WOLF CREEK
NUCLEAR OPERATING CORPORATION

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ET 16-0017

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

References: 1) USNRC Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment," dated July 18, 1989

2) Letter ET 90-0023, dated January 30, 1990, F. T. Rhodes, WCNOC, to USNRC

3) USNRC Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment (Generic Letter 89-13, Supplement 1)," dated April 4, 1990.

4) Letter ET 94-0012, dated February 18, 1994, F. T. Rhodes, WCNOC, to USNRC

5) Letter ET 94-0075, dated November 28, 1994, F. T. Rhodes, WCNOC, to USNRC

6) Letter ET 99-0042, dated November 17, 1999, R. A. Muench, WCNOC, to USNRC

Subject: Docket No. 50-482: Updated Response to Generic Letter 89-13

Gentlemen:

Reference 1 required licensees to supply information about their respective service water systems to assure the NRC of compliance with General Design Criteria 44, quality assurance requirements, and to confirm that the safety functions of their respective service water systems were being met. Reference 2 provided Wolf Creek Nuclear Operating Corporation's (WCNOC) response to NRC Generic Letter (GL) 89-13 and established surveillance testing programs and procedures. Reference 3 provided Supplement 1 to Reference 1. Reference 4 provided an updated response to the generic letter based on the results of a functional self-assessment of the service water systems. Reference 5 provided confirmation that all initial testing and activities associated with Generic Letter 89-13 have been completed, and continuing programs have been established. Reference 6 provided an updated response to Recommendation II of GL 89-13. This letter provides an update to the heat transfer testing of the Safety-Related room coolers.

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WCNOC has determined from years of previous trending data that the condition of the service water system and changes to equipment design that allow for thorough inspection justify making programmatic adjustments which will continue to satisfy the intent of Recommendation II in Generic Letter 89-13. WCNOC plans to discontinue performing representative heat transfer testing on Safety-Related room coolers. Attachment I to this letter provides the justification for the changes being made to the heat transfer testing on the Safety-Related room coolers.

This letter contains no commitments. If you have any questions concerning this matter, please contact me at (620) 364-4156, or Cynthia R. Hafenstine (620) 364-4204.

Sincerely,

Jaime H. McCoy

JHM/rlt

Attachment

cc: K. M. Kennedy (NRC), w/a
C. F. Lyon (NRC), w/a
N. H. Taylor (NRC), w/a
Senior Resident Inspector (NRC), w/a

Updated Information Regarding Generic Letter 89-13 "Service Water Problems Affecting Safety-Related Equipment"

Pursuant to Recommendation II of Nuclear Regulatory Commission (NRC) Generic Letter (GL) 89-13, Wolf Creek Nuclear Operating Corporation (WCNOC) currently verifies heat transfer capability of Essential Service Water (ESW)-cooled heat exchangers is reasonably assured through representative heat transfer verification testing of the Component Cooling Water (CCW) heat exchangers, Safety-Related room coolers, and containment air coolers in accordance with Reference 1. These tests have been done at least once per cycle on a representative sample heat exchanger, or when maintenance or flow balance changes have been executed that could negatively impact heat transfer capability.

WCNOC is discontinuing the performance of representative heat transfer testing on Safety-Related room coolers. The decision to discontinue testing is based on over a decade of test data that has successfully demonstrated maintenance and inspection activities which have been improved by the installation of new equipment have maintained the equipment capable of removing the required heat loads. In lieu of testing the representative room coolers, WCNOC will continue to maintain and monitor an effective inspection and maintenance program, as allowed by GL 89-13 and per further guidance from Reference 2. This change does not impact any other aspects of GL 89-13 commitments, testing, or WCNOC's response to other recommendations of the letter.

Enclosure II of GL 89-13 and Reference 2 recommend a five year minimum frequency for inspection and cleaning. All GL 89-13 room coolers at WCNOC are inspected on a periodic basis. The frequency of inspections will continue to be based on the inspection/maintenance results. Inspection history shows that some components are repeatedly clean due to system elevation and configuration. When components are repeatedly clean the inspection frequencies may be extended beyond five years, provided other comparable components in the system are inspected at a frequency that is at least the minimum recommended five years.

