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Document Control Desk
U.S. NUCLEAR REGULATORY COMMISSION
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Gentlemen:

DOCKETS 50-266 AND 50-301
RESPONSE TO NRC INSPECTION REPORT 95-11
CONTAINMENT FAN COOLER 1HX-15D OPERABILITY
POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2

On November 15, 1995, the NRC forwarded routine safety inspection report 95-11. In that report, you requested us to submit a formal written evaluation and corrective actions discussing the operability issues noted in Section 3.2 of the inspection report.

We have completed and enclosed the formal written evaluation you requested. This evaluation addresses the operability of containment fan cooler 1HX-15D during the period when service water supply temperatures and empirically-determined fouling factors did not coincide with values established in our test procedures. Our test results and analyses indicate that containment fan cooler 1HX-15D was operable in the summer of 1995, and our continuing maintenance, operations, and test procedures ensure that the cooler has continued to be operable since then. This judgment is supported by favorable results from: (1) a special improved-accuracy test, (2) computer analysis of the summer 1995 conditions, (3) recent chemical cleaning of containment coolers, (4) recent visual inspections, (5) routine flushing, and (6) routine radiographs.

To increase our level of confidence, we are continuing to pursue more accurate performance tests for containment coolers. We have implemented some short-term measures to improve test accuracy and we have initiated a long-term plan. The long-term plan retains sufficient flexibility to accommodate the ongoing evaluations of fouling phenomena and testing methodology. Further details of these plans will be provided to the NRC Resident Inspectors.

Our evaluation and description of the accompanying corrective actions are attached. If you have any questions or require additional information please contact us.

Sincerely,

Bob Link
Vice President
Nuclear Power

GDA

Enclosures
cc: NRC Resident Inspector, NRC Regional Administrator - Region III

IE01

Background

As described in the PBNP FSAR (Sections 6.3 and 6.4) and Technical Specifications (15.3.3 bases), adequate containment heat removal capability is provided by two separate, full capacity, engineered safety features systems. These are the containment spray system and the containment fan cooler system. As described in the FSAR and Technical Specifications, the post-accident containment pressure will be maintained below its 60 psig design value by any combination of containment fan cooler or containment spray equipment that removes approximately 200 million Btu/hr. Assuming a nominal capability of 100 million Btu/hr from one train of coolers and a nominal capability of 110 million Btu/hr from one train of containment spray, the FSAR describes the following acceptable equipment combinations:

1. All four containment fan coolers (total nominal capability of 200 million Btu/hr)
2. Both containment spray trains (total nominal capability 220 million Btu/hr)
3. Two containment fan coolers and one containment spray train (total nominal capability 210 million Btu/hr)

More definitively, the FSAR accident analysis (Section 14.3.4) stipulates that the limiting single failure scenario (loss of one electrical train) would result in a minimum safeguards condition of two containment fan coolers and one containment spray train. As analyzed, this configuration limits the post-LOCA containment peak pressure to only 53 psig. Therefore, the analysis demonstrates significant margin when assuming a combined containment fan cooler heat removal capability of 100 million Btu/hr.

The operability of a single containment fan cooler must be defined in context with the entire Containment Heat Removal System, and is not restricted to the nominal design duty of one cooler (50 million Btu/hr). For consistency with ASME guidelines, we have used this nominal (50 million Btu/hr) value as a qualitative baseline for cooler performance testing; however, we do not evaluate cooler operability on this test alone. We evaluate operability of containment fan coolers based on the qualitative testing results of a conservatively-chosen representative cooler in each containment, in combination with the other qualitative factors that we discuss in the evaluation below. We believe this approach is consistent with the guidelines of NRC Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment".

For almost twenty years, PBNP operated containment fan coolers under the assumption that the design basis heat removal rate would be removed if related key parameters were satisfied. These key parameters were: (1) tube-side fouling factor of 0.001, (2) maximum lake temperature (70°F), (3) Service Water (SW) flowrate of 1000 gpm, and (4) air flowrate of 38,500 cfm. If these values were met, then the nominal heat removal capability of 50 million Btu/hr is accomplished. Factors such as air flowrate and water flowrate were tested, but it was understood that fouling factor did not warrant routine monitoring.

