



Constellation Energy

April 25, 2007

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318
Technical Specifications 3.1 and 3.2, Appendix B, Reporting Related to National
Pollutant Discharge Elimination System (NPDES) Permit

REFERENCE: (a) Calvert Cliffs Nuclear Power Plant, Environmental Protection Plan (Non-
Radiological) Technical Specifications, Sections 3.2.1 and 3.2.2

In accordance with Reference (a), Calvert Cliffs Nuclear Power Plant is submitting the following reports as described in Attachments (1) through (7). The reports are related to the site's NPDES permit.

Should you have questions regarding this matter, please contact Mr. Jay S. Gaines at (410) 495-5219.

Very truly yours,

Joseph E. Pollock
Plant General Manager

JEP/CAN/bjd

- Attachments:**
- (1) Letter from K. J. Nietmann (CCNPP) to J. Bowen (MDE), dated August 4, 2004, NPDES Discharge Permit 02-DP-0187 Calvert Cliffs Nuclear Power Plant
 - (2) Letter from J. E. Pollock (CCNPP) to J. McGillen (MDE), dated December 28, 2005, State Discharge Permit No. 02-DP-0187, NPDES MD0002399
 - (3) Letter from J. E. Pollock (CCNPP) to J. McGillen (MDE), dated May 17, 2006, Change Proposed for Sampling Plan
 - (4) Letter from J. E. Pollock (CCNPP) to J. McGillen (MDE), dated October 16, 2006, NPDES Discharge Permit 02-DP-0187, Calvert Cliffs Nuclear Power Plant
 - (5) Letter from J. E. Pollock (CCNPP) to T. Boone (MDE), dated October 25, 2006, Special Report: Noncompliance with Effluent Limitations

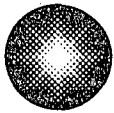
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- (6) Letter from J. E. Pollock (CCNPP) to J. McGillen (MDE), dated October 31, 2006, Section 316(b) Phase II Sampling Plan Interim Report
- (7) Letter from J. E. Pollock (CCNPP) to J. McGillen (MDE), dated January 17, 2007, State Discharge Permit No. 02-DP-0187, NPDES MD0002399

cc: **(Without Attachments)**

D. V. Pickett, NRC
S. J. Collins, NRC

Resident Inspector, NRC
R. I. McLean, DNR



**Constellation
Energy Group**

**Calvert Cliffs
Nuclear Power Plant**

*A Member of the
Constellation Energy Group*

August 4, 2004

Mr. Jack Bowen
Maryland Department of the Environment
Water Management Administration
1800 Washington Boulevard
Baltimore, Maryland 21230

RE: NPDES Discharge Permit 02-DP-0187 Calvert Cliffs Nuclear Power Plant

On July 30, 2004 Calvert Cliffs Nuclear Power Plant personnel identified that the auxiliary boiler blowdown effluent (Monitoring point 103 A) had been discharged intermittently from the CCNPP site in Lusby, MD without monitoring as required by NPDES permit 02-DP-0187. This permit requires flow, total suspended solids, and oil and grease monitoring to be performed monthly, with pH to be monitored during each discharge from monitoring point 103 A. No monitoring was performed between June 1, 2004 when the permit requirement became effective, and July 30, 2004, when the lack of monitoring was discovered.

Approximately 5000 gallons of auxiliary boiler blowdown effluent was discharged to the Chesapeake Bay between June 1, 2004 and July 30, 2004. When plant staff identified that the discharges had occurred, the auxiliary boiler blowdown discharge was sampled for pH, total suspended solids, and oil and grease. All values were within permit limits; oil and grease and total suspended solids results were both less than detectable concentrations. Based on the relatively small discharge volume and the satisfactory analysis results the impact of this discharge on public health and the waters of the state is negligible.

The cause of the unanticipated discharge was the auxiliary boiler blowdown tank discharge pump controls were in the 'automatic' positions when they should have been in the 'manual' position. This caused the tank to discharge whenever a set volume was reached without site personnel being aware of the discharge. Upon discovery the controls were immediately placed in the 'manual' position. A note has been placed on the controls to ensure they are not put back into the 'automatic' mode. Site procedures are being revised to require the auxiliary boiler blowdown tank discharge pump controls be maintained in the 'manual' position and to monitor each discharge as required by the permit.

If you have any questions, please contact Brenda Nuse at (410) 495-4913.

Sincerely,
 for KJN

Kevin J. Nietmann
Plant General Manager

KJN/BDN

cc: B.D. Nuse
T.G. Ringger (CGG-ES)

ATTACHMENTS

- (1) Letter from K. J. Nietmann (CCNPP) to J. Bowen (MDE), dated August 4, 2004, NPDES Discharge Permit 02-DP-0187 Calvert Cliffs Nuclear Power Plant
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- (6) Letter from J. E. Pollock (CCNPP) to J. McGillen (MDE), dated October 31, 2006, Section 316(b) Phase II Sampling Plan Interim Report
- (7) Letter from J. E. Pollock (CCNPP) to J. McGillen (MDE), dated January 17, 2007, State Discharge Permit No. 02-DP-0187, NPDES MD0002399



Constellation Energy

December 28, 2005

Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, MD 21230

ATTENTION: Mr. John McGillen

SUBJECT: Calvert Cliffs Nuclear Power Plant
State Discharge Permit No. 02-DP-0187, NPDES MD0002399

REFERENCE: (a) 40 CFR 125.95(b)(1)

In accordance with Reference (a), Calvert Cliffs Nuclear Power Plant submits the enclosed *Proposal for Information Collection in Compliance with Section 316(b) Phase II-Requirements of the Clean Water Act* (PIC) to the Maryland Department of the Environment (MDE) for review and approval. This information collection is a necessary action to implement the requirements of the Clean Water Act. Additionally, as requested during our meeting with representatives of the MDE and Maryland Department of Natural Resources on November 28, 2005, we have included two hard copies and two CDs containing an electronic copy of the PIC.

A biological sampling program is planned to support the information collection and is included as Appendix B. We expect to initiate the first phase of the sample program in February 2006, therefore, we would appreciate your prompt review and approval of Appendix B so that we can adjust field sampling plans for this work if needed.

Should you have questions regarding this submittal or need additional information, please contact Mr. Steve Sanders at (410) 495-3574, Ms. Brenda Nuse at (410) 495-4913, or Ms. Carla Logan at (410) 787-5132.

Very truly yours,

Joseph E. Pollock
Plant General Manager

JEP/CAN/bjd

Enclosure: Proposal for Information Collection in Compliance with Section 316(b) Phase II-Requirements of the Clean Water Act

cc: Mr. R. I. McLean, DNR

ENCLOSURE

**PROPOSAL FOR INFORMATION COLLECTION IN COMPLIANCE
WITH SECTION 316(B) PHASE II-REQUIREMENTS OF
THE CLEAN WATER ACT**

**Proposal for Information Collection in Compliance with
Section 316 (b) Phase II-Requirements of the Clean Water Act**

For

Calvert Cliffs Nuclear Power Plant

December 19, 2005

Prepared for

Constellation Generation Group

1005 Brandon Shores Road

Baltimore, Maryland 21226

Prepared by:

HDR / LAWLER, MATUSKY & SKELLY ENGINEERS LLP

Environmental Science & Engineering Consultants

One Blue Hill Plaza

Pearl River, NY 10965

Executive Summary

Constellation Generation Group (CGG) submits the following Proposal for Information Collection ("PIC") on behalf of Calvert Cliffs Nuclear Power Plant (Calvert Cliffs) in accordance with the U.S. Environmental Protection Agency's (USEPA) Clean Water Act Section 316(b) Phase II Rule, 40 CFR 125. The Phase II Rule covers existing sources of cooling water intake at steam electric plants. In accordance with 40 CFR Section 125.95(b)(1) of the Phase II Rule, this PIC sets forth CGG's plan to address the information requirements of the Comprehensive Demonstration Study ("CDS"), 40 CFR 125.95(a)(2).

Calvert Cliffs is located on the Chesapeake Bay north of the mouth of the Patuxent River in Lusby, Maryland. The facility has two nuclear generating units, both using once-through cooling water intake systems. Both units have a design electrical rating of 845 megawatts(MW) net. From 2000-2004, the average capacity factor was 88.8% for Unit 1 and 93.9% for Unit 2. The average annual energy generated by Calvert Cliffs from 2000 to 2004, the five most recent years available, was 13,553,452 megawatt-hours (MWh).

Calvert Cliffs withdraws more than 50 million gallons per day (MGD) (maximum 3,456 MGD) from the source waterbody, therefore, it is subject to both impingement mortality (minimum of 80% reduction) and entrainment (minimum of 60% reduction) performance standards as listed in the Phase II Rule (Exhibit V-1). Calvert Cliffs currently operates under State Discharge Permit No. 02-DP-0187, NPDES MD0002399 and the permit expiration date is May 31, 2009.

As the Phase II Rule requires, this PIC, in substantial part, includes:

- information on the location, design, and operation of the facility, its existing cooling water intake system (CWIS), and the source of cooling water for the plant;
- summarizes past studies of impingement and entrainment and discusses their relevance;
- summarizes relevant historical consultations with the State and Federal fish and wildlife agencies;
- provides a preliminary review of technologies and operational and/or restoration compliance measures already implemented and the measures proposed to be evaluated further in the Comprehensive Demonstration Study (CDS);
- provides sampling plans for new field studies;

Extensive biological monitoring for impingement and impingement mortality has been conducted at Calvert Cliffs since the late 1970s. A review of these studies indicates cooling water withdrawal from an aquatic community characteristic of mid-Atlantic estuaries. The monitoring programs were determined to be valid studies incorporating appropriate sampling methods, laboratory analysis techniques, and Quality Assurance/Quality Control procedures.

Because the entrainment data are more than 20 years old and species composition and species abundances have changed in the Chesapeake Bay Estuary, CGG has decided to collect additional entrainment data at Calvert Cliffs to determine the calculation baseline required by the Phase II Rule. CGG will also consider collecting additional physiochemical waterbody sampling (depth profiles, current survey) as required during the CDS.

The existing CWIS at Calvert Cliffs is a close representation of EPA's baseline definition. There are, however, four differences from that definition: 1) there is a baffle wall in front of the screens to withdraw water from lower in the water column, 2) the existing traveling water screens return fish and debris back to the Chesapeake Bay, and 3) the facility can operate at reduced flow, during certain times of the year, with minimal losses in generation, and 4) two of the screens are dual flow screens with a low pressure spray wash. The first deviation may reduce impingement and entrainment rates by withdrawing water from the lower portion of the water column. The fish/debris return reduces impingement mortality by returning fish back to the bay. Operating at 50% of the flow will reduce entrainment by about 50% and would also reduce impingement by some amount. The dual-flow screens may reduce impingement mortality as they have low pressure spray washes. To determine the effects of the baffle wall, organism abundance studies on both sides of the wall are proposed.

In the comprehensive demonstration study (CDS), CGG will perform a review of existing operations at Calvert Cliffs to determine if the facility is in compliance with the Phase II rule. CGG will also investigate a combination of intake technologies, operational measures, and restoration in the event that the existing operations do not meet the Phase II requirements. Overall, a site-specific fish stocking program may be the best alternative, should restoration survive litigation, because of the technologies already in place at the Calvert Cliffs CWIS and the established stocking program in the estuary (Chalk Point) that has already proven effective.

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1.0 INTRODUCTION

In compliance with 40 CFR Section 125.95(b)(1) of the Phase II Rule, HDR/LMS has prepared this Proposal for Information Collection (PIC) for Constellation Generation Group (CGG) before the start of information collection activities related to the preparation of the Comprehensive Demonstration Study (CDS) for the Calvert Cliffs Nuclear Power Plant (Calvert Cliffs). The objective of the PIC is to provide the Maryland Department of the Environment (MDE) and the Maryland Department of Natural Resources (MDNR) with sufficient information that CGG intends to use to ensure that the CDS will meet requirements of the Phase II rule.

1.1 Background of Rule

Section 316(b) of the Clean Water Act (CWA) requires that the location, design, construction, and capacity of a cooling water intake structure (CWIS) reflect the best technology available (BTA) for minimizing adverse environmental impact. CWIS adverse environmental impact may occur as the result of the withdrawal of cooling water containing aquatic organisms from the source waterbody and the subsequent impingement of the larger organisms on protective screens or the passage of the smaller organisms (entrainment) through the cooling water system.

On July 9, 2004 the United States Environmental Protection Agency (USEPA), published the "National Pollutant Discharge Elimination System – Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities" (the Rule) to implement Section 316(b) of the CWA. The Phase II Rule, which became effective on September 9, 2004, establishes regulatory requirements for CWIS at power plants that withdraw 50 million gallons per day (MGD) or more of cooling water from the waters of the United States. The rule establishes performance standards requiring reductions in entrainment (60 to 90%) and/or impingement mortality (80 to 95%) caused by the location and operation of the CWIS. Specific performance standards depend on the source of the cooling water waterbody type and intake flows in relation to the source water flow and plant operating capacity.

1.2 Requirements of the PIC

Compliance with the final 316(b) regulations requires CGG to submit a PIC to the Director of the MDE for review and comment. The PIC is the first submission required for compliance and, as described in the rule, must provide the following:

- A description of the proposed and/or implemented technology(ies) and/or restoration measures to be evaluated in the study (§ 125.95(b)(1)(i)).
- A list and description of any historical studies characterizing impingement and entrainment and/or the physical and biological conditions in the vicinity of the cooling water intake structures and their relevance to this proposed study (§ 125.95(b)(1)(ii)).
- A summary of any past, ongoing, or voluntary consultations with appropriate Federal, State, and Tribal fish and wildlife agencies that are relevant to this study and a copy of written comments received as a result of such consultation (§ 125.95(b)(1)(iii)).
- A sampling plan for any new field studies you propose to conduct in order to ensure that you have sufficient data to develop a scientifically valid estimate of impingement and entrainment at your site (§ 125.95(b)(1)(iv)).

This document serves as the PIC for Calvert Cliffs. It contains each of the bulleted items listed above and is organized as follows:

- Section 2 provides information on the location, design, and operation of the facility, its existing CWIS, and the source of cooling water for the plant;
- Section 3 summarizes past studies of impingement, entrainment and waterbody physiochemical conditions and discusses their relevance;
- Section 4 summarizes relevant historical consultations with the State and Federal fish and wildlife agencies;
- Section 5 provides a preliminary review of technologies and operational and/or restoration compliance measures already implemented and the measures proposed to be evaluated further in the CDS;
- Appendix A summarizes each historic sampling program;
- Appendix B provides sampling plans for new field studies.

1.3 Applicable Performance Standard

Calvert Cliffs is located on the Chesapeake Bay and withdraws more than 50 MGD from the source waterbody, therefore, it is subject to both impingement mortality (minimum of 80% reduction) and entrainment (minimum of 60% reduction) performance standards as listed in the Phase II Rule (Exhibit V-1). Calvert Cliffs currently operates under State Discharge Permit No. 02-DP-0187, NPDES MD0002399 and the permit expiration date is May 31, 2009.

2.0 DESCRIPTION OF FACILITY

2.1 Location/Description

Calvert Cliffs is located on the Chesapeake Bay north of the mouth of the Patuxent River in Lusby, Maryland. The facility has two nuclear generating units, both using once-through cooling water systems. Unit 1 began operation in 1975 and Unit 2 began operation in 1977. Both units have a design electrical rating of 845 megawatts (MW) net and have a maximum cooling water capacity of 3,456 MGD. From 2000-2004, the average capacity factor was 88.8% for Unit 1 and 93.9% for Unit 2. The average annual energy generated by Calvert Cliffs from 2000 to 2004, the five most recent years available, was 13,553,424 megawatt-hours (MWh).

2.2 Cooling Water Intake Structure and Operation

Circulating water for both units is withdrawn through a single CWIS. This CWIS includes a dredged intake channel, a baffle wall, and an intake screen area. When originally dredged, the intake channel extended into the bay about 4,500 ft out from the baffle wall. The original invert of the intake channel varied from El. -40 ft at its mouth down to El. -51 ft at the baffle wall. Over time, siltation has filled in the intake channel such that the bottom of the intake channel is now at El. -45 ft at the baffle wall.

The baffle wall is located about 300 ft in front of the screens and is designed to allow cooler water to be withdrawn from lower in water column. The baffle wall is 560 ft long extending down to El. -28 ft. Due to siltation the opening height under the baffle wall is about 17 ft., originally the opening was about 23 ft high. Occasionally fish can swim under the baffle wall into the area of the screens and get trapped. To allow the fish to escape, two baffle panels are removed during the summer.

The intake is divided into two halves; the twelve northern most bays are for Unit 1, while the southern twelve are for Unit 2. Each bay is 11.2 ft wide and spans from an invert at El. -26.0 ft to the top deck at El. 10.0 ft. The bays are all equipped with a trash rack and traveling water screen. The steel trash racks are made out of three panels, each 9 ft high, and are assumed to be the same width as the screen bays, 11.2 ft wide. The trash racks are made out of 3 in. by 1/4 in. steel bars providing 2.5in clear spacing. To lessen the effects of biofouling the bars are coated in silicone. The trash racks are cleaned by a rail mounted trash rake.

All but four of the twenty-four traveling water screens are identical. The four different screens are the end screens for each unit, 11 A&B and 26 A&B, as described later in this section. The 20 identical traveling water screens are about 9.5 ft wide with 3/8 in. square mesh. The screens are normally rotated in sets of four for 10 minutes every 4 hours, but are also auto-rotated when there is an 8 in. of water differential across the screens. From July through October, jellyfish are the main source of debris loading. In the fall, debris issues are attributed to the hydroid, *Garvia francesca*, being carried over the screens. Fish and debris impinged on the screens are removed via a front spray wash system and flushed into a trash trough - one trash trough per unit. Each trough has 0.9 cubic feet per second (cfs) of added flow to facilitate transportation of fish and debris. The Unit 1 and Unit 2 troughs each discharge just above the water level, outside of the baffle wall and approximately 30 ft offshore. The Unit 1 trough discharge is located north of the screens, while the Unit 2 trough discharges south of the screens. Located within each discharge system is a temporary holding tank that has historically been used in discharge survival studies. The Unit 1 end screens (11 A&B) are both Beaudrey dual-flow traveling water screens. Dual-flow screens are similar to standard through-flow screens except that the screen faces are set perpendicular to the flow allowing water to be withdrawn through both the ascending and descending screens. This arrangement eliminates the potential for debris carryover. The effective screen area is about the same as a through-flow screen in the same size screen bay. These end screens have 3/8 in. mesh, can rotate at one of two speeds depending on the debris loading, and are equipped with dual spray washes. When there is a 6 in. of water differential across the screens, they rotate at 16 ft/min. If the differential increases to 10 in. of water, the screens rotate at 50 ft/min. There is a low pressure spray wash on the ascending side of the screens and a high pressure wash on the descending screens. Fish and debris washed from these screens flow into Unit 1 trash trough.

The Unit 2 end screens (26 A&B) are through-flow screens similar to the other Unit 2 screens, except that they can be rotated at two speeds. When there is a 4 in. of water differential, the screens rotate at 8.5 ft/min but if the differential increases to 8 in. of water, the screens rotate at 38 ft/min. These screens also have both an ascending and descending spray wash. Fish and debris removed from these two screens flow into the Unit 2 trough.

Six circulating water pumps per unit are located downstream of the traveling water screens. Each pump is rated for 200,000 gpm (445.6 cfs). Each set of two pumps flow into a common condenser shell, allowing each unit to generate with one pump per condenser shell; operating in this manner results in a loss of 8-10 MW per unit.

Water passing through the Calvert Cliffs condensers is heated a maximum of 12°F before being returned to Chesapeake Bay. The warmed circulating water combines into four discharge conduits. Each conduit is a 12.5 ft by 12.5 ft square pipe. These pipes discharge (850 ft offshore) north of the facility.

2.3 Description of Source Water Body

Calvert Cliffs is located on the western shore of the Chesapeake Bay Estuary approximately 10 miles north of the mouth of the Patuxent River. This location is in the middle region of Chesapeake Bay proper. The Chesapeake Bay watershed is approximately 64,000 square miles. The Bay is approximately 200 miles long and has an average depth of 21 feet (Chesapeake Bay Program 2003). The Chesapeake Bay is about 6 miles wide at the plant site from its western shore to Taylors Island (U.S. Nuclear Regulatory Commission 1999). The site's geologic setting lies within the Coastal Plain Physiographic Province.

The MDNR maintains a fixed water quality monitoring station in the mainstream of the Bay off of Cove Point, located just south of Calvert Cliffs. Salinity is in the mesohaline range (5 to 18 parts per thousand salinity [ppt]) with minimum salinities as low as 4.8 ppt and maximum salinities as high as 19.9 ppt (MDNR 2005). Water temperatures range from 1.9°C to 27.2°C. Bottom dissolved oxygen concentrations range from 0.3 mg/L to 10.1 mg/L. Concentrations of 0.0 mg/L have been measured during August. Calvert Cliffs is located in a portion of Chesapeake Bay that is affected by hypoxia during the summer. This area of depleted oxygen extends for hundreds of square miles and is a direct result of nutrient inputs to the Bay (Chesapeake Bay Foundation 2003).

The shoreline is lined with rip-rap within 0.5 mile in either direction of the CWIS. The estimated average water levels fluctuate from a mean low of El. 0.0 ft to El. 1.3 ft at mean high water. The normal water level is at El. 0.7 ft, with an extreme low water level of El. -3.5 ft. Velocities within the CWIS were calculated at mean low water level El. 0.0 ft and full flow conditions, 2,400,000 gpm. (5,347.2 cfs). The calculated velocity under the baffle wall is 0.4 ft/sec assuming a bottom elevation of El. -51 ft. However, due to siltation, the actual bottom is expected to be at about El. -45 ft, resulting in a velocity of 0.6 ft/sec. The velocity approaching the trash racks is 0.8 ft/sec and increases to 0.9 ft/sec at the traveling water screens. Through-screen velocities were not calculated due to uncertainties in the open area of the screens, but this velocity is expected to be about twice the screen approach velocity.

The Chesapeake Bay supports over 250 species of fish, including 32 year-round species (Hildebrand and Schroeder 1972, Alliance for the Chesapeake Bay 2005). Anadromous species (e.g. American shad, alewife, and striped bass) are numerous. These species are particularly important in the Calvert Cliffs section of the Bay since many of the saltwater species common in the southern sections of the Bay do not reach Maryland waters in large numbers (Hildebrand and Schroeder 1972). Numerous recreationally and/or commercially important fish species spend at least part of their life cycle in the vicinity of Calvert Cliffs (e.g. spot, bay anchovy, croaker, white perch, winter flounder, hogchoker, Atlantic menhaden, striped bass, silver perch, Atlantic tomcod, alewife, Atlantic herring and blueback herring) (Heck 1987, U.S. Nuclear Regulatory Commission 1999).

Two representative important species (RIS) identified by the State of Maryland that occur in the vicinity of Calvert Cliffs include the eastern oyster, *Crassostrea virginica*, and the blue crab, *Callinectes sapidus* (U.S. Nuclear Regulatory Commission 1999). Oyster breeding and nursery areas occur near the plant and new beds were created during plant construction to mitigate habitat loss. However, sustaining populations are no longer present as evidenced by Calvert Cliffs's need to "plant" oysters for its Radiological Effluent Monitoring Program. Blue crabs are caught by commercial and recreational fishermen and represent a sizable proportion of the fishing industry in some years. Blue crab mating occurs in the areas near the plant, but the females typically migrate down-Bay to a spawning and hatching area with higher salinities (23 to 28 ppt) (U.S. Nuclear Regulatory Commission 1999).

