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SUBJECT: LER 95-003-00:on 950309,intake cooling water flow rate through CCW heat exchangers fell below assumed design basis. Caused by an influx of aquatic grass & algae onto basket strainers.Strainers cleaned.W/950407 ltr.

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L-95-105
10 CFR 50.73

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

Gentlemen:

Re: Turkey Point Units 3 and 4
Docket Nos. 50-250 and 50-251
Reportable Event: 95-003-00
Intake Cooling Water System Flow Rate Found Less Than Required By Design Basis

The attached Licensee Event Report, 250/95-003-00, is being provided in accordance with 10 CFR 50.73(a)(2)(ii)(B).

If there are any questions, please contact us.

Very truly yours,

T. F. Plunkett
Vice President
Turkey Point Plant

JEK

Attachment

cc: Stewart D. Ebneter, Regional Administrator, Region II, USNRC
Thomas P. Johnson, Senior Resident Inspector, USNRC, Turkey Point Plant

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PDR ADOCK 05000250
S PDR

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)		
TURKEY POINT UNIT 3	05000250	1	OF	11

TITLE (4) Intake Cooling Water System Flow Rate Found Less Than Required by Design Basis

EVENT DATE (5)			LER NUMBER (6)			RPT DATE (7)			OTHER FACILITIES INV. (8)	
MON	DAY	YR	YR	SEQ #	R#	MON	DAY	YR	FACILITY NAMES	DOCKET # (S)
03	09	95	95	003	00	04	07	95	Turkey Point Unit 4	05000251

OPERATING MODE (9)	1/5	10 CFR 50.73(a)(2)(ii)(B)
POWER LEVEL (10)	60/0	

LICENSEE CONTACT FOR THIS LER (12)

	TELEPHONE NUMBER
J. E. Knorr, Regulation Compliance Specialist	305-246-6757

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPNT	MANUFACTURER	NPRDS?	CAUSE	SYSTEM	COMPNT	MANUFACTURER	NPRDS?

SUPPLEMENTAL REPORT EXPECTED (14) NO ☒ YES ☐	EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
(if yes, complete EXPECTED SUBMISSION DATE)				

ABSTRACT (16)

At approximately 0435 (EST), on March 9, 1995, the Intake Cooling Water (ICW) flow rate through the Component Cooling Water (CCW) heat exchangers fell below that assumed in the Turkey Point design basis. The reduced flow rate was due to an influx of aquatic grass and algae onto the basket strainers of the ICW flow path upstream of the CCW heat exchangers. The strainers were cleaned and flow returned to required levels at 0521. The plant was operating at 60 percent reactor power as a conservative measure due to the potential for an increasing influx of aquatic grass and algae into the ICW and circulating water systems.

I. DESCRIPTION OF THE EVENT

During the evening of March 8, 1995, an influx of aquatic grass mixed with algae occurred at the cooling water intake [NN] from the closed cooling canal [BS:RVR] system at Turkey Point. The cooling water intake is common to the Intake Cooling Water (ICW) system [BS] and the circulating water system [NN]. The ICW system supplies water to the safety related component cooling water (CCW) system and the non-safety related Turbine Plant Cooling Water (TPCW) [TF] system. The ICW system has three pumps [BS:P] and two headers [BS] leading to three CCW heat exchangers [BS:HX], and two headers leading to two TPCW heat exchangers [TF:HX], with an in-line basket strainer [BS:STR] for each header. The TPCW headers are automatically isolated upon receipt of a safety injection signal. The circulating water system supplies water to the main condensers [NN:HX]. Early in the evening on March 8, reactor power for Unit 3 was conservatively reduced to 60% to provide operating margin if the grass and algae influx were to increase. Unit 4 was in mode 5.

The outlet of the ICW headers with basket strainers feeds a common header at the inlet of the tube side of three CCW heat exchangers. For a basket strainer to be mechanically cleaned, the strainer must be isolated. The ICW header containing that strainer is thus declared inoperable. The remaining header (basket strainer) must pass the minimum design flow to maintain operability of the remaining header.

Early in the morning of March 9, the accumulation of aquatic grass and algae on the strainers caused the differential pressure across one ICW strainer to increase, indicating the need for mechanical cleaning. That ICW header was declared inoperable. As a result of the increasing fouling on the opposite ICW header's basket strainer, at approximately 0435 EST, Florida Power & Light Company (FPL) determined that Unit 3 was in a condition that was outside the design basis for ICW flow.

