of in leakage.

3. Review of procedures for RHR system operation for decay heat removal

The RHR system at KPS is also used as the LHSI system. Therefore, most of the system piping and components are common to both the normal decay removal function of the system and the low head safety injection function.

System piping for both of these functions was included in the scope for system walkdowns, slope determinations, and analysis of gas accumulation sources. Deficiencies in system vent valve arrangements and locations have been identified and are being considered for modifications. Procedures used for filling and venting the system were reviewed and needed improvements have been identified in the corrective action program.

UT examination was also used to check for gas accumulations at locations where gas is likely to collect. One location in the normal cooldown connections from the RCS was identified. Routine monitoring has been implemented at this location. An acceptance criterion has been established that ensures the size of the void is limited so that RHR cooling could be initiated at any time without first requiring filling and venting the piping in the area of the gas void.

RHR pump operation is monitored in the control room using pump discharge pressure indication, pump motor current indication, and pump flow indication. The flow indication shows the combined flow if both trains are aligned for decay heat removal operation. Locally, RHR Pumps are monitored for excessive noise during pump operation. There are also local discharge pressure indicators that can be monitored for cavitation.

A Control Room alarm annunciator is provided for RHR TO RCS COOLDOWN FLOW LOW, which can be an indication of pump cavitation. An additional alarm annunciator, TLA-18 RHR SYSTEM MONITOR ABNORMAL, can be set by the operator to alarm at specified values for RHR Pump flow, discharge pressure and amps to alert the operator of pump cavitation. The Alarm Response procedures for these alarms direct the operator to check for RHR pump cavitation, which is indicated by motor amperage oscillations, pump flow oscillations, pump discharge pressure oscillations or excessive pump noise. The operating pumps are stopped if cavitating.

The RHR system abnormal system operation provides the same guidance for determining if cavitation exists.

4. Results of reviews of Operating and Maintenance Procedures.

The maintenance and operating procedures have been reviewed. Prior to completion of the reviews, UT inspection identified that the containment spray discharge piping at the Train A containment penetrations was voided. This piping had been drained in accordance with SP-23-100A, "Train A Containment Spray Pump and Valve Test – IST." A similar procedure (SP-23-100B, "Train B Containment Spray Pump and Valve Test – IST") for Train B also drains the penetration piping. No other gas intrusion mechanisms resulting from inadvertent draining, valve misalignments or incorrect maintenance practices have been identified.

5. Description of gas void documentation requirements

As discussed above, DEK does not currently have a program for monitoring for gas accumulation at KPS. Therefore, there are currently no specific procedures specifying requirements for measuring or documenting gas voids. To date, normal station practice has been to initiate a condition report whenever gas is suspected or discovered in a system. The corrective action process then documents additional evaluations and corrective actions. Operability determinations are performed for any confirmed gas accumulation greater than 0.01 cubic feet. Consideration is given in the operability determination to increased monitoring that may be required as a compensatory measure.

Gas accumulation in these systems is considered non-conforming to the KPS USAR requirement that the ECCS systems (HHSI and LHSI, except the piping upstream of SI-351A/B) and the ICS system (except piping inside containment) be kept full of water. Corrective actions are developed to eliminate the gas accumulation. Alternately, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation.

6. Detailed list of items that have not been completed, a schedule for their completion, and the basis for that schedule.

DEK plans to establish requirements for periodic monitoring of gas accumulation. Locations to be monitored will be those accessible locations that have been identified as having the potential for gas intrusion and accumulation during normal operation. The exact locations to be monitored, the methods to be used, and appropriate procedures will be approved. Monitoring will be performed quarterly.

Schedule: Monitoring requirements will be developed and implemented by January 30, 2009.

Basis: Recent UT examinations that were performed after over 130 days of plant operation provide assurance that existing gas intrusion sources are known and have not impacted system operability. Where needed, monitoring has already been implemented to monitor and control known gas intrusion sources. Therefore, additional quarterly monitoring will provide reasonable assurance that newly developing gas intrusion mechanisms are identified before system operability is affected.