Submerged aquatic vegetation (SAV) was not observed through aerial photography in this area from 1999-2003 (VIMS 1999-2003). Around Curtis and Cove Points near Calvert Cliffs, four SAV species were documented from 1930 to 1970, but survey teams found no grasses from 1971 to 1976 (Stevenson et al 1979).

2.4 Threatened and Endangered Species

In letters dated April 11, 2005, CGG's representatives contacted the United States Fish and Wildlife Service and the Maryland Department of Natural Resources-National Heritage Program. The letters requested file searches to document the presence/absence of threatened/endangered species located on or within the vicinity of Calvert Cliffs.

Information on threatened/endangered species at the county level, as of May 10, 2005, was obtained via the Maryland Department of Natural Resources website. The United States Fish and Wildlife Service website (updated daily) was accessed on the May 23, 2005 and the results are listed in (Table 1). This is a preliminary list and will be replaced with the official agency documentation of threatened/endangered species list when results are provided.

3.0 HISTORICAL STUDIES REVIEW

Biological monitoring for impingement and entrainment was conducted at Calvert Cliffs during the mid 1970s through 1995 (the most recent data available). A review of these studies indicates cooling water withdrawal from an aquatic community characteristic of mid-Atlantic estuaries. The impingement and entrainment collections were dominated by blue crab and bay anchovy comprising 86% of all organisms collected. The monitoring programs were determined to be valid studies incorporating appropriate sampling methods, laboratory analysis techniques, and Quality Assurance/Quality Control procedures. Results of these studies are summarized below and a statement of their relevance to determining the calculated baseline required by the Phase II Rule is presented at the end of this chapter. A summary of each sampling program is provided in Appendix A.

3.1 Impingement Studies

Extensive impingement data have been collected each year from 1974 through 1995 (the most recent data available) (Hixon and Breitburg 1996). In 1995, sampling was attempted four days per week from mid-October through mid-April and five days a week for the remainder of the year. Samples were collected for one hour unless a circulating pump or the screens at one unit were not in operation then two one-hour samples were collected from the operating unit/screens. Sample collecting times were rotated by day and unit so that the same period was not being sampled consistently (i.e., to remove sampling period effects). Samples were collected by suspending a 1.27 cm stretch mesh net in the screen wash trough for about 30 minutes. Because of the screen rotation schedule, a 30 minute sample collected all the fish that had been impinged over a one hour period. The net was emptied as necessary and, because of the potential to lose fish when the net was not in place, a multiplier was applied to the total number of fish collected beginning in 1988. Fish were identified, enumerated and weighed. Hourly impingement rates were estimated by dividing the adjusted number of fish collected by the total number of hours sampled.

During 1995, the last year sampled an adjusted total of 8,177 fish and blue crab was collected. The collections included 28 species representing 21 families (Table 2). Blue crab (53%) and bay anchovy (33%) were the dominant species of all organisms collected. *Menidia* sp. and hogchoker each accounted for 4% of all organisms collected. The highest impingement period was July through September, with 79% of all organisms collected during this time (Table 3). The highest impingement period varied across

species, with bay anchovy most abundant in July and August, silverside during the winter months, and hogchoker most abundant from June through August. The mean number of organisms collected per circulator pump hour for Calvert Cliffs in 1995 was 21. This impingement rate is the lowest calculated since 1982 (Table 4). The highest yearly impingement rate was 943.9 fish per circulator pump hour in 1984 which was during a year of extensive fish kills in Chesapeake Bay and it is likely that the impinged fish were dead when they entered the plant.

Impingement sampling results from 1993 and 1994 indicate that blue crab are consistently among the most frequently impinged species (45% and 79% of total catch, respectively) (Hixson and Breitburg 1994, 1995). The percent composition of other commonly impinged species varied among years. These species include bay anchovy (3-25%), Atlantic silverside (2-3%), hogchoker (4-15%), Atlantic croaker (<1-8%), and northern pipefish (1%).

3.2 Entrainment/Ichthyoplankton Studies

The most recent entrainment data available for Calvert Cliffs were collected from April 1978 through September 1980 (EA 1981). The frequency of sampling varied from once per month during the winter months to weekly during high entrainment periods (spring and summer). Diel abundance studies were conducted three times during the summer of 1980. The sampling location changed several times to accommodate changes in operations such as outages. Pump samples (120 cubic feet) were collected over a two hour period through a modified 505 micron mesh larval table. Samples were preserved and transported to a laboratory for identification and enumeration. Subsampling was used when the number of sample fish was large and QA/QC measures were in place to ensure correct identification and sample tracking. A total of 22 species of fish representing 14 families were collected in abundance samples. Hogchoker were the dominant species, accounting for almost 75% of all organisms and life stages collected. Bay anchovy eggs and post larvae accounted for 19% of all organisms collected and naked goby larvae for another 3%. Mean densities, of the four most common species/life stages were hogchoker eggs ($200.9 / 100 \text{ m}^3$), bay anchovy eggs ($13.2 / 100 \text{ m}^3$) bay anchovy post larvae ($37.4 / 100 \text{ m}^3$), and naked goby post larvae ($8.8 / 100 \text{ m}^3$). No other species and life stage occurred in densities higher than $1.4 / 100 \text{ m}^3$. Hogchoker eggs were collected at their highest density in June and July while most anchovy were collected in June for two years and July of the third year of the study. Naked goby larvae were most common in late May and early June.

Entrainment survival was measured by collecting fish at the intake and discharge and then comparing mortality between the two groups. Fifteen minute samples were collected and fish were held in aerated jars for up to 88 hours (During 1979 and February through April 1980) or 48 hours (May through September 1980). Survival was estimated by the proportion of fish surviving at the intake as compared to the discharge. A total of 529 survival samples were collected representing 22 species/life stages. Of these, only a few occurred frequently enough and in great enough numbers to analyze. They include various life stages of hogchoker, bay anchovy, blennies, gobies, spot, winter flounder, skilletfish, American eel, and Atlantic menhaden. Survival of hogchoker eggs and bay anchovy (eggs and larvae) was low (9-12.2% and 0% [fish <25 mm], respectively).

3.3 WATERBODY STUDIES

Water temperature, dissolved oxygen concentration, conductivity, and pH were measured *in situ* from April 1978 through early September 1980 in the vicinity of Calvert Cliffs. During the annual cycle, low ambient temperatures of less than 1°C occurred in February and maximum ambient summertime temperatures of 28-29°C were measured in August. Trends in discharge temperature generally paralleled those of the intake (ambient) and were higher than intake temperatures on most days by 5-6°C; the average delta-T was 5.5°C (EA 1981). Salinity data for this period show an irregular pattern contrasting to the cyclic pattern of temperature fluctuations. During spring and summer 1978, salinities rose from 6 ppt in April to 11-12 ppt by late summer, then declined to the 4-5 ppt range by early spring 1979. During late spring and summer 1979, salinity values were quite variable but generally increased to 11-12 ppt in July and August. During the remaining fall and winter 1979, salinities increased to over 15 ppt through early spring 1980 before declining to 8 ppt in May (EA 1981). Dissolved oxygen concentrations at intake and discharge demonstrate an annual pattern of DO values varying between 3 and 8 mg/L during spring and summer and values of 10 mg/L and above during the fall and winter periods. The low values recorded at the intake were often the result of upwelling of low DO water from the deeper waters of nearby channel areas (EA 1981). In the summer of 1975 several episodes of reduced concentrations of dissolved oxygen and some instances of extreme oxygen depletion were recorded in bottom waters of Chesapeake Bay off Calvert Cliffs (Benedictine Estuarine Research Laboratory 1978).

Data from a 1973 survey indicate that surface waters were an average 0.77 °C warmer and 0.56 ppt less saline than bottom waters at certain stations, but no substantial differences between stations were noted. Mean water temperature across all stations and

depths increased from 11.65°C on April 19, peaked at 27.17°C on August 20, and declined to 17.06 °C by November 2. Salinity varied throughout sampling, but generally remained between 7 and 10 ppt (Academy of Natural Sciences of Philadelphia 1975).

3.4 Relevance of Historical Studies

The most recent impingement study conducted during the 1990's provides quantitative information describing the seasonality, abundance, sizes, species composition, and survival of fish collected from the traveling screen. Because these data are current CGG does not believe that additional impingement and post-impingement survival data are needed to determine the calculation baseline required by the Phase II Rule. Entrainment data were last collected at Calvert Cliffs in 1980. Because these data are greater than 20 years old, a year-long seasonally stratified entrainment sampling program has been proposed for Calvert Cliffs. Complete methods for the entrainment characterization studies are presented in Appendix B. The entrainment study is paired with a similar entrainment study to be performed outside the baffle wall to develop information for calculation baseline.

Physiochemical waterbody data may be required to determine the ultimate feasibility of the operational and technological measures for Calvert Cliffs. As a result, CGG will determine if physiochemical waterbody sampling is required during the CDS. Any plans for physiochemical waterbody sampling will be submitted to MDE prior to sampling.

4.0 SUMMARY OF AGENCY CONSULTATIONS

Agency consultation regarding Section 316(b) at Calvert Cliffs has been ongoing since the late 1970's. Recent consultation on the Phase II rule as it applies to Calvert Cliffs has been limited to general working meetings among MDE, MDNR and Constellation both with and without other major steam electric power generating companies in Maryland.

5.0 PROPOSED FEASIBLE COMPLIANCE MEASURES SCREENING PROCESS

The Phase II rule requires that the PIC include a listing and brief description of technologies, operational measures and restoration measures that are potential candidates for compliance with the applicable Performance Standard(s) that the applicant will evaluate in detail in the CDS. The only screening criterion for inclusion on this list is that each candidate is potentially feasible from an engineering perspective. Cost considerations are not necessary in the PIC.

The existing CWIS at Calvert Cliffs has a long regulatory history related to §316(b) and intake technology development to minimize impact. Impingement of fish and crabs has historically been the issue of greatest concern with the MDNR (McLean et al. 2002). Calvert Cliffs experienced relatively high impingement rates from initial operation until the mid-1980s when significant fish kill occurred as a result of low dissolved oxygen within the intake structure embayment. The MDNR, Power Plant Research Program, worked closely with Calvert Cliffs to understand ways to reduce impingement impacts at the Calvert Cliffs CWIS. These studies identified that opening panels in the embayment curtain wall would allow fish to migrate from the enclosed area during low dissolved oxygen condition. The studies also identified that the installation of dual speed screens installed at the intake near the baffle walls, a modified spray wash system to more effectively remove material from the screens and larger openings to the fish return system contribute to post impingement survival.

The Phase II Rule defines the baseline condition as an estimate of impingement mortality and entrainment that would occur at a facility assuming: once-through cooling, a shoreline intake, 3/8 in. mesh screens, and the facility operating at design flow rate. The existing CWIS at Calvert Cliffs is a close representation of EPA's baseline definition. There are however, several differences from baseline: 1) there is a baffle wall in front of the screens that permits the withdrawal of water from lower in the water column, 2) the existing traveling water screens return fish and debris back to the Chesapeake Bay, 3) the facility can operate at reduced flow with minimal losses in generation during certain seasons, and 4) two of the screens are dual flow screens, with Ristroph modifications to the spray wash system.

The first deviation may reduce impingement and entrainment by withdrawing water from the bottom third of the water column. The fish/debris return system has been demonstrated to reduce impingement mortality by returning fish back to the bay. Operating at lower flow will reduce entrainment by an amount approximately equal to the change in flow and also reduce impingement by some amount during periods of reduced pump operation. The dual-flow screens may reduce impingement mortality as they have low pressure spray washes.

Based on the historical physical, chemical and biological information, previous regulatory reviews, and the deviations from baseline described above, it is possible that the Calvert Cliffs CWIS currently meets the standards as established in the Phase II Rule. In an effort to confirm this assumption, CGG proposes to conduct a year long entrainment characterization study at Calvert Cliffs (Appendix B). While these biological data are being collected, CGG will review the feasibility of a series of technologies, operational measures and restoration measures for inclusion in the Calvert Cliffs CDS. This review will provide CGG with alternatives in the event that the existing CWIS does not meet the level of reductions in impingement mortality and entrainment described in the Phase II Rule.

The following section provides results from an appraisal level feasibility assessment that was conducted as part of this PIC to evaluate a reasonable number of alternatives to be reviewed in detail in the CDS.

5.1 Operational Measures

Because of the relationship between intake flow and entrainment and impingement, several operational measures were evaluated as part of this feasibility assessment to determine reduced flow options at Calvert Cliffs. Variable speed drives added to the existing circulating water pumps could be used to reduce cooling water flow during certain times of the year without reducing generation. As a result variable speed drives added to the existing circulating water pumps will be considered in the CDS – additional information on variable speed drives is provided below.

Cooling towers and additional reduced flow options (e.g. outages) beyond that already practiced at Calvert Cliffs could reduce both impingement mortality and entrainment; however, these options will not be considered in the CDS options because they will unnecessarily restrict facility operation at this significant base-loaded plant.

5.1.1 Reduced Flow Options

New variable speed drives could be installed on the existing circulating water pump motors to better regulate the cooling water flow without affecting facility generation or the thermal discharge temperature limits. Operating in this manner could reduce entrainment and impingement, the actual level of flow and entrainment reduction would vary by year based on the generation and ambient water temperatures.

The configuration of the existing intake structure would remain the same, with only minor modifications required to install the variable speed drives. Since both units at Calvert have six cooling water pumps (CWPs), variable speed drive could be added to two or three pumps per unit would provide flow control over the entire range of operation.

A substantial reduction in entrainment may already occur if the peak entrainment period overlaps existing periods of reduced pump operation. If this is the case, reducing the flow an additional 10% or 15% to achieve the 60% entrainment reduction standard may be possible without any impacts on generation. A detailed evaluation of the CWP performance and plant operation during the peak ambient water temperatures and the corresponding entrainment period will be conducted as part of the CDS to quantify the entrainment reduction associated with this option.

HDR/LMS's preliminary engineering and analysis has determined that the existing intake structure would require only minor modifications to install the variable speed drives on the existing circulating water pumps. The existing traveling water screen equipment would not require replacement or upgrade.

5.2 Technological Measures

Intake technologies and systems reviewed in this PIC are grouped on the basis of their fundamental methods of mitigating biological impact. As shown in Figure 4, intake technologies are first separated into two groups – those that prevent or lower the potential for organism entrainment into the cooling water system (exclusionary systems) and those that separate and remove entrapped organisms at some point within the system. The first group includes physical and behavioral barriers located at the interface between the intake structure and the source waterbody. The second group includes separation and removal systems located between the point of withdrawal and the CWPs. The primary advantage of the exclusionary systems is that organisms are not handled. Separation and removal systems have the advantage of easy accessibility, which generally reduces

engineering problems. Exclusionary systems are often inaccessible and must operate unattended for extended periods of time.

Exclusion systems include: physical barriers, which physically block fish passage; and behavioral barriers, which alter or take advantage of natural behavior patterns to attract or repel fish. Separation and removal systems include various screen systems that actively collect fish for their return to a safe release location; and diversion systems, which divert fish to bypasses for return to a safe release location. A review of the biological effectiveness, engineering practicability, and costs of these systems and devices is presented in detail in three Electric Power Research Institute (EPRI) reports prepared in 1986, 1994 and 1999 (EPRI 1986, 1994b, 1999). The EPRI reports and recent research studies provide the basis for the screening of intake technologies for potential use at Calvert Cliffs.

The following sections provide a summary of the feasibility assessment and screening that was conducted on potential technologies measures for Calvert Cliffs. As outlined below a number of measures were deemed not to be feasible for Calvert Cliffs during this appraisal level review.

5.2.1 Physical Exclusion

Based on initial screening, fine-mesh wedge wire screens have the potential to reduce impingement mortality and entrainment at Calvert Cliffs. However, using a slot width of 0.5 mm, 123-90 inch diameter screens would be needed at Calvert Cliffs under full flow operation. The screens would be mounted on intake pipes buried in the bottom of the Bay. Because of the large number of screens and piping that would need to extend into Chesapeake Bay, the shallow water depth, the potential navigation hazards, and nuclear safety concerns, fine-mesh wedge wire screens will not be considered further in the CDS.

A coarse mesh barrier net has the potential to reduce impingement and will be considered in the Calvert Cliffs CDS.

5.2.2 Behavioral Avoidance

Behavioral barriers (sound/light/air bubble curtains EPRI 1988) were not considered suitable for Calvert Cliffs, because they have not been proven biologically effective at deterring the major species historically present at Calvert Cliffs. As a result behavioral avoidance technologies will not be considered in the CDS.

5.2.3 Impingement and Entrainment Removal

Based on initial screening, fine-mesh Ristroph-type screens have the potential to reduce impingement mortality and entrainment at Calvert Cliffs. Ristroph-type traveling screens were recommended as a compliance option for Calvert Cliffs by the USEPA in the Phase II Rule, thus Ristroph-type traveling screens will be evaluated in the CDS. If the entrainment standard can be met through operational measures, coarse-mesh Ristroph-type traveling screens will be considered in the CDS as an option to reduce impingement mortality alone.

5.2.4 Behavioral Guidance

Behavioral guidance (e.g. louvers/angled screens) are not considered feasible at Calvert Cliffs because these technologies are more effective in flowing water environments where organisms can be guided from the cooling water flow by the ambient flow conditions across (perpendicular) the CWIS face (Pearce and Lee 1991). The baffle wall at Calvert Cliff's likely eliminates any perpendicular flow across the CWIS face, thus behavioral guidance technologies will not be considered in the CDS.

5.2.5 Detailed Review of Measures to be considered in the CDS

The following sections provide detail on the technologies deemed feasible above for consideration and further analysis in the CDS.

5.2.5.1 *Fine-mesh and Coarse-mesh Ristroph-type Traveling Screens*

CGG will investigate replacing the existing traveling water screens for both units with fine-mesh and coarse-mesh Ristroph-type screens. The USEPA suggests that fine-mesh screens should be designed with a through-screen velocity of 1.0 ft/sec (0.5 ft/sec approach velocity). The screen approach velocity calculated at the screen-face is higher than the 0.5 ft/sec design point (0.9 ft/sec at normal water levels).

To meet the 0.5 ft/sec velocity criterion, a new screen configuration in front of the existing CWISs will be investigated. The new configuration would be located abutting to the back of the existing baffle wall. In this location the baffle wall would act as a curtain wall for the new screens, allowing water to be withdrawn from the bottom of the water column. The area around the baffle wall may need to be dredged to reduce velocity.

The screen baskets for the new Ristroph screens would have a mesh size of 0.5 mm. Each screen basket would have a fish bucket to contain collected organisms in about 2.0 in. of water while they were lifted to the fish recovery system. A low pressure spray (10-15 psig) would be used to gently remove the fish from the fish holding buckets into a separate fish sluice. A conventional high pressure wash would then remove debris into a separate debris sluice. These two sluices would then flow back into the Chesapeake Bay outside of the baffle wall.

Ristroph-type modified screens have been shown to improve fish survival and have been installed and evaluated at a number of power plants (PSE&G 1999, Ronafalvy 1999). The most important advancement in state-of-the-art Ristroph screen design was developed through extensive laboratory and field experimentation. A series of studies conducted by Fletcher (1990) determined that substantial injury associated with traveling screens was due to repeated buffeting of fish inside the lifting buckets as a result of undesirable hydraulic conditions. Recent modifications to Ristroph-type screens include: angled mesh, smooth-top mesh, variable speed operation and slot mesh.

5.2.5.2 *Barrier Net*

A 3/8 in. or similarly sized mesh barrier net designed for a 0.5 ft/sec approach velocity could be installed within the forebay created behind the baffle wall at Calvert Cliffs to reduce impingement mortality. This option would not result in any reduction in entrainment. Assuming the water depth in the forebay is about 40 ft deep, the net would need to be about 540 ft long. The net would be strung between the baffle walls that make up the intake embayment. This configuration should allow for a relatively even flow through the entire net. The net would be supported by intermediate piles, bottom anchors, and top flotation. Top and bottom anchor lines would run between the anchors and attach to the net panels. The net would be designed for high water levels. A breakaway panel would be installed in the middle of the net to minimize damage to the nets and support system and to ensure nuclear safety is maintained if severe debris loading occurred (this is only one design configuration, others may include installation of a net outside the baffle wall).

Replacement of the nets may be required as frequently as every year. Since the rate of debris loading and biofouling on a barrier net at Calvert Cliffs is not known, the frequency of removal for cleaning cannot be determined prior to actual installation. Under the worse deployment conditions, the net would have to be removed about 56 times a year (twice weekly during the summer and every other week during the winter).

The annual deployment duration will be determined during preparation of the CDS.

Barrier nets have been proven to reduce IM by reducing total impingement (Reider et al. 1997) and have been shown to be effective in excluding blue crab from the cooling water intakes. At the Chalk Point facility there was an 84% reduction in blue crab impingement after installation of a barrier net system (EPRI 1999). Although a pilot study would not be required to demonstrate biological efficacy, it would provide useful data on the biofouling and debris loading conditions for design of a net system at Calvert Cliffs. Optimizing the mesh size, deployment period, and cleaning schedule could be determined after installation of the net using an adaptive management plan based on the results of verification monitoring.

5.2.5.3 *Habitat Restoration*

CGG plans to investigate the use of habitat restoration in the CDS, if restoration is not eliminated as an option in the Phase II rule as a result of ongoing litigation. CGG recognizes that restoration measures are being challenged and that the case is now before the U.S. Court of Appeals for the Second Circuit in New York. A decision is not expected before 2006 and this decision could eliminate restoration completely or modify it substantially. For the purposes of the PIC, restoration is treated as it was set forth in the final rule.

The Phase II rule requires that if restoration is used, the restoration should maintain aquatic community structure and function similar to compliance achieved by a technology. CGG expects that any restoration efforts that will be evaluated for implementation in combination with other technologies or operational measures will be conducted with close consultation among the agencies.

5.2.5.4 *Stocking Program*

Fish stocking will be evaluated in more detail in the CDS. One consideration is that CGG would investigate partial funding of hatchery operations at the Mirant Chalk Point Station. The Chalk Point Station has cooperated with Maryland DNR since the striped bass restoration efforts of 1980s. Annually, the aquaculture facility raises and releases 150,000 – 200,000 fish each year including hickory shad and yellow perch for supplemental stocking in the Chesapeake Bay. The Chalk Point Hatchery is approximately 27 miles from Calvert Cliffs.

5.2.5.5 *Summary*

Feasible alternatives for Calvert Cliffs to achieve compliance with the Phase II rule include a combination of intake technologies, operational measures, and restoration. CGG plans to review these measures individually and in combination in an effort to meet the regulations specified in the Phase II Rule. Overall, restoration may be the best alternative option due to the cooling water requirements at Calvert Cliffs and the established stocking program in the estuary that has already proven effective.

6.0 LITERATURE CITED

Academy of Natural Sciences of Philadelphia. 1975. Ichthyoplankton of the Chesapeake Bay in the vicinity of the Calvert Cliffs plant site April 14 - November 2, 1973.

ANSP, 1981. Assessment of thermal, entrainment and impingement impacts on the Chesapeake Bay in the vicinity of the Calvert Cliffs Nuclear Power Plant. Report No. 81-10 prepared for Baltimore Gas and Electric Company. 298 pp.

