Dominion Nuclear Connecticut, Inc.
Millstone Power Station
Rope Ferry Road
Waterford, CT 06385

Dominion

D17240

September 7, 2001

Mr. Michael Harder
Director, Water Management Bureau
Permitting, Enforcement and Remediation Division
Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127

Reference:

1) COP-99-142- MG, Waterford, (C#09615) dated October 28, 1999

Millstone Power Station
Survival Study Results for the Aquatic
Organism Sluiceway at Unit 2

Dear Mr. Harder,

Dominion Nuclear Connecticut (DNC) recently completed a one-year survival study of aquatic organisms returned to Niantic Bay via the Millstone Unit 2 return sluiceway. A report of the results of this study is attached for your review and approval in accordance with the terms and conditions of the Department of Environmental Protection's approval (Reference 1). Should you have any questions concerning this report, please call Chris Tomichek at (860) 444-4235.

Very truly yours,

DOMINION NUCLEAR CONNECTICUT, INC.

Kathleen McMullin

Kathleen M. McMullin
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Enclosure

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Millstone Unit 2 Aquatic Organism Return System Survival Study

Introduction

This report presents the results of a one-year study conducted to assess the survival of organisms returning to Niantic Bay via the Millstone Unit 2 aquatic organism return system. The return sluice pipe was completed in June 2000 and the one-year survival study commenced in July 2000.

In September 1999, a feasibility study was submitted to the Connecticut Department of Environmental Protection (CTDEP) presenting 4 return system alternatives for Unit 2 (NNECO 1999). The alternative selected carries the intake screen wash water to a sluice pipe that terminates beyond the rock outcrop between Units 1 and 2. A number of factors were considered in the selection of the Millstone Unit 2 aquatic fish return, including the survival rate and return rate of the aquatic organisms at Units 1 and 3, reimpingement and recirculation of debris, as well as the potential of the pipe to clog with debris. After considering these factors, a sluiceway that terminates beyond a rock outcrop between the Units 1 and 2 intake structures was selected. A comparison of Unit 2 results with previously conducted survival studies at Unit 1 (85 psi sprayers) and Unit 3 (10 psi sprayers) showed little difference in the survival of aquatic organisms impinged. Based on these results, the existing traveling screen and spray wash system at Unit 2 (85 psi sprayers) in conjunction with the return of organisms via the sluiceway pipe has been successful. The survival of organisms returned at Unit 2 is similar to that found with the Millstone Unit 3 ristroph fish return system.

The Intake Structure and Aquatic Return System

Millstone Unit 2 is an 870-MWe pressurized water reactor. Condenser cooling water for Unit 2 has a total maximum condenser flow of 548,800 gpm (~1,220 cfs) and is drawn from depths about 8 m below mean sea level by a shoreline intake located on Niantic Bay (Fig. 1). The intake structure has a curtain wall which extends below lowest mean water level, coarse bar racks that exclude debris and fish larger than 2-inches in size, and 3/8-inch mesh vertical traveling screens to prevent smaller fish and debris from entering the pump bays. The water velocity approaching the traveling screen is about 0.8 fps. The screenwash system operates automatically in accordance with the differential pressure (dp) of 6" across the traveling water screen or once every 8 hrs. One screen rotation takes 8 minutes.

The Millstone Unit 2 screenwash system was modified to return aquatic organisms. All material (debris and aquatic organisms) washed from the four intake traveling screens is returned via the sluiceway pipe. The aquatic return sluiceway consists of 14 in. diameter smooth-walled fiberglass pipe with large radius elbows and a slope of approximately 0.01 ft/ft along the flattest run, and then a slope of approximately 0.40 ft/ft at the chute end. The estimated flow rate through the sluiceway is 990 gpm. This flow is more than sufficient for moving debris and aquatic organisms down the 150 ft. length of sluiceway piping and back to Niantic Bay (Fig. 1).

