U. S. NUCLEAR REGULATORY COMMISSION
REGION I

DOCKET/REPORT NOS.	50-334/94-03 50-412/94-03
LICENSE NOS.	DPR-66 NPF-73
LICENSEE:	Duquesne Light Company One Oxford Center 301 Grant Street Pittsburgh, Pennsylvania 15279
FACILITY:	Beaver Valley Power Station, Units 1 and 2
LOCATION:	Shippingport, Pennsylvania
INSPECTION DATES:	January 24-28, 1994

INSPECTORS: Michael Buckley 2/28/94
Michael Buckley, Reactor Engineer — Date
Systems Section, EB, DRS

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APPROVED BY: for Peter O'Reilly 3/8/94
Dr. Plackeel K. Eapen, Chief — Date
Systems Section, EB, DRS

Areas Inspected: A reactive inspection was conducted of the licensee's corrective actions, in response to the Unusual Event declared on January 9, 1994. This Unusual Event was declared when a technical specification shutdown was initiated by a loss of river water flow to the containment recirculation spray coolers. The licensee's actions to restore river water flow, the sequence of events leading to the loss of river water flow, and the history of similar events were reviewed. The licensee's measures to identify the cause of the loss of flow, to correct the immediate adverse condition, and the actions taken to prevent repetition were assessed.

Results: The licensee proceeded in a conservative manner in shutting down the unit and restoring full river water flow to the recirculation spray coolers before resuming power operation. The long term activities for assurance of continued river water flow to the recirculation spray coolers were under development and subject to further review by the NRC.

The technical specifications surveillance test procedure was changed to require flow testing of the containment recirculation spray heat exchangers (RSHXs) prior to cleaning. Pre-cleaning of the RSHXs will be discontinued. There was a similar loss of river water flow event on October 21, 1991. The corrective actions for the 1991 event were not adequate to prevent the recurrence on January 7, 1994.

One violation of NRC requirements was identified for failure to take measures to prevent the recurrence of a loss of river water flow to the RSHXs.

DETAILS

1.0 PURPOSE

The purpose of this inspection was to review the licensee's activities to address the Unusual Event at Unit 1 on January 9, 1994. This Unusual Event was declared when a technical specification required shut down was initiated following the determination that there was inadequate river water flow through the containment recirculation spray heat exchangers. The inspectors also assessed the adequacy of the corrective actions for this event, and the ability of the recirculation spray heat exchangers and the river water pumps to perform their intended safety function.

2.0 EVENT DESCRIPTION

During surveillance testing of the safety-related river water pumps on January 7, 1994, there was inadequate river water flow through the "A" and "C" containment recirculation spray heat exchangers (RSHXs). At 7:40 p.m., on the same day, the licensee declared the two containment recirculation spray subsystems inoperable and entered a 72-hour limiting condition for operation (LCO) at Unit 1. Subsequently, on January 9, 1994, at 11:15 a.m., the licensee declared an Unusual Event and commenced a technical specification shutdown to clean the "A" and "C" RSHXs.

Following the shutdown and containment entry, the licensee cleaned the "A" and "C" RSHXs. The "B" RSHX was also cleaned to assure its flow would be adequate. Approximately 15 gallons of debris (mostly asiatic clams and corrosion products) were removed from the three RSHXs.

On January 15, 1994, the licensee completed post-maintenance testing activities and declared all RSHXs operable. Unit 1 was started back up and connected to the grid on January 19, 1994.

3.0 SYSTEM DESCRIPTION

The Unit 1 system involved is called the river water system. It takes water from the Ohio River through debris-removing travelling screens, and supplies the water to cool several safety-related and nonsafety-related heat exchangers.