D. Corrective Actions Evaluation

1. Summary of the results of the reviews regarding how gas accumulation has been addressed at KPS.

DEK's corrective action program is used to document gas intrusion/accumulation issues as potential nonconforming conditions. Currently DEK has no specific procedures specifying requirements for measuring or documenting gas voids at KPS. Normal station practice is to initiate a condition report whenever gas is suspected or discovered in a system. As part of DEK's corrective action program, Condition Reports related to plant equipment are evaluated for potential impact on operability and reportability.

Therefore, DEK's review concluded that issues involving gas intrusion/accumulation are properly prioritized and evaluated under the corrective action program.

2. Detailed list of items that have not been completed, a schedule for their completion, and the basis for that schedule.

No additional actions related to the KPS corrective action program were identified.

E. Conclusion

Based upon the above, with respect to managing gas accumulation in the subject systems, DEK has concluded that KPS is in conformance with its commitments to 10 CFR 50, Appendix B, Criterion III, V, XI, XVI, and XVII, as described in the Dominion's Quality Assurance Program. Any remaining corrective actions have been entered into the KPS corrective action program for tracking and final resolution, as described in Sections I.B and I.C of this attachment.

II. DESCRIPTION OF NECESSARY CORRECTIVE ACTIONS

A. Summarize the corrective actions that have been completed as a result of the evaluations discussed above.

1. A calculation was developed to identify the maximum potential void volumes at local high point locations and in valve bonnets in the SI, RHR and ICS systems. This calculation used measured piping slopes, existing vent valve locations, and valve design information to determine maximum potential void volumes after static venting.
2. During review of the drawings a preliminary determination was made of piping that might be subject to gas accumulation during operation. A representative sample of high points without vents was selected for Ultrasonic Testing (UT) examination at the start of the KPS spring 2008 refueling outage (KR 29) to check for the presence of gas voids. The UT examinations resulted in the discovery of a void at one location. This location was in the RHR suction piping from the Reactor Coolant loop, between the first and second isolation valves (RHR-1A and RHR-2A). This location was filled and vented prior to placing the RHR system in operation for KR 29. Monitoring is being performed at this location.
3. During the drawing review, it was recognized that leakage of both check valves in each HHSI injection line could result in gas accumulation in the HHSI piping. A test procedure was developed and performed to measure leakage of both check valves in series in each injection line.
4. Two new vent valves were installed on the RHR suction line from the RCS during KR 29. These vent valves were installed to facilitate filling the piping following RHR pump maintenance.
5. To confirm that the discharge piping of the RHR system was sufficiently full, test procedures were developed and performed. Discharge pressure was monitored during the start of the RHR pumps for each LHSI train. It was confirmed that the maximum pressure peak above the steady state discharge pressure of the pump was not excessive.

B. Summarize the corrective actions to be completed.

1. DEK will develop and implement a TRM and TRM Bases section similar to NUREG-1431 SR 3.5.2.3 and LCO 3.6.6. This TRM section will require that the applicable portions of the subject systems are maintained sufficiently full of water to reliably perform their intended safety function and accessible portions of the subsystems susceptible to gas intrusion are verified sufficiently full of water on a quarterly basis. This TRM section will be deleted

if KPS Technical Specifications are amended in the future to address this requirement.