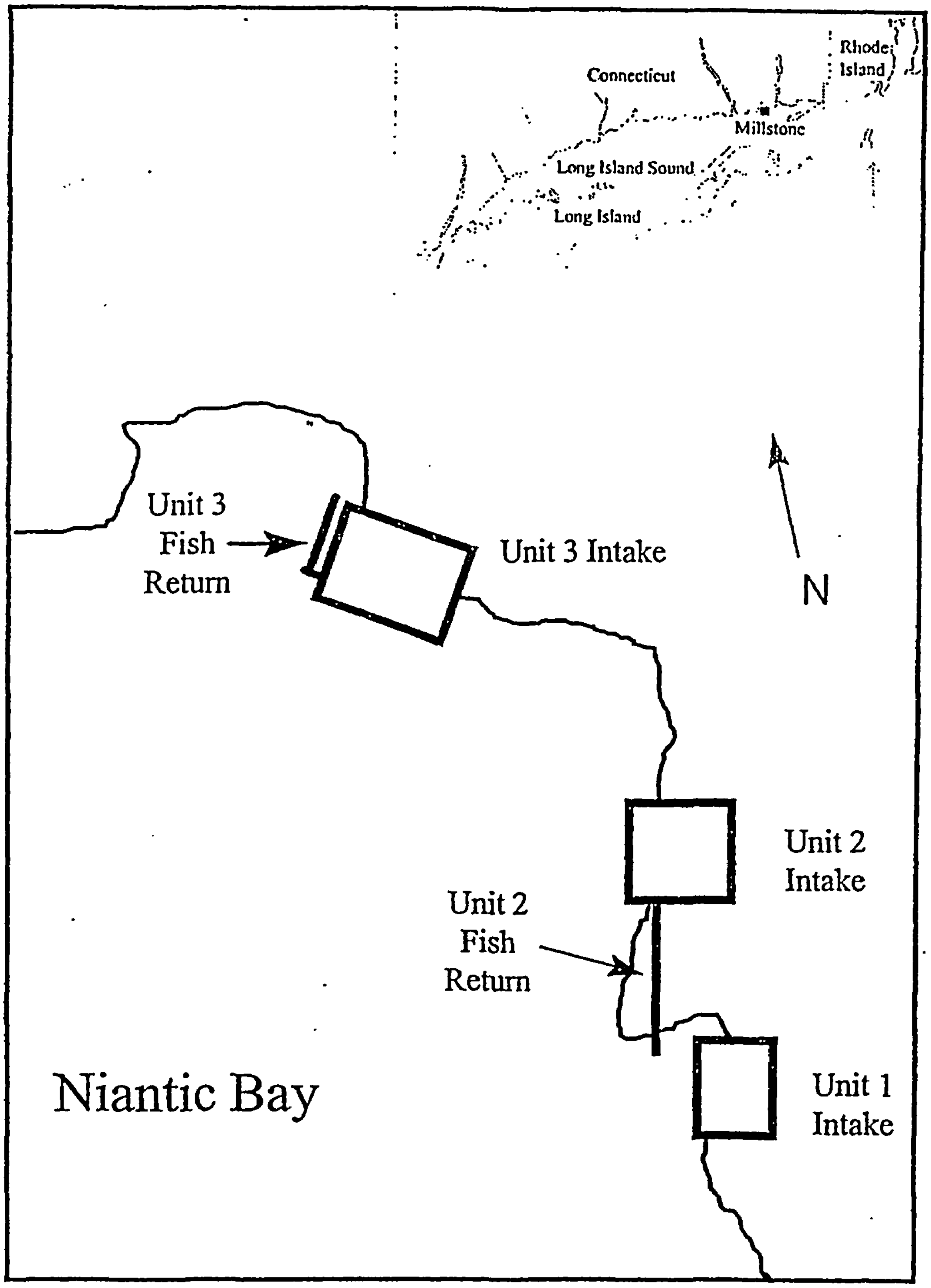

Figure 1. Schematic of Milstone Power Station intake structures and aquatic organism returns.

Materials and Methods

Samples were collected in the Unit 2 aquatic organism return pipe biweekly from July 2000 through June 2001 (Table 1). Most impingement occurs between dusk and dawn so sampling was done in the early morning (5am) shortly before or after dawn. Before a sample was collected, the traveling screens were washed to clean them of previously accumulated debris then the screens were not rotated for 2-h.

