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APPENDIX B

TO

FACILITY OPERATING LICENCE

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FOR

CONSOLIDATED EDISON COMPANY

OF NEW YORK, INC.

INDIAN POINT NUCLEAR GENERATING

UNITS NUMBERS 1 AND 2

DOCKET NUMBER 50-247

ENVIRONMENTAL TECHNICAL SPECIFICATION

REQUIREMENTS

TECTS

April 30, 1973

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LIST OF TABLES

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1. DEFINITIONS

The following terms are defined for uniform interpretation of the Environmental Technical Specification for Indian Point Unit Nos. 1 and 2.

(a) Abnormal Environmental Occurrence

An abnormal environmental occurrence means the occurrence of any plant condition that results in non-compliance with an environmental technical specification.

(b) Intake Water Temperature

Water temperature in the intake water structure forebay.

(c) Discharge Canal Water Temperature

Water temperature in the discharge canal, at the confluence of the discharge canal with the Hudson River.

(d) Ambient River Water Temperature

Hudson River water temperature without the addition of the thermal discharges from the Indian Point site.

(e) Approach velocity

Water velocity at a distance of approximately twenty-four inches away from the outer fixed screens (which are located at the bay openings). The approach velocity is not measured directly but its maximum value is calculated by knowing the volumetric flow rate; i.e.;

$$V_{a_m} = \frac{Q_c}{A_f} \qquad 1\text{-}1$$

where:

V_{a_m} = maximum approach velocity (ft/sec)

Q_c = volumetric flow rate (cfs)

A_f = area of intake forebay opening to river (ft^2)

The approach velocity decreases as the distance away from the intake structure increases.

(h) Discharge Velocity

The average velocity at the vena contracta of the water jets issuing from the discharge ports. The discharge velocity is not measured directly, but is calculated by measuring the difference in water level across the discharge structure.

That is:

$$V_{vc} = C\sqrt{2\,g\,h} \qquad 1\text{-}2$$

where:

V_{vc} = velocity at vena contracta (ft/sec)

g = acceleration of gravity (ft/sec^2)

h = height of water in discharge canal above river level (ft)

C = proportionality constant (about 0.95) (Ref. 1-1)

(f) = Residual Chlorine (or Chlorine Residual)

The amount of available chlorine present at any specified period, subsequent to the addition of chlorine (Reference 1-2).

(g) Total Chlorine Residual

The total amount of chlorine residual (free and/or combined) present, without regard to type (Reference 1-2).

(h) Free Available Chlorine Residual (or Free Chlorine or Free Available Chlorine)

Residual chlorine consisting of hypochlorite ions (OCl), hypochlorous acid (HOCl), or a combination thereof (Reference 1-2).

(i) Combined Available Chlorine Residual (or combined chlorine or combined available chlorine)

Residual chlorine consisting of chlorine combined with ammonia, nitrogen or nitrogenous compounds (Reference 1-2).

(j) Chlorine Demand (or chlorine requirement)

The amount of chlorine required to achieve under specified conditions a desired result.

(k) Releases From Facility

Specification for the releases from the facility apply to the combined discharges from Units 1 and 2.

References

1-1 "Indian Point Model No. 2 Cooling Water Studies," Alden Research Laboratories, May 1969. Appendix O, Environmental Report for Indian Point Unit No. 2 Supplement.

1-2 "Annual Book of ASTM Standards, Part 23, Water: Atmospheric analysis, D 1253-68," American Society for Testing and Materials.

2. NON-RADIOLOGICAL EFFLUENT RELEASE

Objective

To define the conditions for release of non-radioactive liquids and solids to the river and gases to the atmosphere to assure compliance with applicable Federal, state and local regulations.

Specification

I. Applicability

Applies to the release of non-radioactive liquids, gases and solids from the site.

II. Limit

A. Liquid Effluents

1. The release concentrations of chemicals in the discharge canal prior to entry into the river (i.e., at the confluence) shall not exceed the values listed in Table 2-1.