Representative heat transfer testing of the CCW heat exchangers and containment air coolers will continue to monitor for potential adverse micro-fouling conditions throughout the ESW system. Pursuant to Recommendation I in Reference 3, continued flow and differential pressure monitoring on all GL 89-13 heat exchangers at WCNOC will continue to monitor macro-fouling between inspection and cleaning activities.

Background

On July 18, 1989, the NRC issued GL 89-13 to require licensees to address industry-wide negative trends associated with fouling events in open-cycle service water cooling systems. Several information notices and bulletins regarding open-cycle system blockage were issued before the issuance of the Generic Letter, yet safety-significant events continued to occur. It was evident to the NRC that fouling in open-cycle heat exchangers was not being detected, monitored or properly mitigated.

GL 89-13 contained five Recommended Actions to be taken by licensees (the following is an abridged summary):

I. Implement and maintain an ongoing program of surveillance and control techniques to significantly reduce the incidence of flow blockage problems as a result of biofouling.

II. Conduct a test program to verify the heat transfer capability of all safety-related heat exchangers cooled by service water.

III. Ensure by establishing a routine inspection and maintenance program for open-cycle service water system piping and components that corrosion, erosion, protective coating failure, silting and biofouling cannot degrade the performance of the safety-related systems supplied by service water.

IV. Confirm that the service water system will perform its intended function in accordance with the licensing basis for the plant.

V. Confirm that maintenance practices, operating and emergency procedures and training that involves the service water system are adequate to ensure that safety-related equipment cooled by the service water system will function as intended and that operators of this equipment will perform effectively.

In Reference 4, WCNOC established surveillance test programs and procedures to monitor and control fouling in the Safety-Related ESW system.

Specific to Recommendation II, and Safety-Related room cooler heat transfer testing, an initial and ongoing test program plan was established, and it was specified that the ongoing test program would establish a periodic test of at least one safety-related room cooler each cycle. Data from the initial test program would subsequently be used to establish the periodic test program (Reference 4). In 1994, Reference 3 provided an update regarding the initial heat transfer test program that outlined initial test outcomes, discoveries, and updated the ongoing test program attributes. In 1999, Reference 1 provided a second update that delineated test frequencies for representative room coolers would be determined based on trending and monitoring of testing results.

Justification Executive Summary

After a thorough review of heat transfer testing trends, internal visual inspection records, the changes in inspection capability due to upgraded coil designs, industry peer heat exchanger programs, and equipment margin, it has been concluded from the following justification that representative heat transfer testing of Safety-Related room coolers at Wolf Creek is no longer necessary. Given the history of stable heat transfer test results, equipment design changes, and the established inspection and maintenance program for the room coolers, it is evident that heat transfer testing a representative sample adds minimal value as the heat exchanger health is known and appropriately monitored. Since heat transfer testing on other ESW-cooled heat exchangers will continue to monitor micro-fouling, the intent of GL 89-13 Recommendation II will remain met.

Justification

In order to understand fouling mitigation strategies, it is worthwhile to discuss exactly what fouling is. Fouling in general may be defined as an additional resistance to heat

transfer due to the presence of undesired material on physical heat exchanging surfaces. However, it is divided into two separate entities, micro-fouling and macro-fouling. Both types of fouling need to be effectively monitored and the consequences of both must be mitigated to meet the full intent of GL 89-13.

Macro-fouling
Macro-fouling consists of large-scale blockage mechanisms that inhibit fluid flow through or across heat transfer surface areas. Examples include biological growth of plant material or aquatic organisms such as Asiatic clams, and/or blockage due to sediment deposits and/or loose piping corrosion deposits.

In accordance with company responses and commitments to GL 89-13, WCNOC, regularly conducts visual examinations and cleanings on all ESW-cooled heat exchangers; thereby monitoring macro-fouling levels, and subsequently removing the blockage. These visual examinations are conducted by Quality Control (QC) and the Heat Exchanger Engineer on frequencies that are determined on a per-component basis to be acceptable based on operating history. Acceptable frequencies are justified by a combination of the history of inspection results of each unit, on-line heat exchanger flow, and differential pressure testing per surveillance procedures, STN PE-037A/B, "ESW Train A/B Heat Exchanger Flow and DP Trending." This trending can specifically identify any large-scale macro-fouling concerns, and encompasses all open cycle, ESW cooled heat exchangers.