Organisms were collected inside the sluice pipe using a 2-m long net of 6-mm mesh net attached to a 46-cm x 43-cm rectangular aluminum frame. The screens were rotated and cleaned and as material accumulated in the sampler during the approximate 20-min. wash cycle, the net was emptied about every 2 min. Sampling was continuous during the wash cycle as the net was designed to be emptied at the cod-end while the mouth remained secured in the pipe. Occasionally, the cod-end of the net was opened and the contents were emptied into the sluice pipe because there was too much accumulated debris. Organisms were separated from algae and jellyfish by hand and placed into insulated coolers filled with seawater. Live organisms were returned to the laboratory and held in tanks with running seawater for up to 72 hrs. Observations were made at 6 and 24 h following collection and dead organisms were removed. All remaining organisms were measured at 72-h. Total length of fish, carapace width of crabs, carapace length of lobsters, and mantle length of squid were recorded to the nearest mm. Water temperature at the intake and laboratory holding tanks was recorded.

Survival estimates were calculated for individual species as well as for groups of organisms classified by body type and season of occurrence based on water temperature (Table 2). Survival was calculated from the proportion of total numbers of specimens alive at the initial, 6-, 24-, and 72-h observations. Organisms were classified into four body-type groups, which included "pelagic", "demersal", "crustacean", and "squid". Free-swimming fishes (e.g. herring, silversides, butterfish) were considered pelagic, whereas bottom dwellers (e.g. sculpins, flounders) as well as those with hard integument (e.g. sticklebacks, pipefish) were classified as demersal. The crustacean group was composed of crabs and American lobsters. The Atlantic long-finned squid was considered as a separate group. Samples were assigned to three temperature groups: "cold", "cool" and "warm" based on water temperatures at the time of the collection. The water temperatures ranged from 3.0 to 7.6°C (cold), 8.0 to 15.4°C (cool), and 16.0 to 22.0°C (warm).

Results

A total of 25 samples was taken during the study period (Table 1). Collections included 33 species of fish and 10 macroinvertebrates (Table 2). The 1,515 specimens collected during the study were dominated by 6 species and these comprised 85% of the total: Atlantic menhaden (915), butterfish (147), Atlantic long-finned squid (89), threespine stickleback (61), grubby (49), and cunner (32).

Table 1. Number of organisms collected and water temperature on each sampling date at Unit 2 intake.

Sampling Date	Number of Organisms	Water Temperature (°C)
July 11, 2000	17	18.9
July 25, 2000	34	20.0
August 8, 2000	132	21.7
August 22, 2000	666	20.1
September 5, 2000	27	20.6
September 19, 2000	28	20.1
October 3, 2000	10	18.2
October 17, 2000	12	17.0
October 31, 2000	7	13.7
November 14, 2000	191	13.8
November 28, 2000	76	10.8
December 12, 2000	47	8.7
December 27, 2000	32	4.7
January 9, 2001	3	4.6
January 23, 2001	10	3.8
February 6, 2001	12	3.0
February 20, 2001	18	3.5
March 6, 2001	5	3.4
March 20, 2001	34	4.8
April 3, 2001	46	5.2
April 17, 2001	34	7.6
May 1, 2001	1	8.8
May 15, 2001	46	10.6
May 29, 2001	7	12.8
June 12, 2001	20	15.4

Demersal fish and crustacean groups had the greatest survival. Survival of crustaceans was best in cool water (85%) and lowest in warm water (76%). Demersal fish had the highest survival in cold water (86%) followed by cool water (74%) (Table 3). More than half the pelagic fish and squid in cold and cool water survived initial impingement but most died during the 72-h holding period.

Table 2. Latent survival of organisms collected at the Millstone Unit 2 aquatic organism return.

