UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 1000
ARLINGTON, TEXAS 76011

April 21, 1981

MEMORANDUM FOR: Those Listed Below

FROM: G. L. Madsen, Chief, Reactor Projects Branch, IE:RIV

SUBJECT: IE BULLETIN NO. 81-03

Subject IE Bulletin has been sent to the following listed licensees. A copy of the IE Bulletin is attached for your information.

Arkansas Power & Light Company
ANO-1 & 2 (50-313; 50-368)

Nebraska Public Power District
Cooper Nuclear Station (50-298)

Omaha Public Power District
Fort Calhoun (50-285)

Public Service Company of Colorado
Fort St. Vrain (50-267)

Gulf States Utilities
River Bend (50-458; 50-459)

Houston Lighting & Power Company
South Texas (50-498; 50-499)

Kansas Gas & Electric Company
Wolf Creek (STN 50-482)

Louisiana Power & Light Company
Waterford-3 (50-382)

Texas Utilities Generating Company
Comanche Peak (50-445; 50-446)

G. L. Madsen, Chief
Reactor Projects Branch

ATTACHMENT:
As stated

DISTRIBUTION:
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Flow rates measured during surveillance testing through the CCUs at ANO-2 had deteriorated over a number of months. Flushing after plant shutdown initially resulted in a further reduction in flow. Proper flow rates were restored only after the clam debris had been removed manually from the CCUs.

The examination of the Unit 1 service water system revealed that the "C" and "D" containment coolers were clogged by clams. Clams were found in the 3-inch inlet headers and in the inlet water boxes. However, no clams were found in the "A" and "B" coolers. This fouling was not discovered during surveillance testing because there was no flow instrumentation on these coolers.

The service water system in Unit 1 was not fouled other than stated above, and the licensee attributed this to the fact that the service water pump suctions are located behind the main condenser circulating pumps in the intake structure. It was thought that silt and clams entering the intake bays would be swept through the condenser by the main circulating pumps and would not accumulate in the back of the intake bays. In contrast, Unit 2 has no main circulating pumps in its intake structure because condenser heat is rejected through a cooling tower via a closed cooling system. As a result of lower flowrates of water through the Unit 2 intake structure, silt and clams could have a tendency to accumulate more rapidly in Unit 2 than in Unit 1. During the September outage, clams and shells were found to have accumulated to depths of 3 to 4-1/2 feet in certain areas of the intake bays for Unit 2.

The Asiatic clam was first found in the United States in 1938 in the Columbia River near Knappton, Washington. Since then, Corbicula sp. has spread across the country and is now reported in at least 33 states. The Tennessee Valley Authority (TVA) power plants also have experienced fouling caused by these clams. They were first found in the condensers and service water systems at the Shawnee Steam Plant in 1957. Asiatic clams were later found in the Browns Ferry Nuclear Plant in October 1974 only a few months after it went into operation. This initial clam infestation at Browns Ferry was enhanced by the fact that, during the final stages of construction, the cooling water systems were allowed to remain filled with water for long periods of time while the systems were not in use. This condition was conducive to the growth and accumulation of clams. Since that time, the Asiatic clam has spread across the Tennessee Valley region and is found at virtually all the TVA steam-electric and hydroelectric generating stations.

Present control procedures for Asiatic clams vary from station to station and in their degree of effectiveness. The use of shock chlorination during surveillance testing as the only method of controlling biofouling by this organism appears to be ineffective. The level of fouling has been reduced to acceptable levels at TVA stations by using continuous chlorination during peak spawning periods, clam traps, and mechanical cleaning during station outages.

The results of a series of tests on mollusks performed at the Savannah River facility showed that mature Corbicula sp. had as much as a 10 percent survival rate after being exposed to high concentrations of free residual chlorine (10 to 40 ppm) for up to 54 hours. When the clams were allowed to remain buried in a couple of inches of mud, their survival rates were as high as 65 percent.

In studies on shelled larvae, approximately 200 microns in size, TVA reported preliminary results indicating that a total chlorine residual of 0.03 to 0.40 ppm for 96 to 108 hours would be required to achieve 100 percent control of the Asiatic calm larvae.

Corbicula sp. has also shown an amazing ability to survive even when removed from the water. Average times to death when left in the air have been reported for low relative humidity as 6.7 days at 30°C (86°F) and 13.9 days at 20°C (68°F) and for high relative humidity as 8.3 days at 30°C and 26.8 days at 20°C.

Corbicula sp. on the other hand, has shown a much greater sensitivity to heat. Tests performed by TVA resulted in 100 percent mortality of clam larvae, very young clams, and 2mm clams when they were exposed to 47°C (117°F) water for 2 minutes. Mature clams, up to 14mm, were also tested and all died at 47°C following a 2 minute exposure. A statistical analysis of the 2 minute exposure test data revealed that a temperature of 49°C (120°F) was necessary to reach the 99 percent confidence level of mortality for clams of the size tested.

To date, heat has been shown to be the most effective way of producing 100 percent mortality for the Asiatic clam. At ANO, the service water system was flushed with 77°C (170°F) water obtained from the auxiliary boiler for approximately one half hour; 100 percent mortality was expected.