2. (a) Chlorine: The maximum frequency of chlorination for each unit shall be limited to three times per week. The total time for chlorination treatment for both Unit Nos. 1 and 2 shall not exceed six hours per week. Chlorination on Unit No. 2 shall normally be limited to one hour during each treatment except for special tests, and will be staggered with the other unit to prevent simultaneous chlorine treatment occurring. (Chlorination will take place during daylight hours, save that chlorination

for special testing may take place at any time.) Routine chlorinations shall be suspended during the winter months (e.g., when ambient river temperatures are less than 45°F) unless excessive fouling of the condenser occurs.

(b) Other Chemicals: Other chemicals can be released in the following manner:

- released continuously
- released batchwise
- released only in the event of evaporator breakdown
- released on assumption of system leakage

Table 2-2 lists the conditions under which the chemicals may be released, the maximum sustained release, and the concentration under the most adverse conditions. No intentional discharges of oil and greases are planned.

B. Gaseous Effluents

The relaese of gaseous pollutants in combustion products from Unit No. 1 superheaters, the site's plant package boilers, and any diesel powered units (such as auxiliary generators), will be limited through the use of low sulfur fuel oil in accordance with appropriate Federal, state and local regulations.

C. Solid Effluents

Solid wastes collected from the trash bar racks will be disposed of as trash in accordance with local regulations.

Basis of Specifications

Chemical releases from Units No. 1 and 2 are subject to the same dilution in the circulating water system discharge prior to release into the river as the radioactive effluents. The resulting concentrations during any prior operation have not exceeded the limits established under these specifications. No adverse effects have been observed from these discharges and therefore added assurance is gained that future operations under a similar program will also produce no adverse effects to the ecosystem of the Hudson River.

The concentration limits listed in Table 2-1 were developed from the evaluation of the toxic potential of the enumerated chemicals, utilizing values from the literature along with toxicity bioassays (Reference 2-2).

Of special concern ecologically is the potential damage to the river organisms from exposure to chlorine residuals, including chloramines, during and after the periodic chlorination of the circulating water system. Extensive testing on the existing discharge from Indian Point Unit No. 1 has shown that the chlorination program and discharge limits contained in these specifications have not caused significant damage to the ecosystem of the Hudson River (Reference 2-3). Specifically, these tests have shown that:

(a) The decomposition rate of biologically active forms of chlorine result in concentrations in the plume of undetectable quantities (Reference 2-1),

(b) Chloramine formation is minimal (Reference 2-1),

(c) The discharge jets (from the discharge ports) containing chlorine rise to the upper layers of the river, whereas during the day important organisms (such as zooplankton, Gammarus and Neomysis, and fish eggs and larvae) are prevalent in the lower layer (Reference 2-3),

(d) Indian Point Unit No. 1 results can reasonably be used to predict combined effects of Units Nos. 1 and 2.

The chlorine dose is fed into one-half of the Unit No. 2 condenser so as to produce a maximum chlorine concentration at the outlet box of less than 1.0 mg/l of total residual chlorine. Dilution with the unchlorinated portion immediately reduces the maximum total residual chlorine level to less than 0.5 mg/l. before the effects of further chlorine demand and chlorine breakdown in the discharge canal are considered (Reference 2-1).

Oil and grease spills in the facility are cleaned up, drummed, and carted to the local dump (Croton) by a commercial carting service. Should any oil or grease inadvertently enter any drain, their discharge to the river is prevented through the use of an oil slick boom placed across the discharge canal.

Consolidated Edison Company is currently using fuel oil with a sulfur content of not more than 0.30 percent by weight, thus currently meeting a New York State regulation

(Reference 2-4) that does not become effective until September 30, 1973. In addition, the annual average concentrations for the emissions of NO_x and particulates from the sites package boilers and superheaters are currently in compliance with the Federal Air Quality Standards that have to be achieved by 1975 (References 2-5 and 2-6).

Incorporated as part of the intake structure of the circulating water system for Unit No. 2 are a sequence of screens; first a fixed screen, then a trash bar rack, and finally travelling screens. This arrangement is designed to both prevent solid waste material from being drawn from the river into the system and thereby cause damage to equipment such as the travelling screens and the circulating water pumps, and to minimize any impact on the environment. When the fixed screens are raised (about once a day), logs and other large waste material (e.g., plastic bags and large shrubbery) that were on the fixed screens are caught by the trash bar racks. When these racks are cleaned the debris on them is taken off and carried away. These solid wastes are carted away by a commercial service to the Croton dump. The specification to carry away this solid waste rather than throw it back into the river (from whence it came) is consistent with the licensee's commitment to protect the environment.