Species	Common Name	Body Type	Total	Percent Survival Initial	6-h	24-h	72-h
Anchoa mitchilli	bay anchovy	P	5	0	0	0	0
Anguilla rostrata	American eel	D	1	100	100	0	0
Brevoortia tyrannus	Atlantic menhaden	P	915	14	6	2	0.3
Callinectes sapidus	bluecrab	C	15	100	100	93	87
Cancer irroratus	rock crab	C	12	58	58	58	58
Caranx hippos	crevalle jack	P	3	0	0	0	0
Carcinus maenus	green crab	C	25	84	84	84	76
Cyclopterus lumpus	lumpfish	D	2	100	100	100	100
Cynoscion regalis	weakfish	P	5	0	0	0	0
Dactylopterus volitans	flying gurnard	P	1	0	0	0	0
Dorosoma cepedianum	gizzard shad	P	1	100	0	0	0
Etropus microstomus	smallmouth flounder	D	9	67	67	44	44
Fundulus majalis	striped killifish	P	1	100	100	100	100
Gasterosteus aculeatus	threespine stickleback	D	61	97	93	90	90
Gasterosteus wheatlandi	blackspotted stickleback	D	1	100	100	100	100
Hemigrapsus sanguinea	Japanese shore crab	C	2	100	100	100	100
Homarus americanus	American lobster	C	10	100	100	100	100 —
Libinia emarginata	spider crab	C	7	86	86	86	86
Limulus polyphemus	horseshoe crab	C	1	100	100	100	100
Loligo pealei	Atlantic long-finned squid	S	89	35	30	24	17
Lophius americanus	goosefish	D	1	0	0	0	0
Menidia menidia	Atlantic silverside	P	13	70	54	38	23
Merluccius bilinearis	silver hake	P	4	50	50	25	25
Mictogadus tomcod	tomcod	P	1	100	0	0	0
Morone americanus	white perch	P	3	100	67	0	0
Myoxocephalus aenaeus	grubby	D	49	94	88	86	78
Neopanope texana	mud crab	C	10	70	70	50	40
Ophidion marginatum	striped cusk-eel	D	15	93	93	93	93
Ovalipes ocellatus	lady crab	C	10	100	100	100	100
Paralichthys dentatus	summer flounder	D	8	63	63	63	50
Peprilus triacanthus	butterfish	P	147	8	3	3	3
Pholis gunnellus	rock gunnel	D	1	100	100	100	100
Pomatomus saltatrix	bluefish	P	1	0	0	0	0
Prionotus evolans	striped searobin	D	3	67	33	33	33
Pseudopleuronectes americanus	winter flounder	D	16	100	100	100	100 —
Rajx spp.	skates	D	3	100	100	100	100
Scophthalmus aquosus	windowpane	D	4	75	75	75	75
Selene vomer	lookdown	P	2	50	50	50	0
Stenotommus chrysops	scup	P	1	100	0	0	0
Syngnathus fucus	northern pipefish	D	8	100	100	88	75
Tautogolabrus adspersus	cunner	D	32	69	56	56	56
Tautoga onitis	blackfish tautog	D	16	94	75	69	56 —
Urophycis chuss	red hake	P	1	0	0	0	0

* P=pelagic
D=demersal
C=crustacean
S=squid

Table 3. Comparison of latent survival of organisms collected at the Millstone Unit 2 aquatic organism return based on body type and water temperature.

Body Type Group	Temperature Group	Total	Percent Survival Initial	6-h	24-h	72-h
crustacean	cold	9	78	78	78	78
	cool	20	90	90	90	85
	warm	63	86	86	81	76
demersal	cold	140	94	92	88	86
	cool	66	91	83	82	74
	warm	26	54	31	27	27
pelagic	cold	14	64	57	36	14
	cool	289	40	18	5	1
	warm	799	4	2	1	0.5
squid	cool	45	64	60	47	33
	warm	44	4	0	0	0

The six most abundant species collected during the study had varying rates of survival, depending on their body type. The most abundant species, Atlantic menhaden juveniles, accounted for 60% of the catch. Of these, 67% were caught in one sample on August 22, 2000. Atlantic menhaden were unusually abundant during the summer 2000 and collecting such high densities in one sample may have contributed to lower survival. The second most abundant species, butterfish, is another fragile pelagic species that exhibited high mortality. Over 30% of the Atlantic long-finned squid initially survived impingement and over 15% survived the holding period (NUSCO 1986, 1988, 1994). This species is delicate and in previous studies survival was much lower. Most three-spine sticklebacks (90%), grubby (78%) and cunner (56%) survived impingement and the 72-h hold period.