A similar problem has occurred with mussels (Mytilus sp.). Infestations of mussels have caused flow blockage of cooling water to safety-related equipment at nuclear plants such as Pilgrim and Millstone. Unlike the Asiatic clam, mussels cause biofouling in salt water cooling systems.

The event at ANO is significant to reactor safety because (1) the fouling represented an actual common cause failure, i.e, inability of safety system redundant components to perform their intended safety functions, and (2) the licensee was not aware that safety system components were fouled Although the fouling at ANO-2 developed over a number of months, neither the licensee management control system nor periodic maintenance or surveillance program detected the failure.

ACTIONS TO BE TAKEN BY LICENSEES

Holders of Operating Licenses:

1. Determine whether Corbicula sp. or Mytilus sp. is present in the vicinity of the station (local environment) in either the source or receiving water body. If the results of current field monitoring programs provide reasonable evidence that neither of these species is present in the local environment, no further action is necessary except for items 4 and 5 in this section for holders of operating licenses.

2. If it is unknown whether either of these species is present in the local environment or is confirmed that either is present, determine whether fire protection or safety-related systems that directly circulate water from the station source or receiving water body are fouled by clams or mussels or debris consisting of their shells. An acceptable method of confirming the absence of organisms or shell debris consists of opening and visually examining a representative sample of components in potentially affected safety systems and a sample of locations in potentially affected fire protection systems. The sample shall have included a distribution of components with supply and return piping of various diameters which exist in the potentially affected systems. This inspection shall have been conducted since the last clam or mussel spawning season or within the nine month period preceding the date of this bulletin. If the absence of organisms or shell debris has been confirmed by such an inspection or another method which the licensee shall describe in the response (subject to NRC evaluation and acceptance), no further action is necessary except for items 4 and 5 of actions applicable to holders of an operating license.

3. If clams, mussels or shells were found in potentially affected systems or their absence was not confirmed by action in item 2 above, measure the flow rates through individual components in potentially affected systems to confirm adequate flow rates i.e., flow blockage or degradation to an unacceptably low flow rate has not occurred. To be acceptable for this determination, these measurements shall have been made within six months of the date of this bulletin using calibrated flow instruments. Differential pressure (DP) measurements between supply and return lines for an individual component and DP or flow measurements for parallel connected individual coolers or components are not acceptable if flow blockage or degradation could cause the observed DP or be masked in parallel flow paths.

   Other methods may be used which give conclusive evidence that flow blockage or degradation to unacceptably low flow rates has not occurred. If another method is used, the basis of its acceptance for this determination shall be included in the response to this bulletin.

   If the above flow rates cannot be measured or indicate significant flow degradation, potentially affected systems shall be inspected according to item 2 above or by an acceptable alternative method and cleaned as necessary. This action shall be taken within the time period prescribed for submittal of the report to NRC.

4. Describe methods either in use or planned (including implementation date) for preventing and detecting future flow blockage or degradation due to clams or mussels or shell debris. Include the following information in this description:

a. Evaluation of the potential for intrusion of the organisms into these systems due to low water level and high velocities in the intake structure expected during worst case conditions.

b. Evaluation of effectiveness of prevention and detection methods used in the past or present or planned for future use.

5. Describe the actions taken in items 1 through 3 above and include the following information:

a. Applicable porteions of the environmental monitoring program including last sample date and results.

b. Components and systems affected.

c. Extent of fouling if any existed.

d. How and when fouling was discovered.

e. Corrective and preventive actions.

Holders of Construction Permits:

1. Determine whether Corbicula sp. or Mytilus sp. is present in the vicinity of the station by completing items 1 and 4 above that apply to operating licenses (OL).

2. If these organisms are present in the local environment and potentially affected systems have been filled from the station source or receiving water body, determine whether infestation has occurred.

3. Describe the actions taken in items 1 and 2 above for construction permit holders and include the following information:

a. Applicable portions of the environmental monitoring program including last sample date and results.

b. Components and systems affected.

c. Extent of fouling if any existed.

d. How and when fouling was discovered.

e. Corrective and preventive actions.

Licensees of facilities with operating licenses shall provide the requested report within 45 days of the date of this bulletin. Licensees of facilities with construction permits shall provide the report within 90 days.

Provide written reports as required above, signed under oath or affirmation, under the provisions of Section 182a of the Atomic Energy Act of 1954. Reports shall be submitted to the Director of the appropriate Regional Office and a copy forwarded to the Director, Office of Inspection and Enforcement, NRC, Washington, D.C. 20555.

This request for information was approved by GAO under a blanket clearance number R0072 which expires November 30, 1983. Comments on burden and duplication should be directed to Office of Management and Budget, Room 3201, New Executive Office Building, Washington, D.C. 20503.

