Seabrook Station

Offshore Intake Seal Deterrent Barrier Design

North Atlantic

9906040138 990525
PDR ADOCK 05000443
S PDR

ENCLOSURE 1 TO NYE-99

Seabrook Station

Offshore Intake Seal Deterrent Barrier Design

North Atlantic

Table of Contents

Seabrook Station Offshore Intake Seal Deterrent Barrier

1 EXECUT'VE SUMMARY

After an extensive and rigorous evaluation period in which a number of alternatives were assessed, North Atlantic Energy Service Corporation (North Atlantic), the operator of Seabrook Station, has decided to install a fixed barrier seal deterrent on each of the three offshore cooling water system intake structures to preclude the entrapment of seals. North Atlantic's intent is to have the barriers in place prior to September 1, which has historically marked the beginning of the peak seal entrapment season.

The seal barrier will be an enhancement to the existing cooling water system intake that will reduce the vertical bar spacing around each intake from about 14.5 to about 4 inches. Experiments conducted at the New England Aquarium indicate that this spacing should prevent even determined seals from entering. The barriers consist of pre-fabricated panels made out of the same copper-nickel metal alloy as the existing bars. As described below, the barriers will have no impact on any of the functions of Seabrook Station's Cooling Water System. It will have no adverse environmental consequences and will not impact any of the parameters controlled or limited by the National Pollutant Discharge Elimination System (NPDES) permit.

The purpose of this report is to briefly trace the history of this issue, summarize the process that led to the selection of intake barriers as the deterrent and describe the barriers. Additional detail may be found in the enclosures, which are listed below and are cited throughout. The report then begins with a description of the Cooling Water System itself.

2 LIST OF ENCLOSURES

A. Seabrook Station Marine Mammal Protection Act Small Take Permit Application submitted on June 13, 1997.

B. Brief Summary of the Barrier Experiment on 30 August 1997 at the New England Aquarium, Boston, MA

C. Seabrook Station Seal Deterrent Workshop, January 28-29, 1999 – Report and Recommendations

D. Engineering Drawings of Seal Deterrent Design

3 BACKGROUND

3.1 Seabrook Station Cooling Water System and Intakes

As a base load plant, Seabrook Station normally operates at its full power electrical capacity of 1158 megawatts unless shut down for scheduled refuelings and maintenance or for unscheduled forced outages. During normal power operations, the cooling water system provides about 469,000 gallons per minute (gpm) of ocean cooling water to the station. Most of this water, about 448,000 gpm, supplies the main condenser via the Circulating Water System (CWS) and the three CWS pumps. In the main condenser, the cooling water flows through thousands of condenser tubes and condenses the steam exhausted from the main turbine that is used to generate the plant's electrical output. A smaller amount of ocean cooling water, about 21,000 gpm, is supplied to various heat exchangers via the Service Water System (SWS) and the four SWS pumps, two of which are normally in operation. Some of the equipment cooled by the SWS is essential to the safe operation and shutdown of the plant. Thus the SWS and the essential equipment which it serves are referred to as nuclear safety-related equipment.

The ocean cooling water is drawn into three offshore intake structures which are located approximately 7,000 feet offshore from Hampton Beach, New Hampshire (see Figure 1 in Enclosure A). The intake structures are 110 feet apart in water that is about 60 feet deep. The intake structures were designed with velocity caps that allow a relatively large mass flow of ocean water to be drawn in at a low speed of about 0.5 feet per second. The low intake velocities, as well as the horizontal intake currents provided by the velocity caps, minimize the entrapment of marine organisms.

The ocean cooling water is delivered from the intake structures to Seabrook Station, via a 17,000-foot long tunnel, with a 19-foot inside diameter, located in bedrock beneath the ocean and salt marsh floor. Each of the three intake structures is connected to the horizontal intake tunnel by a 110-foot tall riser shaft that has a 9-foot inside diameter. The flow rate inside the vertical shaft is approximately six feet per second. Once the ocean cooling water reaches the intake tunnel, the flow velocity is about four feet per second during normal plant power operations. A 16,500 foot long discharge tunnel with a 19-foot inside diameter returns the water to the ocean at a point about 3,000 feet south of the intake location.

The intake structures, located about 40 feet below the surface, are 30-feet in diameter with seven-foot tall vertical openings. There are twelve openings or "bays" for each intake structure (see Figure 2 in Enclosure A). The bays are six feet wide. Vertical bars are installed every 16 inches around the circumference of the caps to reduce the amount of large debris that can enter the intake. The spacing between the bars is about 14.5 inches. There are four bars per bay with a total of 48 bars per intake.