Experience has shown that fish impingement can be expected to occur on the fixed screens and that those fish in a weakened condition are collected on the travelling screens when the fixed screens are raised for cleaning.

The fish are removed from the travelling screen and conveyed via a sluiceway back to the river. As part of the licensee's efforts to minimize the effect of impingement, a fish pump has been installed on the sluiceway and is currently being tested to determine its effectiveness. The fish pump discharges the impinged fish away from the intake screens so that they are not re-impinged.

Fish collected on the travelling screens and counted and/or analyzed for research purposes will be disposed of as trash in accordance with local regulations. Other fish along with non separable trash will be returned promptly to the river.

References:

2-1 Redirect-Rebuttal Testimony of John P. Lawler, PhD, Quirk, Lawler and Matusky Engineers, "The Effect of Indian Point Unit 2 Chlorination on the Aquatic Biology of the Hudson River," Docket No. 50-247, February 5, 1973.

2-2 Testimony of Gerald J. Lauer, PhD., New York University "Effects of Chemical Discharges from Indian Point Units 1 and 2 on Biota and on River Chemistry," Docket No. 50-247, April 5, 1972.

2-3 Ibid; October 30, 1972

2-4 New York State Department of Environmental Conservation, Title 6, Chapter III, Air Resources, Subchapter A, Prevention and Control of Air Contamination and Pollution, Part 225, Fuel Composition and Use - New York City Metropolitan Area.

2-5 Consolidated Edison of New York, Inc., Supplement No. 3 to the Environmental Report for Indian Point Unit No. 2, Benefit - Cost Analysis, February, 1972.

2-6 "Final Environmental Statement, Indian Point Unit No. 2," United States Atomic Energy Commission, Directorate of Licensing, September, 1972.

TABLE 2-1

MAXIMUM RELEASE CONCENTRATION OF CHEMICALS AT THE CONFLUENCE OF THE DISCHARGE CANAL AND THE RIVER

CHEMICAL	CONCENTRATION (ppm) (Column A)
Phosphate	1.5
Hydrazine	0.1
Cyclohexylamine	0.1
Lithium Hydroxide	0.01
Boron	9
Potassium Chromate	0.05 (hexavalent chromium)
Residual Chlorine (free and combined)	0.5
Sodium Hydroxide	10
Sulfuric Acid	10
Soda Ash	5
Detergent	1
pH	6.5 - 8.5

No heavy metal discharges are planned or anticipated other than those listed in the above table.

TABLE 2-2 ANTICIPATED RELEASES

CHEMICAL AND HOW RELEASED	MAXIMUM SUSTAINED RELEASE, (lb/day) Unit No. 1	Unit No. 2	CONCENTRATION WITH DILUTION FLOW OF 100,000 GPM* (ppm) (Column B)	RATIO;**** $\frac{\text{COLUMN B}}{\text{COLUMN A (Table 2-1)}}$
(A) Released Continuously				
Phosphate	15	24	3.2×10^{-2}	2.2×10^{-2}
Hydrazine	NA	5	4.2×10^{-3}	4.2×10^{-2}
Cyclohexyl-amine	2.5	12	1.2×10^{-2}	1.2×10^{-1}
Sodium Hydroxide	36	NA	3.0×10^{-2}	3.0×10^{-3}
(B) Released on the Assumption of System Leakage				
Potassium Chromate (as Chromium)	NA	30	2.5×10^{-2}	5.0×10^{-1}
(C) Released on a Batch Basis				
Residual Chlorine	--------------see text-----------			
Detergent	3 (2 hr/day)	NA	3.0×10^{-2}	3.0×10^{-2}
Sodium Hydroxide	120 (1 hr, once a day) ***	NA	2.4×10^{0} (2.6×10^{0}) **	2.4×10^{-1} (2.6×10^{-1}) **
Sulfuric Acid	450 (1 hr, once a day)	NA	9.0×10^{0}	9.0×10^{-1}