Bradley, B. P. 1980. Calvert Cliffs Zooplankton Entrainment Study. Maryland Power Plant Siting Program Report No. PPSP-CC-80-1.

Breitburg, D. L. 1989. Trends in impingement of fish and blue crabs at the Calvert Cliffs Nuclear Power Plant: 1982-1986. Report No. 89-12. Academy of Natural Sciences of Philadelphia. 30pp.

Breitburg, D. L., J. H. Hixson III & R. P. Gallagher, 1986. 1984 impingement studies at Calvert Cliffs Nuclear Power Plant for Baltimore Gas and Electric Company. Report No. 86-1. Academy of Natural Sciences of Philadelphia. 23pp.

Breitburg, D. L. & T. A. Thoman, 1986. Calvert Cliffs Nuclear Power Plant fish survival study for Baltimore Gas and Electric Company. Final Report No. 86-19, Academy of Natural Sciences of Philadelphia. 25pp.

Burton, D. T. & W. C. Graves. 1979. Impingement studies II. Survival estimates of impinged fish. In: Non-Radiological Environmental Monitoring Report, Calvert Cliffs Nuclear Power Plant, January-December 1978. Baltimore Gas and Electric Company. Baltimore, MD. pp. 11.2-1-11.2-23

Burton, D. T. & S. L. Margrey. 1980. Impingement studies 2. Survival estimates of impinged fish. In: Non-Radiological Environmental Monitoring Report, Calvert Cliffs Nuclear Power Plant, January-December 1979. Baltimore, MD pp. 9.2-1-9.2-28.

Calvert Cliffs Nuclear Power Plant. 2004. Circulating Water System Description. No.09, 042A, 108. Revision 5.

Detailed Industry Questionnaire: Phase II Cooling Water Intake Structures. Traditional Steam Electric Utilities. D-UT-1268. Calvert Cliffs. 2000.

Davis, R. W., J. A. Matousek, M. J. Skelly and M. R. Anderson. 1988. Biological Evaluation of Brayton Point Station Unit 4 Angled Screen Intake. In: Fish Protection at Steam and Hydroelectric Power Plants, San Francisco, CA, October 28-31, 1987. Sponsored by Electric Power Research Institute (EPRI). CS/EA/AP-5663-SR.

Ecological Analysts Inc., 1980. Evaluation of the effects of the proposed Royce woven slot screen mesh on impingement at Calvert Cliffs Nuclear Power Plant.

Ecological Analysts, Inc. 1981. ^gEntrainment Abundance and Viability Studies, Calvert Cliffs Nuclear Power Plant, Final Report 1978-1980, Baltimore Gas and Electric Company. Report No. BGE04K1. [10-B-54]excerpt pages 5-1 to 5-7.

Electric Power Research Institute (EPRI). 1988. Field Testing of Behavioral Barriers for Fish Exclusion at Cooling-Water Intake Systems. Central Hudson Gas & Electric Company Roseton Generating Station. Prepared by Lawler, Matusky & Skelly Engineers, September 1988.

EPRI. 1986. Assessment of Downstream Migrant Fish Protection Technologies for Hydroelectric Application. 2694-1

EPRI. 1994b. Research Update on Fish Protection Technologies for Water Intakes. TR-104 122

EPRI. 1998. Evaluation of Fish Behavioral Barriers. TR-109483.

EPRI. 1999. Fish Protection at Cooling Water Intakes. TR-1 14013

EPRI. 2002. Cooling System Retrofit Cost Analysis. Report 1007456. July 2002. Palo Alto, CA.

EPRI. 2003. Laboratory Evaluation of Wedge Wire Screens for Protecting Early Life Stages of Fish at Cooling Water Intakes. 1005339.

Fletcher, I. R. 1990. Flow Dynamics and Fish Recovery Experiments: Water Intake Systems. Transactions of the American Fisheries Society 119: 393-415

Gallagher, R. P. & L. E. Currence. 1982. Ichthyoplankton and macroplankton studies in the vicinity of Calvert Cliffs Nuclear Power plant 1981. Academy of Natural Sciences of Philadelphia. Report No. 82-1. [10-D-23]

Heck, K.L., Jr. (Ed.) 1987. Ecological Studies in the Middle Reach of Chesapeake Bay, Lecture Notes on Coastal and Marine Studies. Springer-Verlag - Berlin, Heidelberg, New York.

Hildebrand S.F. and W.C. Schroeder. 1972. Fishes of Chesapeake Bay. Reprinted for the Smithsonian Institution by T.F.H. Publications, Inc., Neptune, NJ, USA. 388 pp.

Hirshfield, M. F. & J. H. Hixson III, 1981. Impingement studies 2. Survival estimates of impinged fish. In: Non-Radiological Environmental Monitoring Report, Calvert Cliffs Nuclear Power Plant, January-December 1980. Baltimore Gas and Electric Company, Baltimore, MD. pp 9.2-1-9.2-9.

Hixson III, J. H. 1977. Chesapeake Bay fish survey, shore zone fishes. Progress Report VI, January 1976 - December 1976 for the Baltimore Gas & Electric Company. Academy of Natural Sciences of Philadelphia. Report No. 77-25.

Hixson III, J. Howard and Denise L. Breitburg. 1993. Impingement studies at Calvert Cliffs Nuclear Power Plant for Baltimore Gas and Electric Company. Estuarine Research Center. Report No. 94 - 28

Hixson III, J. Howard and Denise L. Breitburg. 1995. 1994 Impingement studies at Calvert Cliffs Nuclear Power Plant for Baltimore Gas and Electric Company. Estuarine Research Center. Report No. 95 - 13

Hixson III, J. Howard and Denise L. Breitburg. 1996. 1995 Impingement studies at Calvert Cliffs Nuclear Power Plant for Baltimore Gas and Electric Company. Estuarine Research Center. Report No. 96 - 12

Lawler, Matusky, and Skelly Engineers (LMS). 1991. Intake Debris Screen Post Impingement Survival Evaluation Study Roseton Generation Station 1990. Central Hudson Gas & Electric Company.

LMS. 1992. Intake Technology Review Oswego Steam Station Units 1-6. Niagara Mohawk Power Corporation.

Lifton, W.S. 1979. Biological aspects of screen testing on the St. Johns River, Palatka, Florida. Passive Intake Screen Workshop. December 4-5, 1979. Chicago, IL.

Maryland Department of the Environment, State Discharge Permit No. 02-DP-0187 (NPDES No. MD0002399).

Maryland Department of Natural Resources (MDDNR). 2005. Fixed Station Monthly Monitoring. Chesapeake Bay Mainstem – Cove Point (CB4.4).
http://mddnr.chesapeakebay.net/bay_cond/bay_cond.cfm?param=bdo&station=CB44

Pearce, R.O. and R.T. Lee. 1991. Some Design Considerations for Approach Velocities at Juvenile Salmonid Screening Facilities. In: Fisheries Bioengineering Symposium. American Fisheries Society 10:237-248

Public Service Enterprise Group (PSEG). 2004. Special Study Report, Salem Generating Station, Estimated Latent Impingement Mortality Rates: Updated Pooled Estimates Using Data From 1995, 1997, 1998, 2000, and 2003. Prepared for PSEG by Allee, King, Rosen, and Fleming, 7250 Parkway Drive, Suite 210, Hanover, MD 21076. June 18, 2004.

Reider, R.H., D.D. Johnson, P. Brad Latvatis, J.A. Gulvas, E.R. Guilfoos. 1991. Operation and Maintenance of the Ludington Pumped Storage Project Barrier Net. Proceedings of Fish Passage Workshop, Milwaukee, Wisconsin, May 6-8, 1997. Sponsored by Alden Research Laboratory, Conte Anadromous Fish Research Laboratory, Electric Power Research Institute, and Wisconsin Electric Power Company.

Ringger, T.G. Investigations of impingement of aquatic organisms at the Calvert Cliffs Nuclear Power Plant, 1975-1995. Environmental Science & Policy 3 (2000).

Sage, L. E. & M. E. Thompson. 1978. Calvert Cliffs Nuclear Power Plant Curtain Wall Study - Zooplankton 1976 for the Baltimore Gas & Electric Company. Academy of Natural Sciences of Philadelphia. Report No. 78-22

Stevenson, J.C., C.B. Piper and N. Confer. 1979. Decline of submerged plants in Chesapeake Bay. Chesapeake Bay Field Office of the United States Fish and Wildlife Service. <http://www.fws.gov/chesapeakebay/savpage.htm>

United States Environmental Protection Agency (EPA). 2004. National Pollutant Discharge Elimination System - Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities. July 9, 2004 Federal Register: Vol. 69, No. 131 Pg 41576-41693

United States Nuclear Regulatory Commission. 1999. Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Calvert Cliffs Nuclear Power Plant (NUREG-1437, Supplement 1). Final Report. Office of Nuclear Reactor Regulation, Division of Regulatory Improvement Programs, Washington, DC, USA.

Virginia Institute of Marine Science (VIMS). SAV Monitoring Reports 1999-2003. Bay Grasses (SAV) in Chesapeake Bay and Delmarva Peninsula Coastal Bays. VIMS SAV Web Page. <http://www.vims.edu/bio/sav/>

Alliance for the Chesapeake Bay. About the Bay.
<http://www.acb-online.org/about.cfm>

Chesapeake Bay Foundation. 2003. The Chesapeake Bay's Dead Zone.
http://www.cbf.org/site/PageServer?pagename=resources_facts_deadzone#mainstem

Chesapeake Bay Program. 2003. Bay FAQ.
<http://www.chesapeakebay.net/info/bayfaq.cfm#big>

Table 1. Threatened and endangered aquatic species identified near Calvert Cliffs

LOCATION	SCIENTIFIC NAME	COMMON NAME
Calvert Cliffs- Calvert County		
	¹ <i>Acipenser oxyrinchus</i>	Atlantic sturgeon
	¹ <i>Fundulus luciae</i>	Spotfin killifish

¹ State Listed

Table 2. Family, Scientific Name, and Common Name of Species Impinged at the Calvert Cliffs, 1995

Family	Scientific Name	Common Name	Number Collected	Percent Composition
Portunidae	Callinectes sapidus	blue crab	4,294	53%
Engraulidae	Anchoa mitchilli	bay anchovy	2,728	33%
		Unidentified		
Atherinopsidae	Menidia sp.	Silverside	310	4%
Achiridae	Trinectes maculatus	hogchoker	301	4%
Syngnathidae	Syngnathus fuscus	northern pipefish	172	2%
Clupeidae	Alosa aestivalis	blueback herring	102	1%
Sciaenidae	Cynoscion regalis	weakfish	72	1%
Gobiesocidae	Gobiesox strumosus	skilletfish	63	1%
Sciaenidae	Leiostomus xanthurus	spot	29	0%
Stromateidae	Peprilus paru	harvestfish	23	0%
Tetraodontidae	Sphoeroides maculatus	northern puffer	20	0%
	Micropogonias			
Sciaenidae	undulatus	Atlantic croaker	14	0%
Triglidae	Prionotus carolinus	northern searobin	8	0%
Clupeidae	Brevoortia tyrannus	Atlantic menhaden	6	0%
Paralichthyidae	Paralichthys dentatus	summer flounder	6	0%
Clupeidae	Alosa pseudoharengus	alewife	5	0%
Moronidae	Morone saxatilis	striped bass	4	0%
Batrachoididae	Opsanus tau	oyster toadfish	3	0%
Belonidae	Strongylura marina	Atlantic needlefish	3	0%
Moronidae	Morone americana	white perch	3	0%
Syngnathidae	Hippocampus erectus	lined seahorse	3	0%
Anguillidae	Anguilla rostrata	American eel	2	0%
Dasyatidae	Dasyatis say	bluntnose stingray	1	0%
Gobiidae	Gobiosoma bosc	naked goby	1	0%
Phycidae	Urophycis regia	spotted hake	1	0%
Pomatomidae	Pomatomus saltatrix	bluefish	1	0%
Stromateidae	Peprilus triacanthus	butterfish	1	0%
Trichiuridae	Trichiurus lepturus	Atlantic cutlassfish	1	0%
			8,177	100%

(Hixon and Breitburg 1996)

Table 3. Estimated Number of Fish Impinged Per Month for Dominant Species Collected at Calvert Cliffs, 1995

Month	Total Estimated Impingement	Percent of Total Impingement	Percent Composition By Species and Month			
			Blue Crab	Bay Anchovy	Atlantic Silverside	Hogchoker
Jan	4,739	1%	0.0%	0%	56%	0%
Feb	3,802	1%	0.0%	0%	79%	0%
Mar	7,720	2%	0.0%	44%	32%	0%
Apr	4,853	1%	49.8%	43%	2%	0%
May	16,368	4%	69.8%	15%	3%	9%
Jun	26,621	6%	73.7%	8%	0%	10%
Jul	134,516	30%	38.1%	56%	0%	3%
Aug	170,938	38%	60.4%	29%	0%	4%
Sep	50,149	11%	66.9%	24%	0%	2%
Oct	17,988	4%	73.8%	22%	0%	0%
Nov	11,473	3%	56.6%	16%	25%	0%
Dec	2,063	0%	0.0%	19%	81%	0%
Total	451,230	100%	53.5%	34%	3%	4%

(Hixson and Breitburg 1996)

Table 4. Yearly Impingement Rates (Number of Organisms Per Circulator Pump Hour) for Finfish and Blue Crab at Calvert Cliffs from 1982 through 1995 (Hixson and Breitburg 1996)

Year	Finfish	Blue Crab	Total
1982	59.0	16.9	75.9
1983	111.3	35.3	146.6
1984	840.5	103.4	943.9
1985	38.6	27.3	65.9
1986	69.2	17.6	86.8
1987	67.3	44.1	111.4
1988 ^a	90.4	59.2	149.6
1989	59.3	14.6	73.9
1990	14.0	19.0	33.0
1991	23.1	34.4	57.5
1992	5.7	15.4	21.1
1993	49.3	40.7	90.0
1994	8.8	33.0	41.8
1995	10.0	11.0	21.0

a = 1988 was the first year when the total number of fish impinged was adjusted for fish losses while emptying the collection net.

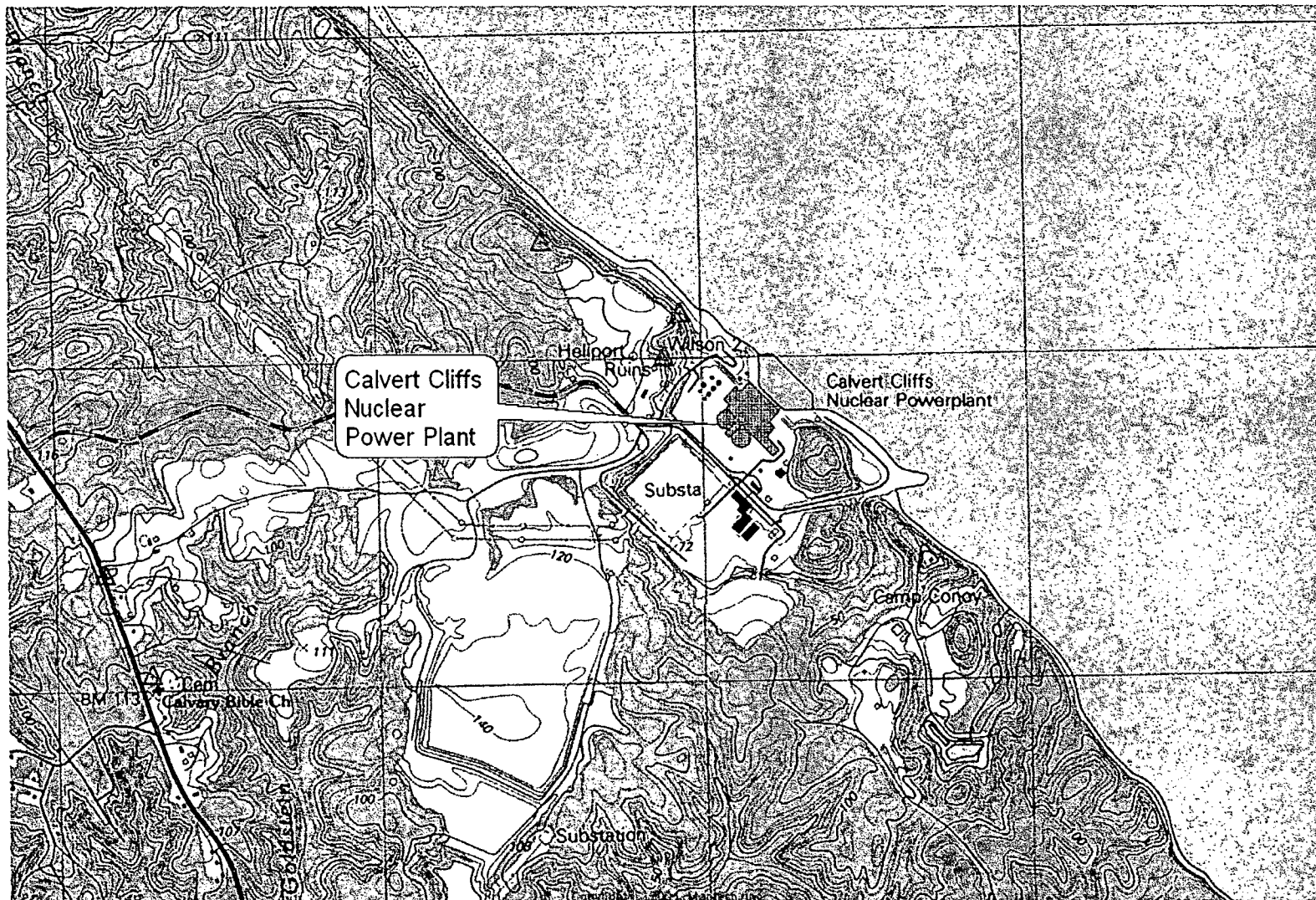


Figure 1. Topographic view of the Calvert Cliffs Nuclear Power Plant, Calvert Co., Maryland.

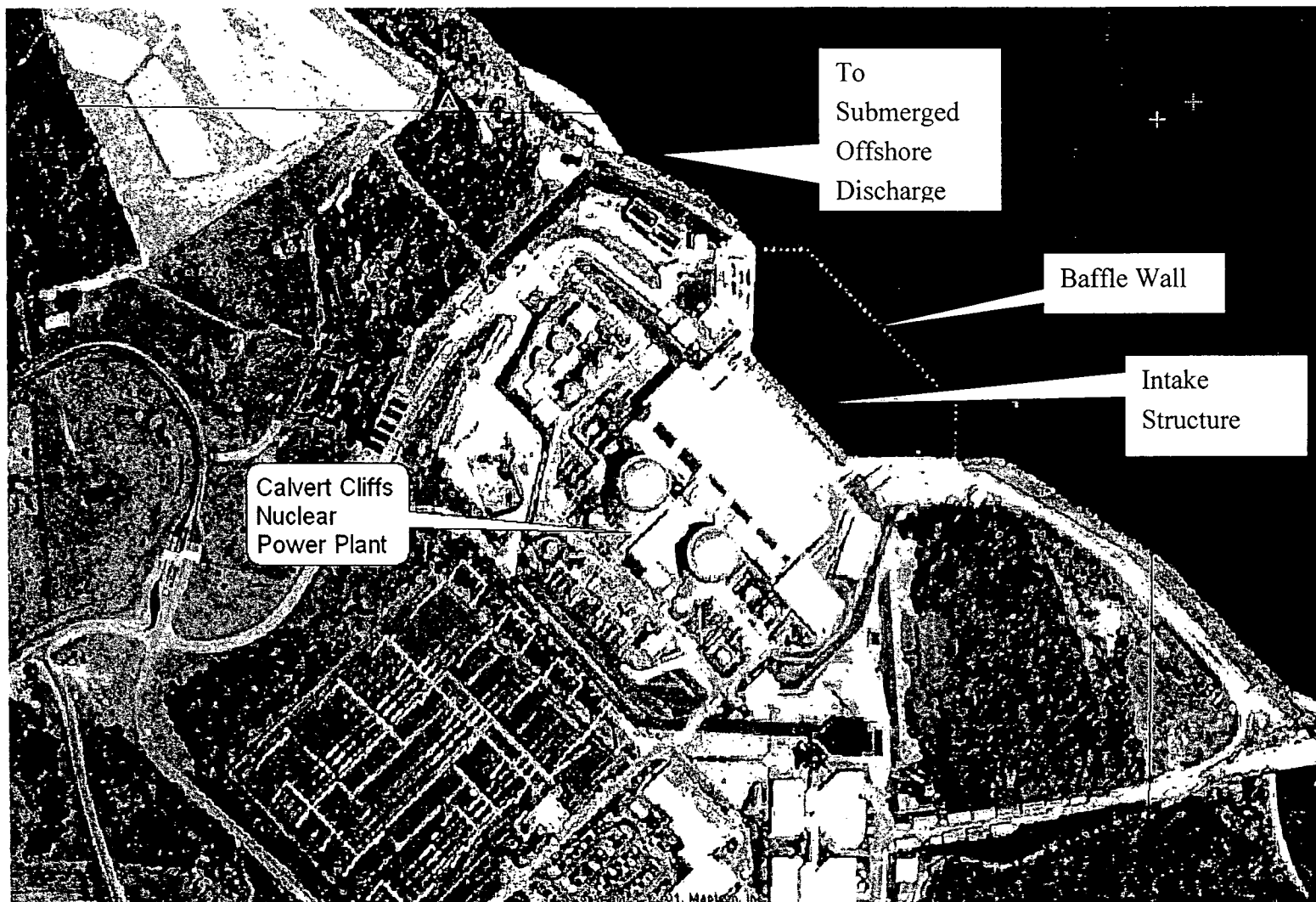


Figure 2. Aerial View of the Calvert Cliffs Nuclear Power Plant, Calvert Co., Maryland.