Discussion

The results of the sluiceway study at Millstone Unit 2 revealed that survival rates were similar to those found at both Units 1 and 3 (NUSCO 1986, 1988, 1994) (Table 4). In general, crustaceans and demersal fish, including the commercially important American lobster (100%) and winter flounder (100%), had high survival rates. Survival of some fragile pelagic species, Atlantic long-finned squid, Atlantic silversides, and butterfish, was notably higher at Unit 2 than Unit 3. Returning both the aquatic organisms and the debris down the sluiceway, as is done at Unit 2, results in 100% return of all aquatic organisms to LIS. Separating the organisms from the debris, as is done at Unit 3, results in return rates somewhat less than 100%.

The results of impingement survival studies at other northeastern Atlantic coastal and estuarine power stations are summarized on Table 5 and compared to the results of this study. Results were similar, even though sampling methods and plant operations differ among the studies.

Survival of fish from Unit 2 appears to be similar to rates found at Brayton Point, MA and greater than Pilgrim, MA for similar wash cycles (Anderson 1985a, 1985b; LMS 1985, 1986). Initial survival for demersal species was similar to that at Oyster Creek, NJ even though less time elapsed between screen washes there (Tatham et al. 1977).

Table 4. Comparison of percent latent survival (72-h) of aquatic organisms at Units 1, 2 and 3.

Species	Common Name	Percent Survival Unit 1[a] (1981)	Unit 3[b] (1986)	Unit 3[c] (1993)	Unit 2 (2001)
Anchoa mitchilli	bay anchovy	0	0	0	0
Brevoortia tyrannus	Atlantic menhaden	0	0	0	0.3
Callinectes sapidus	blue crab	86	100	75	87
Cancer irroratus	rock crab	92	83	91	58
Carcinus maenus	green crab	62	77	82	76
Gasterosteus aculeatus	threespine stickleback	91	72	86	90
Homarus americanus	American lobster	38	86	100	100
Libinia spp.	spider crab	71	94	89	86
Loligo pealei	Atlantic long-finned squid	0	0	6	17
Menidia menidia	Atlantic silverside	0	0	0	23
Myoxocephalus aenaeus	grubby	74	97	86	78
Ovalipes ocellatus	lady crab	81	90	71	100
Peprilus triacanthus	butterfish	0	0	0	3
Pomotomus saltatrix	bluefish	0	0	0	0
Pseudopleuronectes americanus	winter flounder	86	100	94	100
Syngnathus fucus	northern pipefish	16	91	92	75
Tautogolabrus adspersus	cunner	20	86	67	56

[a] NUSCO 1986
[b] NUSCO 1988
[c] NUSCO 1994

Conclusions

The Millstone Unit 2 aquatic organism return worked as designed and successfully returned impinged marine organisms back to Long Island Sound. Survival at Unit 2 was comparable to survival found at Unit 3. Returning both the aquatic organisms and the debris down the sluiceway, as is done at Unit 2, results in 100% return of all aquatic organisms to LIS. Based on the numbers and types of aquatic organisms impinged, survival of a large majority of demersal fish and non-molting crustaceans has occurred since the sluiceway was installed. The survival of important fishes and invertebrates, such as winter flounder and American lobster has lessened the impact of impingement on the local marine community.

Table 5. Comparison of data from impingement survival studies at other northeast Atlantic power stations.

Power Station	Species	Body Type[a]	Wash Cycle	Holding Period	% Survival	Remarks	References
Bowline, NY	white perch	P	0[b]	96	56	Not adjusted	King et al.
	white perch	P	4	96	19	for controls	1977
Brayton Point,	Atlantic silverside	P	0-8	48	43		LMS 1985
MA	bay anchovy	P	0-8	48	0		
	northern pipefish	D	0-8	48	94		
	tautog	D	0-8	48	95		
	winter flounder	D	0-8	48	75		
Brayton Point	Atlantic silverside	P	0-8	48	18		LMS 1986
MA	bay anchovy	P	0-8	48	2		
	cunner	D	0-8	48	75		
	grubby	D	0-8	48	100		
	tautog	D	0-8	48	98		
	winter flounder	D	0-8	48	94		
Danskammer	white perch	P	0	84	40-61	Adjusted for	King et al.
Point, NY	white perch	P	4	84	9	control mortality	1977
	Atlantic tomcod	D	0	84	83		
	Atlantic tomcod	D	2	84	87		
Oyster Creek,	blueback herring	P	2	none[c]	17		Tatham et al.
NJ	Atlantic herring	P	2	none[c]	8		1977
	bay anchovy	P	2	none[c]	7		
	Atlantic silverside	P	2	none[c]	34		
	northern pipefish	D	2	none[c]	90		
	striped searobin	D	2	none[c]	82		
	smallmouth flounder	D	2	none[c]	74		
	winter flounder	D	2	none[c]	85		
	blue crab	C	2	none[c]	93		
Pilgrim,	Atlantic silverside	P	8	56	3	Data combined	Anderson
MA	grubby	D	8	56	30	for 1984-85	1985 a, b
	winter flounder	D	8	56	33	studies.	
Pilgrim,	Atlantic silverside	P	8	none[c]	77		Anderson
MA	tautog	D	8	none[c]	87		1993
	grubby	D	8	none[c]	95		
	winter flounder	D	8	none[c]	88		
Roseton,	white perch	P	0	84	29-60	Adjusted for	King et al.
NY	white perch	P	4	84	23-36	control	1977
	Atlantic tomcod	D	0	84	81	mortality	
	Atlantic tomcod	D	2	84	72		