TABLE 2-2: ANTICIPATED RELEASES

CHEMICAL AND HOW RELEASED	MAXIMUM SUSTAINED RELEASE, (lb/day) Unit No. 1	Unit No. 2	CONCENTRATION WITH DILUTION FLOW OF 100,000 GPM * (ppm) (Column B)	RATIO; **** COLUMN B / COLUMN A (TABLE 2-1)
(C) Released on a Batch Basis (continued)				
Soda Ash	1000 (2-4 times/year)	NA	$2.5x10^{0}$	$5.0x10^{-1}$
Hydrazine+	24 (once/year)	NA	$2.0x10^{-2}$	$2.0x10^{-1}$
(D) Released on a Batch Basis, in Event of Evaporator Breakdown++				
Lithium Hydroxide	2.5	2.5	$4.2x10^{-3}$	$4.2x10^{-1}$
Boron	600	600	$1.0x10^{0}$	$1.1x10^{-1}$
Sodium Hydroxide	NA	12 (2 hrs. once every 4-7 days)	$1.2x10^{-1}$	$1.2x10^{-2}$

NA Not Applicable (Chemical is not discharged from Unit)

* Concentration calculated under most adverse condition, simultaneous release from Units 1 and 2. Normal dilution flow is 1,188,000 gpm; hence with this flow concentrations would be 1/10 as much.

** Concentration calculated considering sodium hydroxide release from (A) in addition.

*** This release results from regeneration of mixed bed ion exchangers. Sulfuric acid and sodium hydroxide are also released simultaneously during this regeneration for 1 hour and neutralization occurs. Neutralized chemicals are not included in this table.

**** This is the ratio of the most adverse concentration (Column B) to the maximum release concentration (Column A). It is an indication of the degree of protection afforded the environment without consideration of normal dilution flow and further dilution in the river itself.

TABLE 2-2: ANTICIPATED RELEASES (CONTINUED)

+ Chlorination will not take place at the same time hydrazine is released from Unit 1 (once/year).

++ This release (in lbs/day) is based upon the direct release of maximum reactor coolant system concentrations at the maximum rate of the waste disposal system. The occurrence of this release is therefore very unlikely.

3. THERMAL RELEASE

Objective

To define the conditions for discharge of the effluent cooling water to assure compliance with applicable regulations.

Specification

I. Applicability

Applies to the discharge of the heated coolant water from the discharge structure.

II. Limit

A. The thermal discharges resulting from operations of Units Nos. 1 and 2 shall be limited so as not to exceed the New York State Thermal Criteria (6 NYCRR 704.1 (B) (4)):

> "The water temperature at the surface of an estuary shall not be raised to more than 90°F at any point provided further, at least 50 percent of the cross sectional area and/or volume of the estuary including a minimum of one third of the surface as measured from water edge to water edge at any stage of tide, shall not be raised to more than 4°F over the temperature that existed before addition of heat of artifical origin or a maximum of 83°F, whichever is less. However, during July through September if the water temperature at the surface of an esturay before the addition of heat of artifical origin is more than 83°F, an increase in temperature not to exceed 1.5°F, at any point of the estuarine passageway as delineated above, may be permitted.

B. The maximum heat rejection rates to the river are caculated to be as follows:

Unit 1	2.0×10^9 Btu/hr
Unit 2	6.5×10^9 Btu/hr
Units 1 + 2	8.5×10^9 Btu/hr

C. The maximum difference between the intake water temperature and the discharge canal water temperature shall be as follows:*

	Maximum differential (°F)
Intake water temperature greater than 40°F	15
Intake water temperature less than 40°F	25

Basis of Specification

The thermal discharges shall be limited in that the temperature rises above ambient shall be within the New York State Thermal Criteria at all power levels and shall be maintained at all times to adequately protect biota against exposure to excess temperature.

* These values are predicated on the limitations on the intake velocity specified in Section 4.II.A.(all circulators operating).

4. CIRCULATING WATER SYSTEM

Objective

To define the limiting conditions of operation of the circulating water system.

Specification

I. Applicability

Applies to the mode of operation of the circulating water system.

II. Limit

A. Intake Velocity

1. The withdrawal of cooling water from the Hudson River shall be maintained so that the average approach velocity shall not exceed one (1) foot per second.

