ATTACHMENT 71111.07

INSPECTABLE AREA: Heat Sink Performance

CORNERSTONES: Initiating Events
Mitigating Systems
Barrier Integrity

INSPECTION BASES: Heat exchangers and heat sinks are required to remove decay heat, and provide cooling water for risk significant or safety related equipment. Degradation in performance can result in failure to meet system success criteria, and lead to increased risk primarily due to common cause failures. This inspectable area verifies aspects of the associated cornerstones for which there are no indicators to measure performance.

LEVEL OF EFFORT: The effort of this procedure consists of the review of a sample of one or two heat exchangers/sinks, on an annual basis, in accordance with the requirements specified in Section 02.01. On a triennial basis, review a sample of two or three heat exchangers/ heat sinks in accordance with the requirements in Section 02.02.

71111.07-01 INSPECTION OBJECTIVES

01.01 To verify that any potential heat exchanger deficiencies which could mask degraded performance are identified. Applies to all risk significant or safety related heat exchangers directly or indirectly connected to service water systems or the ultimate heat sink (UHS), including heat exchangers in closed cooling water systems.

01.02 To verify that any potential common cause heat sink performance problems that have the potential to increase risk are identified, i.e., icing at circulating and service water intake structures.

01.03 To verify that the licensee has adequately identified and resolved heat sink performance problems that could result in initiating events or affect multiple heat exchangers in mitigating systems and thereby increase risk, i.e., component cooling water heat exchanger performance affected by corrosion, fouling, or silting.

71111.07-02 INSPECTION REQUIREMENTS

When scheduling this inspection, inspectors should consider refueling outage and at-power maintenance schedules. The review should be to identify opportunities to observe infrequent activities associated with risk significant heat exchangers or service water inspections/testing (heat exchanger inspections and testing, internal service water pipe inspections).

02.01 Annual Review. Verify the readiness and availability of a sample of one or two heat exchangers/sinks by monitoring licensee programs, or invoking industry standards, and also, if necessary, checking critical operating parameters, and/or maintenance records. The readiness and availability of the sample of heat exchangers/heat sinks may be verified by one of the items a. through d. below. Items e. and f. may be performed as additional assurance of the heat exchanger(s) operability.

a. Observe actual performance tests for heat exchanger/sinks or review the data/reports for those tests for any obvious problems or errors.

b. Verify the licensee utilizes the periodic maintenance method outlined in EPRI NP-7552.

c. Observe licensee's execution of biofouling controls.

d. Observe the licensee's heat exchanger inspections and the state of cleanliness of their tubes.

e. Check, by either a walkdown or the review of operations data, any or all of the following:

   1. The heat exchanger's inlet and/or outlet temperatures.

   2. Primary or secondary side fluid flow.

   3. If there are any evident leaks.

   4. Verify whether the heat exchanger can perform its safety related or risk significant function by assessing documentation or results of licensee inspections.

   5. Compare end bell orientation of one heat exchanger to the orientation of a similar redundant train heat exchanger, to confirm proper orientation.

f. Determine if heat exchanger is correctly categorized under the Maintenance Rule and verify if it is receiving the required maintenance.

02.02 Triennial Review

a. Select a sample of 2-3 heat exchangers and/or heat sinks for systems that are ranked high in the plant specific risk assessment. This includes all risk significant or safety related heat exchangers or UHS.

b. For the selected heat exchangers that are directly cooled by the service water system, verify that testing, inspection, maintenance, and monitoring of biotic fouling and macrofouling programs are singularly or in combination adequate to ensure proper heat transfer.

   1. Review the method and results of heat exchanger performance testing or equivalent methods to verify performance. Verify the following items, as applicable:

      (a) The selected test methodology is consistent with accepted industry practices, or equivalent.

      (b) Test conditions (e.g., differential temperatures, differential pressures, and flows) are consistent with the selected methodology.

      (c) Test acceptance criteria (e.g., fouling factors, heat transfer coefficients) are consistent with the design basis values.

(d) Test results have appropriately considered differences between testing conditions and design conditions (functional testing at design heat removal rate may not be practical).

(e) Frequency of testing based on trending of test results is sufficient (based on trending data) to detect degradation prior to loss of heat removal capabilities below design basis values.