2. The KPS USAR will be revised to reflect that the applicable portions of the subject systems must be verified sufficiently full of water following the opening of the systems for maintenance or testing, and by periodic monitoring of the accessible portions of the subject systems susceptible to gas intrusion, consistent with the guidance of GL 2008-01 and the supporting analysis.
3. The USAR will be revised following completion of the evaluation to change the design or operating practices to maintain the containment sump suction piping between valves SI-350A/B and SI-351A/B sufficiently full of water, consistent with the guidance of GL 2008-01 and the supporting analysis, if applicable design bases are changed.
4. DEK will monitor the status of the industry/NRC Technical Specifications Task Force (TSTF) Traveler to be developed as a follow-up to GL 2008-01. Following NRC approval of this TSTF, DEK will evaluate adopting it.
5. DEK will monitor the results of industry testing and analytical programs related to gas accumulation and pump suction acceptance criteria to determine if any changes to KPS licensing basis documents are required.
6. The existing design basis calculations for assuring adequate NPSH margin for the SI, RHR and ICS pumps during alignment to the RWST do not specifically include consideration of air ingestion effects resulting from pump recirculation flows. The existing calculations may require revision to document the potential effects of air ingestion from recirculation flows into the RWST.
7. A manual RHR system valve was identified as a vent valve on the P&ID and equipment database, but is installed on the bottom of the pipe. The system isometric drawing correctly showed the actual location of this valve. This was entered in the corrective action system and actions are required to correct the associated documents, databases and labels as applicable.
8. DEK will take actions needed to eliminate gas accumulations that were found during UT examinations of subject systems. The actions to be taken are still in development, but are expected to include some combination of installation of additional vent valves and procedure modifications to ensure systems are sufficiently filled after draining for maintenance. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation. The locations where gas accumulations were found that will be corrected include:

   - Train A ICS discharge piping near the containment penetration
   - Train A ICS discharge piping branch line associated with the full flow test line

- Caustic addition branch line to the ICS suction piping
- CVCS-RHR cross-connect piping from the RHR discharge piping
- RHR-to-Spent Fuel Pool interconnection branch line from the RHR discharge piping
- Train A RHR mini-flow recirculation branch line from the RHR discharge piping
- SI test line branch from the SI discharge piping
- Suction bypass branch to the SI suction piping
- RHR normal cooldown suction line from RCS loop A.

9. DEK will evaluate actions to address system high points that may not have an existing vent valve. The actions to be taken are still in development, but are expected to include some combination of installation of additional vent valves or procedure modifications to ensure systems are sufficiently filled after draining for maintenance. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation.
10. System modifications and operating practices will be evaluated to permit maintaining the containment sump suction piping between the first and second isolation valves (SI-350A/B and SI-351A/B) sufficiently full of water to prevent gas intrusion. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation or use other means to resolve the concern with gas at this location.
11. DEK will revise current fill and vent procedures to provide a means and acceptance criteria to ensure that piping is sufficiently full after system fill and vent. This may include confirmation by UT or other appropriate means.
12. DEK will revise current inservice test procedures to provide dynamic sweeping as part of the filling of the systems where needed to ensure systems are sufficiently full.
13. DEK plans to establish requirements for periodic monitoring of gas accumulation at KPS. The exact locations to be monitored, the methods to be used, and appropriate procedures will be approved. Monitoring will be performed quarterly.

III. CORRECTIVE ACTION SCHEDULE

A. Summarize the corrective actions that have been completed as a result of the evaluations discussed above.

1. A calculation was developed to identify the maximum potential void volumes at local high point locations and in valve bonnets in the SI, RHR and ICS systems. This calculation used measured piping slopes, existing vent valve locations, and valve design information to determine maximum potential void volumes after static venting.
2. During review of the drawings a preliminary determination was made of piping that might be subject to gas accumulation during operation. A representative sample of high points without vents was selected for Ultrasonic Testing (UT) examination at the start of the KPS spring 2008 refueling outage (KR 29) to check for the presence of gas voids. The UT examinations resulted in the discovery of a void at one location. This location was in the RHR suction piping from the Reactor Coolant loop, between the first and second isolation valves (RHR-1A and RHR-2A). This location was filled and vented prior to placing the RHR system in operation for KR 29. Monitoring is being performed at this location.
3. During the drawing review, it was recognized that leakage of both check valves in each HHSI injection line could result in gas accumulation in the HHSI piping. A test procedure was developed and performed to measure leakage of both check valves in series in each injection line.
4. Two new vent valves were installed on the RHR suction line from the RCS during KR 29. These vent valves were installed to facilitate filling the piping following RHR pump maintenance.
5. To confirm that the discharge piping of the RHR system was sufficiently full, test procedures were developed and performed. Discharge pressure was monitored during the start of the RHR pumps for each LHSI train. It was confirmed that the maximum pressure peak above the steady state discharge pressure of the pump was not excessive.