The external surfaces of the intake structures are clad with copper-nickel, an anti-fouling, anti-corrosive alloy. The one-inch thick bars are made of solid copper-nickel. The base of the intake structure caps are ten feet above the ocean bottom to minimize the entrapment of bottom fish and lobsters.

The ability of this design to prevent any adverse consequences from the plant's operation on the aquatic ecosystems or the commercial and recreational fisheries in the area has been confirmed through over 20 years of comprehensive environmental monitoring.

3.2 Summary of Seabrook Station Seal Entrapments

The first seal entrapment was observed in Seabrook Station's Cooling Water System in 1993, eight years after the cooling water system was first placed in-service and more than three years after the plant began commercial operation.

As shown in Table 1 below, there have been an estimated total of 61 lethal seal takes to-date.

Table 1. Seal Takes by Year

1990-1992	0
1993	2
1994	7
1995	6 [7] *
1996	12 [17] *
1997	9
1998	13 [14] *
1999 (through 5/20/99)	5
Total	**54 [61]** *

All but seven of the takes have been harbor seals. The remainder consisted of five gray seals and based on limited bone fragments, one seal believed to be a harp seal and another believed to be a hooded seal. The majority were young animals, and as shown in Table 2, about half were entrapped during the September-October timeframe coinciding with the fall period of southward seal migration.

* Seal takes sometimes consist of only partial remains. It is therefore, not always possible to determine if the remains come from one or more seals making precise counts of seals entrapped difficult. The estimate of the total number of seals entrapped to-date is between 54 and 61. This number was determined from the seal remains recovered, including intact seals, skulls, partial skulls, bone, hide and internals.

Table 2. Intact Seal Observations by Month *

Jan	0
Feb	2
Mar	1
Apr	2
May	1
Jun	2
Jul	2
Aug	4
Sep	7
Oct	13
Nov	4
Dec	3

As part of seal necropsies performed by the New England Aquarium, stomach contents of intact seals were evaluated whenever possible. No correlation has been made between stomach contents of seals and fish impinged by the cooling water system which are identified as part of screen wash debris assessments.

According to the 1998 National Marine Fisheries Service Marine Mammal Stock Assessment, the population of harbor seals along the New England coast has increased nearly five-fold since the passage of the Marine Mammal Protection Act in 1972. A minimum population estimate for harbor seals along the Maine coast in 1997 was estimated to be more than 30,900. Incidental harbor seal takes at Seabrook Station, therefore, have a negligible impact on seal populations.

3.2 Notification of Seal Takes to the National Marine Fisheries Service

North Atlantic provides notification of seal takes to the National Marine Fisheries Service and the Environmental Protection Agency by telephone within 24 hours and a follow-up written report is provided to these agencies within two weeks. Seal remains are provided to the New England Aquarium for necropsy.

* This table only includes the 41 intact seal remains which can be correlated to the time of entrapment as opposed to the total estimated number of entrapped seals shown in Table 1 which also includes partial remains that cannot be correlated to a time of entrapment.

3.3 Summary of Major Milestones in Seabrook Station Seal Entrapment Issue:

1. October 1993 – First seal recovered in cooling water system.

2. January 1995 – National Marine Fisheries Service formally recommends seal entrapment monitoring and reporting and exploration of deterrent devices in event seal takes become more frequent and states that a small take exemption permit may be required if seal mortalities are increasing and unavoidable.

3. March-June 1997 – Screening of seal deterrent options as part of small take exemption permit application to the National Marine Fisheries Service.

4. June 1997 – North Atlantic submits small take exemption permit application.

5. August 1997 – Seal barrier test at New England Aquarium.

6. December 1997 – Initial conceptual barrier design completed.

7. March 1998 – Buoy-deployed acoustical deterrent device conceptual design completed by University of New Hampshire.

8. August 1998 – Proposed rule on Seabrook Station Small Take Exemption Permit published in the Federal Register for public comment.

9. January 1999 – Seal Deterrent Workshop.

10. April 1999 – North Atlantic selects/funds barrier design.

4 EVALUATION OF SEAL ENTRAPMENT DETERRENT OPTIONS

Provided below is a detailed discussion of the major milestones in Seabrook Station seal deterrent decision making.