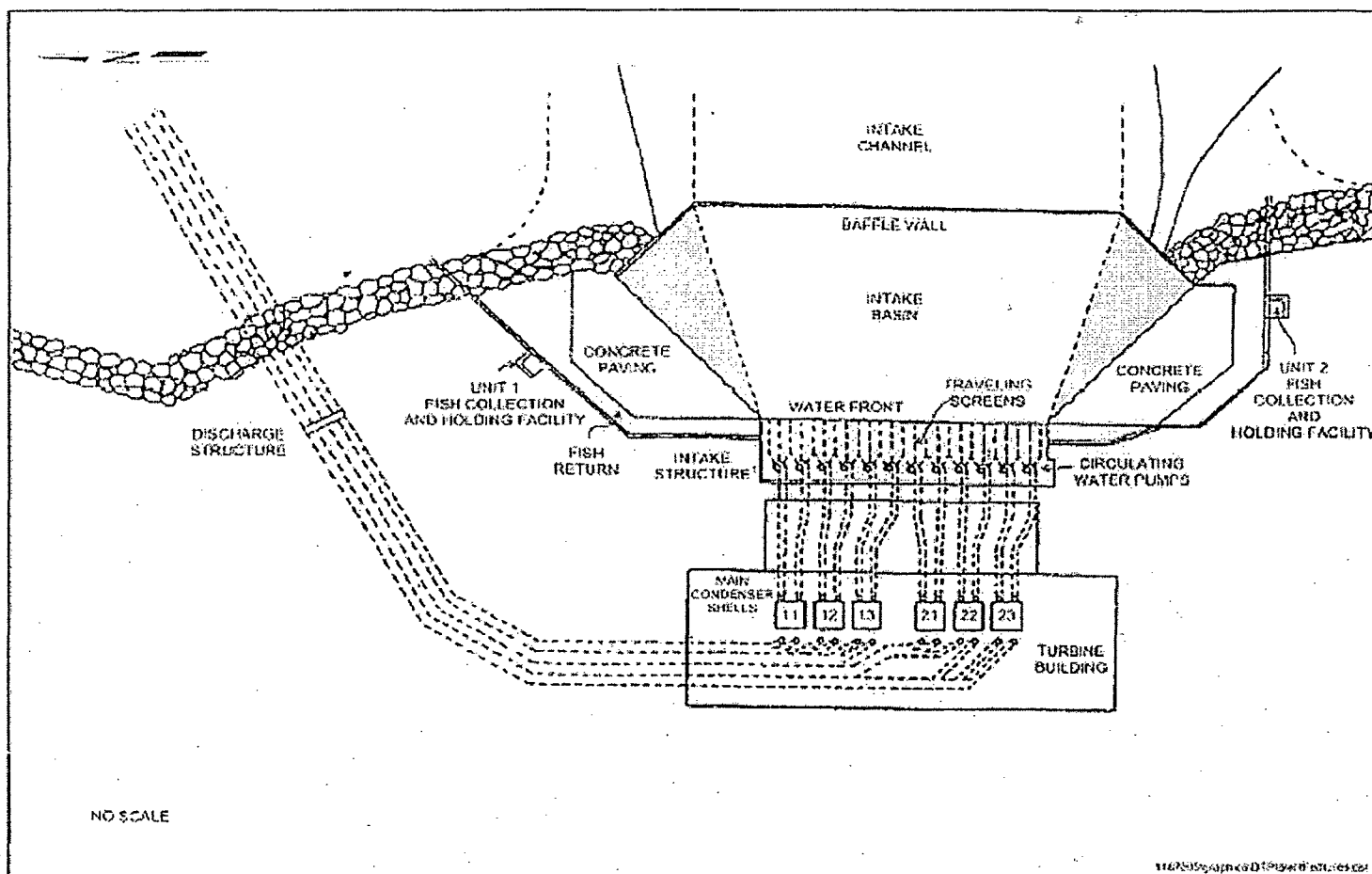


Figure 3. Circulating water system simplified diagram

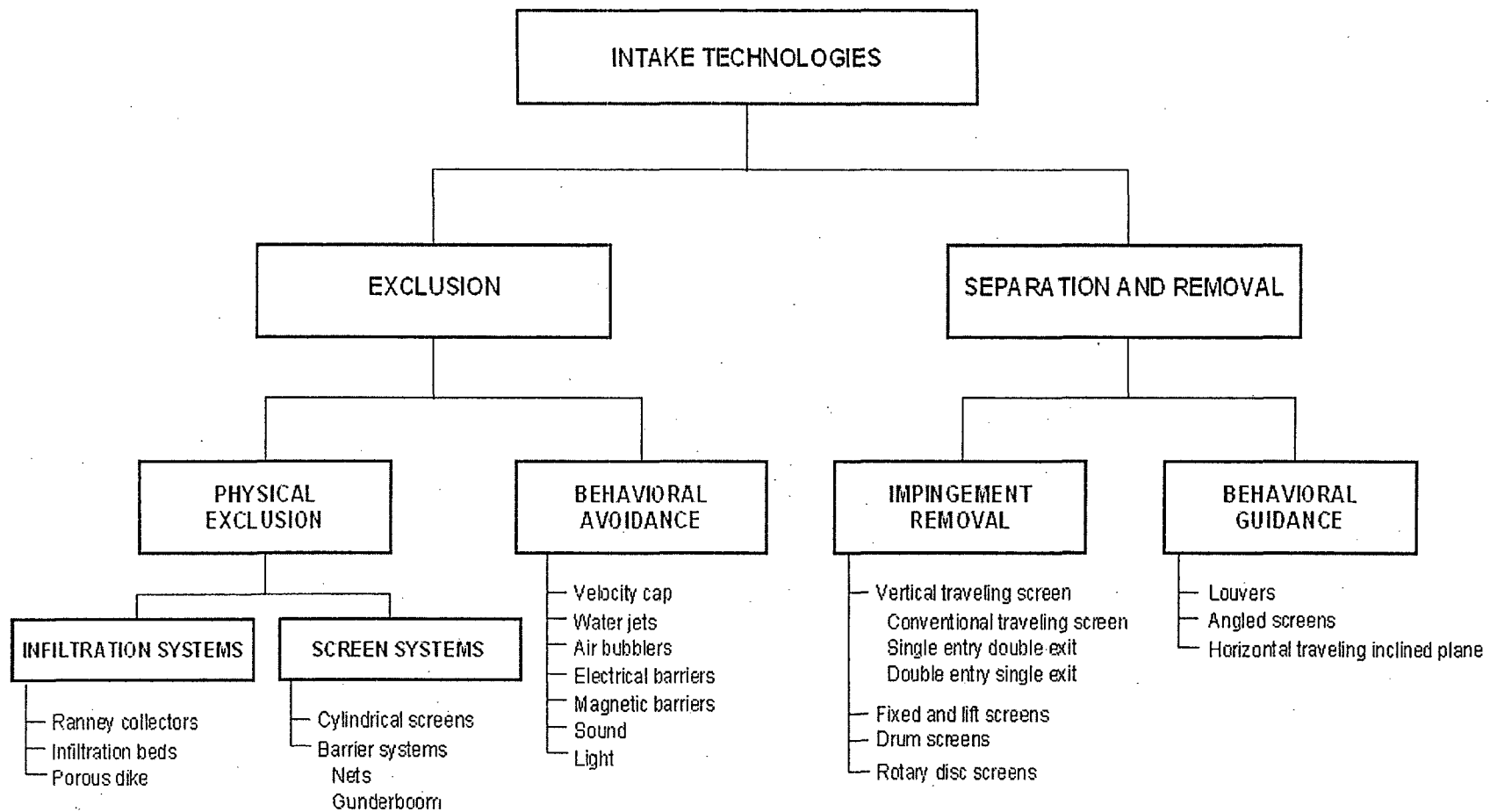


Figure 4. Intake Technology Matrix.

APPENDIX A
Impingement/Entrainment Studies

Calvert Cliffs Nuclear Power Plant Impingement/Entrainment Summaries

Ringger, T.G. Investigations of impingement of aquatic organisms at the Calvert Cliffs Nuclear Power Plant, 1975-1995. Environmental Science & Policy 3 (2000).

From 1975 to 1995, impingement monitoring was conducted at CCNPP. A total of 73 species were identified. Often, five species accounted for over 90% of the total number of fish collected in any year. Estimates of total annual fish impingement ranged from 79,000 to 9.6 million with a 21 year average of 1.3 million fish per year. Six different survival studies were conducted at CCNPP and species-specific impingement tolerances were determined. Eleven of the 14 species caught most often had survival rates over 50% and blue crabs demonstrated greater than 99% survival. Fish impingement was generally highest during spring and summer. Peak blue crab abundance was more variable with high numbers reported in the spring, summer or fall. Survival studies were conducted in the months before Unit 1 began commercial operation to determine survival of impinged organisms. (No data was provided other than during the first survival study, blue crabs and hogchokers had survival rates greater than 99% and that the two species were not included in subsequent studies.

Although certain refinements have been made over the 21-year period of studies, the protocol has been as follows:

- A 1.27 centimeter stretch mesh nylon collecting net was placed in the screen wash discharge trough and left in place for one hour. During normal plant screen rotation cycles, one hour collections were made at each unit at various intervals over a six day period that alternated in a way to ensure all hours of the day and all tidal conditions sampled. This process was repeated for the entire year until 1994 when it was scaled back to four- and five-day periods (October -April and April - October, respectively).
- Impinged organisms were identified to species and the number of each species collected was counted. Up to 50 individuals of each species were measured, weighed and examined for external injury.

Six initial species-specific survival studies were done in the months prior to Unit I becoming operational to determine survival of impinged organisms. Numbers dead, alive

and loss of equilibrium (counted as dead) were recorded. Influences of environmental variables (e.g. daylight and water temperature) and plant operations (e.g. unit differences, screen technology and cycling times) were tested.

A total of 73 species of fish were identified in the 21-year period. Often, five species accounted for over 90% of the total number collected in any year. Most common species collected included: Bay anchovy, hogchoker, spot, A. menhaden, A. silverside. Total annual fish impingement estimates ranged from 79,000 to over 9.6 million with a 21-year average of 1.3 million fish per year. Total impinged biomass ranged from 1300 to 18,600 kg/yr, with an average of 9100 kg/yr.

Eleven of the 14 species caught most often had survival rates over 50% and blue crabs demonstrated greater than 99% survival. When total impingement estimates are adjusted to account for survival, the fish impact is reduced by over 73%. This impact is small compared to commercial, recreational and natural mortality. Furthermore, many of the significant impingement events were episodic that correlated with high temperature and low dissolved oxygen (DO) conditions. The MD Dept. of Natural Resources concluded that CCNPP does not pose a significant impact on fish populations in the Bay.

Breitburg, D. L. 1989. Trends in impingement of fish and blue crabs at the Calvert Cliffs Nuclear Power Plant: 1982-1986. Report No. 89-12. Academy of Natural Sciences of Philadelphia. 30pp.

Studies have been done at Calvert Cliffs Nuclear Power Plant to determine species composition, numbers and weights of fishes and selected macroinvertebrates impinged since 1975. This report summarizes those results over the 1982 to 1986 period.

CCNPP has 6 pairs of rotating, 1-cm² mesh screens at each of the two units. Each pair rotates in succession for 10 minutes at a time. Impinged organisms are washed into a trough and returned to the Bay.

Sampling was done in 6-day cycles separated by 2 or 3 day intervals. 1-hr collections were made on each sampling day at each of the two units (only if the unit was operational). The first sampled unit alternated each day. Collections were taken 4 hours apart from each other on successive days of the 6 day period (i.e. 0000 day 1, 0400 day 2, 0800 day 3, etc.). On each day, the second collection began 2-hr after the first. Therefore, all hours of the day were sampled in two 6day periods. A 1.27-cm stretch-mesh nylon collecting net was held in the screen-wash trough for approximately 1-hr at

each operating unit. Impinged organisms were identified (to species) and the number of individuals collected was recorded. Total lengths of up to 50 individuals and total weight of each species for each sample were measured at each unit.

A total of 510,906 fish from 54 species and 181,313 blue crabs was collected at both units during 1982 to 1986. The most abundant fish were: spot (35%), bay anchovy (29%), hogchoker (14%) and Atlantic menhaden (13%), which together comprised 91% of the total catch. These were also the most abundant fish in the previous five year study (although ranks differed). Annual finfish impingement did not differ significantly from previous years. Estimated total impingement for the 5-year period was 15,175,878 fishes and 5,614,276 blue crabs.

Years of peak abundance varied among species. Numbers of anadromous fishes impinged were lower in this study period than the previous 5 year period. For many of the abundant species, the majority of individuals collected over the 5 years occurred in a single season, usually spring or summer. Most abundant species were impinged in significantly larger numbers during some years than during others. However, these years did not coincide with peak years of commercial catches. Instead, large impingements often resulted from fish kills associated with low DO. Inter-annual variation in numbers of fish and crabs impinged was independent of variation in numbers of hours sampled per year.

Maryland Department of the Environment, State Discharge Permit No. 02-DP-0187 (NPDES No. MD0002399)

This document is the permit for discharging effluent from the plant and the associated regulations that must be adhered to. There are no specific impingement and/or entrainment data, although stipulations are included for such event. Any impingement on the water intake apparatus that would be substantial enough to cause modification to plant operations were to be reported within 24-hrs by written notification. Also, within 30 days of each occurrence, a written report that discusses the cause of the problem, plant reaction and precautions to be taken to avoid similar impingements would be submitted.

Breitburg, D. L., J. H. Hixson III & R. P. Gallagher, 1986. 1984 impingement studies at Calvert Cliffs Nuclear Power Plant for Baltimore Gas and Electric Company. Report No. 86-1. Academy of Natural Sciences of Philadelphia. 23pp.

Studies were conducted at the Calvert Cliffs Nuclear Power Plant to determine species composition, numbers and weights of fishes and selected macroinvertebrates impinged during 1984.

CCNPP has 6 pairs of rotating, 1-cm² mesh screens at each of the two units. Each pair rotates in succession for 10 minutes at a time. Impinged organisms are washed into a trough and returned to the Bay.

Sampling was done in 6-day cycles separated by 2 or 3 day intervals. 1-hr collections were made on each sampling day at each of the two units (only if the unit was operational). The first sampled unit alternated each day. Collections were taken 4 hours apart from each other on successive days of the 6 day period (i.e. 0000 day 1, 0400 day 2, 0800 day 3, etc.). On each day, the second collection began 2 hours after the first. Therefore, all hours of the day were sampled in two 6-day periods. A 1.27-cm stretch-mesh nylon collecting net was held in the screen-wash trough for approximately 1-hr at each operating unit. Impinged organisms were identified (to species) and the number of individuals collected was recorded. Total lengths of up to 50 individuals and total weight of each species for each sample were measured at each unit.

A total of 387,452 fish from 38 species was collected at both units in 1984 (7 times that of 1983, nearly 14 times 1982 collection). The five most abundant fish species were spot, bay anchovy, menhaden, hogchoker, and summer flounder, which together compromised 99% of the total catch. Three additional species, A. Croaker, A. silversides and blueback herring, were caught in sufficient numbers to be considered important. Blue crabs (95,382 collected at both units) were abundant in 1984 impingement samples. Estimated total impingement of fishes in 1984 was 9,671,262 (blue crabs = 1,883,619).

The highest monthly total number of fish collected, and the month(s) in which the greatest number of fish were collected per hour, occurred in June and August at Unit 1 and July at Unit 2. More fish—both total numbers and mean number per hour—were collected during June and August at Unit 1, and during April at Unit 2 than at other times of the year. The total numbers of fish, blue crabs, coelenterates, and ctenophores were higher than those for 1981, 1982, and 1983 totals.

Breitburg, D. L. & T. A. Thoman, 1986. Calvert Cliffs Nuclear Power Plant fish survival study for Baltimore Gas and Electric Company. Final Report No. 86-19, Academy of Natural Sciences of Philadelphia. 25pp.

Survival and impingement studies were conducted at CCNPP from June to August 1986 to compare survival rates, sizes and numbers of impinged finfishes. There were no overall differences among screen types in survival of impinged finfish. Beauderey screens impinged fish of larger average sized than did control screens. More fish were impinged by both experimental screens than by FMC single-speed screens. However, the difference in impingement rates may be due to screen positions rather than screen types.

FMC single-speed screens are currently used at CCNPP. Two experimental screen types, Beauderey screens and FMC dual-speed screens, were installed at Units 1 and 2, respectively, to test their effectiveness at cooling and whether they significantly increase the number of fish killed. This study cannot distinguish between screen and position effects because each type of experimental screen was installed in only one position.

Fish and wash-water were diverted from the troughs to 9.3m X 4.3m X 0.8m survival pools. At Unit 1, sampling occurred 100 s (the travel time from the trough to the survival pool, t_{t-s}) after the screen began to rotate and flow into the pool remained for the duration of the screen rotation (10 min). This procedure was not used at Unit 2 because of the variable t_{t-s} . Unit 2 screens were manually rotated, flow into the pool remained for 25min, starting 3 min after the screen to be sampled began its hourly rotation. At the end of the sampling period, blue crabs, coelenterates and ctenophores were removed. Dead finfish were removed and identified to species and total length (nearest 0.5cm) of 25 (max) randomly chosen individuals of each species was measured. At the end of the day's sample, DO, salinity, temperature, water depth and weather were recorded. Twenty-four hours after pools were filled, DO, salinity, and temperature were re-measured. All finfish except hogchokers were removed, identified and classified as live, dead, or loss of equilibrium.

Sampling was done in 6 day cycles separated by 2 or 3 day intervals. 1-hr collections were made on each sampling day at each of the two units (only if the unit was operational). The first sampled unit alternated each day. Collections were taken 4 hours apart from each other on successive days of the 6 day period (i.e. 0000 day 1, 0400 day 2, 0800 day 3, etc.). On each day, the second collection began 2 h after the first. Therefore, all hours of the day were sampled in two 6 day periods. A 1.27-cm stretch-mesh nylon

collecting net was held in the screen-wash trough for approximately 1-hr at each operating unit.

Twenty nine species of finfish from 22 families were collected. In general, survival rates were lowest for schooling, midwater species (bay anchovy, Atlantic menhaden, blueback herring) and highest for benthic species (oyster toadfish and flatfishes). Survival of spot was lower when impinged on Beaudrey screens than control screens, survival of bay anchovy was lower on FMC dual-speed screens than on controls.

Beaudrey screen impinged fish (bay anchovy, A. menhaden, weakfish, spot, oyster toadfish, harvestfish, blackcheek tonguefish) were of larger average size (and thus, economic importance) than control screens. FMC dual and single speed screens had similar average sizes of impinged fish. More fish were impinged by both experimental screens than control screens. However, the difference in impingement rates may be due to screen positions rather than screen types (un-testable in this experimental design).

Academy of Natural Sciences of Philadelphia. 1975. Ichthyoplankton of the Chesapeake Bay in the vicinity of the Calvert Cliffs plant site April 14 - November 2, 1973.

A study of the ichthyoplankton in the vicinity of the Calvert Cliffs plant site was conducted from April 14 to November 2, 1973. The purpose of this project was to estimate the relative abundance of the fish eggs and larvae periodically throughout the spawning season, and to look for trends in their vertical and horizontal distribution. The species composition was determined to check for the presence of commercially important species, and/or forage for these fish.

Study area was the western shore of the Bay. Five sampling stations were placed parallel to shore at the 30' contour line; three stations were placed normal to the shore at 10', 40' and 70' depths. Tows were made weekly from April 14 to June 1 and every other week thereafter. Samples were collected with a one meter, #2 mesh, plankton net equipped with a flow meter. Most tows strained 200-400 m³ of water.

Only 43% of the tows made contained ichthyoplankton. Bay anchovy was by far the dominant component of the IP in the vicinity of CCNPP during the sampling period. Occurrence and abundance of other species was very spotty but included: skilletfish, silversides, northern pipefish, comb-toothed blennies, naked goby, hogchoker. Although no species of direct commercial importance was found, bay anchovy is indirectly

important as it is a major constituent of striped bass diet. Greater densities of bay anchovy and hogchoker eggs were found in bottom tows than surface tows. No significant differences in egg abundance were found among stations or between ebb and flood tides. Because low densities of eggs were found (anchovy eggs were an order of magnitude lower than a previous study) it is concluded that the study area is not a major spawning ground for any of the species caught.

Hixson III, J. H. 1977. Chesapeake Bay fish survey, shore zone fishes. Progress Report VI, January 1976 - December 1976 for the Baltimore Gas & Electric Company. Academy of Natural Sciences of Philadelphia. Report No. 77-25.

Shore seining is one of several ongoing studies to determine fish population structure and life history of estuarine fishes in the CCNPP vicinity. Monthly seine hauls have been made at four stations at varying distances from the plant site since February 1971. Number of individuals, relative abundances of species, and sizes of individuals are recorded. These data are compared among stations and between pre- and post-operational periods to determine whether the operation of the plant affects fish distribution within the study area. In this report, results of the 1976 shore seining program are discussed and compared with the previous 5 years.

Shore seining is conducted monthly at four stations. All collections are made with a 15.2m nylon bag seine (1.5m deep, 1.3cm stretch mesh). The seine is stretched along the water's edge with one end held stationary. The other end is swept in a 180° arc directly off shore covering 0.09 acres with each haul. Five hauls are made and all fish collected are enumerated and separated by species, up to 50 individuals of each species are randomly selected and preserved in 10% formalin for later length measurement. Prior to each collection, tide, weather time, temperature and salinity are also measured.

A total of 18,196 fish from 29 species was collected in 1976. Almost 91% of these were collected from May to August. Atlantic menhaden was most abundant (28.2% total catch), followed by spot (26.5%), Atlantic silversides (21.4%) and winter flounder (17.1%). The remaining 25 species comprised 6.8% of the catch.

The same species were dominant at all stations; there is no indication that species composition at the Plant Site has been altered since the power plant became operational, nor were there significant differences in monthly abundances among sites in 1976. Length-frequency data indicate that in April and May, many juvenile spot occurred at

Kenwood Beach (KB) and Long Beach (LB) stations when virtually none were present at the Plant Site and Rocky Point stations. This may be related to the protected shore zone at both KB and LB.

Bradley, B. P. 1980. Calvert Cliffs Zooplankton Entrainment Study. Maryland Power Plant Siting Program Report No. PPSP-CC-80-1. [11-D-20] File: zoopl entr-bradley 1980.

The major objective of the study was to demonstrate conservation of entrained zooplankton, whether dead or alive (and accounting for sampling error). Since densities were not conserved, secondary objectives were to explain why densities were lower at the discharge than at the intake and to estimate mortality due to entrainment.

The overall conclusion is that no solid hypothesis could be posited to explain entrainment density differences.

Ecological Analysts Inc., 1980. Evaluation of the effects of the proposed Royce woven slot screen mesh on impingement at Calvert Cliffs Nuclear Power Plant. EA Report BGE03R1.

The purpose of this study is to determine the dimensions and life stages of these fishes that are presently being entrained through or impinged on the existing 9 x 9mm screens at CCNPP as compared to the dimensions and life stages of the same species that will be impinged on the proposed smaller 3.2 x 12.7mm Royce screens.

Resident species that spawn locally are susceptible to entrainment as eggs and/or larvae and become susceptible to impingement at some later time as the growing fish become too large to be entrained through the 9.0mm square mesh on the traveling screens.

Screen aperture is the critical parameter that determines whether an organism will be entrained or impinged. The proposed use of a smaller (12.7 x 3.2 mm) mesh on the intake screens at CCNPP could affect whether the species that encounter the intake structure are entrained through the plant or impinged on the screens. Determining the impact of this anticipated increase in impingement is the primary objective of this study, including which species will be affected by the new screens, over what time period, what the increase in numbers impinged will be and what effect this will have on the existing natural local populations of these species.

Data were collected for this study from a variety of previous and ongoing sampling projects. Sufficient numbers of bay anchovy, Atlantic menhaden, spot and Atlantic croaker were available from these studies to produce meaningful scatter plots (used to determine which morphometric parameter, body depth or width, would exceed screen mesh aperture dimensions).

The yearly increase in impingement of these four species is projected to be approximately 36.8 million fish (anchovy = 8.4 mil, menhaden = 1.12 mil, spot = 17.8 mil, croaker = 9.5 mil) with a dollar value between \$3,365,000 (assuming 0% impingement survival) and \$1,388,000 (impingement survival equal to existing screens). The bulk of impingements occurred in April through June (anchovy), May through June for menhaden and spot, fall through winter for croaker (see table below).

