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FEB 2 2 2011

LR-E11-0026

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Nuclear LLC

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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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Salem Generating Station, Units 1 And 2
Facility Operating License Nos. DPR-70 And DPR-75
NRC Docket Nos. 50-272 and 50-311

Subject: **Fish Collected at Salem Circulating Water Intake Structure**

On January 24, 2011, Salem Site Maintenance workers performing weekly cleaning of the Salem Unit 1 Circulating Water trash racks made an unusual observation of fish that had been stranded below the surface of the water on the intake trash bars. No threatened or endangered species were observed.

The fish were observed to be extremely lethargic. The combination of unusually cold and rapidly declining river water temperatures, higher than normal salinity, combined with the increasing abundance of striped bass in the Delaware Estuary are believed to have resulted in the cold coma/cold shock to striped bass and the other species observed at the Salem Circulating Water Intake Structure trash bars during January 2011 (see Attachment 1). Several fish were returned to the river but they did not appear to survive.

Further cleaning of the trash racks was suspended, and management (Operations and Environmental Affairs) was notified. The NRC resident and New Jersey Department of Environmental Protection (NJDEP), Division of Fish and Wildlife were notified of this event. The NJDEP indicated that this event did not constitute a violation of the NJPDES permit.

Both Salem Units and the adjacent Hope Creek Unit have been in continuous service prior to the event with no significant changes in circulating water discharge temperature. At the time of the event all three units were at 100% power.

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This report is being provided in accordance with Appendix B to Facility Operating License Nos. DPR-70 and DPR-75, PSEG Nuclear LLC Environmental Protection Plan (Non-radiological), Section 4.1.

There are no commitments contain in this letter. If there are any questions or additional information is required, please do not hesitate to contact Jeff Pantazes, Manager of Nuclear Environmental Affairs at (856) 339-7900.

Sincerely,

for CJF

Carl J. Fricker
Site Vice President – Salem

Attachments (1)

cc: Mr. William Dean, Administrator, Region 1, NRC
Mr. Daniel Schroeder, NRC Senior Resident Inspector, Salem
Mr. Patrick Mulligan, Manager IV, New Jersey Bureau of Nuclear Engineering
H. Berrick, Salem Commitment Tracking Coordinator
L. Marabella, Corporate Commitment Tracking Coordinator

FEB 2 2 2011

Bcc:

T. Joyce, President & CNO PSEG
R. Braun, Sr Vice President - Nuclear
E. Eilola, Plant Manager - Salem
C. Neely, Director Regulatory Affairs
J. Pantazes, Manager – Nuclear Environmental Affairs
J. Kandasamy, Manager Regulatory Assurance - Salem
J. Keenan, Manager Licensing
Records Management

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PSEG
Power LLC

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Cold Shock Mortality in Striped Bass (*Morone saxatalis*)
Biological Background

__Cold Shock__ - Most fishes maintain a body temperature that is about the same temperature as the surrounding water. Organisms such as striped bass (*Morone saxatalis*), and most other fish species, rely on external heat sources and are referred to as ectotherms[1]. Temperature controls and limits all physiological and behavioral parameters of ectotherms. Optimal temperature ranges, as well as upper and lower lethal temperatures, vary widely between and among species and are dependent on genetics, developmental stage and thermal histories. Within the range of non-lethal temperatures, fishes are generally able to cope with gradual temperature changes that commonly occur in natural systems (e.g. diel variation, tidal activity, currents and seasonal cooling). Rapid decreases in water temperature may result in a number of physiological, behavioral, and fitness consequences for fishes termed "cold shock." Cold shock can be defined as an acute decrease in ambient temperature that has the potential to cause a rapid reduction in body temperature, resulting in a cascade of physiological and behavioral responses. A cold shock that reduces body temperatures to the lower limit of an organism's thermal range can result in sublethal disturbances and mortality. The magnitude of the cold shock response is dependent on both the rate of temperature decrease and the magnitude of change in relation to thermal tolerance limits[2].