(f) Test results have considered test instrument inaccuracies and differences.

(g) Tube and shell side heat loads are equal if adequate information is available in test results to calculate these two values.

2. For inspection/cleaning, review the methods and results of heat exchanger performance inspections or observe the actual inspection/ cleaning. Verify the following first three steps ((a)-(c)) if conducting the review and the last step (d) only if actually observing the inspection/cleaning:

(a) Methods used to inspect and clean heat exchangers are consistent with as-found conditions identified and expected degradation trends and industry standards.

(b) Inspection and cleaning activities have established acceptance criteria, and are consistent with industry standards.

(c) As found results are recorded, evaluated, and appropriately dispositioned such that the as-left condition is acceptable.

If observing the inspection/cleaning then perform the following:

(1) Prior to cleaning, inspect the extent of fouling and blockage of tubes.

(2) Inspect the condition of the cleaned surfaces.

(3) Verify that the actual number of installed tube plugs agree with the recorded tube plug data, as documented in controlled drawings and heat transfer calculations.

(4) Verify that both ends of the same tube are plugged.

(5) Look for indications of macrofouling, including live or dead mussels and clams, plant material, or silt.

(6) Verify end bell and flange gaskets are properly installed.

(7) Verify end bell orientation is correct after final installation.

3. Verify condition and operation are consistent with design assumptions in heat transfer calculations, and as described in the final safety analysis report.

4. Verify licensee has evaluated the potential for water hammer in susceptible heat exchangers and undertaken appropriate measures to address it.

5. Verify adequate controls and operational limits are in-place to prevent heat exchanger degradation due to excessive flow induced vibration during operation.

6. Review, if available, periodic flow testing at or near maximum design flow for redundant and infrequently used heat exchangers.

7. Verify that the number of plugged tubes are within pre-established limits, based on heat transfer capacity and design heat transfer assumptions, and are appropriately accounted for in heat exchanger performance calculations.

8. Review, if available, eddy current test reports and visual inspection records, to determine the structural integrity of the heat exchanger.

c. For the selected heat exchangers that are directly cooled by a closed loop cooling water system (e.g., Residual Heat Removal (RHR) heat exchangers indirectly cooled by the service water system, or directly cooled by an air radiator), verify the following items:

1. Condition and operation are consistent with design assumptions in heat transfer calculations.

2. Licensee has evaluated the potential for water hammer in susceptible heat exchangers and undertaken appropriate measures to address it.

3. Verify adequate controls and operational limits are in-place to prevent heat exchanger degradation due to excessive flow induced vibration during operation.

4. Verify chemical treatment programs for corrosion control were consistent with industry standards, and are controlled, tested, and evaluated.

5. Review, if available, periodic flow testing at or near maximum design flow for redundant and infrequently used heat exchangers.

6. Verify that the number of plugged tubes are within pre-established limits, based on heat transfer capacity and design heat transfer assumptions, and are appropriately accounted for in heat exchanger performance calculations.

7. Review, if available, eddy current test reports and visual inspection records, to determine the structural integrity of the heat exchanger.

d. Verify the performance of ultimate heat sinks (UHS) and their subcomponents like piping, intake screens, pumps, valves, etc. by tests or other equivalent methods. For heat sinks, the issue is their availability and accessibility to the in-plant cooling water systems.

The inspector should check at least two of the following for heat sinks and their subcomponents as applicable. (For plants that have dams or other containment devices for the UHS, items 1 or 2 below must be checked every other triennial assessment.)

1. For an above-ground UHS encapsulated by embankments, weirs or excavated side slopes:

(a) The toe of the weir or embankment should be checked for seepage of water and the crest of the dam should be checked for settlement.

(b) The rip rap protection placed on excavated side slopes should be in place. Ensure that if vegetation is present along the slopes that it is trimmed, maintained and is not, or has not, adversely impacted the embankment.

(c) If available, review the licensee or third party dam inspections that monitor the integrity of the heat sink.

(d) Verify sufficient reservoir capacity.

2. For underwater UHS weirs or excavations, perform or verify visual or other inspections have been performed to check for:

(a) Any possible settlement or movement indicating loss of structural integrity and/or capacity.

(b) Sediment intrusion that may reduce capacity.