**SELECTED SPECIES PERIODS OF SUSCEPTIBILITY,
ESTIMATED INCREASE IN IMPINGEMENT,
SURVIVAL ESTIMATES, DOLLAR VALUATION OF IMPINGED SPECIMENS
AND RANGE OF DOLLAR LOSS DUE TO IMPINGEMENT INCREASES
ATTENDANT WITH INSTALLATION OF ROYCE WOVEN
SLOT MESH SCREEN PANELS AT CCNPP**

Species	Period(s) of Susceptibility	Estimated Impingement Increase (x 10 ⁶)	Yearly Total (x 10 ⁶)	ANSP Survival Estimates	RIS Valuation ^(a) (\$/10 ⁶ fish)	Species Function/Factor ^(b)	Adjusted Value (\$/ea)	Losses Due to Impingement Increases	
								\$ ^(c)	\$ ^(d)
Bay Anchovy	Jan. – Jun.	4.523	8.432	0.63		f	0.00075	2,340	6,314
	Sep. – Dec.	2.985			1,000	0.75			
Atlantic menhaden	May – Jun.	1.119	1.119	0.51	100,000	c,f	0.075	41,130	83,930
						0.75			
Spot	Apr. – Jun.	17.753	17.753	0.89	150,000	c,r,f	0.12	234,340	2,130,360
						0.80			
Atlantic croaker	Nov. – Dec.	5.476	9.535	0.03	150,000	c,r,f	0.12	1,109,870	1,144,200
	Jan. – Feb.	4,059				0.80			
Yearly Totals			36.83					1,387,680	3,364,804

(a) Values for specimens less than 4 inches in length from COMAR 08.02.09.01.

(b) Species function and adjustment factors from COMAR 08.05.04.13 Sections d, f.

(c) Assuming ANSP impingement survival estimates.

(d) Assuming 0 impingement survival.

Ecological Analysts, Inc. 1981. Entrainment Abundance and Viability Studies, Calvert Cliffs Nuclear Power Plant, Final Report 1978-1980, Baltimore Gas and Electric Company. Report No. BGE04K1. [10-B-54]

In order to evaluate the impact of plant passage on macro zooplankton (MZ) and ichthyoplankton (IP) organisms entrained at CCNPP, an Entrainment Abundance sampling program was begun in April 1978 and expanded to include entrainment viability in 1979. The abundance program was designed to identify the major species, the densities of the entrainable life stages, and periods of abundance. For the viability program, several of the more abundant species/life stages were collected at the intake and at the discharge. The rates of survival were compared both immediately after entrainment and after a period sufficient to allow for the manifestation of latent effects.

Samples for both the abundance and viability programs were collected with a large volume pump and larval table at the intake and discharge, sampling was timed so that collections were taken from the same water mass as it passed through the plant. Entrainment samples were collected simultaneously from intake and discharge. Live organisms were counted and held at ambient temperatures for 88 hours (48 h in 1980). These organisms were observed regularly and noted live/dead status and survival rates were calculated.

Ichthyoplankton was most abundant during the May through September period each year and was dominated by early life stages of hogchoker (eggs), bay anchovy (eggs and larvae) and naked goby (larvae). These represented over 90% of IP collected. Species composition for both IP and MZ was fairly constant between years.

Hogchoker eggs were significantly more abundant at night in all three summers. Anchovy were significantly more abundant at night during all three years. Spot juveniles more abundant at night in the spring. Atlantic croaker juveniles were more abundant at night during the winter. Hogchoker eggs and bay anchovy larvae exhibited fluctuations in density that were repeatable, and related to a 24-hour cycle.

Differences between rates of survival at intake and discharge were not statistically significant for the more abundant fish species. Moreover, the mortalities observed may be related to collection damage. Results from entrainment viability indicate that

entrainment at CCNPP does not seem to be a major source of mortality for the species tested.

The species entrained at egg and larval stages (and the MZ) are found widely throughout the Chesapeake Bay estuary. Furthermore, the location of the CCNPP is not in an area that is of critical importance to the life history of the more abundant taxa. Survival of these species does not seem to be affected by plant passage. The location and operation of CCNPP does not appear to exert an adverse impact on IP and MZ population levels in this region of Chesapeake Bay.

ANSP, 1981. Assessment of thermal, entrainment and impingement impacts on the Chesapeake Bay in the vicinity of the Calvert Cliffs Nuclear Power Plant. Report No. 81-10 prepared for Baltimore Gas and Electric Company. 298 pp.

Bay anchovy, naked goby and spot (RIS) are all present in either egg, larval or juvenile stages in the area surrounding CCNPP. Although significant numbers of anchovy eggs and larvae and naked goby larvae are entrained, these species reproduce and maintain extremely large populations throughout the entire Chesapeake Bay drainage system. Even if 100% entrainment mortality is assumed, the effects of entrainment on the viability of the populations as a whole are negligible. Given the small number of juvenile spot entrained, and its enormous population size, effects of CCNPP operation are likewise negligible.

Survival studies were performed to estimate mortality as a result of impingement. These values were used to estimate the monetary values lost due to impingement from three years of two unit operation. The expected yearly loss is \$24,289 with a 95% upper confidence limit of \$34,425.

Samples were collected at four stations located up- and down stream of the plant along a transect approximating the 10-m contour. Two stations in the immediate areas of intake and discharge were sampled to obtain estimates of populations possibly entrained. All stations were sampled monthly. All sampling was done at night to minimize net avoidance and because some groups tend to be more abundant in the water column at night. Sampling gear consisted of three 0.5-m diameter conical plankton nets of 223 micron mesh equipped with flowmeters. The nets were arranged to fish simultaneously at 0, 5 and 10m depths. Temperature, salinity and DO were measured at each station.

The IP collected were typically for the area. Bay anchovies usually dominated the catch and naked goby larvae were common. Young spot were low, but that may reflect limitations of sampling gear. The area around CCNPP is not used as a major spawning or nursery area by these groups. Goby larvae appear locally concentrated at near-plant stations, perhaps because of desirable habitat supplied by benthic rubble in the area.

The thermal plume did not appear to attract naked goby or spot, but may attract anchovy larvae. However, statistical testing did not show a significant variation in larval densities for all three species when comparing all stations.

Organisms were entrained approximately in proportion to their abundance near the plant. Anchovy eggs may be a greater risk of entrainment because they tend to concentrate at lower depths; anchovy larvae can avoid entrainment by avoidance behavior; goby larvae may be at increased risk because of habitat preference. Juvenile spot are able to avoid entrainment (and sampling) probably because of strong swimming ability.

Impingement sampling was done in 6 day cycles separated by 2 or 3 day intervals. 1-hr collections were made on each sampling day at each of the two units (only if the unit was operational). The first sampled unit alternated each day. Collections were taken 4 hours apart from each other on successive days of the 6 day period (i.e. 0000 day 1, 0400 day 2, 0800 day 3, etc.). On each day, the second collection began 2 hrs after the first. Therefore, all hours of the day were sampled in two 6 day periods. A 1.27-cm stretch-mesh nylon collecting net was held in the screen-wash trough for approximately 1-hr at each operating unit. Impinged organisms were identified (to species) and the number of individuals collected was recorded. Total lengths of up to 50 individuals and total weight of each species for each sample were measured at each unit.

In 1977, 43,959 finfish and blue crabs were collected, yielding an estimate of 1,238,991 individuals impinged. Bay anchovy, spot, and hogchokers represent 70.6% of the estimated 841,931 finfish impinged. An estimated 219,861 finfish and blue crabs were killed by impingement. Anchovy, menhaden, and weakfish represent 77.5% of the estimated 218,034 finfish killed by impingement. The monetary value of finfish and blue crabs estimated as killed in 1977 is \$23,453 with 95% upper confidence limit of \$36,741.

In 1978, 50,359 finfish and blue crabs were collected, yielding an estimate of 1,576,264 individuals impinged. Bay anchovy, menhaden, hogchoker, Atlantic silversides and spot represent 94.2% of the estimated 1,103,343 finfish impinged. An estimated 299,111 finfish and blue crabs were killed by impingement. Anchovy, Atlantic menhaden, and

silversides represent 80.3% of the estimated 296,936 finfish killed by impingement. The monetary value of finfish and blue crabs estimated as killed in 1978 is \$23,274 with 95% upper confidence limit of \$38,276.

In 1979, 67,736 finfish and blue crabs were collected, yielding an estimate of 1,973,692 individuals impinged. Bay anchovy, hogchoker, and blueback herring represent 61.6% of the estimated 855,193 finfish impinged. An estimated 261,785 finfish and blue crabs were killed by impingement. Anchovy, blueback herring and croaker represent 66.3% of the estimated 256,640 finfish killed by impingement. The monetary value of finfish and blue crabs estimated as killed in 1979 is \$26,141 with 95% upper confidence limit of \$40,258.

In a composite year at CCNPP, based on 3-yr averages, 54,018 finfish and blue crabs would be collected during impingement samples, with an estimated abundance of 1,596,316 individuals. Of these, 260,252 would be killed with an expected approximate 95% upper confidence limit on the total number killed by impingement of 430,184.

Hirshfield, M. F. & J. H. Hixson III, 1981. Impingement studies 2. Survival estimates of impinged fish. In: Non-Radiological Environmental Monitoring Report, Calvert Cliffs Nuclear Power Plant, January-December 1980. Baltimore Gas and Electric Company, Baltimore, MD.

Calvert Cliffs nuclear power plant, located on western shore of Chesapeake Bay, has two units that generate a net output of ~ 850 MWe each. Both reactors are cooled by a once-through cooling system using ~9.06 million liters per minute of Bay water. There are 12 traveling screens (operated sequentially in pairs for 10 min each hour) at each unit with 1-cm square mesh designed to prevent organisms from entering the plant. Organisms impinged on the screen are removed by a high-pressure water jet and returned to the Bay via a storm drain system.

A total of 31,145 fish from 37 species was collected in 1980 at both units (31 species at Unit 1, 24 species at Unit 2). The most common species collected were spot (48.3% at Unit I), bay anchovy (40.63% at Unit I), and Atlantic menhaden (5.39% at Unit I). Skilletfish, winter flounder and summer flounder had survival rates >90%. Bay anchovy and spot had survival rates between 80% and 90%. Menhaden and Atlantic silverside had survival rates <80%. There are no consistent differences in survival rates between units. Three of the seven dominant species (bay anchovy, Atlantic menhaden, and

Atlantic silverside) had higher survival rates in 1980 than 1979, the other four had similar rates in both years.

Burton, D. T. & W. C. Graves. 1979. *Impingement studies II. Survival estimates of impinged fish.* In: *Non-Radiological Environmental Monitoring Report, Calvert Cliffs Nuclear Power Plant, January-December 1978.* Baltimore Gas and Electric Company. Baltimore, MD.

Investigate the survival potential of fish impinged on the traveling screens at Calvert Cliffs. Objectives included:

- Determine if overall survival differs for fish impinged at Unit I or Unit II
- Determine if survival differs among dominant species at each Unit.
- Examine overall and individual species survival over a 48-hr post-impingement period.
- Evaluate the effect of time of collection on fish survival
- Determine the influence of seasonal temperature on survival.

One hour observations period were conducted at t_0 , t_{24} and t_{48} hours. During these periods, the following were recorded:

- Mortality. Death determined when fish failed to exhibit opercula movement.
- Anatomical: Total length and weight (to nearest 0.1 cm and gram, respectively). 25 individuals measured.
- Water Quality: DO, salinity, temperature
- Loss of Equilibrium (LOE) observations at end of 48-hr study period.

Three dominant species accounted for 91.6% of the total catch at both units: bay anchovy (59.2%), Spot (25.9%) and Atlantic menhaden (6.4%). The survival potential was: spot (89.1%), bay anchovy (37.6%), Atlantic menhaden (25.4%). The combined percent loss of equilibrium at t_{48} was 0% (spot), 7.6% (bay anchovy) and 1.0% (Atlantic menhaden).

No significant differences in overall or individual species survival between units, or between t_0 , t_{24} , and t_{48} , were found. However, a significant decrease in survival from t_0 to t_{48} was found for Atlantic menhaden. Greater numbers of fish were collected at night, but no statistically significant difference in survival occurred between day and night impinged fish. Temperature influence could not be determined due to insufficient data.

Gallagher, R. P. & L. E. Currence. 1982. Ichthyoplankton and macroplankton studies in the vicinity of Calvert Cliffs Nuclear Power plant 1981. Academy of Natural Sciences of Philadelphia. Report No. 82-1. [10-D-23]

Samples were collected of ichthyoplankton and macroplankton communities in the vicinity of Calvert Cliffs Nuclear Plant.

Objectives:

- Identify major taxa based on relative abundance
- Define spatial and temporal distribution patterns of the major taxa
- Assess the effects of plant operation on the size and structure of these communities

Monthly sampling (Feb., Mar., Apr. and Jun³) was conducted in 1981 at three reference stations (Kenwood Beach, Long Beach, Rocky Point) and at three near-plant stations (Plant Site, Plant Site Intake Canal and Plant Discharge Plume). The near-plant sites were sampled two additional dates in June.

Spatial and temporal distributions of impingement in the spring and early summer were virtually identical to previous years. Bay anchovy and hogchoker were the predominant species. Winter flounder larvae were most abundant at Rocky Point and decreased northward through the study area. Anchovy (eggs, larvae and juveniles), hogchoker eggs, and naked goby larvae were most abundant at the near-plant stations. Density distribution of these species appears similar to previous years.

The effect (if any) of the plant on these populations was unchanged in 1981 compared to previous years. Slightly greater abundance of certain taxa at near-plant stations were related to higher water temperatures and suitable habitat in the vicinity of the plant.

Burton, D. T. & S. L. Margrey. 1980. Impingement studies 2. Survival estimates of impinged fish. In: Non-Radiological Environmental Monitoring Report, Calvert Cliffs Nuclear Power Plant, January - December 1979. Baltimore, MD.

The objectives of the impingement studies were:

- Determine differences in survival potential of impinged fish at Units I and II during the intermittent screen rotation schedule normally employed
- Determine differences in survival potential of impinged fish at Units I and II during a continuous screen rotation schedule.

- Observe species immediately following the collection period.
- Evaluate effect of time of collection (day/night) and screen rotation schedule on survival potentials of the species collected at each unit.
- Determine interaction effects of time of collection, Unit, screen rotation schedule and various seasonal temperatures on the survival potentials of the species collected
- Compare responses to impingement within and between Units.

Weekly sampling was done at each Unit during the study. Collections were made in the 9.1 X 3.7 X 0.5 X 0.6 meter animal surveillance pool located near the terminus of the storm drain systems for each unit. Day samples were taken between 0700 and 1630 hrs, night samples were taken between 1700 and 0255 on alternating weeks.

Following collection for most regimes (see below), observations were made at t_0 , t_{24} and t_{48} hours after collection and the number of live, dead and loss of equilibrium organisms were recorded to determine latent effects caused by impingement.

To perform the statistical analyses mentioned in objectives, the following sampling regime was employed:

Regime	Period	Operating Units	Screen schedule	Time
1	Jan-Feb	1,2	IN	D, N
2	Mar-Apr	1,2	IN, C	D, N
3	May-Jul	2	IN, C	D, N
4	Aug-Sept	2	IN	D, N
5	Oct-Dec	1	IN	D, N

IN = Intermittent screen rotation

C = Continuous screen rotation

D = Day sample

N = Night sample

Forty three thousand nine hundred forty four fish were collected during 1979 at both Units. There were 32 species at Unit I, 39 species at Unit II and 45 species combined. Greater than double the amounts of fish were collected at Unit II (30,560) than Unit I (13,384). Survival at Unit I (70.4%) was better than at Unit II (59.4%). Species that were dominant in at least one regime throughout the year were: blueback herring,

alewife, Atlantic menhaden, gizzard shad, bay anchovy, Atlantic silverside, weakfish, spot, Atlantic croaker and white flounder. There was no significant difference in the survival of impinged dominant species between Units I and II. Continuous screen rotation did not significantly improve survival estimates for all species compared to intermittent rotation. Time of day at which collections were made did not affect survival estimates. Survival of all species appeared to be greater at ambient temperatures above 25°C. However, survival of the major species was not significantly greater at these temperatures.

Sage, L. E. & M. E. Thompson. 1978. Calvert Cliffs Nuclear Power Plant Curtain Wall Study - Zooplankton 1976 for the Baltimore Gas & Electric Company. Academy of Natural Sciences of Philadelphia. Report No. 78-22. [10-B-60] zoopl-curtain wall 1978.

The principal objective of the study was to determine any effects on density, number of species or lifestages of the entrained zooplankton community, resulting from removal of the curtain wall panels. Two 24-hr sampling programs were conducted, bracketing May 31, 1976, the date of removal of two curtain wall panels. The first, conducted on May 27, preceded the removal of the panels; the second was conducted on June 7. This study contains no relevant information on impingement/entrainment of RIS fish.

Impingement studies at Calvert Cliffs nuclear power plant for Baltimore Gas and Electric Company. 1993. J. Howard Hixson III and Denise L. Breitburg. Estuarine Research Center. Report No. 9 - 28

Studies were done at Calvert Cliffs Nuclear Power Plant to determine species composition, numbers and weights of finfishes and selected macroinvertebrates impinged during January through December 1993. Sampling was conducted in 6 day cycles where each day consisted of a one hour collection at each unit. Two 1-hr collections were made if pumps were operational at only one unit. Organisms were collected using a 1.27-cm stretch-mesh net held in the operating unit's screen-wash trough.

Twenty-one thousand eight hundred and forty six (adjusted) finfish (712,946 estimated yearly total) from 33 species were collected at Units 1 and 2. Ninety nine percent of the total catch consisted of (in decreasing abundance) bay anchovy, hogchoker, Atlantic croaker, silversides, northern pipefish, Atlantic menhaden, spot, and skillettfish. In addition, 18,035 blue crabs were collected at both units, mainly from May through

October. Total length of up to 50 individuals of each species was recorded as well as total weight for each species at each unit.

The average impingement rate for finfish was 49.3 h^{-1} at both units combined. Heaviest impingements occurred from March through June. No large impingements associated with severely hypoxic or anoxic conditions were observed. Total and mean impingements per hour were higher than 1992 and more consistent with 1982 to 1991 totals.

Impingement studies at Calvert Cliffs nuclear power plant for Baltimore Gas and Electric Company. 1994. J. Howard Hixson III and Denise L. Breitburg. Estuarine Research Center. Report No. 95 – 13

Studies were done at Calvert Cliffs Nuclear Power Plant to determine species composition, numbers and weights of finfishes and selected macroinvertebrates impinged during January through December 1994. Sampling was conducted in 6 day cycles where each day consisted of a one hour collection at each unit. Two 1-hr collections were made if pumps were operational at only one unit. Organisms were collected using a 1.27-cm stretch-mesh net held in the operating unit's screen-wash trough.

Three thousand one hundred seventy six (adjusted) finfish from 35 species were collected at Units 1 and 2. Ninety three percent of the total catch consisted of (in decreasing abundance) blueback herring, hogchoker, silversides, bay anchovy, spot, northern pipefish, white perch, threespine stickleback and striped bass. In addition, 11,973 blue crabs were collected at both units, mainly from April through September. Total length of up to 50 individuals of each species was recorded as well as total weight for each species at each unit.

Average impingement rate for finfish was 8.8 h^{-1} at both units combined. Heaviest impingements occurred from February through September. No large impingements associated with severely hypoxic or anoxic conditions were observed. Estimated total impingements in 1994 for finfish (149,472 individuals) and blue crabs (257,167 individuals) were much lower than those in previous years excluding 1992.

Impingement studies at Calvert Cliffs nuclear power plant for Baltimore Gas and Electric Company. 1995. J. Howard Hixson III and Denise L. Breitburg. Estuarine Research Center. Report No. 96 – 12

Studies were done at Calvert Cliffs Nuclear Power Plant to determine species composition, numbers and weights of finfishes and selected macroinvertebrates impinged during January through December 1995. Sampling was conducted in 6 day cycles where each day consisted of a one hour collection at each unit. Two 1-hr collections were made if pumps were operational at only one unit. Organisms were collected using a 1.27-cm stretch-mesh net held in the operating unit's screen-wash trough.

Three thousand eight hundred eighty five (adjusted) finfish (209,988 estimated yearly total) from 27 species were collected at Units 1 and 2. Ninety six and a half percent of the total catch consisted of (in decreasing abundance) bay anchovy, silversides, hogchoker, northern pipefish, blueback herring, weakfish and skillettfish. In addition, 4,294 blue crabs were collected at both units, mainly from May through October. Total length of up to 50 individuals of each species was recorded as well as total weight for each species at each unit.

Average impingement rate for finfish was 10.0 h^{-1} at both units combined. Heaviest impingements occurred from July through August. Many low DO episodes occurred in July and August, however, no large impingements associated with severely hypoxic or anoxic conditions were observed. Estimated total impingements for 1995 were lower than most years excluding 1992 and, by a narrow margin, 1994.

APPENDIX B
Section 316(b) Sampling Plan

**CONSTELLATION GENERATION GROUP
CALVERT CLIFFS NUCLEAR POWER PLANT
SECTION 316(b) PHASE II SAMPLING PLAN**

1.0 INTRODUCTION

This sampling plan is being submitted by Constellation Generation Group for the Calvert Cliffs Nuclear Generating Station (Calvert Cliffs) to meet the requirements of Section 316(b) of the Clean Water Act Phase II Rule published 9 July 2004. Calvert Cliffs is located in the Chesapeake Bay north of the mouth of the Patuxent River in Lusby, Maryland. The facility has two nuclear generating units, both using once-through cooling water. Each once-through condenser cooling water system withdraws a maximum of 1,728,000,000 gallons per day (GPD) (CCNPP 2004) from Chesapeake Bay through a shoreline cooling water intake structure (CWIS).

The Phase II rule has established performance standards for cooling water intake systems CWIS of existing electric generating facilities that withdraw more than 50 million gallons per day (MGD) from surface waters and operate at a capacity factor >15%. Based on these criteria Calvert Cliffs is subject to the performance standards of the Phase II rule. These performance standards require an 80% to 95% reduction in impingement mortality and a 60% to 90% reduction in entrainment at facilities that withdrawal from tidal/estuarine systems.

The Phase II rule ("the rule") requires that a Comprehensive Demonstration Study (CDS) be conducted to demonstrate that a facility can meet the performance standards for impingement mortality and entrainment. The CDS should include the following informational and study components:

1. Proposal for Information Collection (PIC)
2. Source Water body Flow Information
3. Impingement Mortality and Entrainment Characterization Study
4. Design and Construction Technology Plan
5. Information to Support Proposed Restoration Measures

The PIC is the first submittal required for compliance under the Phase II rule and serves as the roadmap for the CDS. One requirement of the PIC is a sampling plan for field studies proposed to develop a scientifically valid estimate of impingement mortality and entrainment.

1.1 Proposed Sampling Program

Based on the review of the historical data collected for Calvert Cliffs it has been determined that additional entrainment sampling should be conducted to meet the requirements of the CDS, since sampling has not been conducted since 1980. The sampling program described below is similar to previous entrainment sampling programs conducted at Calvert Cliffs and will allow for comparisons across databases. In addition, a near-field plankton study will be conducted concurrently outside the baffle wall to provide data to quantify the contribution of the baffle wall to the Calculation Baseline. These proposed studies will be used in conjunction with the historical data to complete the characterization of entrainment in the CDS, provide information for the Calculation Baseline, and help develop the selected compliance alternatives (technological, operational, and/or restoration options).

Because Calvert Cliffs Units 1 and 2 are identical units that require the same volume of cooling water and have the same intake structure, entrainment sampling programs described below will be conducted at only one unit during each sampling event. The data will be used to characterize entrainment at both units. This scenario will also allow the facility to meet the sampling schedule, except in the event that both units are off-line.