Massive cold kills have been recorded for certain species, particularly in southern waters of the United States. These natural kills have usually been attributed to the sudden onset of cold weather. The cold shock kills have often occurred where species have lingered too long in abnormally warm water before beginning their southward or seaward migration to warmer waters[3].

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[1] Helfman, G. S., B. B Collette, and D. E. Facey. 1997. The Diversity of Fishes; Blackwell Science, Inc.; Malden, MA. 529 pp.
[2] Donaldson, M. R., S.J. Cooke, D. A. Patterson, and J. S. MacDonald. 2008. Cold shock and fish: A review paper. Journal of Fish Biology 73:1491-1530.
[3] Coutant, C. C. 1977. Cold shock to aquatic organisms: Guidance for power plant siting, design, and operation. *In* Environmental Effects (edited by R. O. Chester and J. E. Till). Nuclear Safety 18(3):329-342.

acclimation involves extensive changes in the internal biochemical composition of organisms which allow them to be as efficient in their physiological processes as possible at any given temperature. These physiological adjustments made during acclimation take time (on the order of days), and the rate of temperature decline can exceed the rate at which aquatic organisms can acclimate to decreasing temperature. The length of time required for acclimation is also proportional to the magnitude of temperature change. Each species also has a genetically determined minimum temperature beyond which metabolic adjustments are impossible. These temperature limits are called ultimate lethal thresholds or ultimate incipient lethal temperatures. For most temperate-zone fishes, this genetic minimum is near 0°C.

The dying process of fish due to cold shock is generally slow and fish can survive short durations of exposure to temperatures not far below the tolerance limit. Discrete steps in the dying process of fish can include a short period of hyperactivity, immediately followed by slowed movements and sinking to the bottom; a period of low responsiveness; a loss of body equilibrium; and a "cold coma" in which the fish is alive with gill covers that beat faintly. If the cold exposure continues, the cold coma is ended by a cessation of all gill-cover movements, and death[4].

Striped Bass - Striped bass (*Morone saxatilis*), an anadromous member of the temperate bass family, is a common inhabitant of bays, estuaries, and inshore coastal waters from Nova Scotia to Louisiana. Striped bass use fresh and brackish areas of the Delaware Estuary as spawning and nursery habitat and higher-salinity areas of the lower Bay as feeding grounds for larger juveniles and adults. In early spring, adult striped bass move from the ocean toward freshwater spawning areas in the Estuary. Spawning typically occurs from mid-April through mid-June in the main stem of the Tidal River Zone, usually upstream of Wilmington, Delaware, when water temperatures are in the range of 55º to 68°F. After spawning, the adults rapidly return to more brackish estuarine waters. Newly hatched larval striped bass remain planktonic and continue to be transported downstream as they grow and develop. As they grow, larval and early juvenile striped bass begin to orient toward the bottom and move toward shallow-water nursery areas along the shore. Juvenile striped bass reach adult appearance when they are approximately one month old and one inch long. These juveniles can be found in shallow, fresh or brackish areas of the Estuary throughout the summer[5].

As water temperatures decline in the fall, juvenile striped bass leave the shallow nursery waters and move toward deeper areas of the Transition and upper Delaware Bay Zones to overwinter. This migration begins in September or early October and is essentially complete in December. At the time of emigration, juvenile striped bass average three to five in. long and are active swimmers. During subsequent years, juveniles can be found in higher-salinity areas of the lower Bay Zone as they gradually assume adult behavioral

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[4] Coutant (1977)
[5] PSEG. 2006. Salem NJPDES Permit NJ0005622 Permit Renewal Application. PSEG Nuclear, LLC.

characteristics. Most striped bass reach sexual maturity when they are three to six years old[6].

The larger juveniles and adults of both sexes typically overwinter in the deeper waters of the Delaware Bay, or move offshore into oceanic waters. Many adult striped bass undertake seasonal migrations, moving north in late winter to early spring and south in the fall. Females gradually shift to increase use of ocean habitats at about ages 5 to 8. Detailed studies of acoustically tagged large juveniles and adults have demonstrated seasonal movements, including those between southern New Jersey and Maine estuaries. Evidence of repeated seasonal movements with return to native estuaries has also been observed[7].