For the first twenty years, the fouling factor of 0.001 was considered a conservative assumption based on industry experience with Great Lakes water (Reference PBNP FSAR 14.3.4). The lake temperature was monitored, but rarely exceeded the nominal value of 70°F, and it was never instituted as a Technical Specification limit. The only parameters warranting evaluation were the SW flowrate and air flowrate to each cooler. These were the only parameters with potential for significant degradation. Therefore, the air flowrate tests and the SW flowrate tests (TS-33/34) were the primary determinates of containment fan cooler operability.

It was not until the discovery of new freshwater fouling phenomena in the 1980s that we rigorously reviewed the design basis performance of containment fan coolers and challenged the conservatism in the key parameters related to those coolers. Pursuant to GL 89-13, we instituted a series of tests, inspections, analyses, and maintenance to ensure these safety-related heat exchangers could remove their design basis heat load. One of these steps included the initiation of a performance test procedure (Periodic Check PC-56) to calculate the coolers' fouling factor and predict their performance under design basis conditions. This was a qualitative test on a representative cooler which complements the other tests, inspections, and maintenance on which we judge cooler operability. Other steps include: (1) chemical cleaning of the SW side, (2) routine radiographic examination of SW piping to monitor silting, (3) routine

SW System chlorination, (4) routine SW flushes through each cooler, (5) internal visual inspection, and (6) routine external inspections (initiated in 1995). In addition, we continued operability testing using the SW flowrate tests of TS-33/34 and the routine air flowrate tests of Routine Maintenance Procedure 31 (RMP-31).

The performance test (PC-56) was initiated as a qualitative method to trend containment cooler performance and verify its capacity to remove the nominal heat load. However, as identified in Inspection Report 95-11, our testing experience has proven that test conditions and instrument inaccuracies have not provided conclusive, high-confidence, reliable test results. Therefore, we have continued the maintenance, cleaning, testing, and inspections which provide us reasonable confidence that the tube side fouling is less than or equal to 0.001 and the containment fan coolers are capable of meeting their nominal heat removal duty. Based on analysis and judgment, we believe that the fouling factor has never exceeded the value of 0.001.

As discussed herein, we are investigating improvements to the performance test while we continue its use as a trending tool and as a qualitative factor in our operability determinations. We will evaluate the feasibility of improving test accuracy sufficiently to use the heat exchanger performance test as an operability test. In the interim, we will continue to complement the qualitative performance test with other tests, inspections, and maintenance currently in effect (as found acceptable per GL 89-13).

Notwithstanding our qualitative approach to evaluating cooler performance, we acknowledge the particular NRC concerns for our management of the analytical methods and the results. These analytical concerns were raised in NRC Inspection Report 95-11. The accuracy of our containment cooler performance test and the adequacy of our response to particular test data were questioned. In response, we have provided a description and evaluation of our analytical methods below. As discussed in this evaluation, we plan to improve the accuracy of our performance test and implement the commensurate level of review and response to test data.

Evaluation

1. **NRC Comment:** "Although the licensee performed an evaluation in accordance with NP 10.3.2, "Justification for Continued Operation (JCO)", they did not perform a formal screening in accordance with procedure NP 10.3.1, "Authorization of Changes, Tests, and Experiments (10CFR50.59 and 72.48 Reviews)", to ensure an unreviewed safety question did not exist by using a flow rate of less than 1000 gpm."