B. Summarize the corrective actions to be completed including the scope, schedule, and a basis for that schedule.

1. DEK will develop and implement a TRM and TRM Bases section similar to NUREG-1431 SR 3.5.2.3 and LCO 3.6.6. This TRM section will require that the applicable portions of the subject systems are maintained sufficiently full of water to reliably perform their intended safety function and accessible portions of the

subsystems susceptible to gas intrusion are verified sufficiently full of water on a quarterly basis.

Schedule: This action will be complete by January 30, 2009.

Basis: Technical evaluations and field verification activities performed in support of the GL 2008-01 response have demonstrated system operability and monitoring actions are in place where required. The timeframe for completion of these additional licensing basis requirements are consistent with the proposed surveillance frequency.

This TRM section will be deleted if KPS Technical Specifications are amended in the future to address this requirement.

2. The KPS USAR will be revised to reflect that the applicable portions of the subject systems must be verified sufficiently full of water following the opening of the systems for maintenance or testing, and by periodic monitoring of the accessible portions of the subject systems susceptible to gas intrusion, consistent with the guidance of GL 2008-01 and the supporting analysis.

   Schedule: This action will be complete within 6 months of the next KPS refueling outage KR 30 (Fall of 2009).

   Basis: The recent evaluations and actions performed in support of the GL 2008-01 response have demonstrated system operability. Changes to the USAR clarify licensing basis requirements and should be accomplished in an orderly manner consistent with the applicable USAR update cycle.

3. The USAR will be revised following completion of the evaluation to change the design or operating practices to maintain the containment sump suction piping between valves SI-350A/B and SI-351A/B sufficiently full of water, consistent with the guidance of GL 2008-01 and the supporting analysis, if applicable design bases are changed.

   Schedule: This action will be complete within 6 months of the next KPS refueling outage KR 30 (Fall of 2009).

   Basis: Incorporation of design changes into the USAR is a programmatic requirement contained within the design change program. Anticipated design changes will require KPS to be in a shutdown condition. Associated changes to the USAR should be accomplished in an orderly manner consistent with the applicable USAR update cycle.

4. DEK will monitor the status of the industry/NRC Technical Specifications Task Force (TSTF) Traveler to be developed as a follow-up to GL 2008-01. Following NRC approval of this TSTF, DEK will evaluate adopting it.

   Schedule: The completion date for this action is dependent on NRC approval of the TSTF. DEK evaluation of the TSTF and any subsequent TS submittal to supplement or replace the current TS or TRM will be completed within twelve months of NRC approval of the TSTF.

   Basis: The completion date for this action is dependent on the NRC approval of the TSTF. This action will require significant effort by both the industry and NRC. Until the TSTF is approved no specific target date for completion can be made.

5. DEK will monitor the results of industry testing and analytical programs related to gas accumulation and pump suction acceptance criteria to determine if any changes to KPS licensing basis documents are required.

   Schedule: The completion date for this action is dependent on completion of the industry testing and analytical programs, which are not presently defined.

   Basis: Completion of the industry testing and analytical programs will require an extended period and significant industry funding. While the programs may provide additional information, the existing acceptance criteria in place for Kewaunee are considered conservative. The acceptance criteria are based on historical results and empirical testing that has been documented as meeting the design requirements.

6. The existing design basis calculations for assuring adequate NPSH margin for the SI, RHR and ICS pumps during alignment to the RWST do not specifically include consideration of air ingestion effects resulting from pump recirculation flows. The existing calculations may require revision to document the potential effects of air ingestion from recirculation flows into the RWST.

   Schedule: Complete by January 30, 2009.

   Basis: The completion of this activity is dependent on identification and analysis of sufficient test data to adequately characterize the hydraulic behaviors and determine if NPSH or vortexing would be impacted. Sufficient time is required to research this condition, and, if necessary, develop and approve a safety related calculation to document the results.