Salem Station - The Salem circulating water intake structure ("CWIS") is located along the shoreline at the southwestern side of Artificial Island and consists of 12 separate intake bays (six for each unit). In winter, removable ice barriers are usually installed on the face of each of the 12 intake bays to prevent damage during severe icing conditions. River water enters the intake bays through fixed bar racks called trash racks designed to prevent large floating or submerged debris from entering the system. Each intake is equipped with a trash rack approximately 11 ft wide and 50 ft high. The bar assemblies extend from station grade to the bottom of each intake cell. The trash racks are constructed of half-inch-wide steel bars on three-and-a-half-inch centers; the size of the clear slot opening is three inches.

PSEG employees routinely inspect the trash racks and, if required, remove any debris using a mobile clamshell-type mechanical rake. There are two trash rakes which are self-contained and traverse the entire width of the intake. The trash rakes contain a hopper that transports the debris to basket-lined pits at each end of the intake. The removed debris is de-watered by gravity and disposed of offsite. After passing through the trash racks, intake water flows through vertical traveling screens of a modified Ristroph design that catch any remaining fish and debris. The traveling screens have been extensively upgraded to improve fish survival and debris removal.

Each traveling screen unit is a vertical, chain-link, four-post type machine on which the screen rotates continuously to collect debris as the water passes through the screen. Each traveling screen panel is 10 ft wide by 21 in. high with a composite material (nonmetallic) frame, and each traveling screen contains 62 panels. The wire mesh on each screen panel is 14-gauge Smooth Tex ® screening material with openings ¼ in. wide by ½ in. high.

Each screen panel has a 10-ft long composite-material fish bucket attached to its bottom support member. As the bucket travels over the head sprocket of the traveling

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[6] PSEG (2006)

[7] Able, K. A. and M. P. Fahay. 2010. Ecology of Estuarine Fishes – Temperate Waters of the Western North Atlantic. John Hopkins University Press, Baltimore, MD.

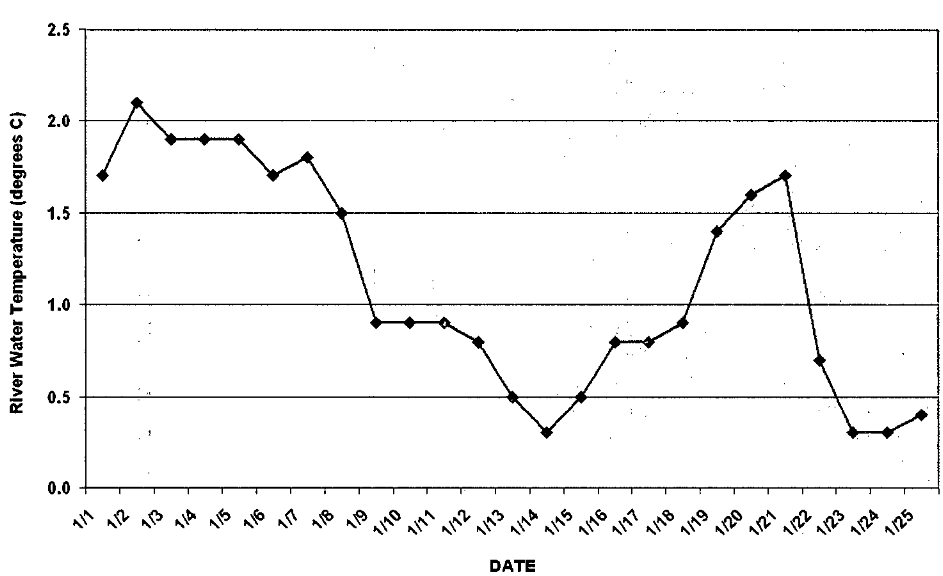
screen, organisms slide onto the screen face and are washed by the low-pressure spray system over a flap seal into a bi-directional fish trough. The troughs are bi-directional in that they are emptied in the direction of the tide, so that fish and debris will flow away from the CWIS, thus minimizing the likelihood of re-impingement. Wash water in the troughs is discharged either north or south depending upon tidal conditions.