3. For an UHS such as a forced draft cooling tower or spray pond, perform a system walkdown. Verify the following items, as applicable:

(a) Sufficient reservoir capacity.

(b) Periodic monitoring and trending of sediment build-up.

(c) Adjacent non-seismic or non-safety related structures cannot degrade or block safety-related flow paths, during a severe weather or seismic event.

(d) Periodic performance monitoring of heat transfer capability.

(e) Periodic performance monitoring of the UHS structural integrity.

4. Review operation of service water system and UHS.

(a) Review design changes to the service water system and the UHS.

(b) Review licensee procedures for a loss of the service water system or UHS. Verify that instrumentation, which is relied upon for decision making, is available and functional.

(c) Review licensee controls to prevent clogging due to macrofouling. Verify that macrofouling is adequately monitored, trended, and controlled, consistent with maintenance program frequencies and assumptions.

(d) If applicable, verify biocide treatments, for biotic control, were conducted as scheduled, controlled, and the results monitored, trended, and evaluated.

(e) For fixed volume UHS (i.e., not a river, lake, or ocean), verify adequate chemistry monitoring to ensure adequate pH, calcium hardness, etc. are maintained.

(f) Strong-pump weak-pump interaction. For susceptible system designs, verify the licensee monitors pump performance for potential strong-pump weak-pump interaction, during routine system operation and testing, and following pump maintenance.

5. Review performance testing of service water system and UHS.

   (a) Review performance tests, such as ASME inservice tests, for a sample of pumps, tower fans, and valves in service water system.

   (b) Review service water flow balance test results for adverse effects.

   (c) Interface valves between safety-related service water and non-safety related (i.e., non-ASME Class 3) or non-seismic piping systems, should be periodically tested, inspected, or monitored to verify adequate isolation during a design basis event. Verify that the licensee's methodology is adequate for the leakage rate assumptions in their design basis (i.e., flow divergence or UHS total volume).

   (d) Verify performance of risk significant non-safety related functions, such as back-up cooling to turbine building or reactor building closed cooling water systems, air compressors, or turbine driven auxiliary feedwater systems.

6. Perform a system walkdown on service water and/or closed cooling water systems. Verify the following items, as applicable:

   (a) For buried or inaccessible piping, review the licensee's pipe testing, inspection, or monitoring program to verify structural integrity, and ensure that any leakage or degradation has been appropriately identified and dispositioned.

   (b) Review, if available, ultrasonic test results and/or visual inspections to determine the structural integrity of the piping.

   (c) Review licensee's disposition of any active thru wall pipe leaks, including completed or planned corrective actions and structural evaluations.

   (d) Review history of thru wall pipe leakage to identify any adverse trends since the last NRC inspection (i.e., about two to three years).

   (e) For closed cooling water systems, the walkdown should include the head or surge tank. Review operating logs or interview operators or system engineer, to identify adverse make-up trends that could be indicative of excessive leakage out of the closed system

   (f) Review the periodic inspection program used to detect protective coating failure, corrosion, and erosion, as applicable.

   (g) For deep draft vertical pumps, review operational history and IST vibration monitoring results for adverse trends.

7. Perform a walkdown of the service water intake structure. Verify the following items, as applicable:

(a) Proper functioning of traveling screens (typically non-safety related) and strainers (typically safety related), including strainer backwash function.

(b) Structural integrity of component mounts has not degraded (i.e., due to excessive corrosion).

(c) Service water pump bay silt accumulation is monitored, trended, and maintained at an acceptable level.

(d) Service water pump bay water level instruments are functional and routinely monitored.

(e) Assess functionality during adverse weather conditions (e.g. algae bloom, grass intrusion, storm debris, icing, frazil ice formation, high temperatures, etc.). If the facility is located in an area that is susceptible to frazil ice, then assess licensee's ability to identify or mitigate frazil ice conditions.

(f) For underwater weir walls, intended to limit silt or sand intake, verify whether water could flow around, rather than over, the weir wall during periods of river or lake low water level. Verify that the licensee has evaluated the potential of silt introduction during periods of low flow/level or that the height of the wall is appropriate.

02.03 Identification and Resolution of Problems. Verify that the licensee has entered significant heat exchanger/sink performance problems in the corrective action program. Significant problems include degraded heat exchanger/sink performance, silting, water hammers, voiding, corrosion, fouling, and heat exchanger testing. Verify that the licensee's corrective actions are appropriate. See Inspection Procedure 71152, "Identification and Resolution of Problems," for additional guidance.