2. When the daily average (24 hour average) ambient river water temperature is less than 40°F, the average intake velocity shall be reduced to approximately 60% of the maximum full flow condition. The adjustment in the velocity is to be made within one week of the change of the daily average (24 hour) ambient river water temperature to below 40°F.

B. Dissolved Oxygen

When the ambient river concentration of dissolved oxygen is below 5.5 ppm the maximum decrease in concentration of dissolved oxygen at the confluence of the discharge canal and the river, shall not be more than 0.5 ppm. When the ambient river concentration of dissolved oxygen is 5.5 ppm or above, the concentration of dissolved oxygen at the confluence of the discharge canal and river shall not be less than 5.0 ppm.

C. Discharge Velocity

The adjustable ports in the outfall structure shall be adjusted such that the discharge velocity, during initial operation, is in accordance with NYS requirements (except during testing of the structure and the circulating water system, and exploration of the effect of discharge velocity on the thermal plume temperature distribution). The adjustment in the ports is to be made within 24 hours of any change in the steady-state flow in the discharge canal.

D. Air Bubbler System

The air bubbler system shall be operated in front of the outer intake screens in accordance with New York State requirements, except when out of service for unscheduled maintenance. The specific mode of operation (i.e., continuous, bursts, sporadic, random, specific pressures, etc.,) shall be determined through testing to provide the most effective fish protection mode.

Basis of Specification

The withdrawal of cooling water from the Hudson River through the outer protective screens may cause damage to aquatic biota by impingement on these screens. Fish collections have been experienced at the Indian Point Unit No. 1 intake screens and at Unit No. 2 during testing of the circulating water pumps. Information indicates that by maintaining the approach velocity at one (1) foot per second (fps) or less, this problem should be significantly reduced.

By design, the velocity approaching the outer screens of the intake structure is less than 1 fps. When the daily average river ambient temperatures are less than 40°F, Unit No. 2 will be operated with the cooling water flow reduced to approximately 60% of full flow. Flow reduction will be accomplished with recirculation loops installed on the discharge side of the pump. These loops permit approximately 40% of the pump flow to be returned back to the intake bay. Thus, the approach velocity of the river water transversing the outer fixed screens will be reduced to approximately 0.5 fps.

Dissolved oxygen concentrations of the circulating water system will be measured to note any changes from continued operation of Unit No. 2. Any large reduction in dissolved oxygen may be harmful to certain aquatic life during periods when the dissolved oxygen levels are low as a result of occurrences not related to the operation at Indian Point.

A series of experimental studies conducted on Unit No. 1, along with analytical investigations on the combined operation of Units Nos. 1 and 2, have indicated that D.O. levels in the river will not be affected by continued full power operation of Unit No. 2 (References 4-1 and 4-2). Namely:

(a) Dissolved oxygen reduction in the Indian Point Unit Nos. 1 and 2 cooling water system (inplant losses) will be minor, about 0.4 ppm and 0.2 ppm under winter (ambient river temperature of 33°F and river D.O. about 11.3 ppm) and summer (ambient river temperature of 79°F and river D.O. about 6.5 ppm) conditions, respectively.

(b) If the Hudson River D.O. concentration is less than 6.5 ppm, the loss in the system will be less than 0.17 ppm, and the decrease of the river D.O. concentration would be about 0.02 ppm, or less than 0.3% of the Hudson River concentration.

(c) The above changes in Hudson River D.O. (due to the plant) are significantly less than the present diurnal variation (about 0.2 ppm) in the river.

The modified multiport discharge structure uses adjustable gates that can provide a discharge velocity of approximately 10 fps under varying flow rates. Such operation will be conducted to give assurance that, at full power levels, the applicable New York State Thermal criteria will be met. The discharge velocity is obtained through the use of equation 1-2, in Section 1. For a discharge velocity at the vena contracta of about 10 ft/sec, the difference in height across the discharge structure is about 1½ feet.

The relationship between power level, plant flow rate, discharge velocity, and characteristics of the thermal discharge (i.e., dilution of the discharge jet with the ambient river) can be investigated to determine the optimum relationship, and the final operating modes.

The air bubbler system will be tested in various modes of operation and in conjuction with other devices designed to keep fish away from the intake area. The final operational scheme of this system will depend on the results of these tests.