Description of Event – On January 24, 2011, intake operators cleaning the trash bars along the front of the CWIS made an unusual observation of fish that had become stranded below the water surface on the intake trash bars. Approximately 175 striped bass, ranging in size up to approximately 40-in, along with smaller numbers of catfish and other miscellaneous species were brought to the surface with the trash rake among the grass and trash normally cleaned from the trash bars. No threatened or endangered species were observed. These fish were observed to be extremely lethargic and most had no gill cover movement, indicating that the fish were most likely dead or very near death. Further cleaning of the trash bars was suspended and Nuclear Environmental Affairs was notified.

As discussed below, based on the lack of external damage to the observed striped bass, the presence of some gill cover movement, the unusually cold river water temperature, and the recent drop in water temperatures, PSEG believes that this unusual occurrence is a result of cold coma or cold shock to fish present in the vicinity of Salem Station.

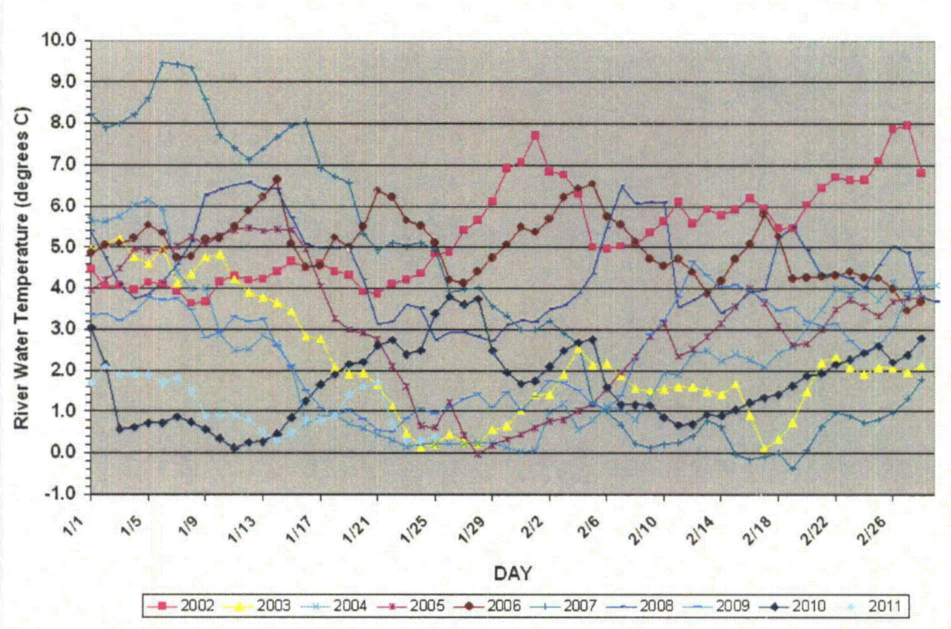
Evaluation of the Delaware River conditions indicates that ambient water temperatures on January 24th were averaging 0.3 °C. Examination of river temperatures for January 2011 indicates the average water temperature had also dropped 1.4 °C over the last two days (**Figure 1**).

Figure 1. Salem CWS Intake Temperature - January 2011



Historical temperature records for the Salem CWS intake during the critical winter period indicate that daily mean ambient river water temperatures approach 0°C every several years (**Figure 2**); however, dependent on acclimation temperature, fish physiology, and the rate of temperature decline, fish can typically tolerate these conditions for limited duration or are able to retreat to deeper, warmer water in the Delaware Bay. The ability of fish to tolerate these short duration fluctuations in temperature, and their ability to retreat to warmer waters when the temperature declines more gradually, explain why instances of cold coma and/or cold shock have not previously been observed at the Salem CWS intake.