During visual examinations, upon the opening of a heat exchanger, an as-found condition is documented. Quality Control documents tube blockage in a conservative manner, by considering a tube as plugged if there is any question of the ability of water to easily flow down the tube. The total number of blocked tubes indicated (including mechanically plugged and macro-fouled tubes) is then totaled and compared to the tube-plugging limit.

The plugging limit is defined by the applicable tube-plugging limit calculation for each open-cycle heat exchanger. Each tube-plugging calculation contains additional margin over the available design margin as they are conservative beyond the design conditions for the following reasons:

a) Each tube blocked is considered to take away a directly proportional percentage of heat transfer area. It is then assumed that the percentage loss in heat transfer area is equivalent to the same percentage loss in heat transfer capability. In reality, other tube velocities increase when tubes are plugged, which increases the heat transfer capability per tube, provided the flow stays the same, thus the actual decrease in heat transfer capability is much less than what is presented in the calculation.

b) Calculations assume tube-side flow is at the design flow for the respective heat exchanger. All ESW-cooled heat exchangers are maintained above tube-side design flow. Flows are verified semiannually per procedures STN PE-037A/B.

c) If the tube plugging limit is met or exceeded, or other indeterminate as-found conditions exist, it is then the responsibility of Engineering to generate a condition report to document the condition. This process, and the basis of tube-

plugging calculations ensures that all ESW-cooled heat exchangers are monitored for macro-fouling conditions, and the existence of any macro fouling condition is documented and addressed in a timely manner.

Since the establishment of a test program in response to GL 89-13, there have been significant design changes on all the safety-related room cooling coils that allow for better inspection of coil blockage conditions. The previous designs were 90/10 Copper-Nickel coils that utilized an H-Bend design (rather than a U-Bend type), to enable inspection. This configuration required removing an individual end-cap to inspect each tube. This limited the ability to identify/remove blockage and perform 100% inspections, and influenced the decision to perform representative heat transfer testing of room coolers as part of the response to Recommendation II of GL 89-13 to gauge room cooler fouling. From 1999 to 2009, all safety-related room cooler coils were replaced with AL6XN coils that are a waterbox-type design that allows visual inspection of 100% of the tubing. This ease of access was not available when the test program was initially established.

Micro-fouling

Micro-fouling is considered to be an additional heat transfer resistance as a result of small-scale buildup on effective heat transfer area surfaces. This includes scale and film buildup on tube walls and limited sediment deposits that do not inhibit flow. Micro-fouling can occur on both inner and outer heat transfer surfaces.

Micro-fouling is what is considered fouling in heat exchanger design calculations. All heat exchangers are designed with pre-selected fouling factors, typically based on the process fluids used in the heat exchanger. Additional margin is then built into heat exchangers, by means of including more physical effective heat transfer area than is required; providing further assurance that the component will still remove the required heat load with excess heat removal margin available, even when fouled to or beyond design conditions.

Micro-fouling in some cases may be visible upon inspection, but it cannot be quantified in the same manner as large scale macro-fouling inspections. Entire inner or outer heat transfer surface areas of the heat exchanger may be affected. It is therefore possible, particularly in shell and tube heat exchangers, that the shell-side may have some significant level of micro-fouling. Shell-side fouling would thus go unseen from a tube-side visual inspection on a shell and tube heat exchanger, and could only be inferred from a combination of visual inspection and heat transfer testing results. Fins on air coils, such as the safety-related room coolers, are visually inspectable for cleanliness and are typically not subject to excess micro-fouling.

Current Practice

In accordance with Reference 1, regarding Recommendation II of GL 89-13, the following heat transfer tests are currently performed:

a) One Component Cooling Water (CCW) heat exchanger is heat transfer tested at a frequency determined by WCNOC (currently 18 months), and is representative of both trains of CCW. The train tested is alternated each cycle.

b) One Containment Air Cooler is heat transfer tested at a frequency determined by WCNOC (currently 18 months), and is representative of all Containment Air Coolers.

c) One safety-related room cooler per train is tested at a frequency determined by WCNOC (currently 18 months), and is representative of all similar safety-related room coolers.