2.0 ENTRAINMENT MONITORING PROGRAM

2.1 Sampling Program

A one-year entrainment monitoring program will be conducted at the Calvert Cliffs Generating Station. The proposed sampling year will extend from February 2006 through January 2007. Entrainment sampling will be conducted once per week from March through August and twice per month during the remainder of the year. If necessary, a sampling program will be conducted in year two, but may be modified based on year one sampling to include a stratified sampling program to focus the effort on periods of peak entrainment.

Entrainment sampling will be conducted in front of the trash racks using portable 4-inch trash pumps. The pumping rate will be established and maintained using an in-line flow meter at approximately 300 gallons per minute (gpm) (1.1 cubic meters per minute [m^3/min]), with the flow meter located on the pump discharge pipe. The trash pump discharge will be directed to a net constructed of 500 micron(μ) mesh and located in a

buffering water bath. Sample water will be withdrawn independently from three depths (i.e. surface, mid-depth, and bottom based on Mean Low Water [MLW] conditions). The pump sampling system will be configured to allow for independent sampling at each discrete depth.

Samples will be collected between dusk (about 1900 hours) and dawn (about 0700 hours) to target the period when ichthyoplankton are typically most susceptible to the sampling gear. Daytime (0800-1800) samples will be collected once per month during the peak-sampling period (March through August) to characterize the diurnal period. Daytime samples will be collected within the same 24-hr period that nighttime samples are collected.

Five (5) independent sampling events will be conducted during each dusk-to-dawn time period and during each daytime period on each sampling date. Samples will be collected from each of the three depths for approximately 20 minutes (resulting in a 1-hour composite sample) during each event. One-hour samples will be analyzed independently.

To complement the in-plant entrainment sampling program, a near-field ichthyoplankton study will be conducted concurrently. Ichthyoplankton sampling, performed using the same entrainment sampling methodology, will be conducted in the Chesapeake Bay outside the baffle wall using portable 4-inch trash pumps. Sampling will be conducted from a stable, anchored work platform. The pumping rate will be established and maintained using an in-line flow meter at approximately 300 gallons per minute (gpm) (1.1 cubic meters per minute [m^3/min]), with the flow meter located on the pump discharge pipe. The trash pump discharge will be directed to a net constructed of 500 μ mesh and located in a buffering water containing tank. Sample water will be withdrawn independently from three depths (i.e. within three feet of the surface, mid-depth, within three feet of the bottom). The pump sampling system will be configured to allow for independent sampling at each discrete depth.

Five (5) independent sampling events will be conducted during each dusk-to-dawn time period and during each daytime period on each sampling date. Samples will be collected from each of the three depths for approximately 20 minutes (resulting in a 60 minute composite sample, having a sample volume of approximately 50 cubic meters.) Each 60 minute composite sample will be analyzed independently.

2.2 Sample Processing

Following the collection period, the net will be rinsed down from the outside concentrating the sample in the cod-end container and carefully transferred to sample jars. Samples will then be preserved with 10% buffered formalin containing the vital stain Rose Bengal, to aid in sorting, before being transferred to the laboratory for analysis.

All ichthyoplankton and juvenile fish collected will be identified to the lowest practicable taxonomic level, enumerated, and assigned a life stage (i.e. egg, yolk-sac larvae [YSL], post yolk-sac larvae [PYSL], juvenile). Total length will be measured to the nearest millimeter from up to 25 individual larvae of each Representative Important Species (RIS) from each sample date. If more than 25 larvae of a given species are collected, 25 randomly selected specimens per life stage will be measured.

2.3 Data Presentation

Entrainment density data will be presented for each species collected during each sampling period. These results will be expanded to yield weekly and monthly estimates and these estimates summed to yield annual estimates (by species and life stage). Using annual facility flow information, entrainment data will be extrapolated on a flow-weighted basis from the density of eggs and larvae observed (no./volume) to the number entrained during the period between each sampling date.

3.0 Reports

One interim report and one final report will be prepared for Constellation Generation Group and the appropriate agencies. The report will include the data summaries and the expanded estimates described above.

The interim and final reports will include the following:

- The number of samples collected and any deviation from the scheduled samples
- A brief summary of sampling conditions, particularly unusual events
- The general operational data from the plant (circulating water pumps, operating screens, etc.)
- Water quality data
- Entrainment catch data

In addition, the final report will present and discuss the following:

- Weekly, monthly, and annual entrainment estimates by species and life-stage
- Length frequency data

4.0 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

A QA/QC Plan will be prepared for this project. The QA/QC Plan will provide for (1) verification of the accuracy of all field and laboratory work; (2) technical review of the work for feasibility, completeness, and accuracy; and (3) review of data entry for correctness. Measures used to ensure technical accuracy and work quality are described below. The objectives of the QA/QC programs are to include:

- Ensuring that the technical staff assigned to each task are qualified and appropriately trained
- Ensuring that work quality meets a specified Average Outgoing Quality Limit (AOQL)
- Establishing a system of appropriate QA documentation and QC records and maintaining this system with routine audits
- Ensuring adequate and appropriate technical and peer review of work scopes and deliverables
- Investigating QA/QC problems and initiating corrective actions as necessary
- Ensuring that the data recorded in the field and laboratory are correctly entered in electronic files
- Ensuring all instruments and equipment are routinely inspected, calibrated, and adjusted.

4.1 Entrainment Identification and Enumeration QC

QC for entrainment identification (including life stage assignment where appropriate) and enumeration will consist of a Continuous Sampling Plan (CSP), by analyzer, to assure an AOQL of >90%. The first eight consecutive samples will be reanalyzed in Mode 1 ($i=8$; 100%). If all eight samples pass at the 90% level, the analyzer will then move into Mode 2 ($f=1/7$). At this level, one out of every seven samples will be randomly selected for reanalysis. This mode will continue until the end of the program or until there is a failure

(<90%). If a sample fails in Mode 2, the analyzer will begin Mode 1 over again and so on.

4.2 Entrainment Sort QC

QC for entrainment sample sort will consist of a Continuous Sampling Plan (CSP), by laboratory, to assure an Average Outgoing Quality Limit (AOQL) of >90%. The first 14 consecutive samples will be reanalyzed in Mode 1 ($i=14$; 100%). If all 14 samples pass at the 90% level, the laboratory will then move into Mode 2 ($f=1/20$). At this level, one out of every 20 samples will be randomly selected for reanalysis. This mode will continue until the end of the program or until there is a failure (<90%). If a sample fails in Mode 2, the laboratory will begin Mode 1 over again and so on.

4.3 Data QC

A review of the data sheets will be conducted on each sample date to identify critical items before the data are submitted to the project team for review. Each data sheet will be proofed to ensure completeness and to detect any errors or anomalies before entry in electronic files. Data will be entered into a database developed to reflect all data fields recorded in the field or laboratory to minimize keypunch errors. Data will be entered from field data sheets to electronic data sheets. Once entered, each data deliverable will be checked against hard copies of the field and laboratory data sheets to ensure accuracy.



Constellation Energy

May 17, 2006

Maryland Department of the Environment
Industrial Discharge Permits Division
1800 Washington Boulevard
Baltimore, MD 21230

ATTENTION: Mr. John McGillen

SUBJECT: Calvert Cliffs Nuclear Power Plant
Change Proposed for Sampling Plan

REFERENCE: (a) Letter from Mr. J. E. Pollock (CCNPP) to Mr. J. McGillen (MDE), dated December 28, 2005, State Discharge Permit No. 02-DP-0187, NPDES MD0002399

Calvert Cliffs Nuclear Power Plant submitted the *Proposal for Information Collection in Compliance with Section 316(b) Phase II-Requirements of the Clean Water Act* to the Maryland Department of the Environment (MDE) for review and approval on December 28, 2005 (Reference a). Following discussions with MDE representatives, we are proposing two changes to the Sampling Plan described in Reference (a). The first change involved changing the sample location from in front of the trash racks to behind the track racks. This change was made due to existing plant design constraints. The second change involves the proposed sampling year. The Sampling Plan states, "The proposed sampling year will extend from February 2006 through January 2007." Our current schedule for sampling began in March 2006 and continues through February 2007. This will support all the objectives of our Sampling Plan.

Should you have questions regarding this submittal or need additional information, please contact Mr. Lou Larragoite at (410) 495-4922, Ms. Brenda Nuse at (410) 495-4913, or Ms. Carla Logan at (410) 787-5132.

Very truly yours,

Joseph E. Pollock
Plant General Manager

JEP/CAN/bjd

cc: Mr. R. I. McLean, DNR



Constellation Energy

October 16, 2006

Maryland Department of the Environment
Water Management Administration
1800 Washington Boulevard
Baltimore, Maryland 21230

ATTENTION: Mr. John McGillen

SUBJECT: Calvert Cliffs Nuclear Power Plant
NPDES Discharge Permit 02-DP-0187 Calvert Cliffs Nuclear Power Plant

This letter provides Calvert Cliffs Nuclear Power Plant's response to comments on the *Proposal for Information Collection in Compliance with Section 316(b) Phase II Requirements of the Clean Water Act* (PIC) received via email from you to Ms. Brenda Nuse on April 7, 2006. The responses contained herein were discussed during the meeting on May 19, 2006 with representatives from Maryland Department of the Environment and Maryland Department of Natural Resources.

As discussed during the meeting, this response to comments should be considered as an amendment to the PIC. Following your review and approval of these responses, Calvert Cliffs Nuclear Power Plant requests written approval of the PIC.

Should you have questions regarding this matter, please contact Mr. Jay S. Gaines at (410) 495-4922 or Mrs. Brenda Nuse at (410) 495-4913.

Very truly yours,

Joseph E. Pollock
Plant General Manager

JEP/CAN/bjd

Enclosure: (1) Responses to Comments on Proposal for Information Collection in Compliance with Section 316(b) Phase II Requirements for the Clean Water Act for Calvert Cliffs Nuclear Plant

Attachment (1) Licensee Event Report 84-15

ENCLOSURE (1)

**Responses to Comments on Proposal for Information Collection in
Compliance with Section 316(b) Phase II Requirements for the Clean Water
Act for Calvert Cliffs Nuclear Plant**

ENCLOSURE (1)

**RESPONSES TO COMMENTS ON PROPOSAL FOR INFORMATION COLLECTION IN
COMPLIANCE WITH SECTION 316(B) PHASE II REQUIREMENTS FOR THE CLEAN
WATER ACT FOR CALVERT CLIFFS NUCLEAR PLANT**

The responses to comments contained in this attachment reflect the discussion at the meeting between Maryland Department of the Environment, Maryland Department of Natural Resources, and Constellation Energy representatives on May 19, 2006.

Comment 1: p. ES-2, there is a statement made that the 'monitoring programs were determined to be valid studies...' Provide a reference to who made such a determination.

Response: HDR/LMS staff made the determination that the studies are valid and were subject to acceptable quality control and quality assurance procedures based on their review of monitoring program reports.

Comment 2: p. 3, An explanation should be provided as to why the baffle walls are only removed during the summer (i.e., escape from low dissolved oxygen is only necessary in summer).

Response: As noted above, the baffle walls are only removed during the summer because that is the period when low dissolved oxygen conditions occur. The panels are removed from about May 1st through September 30th each year. The requirement is tracked in the plant's maintenance schedule.

Comment 3: p. 3, Why are the trash racks assumed to be the same width as the screen bays? Are they the same or not?

Response: The trash racks fit inside the screen bays; the screen bays are 11.2 feet wide and the trash racks are 11.1 feet wide. The traveling screens are 10 feet wide.

Comment 4: p. 8, Text says "...impingement and entrainment collections were dominated by blue crab and bay anchovy comprising 86% of all organisms collected...." In later text, the 86% figure relates only to impingement; hogchoker dominated entrainment.

Response: The sentence should be revised to read: "The impingement collections were dominated by blue crab and bay anchovy comprising 86% of all organisms collected, while entrainment collections were dominated by hogchoker and bay anchovy comprising 94% of the organisms entrained."

Comment 5: Text says Hogchoker is most abundant from June through August, but Table 3 shows this should be May through August.

Response: The sentence is correct as written. The number of hogchoker collected in impingement collections during 1995 is as follows: April (1), May (20), June (34), July (40), August (45), and September (8) as shown in Hixson and Breitburg 1996¹. Table 3 shows total estimated impingement and percent composition, but not abundance by species.

¹ Hixson, III, J.H. and D.L. Breitburg. 1996. 1995 Impingement Studies at Calvert Cliffs Nuclear Power Plant for Baltimore Gas and Electric Company. Report No. 96-12. Academy of Natural Sciences, Philadelphia, PA

ENCLOSURE (1)

RESPONSES TO COMMENTS ON PROPOSAL FOR INFORMATION COLLECTION IN COMPLIANCE WITH SECTION 316(B) PHASE II REQUIREMENTS FOR THE CLEAN WATER ACT FOR CALVERT CLIFFS NUCLEAR PLANT

Comment 6: p. 9, Statement is made that 1984 was a year of extensive fish kills which may have resulted in the high impingement rate for that year. Greater detail is needed here. How extensive were fish kills, what were their causes, and what evidence was there that many of the fish impinged were dead before being impinged. References should be provided to substantiate these statements.

Response: Information on the fish kills is summarized in Breitburg (1989)² and Ringger (2000)³. To summarize, on three days in 1984, the hourly samples yielded unusually high numbers. On June 24th, over 140,000 spot, menhaden, and bay anchovy were collected in one hour at Unit 1. On August 2nd, 12,650 blue crabs were collected in one hour also at Unit 1. On August 28th, over 146,000 spot were collected in one hour at both units. These events were attributed to low dissolved oxygen levels. In addition, "cold shock" from changing weather conditions, not plant shutdown, resulted in an event on November 20, 1984. This impingement event did not occur during routine impingement sampling and, therefore, was not included in the 1984 impingement estimates. Attachment 2 is a copy of the Licensee Event Report 84-15 sent to the Nuclear Regulatory Commission documenting the high impingement due to cold shock.

Comment 7: p. 13, Reference to McLean 2002 is not listed in the reference section.

Response: The reference should be McLean, R., W.A. Richkus, S.P. Schreiner, and D. Fluke 2002. Maryland Power Plant Cooling Water Intake Regulations and their Application in Evaluation of Adverse Environmental Impact. Maryland Department of Natural Resources. Power Plant Research Program. PPRP-127.

Comment 8: p. A-2, Provide a reference to the statement that Maryland Department of Natural Resources concluded that Calvert Cliffs Nuclear Power Plant (CCNPP) does not pose a significant impact on fish populations in the Bay.

Response: The reference should be Ringger (2000), page S272 with respect to impingement and McLean et. al. 2002 with respect to overall impacts.

Comments on Calvert Cliffs Sampling Plan (Appendix B)

General Comments: The plan calls for using pumps as the sampling gear and sampling at night. Both methodologies are generally accepted by most researchers as being the only feasible methods of conducting entrainment sampling when samples are being collected within plant intakes. However, it is also well known that sampling efficiency of pumps is less than sampling efficiency of more standard sampling gears such as bongo nets. The result is that entrainment estimates derived solely extrapolating from density estimates from pumped samples may significantly underestimate total entrainment. Given these concerns, we believe it would be appropriate to consider additional sampling with nets as part of the overall sampling program. At a minimum, conducting side-by-side net sampling and pump sampling in the near-field would provide a basis for adjusting pumped sample density estimates at least to the extent to which densities from net samples might be higher than pumped samples. Alternatively given the large

² Breitburg, D.L. 1989. Trends in impingement of fish and blue crabs at the Calvert Cliffs Nuclear Power Plant 1982 – 1986. Report No. 89-12. Academy of Natural Sciences of Philadelphia. (30 pp)

³ Ringger, T.G. 2000. Investigations of impingement of aquatic organisms at the Calvert Cliffs Nuclear Power Plant, 1975 – 1995. Env. Science and Policy, 3(2000):261-273

ENCLOSURE (1)

RESPONSES TO COMMENTS ON PROPOSAL FOR INFORMATION COLLECTION IN COMPLIANCE WITH SECTION 316(B) PHASE II REQUIREMENTS FOR THE CLEAN WATER ACT FOR CALVERT CLIFFS NUCLEAR PLANT

intake embayment at Calvert Cliffs, consideration might be given to conducting net sampling in the intake embayment in lieu of pumped samples behind the trash racks. If security constraints preclude use of a boat in the embayment, perhaps nets could be towed across the embayment via suspended cable, or some similar arrangement. This approach would assume that densities in the embayment are representative of densities in the water passing into the intake pumps, but would eliminate the issue of pump sampling inefficiencies.

Response: There is some degree of bias to every sampling method. The primary purpose of the ichthyoplankton studies, as proposed and currently being conducted is to provide comparative data of ichthyoplankton abundance and species composition in the near field compared to the intake. Therefore, it is essential to use the same gear type. As pointed out in the comment, pumps are the only feasible method of collecting samples in the intake. Constellation determined that towing nets within the baffle wall either by boat or other means could present a safety risk. As summarized in EPRI 2005⁴, gear avoidance of nets is well known and studies of effectiveness of nets and pumps conducted at Indian Point Generating Plant on the Hudson River showed no consistent differences in density estimates between nets and pumps.

Comment S1: p. B-2, 3rd par. The day that sampling occurs should be selected randomly within the weekly or biweekly sampling period, at least within the work week.

Response: Constellation recognizes that random dates may provide some additional statistical benefit, but considering that sampling is being conducted at three of its Maryland plants in 2006, randomizing sampling dates each week would be difficult. Within each week, sampling at CCNPP is scheduled first, followed by C.P. Crane Power Plant, and H.A. Wagner Power Plant. At CCNPP sampling is weather dependent since one of the two sample locations is in the Chesapeake Bay outside the baffle wall, where sampling during high wind/wave conditions could be dangerous. Scheduling CCNPP early in the week allows flexibility if weather is adverse on the scheduled date, thereby minimizing the potential for missed samples. It should be noted that weather conditions vary randomly making no day in the week better than another. Sampling occurs from dusk to dawn during routine nighttime sampling and over 24-hours during events when daytime sampling is also scheduled, resulting in coverage of entire tidal cycles.

Comment S2: p. B-3, 2nd par. If ichthyoplankton abundance is measured per unit of water volume sampled and then extrapolated to the volume taken into the plant, an implicit assumption is that there is no avoidance by ichthyoplankton of the sampling gear. We noted above that pumps are known to be relatively inefficient sampling devices, so it is important to address how the efficiency issue can be addressed, as we noted above.

Response: See response to the general comment above. In addition, several factors described in EPRI (2005) serve to minimize sampling gear avoidance at CCNPP, including intake velocity, pumping velocity, turbidity of Chesapeake Bay waters and nighttime sampling.

Comment S3: A second suggestion is that a small amount of daytime sampling also be conducted during the non-peak period, since there is no way to estimate total catch for those months or for the entire year

⁴ Electric Power Research Institute. 2005. Entrainment Abundance Monitoring Technical Support Document. Technical Report Number 1011280. EPRI, Palo Alto, CA

ENCLOSURE (1)

RESPONSES TO COMMENTS ON PROPOSAL FOR INFORMATION COLLECTION IN
COMPLIANCE WITH SECTION 316(B) PHASE II REQUIREMENTS FOR THE CLEAN
WATER ACT FOR CALVERT CLIFFS NUCLEAR PLANT

without using an ad hoc method to determine values for the unsampled time. Alternatively, an explanation should be provided as to why such additional sampling is not necessary.

Response: The time period for daytime sampling was selected to cover the time period of greatest potential ichthyoplankton abundance based on historical studies. Collecting daytime samples during periods of relatively low entrainment was determined not to be cost-effective. A conservative approach to estimating total catch would be to use nighttime data to extrapolate 24-hour catch.

Comment S4: p. B-3, 4th par. It is unclear how the near-field sampling data will be used. How will this portion of the study be related to entrainment?

Response: The Phase II rule at 40 CFR 125.94(b)(1) and (2) assumes a baseline cooling water intake system (CWIS) against which performance standards is measured. That condition is a shore-line intake with traveling water screens perpendicular to the water flow and fitted with 3/8-inch wire mesh. The CCNPP CWIS, with its baffle wall that withdraws water from the bottom of the water column may provide a credit against the baseline CWIS. The intent of the paired near-shore and entrainment sampling is an attempt to quantify what, if any, credit should apply.

Comment S5: p. B-4, 3rd par. If sampling during daytime is conducted only once per month, the smallest unit to which results can be expanded with an estimate of uncertainty is a bi-monthly period. The estimators for a two-stage sampling design (day or night samples within the bi-monthly period) are listed below in case they are helpful. We note that these estimators apply to the sampling program as described in Appendix B, not one that includes an estimate of sampling efficiency as suggested above. If the sampling is modified to include an estimate of sampling efficiency, we would be happy to provide additional assistance if desired.

The total catch for day i daytime samples, $\hat{x}_i$ is estimated as

$$\hat{x}_i = \frac{M_i}{m_i} \sum_{j=1}^{m_i} x_{ij},$$

where M = the number of hours during each day (10 hours, 8:00 – 18:00 according to the study plan), m = the number of hours sampled for each day (study plan calls for 5), and x_{ij} 's are individual hourly catches.

The total catch for the bi-monthly period, $\hat{x}$ is estimated as

$$\hat{x} = \frac{N}{n} \sum_{i=1}^n \hat{x}_i$$

where N = the number of days in the bimonthly period, n = the number of days sampled in the bimonthly period (the study plan calls for 2),

ENCLOSURE (1)

RESPONSES TO COMMENTS ON PROPOSAL FOR INFORMATION COLLECTION IN
COMPLIANCE WITH SECTION 316(B) PHASE II REQUIREMENTS FOR THE CLEAN
WATER ACT FOR CALVERT CLIFFS NUCLEAR PLANT

The estimated variance for $\hat{x}$ is

$$s^2(\hat{x}) = N(N-n) \frac{s_u^2}{n} + \frac{N}{n} \sum_{i=1}^n M_i (M_i - m_i) \frac{s_i^2}{m_i},$$

where

$$s_u^2 = \frac{\sum_{i=1}^n \left(\hat{x}_i - \frac{\sum_{i=1}^n \hat{x}_i}{n} \right)^2}{n-1},$$

and

$$s_i^2 = \frac{\sum_{j=1}^n \left(x_{ij} - \frac{\sum_{i=1}^n \bar{x}_i}{n} \right)^2}{m_i - 1}$$

Total catch for nighttime samples, $\hat{y}$, and its variance are calculated using the same equations as above except that M should be 14 hours according to the study plan, and n will be 4 - 8 depending on the sampling period.

Estimated total catch for each bimonthly period $\hat{b}_h$ will be

$$\hat{b}_h = \hat{x} + \hat{y}, \text{ with variance } s^2(\hat{b}_h) = s^2(\hat{x}) + s^2(\hat{y})$$

Estimated annual total catch will be

$$\sum_{h=1}^6 \hat{b}_h, \text{ with variance } \sum_{h=1}^6 s^2(\hat{b}_h)$$

Standard errors may be estimated as square root of the variance for all estimators, and approximate 95% confidence intervals as estimate $\pm 1.96 * SE$.

Response: The comment is noted.

ATTACHMENT (1)

LICENSEE EVENT REPORT 84-15

60-18.0

BALTIMORE GAS AND ELECTRIC COMPANY

P.O. BOX 1475

BALTIMORE, MARYLAND 21203

NUCLEAR POWER DEPARTMENT
CALVERT CLIFFS NUCLEAR POWER PLANT
LUSBY, MARYLAND 20657

December 10, 1984

U. S. Nuclear Regulatory Commission Docket No. 50-317
Document Control Desk
Washington, D. C. 20555 License No. DPR 53

Dear Sirs:

The attached LER 84-15 is being sent to you as required by
10 CFR 50.73.