The necessary flows through the heat exchangers are maintained by three 100 percent capacity river water pumps. Each pump delivers approximately 9000 gallons per minute (gpm) and is designed to provide the quantity of water for the essential safety-related cooling requirements for all Unit 1 operating conditions. The pumps deliver river water from the screenwell to the primary auxiliary building (PAB) through two-24 inch headers. During normal operations, the river water flows through one or more of the nonsafety-related reactor plant component cooling water (CCW) heat exchangers inside the PAB. On a containment isolation following a design basis accident (DBA), the flow is diverted from the reactor plant CCW heat exchangers to four RSHXs.

The RSHXs (RS-E-1A, 1B, 1C, and 1D) are aligned such that two heat exchangers per train receive flow from one river water system header in a parallel flow arrangement. Each RSHX is a vertical, one pass heat exchanger with 37 foot-long tubes through which river water flows for post-accident heat removal. Normal RSHX flow is in excess of 5000 gallons per minute (gpm) per heat exchanger.

The Unit 1 RSHXs are located within the Unit 1 containment building which is at subatmospheric pressure during plant operation. The head flanges of the Unit 1 RSHXs are sealed with canopy welds ("B" and "D" RSHXs were replaced with bolted flange heat exchangers in 1993). Therefore, the licensee needs to shut down the unit to enter Operating Mode 5, break containment vacuum, and enter the containment to clean the RSHXs.

Unit 1 Technical Specification Surveillance Requirements 4.6.2.2.e.3, require, in part, that at least once per 18 months during shutdown, a flow rate of at least 8000 gpm shall be verified through each river water subsystem. Information provided by the licensee indicated that the 18 month surveillance was performed after the cleaning of the RSHXs during shutdowns. The licensee has since committed to conducting flow tests prior to cleaning the RSHXs.

The Unit 2 design is somewhat similar to Unit 1. However, Unit 2 is less vulnerable to a shutdown from RSHX problems since the RSHXs are located outside the Unit 2 containment and have bolted head flanges.

4.0 HISTORY OF THE UNIT 1 RIVER WATER AND THE UNIT 2 SERVICE WATER SYSTEM PROBLEMS

On 4/28/89, during Unit 2's refueling outage, the "A" & "B" trains of the service water system failed Operational Surveillance Test (OST) 2.30.13, "Reactor Plant Service Water System Full Flow Test." Subsequent inspection of the 4 recirculation spray heat exchangers (RSHX) revealed about 25 lbs. of Asiatic clams in the "B" and "D" heat exchangers. The licensee also found the limit switches for inlet isolation valves slightly out of alignment and determined that this allowed a small amount of service water leakage and the origin/growth spot for the Asiatic clams. The heat exchangers were cleaned/flushed and satisfactory flow rates were restored prior to the end of Unit 2 outage.

On 10/3/90, during a quarterly river water pump surveillance test at Unit 1, the licensee noted an unexpected drop in river water flow to the "A" & "C" RSHXs. The "C" RSHX was subsequently declared inoperable. The licensee performed an analysis using 75 degree F river water vice 90 degrees F and demonstrated that 6000 gpm was sufficient river water flow instead of the original requirement of 8000 gpm. Boroscope inspection showed tube plugging from asiatic clams and debris. The licensee applied for, and subsequently received, a Temporary Wavier of Compliance to operate this system at a reduced flow until the April 1991 outage.

On October 21, 1991, while performing the river water pump quarterly surveillance tests at Unit 1, the "A" train RSHXs were declared inoperable. The licensee performed a plant shutdown on October 22, 1991, due to the heat exchanger fouling and potential pump coupling problems. The root cause of the event appeared to be Asiatic Clams. The deteriorated condition of the shells indicated that the clams were in the system for some time.

It was further determined by the licensee that due to the current piping configuration, it was possible, by alternating river water header use and component cooling water heat exchanger maintenance, for a quantity of clams to be lodged in low flow areas upstream of the heat exchanger inlet isolation valves. When flow was initiated to the RSHXs during pump testing, the clams were swept into the "A" and "C" heat exchangers to cause a reduced flow.