References

4-1 Redirect-Rebuttal Testimony of John P. Lawler, Ph.D., Quirk, Lawler and Matusky Engineers, "The Effect of Indian Point Units 1 and 2 Operation on Hudson River Dissolved Oxygen Concentrations." Docket No. 50-247, February 5, 1973.

4-2 Quirk, Lawler and Matusky Engineers, "Effect of Indian Point on Hudson River Dissolved Oxygen," February 1972 (Follows TR. 6256, Docket No. 50-247), Report Submitted to ASL Board for Licensing Hearing, Appendix B-2, May 30, 1972.

5. LIQUID EFFLUENT MONITORING SURVEY

Objective

To establish a sampling schedule which will assure that liquid effluent releases are kept within applicable limits.

Specification

I. Applicability

Applied to routine testing of the plant effluents and to an analytical evaluation of the data collected from the non-radiological environmental monitoring survey.

II. Limit

The survey for liquid effluents shall be conducted in accordance with Table 5-1.

Basis of Specification

The liquid effluent monitoring program is designed to demonstrate that the plant is being operated in accordance with Environmental Technical speciifcations with respect to chemical discharges, water quality, changes in dissolved oxygen and other parameters. Administrative controls will be such that all releases meet applicable regulations. The liquid effluent monitoring program also provides a means of ensuring that the administrative controls are effectively meeting these regulations.

In addition to the liquid effluent monitoring schedule detailed in Table 5-1, the applicant has embarked on an extensive chemical monitoring survey in the environs of Indian Point (see Section 8. ECOLOGICAL SURVEY), the objective of which is to determine the significance of the liquid effluents on the biota.

TABLE 5-1

LIQUID EFFLUENT MONITORING SURVEY

Parameter Analyzed for	Collection and Analyses Frequency
Phosphate (Orthoposphate)	WK
Hydrazine	MO
Cyclohexylamine	MO
ph	WK
Boron	WK
Chromium (Hexavalent)	MO
Residual Chlorine (free and combined)	D
Chlorine Demand	WK
Specific Conductance	WK
Turbidity	WK
Dissolved Oxygen	WK

Notes for Table 5-1:

1. WK (weekly), MO (monthly), D (during discharge)

2. Samples for the analyses of all parameters except chlorine demand and residual chlorine will be taken at the plant intake and at the confluence of the discharge canal with the Hudson River.

3. Chlorine demand will be taken at the plant intake. Samples for residual chlorine measurement will be taken at both the condenser outlet water box and at the confluence of the discharge canal with the Hudson River. The latter measurements are performed at approximately ten minute intervals while chlorination is taking place.

4. All samples shall be taken and analyzed in accordance with approved standard methods.

Approved standard methods are published by: (1) the American Society for Testing and Materials in the "Annual Book of ASTM Standards, Part 23, Water: Atmospheric Analysis", (2) Water Works Association and the Water Pollution Control Federation in the book "Standard Methods for the Examination for Water and Waste Water," and (3) "Methods for Chemical Analyses for Water and Wastes", Publication No. 16020, Environmental Protection Agency, 1971. In cases where : (a) the existing standards are not applicable; (b) conflicts exist between standards; (c) no standards exist; or (d) newer technology outdates existing standards, an evaluation will be made by Con Edison in light of the latest technology as to the applicable standard method to be used.

5. Lithium Hydroxide, Sodium Hydroxide, Sulfuric Acid and Soda Ash will be inferred by monitoring pH.

6. THERMAL MONITORING

Objective

To establish that thermal releases will conform with applicable limits.

Specification

I. Applicability

Applied to temperature measurements on the discharge canal and environs of Indian Point.

II. Limit

The river temperature in front of the intake structure and the temperature in the discharge canal before its confluence with the river shall be monitored continuously except for system downtime for calibration or repairs, when temperature readings will be obtained four (4) times a day. The flow rate through the plant will also be logged.

Basis of Specification

The rate at which the plant rejects heat to the river is determined by knowledge of the temperature rise across the plant and the volumetric flow rate of cooling water through the plant. It is this parameter (heat rejection rate) along with the discharge canal temperature at the confluence of the canal with the river, that determines the response of the river to the thermal discharge; that is, the maximum river surface temperature and the extent and intensity of the thermal plume (References 6-1, 6-2, 6-3 and 6-4).