Should you have any questions regarding this report, we would be
pleased to discuss them with you.

Very truly yours,

LBR Russell

L. B. Russell
Plant Superintendent

src
LBR/SRC/pah

cc: Dr. Thomas E. Murley
Director, Office of Management Information
and Program Control
Messrs: A. E. Lundvall, Jr.
J. A. Tiernan



1522
11

LICENSEE EVENT REPORT (LER)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO 3150-0104
EXPIRES: 8/31/86FACILITY NAME (1)
Calvert Cliffs Unit 1DOCKET NUMBER (2)
05000317PAGE (3)
1 OF 04

TITLE (4)

Loss of Circulating Water Caused by Fish Impingement

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)					
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)				
11	20	84	84	0115	00	11	21	84	N/A	050000				
OPERATING MODE (9)			THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR 43.61 (Check one or more of the following) (11)						73.71(b)					
1			20.402(b)						X 80.73(a)(2)(iv)			73.71(c)		
POWER LEVEL (10)			20.405(a)(1)(i)						80.73(a)(2)(v)			OTHER (Specify in Abstract below and in Text, NRC Form 366A)		
11010			20.405(a)(1)(ii)						80.73(a)(2)(vi)					
			20.405(a)(1)(iii)						80.73(a)(2)(vii)(A)					
			20.405(a)(1)(iv)						80.73(a)(2)(vii)(B)					
			20.405(a)(1)(v)						80.73(a)(2)(viii)					

LICENSEE CONTACT FOR THIS LER (12)

NAME
S. R. Cowne, Operational Safety Analyst

TELEPHONE NUMBER

AREA CODE
31011 216101-14131616

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

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRC	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRC

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE) ☒ NO

EXPECTED SUBMISSION DATE (15)

MONTH DAY YEAR

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

At 1716, on November 20, 1984, Unit 1 was manually tripped while operating in MODE 1 at 100% power. This trip was caused by an imminent loss of circulating water due to the clogging of eight of twelve Unit 1 traveling water screens with fish.

An unusual seasonal change in water temperature in the Chesapeake Bay, the ultimate heat sink, caused by seasonal weather conditions, resulted in fish impingement that clogged Traveling Water Screen Nos. 11A, 11B, 12A, 12B, 13A, 13B, 14A, and 14B. Circulating Water Pump Nos. 11, 12, 13, and 14 were stopped alternately, in accordance with established procedure, to prevent damage to their associated traveling water screens. The Unit was manually tripped, by procedure, when it was known that more than one circulating pump would be stopped at the same time.

An evaluation of alternative traveling water screens and methods for minimizing fish impingement are actively being pursued.

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PDR ADOCK 05000317
S PDRIE 22
11

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)	PAGE (3)
		YEAR SEQUENTIAL NUMBER REVISION NUMBER	
Calvert Cliffs Unit 1	0 5 0 0 0 3 1 7 8 4	- 0 1 5 - 0 1 0 0 2	OF 0 4

TEXT (If more space is required, use additional NRC Form 365A's) (17)

At 1711, on November 20, 1984, during normal MODE 1 operation at 100% power, an alarm indicated to the Unit 1 Control Room Operator that the differential pressures across Traveling Water Screen (KE-SCN) Nos. 11A, 11B, 12A, 12B, 13A, 13B, 14A, and 14B were greater than 10" water and rising rapidly. The Operator noted that all of the above-mentioned traveling water screens were rotating.

At 1712, the differential pressure across Traveling Water Screen Nos. 11A and 11B had reached 40" water and Circulating Water Pump (KE-P) No. 11 was stopped in accordance with Operating Instruction (OI)-38A in order to prevent damage to the associated screens due to excessive differential pressure. With continued evidence of rising differential pressure for all other traveling water screens, a power reduction for the Unit was commenced at this time.

At 1713, the differential pressure across Traveling Water Screen Nos. 14A and 14B reached 40" water. Circulating water Pump (CWP) No. 11 was started and CWP No. 14 was stopped in accordance with OI-38A. Differential pressure across Traveling Water Screen Nos. 13A and 13B reached 40" water at 1714. Circulating Water Pump No. 14 was started and CWP No. 13 was stopped in accordance with OI-38A. Traveling Water Screen Nos. 12A and 12B then reached 40" water. At this time, CWP No. 13 was started and CWP No. 12 was stopped in accordance with OI-38A at 1715.

By 1715, a technician arrived at the intake and noticed a large number of fish, some of them dead, in the intake. He saw that Traveling Water Screen No. 11A had a drive shear pin that sheared off and the motor for Traveling Water Screen No. 11B was heavily loaded. He then notified the Control Room of these facts. Circulating water Pump No. 12 was then started and CWP No. 11 was stopped in accordance with OI-38A. When CWP No. 12 was started, the shear pin on No. 12B Traveling Water Screen sheared off and No. 12A Traveling Water Screen motor tripped on overload. Circulating Water Pump No. 11 was then started.

At 1716, CWP No. 12 was stopped but the technician at the scene noticed that No. 13A Traveling Water Screen shear pin had sheared off and that No. 13B Traveling Water Screen motor tripped on overload. The differential pressures across Traveling Water Screens 11A, 11B, 12A, 12B, 13A, 13B, 14A, and 14B had again reached 40" water. The Shift Supervisor recognized the imminent loss of circulating water to Main Condenser Shell (SG-COND) Nos. 11 and 12, and with reactor power at 99%, ordered Unit 1 tripped in accordance with OI-14.

The actions in Emergency Operating Procedure Number 1 (EOP-1), were properly carried out following the trip. All safety systems functioned as expected. No personnel errors occurred during the event. All traveling water screens were checked and cleaned as necessary. The shear pins for Traveling Water Screen Nos. 11A, 12B, and 13A were replaced prior to restart of the Unit. In addition, a screen panel for No. 11A Traveling Water Screen was replaced due to denting incurred during fish impingement. Unit 2 traveling water screens were not affected.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO. 3150-0104

EXPIRES: 8/31/85

FACILITY NAME (1) Calvert Cliffs Unit 1	DOCKET NUMBER (2) 0 5 0 0 0 3 1 7	LER NUMBER (6)			PAGE (3)	
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER		
		8 4	— 0 1 5	— 0 0	0 3	OF 0 4

TEXT (If more space is required, use additional NRC Form 368A's) (17)

The root cause of this event was fish impingement of the traveling water screens. An extremely large number of fish that were unable to avoid the traveling water screens impinged upon the screens and exceeded the fish removal capability of the screens. As a result, the differential pressure across four sets of traveling water screens rose rapidly, forcing Operator action to protect the condensers and turbine. The pins for the traveling water screens are designed to shear in order to protect the major components of the screens and had done so for Traveling Water Screen Nos. 11A, 12B, and 13A during this fish overload condition.

The massive influx of fish into the traveling water screens was an abnormal occurrence. An abrupt change from relatively mild to cold weather this fall discouraged schools of fish from migrating south before water temperatures cooled significantly. Spot was identified as the type of fish involved in this event. They are very susceptible to rapid water temperature changes. Consequently, the large population of spot became sluggish in the cold water and the fish were unable to avoid the traveling water screens. This phenomenon is called "cold shock" and, as mentioned above, many species are vulnerable to this effect in the Chesapeake Bay. However, this is the first time since beginning operation of the Plant that "cold shock" phenomenon has caused significant fish impingement of the traveling water screens.

There have been five similar events at Calvert Cliffs Nuclear Plant. Four of the previous events were caused by fish impingement as a result of low dissolved oxygen conditions in the months of August and September. One previous event was caused by sea nettle impingement in October of this year.

Since this event occurred during MODE 1 operation at 100% power, the heat load on both the Circulating Water (KE) and Saltwater (BI) Systems, whose suctions are protected by the traveling water screens, was at a maximum for non-accident conditions. Therefore, the safety consequences of this event would not have been more severe under reasonable and credible alternative circumstances.

During the first fish impingement in August 1975, it was noted that if the circulating water pumps were allowed to operate continuously with their associated traveling water screens clogged with fish, it is possible to lower the suction head of the Saltwater Pump (BI-P) enough to degrade pump operation. Since then, procedural changes have been implemented that require stopping a circulating water pump at excessive differential pressures to prevent damage to the traveling water screens. Operating experience since the 1975 event has substantiated the fact that timely stoppage of the circulating water pumps prevents any degrading effect on the Saltwater System. It is important to note that when circulating water pumps are secured, the traveling water screen differential pressures rapidly drop to 0", due to the reduction in flow from 215,000 to 15,500 gpm.

Attachment 1 is provided as a description of the Unit 1 Intake Structure (NN). Each saltwater pump takes a suction on either of two adjacent circulating water pump wells. There are three saltwater pumps, six circulating water pumps, and twelve traveling water screens for each Unit.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)	
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER		
Calvert Cliffs Unit 1	0500031784	-015	-010	04	OF	04

TEXT (If more space is required, use additional NRC Form 364A's) (17)

Only one saltwater pump is necessary to meet the system design function of providing cooling water for the Servicewater (BI) and Component Cooling Water (CC) Heat Exchangers; and the Emergency Core Cooling Systems Pump Room cooler (VF) during a Loss of Coolant Incident (LOCI). A massive fish impingement more severe than any previous event, of all the traveling water screens, and the failure of operators to stop the Circulating Water Pumps in accordance with procedure would be necessary for degradation of the Saltwater System's ability to mitigate the consequences of a LOCI. Therefore, the overall safety significance of this event is considered minimal.

Several long-term corrective actions are currently being evaluated to prevent recurrence of this event:

1. Upgrading the existing traveling water screens or replacing with dual-flow or center-flow types that would be activated continuously to improve the capability for fish removal.
2. Installing a sound system to act as a "behavioral barrier" to fish.

The contact for further discussion of this event is S. R. Cowne, telephone: (301)-260-4366.



Constellation Energy

October 25, 2006

Maryland Department of the Environment
Water Management Administration
Compliance Program
1800 Washington Boulevard
Baltimore, MD 21230-1708

ATTENTION: Mr. Tom Boone

SUBJECT: Calvert Cliffs Nuclear Power Plant
Special Report: Noncompliance with Effluent Limitations

REFERENCE: (a) State Discharge Permit No. 02-DP-0187, NPDES MD0002399,
Management Requirement B.2

On October 21, 2006 Calvert Cliffs Nuclear Power Plant personnel identified that a portable toilet had been blown over by the wind and some of the liquid contents had flowed across the paved surface and entered a storm drain. This report is being provided in accordance with Reference (a).

Approximately 20 gallons of the liquid contents of the portable toilet entered the storm drain leading to the Chesapeake Bay. When plant staff identified that the spill had occurred, they cleaned up the solids and residual liquid that had been captured on the ground and that did not enter the storm drain. Based on the relatively small discharge volume, the impact of this discharge on public health and the waters of the state is negligible.

No fluid was released after the spill was identified. As there was no ongoing release, no additional monitoring was performed as a result of this discharge.

The cause of the unanticipated discharge was high wind gusts. This caused the toilet to blow over. The portable toilets on site are being evaluated to determine if they should be relocated or otherwise stabilized to prevent them from blowing over in the future.

Should you have questions regarding this matter, please contact Mr. Jay S. Gaines at (410) 495-4922 or Ms. Brenda D. Nuse at (410) 495-4913.

Very truly yours,

Joseph E. Pollock
Plant General Manager

JEP/CAN/bjd



Constellation Energy

October 31, 2006

Maryland Department of the Environment
Water Management Administration
1800 Washington Boulevard
Baltimore, MD 21230

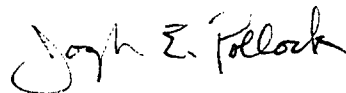
ATTENTION: Mr. John McGillen

SUBJECT: Calvert Cliffs Nuclear Power Plant
Section 316(b) Phase II Sampling Plan Interim Report

This letter transmits the *Entrainment and Near-Shore Ichthyoplankton Sampling at the Calvert Cliffs Nuclear Power Plant -- Interim Report*, as required by Appendix B, Sampling Plan of the Proposal for Information Collection in Compliance with Section 316(b) Phase II Requirements of the Clean Water Act submitted to you in a letter dated December 28, 2005.

Should you have questions regarding this matter, please contact Mr. Jay S. Gaines at (410) 495-4922 or Ms. Brenda D. Nuse at (410) 495-4913.

Very truly yours,



Joseph E. Pollock
Plant General Manager

JEP/CAN/bjd

Enclosure: (1) Entrainment and Near-Shore Ichthyoplankton Sampling at the Calvert Cliffs Nuclear Power Plant Interim Report

ENCLOSURE (1)

**Entrainment and Near-Shore Ichthyoplankton Sampling at the
Calvert Cliffs Nuclear Power Plant
Interim Report**

**Calvert Cliffs Nuclear Power Plant, Inc.
October 31, 2006**

**ENTRAINMENT AND NEAR-SHORE
ICHTHYOPLANKTON SAMPLING
AT THE CALVERT CLIFFS NUCLEAR POWER PLANT**

Interim Report

Prepared for:
Constellation Generation Group

Prepared by:
**EA Engineering, Science, and Technology, Inc.
15 Loveton Circle
Sparks, Maryland 21152**

October 2006

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APPENDIX B: WATER QUALITY DATA	
APPENDIX C: PLANT FLOW DATA	

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1	Abundance of Ichthyoplankton Entrained at Calvert Cliffs Nuclear Power Plant Intake, March-May 2006
2	Abundance of Ichthyoplankton Entrained at Calvert Cliffs Nuclear Power Plant Baffle-Wall, March-May 2006
3	Day vs Night Comparison of 24-hr Entrainment Events at the Calvert Cliffs Nuclear Power Plant Intake

1.0 INTRODUCTION

1.1 BACKGROUND

Pursuant to U.S. EPA's new Rule for implementation of Section 316(b) of the Clean Water Act, CGG must demonstrate compliance with new performance standards for the reduction of impingement mortality and entrainment of aquatic organisms within the cooling-water intake system at the Calvert Cliffs Nuclear Power Plant (CCNPP). Impingement refers to the trapping of juvenile and adult fish and larger macroinvertebrates on the cooling-water intake traveling screens. Entrainment is the pumping of small aquatic organisms through the cooling water system. As a first step in the process, CGG prepared a Proposal for Information Collection (PIC) and submitted it to the Maryland Department of the Environment (MDE) on December 28, 2005. The PIC included a sampling plan for collection of entrainment samples. This sampling plan covers those activities necessary to collect the required entrainment data at Calvert Cliffs for development of a scientifically valid estimate of entrainment. It also included sampling in the Chesapeake Bay to ascertain populations in the waterbody potentially entrainable and to determine if the CCNPP intake might be subject to a Calculation Baseline credit as allowed under 40 CFR 125.93 and 125.94(b)(1). This report is an interim data report containing data collected to date, as described in Appendix B of the PIC.

1.2 LOCATION AND FACILITY DESCRIPTION

CCNPP is located on the Chesapeake Bay north of the mouth of the Patuxent River in Lusby, Maryland. The facility has two nuclear generating units, both using once-through cooling water. Each once-through condenser cooling water system withdraws a maximum of 1,728 MGD from Chesapeake Bay through a shoreline cooling water intake structure (CWIS) located behind a baffle wall designed to take water from the lower portion of the water column.

2.0 SCOPE OF STUDY

The objectives of this study are as follows:

- Provide data on the rates of entrainment currently occurring at the cooling water intake structure;
- Collect and identify early life stages of fish in the near shore vicinity of cooling water intake structure that could be susceptible to entrainment;
- Characterize, by species and life stage, the seasonal variation in entrainment of fish;
- Provide data for the determination of the entrainment calculation baseline based on the results of the Entrainment Characterization Studies; and
- Provide sound data necessary for choosing an appropriate compliance alternative, if required.

Samples of entrained ichthyoplankton are being collected from the cooling water intake forebay utilizing a sampling intake apparatus incorporated in the stop log slot behind the trash racks. In accordance with the Sampling Plan, samples were collected once per week from April through August 2006, and will be collected twice per month from September 2006 through February 2007, and weekly in March 2007. A 4-inch trash pump is used to collect water from an intake forebay at Unit 1 of CCNPP. Water is then pumped into a conical 0.5 m plankton net made with 500- μ m mesh suspended in a 200-gal 48-inch deep barrel. A digital flow meter is used to monitor sample volume.

Entrainment sampling is conducted generally over a 12-hr period one night (dusk to dawn, approximately 1900-0700 hours) during each sampling event. Five 1-hr samples were collected at approximately 1.75-hr intervals. Each 1-hr sample was a composite, composed of three 20-min segments, collected near-bottom, mid-depth, and near surface. On one scheduled sampling date during each month from March through August, daylight sampling was conducted; similar to the standard night sampling, each daylight event consisted of five 1-hr depth-composite samples.

3.0 ENTRAINMENT SAMPLING METHODS

3.1 SAMPLING LOCATION(S) AND GEAR DESCRIPTION

Samples of entrained ichthyoplankton were collected from the cooling water intake forebay utilizing a sampling intake apparatus incorporated in the stop log slot behind the trash racks. Entrainment abundance samples were collected using a pump and net/barrel collection system. A 4-in. gas-powered trash pump was used to direct water from the intake to the collection device. The pump was connected sequentially to each of three rigid pipes set with their intakes at depths to collect distinct samples at three sampling depths relative to mean low water (MLW): near bottom, mid-depth and near surface. The pipes are attached to a frame that can be raised and lowered in the stop log tracks at the intake. At the beginning of each sampling event, the near surface pipe was adjusted to 3-feet below surface, if necessary. An inline flowmeter (GF+Signet 8150) was used to measure sample volume on the discharge side of the pump. The pump was throttled to adjust flow (approximate flow of 1.1 m³/min or 300 gal/min) into the net/barrel systems. Each sampling barrel contained a 0.5-m diameter conical plankton net (1:3 diameter to length ratio) made of 500- μ m mesh nylon net. The net was fit with a standard cod end collection jar. The net was suspended such that the mouth ring was approximately 6-inches above the top of the barrel.

3.2 SAMPLING PROCEDURE

3.2.1 In-Plant Sampling

The open end of the intake hose was attached via camlock to the surface-depth pipe, and the pump started and allowed to run for 5 minutes to flush the line; during this flush, flow adjustments were made and water was discharged directly into the sampling barrel, not through the plankton net. After flushing the sampling line, the start volume was recorded from the flowmeter and pumping was started through the plankton net suspended in the barrel. The outlet was positioned just beneath the surface of the water in the barrel to avoid damage to any organisms. Sampling continued for approximately 20 minutes at each of the three depths (surface, mid-depth, and bottom) resulting in a 1-hour composite sample during each event. Approximately five (5) independent sampling events were conducted during each dusk-to-dawn or daytime period. Pumping started from the surface-depth pipe and continued for 20 minutes. At the end of this time, the pump was stopped, and the intake line was switched to the mid-depth pipe. If necessary at this time, due to debris or ctenophores, a new net was switched in and the original net rinsed. After 20 minutes the procedure was repeated, and the intake line was connected to the bottom-depth pipe, and pumping was continued for 20 minutes. At the end of each 1-hour sample period, the end volume and total volume sampled was recorded from the flowmeter, and the pump was shut down. The standpipe in the barrel was pulled to drain the barrel, and the net was washed down from the outside to move all sample material into the codend receiver. The sample was concentrated to approximately 900 ml, and preserved with 10 percent buffered formalin containing Rose Bengal stain and stored in jars labeled inside and out. All collection information was recorded by field crews onto standard Entrainment Sampling Data Sheets. All samples were checked for proper preservation before being packed up onsite for return to the laboratory.

3.2.2 Baffle-Wall Sampling

The near shore ichthyoplankton community in the vicinity of the CCNPP cooling water intake was sampled on the outboard side of the intake baffle wall. Sampling gear, procedures, and frequency were the same as described in Section 3.2.1 for entrainment sampling in the CCNPP intake. Samples were collected concurrent with the intake entrainment samples; i.e., samples started and ended within a few minutes of one another.

EA subcontracted a 55-foot research vessel to provide a stable work platform for sampling at the intake baffle wall. The vessel was anchored outboard of the baffle wall during each sampling event. Entry and departure from the secured area in front of the intake was coordinated with CCNPP security for each sampling event. Communication and coordination between the crews sampling at the intake and the baffle wall was maintained by 2-way radio, cell phones, or both, contingent on CCNPP security clearance and procedures.

Sample handling and processing, and analytical procedures were as described above for the intake sampling.

3.3 WATER QUALITY MEASUREMENTS

Measurements of water temperature, dissolved oxygen, pH, specific conductance, and salinity were made at mid-depth in the intake forebay at the beginning and end of each sample period (dusk and dawn). At the baffle wall, the same parameters were measured at surface, mid-depth, and near bottom. The collected water quality data are presented in the Appendix B.

3.4 PLANT FLOW DATA

Plant flow data, reported as million gallons per day, on each sampling date are in Appendix C. These data were provided by CCNPP personnel.

4.0 ENTRAINMENT RESULTS

The following interim data summary includes information from one survey in March, four surveys in April, and three surveys in May. Samples were collected at an intake forebay from a fixed sampling apparatus incorporated in the stop leg slot behind the trash racks. Samples were also taken simultaneously from a boat anchored just outside of the baffle wall to compare abundance in the bay before the water is withdrawn below the baffle wall. The baffle wall was not sampled in March. The ichthyoplankton abundance data is a combination of the number of eggs, fish larvae, and juveniles that were collected per survey and is not broken down by specific life stage. The data presented is raw data (actual sample counts) and has not been adjusted to a common density (e.g. number per m³) nor has it been extrapolated using time specific plant flow information for both generating units. All the abundance data analyzed to date is presented in Appendix A, the water quality data is in Appendix B, and the total plant flow during sampling is in Appendix C.

From March to the present the only deviations from scheduled sampling were as follows: on 8 May the first of the five samples was not collected at the intake due to equipment problems; 24-25 July (24-hr event), three of the ten scheduled mid water samples could not be collected at the intake due to fouling on the sampling pipe.

A total of 1,071 individuals were collected at the intake during eight surveys over the period March through May (Table 1). The highest abundance of ichthyoplankton on a monthly basis was in May when a total of 879 individuals were collected (average of 293 per survey). The lowest number was in April with an average of 27 per survey. A total of 86 individuals were collected during the one survey in March. At the baffle wall, 474 individuals were collected during the seven surveys in April and May (Table 2). This was slightly less than half the individuals collected at the intake (985 individuals) during the same period. On a monthly basis, May had the highest abundant at the baffle wall with 473 individuals. The trend of high abundance in May was the same as at the intake but only approximately half as many individuals were collected at the baffle wall.

There were a total of 7 taxa (damaged unidentifiable individuals excluded from the total) collected at the intake during the period March through May (Table 1) and 5 taxa at the baffle wall during April and May (Table 2). The taxa *Atherinopsidae* sp. includes damaged silversides that could not be identified to species. The American eel, rough silverside, and spot were collected at the intake but not at the baffle wall and gizzard shad were collected only at the baffle wall. The highest number of taxa per month was in May at the intake and the baffle wall with 6 and 5 taxa, respectively. Four taxa were collected at the intake in April and only one taxa was collected at the baffle wall.