During NRC inspection 92-18 of Unit 1, the quarterly pump flow test was observed by the resident inspector and the measured flows through the heat exchangers were found to be acceptable. However, with the heat exchanger outlet valves completely open, the minimum flow rates were not achieved until after individual flushing of each heat exchanger. The licensee determined the cause to be silt and sediment build-up.

On January 21, 1993, the licensee declared the Unit 1 "B" RSHX inoperable because of inadequate river water flow during monthly flushing. The cause was attributed to silt getting by the leaking heat exchanger inlet isolation valves.

On January 7, 1994, the licensee declared the Unit 1 "A" & "C" RSHX's inoperable due to inadequate flow. On January 9, 1994, the licensee declared an Unusual Event and commenced a technical specification shutdown. The cause of the flow blockage was Asiatic clams and corrosion products. The inadequate river water flow condition was discovered during the quarterly pump flow surveillance test.

During the April 1993 outage, the heat exchanger inlet isolation valves were replaced. Following this, the licensee started performing the quarterly pump flow test using an alternate flow path (component cooling water heat exchangers). When the licensee determined that the instrumentation used for testing was not reliable, they returned to the original flow path. Since that time, the licensee has performed numerous flushing evolutions. The inspectors determined that during these numerous flushes, debris was collected in the low flow area of the piping system upstream of the heat exchanger isolation valves. Subsequently, when the pump flow test was performed utilizing the original flow path, the heat exchangers became clogged and the technical specifications requirements for river water flow were not met.

The increased periodicity of RSHX flushes following degraded flow observations by the licensee have proven to be one method of keeping the RSHXs clear of debris. Quarterly surveillance testing of the three river water pumps have been the means for determining degraded flow. Changing the quarterly river water pump surveillance test to incorporate RSHX monitoring was a good initiative. However, when the licensee changed the OST to

utilize a non-RSHX flow path, the quarterly monitoring of the RSHXs ended. This was a contributing factor in the event of January 9, 1994. The inspectors determined that the accumulation of debris upstream of the "A" and "B" train RSHX inlet isolation valves could prevent the RSHXs from performing their safety function. The licensee has shown in this and past events that the design basis heat loads would have been met with the measured flow rates and river water temperatures at the time of the event.

5.0 CORRECTIVE ACTION

The licensee's corrective actions only focused on corbicular and silt fouling of the river water and service water systems as summarized below.

- A Corbicula (Asiatic Clams) Control program was developed including an ongoing environmental monitoring program.

- A maintenance procedure was developed to inspect for clams when heat exchangers are opened.

- The frequency of cleaning the main and emergency intake structure was increased.

- The RSHXs are flushed when flow degradation is determined. Flushing only follows other river water system testing.

- Procedure changes were made to reduce the chances of dead leg accumulation of debris.

- River dredging operations are performed to minimize silt/sediment deposits.

- Engineering studies were made to evaluate intake structures to help prevent silt and clams from entering the river water pump inlets.

- Isolation valves were replaced to help prevent silt from accumulating in the RSHXs.

5.1 Corbicula Control Program (Asiatic Clams)

In 1992, permission was granted by the Pennsylvania Department of Environmental Resources (DER) to use a chemical additive (Clam-trol or CT-1) in combination with a detoxification agent (DT-1), a bentonite clay, in the Unit 1 and Unit 2 river water systems for the control of the biofouling clam, Corbicula. This approval followed an extensive investigation during 1990 and 1991 to determine the effect of the chemical additives on the environment.

The corbicula, unlike other biofouling, do not adhere to internal surfaces, but instead settle into low-flow, silt laden areas and grow or move about as environmental conditions change. This phenomena creates a flow blockage problem for heat exchangers throughout the river water system. The traveling screens in the intake structure prevent any large corbicula (greater than 1/2-inch) from entering the system. However, the problem occurs when juvenile corbicula enter the system through the traveling screen structure, settle out, and grow to a size that can cause flow blockage.

Flow blockages were not observed in parts of the plant where there was constant river water flow or where system design allowed the licensee to clean and inspect the heat exchangers without impeding plant operations.