Thermal monitoring at Indian Point is designed to demonstrate that the plant is operating in accordance with the

Environmental Technical Specifications. Administrative controls will be such that the thermal discharge will meet applicable criteria.

Con Edison has initiated a program that entails an extensive thermal monitoring survey in the neighborhood of Indian Point (see Section 7. THERMAL SURVEY). Consonant with the incremental increased power levels from Unit No. 2, thermal plume measurements will be made to supplement previous studies and provide information to verify the mathematical and physical-hydrothermal models (References 6-1, 6-2, 6-3, 6-4 and 6-5).

The aforementioned program will compare the model analyses with the measured response of the river to the heat load from Indian Point, and enable the applicant to predict the intensity and extent of the thermal plume and demonstrate compliance with applicable criteria through the above specification.

References

6-1 Quirk, Lawler and Matusky, Engineers, "Effect of Submerged Discharge of Indian Point Cooling Water On Hudson River Temperature Distribution," October 1969, Appendix M, Environmental Report, Indian Point Unit No. 2, Supplement.

6-2 Ibid, "Supplement Study of Effect of Submerged Discharge of Indian Point Cooling Water on Hudson River Temperature Distribution," May 1972, Submitted as Appendix B-2 to the ASL Board for the Licensing Hearing Docket No. 50-247.

6-3 Testimony of John P. Lawler, Quirk, Lawler and Matusky Engineers," The Effect of Indian Point Units 1 and 2 Cooling Water on Hudson River Temperature Distribution," April 5, 1972, Docket No. 50-247.

6-4 Ibid, "The Thermal Effects of Indian Point Cooling Water on the Hudson River," February 5, 1973, Docket No. 50-247.

6-5 Alden Research Laboratories, "Indian Point Cooling Water Studies: Model No. 2, May 1967," Appendix O, Environmental Report, Indian Point Unit No. 2, Supplement.

7. THERMAL SURVEY

Objective

To provide the following:

(i) establish the relationship between the thermal discharge to the river and the thermal response of the river,

(ii) demonstrate that the thermal discharge is in compliance with the New York State Thermal criteria, and

(iii) provide data for comparison with the results predicted by mathematical and physical models.

Specification

I. Applicability

Applies to measurements made on the river during the thermal survey.

Basis of Specification

The following field survey and analysis program for the thermal discharges from the Indian Point facility, commencing with full power operation of Unit No. 2, has been designed to achieve the objectives enumerated above.

The survey can be conveniently divided into the following areas:

A. Preliminary

An introductory analysis will be made, using both the mathematical and physical models (References 7-1,-2,-3,-4, and -5), to determine the location for possible surface and subsurface transects. These predicted thermal plumes will be compared to the existing plume obtained via infrared over-flights and/or surface measurements in order to determine and optimize the station locations for the transects. Possible interaction between the Indian Point and Lovett (and Bowline) plumes will be considered.

B. Near-Field Measurements

The near field is defined as the region within which effluent momentum is detectable as compared to dispersive processes and tidal momentum. For several discharge port configurations, thermal plume velocity (speed and direction) as well as temperature will be obtained. The results will be time dependent three-dimensional temperature and velocity profiles (over a tidal cycle).

C. Far-Field Measurements

The far-field program will include aerial temperature surveys along with tri-axial measurements through the detectable plume along with velocity measurements. The interaction between the near field and far field will be considered. The results will be time dependent three-dimensional temperature and velocity profiles (over tidal cycle).

D. Measurement of River Parameters

This aspect will determine the salient river and atmosphere parameters, such as salinity, net non-tidal flow, fresh water run-off, heat exchange (or heat transfer) coefficient, dispersion coefficient, and the local meteorology.

E. Analysis

The near field measurements will be compared to the results of the undistorted hydraulic model and the submerged discharge mathematical model. The far field measurements will be compared to the distorted physical model and the far field mathematical model. The results of both the far field and near field will be integrated to present the spatial and temporal temperature distribution in the river.

Additional temperature measurements on the river will be obtained from the Ecological Survey (Section 8. ECOLOGICAL SURVEY). While these measurements, consisting also of transects and overflights, are geared primarily for evaluating the effect of the thermal discharges on the biota, they can be used to supplement the thermal survey data.