a P=pelagic, D=demersal, C=crustacean
b 0 indicates continuous wash
c immediate survival estimates given as few specimens held for delayed mortality

References Cited

Anderson, R.D. 1985a. Impingement of organisms at Pilgrim Nuclear Power Station (January-December 1984). In R.D. Anderson and L.N. Scotton. Marine ecology studies related to operation of Pilgrim Station. Semi-annual Rep. No. 25. January 1984-December 1984. Nucl. Management Serv. Dept., Boston Edison Co., Braintree, Mass.

Anderson, R.D. 1985b. Impingement of organisms at Pilgrim Nuclear Power Station (January-December 1985). In R.D. Anderson and L.N. Scotton. Marine ecology studies related to operation of Pilgrim Station. Semi-annual Rep. No. 26. January 1984-June 1984. Nucl. Management Serv. Dept., Boston Edison Co., Braintree, Mass.

Anderson, R.D. 1993. Impingement of organisms at Pilgrim Nuclear Power Station (January-December 1993). In R.D. Anderson. Marine ecology studies related to operation of Pilgrim Station. Semi-annual Rep. No. 43. January 1993-June 1993. Nucl. Management Serv. Dept., Boston Edison Co.,Braintree, Mass.

King, L.R., J.B. Hutchinson Jr. and T.G. Huggins. 1977. Impingement survival studies on white perch, stripped bass and Atlantic tomcod at three Hudson River power plants. Pages 217-234 in L.D. Jensen ed. Fourth national workshop on entrainment and impingement. E.A. Communications, Melville, N.Y.

LMS (Laweler, Matasky, and Skelly Eng.) 1985. Brayton Point Station Unit No. 4; Angled screen intake biological evaluation program. 1984 Ann. Rpt. Prepared for New England Power Service Company.

LMS 1986. Brayton Point Station Unit No. 4; Angled screen intake biological evaluation program. 1985 Ann. Rpt. Prepared for New England Power Service Company.

NUSCO (Northeast Utilities Service Company). 1986. The effectiveness of the Millstone Unit 1 sluiceway in returning impinged organisms to Long Island Sound. 18 pp.

NUSCO. 1988. The effectiveness of the Millstone Unit 3 fish return system. Appendix 1 to Enclosure 3 to Letter D01830 dated January 29, 1988 from E.J. Mroczka, NUSCO, to L. Carothers, Commissioner, CT DEP. 21 pp.

NUSCO. 1994. Progress report on the MNPS fish return systems. Enclosure 1 to letter D08071 dated October 20, 1994 from D. Miller, NNECO, to T. Keeney, Commissioner, CT DEP.

NNECO.(Northeast Nuclear Energy Company) 1999. Letter D14813 and enclosures dated October 8, 1999 from H.M. Blinderman, Updike, Kelly & Spellacy, P.C. on behalf of NNECO, to K. Zawoy, Long Island Sound Programs, CT DEP.

Tatham, T.R., D.L. Thomas, and G.J. Miller. 1977. Survival of fishes and macroinvertebrates impinged at Oyster Creek Generating Station. Pg. 235-244 in L.D. Jensen, ed. Fourth national workshop on entrainment and impingement. E.A. Communications, Melville, N.Y.