Technical Specification 3.7.3 reads as follows:

> "The Intake Cooling Water System (ICW) shall be OPERABLE with:
>
> a. Three ICW pumps, and
> b. Two ICW headers.
>
> <u>APPLICABILITY</u>: MODES 1, 2, 3, and 4.
>
> <u>ACTION</u>:
>
> a. ...
>
> b. ...
>
> c. With only one ICW header OPERABLE, restore two headers to OPERABLE status within 72 hours or be in HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours."

Operating Procedure 3/4-OP-019, "Intake Cooling Water System," provides guidance on the minimum flow criteria for operability of an ICW header. The criteria are based on fouling factors and canal temperatures. In this case, the minimum flow rate for the conditions at the time was approximately 9500 gpm. The flow rate of 9500 gpm ensures that the CCW heat exchangers, with the canal temperature of 75.5°F, are capable of removing the design basis post-accident heat load.

With one of the strainers out of service for mechanical cleaning, flow through the opposite strainer declined to below the required 9500 gpm as a result of clogging of that strainer. As the aquatic grass and algae continued to flow into the remaining strainer, the ICW flow to the CCW heat exchangers continued to drop to approximately 2500 gpm. At 0435, the second header of ICW was declared inoperable. The action statement in Technical Specification 3.7.3 does not apply to the condition of two inoperable headers. Therefore, the plant entered Technical Specification 3.0.3 which required, within one hour, action to place the unit in Mode 3 within the next 6 hours. At 0521, one basket strainer was cleaned and returned to service, restoring the overall ICW flow rate to greater than 9500 gpm. Therefore, no plant shutdown was required.

II. CAUSE OF THE EVENT

In February and early March 1995, south Florida had little rain. As a result, the Turkey Point closed cooling canal water level was reduced. When heavy rain and wind occurred just prior to the event, the canal levels increased allowing clumps of canal aquatic grass (*ruppia maritima*) mixed with algae (*batophora*) to break loose and flow toward the ICW/circulating water system intake. Under normal grass and algae loading conditions, the aquatic grass and algae are captured by traveling screens at the plant's cooling water intake structure, and washed off of the screens by a screen wash system. In this event, the large amount of suspended grass and algae was enough to cause some of the aquatic material to carry over the traveling screens and into the intake bays for the ICW and circulating water systems. The ICW pumps picked up the carry over material. The ICW basket strainers, as designed, removed the majority of the grass and algae from the flow stream to the CCW heat exchangers. The circulating water pumps also pumped some of the material into the inlet side of the main condenser waterboxes affecting condenser cooling efficiency.

III. ANALYSIS OF THE EVENT

The analysis of this event includes a safety assessment of the following seven areas:

- ICW system functionality
- CCW system functionality
- Containment integrity
- Equipment qualification
- Loss of coolant accident (LOCA) Emergency Containment Cooling (ECC) system analysis
- Main steamline break
- Radiological consequences

Initial Conditions and System Configuration

Following is a list of some of the key parameters used in the event safety assessment. They reflect the actual conditions found or design basis assumptions at Turkey Point on the morning of March 9, 1995.

- Containment air temperature = 105°F
- Outside ambient temperature = 68.5°F
- Refueling Water Storage Tank (RWST) fluid temperature = 75°F (assumed)
- ICW canal (inlet) temperature = 75.5°F
- Offsite power available
- 3 Emergency Containment Coolers (ECCs) available
- 2 Containment Spray pumps available
- 2 ICW pumps in service
- 2 CCW pumps in service
- 2 Residual Heat Removal (RHR) pumps and heat exchangers available
- Average CCW heat exchanger total fouling level at the original design level (0.00159 hr-ft^2-°F/BTU)
- All three CCW heat exchangers in service
- Containment pressure = 0.3 psig (assumed)
- TPCW isolation upon a safety injection signal (by design)

ICW System Functionality

The overall function of the ICW system during post-accident conditions is to provide continuous cooling to the CCW heat exchangers. The ICW system design basis for post-accident operation is a minimum of ICW flow to CCW heat exchangers. A network of closed cooling canals is used as the ultimate heat sink for Turkey Point and provides a continuous supply of cooling water. The limiting safety related ICW flow requirement is based upon the heat load during the mitigation of a design basis large break loss of coolant accident (LBLOCA).