71111.07-03 INSPECTION GUIDANCE

General Guidance

Refer to the table below for selecting inspection activities to achieve each cornerstone objective and to those activities that have a risk priority (i.e., those common-cause failures with a reasonable probability of occurring should be targeted by inspection to determine impact on cornerstones).

Cornerstone	Inspection Objective	Risk Priority	Example
Initiating Events	Evaluate events, issues, or conditions involving the degradation or loss of both the normal and ultimate heat sinks.	Common-cause issues affecting heat removal capabilities.	Icing of a circulating water and service water intake structure.
Mitigating Systems/ Barrier Integrity	Evaluate any potential degraded performance of heat exchangers/ containment fan coolers	Heat exchanger selection should focus on the potential for common-cause failures or on potentially high risk heat exchangers with a low margin to their design point or the high potential for fouling.	Degraded containment cooling or component cooling water heat exchanger performance due to corrosion, fouling, silting, etc.

Specific Guidance

03.01 Annual Review

This inspection should encourage the timely identification of heat exchanger/sink performance problems so the licensee may take prompt corrective actions.

- The heat exchangers/sinks should be ranked high in the plant specific risk assessment. This includes all risk significant or safety related heat exchangers/sinks.

- The inspection activities in some cases may be the same as those in Section 02.02 but the inspection should not be conducted at the same level of detail or depth.

- Inspection results are appropriately categorized against pre-established engineered acceptance criteria, and are acceptable.

- Frequency of testing or inspection is sufficient (given the potential for fouling) to detect degradation prior to loss of heat removal capabilities below design basis values.

a. These tests should be those typically sanctioned by industry. Test acceptance criteria and results have appropriately considered differences between testing conditions and design conditions (functional testing at design heat removal rate may not be practical); and the test results have appropriately considered test instrument inaccuracies and differences.

b. No specific guidance

c. The licensee should have an acceptance criteria for its bio-fouling controls that is based on an industry standard, supportive program results, or the recommendation of the appropriate vendors.

d. Primarily focus on whether the number of tubes plugged affects the heat exchanger's operability and not the biofilm on the inside of tubes which should be covered in the triennial inspection by a specialist. The licensee should have an acceptance criteria that indicates the maximum number of tubes that may be clogged for a specific heat exchanger and a basis for that acceptance criteria.

e. (1- 4) No specific guidance.

5. Improper end bell orientation can significantly reduce or isolate flow to an otherwise functional heat exchanger.

03.02 Triennial Review

a. There is no limitation on the type and size of heat exchangers that can be selected as long as they are risk significant or safety related. The selection of the heat exchanger/sink also should consider results from previous annual inspections and heat exchangers with a history of problems/extensive corrective actions.

b. This inspection requirement should target those risk significant or safety related heat exchanges that are directly cooled by the service water system (e.g., those cooled directly by raw water).

1. No specific guidance.

(a-c) No specific guidance.

(d) Test results need to be extrapolated to the heat exchanger design conditions.

(e) Trending of the results of heat exchanger performance tests should not have abrupt step changes without the licensee providing some valid justification as to the reason for the deviation.

(f) Test instruments should be calibrated and set on appropriate range for the parameters to be measured; otherwise small measurement errors could affect the test results. The required accuracy of the instruments depends on the margins available between the calculated parameter based on the test results and the limiting design condition.

(g) No specific guidance.

2. The inspector can refer to either design assumptions in calculations or parameters on design data sheets that can be evaluated by observation, review of licensee inspection records, or review of procedural operation limits.

(a) Methods are adequate, based on identified degradation trends, if they ensure no loss of capability between scheduled inspections or cleanings. Methods should be consistent with the guidance in EPRI NP-7552.

(b) Acceptance criteria considers fouling factor and heat transfer coefficient, consistent with design assumptions and as-found conditions. The inspection and cleaning frequency is consistent with as-found conditions and identified trends. Based on the inspection and/or cleaning frequency, and the identified trends, the acceptance criteria is adequate to ensure no loss of capability during scheduled in-service period.