4.1 Screening of Seal Deterrent Options

As part of the Small Take Exemption Permit Application submitted to the NMFS on June 13, 1997, North Atlantic reviewed a range of possible technologies or measures to minimize seal entrapments at Seabrook Station. North Atlantic screened these technologies or measures using a set of acceptance criteria which included effectiveness, proven application, meeting nuclear safety and operational constraints, implementability, economic practicability, acceptability to federal and state agencies and avoidance of impact on non-target species. Two options passed the initial screening process and were carried forward for further evaluation. They were a grid barrier either mounted directly on or offset from the intake structures, and an acoustical deterrent device mounted on the intake structures.

4.2 Seal Barrier Test at New England Aquarium – August 1997

As part of the evaluation of an effective grid barrier, it was necessary to determine the size opening and configuration for a grid barrier that would preclude the passage of a seal. With the cooperation of the New England Aquarium, North Atlantic conducted a test to determine the effectiveness of various intake barrier configurations on August 30, 1997.

Dr. Kathryn Ono, a pinniped specialist and professor from the University of New England, supervised the test. The test was conducted at the New England Aquarium's pool with seven juvenile harbor seals being held in the Aquarium's rehabilitation facility after recovery from earlier strandings. All seals were about 2-3 months old and in healthy condition at the time of testing.

The tested configurations included 10-inch, 8-inch, 6-inch and 4-inch vertical bar spacing as well as 8-inch square grating. Barrier panels with these configurations were mounted on the front of a four-foot cube opaque box. In order to increase the seal's motivation to enter the box, one of their feedings was skipped. When their interest in entering the box declined, the box was baited with fish to increase their motivation.

The test determined that the 8-inch grid and 6-inch vertical bar spacing significantly reduced the number of seals entering the box. Seals successfully passed through the 6-inch vertical bar spacing about twelve percent of the time. No seals even attempted to enter through the 4-inch vertical bar spacing.

The barrier test report is provided as Enclosure B.

4.3 Initial Barrier Concept – December 1997

A consultant engineering firm was retained to developed barrier options. The options evaluated included different materials, different attachment methods and barrier opening size options. Their recommendations also included a pilot phase in which two of the three intakes would have a variety of barrier design panels attached in order to monitor them for clogging potential over a period of two years.

4.4 Acoustical Deterrent Device Conceptual Design Completed by the University of New Hampshire – March 1998

North Atlantic investigated acoustic deterrent devices (ADD) that would prevent seals from entering the intakes, without harming them. Included were discussions and meetings with the salmon aquaculture industry in Maine to study their techniques to minimize seal predation in their fish pens.

A system designed by Airmar Technology Corporation, already being used in the salmon aquaculture industry, was determined to be the most viable ADD. Because Seabrook Station's three intakes are located at the end of a three-mile tunnel, about one mile offshore and in about 60 feet of water, installation of an acoustic deterrent system presented many challenges not found in other applications. Chief among these was that of providing power and a platform for the power source that could operate reliably and be maintained in ocean conditions.

North Atlantic then worked with the University of New Hampshire Center for Ocean Engineering to develop a conceptual design and deployment scheme. The resultant complex design included an array of acoustic transmitters in the seabed with power, instrumentation and telemetry being provided from a buoy platform. Power would be provided by a combination of batteries, solar panels and a charging diesel generator located on the buoy.

4.5 Seal Deterrent Workshop – January 1999

In late 1998, with seal takes continuing and the local seal population continuing to increase, North Atlantic resolved to install a deterrent before the beginning of the historical peak entrapment season or by September 1, 1999. Before making a final decision on a deterrent, North Atlantic decided to reevaluate all options including those that had not passed the initial screening performed in conjunction with the Small Take Permit application. The most efficient way to do this was to reach outside of the company to individuals with expertise in marine mammal behavior, ocean engineering and operations and bring them together at a conference with Seabrook Station's environmental, licensing and engineering staffs. The result was the Seal Deterrent Workshop on January 28 and 29, 1999. The workshop's objective was to determine a direction for short-term actions to eliminate, if possible, or minimize seal entrapment in the Seabrook Station offshore intakes before the next high-potential entrapment period (summer 1999).

Workshop participants evaluated the aforementioned acoustic and barrier conceptual designs and brainstormed other possible deterrent options. Those options warranting more detailed consideration were evaluated based on effectiveness and implementability. Twelve different deterrent technologies were identified in the brainstorming process. Technologies that could be implemented in the required timeframe were divided into the following three categories for detailed discussion and evaluation.