The licensee's Corbicula Control Program philosophy has been to perform clamicide applications as necessary to exterminate any juvenile corbicula that may have entered the plant's river water system before they grow to a size that could impact plant operations. The clamicide applications are typically scheduled after periods of high clam migration and spawning periods which are during the months of late April to early June, and late August to early October.

The inspectors determined, by review of documentation and interviews, that the Corbicula Control Program is very effective when treatments are scheduled at the correct time of the year. Licensee studies have shown that greater than a 90 percent mortality rate has been achieved when timely application has been performed. The on-going surveillance monitoring of the intake structure and cooling tower corbicula give the licensee a reliable representation of corbicula activities.

Following the event of January 9, 1994, the debris removed from the heat exchangers included corbicula. The origin of the clams appear to be either the intake structure (upstream of the traveling screens) or the low flow (dead leg) areas upstream of the normally closed RSHXs inlet isolation valves. The late November 24, 1993, application of clamicide may have not been a factor in this instance because the recently installed isolation valves would have prevented any clamicide from flowing to the dead leg areas. The inspectors determined by review of inspection documentation and observation of the licensees video of RSHX inspection, that as little as 1/2 a gallon of clams can block as much as 50% of the heat exchanger tubes.

5.2 Silt Control

In the past, the licensee determined that the RSHX river water flow problems were partially caused by silt and sediment from the Ohio River accumulating in some areas of the river water system.

The corrective actions included continuous chemical injection, monthly flushes through the RSHXs, alternate flush paths prior to flow testing, replacement of leaking isolation valves, cleaning of intake bays, and dredging of the river by the intake structure.

5.3 Corrosion Products

The recent event on January 7, 1994, revealed an additional flow blockage problem that the licensee stated has not been observed in the past. After opening and inspecting the RSHXs, a large amount (approximately 35 pounds) of ferro-magnetic corrosion products and turbucles were removed. Tubercles are knob like mounds of corrosion products that result from the formation of localized corrosion products on the interior walls of the system components.

6.0 CONCLUSIONS

Based on interviews, review of documentation, and system walkdowns, the inspectors determined that the licensee has taken good short term corrective action. However, the numerous actions taken to restore adequate river water flow through the Unit 1 RSHXs have been ineffective.

The Corbicula Control Program is an extensive program. However, due to the environmental variables which control the spawning and growth cycle of the corbicula and the requirement to have the units in operation at the time of application, the timeliness of application has not always been adequate.

The event of October 21, 1991, in which the licensee identified low flow areas as a source of clogging debris, was again repeated on January 7, 1994. The corrective actions taken, cleaning and flushing, procedural changes, corbicula control program, and dredging did not prevent repetition of flow blockage from dead leg areas. This inadequate corrective action is a violation of 10 CFR, Part 50, Appendix B, Criterion XVI requirements (NOV 50-334/94-03-01).

7.0 EXIT MEETING

The inspector met with licensee personnel, denoted in Attachment A of this report, at the conclusion of the onsite inspection on January 28, 1994. At that time, the scope of the inspection and inspection results were summarized. The licensee acknowledged the inspection findings as detailed in this report and had no additional comments regarding the inspection results.

ATTACHMENT A

Persons Contacted

Duquesne Light Company

R. Boyle, River/Service Water System Engineer
* A. Dulick, Manager, Chemistry Operations
* S. Fenner, General Manager Maintenance Programs
* L. Freeland, General Manager, Nuclear Operations
J. Johns, Supervisor, Quality Services
* F. Lipchick, Sr. Licensing Supervisor
* T. Mcghee, Supervisor, Onsite Safety Committee
* D. McLain, Manager, Maint. Engr. & Assessment
* A. Mizia, Supervisor, Quality Services Unit
* T. Noonan, General Manager Nuclear Engr. and Safety
* D. Orndorf, Director, Chemistry Operations
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* L. Rossbach, Senior Resident Inspector, Beaver Valley
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* Denotes those personnel attending the exit meeting on January 28, 1994.