7. A manual RHR system valve was identified as a vent valve on the P&ID and equipment database, but is installed on the bottom of the pipe. The system isometric drawing correctly showed the actual location of this valve. This was entered in the corrective action system and actions are required to correct the associated documents, databases and labels as applicable.

   Schedule: Complete by January 30, 2009.

   Basis: The completion of this activity has no significant impact to the operation of the facility. The proposed date provides sufficient time for processing the changes.

8. DEK will take actions needed to eliminate gas accumulations that were found during UT examinations of subject systems. The actions to be taken are still in development, but are expected to include some combination of installation of additional vent valves and procedure modifications to ensure systems are sufficiently filled after draining for maintenance. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation.

   The locations where gas accumulations were found that will be corrected include:

   - Train A ICS discharge piping near the containment penetration
   - Train A ICS discharge piping branch line associated with the full flow test line
   - Caustic addition branch line to the ICS suction piping
   - CVCS-RHR cross-connect piping from the RHR discharge piping
   - RHR-to-Spent Fuel Pool interconnection branch line from the RHR discharge piping
   - Train A RHR mini-flow recirculation branch line from the RHR discharge piping
   - SI test line branch from the SI discharge piping
   - Suction bypass branch to the SI suction piping
   - RHR normal cooldown suction line from RCS loop A.

   Schedule: Complete prior to the end of the next refueling outage KR 30 (Fall of 2009).

   Basis: Sufficient time is required for design change development, material procurement, and work order planning. KR 30 is the first available planned shutdown to install these vent valves. The current system has minor gas accumulation areas that are being monitored and do not represent a challenge to operability.

9. DEK will evaluate actions to address system high points that may not have an existing vent valve. The actions to be taken are still in development, but are expected to include some combination of installation of additional vent valves or procedure modifications to ensure systems are sufficiently filled after draining for maintenance. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation.

   Schedule: Complete prior to the end of the next refueling outage KR 30 (Fall of 2009).

   Basis: Sufficient time is required for thorough evaluation and development of the appropriate actions, potential design change, material procurement, and work order planning. The refueling outage is the first available planned shutdown to install these vent valves. There are currently no gas accumulations known to exist at these locations, although some are not accessible for UT examination.

10. System modifications and operating practices will be evaluated to permit maintaining the containment sump suction piping between the first and second isolation valves (SI-350A/B and SI-351A/B) sufficiently full of water to prevent gas intrusion. Alternatively, DEK may choose to revise design basis documents to establish new allowable design basis limits on gas accumulation or use other means to resolve the concern with gas at this location.

    Schedule: Complete prior to the end of the next refueling outage KR 30 (Fall of 2009).

    Basis: Sufficient time is required for thorough evaluation and development of the appropriate, potential design change, material procurement, and work order planning. Evaluations have determined that the containment sump recirculation system is operable with the current system arrangement.

11. DEK will revise current fill and vent procedures to provide a means and acceptance criteria to ensure that piping is sufficiently full after system fill and vent. This may include confirmation by UT or other appropriate means.

    Schedule: Complete by October 1, 2009.

    Basis: This due date will ensure the revised procedures are available for their next scheduled use during the refueling outage in 2009.

12. DEK will revise current inservice test procedures to provide dynamic sweeping as part of the filling of the systems where needed to ensure systems are sufficiently full.

    Schedule: Completed prior to October 1, 2009.

    Basis: The addition of dynamic sweeps will further assure that the systems are sufficiently full prior to operation. This due date will ensure the revised procedures are available for use during the refueling outage in 2009.

13. DEK plans to establish requirements for periodic monitoring of gas accumulation at KPS. The exact locations to be monitored, the methods to be used, and appropriate procedures will be approved. Monitoring will be performed quarterly.

    Schedule: Monitoring requirements will be developed and implemented by January 30, 2009.