- Structural barriers — additions to the intakes that would physically prevent the entry of seals;
- Acoustic deterrent devices (ADDs) — underwater sound-producing devices that produce sound that is irritating or painful as seals come in closer proximity to the intakes; and
- Behavioral deterrents — any other approach which would rely on a behavioral response of the seals to either avoid the intakes or to exit the center of the intake caps without moving toward the higher intake velocity center.

After evaluating each option, workshop participants reached a consensus recommendation that a physical barrier best met the screening criteria discussed earlier and could also be implemented during the summer of 1999. Participants specifically recommended vertical bar barriers that can prevent young-of-the-year harbor seals from entering. Based on the New England Aquarium experiment of August 1997, this equated to spacing of about 4-inches between bars. Participants were concerned that larger spacing might discourage but not prevent seal entry.

The Seal Deterrent Workshop Report is provided as Enclosure C.

5 SEAL BARRIER DESCRIPTION

5.1 Seal Barrier Design Summary

The new seal barrier will add 120 new bars to the existing 48 bars in each intake structure, reducing the current bar spacing from about 14.5 inches to a nominal four inches with a maximum spacing of 4.9 inches. The bar thickness is 1-inch in width by 1.5-inches in depth.

The additional bars will be fabricated into three-foot by seven-foot panels. Two panels will be installed in each intake bay for a total of 24 panels per intake structure. The copper-nickel panels will be constructed of the same anti-fouling material as the existing bars and external cladding of the intake structures.

Bar spacing for the vertical bars on the seal barrier panels are based on the following major considerations:

- Barrier spacing must provide a deterrent for seal passage and subsequent entrapment into the station's intake cooling water system.

- Barrier spacing must also minimize the potential for clogging of the reduced openings with seaweed and marine growth that could adversely impact the operation of the plant.

- Increase in flow velocity at the panel location should be minimized so as not to increase entrapment of other marine species.

- The design needed to be one that could be fabricated, built and installed prior to the peak seal entrapment period (September).

Other secondary considerations included: the use of copper-nickel as a proven anti-fouling material, material stock availability, lead time for panel fabrication, ease of panel installation, accessibility for manual cleaning of the intake structure surfaces inside the bars, variability in existing width openings, structural impact on the existing guard bars to which the panels will be attached and the structural impact on the intake structure and riser shafts.

Panel design, and in particular the vertical bar spacing, was optimized within the above considerations.

Some field measurements were taken in support of the seal barrier design effort. They indicate that the actual width of the existing openings range from about 14-inches to 16.5 inches. Given this variation in width openings, the panels were designed so as to allow for maximum flexibility during installation in order to limit the space between bars to no greater than 4.9 inches. This will be accomplished by optimally lining up the two panels in each bay during underwater installation so as to equalize, as much possible, the openings between adjacent bars. Once installed, the panels will result in a range of openings from approximately four inches up to a maximum of 4.9 inches. It is expected that most panels will only have one opening with a width of 4.9 inches. Most openings will fall into the 4.0-inch to 4.5-inch range.

Drawings of the seal barrier design are provided as Enclosure D.

5.2 Seal Barrier Design Consistency with Seabrook Station NPDES Permit

The cooling water system intake structure seal barrier has no impact on the functioning of the Cooling Water System. It is an enhancement that has no impact on the parameters controlled or limited by Seabrook Station's NPDES permit. Because of its ability to prevent seal entrapments, it represent the best technology available to minimize adverse environmental consequences. The specific sections of Seabrook Station's NPDES permit that have the potential to bear upon this enhancement and the reasons why the barriers will have no impact on our conformance to these requirements are provided below.

NPDES Permit: "The permittee shall use an anti-fouling protective coating." [Part I.A.k.(2), p.7].

> The new barriers shall be copper-nickel for anti-fouling purposes. This represents no change from the existing bars.

NPDES Permit: "The velocity of water as it enters the Cooling Water Intake Structures shall at no times exceed 1.0 foot per second." [Part I.A.k.(3), p.7]

> After the barrier is installed, the intake velocity will continue to be well below the NPDES Permit limit of 1.0 foot per second. The current intake velocity is about 0.5 feet per second. The velocity of the water at the face of the intakes will be unaffected by the bars. The velocity at the bars, which are set back about 5-6 inches, will increase slightly but continue to be well below the NPDES limit.