The configuration of the ICW system at the time of the event was two ICW pumps directing flow to three CCW heat exchangers via one header. The second header was out of service for strainer cleaning, as discussed above. The ICW system was also delivering

flow to the TPCW heat exchangers. The TPCW system is automatically isolated on a safety injection signal. As a conservatism, for the purposes of this evaluation, credit was not taken for the increased ICW flow through the CCW heat exchangers due to the TPCW isolation.

The controlling parameter on the functionality of the CCW heat exchangers during post-accident conditions at reduced ICW flows is the ICW temperature at the outlet of the CCW heat exchangers. The reduction in ICW flow through the CCW heat exchanger, given a constant heat removal duty, results in an increase in the ICW outlet temperature of the CCW heat exchanger. The relatively low ICW system inlet temperature (approximately 75°F compared to 95°F design basis canal temperature) at the time of the event, reduced the potential maximum for the post accident ICW temperature at the outlet of the CCW heat exchangers.

As discussed below, a detailed thermal analysis of the design basis LBLOCA event was analyzed assuming that the event occurred concurrent with the ICW low flow event. To support the LBLOCA thermal analysis, a time averaged ICW flow to the CCW heat exchangers was established for the ICW low flow event. The following flow profile was used, representative of the plant conditions observed:

- 0-10 minutes, 9000 gpm
- 11 minutes, step change to 5000 gpm
- 11-40 minutes, gradual reduction to 2500 gpm
- 40-56 minutes, 2500 gpm
- 57 minutes, step change to 9500 gpm
- 57-60 minutes, 9500 gpm

Using the above profile a time averaged ICW flow of approximately 4675 gpm (1560 gpm per CCW heat exchanger) was used in the analysis for the first hour and 9500 gpm thereafter. This is a conservative assumption since the ICW flow rates returned to levels greater than 9500 gpm after the a basket strainer was mechanically cleaned. This time averaged ICW flow was used to provide a more realistic set of input parameters for the LBLOCA thermal analysis. The analysis model used conservative assumptions for overall heat transfer.

Based upon the time averaged flow conditions, the peak ICW temperature was calculated to occur shortly after the beginning of an assumed LBLOCA following the start of the emergency containment coolers (ECCs). The maximum calculated CCW heat exchanger ICW outlet temperature is approximately 134°F. The temperature steadily declines to less than 100°F after about 45 minutes. Following switchover to cold leg recirculation (after placing the RHR heat exchangers in service), the ICW temperature increases to approximately 124°F, again decreasing steadily after reaching that temperature.

FPL performed an assessment of the temperature affects on the structural integrity of the ICW system and has concluded that the ICW system would remain functional. Therefore, the ICW system

would have continued to perform its safety function of continuing to cool the CCW heat exchangers.

CCW System Functionality

The overall function of the CCW system during post-accident conditions is to provide a continuous cooling of safety related components. This requires that the CCW return header temperature remain within the design basis of the system and that the supply temperature remain within equipment operating limits.

At Turkey Point, essential components served by the CCW system are the RHR pumps, Safety Injection (SI) pumps, Containment Spray (CS) pumps, ECCs and RHR heat exchangers. In addition a Chemical and Volume Control System (CVCS) positive displacement (charging) pump is used post-accident to adjust containment sump pH and is also served by CCW.

The following are the CCW system temperatures of interest:

- CCW shell side outlet ("supply") temperature
- ECC CCW outlet temperature
- RHR heat exchanger CCW outlet temperature
- CCW shell side inlet ("return") temperature

The post accident operability limit for CCW "supply" is 150°F. The temperature has been modeled to remain at 150°F for four hours and then to decrease at a minimum of 1°F/hr for the next 30 hours to 120°F, remaining at that level for the remainder of the LBLOCA. The SI pump oil cooler is controlling for this temperature profile. The analysis shows that the SI pump remains operable.

For the ECCs and RHR heat exchangers, the analysis verified that the CCW "supply" temperature remained below the system design temperature for those systems. The limit on the "supply" temperature is required to ensure maintenance of single phase flow through the systems.

For the CCW heat exchanger "return," the limiting temperature is dictated by the net positive suction head of the CCW pump. A temperature as high as 172.7°F has been evaluated as acceptable for the CCW pump suction. This calculation ensured single phase flow at the suction of the CCW pumps.

An assessment of the overall CCW heat removal capability was made based upon the operating conditions at the time of the ICW low flow event. The design basis post-accident CCW heat exchanger heat load used to verify the thermal performance of the CCW heat exchangers is approximately 60 million BTU/hr per heat exchanger. With two heat exchangers (design basis) available the total heat removal capability of the CCW system is 120 million BTU/hr.