IE Bulletin No. 81-03,
April 10, 1981

RECENTLY ISSUED IE BULLETINS

Bulletin No.	Subject	Date Issued	Issued To
80-23	Failures of Solenoid Valves Manufactured by Valcor Engineering Corporation	11/14/80	All power reactor facilities with Operating License (OL) or Construction Permit (CP)
80-24	Prevention of Damage Due to Water Leakage Inside Containment (October 17, 1980 Indian Point 2 Event)	11/21/80	All power reactor facilities with Operating License (OL) or Construction Permit (CP)
Sup. 4 Bulletin 80-17	Failure of Control Rods to Insert During A Scram at a BWR	12/18/80	To specified BWRs with an Operating License (OL) and All BWRs with a Construction Permit (CP)
80-25	Operating Problems with Target Rock Safety-Relief Valves at BWRs	12/19/80	All BWR facilities with Operating License (OL) and specified near term Operating License (OL) BWR facilities and all BWRs with a Construction Permit (CP)
81-01	Surveillance of Mechanical Snubbers	1/27/81	All power reactor facilities with an Operating License (OL) and to specified facilities with Construction Permit (CP)
80-17, Sup. 5	Failure to Control Rods to Insert During a Scram	2/13/81	All BWR facilities with Operating License (OL) or Construction Permit (CP)
81-01 Rev. 1	Surveillance of Mechanical Snubbers	3/4/81	All power reactor facilities with an Operating License (OL) and specified facilities with a Construction Permit (CP)
81-02	Failure of Gate Type Valves to Close Against Differential Pressure	3/9/81	All power reactor facilities with an Operating License (OL) or Construction Permit (CP)

Enclosure

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SSINS No.: 6820
Accession No.:
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IEB 81-03

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

FLOW BLOCKAGE OF COOLING WATER TO SAFETY SYSTEM COMPONENTS BY CORBICULA SP. (ASIATIC CLAM) AND MYTILUS SP. (MUSSEL)

Description of Circumstances:

On September 3, 1980, Arkansas Nuclear One (ANO), Unit 2, was shut down after the NRC Resident Inspector discovered that Unit 2 had failed to meet the Technical Specification requirements for minimum service water flow rate through the containment cooling units (CCUs). After plant shutdown, Arkansas Power and Light Company, the licensee, determined that the inadequate flow was due to extensive plugging of the CCUs by Asiatic clams (Corbicula species, a non-native fresh water bivalve mollusk). The licensee disassembled the service water piping at the coolers. Clams were found in the 3-inch diameter supply piping at the inlet to the CCUs and in the cooler inlet water boxes. Some of the clams found were alive, but most of the debris consisted of shells. The size of the clams varied from the larvae stage up to one inch. The service water, which is taken from the Dardanelle Reservoir, is filtered before it is pumped through the system. The strainers on the service water pump discharges were examined and found to be intact. Since these strainers have a 3/16-inch mesh, much smaller than some of the shells found, it appears that clams had been growing in the system.

Following the discovery of Asiatic clams in the containment coolers of Unit 2, the licensee examined other equipment cooled by service water in both Units 1 and 2. Inspection of other heat exchangers in the Unit 2 service water system revealed some fouling or plugging of additional coolers (seal water coolers for both redundant containment spray pumps and one low-pressure safety injection pump) due to a buildup of silt, corrosion products, and debris (mostly clam shell pieces). The high-pressure safety injection (HPSI) pump bearing and seal coolers were found to have substantial plugging in the 1/2-inch pipe service water supply lines. The plugging resulted from an accumulation of silt and corrosion products.

Clam shells were found in some auxiliary building room coolers and in the auxiliary cooling water system which serves non-safety-related equipment.

Flow rates measured during surveillance testing through the CCUs at ANO-2 had deteriorated over a number of months. Flushing after plant shutdown initially resulted in a further reduction in flow. Proper flow rates were restored only after the clam debris had been removed manually from the CCUs.

The examination of the Unit 1 service water system revealed that the "C" and "D" containment coolers were clogged by clams. Clams were found in the 3-inch inlet headers and in the inlet water boxes. However, no clams were found in the "A" and "B" coolers. This fouling was not discovered during surveillance testing because there was no flow instrumentation on these coolers.

The service water system in Unit 1 was not fouled other than stated above, and the licensee attributed this to the fact that the service water pump suctions are located behind the main condenser circulating pumps in the intake structure. It was thought that silt and clams entering the intake bays would be swept through the condenser by the main circulating pumps and would not accumulate in the back of the intake bays. In contrast, Unit 2 has no main circulating pumps in its intake structure because condenser heat is rejected through a cooling tower via a closed cooling system. As a result of lower flowrates of water through the Unit 2 intake structure, silt and clams could have a tendency to accumulate more rapidly in Unit 2 than in Unit 1. During the September outage, clams and shells were found to have accumulated to depths of 3 to 4-1/2 feet in certain areas of the intake bays for Unit 2.

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Present control procedures for Asiatic clams vary from station to station and in their degree of effectiveness. The use of shock chlorination during surveillance testing as the only method of controlling biofouling by this organism appears to be ineffective. The level of fouling has been reduced to acceptable levels at TVA stations by using continuous chlorination during peak spawning periods, clam traps, and mechanical cleaning during station outages.

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