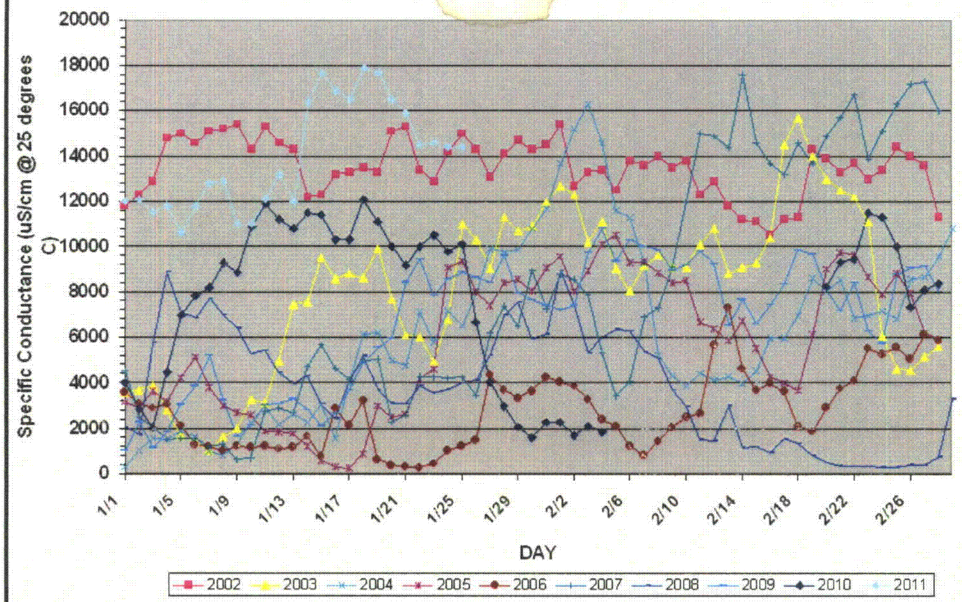
Figure 2. Average Daily Salem CWS Intake Temperature January-February (2002-2011)



Salinity is another factor that directly affects the winter distribution of fish in the Delaware Bay, and, potentially, the ability of these fish to physiologically adjust to declining temperature. Automated water quality instruments typically measure specific conductance, which is a good indicator of dissolved solids, and therefore, salinity. Specific conductance is the ability of water to conduct electricity and varies by temperature. To account for the affect of temperature, specific conductance values are normalized and reported in µS/cm @ 25 °C. The specific conductance of pure, freshwater would be approximately 0 µS/cm @ 25 °C and seawater would be approximately 50,000 µS/cm @ 25 °C.

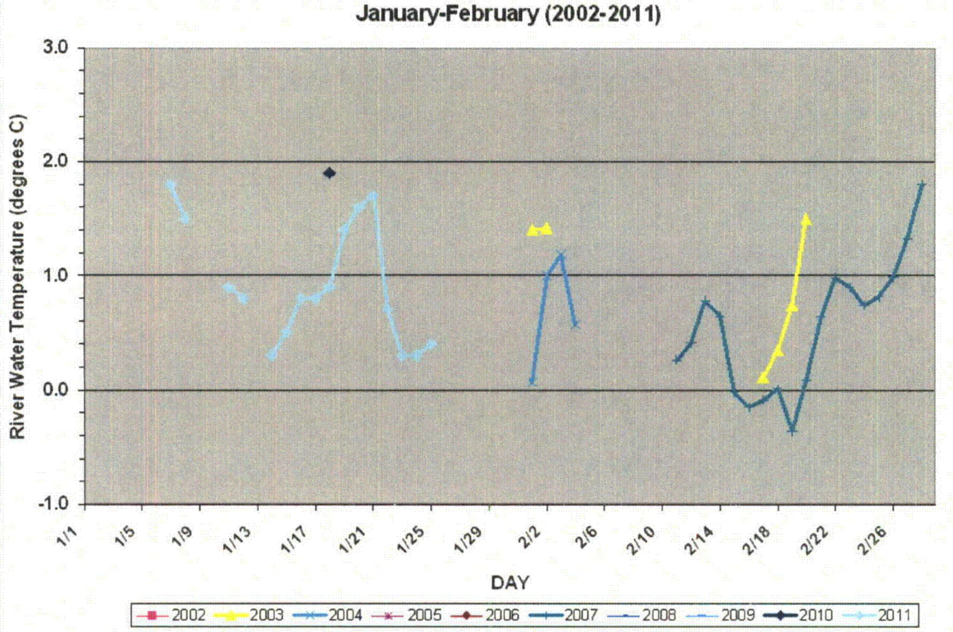
As indicated in **Figure 3**, the presence of higher salinity water in the vicinity of Salem Station during the critical low temperature period is a relatively infrequent occurrence.