(c) Changes in trends are identified and evaluated. The licensee has evaluated the as-left condition and determined, based on frequency and trend, the heat exchanger would remain operable (or identified limitations to ensure operable but degraded) through the in-service period until the next inspection.

(d) No specific guidance

(1) No specific guidance.

(2) Inspect surface preparations.

(3-4) No specific guidance.

(5) Indications of macrofouling include accumulation of silt or sediment, live or dead mussels or clams, aquatic material (e.g., fish, algae, grass, kelp, etc.), and foreign material from maintenance or construction activities (i.e., gasket material or other debris).

(6) Verify the use of sealants in combination with gaskets.

(7) Improper end bell orientation can significantly reduce or isolate flow to an otherwise functional heat exchanger.

3. The inspector can refer to either design assumptions in calculations or parameters on design data sheets that can be evaluated by observation, review of licensee inspection records, or review of procedural operating limits. Verify that the as-found condition of the heat exchanger tube inner surfaces is consistent with the fouling factor used in design calculations, or credited in design basis documents or Updated Final Safety Analysis Report (UFSAR).

4. Heat exchangers susceptible to water hammer include:

- Heat exchangers kept isolated in standby or dry lay-up.
- Heat exchangers that can partially drain during design basis events (i.e., loss of offsite power (LOOP) or loss of coolant accident (LOCA)), such as containment air coolers.
- Containment heat exchangers following station blackout or other event where flow is temporarily stopped.

5. Heat exchangers that exhibit excessive flow induced vibration may be susceptible to potential damage to their tubes or tube sheets. Such heat exchangers may be identified based on:

- Direct observation during high flow conditions (i.e., tube rattle).
- Issues identified in corrective-action documents (e.g., vibration during operation, unexpected or excessive tube damage).
- Issues identified during interviews of licensee staff.

- Administrative limits procedurally established to limit flow according to manufacturer's recommendations or engineering calculations.

Additionally, review system flow balance results and individual heat exchanger flow data. Verify the licensee is maintaining the calculated flow through each heat exchanger.

6 - 8. No specific guidance.

c. This inspection requirement should target those risk significant or safety related heat exchanges that are cooled by closed cooling water systems (e.g., RHR heat exchangers not directly connected to the service water system).

These heat exchangers are directly cooled by a closed cooling water system, and either indirectly cooled by the service water system, or cooled directly by an air radiator. Examples of risk significant or safety related heat exchangers that are air cooled at some nuclear plants (i.e., no reliance on the service water system or UHS) include station blackout diesel generator, emergency diesel generator, or instrument air compressors.

1. The inspector can refer to either design assumptions in calculations or also parameters on design data sheets that can be evaluated by observation, review of licensee inspection records, or review of procedural operating limits.

2. Heat exchangers susceptible to water hammer include:

   - Heat exchangers kept isolated in standby or dry lay-up.

   - Heat exchangers that can partially drain during design basis events (i.e., LOOP or LOCA), such as containment air coolers.

3. Heat exchangers that exhibit excessive flow induced vibration may be susceptible to potential damage to their tubes or tube sheets. Such heat exchangers may be identified based on:

   - Direct observation during high flow conditions (i.e., tube rattle).

   - Issues identified in corrective-action documents (e.g., vibration during operation, unexpected or excessive tube damage).

   - Issues identified during interviews of licensee staff.

   - Administrative limits procedurally established to limit flow according to manufacturer's recommendations or engineering calculations.

4. Chemical treatment programs should be consistent with industry standards. Treatment results should be evaluated for adverse effects on heat exchangers or other system components, should consider stress corrosion cracking, and should conform to licensee established acceptance criteria. Chemical treatments should be conducted as scheduled, controlled, and the results monitored, trended, and evaluated.

5. Review system flow balance results and individual heat exchanger flow data. Verify the licensee is maintaining the calculated flow through each heat exchanger.

6 - 7. No specific guidance.

d. For this requirement focus on the credited water source as defined in 03.02a. above. The inspector should assess whether the ultimate heat sink and its subcomponents are capable of performing their intended risk significant or safety functions. Only two of the listed parameters which are applicable for the respective plant should be reviewed on a triennial basis. For plants that have dams or other containments for the UHS, the inspection frequency is no longer always optional. This is based on findings concerning capacity and structural integrity on a facility with an UHS dam. Consideration for more frequent inspection should be made if there is known or suspected degradation. If the UHS is not licensee owned, ensure advance notice is provided to allow preparations for visual inspection if desired.