The testing, performed in accordance with EPRI Service Water Heat Exchanger Testing Guidelines, calculates the as-found test-condition, steady-flow heat transfer rate equations for the tube and shell (or air-side), equates them to the log mean temperature difference heat transfer rate equation and back-calculates an overall fouling factor from the overall heat transfer coefficient. With the known fouling factor back-calculated from the test, which globally includes both micro-fouling and macro-fouling by definition, the log mean temperature difference equation is then extrapolated to accident conditions. Thus, the as-found, total fouling is used to determine projected heat exchanger performance at accident conditions, as accident loading with design conditions is not typically achievable. The test uncertainty is then applied and accounted for in the final result.

Conclusion

Irrespective of the additional testing and actions performed to meet Recommendation I of GL 89-13, discontinuing the heat transfer testing program on representative safety-related room coolers will not result in a condition such that safety-related room cooler cleanliness is unknown. Heat transfer testing of components cooled by the same medium will continue monitoring potential micro-fouling conditions. Furthermore, the heat exchanger maintenance program will continue to clean and inspect the coils thereby monitoring macro-fouling and controlling overall fouling.

It is reasonable that fouling between different components in the ESW system will be similar as they use the same tube-side process fluid. Tube-side velocities are very similar for the CCW heat exchangers, containment coolers, and all safety-related room coolers resulting in similar fouling. It is not reasonable to assume that heat exchangers of similar tube velocities with the same process fluids will show extreme ranges of micro-fouling levels. At WCNOC, a non-safety-related service water system supplies both trains of ESW during normal operation, thus all safety-related heat exchangers utilize the same water from the same intake structure during the majority of a cycle. Both trains of the safety-related ESW pumps receive the same treatment strategies, thus there is no significant differentiation in cooling water between the safety-related trains. Further, historical data proves that overall fouling per test has remained reasonably steady even with variations in service water treatment through the years; proving the existing heat exchanger program has adequately maintained heat exchanger cleanliness.

The ongoing heat transfer test program of a representative containment air cooler and the CCW heat exchangers will continue to verify that overall micro-fouling of all safety-related heat exchangers cooled by ESW is acceptable. Ongoing monitoring of flow and differential pressure of each ESW-cooled heat exchanger will continue to verify that all individual ESW heat exchangers are not macro-fouled.

Excluding the non-inspectable copper-nickel containment coolers, all GL 89-13 program heat exchangers at WCNOC are cleaned and inspected by means of regular maintenance at frequencies determined by experience and trending. This in itself is an acceptable practice to meet Recommendation II of GL 89-13 according to Reference 2, as outlined in section B, Maintenance of Heat Exchangers, provided that sufficient data has been collected to show maintenance frequencies are acceptable. Over a decade of heat transfer testing results on the CCW heat exchangers, the representative containment cooler, and representative room coolers have remained reasonably stable, with no test failures. The trends across the different tests are also comparable, indicating the testing is representative in nature. It is evident from years of internal visual inspection results and stable semi-annual flow and differential pressure trending that safety-related room cooler cleanliness remains satisfactory.

Therefore, discontinuing the representative safety-related room cooler heat transfer testing program will not compromise the ability of WCNOC to reasonably assure that ESW-cooled heat exchangers are capable of removing design basis heat loads. Safety-related room coolers already undergo periodic inspection and maintenance in accordance with Recommendation III of GL 89-13, and that inspection and maintenance may be used in lieu of heat transfer testing to ensure adequate heat exchanger macro-fouling cleanliness. Representative heat transfer testing of the CCW heat exchangers and containment coolers will continue to effectively monitor the micro-fouling in heat exchangers cooled by Service Water. Other tests and actions performed by WCNOC in response to GL 89-13 remains unchanged.

References:

1. WCNOC Letter ET 99-0042, "Updated Response to Generic Letter 89-13," November 17, 1999. ADAMS Accession No. ML993280349

2. Letter from J. G. Partlow, USNRC, to B. D. Withers, "Service Water Problems Affecting Safety-Related Equipment (Generic Letter 89-13, Supplement I)," April 4, 1990. ADAMS Accession No. ML031140185

3. WCNOC Letter ET 94-0012, "Updated Response to Generic Letter 89-13," February 18, 1994.

4. WCNOC Letter ET 90-0023, "Response to Generic Letter 89-13, Service Water System Problems Affecting Safety-Related Equipment," January 30, 1990.