At the lower ICW flow and lower ICW inlet temperature present on March 9, with an allowance for the CCW "supply" temperature to rise to 150°F and three CCW heat exchangers available, the total heat removal capability of the CCW system is estimated to be approximately 123 million BTU/hr. This assessment indicates that the reduced ICW flow to the CCW heat exchangers would not have caused the CCW system "supply" temperature to be significantly higher than the limit of 150°F. If CCW system thermal inertia and heat up times were considered, the actual CCW "supply" temperature rise would have been less than calculated above.

A detailed analysis of the ICW low flow event limiting system flows and maximum heat loads (e.g., three ECCs) was also completed. The analysis assumed two CCW pumps and three CCW heat exchangers with the fouling factors experienced when the ICW low flow event occurred. As mentioned before, the time averaged ICW flow rate of approximately 4675 gpm was used for the first 60 minutes and 9500 gpm for the remainder of the analysis. Credit was taken for operation of all essential safeguards equipment and actual plant operating conditions at the time of the ICW low flow. In general, the actual plant operating conditions at the time of the event were much less limiting that those assumed in the safety analysis. The conditions present at the time of the event provided a benefit that compensated for the lower than normal ICW flow. However the assumption of 3 ECCs in service is more limiting from a CCW system heat removal perspective.

The peak CCW "return" temperature was calculated to reach approximately 170°F, decreasing to about 105°F within 45 minutes. Following switchover to cold leg recirculation, a second peak of approximately 155°F was calculated to occur.

For the CCW "supply" temperature, a peak of 156°F was calculated decreasing to 150°F within about a minute. Over the next 45 minutes the temperature would drop to about 100°F. After switchover to cold leg recirculation, the temperature would again increase to about 141°F. Although the maximum calculated temperature slightly exceeded the previously established limit (156°F versus 150°F), the duration of the higher temperature condition (less than a minute) was much less than previously considered. Over the short time frame, the thermal lag of the system combined with thermal inertia would have limited the temperature rise to less than 150°F. In all cases the temperatures steadily decline as ICW flow is restored after a basket strainer is cleaned.

Although the specific detailed thermal analysis results are clearly conservative in nature to the use of steady-state instantaneous heat transfer assumptions, the results are consistent with the overall heat removal assessment noted earlier. Considering the dynamic nature of the CCW heat removal process, the analyses show that the CCW temperature would have remained within the component allowable temperatures and the CCW system would not have been adversely affected by the ICW low flow event.

In addition, FPL performed a preliminary assessment of temperature conditions which bound the above analyses and concludes, considering thermal stress effects, the CCW system would remain functional. Therefore, the overall functionality of the CCW system with respect to its primary safety function would not have been affected by this event.

Containment Integrity

The impact of this ICW low flow condition was evaluated for containment pressure response with respect to LBLOCA and Main Steamline Break (MSLB) inside containment. The plant conditions and configuration at the time of the ICW low flow event are less limiting than the current design basis LOCA containment transient. The current limiting transient is the containment response to the double-ended pump suction (DEPS) break with a concurrent loss of off-site power and the failure of an emergency diesel generator. The current peak containment pressure for this transient is 49.9 psig which occurs during the initial blowdown period. The containment design pressure for Turkey Point is 55 psig. Recently revised calculations of mass and energy releases provided additional conservatism in the initial core stored energy, decay heat level, initial internal RCS energy, and safety injection enthalpy over the current plant conditions.

In the analysis, the containment response to the DEPS break was terminated at 5 hours. Modeling the low ICW flow transient for 4 hours after regaining the required ICW flow of 9500 gpm ensured the data recovery for containment response from the blowdown period through cold leg recirculation. This analysis showed a peak containment pressure of 45.2 psig at approximately 19.4 seconds after initiation of the DEPS. Although not part of the design basis for Turkey Point, NRC Standard Review Plan criteria for pressure reduction after an event is 50% of the peak pressure within 24 hours. Due to the amount of available heat removal equipment, the containment pressure met the criteria within approximately 30 minutes and is near 25% of peak pressure within 5 hours.

Using recently revised calculations, the limiting MSLB containment peak pressure is 42.8 psig. This is based upon a transient beginning at zero power with a failure of a main steam check valve (MSCV) and a break area of 1.4 ft^2. With all secondary safety systems assumed operable and no single active failures, the mass and energy releases from the broken steam line would be significantly less when compared to the limiting transient. Peak containment pressures which result from a MSLB transient with no system failures typically are less than 30 psig.