1. Inspection of above ground UHS embankments, where they exist, should identify:

(a) Erosion which could lead to loss of structural integrity.

(b) Loss of shoreline protection can lead to a changing shoreline resulting in UHS capacity that is less than the design. Large vegetation, such as tree roots or burrowing animals can weaken the integrity of the embankments. Similarly, decayed tree roots can allow formation of a water channel in the embankment that weakens the integrity.

(c) If available, review licensee or third party dam inspections for integrity of heat sink.

(d) Changing shore lines or sediment intrusion can reduce UHS capacity. Lessons learned from plant inspections include: degradation of the shoreline by vegetation growth can cause compacted clay to degrade and slump into the heat sink reducing capacity, also an insufficient number of measurements taken of the depth of water may not identify significant debris or sediment build-up in the UHS.

2. Inspection of underwater UHS structures should identify settlement or movement indicating loss of structural integrity and/or capacity. The height of water over the crest of the weir should be constant in cases where the licensee takes these measurements to verify capacity.

3. No specific guidance.

4. No specific guidance.

(a) Review of changes or modifications should ensure that key design basis requirements were considered as inputs and maintained. Consideration may be given to reviewing planned modifications as well as age-related changes that have the potential to adversely impact the UHS design basis including intake structures, reservoir and dam material conditions.

(b) Procedures should include specific guidance for a loss of intake structure, loss of all service water pumps, or pipe rupture, as applicable. Intake bay water level instrumentation may be used by emergency operating procedures (EOPs) and Emergency Plan emergency action levels (EAL), during abnormal or emergency conditions. Verify that the locations for measuring the technical specification UHS water level and the emergency plan EAL UHS water level are effectively the same.

(c) This requirement can be satisfied by test results, observation, or other equivalent methods that verify ultimate heat sink and sub-components can accommodate maximum system flow. During 2004 to 2006, industry operating experience showed a number of events involving foreign material intrusion into the systems. These events included clogging of system piping, heat exchangers, strainers, and trash racks due to intrusion of aquatic life (e.g., fish, algae, grass, kelp, etc.), floating or submerged river debris, or entrained silt and sediment. Additional considerations include:

- Over-population of small fish that could be pulled into the system.
- Live or dead zebra mussels or asiatic clams.
- Other foreign material from maintenance or construction activities (i.e., gasket material, or other debris).

Generic Letter 89-13 recommended that once per refueling outage, a visual inspection for macroscopic biological fouling, sediment, and corrosion, and for removal of any accumulation. Some licensees have made commitments pursuant to Generic Letter 89-13 to minimize the potential for clogging equipment.

Susceptible components may include:

- Heat exchangers with small diameter tubes, or small passages in flat plate style heat exchangers.
- Valves or heat exchangers with low velocity flow rates.
- Valves or heat exchangers in low elevation locations.
- Valves that are typically closed in dead legs.

(d) The biocide treatment program should be consistent with industry standards. Treatment results should be evaluated to ensure satisfactory biotic control, and should conform to licensee established acceptance criteria. In addition, microbiological induced corrosion (MIC) should be monitored, trended, and controlled.

(e) Inadequate chemistry monitoring or control can result in calcium plate-out on hot heat exchanger tubes during a design basis event. Langeliers Index is a common water quality chemistry analysis which can be used to reduce the likelihood of degrading the heat transfer coefficient due to calcium deposits.

(f) Strong-pump weak-pump interaction guidance. System design is susceptible to strong-pump weak-pump interaction whenever two (or more) centrifugal pumps operate in parallel and share a common minimum flow line. If one of the pumps is stronger (i.e., has a higher developed head for the same flow rate) than the other, the weaker pump may be dead-headed when the pumps are operating under low flow conditions, such as the mini-flow mode. Compare vendor pump curves, or pump curves developed during system testing, for differences in pump discharge pressure at the same flow rates. Review licensee's response to Bulletin 88-04. During single pump testing, compare pump head at low flow rates. Review licensee's system hydraulic model, for assumptions on mini-flow, or case studies with parallel pumps operating in the mini-flow mode.