   Evaluation: As discussed in the "Background" section, the design basis heat removal requirement of the Containment Heat Removal System is not contingent on a particular limit on any single component of the system. The containment integrity analysis does not rely on the nominal heat duty (50 million Btu/hr) from each cooler, but rather, it demonstrates considerable margin if the combined capability of a containment cooler train (2 coolers) can provide 100 million Btu/hr. Likewise, the operability of the containment heat removal system is not contingent on any particular component parameter. We do not consider the nominal cooler parameters (70°F SW temp, 1000 gpm SW flowrate, 0.001 SW fouling factor) which relate to the nominal cooler heat duty (50 million Btu/hr) to be independent limits that define cooler operability. The design basis heat removal rate (100 million Btu/hr) for a train of containment coolers can be achieved with varying combinations of SW temperature, SW flowrate, and fouling factor. For example, WE Calculation N-94-065 achieves the 50 million Btu/hr per cooler rate with a SW flowrate of 920 gpm, SW temperature of 75°F, and a tube-side fouling factor of 0.001. We will revise our Design Basis Documents to more clearly define these design basis requirements.

   The 1000 gpm flowrate value listed in FSAR 6.3.2 is the nominal flow rate through each fan cooler unit assuming two service water pumps running. This is not a design basis value; it is only a nominal expected flowrate based on the design of the service water system. The FSAR accident analysis design basis for the Containment Fan Coolers is that one train (two coolers) can remove a total of 100 million

Btu/hr from containment at accident conditions (assumes two containment coolers inoperable due to single active failure). The containment integrity analyses are based on this heat removal capability, not a certain flow rate through the cooler units.

Therefore, when we determined that a lower flow rate through 1HX-15D would still be capable of removing the design basis heat load, the design basis was met. We also determined that the 1000 gpm flow rate listed in the FSAR need not be changed since it is only a nominal, expected flow rate. Since our design basis was met, and no FSAR changes were required, no 10 CFR 50.59 safety evaluation or screening was necessary.

2. **NRC Comment:** "The supporting calculations for the JCO assumed a 0.001 fouling factor. The licensee stated that this fouling factor was per the containment cooler design data and the FSAR states that a fouling factor of 0.001 has been assumed for cooling coil design purposes under normal and design basis accident conditions. However, the FSAR states that computer analysis of the coils showed that the post-accident heat removal rate could be achieved with a fouling factor approaching 0.002 hr-ft^2-°F/Btu. A fouling factor of >0.001 was never used to bound any of the calculations contained in N-94-065 even after the 0.0014 fouling factor was calculated after the July Unit 1 containment fan cooler test. Calculations in N-94-065 determined required containment fan cooler flows vs. service water temperatures so that the coolers can properly remove the required 50 million Btu/hr heat load during a design basis accident. The licensee had no method to ensure that fouling factors determined by performance testing which were greater than assumed values in Calculation N-94-065 were used to re-perform this calculation and determine if this affected JCO 95-05-01."

Evaluation: We have researched the basis for the FSAR statements relating to containment fan cooler performance. Although the description of the 0.002 fouling factor has been in the FSAR since its origin, we could find no documented basis for its existence. The original computer model used by Westinghouse is no longer in use for PBNP, and Westinghouse could provide no evidence that would support the 0.002 value. Although we have determined that fouling factors > 0.001 are acceptable under some conditions, our informal calculations indicate that a fouling factor of 0.002 does not support the 50 million Btu/hr nominal heat duty when considering the 75°F service water temperature and the anticipated SW flowrates. Although we have determined fouling factors greater than 0.001 to be acceptable, the FSAR statement containing the words "approaching 0.002" is misleading. Therefore, we intend to remove that statement from the FSAR to avoid future confusion.

We recognize the concern for preserving the integrity of JCO assumptions. A statement regarding the assumed fouling factor (0.001) and the PC-56 testing results should have been placed into JCO 95-05-1. We have reviewed our JCO process and will revise the JCO procedure to require that key assumptions of the supporting analyses be explicitly identified in the JCO. Also, we are preparing a change to require JCOs to list compensatory measures to monitor the key supporting assumptions/conditions of the analysis. Under such requirements, the tube-side fouling factor would have been identified as one of the key assumptions, and JCO 95-05-1 would have specified that this value be monitored and verified by the performance test (PC-56). This JCO and the other existing JCOs will be upgraded in accordance with the revised procedure.