Figure 3. Mean Daily Specific Conductance (uS/cm @ 25 degrees C)
Reedy Island Jetty
January-February (2002-2011)



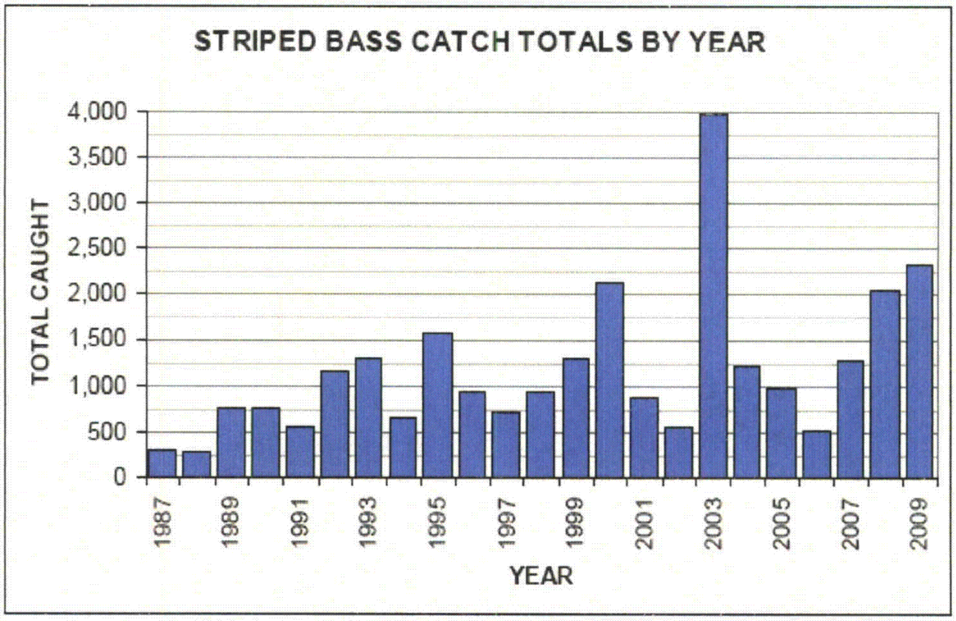
As indicated in Figure 4, a combination of ambient river water temperature less than 2°C and specific conductance > 12,000 µS/cm @ 25 °C (salinity >~8 ppt), has occurred only several times in the last 10 years.

Figure 4. Average Daily Salem CWS Intake Temperature
Concurrent with SC>12,000 (uS/cm)
January-February (2002-2011)



Examination of the river water temperature data during these historical occurrences, indicates that the combination of conditions that occurred on January 21-24, 2011 are unique, and that this is the only instance where fish in higher salinity water were not provided an opportunity to acclimate to temperatures < 2°C before being subjected to a greater than 1.4°C temperature drop within a two-day period.

Another potential contributing factor to the unusual event that was observed at the Salem CWS intake on January 24th is the increasing abundance of striped bass in the Delaware Estuary. As evidence by NJDEP River Beach Seine Survey data (**Figure 5**) and Delaware Department of Natural Resources Juvenile Trawl Survey data, the abundance of juvenile striped bass in the Delaware Estuary has been steadily increasing since the 1980's.



*from 1980 to 1986, the largest catch was 70 fish in 1986

Figure 5. NJDEP Delaware River Seine Survey

The combination of unusually cold and rapidly declining river water temperatures, higher than normal salinity, and an increasing abundance of striped bass in the Delaware Estuary are believed to have caused the cold coma/cold shock to striped bass and the other species observed at the Salem CWIS trash bars during January 2011.