5. No specific guidance.

(a) The flushing and flow testing provisions of GL 89-13 also apply to service water cross-tie lines between units. In addition, verify that pump runout conditions are not present with minimum number of pumps operating with worst-case alignment on non-safety related loads. Refer to IP 71111.22, Surveillance Testing, for additional guidance.

(b) Compare flow balance results to system configuration and flow assumptions during design basis accident conditions. Verify that system flow balance data are consistent with key design assumptions, such as flow coefficients, pressure drops across components and piping during accident alignment configurations, rated heat removal flow rates, and total system flow specifications.

(c-d) No specific guidance

6. No specific guidance.

(a) Piping inspection and monitoring programs should include periodic checks of riser penetrations (e.g., a vertical pipe coming up through a cement floor or foundation), and should also include checks of inspection manways on large bore piping (e.g., where the manway attaches to the pipe).

(b-f) No specific guidance.

(g) Common deep draft vertical pump problems include:

- Shaft coupling failures due to corrosion.
- Corrosion of shaft ends and/or coupling bolts has led to elongation of shaft, and resulted in pump damage (IN 07-05).
- Shaft bearing cooling problems.
- Inability to detect pump degradation.
- Backward pump rotation with pump off or standby, can result in fatigue failure of shaft coupling when pump is started.

- Numerous failures have resulted from misalignment, imbalance, installation errors, and intergranular stress corrosion cracking (IGSCC).

- Operating experience includes Bulletin 79-15, and Information Notices 80-07, 93-68, 94-45, and 07-05.

7. No specific guidance.

(a) Review maintenance and operating history for the traveling screens and strainers to identify any adverse trends, such as repetitive shear pin failures. Also review history of trash rack blockage and trash rack cleaning frequency. Verify whether intake fouling or blockage has resulted in any reactor power reductions. Review operating and abnormal procedures to determine whether guidance permits strainer bypass, even for temporary periods, for corrective maintenance. If so, then independently review licensee's evaluation of this condition with regard to potential adverse impact on downstream structures, systems and components (SSCs), such as heat exchangers or coolers with small diameter tubes, because of fouling.

For strainers, key inspection items may include:

- Check whether operators monitor strainer motor running amperage and compare readings when clogging is suspected.

- Check how strainer backwash flow is verified, measured, or observed.

- Verify automatic strainer backwash is functional, if available. For those strainer systems which are not safety-related, ensure procedures address service water operability if these strainers become clogged during a loss of power event.

(b-c) Review the periodic inspection program for the service water intake structure (recommended by GL 89-13). The inspection program should include silt monitoring and verification of continued component structural integrity, including underwater components (i.e., vortex preventer, trash rack, etc.).

(d) Assess operational controls to prevent excessive drawdown of the service water intake bay water level, with associated loss of service water pump suction because of clogging, fouling, or blockage of screens or racks. Operators should be able to identify lowering intake bay level before the emergency plan emergency action level (EAL) value is reached. Abnormal operating procedure should direct sequential steps (e.g., sequential tripping of service water or circulating water pumps, or reducing reactor power) prior to reaching the EAL action level. Review should include indication, annunciation, and manual operator actions (operator response) for traveling screens, trash racks, and circulating water pumps.

(e) This inspection requirement should determine whether licensee has procedures to deal with adverse weather conditions. Coordinate the performance of this step with the inspection requirements of IP 71111.01, "Adverse Weather Protection." This inspection should also verify the UHS water temperature is monitored and has not exceeded licensing or design basis limiting values. Causal factors that have resulted in intake structure blockage have included environmental changes, such as storm and wind effects, aquatic life, frazzle ice, sand, silt, and crude oil from spills.

Conditions which may allow frazil ice formation include:

- Water temperature near freezing.
- Intake water level low.
- Windy conditions.
- No ice cap on river or lake.

(f) No specific guidance.

03.03 Identification and Resolution of Problems

The inspector should focus on events or conditions that could cause the loss of a heat exchanger/sink due to events such as heat transfer problems, improper cleaning, ice buildup, grass intrusion, or blockage of pipes and components. The inspector should determine whether the licensee has appropriately considered common-cause failures. If any loss of heat exchanger/sink events have occurred, these should receive the priority for review. Review the corrective actions to determine if actions were sufficient to prevent recurrence of the problem. Refer to IP 71152, "Identification and Resolution of Problems," for further guidance in this area.