Corrective Action Summary:

1. We will revise the FSAR to remove the 0.002 fouling factor statement.

2. We will revise the JCO process to better identify and control the supporting assumptions.

3. After we revise the JCO process, we will review and revise existing JCOs, as appropriate.

3. **NRC Comment**: "Additionally, the inspector noted that non-conservative service water temperature of 70°F and flow rate of 1000 gpm were used in the AIRCOOL program for determining the performance capability of the 1HX-15D heat exchanger in July 1995 despite the fact that JCO 95-05-01 was in place and allowed service water temperatures up to 76°F and flow rates down to 920 gpm. Also the Service Water System Design Basis Document determined that the design basis service water temperature was 75°F. Weaknesses in the service water heat exchanger performance testing program were noted over two years ago by the NRC Service Water System Operational Performance Inspection. Therefore, it is unclear to the inspectors why 1HX-15D was not declared inoperable during those days in July and August 1995, when the lake temperature exceeded 70°F."

Evaluation: As stated earlier, the nominal values of 75°F, 1000 gpm, and 0.001 fouling factor are not independent limits that define the operability of containment fan coolers. Rather, the Containment Heat Removal System can remove its design basis heat load, irrespective of the nominal values, as long as the design basis limits on containment integrity are preserved.

We analyzed the heat removal capability of 1HX-15D at the .0014 fouling factor value determined during the July 1995 test to conservatively demonstrate its operability throughout the summer period. One of six SW Pumps was out of service for three days in mid-July; a condition which could result in only two running SW pumps when the worst-case single failure is considered in the post-accident scenario. In this case, we proved operability considering the actual lake temperatures of that period, the SW flowrate value in the JCO (920 gpm), and a fouling factor of greater than 0.0014. At all other times during the summer, all six service water pumps were operable; a condition which would ensure that at least three service water pumps are available under any design basis accident scenario. In this case, we demonstrated operability considering 1100 gpm SW flowrate, a 77°F lake temperature, and the 0.0014 fouling factor. In both cases, the AIRCOOL analyses concluded that 1HX-15D would remove at least 50 million Btu/hr at accident conditions.

We conducted a "fiberscope" visual inspection of the service water side of accessible containment cooler tubing during the recent Unit 2, Fall 1995 outage. The scope of the inspection was limited because the cooler design limits our access. The results were subjective, but provided evidence that gross fouling and scaling were not taking place in these heat exchangers. A specific fouling factor could not be determined by the visual inspection. Other utilities and EPRI were queried on the existence of inspection criteria that would allow such a determination. No such criteria were identified.

The .0014 fouling factor determined from the July 1995 test was discounted by the responsible engineer due to known concerns with the test accuracy. On October 4, 1995, we conducted two enhanced performance tests (PC-56 Part 1) on 1HX-15D. Test conditions were modified and better instruments were used to improve the test accuracy considerably (by a factor of 10). One test provided a fouling factor of 0.001. The other test, at a higher SW flow condition, provided a fouling factor of 0.0006. These favorable test results provided further evidence that the tube-side fouling factor of 0.001 was not exceeded during the period of the JCO. Although the test instrument and analysis errors were greatly reduced during these tests, the accuracy was still insufficient to rely solely on test results to verify fan cooler operability.

Historically, we have used nominal vendor design values as a baseline in performance testing; however, we understand that this approach does not adequately verify the design basis capability of the heat exchanger, and is inconsistent with the use of the test results as an operability measure. In the case of containment fan coolers, we have used the 70°F SW inlet temperature in the performance test algorithms because that value was the baseline value provided on the original heat exchanger manufacturer's data sheet and was the original design inlet temperature listed in the FSAR.

We have reviewed our containment cooler performance test procedure (PC-56 Parts 1 and 2). We are satisfied that the "Performance Prediction Evaluation" clearly states that 50 million Btu/hr heat removal capability is the acceptance criterion. We are also satisfied that the procedure appropriately describes the qualitative nature of the test. However, this evaluation uses a nominal value of Service Water temperature (70°F) that is inconsistent with the nominal service water design temperature of 75°F. We will be revising our Performance Prediction Evaluations to use the 75°F value.