Based upon the above results, the current design basis DEPS break containment response with the failure of a diesel generator and concurrent loss of offsite power, and the 1.4 ft^2 MSLB at zero power with a MSCV failure, remain bounding. The low ICW flow event would not have caused a more limiting condition than that which is already analyzed for containment integrity.

Equipment Integrity

From the containment integrity analyses above, the calculated limiting peak containment temperature was determined to be 268.4°F at 19.4 seconds into the event. The analyses indicate that, assuming a low ICW flow event, containment temperatures are maintained well below the environmental qualification (EQ) envelope at all times. At 5 hours after a LOCA event, the containment temperature will be approximately 197°F. Also, from the containment integrity analyses, the peak containment pressure reached was 45.2 psig at 19.4 seconds and fell to 13.5 psig within 5 hours. Therefore, the calculated containment temperatures and pressure levels due to the low ICW flow event did not exceed the EQ allowables.

LOCA Emergency Containment Cooling System

This analysis is not affected by the low ICW flow event in a non-conservative manner. Elevated CCW system "supply" temperatures to the ECCs are a benefit to the containment pressure affects on the LOCA peak clad temperature (PCT) calculations. The minimum backpressures assumed in PCT calculations are conservative since the elevated CCW temperatures to the ECCs would reduce the ECCs performance and therefore increase backpressures.

See above for a discussion of the affect of the event on containment integrity.

Main Steamline Break

The MSLB analysis is not affected by the ICW low flow event as long as the SI pumps and all other safety systems remain operable.

Radiological Consequences

The design basis doses are not affected by the ICW low flow event. As stated earlier, the design basis containment integrity analyses remain bounding, the LOCA PCT analyses are not affected, the MSLB analyses are not affected and the safety system components remain operable and intact. Therefore, doses to plant personnel and the general public are not affected.

Overall Safety Significance

The overall conclusions of the above safety assessments are that all critical areas of plant accident analyses remain bounded. This conclusion is possible because of the short duration of the low flow transient and actual plant operating conditions at the time of the event are well below limiting analyses conditions. The inherent margin provided by the plant configuration and the lower operating conditions countered the adverse affects associated with the temporary low ICW flow.

Additionally, FPL performed a probablistic safety assessment for this event. The low ICW flow was conservatively modeled as a complete loss of CCW flow for one hour. The assessment concluded that the calculated core damage frequency did not increase above the base line of 6.63×10^{-5}/year.

IV. CORRECTIVE ACTIONS

1. The basket strainers were mechanically cleaned to restore ICW flow to greater than the minimum flow required for the canal temperature and CCW heat exchanger fouling factors found at the time of the event.

2. Two floating booms are installed in the canal system. The first, installed prior to the event, is at the extreme southern end of the canal system to catch floating aquatic grass and algae material prior to the flow release point into the return canals. This first boom was only partially effective in controlling the grass and algae influx. The second was installed in the final return canal within a quarter mile of the intakes to catch any floating material which was not caught by the first floating boom. These booms are used on an as needed basis.

3. A pump has been installed to remove the grass and algae from the canal at the location of the first boom installed at the southern end of the canal system. This pump is used on an as needed basis.

4. An Off Normal Operating Procedure, 3/4 ONOP-011, "Screen Wash System/Intake Malfunction," has been developed (March 28, 1995) to provide guidance on actions to be taken in the event of a major influx of grass/debris into the intake structure. This procedure also references 3/4-ONOP-019, "Intake Cooling Water Malfunction."

5. Training brief #544, which clarifies the need to run ICW pumps in bays without circulating pumps operating to reduce the level of basket strainer fouling, has been issued.

6. A traveling screen performance program will be developed to monitor and improve the performance of the screen system. Areas to be considered, and included if appropriate, are screen wash nozzle performance, screen wash pump performance, screen wash strainer performance, and traveling screen hole size. The program will be evaluated and implemented by July 15, 1995.

7. The ICW/CCW basket strainer performance can be improved. A method for determining flow through each basket strainer will be evaluated and implemented as appropriate. The evaluation and recommendation of corrective actions will be completed by July 1, 1995. Any recommended system modifications will be scheduled for refueling outages starting after 1996.

V. ADDITIONAL INFORMATION

EIIS Codes are shown in the format [EIIS SYSTEM: IEEE component function identifier, second component function identifier (if appropriate)].

No similar Licensee Event Reports have been submitted concerning low ICW flow.