Atlantic menhaden was the dominant species at the intake in March and April comprising 93 and 76 percent, respectively, of the monthly totals collected (Appendix A). Bay anchovy was the dominant at the intake in May comprising 53 of the total and Atlantic menhaden comprised 44 percent. At the baffle wall, bay anchovy was the dominant in May comprising 64 percent of the total abundance followed by Atlantic menhaden which comprised 30 percent of the total.

Sampling was conducted over a 24 hr period once a month to determine if there were day versus night differences in entrained ichthyoplankton abundance. The only data available at this time is for the April survey at the intake. A total of 30 individuals were collected at night and 16 individuals during the day (Table 3). This supports the accepted trend of higher nighttime abundance of ichthyoplankton but because of the low total abundance it is not a strong conclusion. Further sample analysis will follow and is necessary to make any determination of trends.

On a species level, Atlantic menhaden was slightly more abundant at night than day when it was the only species collected. American eel, bay anchovy, and spot were also collected at night and contributed to the higher nighttime abundance (Table 3).

Water quality measurements taken at the beginning and end of each sampling event are presented in Appendix B. Most values were within normal and expected ranges at the intake and the baffle wall except for dissolved oxygen. Beginning with the 20 June sampling date and through 11 September dissolved oxygen at the intake was very low during many of the sampling events. Dissolved oxygen was less than 4 mg/L, which is acknowledged to be below acceptable water quality levels, ranging from as low as 0.6 to 6.8 mg/L measured at the mid-water level at the intake. At the baffle wall the levels also were very low starting on 20 June and during some sampling events through 28 August. Because dissolved oxygen is known to be naturally low in this part of the Bay, measurements were taken at the surface, mid-water, and bottom at the baffle wall to identify where the lowest readings were present. As expected, dissolved oxygen was lowest at the bottom ranging from as low as 0.4 to 7.6 mg/L during the period. At the mid-water depth, the values ranged from 1.02 to 10.4 mg/L. At the surface the range was 2.1 to 11.4 mg/L and the values were always higher than at the mid-water level.

**Table 1. Abundance of Ichthyoplankton Entrained at the Calvert
Cliffs Power Plant Intake, March-May 2006**

Taxon/Species	March	April	May
	(1 survey)	(4 surveys)	(3 surveys)
American eel		1	1
Atherinopsidae sp.			2
Atlantic menhaden	80	81	388
Atlantic silverside			18
Bay anchovy		12	466
Rough silverside			1
Spot	6	11	
Damaged egg		1	2
Damaged fish			1
Total	86	106	879

Table 2. Abundance of Ichthyoplankton Entrained at the Calvert Cliffs Power Plant Baffle Wall, March-May 2006

Taxon/Species	April	May
	(4 surveys)	(3 surveys)
Atherinopsidae sp.		5
Atlantic menhaden		140
Atlantic silverside		6
Bay anchovy		304
Damaged egg	1	
Damaged fish		7
Gizzard shad		11
Total	1	473

Table 3. Day vs Night Comparison of 24-hr Entrainment Events at the Calvert Cliffs Power Plant Intake

Taxon/Species	04/24/06	
	DAY	NIGHT
American eel		1
Atlantic menhaden	16	21
Bay anchovy		3
Spot		5
Total	16	30

Appendix A

Entrainment Tables

**Table A-1 Ranked Abundance and Percent
Composition of Ichthyoplankton Entrained at Calvert
Cliffs Power Plant Intake, March 2006**

Species/Taxon	Count	Percent
Atlantic menhaden	80	93.02
Spot	6	6.98
Total	86	100

**Table A-2 Ranked Abundance and Percent
Composition of Ichthyoplankton Entrained at
Calvert Cliffs Power Plant Intake, April 2006**

Species/Taxon	Count	Percent
Atlantic menhaden	81	76.42
Bay anchovy	12	11.32
Spot	11	10.38
American eel	1	0.94
Damaged egg	1	0.94
Total	106	100

**Table A-3 Ranked Abundance and Percent
Composition of Ichthyoplankton Entrained at
Calvert Cliffs Power Plant Baffle Wall, April 2006**

Species/Taxon	Count	Percent
Damaged egg	1	100

**Table A-4 Ranked Abundance and Percent
Composition of Ichthyoplankton Entrained at
Calvert Cliffs Power Plant Intake, May 2006**

Species/Taxon	Count	Percent
Bay anchovy	466	53.01
Atlantic menhaden	388	44.14
Atlantic silverside	18	2.05
Atherinopsidae sp.	2	0.23
Damaged egg	2	0.23
American eel	1	0.11
Damaged fish	1	0.11
Rough silverside	1	0.11
Total	879	100

**Table A-5 Ranked Abundance and Percent
Composition of Ichthyoplankton Entrained at
Calvert Cliffs Power Plant Baffle Wall, May 2006**

Species/Taxon	Count	Percent
Bay anchovy	304	64.27
Atlantic menhaden	140	29.60
Gizzard shad	11	2.33
Damaged fish	7	1.48
Atlantic silverside	6	1.27
Atherinopsidae sp.	5	1.06
Total	473	100

**Table A-6 Ranked Abundance and Percent
Composition of Fish Larvae and Eggs Entrained at
Calvert Cliff Power Plant Intake, March -- May 2006**

Species/Taxon	Count	Percent
Atlantic menhaden	549	51.26
Bay anchovy	478	44.63
Atlantic silverside	18	1.68
Spot	17	1.59
Damaged egg	3	0.28
Atherinopsidae sp.	2	0.19
American eel	2	0.19
Damaged fish	1	0.09
Rough silverside	1	0.09
Total	1071	100

**Table A-7 Ranked Abundance and Percent
Composition of Fish Larvae and Eggs Entrained at
Calvert Cliff Power Plant Baffle Wall, April -- May
2006**

Species/Taxon	Count	Percent
Bay anchovy	304	64.14
Atlantic menhaden	140	29.54
Gizzard shad	11	2.32
Atlantic silverside	6	1.27
Damaged fish	7	1.48
Atherinopsidae sp.	5	1.05
Damaged egg	1	0.21
Total	474	100

Appendix B

Water Quality Data

Table B-1. Calvert Cliffs Power Plant In-Plant Entrainment Water Quality Data

Sampling Date	Initial/Final	Depth	Water Quality Parameter				
			Conductivity	Dissolved Oxygen	pH	Salinity	Temperature
			µs/cm	mg/L	pH Units	ppm	degrees C
03/30/06	Initial	Middle	16431	7.7	7.7	14.6	8.3
	Final	Middle	16730	8	7.8	15	7.9
04/06/06	Initial	Middle	15577	9.6	8.2	12.8	10.8
	Final	Middle	15293	9.4	8.1	12.7	10.5
04/13/06	Initial	Middle	18255	9.52	8	15.03	11.36
	Final	Middle	18408	9.15	7.95	14.99	11.77
04/18/06	Initial	Middle	No Data	7.8	No Data	13	15
	Final	Middle	No Data	7.2	No Data	12.9	14.4
04/24/06	Initial (Day)	Middle	21103	8.3	7.7	15.9	15.2
	Final (Day)	Middle	21100	10.1	8.1	15.6	16
	Initial (Night)	Middle	21296	9.3	8	15.3	17.1
	Final (Night)	Middle	22092	7.1	7.7	17.2	14.1
05/01/06	Initial	Middle	18077	8.4	8.1	13.4	15.4
	Final	Middle	18036	8	8.3	13.3	15.4
05/08/06	Initial	Middle	18417	9	8.2	13.2	16.7
	Final	Middle	18195	8.7	8.3	13.2	16.3
05/15/06	Initial	Middle	21174	8.9	8.3	14.7	18.6
	Final	Middle	20452	8.4	8.2	14.3	18.1
05/23/06	Initial (Day)	Middle	22510	8.1	No Data	13.6	24.4
	Final (Day)	Middle	No Data	11.9	No Data	14.2	26.7
	Initial (Night)	Middle	22520	No Data	No Data	13.6	18.1
	Final (Night)	Middle	No Data	No Data	No Data	15.4	15.3
05/30/06	Initial	Middle	20086	6.5	7.6	13.6	19.6
	Final	Middle	19719	4.7	7.4	13.6	18.7
06/05/06	Initial	Middle	20668	8.2	8.2	13.1	22.3
	Final	Middle	20706	6.9	8	13.4	21.3
06/12/06	Initial	Middle	20907	7.7	8.2	13.3	22.1
	Final	Middle	21336	6.4	8.1	13.8	21.6
06/20/06	Initial (Day)	Middle	21940	0.8	7.3	14.5	20.8
	Final (Day)	Middle	21888	1.6	7.4	14.1	22
	Initial (Night)	Middle	21930	1.8	7.5	14.2	21.7
	Final (Night)	Middle	21885	1.2	7.4	14.2	21.4
06/28/06	Initial	Middle	20604	6.3	8	12.8	24.4
	Final	Middle	20707	6.8	8.1	12.5	24.6
07/03/06	Initial	Middle	17092	5.4	7.3	9.8	26.2
	Final	Middle	18126	1.4	7.1	10.7	25
07/10/06	Initial	Middle	19299	0.6	7.2	11.6	24.6
	Final	Middle	18038	1.4	7.3	10.6	25.1
07/17/06	Initial	Middle	15263	6.49	8.16	8.32	27.61
	Final	Middle	15660	5.4	8	8.7	27.5
07/24/06	Initial (Day)	Middle	15845	3	7.6	8.8	27.2
	Final (Day)	Middle	17197	0.54	7.3	9.8	26.3
	Initial (Night)	Middle	17279	0.44	7.2	9.9	26.2
	Final (Night)	Middle	16705	0.7	7.3	9.5	26.5
07/31/06	Initial	Middle	16130	6.1	8	8.8	28.4
	Final	Middle	17110	4.6	7.7	9.5	27.9
08/07/06	Initial	Middle	18300	3.14	7.5	10.8	28.1
	Final	Middle	19930	1.3	7.2	11.8	27.3
08/14/06	Initial	Middle	No Data	No Data	7.15	No Data	26.5
	Final	Middle	No Data	No Data	7.18	No Data	26.2
08/21/06	Initial	Middle	20602	6.4	8.2	11.8	27.2
	Final	Middle	25151	2.7	7.7	14.9	26.3
08/28/06	Initial (Day)	Middle	23464	5.2	8	13.4	27.6
	Final (Day)	Middle	23356	4.6	7.8	13.3	27.7

Table B-1. Calvert Cliffs Power Plant In-Plant Entrainment Water Quality Data

			Water Quality Parameter				
Sampling Date	Initial/Final	Depth	Conductivity	Dissolved Oxygen	pH	Salinity	Temperature
			µs/cm	mg/L	pH Units	ppm	degrees C
	Initial (Night)	Middle	23597	5.7	7.9	13.5	27.7
	Final (Night)	Middle	23690	3.4	7.6	13.7	27.1
09/11/06	Initial	Middle	24888	2.9	7.3	15.4	24.3
	Final	Middle	21188	5.6	8	13.1	23.7
09/25/06	Initial	Middle	23320	7.6	7	14.9	22.4
	Final	Middle	23300	7.2	6.1	14.9	22.3
10/09/06	Initial	Middle	23121	6.8	7.7	15.7	19.8
	Final	Middle	20694	8.9	7.9	14	19.6

*No Data due to equipment malfunction

Table B-2. Calvert Cliffs Power Plant Baffle Wall Entrainment Water Quality Data

Sampling Date	Initial/Final	Depth	Water Quality Parameter				
			Conductivity	Dissolved Oxygen	pH	Salinity	Temperature
			µs/cm	mg/L	pH Units	ppm	degrees C
04/06/06	Initial	Middle	16090	12	8.3	13.18	11.1
	Final	Middle	15896	11	8.2	13.2	10.5
04/13/06	Initial	Middle	18918	9.2	8	15.7	11.3
	Final	Middle	19285	8.5	7.9	15.8	11.7
04/18/06	Initial	Middle	16132	10.3	8.1	12.19	14.2
	Final	Middle	15963	9.2	8	12.2	13.8
04/24/06	Initial (Day)	Middle	19385	9.19	8.1	14.4	15.5
	Final (Day)	Middle	20115	9.39	8.2	14.4	17.1
	Initial (Night)	Middle	19689	8.9	8.2	14.3	16.5
	Final (Night)	Middle	19809	9.3	8.2	14.3	16.7
05/01/06	Initial	Middle	18828	10.2	8.2	13.8	16
	Final	Middle	18721	8.9	8.2	13.9	15.5
05/08/06	Initial	Middle	18637	9.2	8.4	13.1	17.7
	Final	Middle	17902	9	8.4	12.9	16.4
05/15/06	Initial	Middle	20967	8.5	8.4	14.6	18.4
	Final	Middle	No Data	No Data	No Data	No Data	No Data
05/23/06	Initial (Day)	Middle	21976	8.4	8.2	15.2	18.9
	Final (Day)	Middle	21925	7.6	8	15.7	17.1
	Initial (Night)	Middle	21929	8.8	8.2	15.2	18.8
	Final (Night)	Middle	22295	8	8.1	15.6	18.3
05/30/06	Initial	Middle	20757	9.4	8.2	13.3	21.8
	Final	Middle	20053	5	7.5	13.7	19.1
06/05/06	Initial	Middle	20877	8.6	8.2	13.25	22.3
	Final	Middle	20794	7.6	8.2	13.2	22.1
06/12/06	Initial	Middle	20403	7.8	8.5	12.8	22.7
	Final	Middle	20023	7.1	8.4	12.8	22
06/20/06	Initial (Day)	Middle	21760	3.5	7.5	14	21.9
	Final (Day)	Middle	22243	3.2	7.6	14.1	22.5
	Initial (Night)	Middle	22289	1.8	7.3	14.5	21.5
	Final (Night)	Middle	22080	3.9	7.6	14.1	22.4
06/28/06	Initial	Surface	20734	9.2	8.3	12.3	25.4
	Initial	Middle	20384	8.5	8.3	12.2	24.7
	Initial	Bottom	20033	7.6	8.2	12.2	24.2
	Final	Surface	20726	8.2	8.3	12.3	25.5
	Final	Middle	20502	7.6	8.2	12.2	25
	Final	Bottom	20249	7.2	8.1	12.2	24.5
07/03/06	Initial	Surface	15896	9.5	8.4	8.8	27.5
	Initial	Middle	16137	7.2	8.5	9.1	26.7
	Initial	Bottom	16611	5.7	7.8	9.5	26.2
	Final	Surface	15942	7.6	8.3	9	26.6
	Final	Middle	16737	3.9	7.6	9.6	25.8
	Final	Bottom	17845	0.8	7.2	10.6	24.7

Table B-2. Calvert Cliffs Power Plant Baffle Wall Entrainment Water Quality Data

Sampling Date	Initial/Final	Depth	Water Quality Parameter				
			Conductivity	Dissolved Oxygen	pH	Salinity	Temperature
			µs/cm	mg/L	pH Units	ppm	degrees C
07/10/06	Initial	Surface	15859	4.41	7.2	9.12	25.78
	Initial	Middle	18412	1.02	6.9	10.87	25.19
	Initial	Bottom	19049	0.98	6.9	12.4	24.98
	Final	Surface	17787	2.1	7.1	10.5	25.2
	Final	Middle	18046	1.2	7	10.6	25.2
	Final	Bottom	18127	1.1	7	10.7	25.2
07/17/06	Initial	Surface	13501	11.4	8.8	7	29.7
	Initial	Middle	13618	10.4	8.7	7.2	29
	Initial	Bottom	18357	0.83	7.8	10.9	24.9
	Final	Surface	13764	8.2	8.6	7.3	28.9
	Final	Middle	14035	7.4	8.5	7.5	28.8
	Final	Bottom	19333	0.4	7.5	11.5	25
07/24/06	Initial (Day)	Surface	13677	10.1	8.7	7.3	28.6
	Initial (Day)	Middle	15139	4.7	8	8.3	27.6
	Initial (Day)	Bottom	16250	2.6	7.5	9.1	26.7
	Final (Day)	Surface	15988	3.7	7.6	8.8	27.7
	Final (Day)	Middle	16177	1.9	7.4	8.9	27.5
	Final (Day)	Bottom	16770	0.4	7.3	9.6	26.4
	Initial (Night)	Surface	14308	7.7	8.4	7.8	27.7
	Initial (Night)	Middle	16220	2.1	7.5	9.1	26.9
	Initial (Night)	Bottom	17493	0.3	7.2	10.1	26
	Final (Night)	Surface	15581	3.2	7.5	8.7	26.9
	Final (Night)	Middle	16147	1.9	7.4	9	27.1
	Final (Night)	Bottom	18517	0.2	7.3	10.8	25.7
07/31/06	Initial	Surface	14941	10.1	8.6	7.7	30.6
	Initial	Middle	14919	8.4	8.5	7.9	29.7
	Initial	Bottom	18082	0.65	7.4	10.4	26.2
	Final	Surface	14844	7.5	8.3	7.9	29.4
	Final	Middle	14849	7.2	8.3	7.9	29.3
	Final	Bottom	18191	0.3	7.4	10.6	25.7
08/07/06	Initial	Surface	15606	7.8	8.3	8.3	30.1
	Initial	Middle	15869	6.8	8.3	8.3	30.1
	Initial	Bottom	15940	6.5	8.3	8.4	30
	Final	Surface	15522	7.5	8.3	8.3	29.1
	Final	Middle	15854	6.4	8.2	8.49	29.1
	Final	Bottom	18424	2.3	7.5	10.16	28.4
08/14/06	Initial	Surface	No Data	No Data	8.2	No Data	27.2
	Initial	Middle	No Data	No Data	8	No Data	27.1
	Initial	Bottom	No Data	No Data	7.4	No Data	26.7
	Final	Surface	No Data	No Data	7.8	No Data	27.2
	Final	Middle	No Data	No Data	7.4	No Data	27.2
	Final	Bottom	No Data	No Data	7.4	No Data	26.1

Table B-2. Calvert Cliffs Power Plant Baffle Wall Entrainment Water Quality Data

Sampling Date	Initial/Final	Depth	Water Quality Parameter				
			Conductivity	Dissolved Oxygen	pH	Salinity	Temperature
			µs/cm	mg/L	pH Units	ppm	degrees C
08/21/06	Initial	Surface	28420	8.8	8.2	17.5	27.7
	Initial	Middle	28418	8.1	8.4	17.5	27.7
	Initial	Bottom	28602	5.7	8.2	17.6	27.1
	Final	Surface	28728	6.1	8.2	17.6	27.4
	Final	Middle	28760	6.2	8.2	17.7	27.4
	Final	Bottom	31230	4.2	8	19.4	26.9
08/28/06	Initial (Day)	Surface	22510	5.8	7.8	13.5	27.5
	Initial (Day)	Middle	22940	4.8	7.8	13.8	27.6
	Initial (Day)	Bottom	23024	4.2	7.7	13.9	27.5
	Final (Day)	Surface	22219	5.64	7.89	13.32	28.05
	Final (Day)	Middle	22279	5.13	7.88	13.35	28
	Final (Day)	Bottom	22341	4.95	7.87	13.4	27.72
	Initial (Night)	Surface	22200	8.7	8	13.3	28.4
	Initial (Night)	Middle	22435	6.9	8	13.5	27.9
	Initial (Night)	Bottom	22502	6.2	7.9	13.5	27.6
	Final (Night)	Surface	22373	4.85	7.77	13.43	27.69
	Final (Night)	Middle	22387	4.55	7.8	13.44	27.66
	Final (Night)	Bottom	22799	3.78	7.7	13.71	27.26
09/11/06	Initial	Surface	20617	8	8.2	12.5	24.3
	Initial	Middle	20573	7.8	8.2	12.5	24.2
	Initial	Bottom	24100	4	7.5	15	24.4
	Final	Surface	20590	6.8	8.1	12.6	23.8
	Final	Middle	20704	6.6	8.1	12.7	23.9
	Final	Bottom	21037	6.7	8	12.9	24
09/25/06	Initial	Surface	27063	9.1	8.2	17.6	22.3
	Initial	Middle	27145	8.4	8.2	17.7	22.3
	Initial	Bottom	29546	4.5	7.6	19.2	22.7
	Final	Surface	27203	7.8	8.1	17.8	22.2
	Final	Middle	27244	7.6	8.1	17.8	22.2
	Final	Bottom	28659	6.2	7.9	18.5	22.8
10/09/06	Initial	Surface	19229	9.9	8.3	12.9	19.6
	Initial	Middle	19138	10.1	8.3	13	19.3
	Initial	Bottom	20551	8.6	8.1	13.9	19.4
	Final	Surface	19177	9.1	8.2	13	19.3
	Final	Middle	19231	8.7	8.2	13	19.4
	Final	Bottom	19604	8.8	8.2	13.2	19.5

*No Data due to equipment malfunction

Appendix C

Plant Flow Data

Table C-1. Total Plant Flow during Entrainment sampling at Calvert Cliffs Power Plant

<u>DATE</u>	<u>FLOW-MGD</u>	
March 30-31	2284	2284
April 6-7	2491	3114
April 13-14	3460	3460
April 18-19	3460	3460
April 24-25	3460	3460
May 1-2	3322	3460
May 8-9	3460	3322
May 15-16	3356	3460
May 23-24	3460	3460
May 30-31	3460	3460
June 5-6	3460	3460
June 12-13	3460	3460
June 19-20	3460	3460
June 28-29	3460	3460
July 3-4	3460	3460
July 10-11	3460	3460
July 17-18	3460	3460
July 24-25	3460	3460
July 31-Aug 1	3460	3460
August 7-8	3460	3460
August 14-15	3460	3460
August 21-22	3460	3460
August 28-29	3460	3460
September 11-12	3460	3460
September 25-26	3460	3460

39.03



Constellation Energy

January 17, 2007

Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, MD 21230

ATTENTION: Mr. John McGillen

SUBJECT: Calvert Cliffs Nuclear Power Plant
State Discharge Permit No. 02-DP-0187, NPDES MD0002399

REFERENCE: (a) Letter from Mr. J. E. Pollock (CCNPP) to Mr. J. McGillen (MDE), dated December 28, 2005, State Discharge Permit No. 02-DP-0187, NPDES MD0002399

Appendix B of Reference (a) contains the sampling plan to provide data for assessing baseline levels of entrainment at Calvert Cliffs Nuclear Power Plant (CCNPP) and the potential credit, if any, of the baffle wall towards the Calculation Baseline. On December 15, 2006, representatives from CCNPP met with Maryland Department of the Environment (MDE) and Maryland Department of Natural Resources (MDNR) Power Plant Research Program representatives to discuss the status of the program and proposed field studies for 2007. During that meeting we presented comparative data collected between April and July 2006 for the two sampled locations (outside the baffle wall and in-plant at the traveling screens). The data showed no substantial difference in total counts, dominant species or numbers of species collected between the two locations. Based on evaluation of the data, CCNPP recommended that the baffle wall sampling location be discontinued since the baffle wall does not appear to provide any benefit towards reduction in entrainment at CCNPP. In-plant sampling is proposed to be continued through the end of 2007.

By this letter, CCNPP requests concurrence from MDE and MDNR that CCNPP can eliminate this sampling location immediately.

Should you have questions regarding this matter, please contact Mr. Jay S. Gaines at (410) 495-5219 or Ms. Brenda D. Nuse at (410) 495-4913.

Very truly yours,

Joseph E. Pollock
Plant General Manager

JEP/CAN/bjd

cc: Mr. R. I. McLean, MDNR