We have reviewed the circumstances of the original engineering decision to discount the subject test results (0.0014 fouling factor) in the summer of 1995. Test inaccuracy was the primary factor. The calculated test inaccuracy prompted the test engineer to defer to his engineering judgment and determine that the results were inconclusive. The engineer concluded that the calculation of the 0.0014 fouling factor was overconservative because the value used for SW flowrate in the calculation was less than the actual test value (due to instrumentation limits). Since that time, we have used our test-accuracy algorithm to identify the other factors which contribute most to the test inaccuracy. Based on our current assessment, we have determined that our air cooler performance tests (PC-56 Parts 1, 2) alone are insufficient to provide conclusive operability determinations. In the short-term, we hae approved Modification Request MR 94-028 to install higher range flow meters; reducing the test inaccuracy caused by the SW flow error. In the long-term, we are evaluating improvements and alternatives to the performance tests.

The classification of the test procedure may have been another contributing factor in the engineer's descision to discount the results. The engineer's response to the test results (0.0014 fouling factor) was commensurate with the classification of the test procedure as a "Periodic Check (PC)." A Periodic Check does not require the same strict control of results as an "Inservice Test (IT)" or "Technical Specification Test (TS)." The safety-related heat exchanger performance tests (PC-56 Parts 1-4) were originally established as Periodic Checks because they were designed to provide for performance trending rather than a verification of operability. PC-56 was not intended to be an operability test. We had been relying on SW flow tests (TS-33/34) and the other qualitative factors (discussed previously) to verify operability of the containment coolers. To ensure all of these factors are considered in determining CFC operability, we will routinely consolidate all the factors involved and definitively report the state of cooler operability.

In addition, we will review the classification of these tests as we evaluate and improve test methods. We will classify the containment fan cooler performance tests appropriately to ensure that test results get adequate review and timely response.

Corrective Action Summary:

1. We will revise our Design Basis Documents to more clearly define the design basis requirements of the Containment Heat Removal System.

2. We researched the plant conditions during the summer of 1995 and verified by AIRCOOL computer analysis that 1HX-15D remained operable throughout the period.

3. We performed a "fiberscope" visual inspection of a containment cooler and determined no gross fouling or scaling was occurring.

4. We performed enhanced performance tests on 1HX-15D (10/4/95) using improved instruments and improved test conditions to demonstrate a fouling factor $\leq$ 0.001.

5. We reviewed PC-56 Part 1 & 2 test procedures. We plan to revise the containment fan cooler tests to consistently use the SW design temperature (75°F) when calculating performance capability.

6. We approved Modification Request 94-028 to install higher range flow meters in the containment cooler return lines.

7. We will routinely consolidate test results and other factors related to cooler operability. This report will definitively describe the status of cooler operability.

8. We will continue to pursue and evaluate improved test methods for containment fan coolers. We will also pursue other means, such as visual inspections and/or periodic cleanings (as allowed by GL 89-13), to ensure the heat exchanger's capability to remove its design basis heat load. The details of our integrated plan will be provided to the NRC Resident Inspectors by April 1, 1996. We will appropriately classify the containment cooler tests to ensure that results receive timely review and attention.

Conclusion:

We have conducted a thorough review of the conditions described in IR 95-11 and determined that the subject containment fan cooler was operable during the summer of 1995. Our confidence in this judgment is based on the qualitative analyses, inspections, tests, and maintenance described in this evaluation. We are taking steps to improve our confidence in this judgment by improving the accuracy of the performance tests. We will continue our efforts to assess the mechanisms of SW fouling, and our commitment to revise our testing methodology or testing equipment as necessary. If we determine that it is not feasible to perform sufficiently accurate and reliable tests upon which to conclusively judge operability, we will pursue alternative means such as visual inspection or periodic cleanings to verify heat exchanger performance capability. In addition, we will improve our process for handling performance test data and JCO assumptions.