71111.07-04 RESOURCE ESTIMATES

This inspection procedure is estimated to take, on average, 5 to 7 hours for an annual review and 34 to 46 hours for a triennial review at a site regardless of the number of units at that site. These estimates depend on the number of heat exchangers/sinks tested by the licensee during the inspection period.

71111.07-05 PROCEDURE COMPLETION

Inspection of the minimum sample size will constitute completion of this procedure in the Reactor Programs Systems (RPS). That minimum sample size will consist of one sample, on an annual basis, to verify the readiness/availability of one heat exchanger/sink per Section 02.01, and two samples, on a triennial basis, to verify the heat exchanger/sink performance in accordance with Section 02.02.

71111.07-06 REFERENCES

EPRI NP-7552 Heat Exchanger Performance Monitoring Guidelines (Call the NRC Technical Library to get a copy of this if needed.)

EPRI TR-106438	Water Hammer Handbook for Nuclear Plant Engineers (Call the NRC Technical Library to get a copy of this if needed.)
TEMA Standards	Standards of the Tubular Exchanger Manufacturers Association
ASME OM-S/G Part 21	Inservice Performance Testing of Heat Exchangers in Light-Water Reactor Power Plants
NUREG 1275 Vol. 3	Operating Experience Feedback Report- Service Water System Failures and Degradations
NUREG/CR-5865	Generic Service Water System Risk-Based Inspection Guide
NUREG/CR-0548	Ice Blockage of Water Intakes
Generic Letter 89-13	Service Water System Problems Affecting Safety-Related Equipment
Generic Letter 91-13	Request for Info Related to the Resolution of GI 130, "Essential Service Water System Failures at Multi-Unit Sites"
Generic Letter 96-06	Assurance of Equipment Operability and Containment Integrity During Design-basis Accident Conditions
Generic Letter 96-06 Supplement 1	Assurance of Equipment Operability and Containment Integrity During Design-basis Accident Conditions
Bulletin 79-15	Deep Draft Pump Deficiencies
Bulletin 88-04	Potential Safety-Related Pump Loss [strong-pump to weak-pump interaction, and minimum flow requirements]
IN 80-07	Pump Shaft Fatigue Cracking
IN 93-68	Failure of Pump Shaft Coupling Caused by Temper Embrittlement
IN 94-45	Potential Common-Mode Failure for Large Vertical Pumps
IN 2004-07	Plugging of Safety Injection Pump Lubrication Oil Coolers with Lakeweed
IN 2006-17	Recent Operating Experience of Service Water Systems due to External Conditions
IN 2007-05	Vertical Deep Draft Pump Shaft and Coupling Failures
IN 2007-06	Potential Common Cause Vulnerabilities in Essential Service Water Systems
RG 1.127	Inspection of Water-Control Structures Associated with Nuclear Power Plants

See the following web links for reference documents:

http://www.internal.nrc.gov/IRM/LIBRARY/standards/ihs.htm

http://www.internal.nrc.gov/IRM/LIBRARY/library.htm

http://nrr10.nrc.gov/rorp/ip71111-07.html

END

Attachment 1 - Revision History for IP 71111.07

Commitment Tracking Number	Issue Date	Description of Change	Training Required	Training Completion Date	Comment Resolution Accession Number
	05/25/06	Researched commitments back four years - none found.	None	N/A	N/A
	05/25/06	Revised to incorporate lessons learned from ANO inspection regarding UHS dam integrity (report number 2005008); FB-937. Inspections of the UHS water reservoir is required every other biennial inspection. Also, addressed FB-996 regarding inspections to prevent clogging of UHS equipment with sediment. Other minor editorial comments also included.	None	N/A	ML061290102
	01/31/08 CN 08-005	Revised to change biennial portion of this inspection procedure to triennial inspection periodicity based on 2007 ROP realignment results. Revise to provide more specific inspection guidance, and to make it more effective and efficient. Other minor editorial comments also included.	None	N/A	ML080290277
	03/23/09 CN 09-010	Revised to provide more specific inspection guidance. Other minor editorial comments also included.	None	N/A	ML090130171