    Basis: Recent UT examinations that were performed after over 130 days of plant operation provide assurance that existing gas intrusion sources are known and have not impacted system operability. Where needed, monitoring has already been implemented to monitor and control known gas intrusion sources. Therefore, additional quarterly monitoring will provide reasonable assurance that newly developing gas intrusion mechanisms are identified before system operability is affected.

CONCLUSION

DEK has evaluated the accessible portions of those KPS systems that perform the functions described in this GL and has concluded that these systems are Operable, as defined in the KPS TS and are in conformance to our commitments to the applicable General Design Criteria (GDC), as stated in the KPS USAR.

The open actions cited above are considered to be enhancements to the existing programs/processes/procedures for assuring continued Operability of these subject systems.

References

1. License No. DPR-43, Kewaunee Power Station Facility Operating License as Amended (Amendment 198), dated August 22, 2008.
2. Kewaunee Power Station Updated Safety Analysis Report (Revision 20 – Version 2), dated July 9, 2008, and approved changes through October 6, 2008.
3. Letter from P. A. Morris (AEC) to E. W. James (WPSC), requesting additional information pursuant to the Kewaunee Power Plant Application for Construction Permit and Operating License, dated July 9, 1971.
4. Letter from E. W. James (WPSC) to P. A. Morris (AEC), "Amendment No. 10 to the Application for Construction Permit and Operating License for the Kewaunee Nuclear Power Plant," dated September 15, 1971.
5. Kewaunee Power Station Technical Requirements Manual (Rev. 24), dated August 28, 2008.
6. NRC Generic Letter 1988-17, "Loss of Decay Heat Removal," dated October 17, 1988.
7. Letter from D. C. Hintz (WPSC) to Document Control Desk (NRC), "Response to Generic Letter 88-17," dated January 3, 1989.
8. Letter from D. C. Hintz (WPSC) to Document Control Desk (NRC), "Response to Generic Letter 88-17," dated February 2, 1989.
9. Letter from K. H. Evers (WPSC) to Document Control Desk (NRC), "Response to Generic Letter 88-17," dated January 30, 1990.
10. NRC Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," dated August 17, 1995.
11. Letter from C. R. Steinhardt (WPSC) to Document Control Desk (NRC), "Response to Request for Additional Information – Generic Letter 95-07," dated July 18, 1996.
12. Letter from R. L. Laufer (NRC) to M. L. Marchi (WPSC), "Safety Evaluation of Licensee Response to Generic Letter 95-07, 'Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves,' for the Kewaunee Nuclear Power Plant (TAC No. M93475)," dated January 13, 1998.
13. Letter from C. D. Pederson (NRC) to DA Christian (DEK), "Kewaunee Power Station – NRC Supplemental Inspection Report 05000305/2007011-04," dated February 1, 2008.
14. NRC Generic Letter 96-06, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," dated September 30, 1996.

15. NRC Generic Letter 96-06 Supplement 1, "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions," dated November 13, 1997.

16. Letter from C. R. Steinhardt (WPSC) to Document Control Desk (NRC), "Generic Letter 96-06," dated November 20, 1997.

17. Letter from C. F. Lyon (NRC) to T. Coutu (NMC), "Kewaunee Nuclear Power Plant – Completion of Licensing Action for Generic Letter (GL) 96-06, Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions (TAC No. M96824)," dated September 22, 2004.

18. NRC Generic Letter 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," dated October 7, 1997.

19. Letter from C. R. Steinhardt (WPSC) to Document Control Desk (NRC), "Wisconsin Public Service Corporation's (WPSC's) 90-Day Response to Generic Letter 97-04," dated January 5, 1998.

20. NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors," dated September 13, 2004.

21. Letter from G. T. Bischof (DEK) to Document Control Desk (NRC), NRC Generic Letter 2004-02 Supplemental Response – Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors, dated February 29, 2008.

22. NUREG/CR-2792, "An Assessment of Residual Heat Removal and Containment Spray Pump Performance Under Air and Debris Ingesting Conditions," dated September 1982.