NPDES Permit: "It has been determined that the Cooling Water Intake Structures employ the best technology available for minimizing adverse environmental impact." [Part I.A.l., p. 8]

> Seabrook Station's intakes were determined to be the best technology available for minimizing environmental consequences after a rigorous review by federal and state regulatory agencies during the construction and licensing phase of the Station in the 1970's. Over 20 years of comprehensive environmental monitoring, and annual reviews by Seabrook Station's Ecological Advisory Committee and these same regulatory agencies, continue to confirm that the cooling water system has no significant adverse effects on aquatic ecosystems or the commercial and recreational fisheries. The seal entrapments that began in 1993 are of great concern to North Atlantic as evidenced by the actions described in this report. They have not, however, had any impact on the viability of the species. The new barriers that are being installed will, nonetheless, prevent further entrapments. The intake structures with this enhancement will, therefore, continue to represent the best technology available for minimizing adverse environmental impact.

NPDES Permit: "No change in the *location, design* or *capacity* of the present structures can be made without prior approval of the (EPA) Regional Administrator and the (NHDES) Director." [emphasis added] Part I.A.1., p. 8]

Location	The new barriers will not change the location of the intakes.
Design	The new barriers are simply an enhancement that will not affect the operating characteristics of the cooling water system or the intake structures in particular. They will not impact any of the parameters controlled or limited by the NPDES permit. Any potential for increased marine growth provided by the increased surface area will be precluded by increased cleaning and inspection frequencies.
Capacity	The new barrier will not change the capacity of the intakes or the discharge characteristics.

5.3 Seal Barrier Design Effect on Plant Safety/Reliability

The installation of seal barrier panels with a nominal four-inch vertical bar spacing on all three of the intake structures has been subjected to comprehensive engineering and safety analyses to ensure that the potential consequences related to nuclear safety and reliable electrical generation are acceptable.

With respect to nuclear safety, the seal barrier system has been evaluated pursuant to the safety evaluation requirements of the Nuclear Regulatory Commission (NRC) and the Seabrook Station Operating License (reference 10CFR50.59). The safety evaluation demonstrates that the seal barrier system does not reduce the level of safety afforded by the station cooling water system design and thus does not represent an "unreviewed safety question" which would necessitate NRC approval prior to implementation.

The reliable generation of electricity, although not a safety issue, is critical from the standpoint of ensuring that the generating station is capable of providing a reliable source of power to the region. The owners of Seabrook Station cannot accept a seal barrier system that would result in any significant reduction of the reliability of electric generation through a plant shutdown or power reduction caused by clogging of the intakes.

The manner in which these two fundamental factors, nuclear safety and reliable generation, were considered in the safety evaluation and engineering analyses is summarized below.

Nuclear Safety

The seal barrier design must not significantly increase the risk of impacting the operation of the ocean Service Water Pumps that supply cooling water to safety-related plant systems. The ocean Service Water Pumps are safety related equipment. The Operating License requires the Service Water Pumps to be "operable" or capable of performing their safety function when Seabrook Station is operation. A safety analysis has demonstrated that seaweed blockage of up to 97 percent of the surface area of all three intakes could be tolerated before impacting the Service Water Pumps. It is highly unlikely that such a very large degree of blockage could occur. In this highly unlikely scenario the safety-related mechanical draft cooling tower could then provide an adequate supply of cooling water to the safety-related heat loads in the station and maintain the station in a safe shutdown condition. Therefore, nuclear safety is not compromised even in an extremely improbable event in which cooling water flow is fully impeded.

Reliable Generation

The three intake structures are designed to supply cooling water to two operating nuclear units. Seabrook Station Unit 2 was cancelled in the mid-1980's. With only a single nuclear unit in operation, a very large degree of blockage of the intake structures by seaweed can be tolerated before electrical generation is adversely impacted. The engineering analysis estimates that seaweed blockage of up to 50 percent of the surface area on all three intake structures could be tolerated without an impact on electrical generation. It is highly improbable that such a very large degree of intake structure blockage could occur. While the risk is considered to be acceptably low, the frequency of inspections and cleaning of the seal barrier panels will be increased, as described in Section 6, to fully ensure that seaweed blockage is not an issue.

6 INTAKE STRUCTURE INSPECTION AND CLEANING WITH NEW SEAL BARRIER

The following represents North Atlantic's plans regarding inspection and cleaning of the intake structures. Adjustments to the inspection and cleaning schedule will be made as fouling conditions warrant.

Seabrook Station's three offshore intakes will be cleaned of fouling organisms at least once each year during the early fall which is after the peak summer fouling period. In the past the intake structures have been cleaned once every two to three years.

In the spring of each year, all three intakes will be inspected by divers. The results of this inspection will determine if a spring-cleaning is necessary.