References

7-1 Quirk, Lawler and Matusky Engineers, "Effect of Submerged Discharge of Indian Point Cooling Water on Hudson River Temperature Distribution," October 1969, Appendix M, Environmental Report, Indian Point Unit No. 2, Supplement.

7-2 Ibid, "Supplemental Study of Effect of Submerged Discharge of Indian Point Cooling Water on Hudson River Temperature Distribution," May 1972, submitted as Appendix B-2 to the ASL Board for the Licensing Hearing Docket No. 50-247.

7-3 Testimony of John P. Lawler, Quirk, Lawler and Matusky Engineers, "The Effect of Indian Point Units 1 and 2 Cooling Water on the Hudson River Temperature Distribution," April 5, 1972, Docket No. 50-247.

7-4 Ibid, "The Thermal Effects of Indian Point Cooling Water on the Hudson River," February 5, 1973, Docket No. 50-247.

7-5 Alden Research Laboratories, "Indian Point Cooling Water Studies: Model No. 2, May 1967,"Appendix O, Environmental Report, Indian Point Unit No. 2, Supplement.

8A. ECOLOGICAL SURVEY

Objective

The objective of these studies is to evaluate the effects of the operation of Indian Point 1 and 2 once through cooling systems on the ecosystem of the river and to devise means and methods for minimizing adverse effects. This is for the purpose of determining the need for modification of the once-through cooling system within the guidelines of the National Environmental Policy Act.

The Indian Point Ecological Study has three major objectives which are as follows (References 8-1 and 8-2):

1) Determine the biological significance on the Hudson River ecosystem of impingement of screenable fishes at the intake of Indian Point Units 1 and 2.

2) Determine the biological significance on the Hudson River ecosystem of aquatic organisms passing through or being attracted to the thermal plume and/or into the effluent canal or intake.

3) Determine the biological significance on the Hudson River ecosystem of thermal and chemical additions from Indian Point Units 1 and 2, and the acute and chronic effects of temperature on life stages and migrating habits of key fish species, on the behavior of these organisms, the upper and lower temperature tolerance of these organisms, and relate these data to plant operations.

I. Population Dynamics

Summary

Using data from studies completed between 1965-70 and from the Indian Point Ecological Study now underway and planned for completion in 1976, the following fish population parameters will be monitored for striped bass and white perch:

1. Population Density
2. Survival
3. Age Composition
4. Growth Rate
5. Age at Sexual Maturation
6. Sex Ratio
7. Identification of Sub-Populations

These parameters change in predictable ways as a result of serious exploitation; population density and survival rates decrease; reduced recruitment causes a predictable decline in the relative abundance of certain age groups in subsequent years reflected in age frequency distribution data; growth rate increases; sexual maturity may be attained at young ages; and aberrations in sex ratio may appear. A data base exists from which each of these parameters can be contrasted before and after activation of Indian Point Unit #2.

Discussion

POPULATION DENSITY

Five different measures of fish population density are available:

Catch/Effort Trawl data - relative abundance

Catch/Effort Seine data - relative abundance

Mark-Recapture population estimates - absolute abundance

Egg Deposition estimates - absolute abundance

Pelagic larvae estimates - absolute abundance

In addition, work is underway to develop echo-sounding techniques which would allow much broader collection of catch/effort data. It will be possible, if this technique is successful, to follow changes in abundance and seasonal movements to different locations in the estuary more closely than is possible through trawling techniques alone.

CATCH/EFFORT

The number of fish caught in a standardized amount of fishing effort using standardized collecting gears is an index of relative abundance of the fish population. Such indices are one of the longest established and most widely used types of data in the study and management of fish populations. Catch per unit of fishing effort - or catch/effort, the term used here - has been used to monitor changes in abundance from year to year and place to place in such widely differing situations as the great high seas fisheries of the world and local, hook and line, sport fisheries.

Catch/effort data have been collected for striped bass, white perch and other species in the vicinity of Indian Point by the use of trawls and beach seines. In the Indian Point Ecological Study now underway stations have been established from Ossining to Denning Point. These sampling stations, are distributed among three study regions, as shown in Figure 8A-1, the most important being Region I, extending from Haverstraw Bay to the Bear Mountain Bridge, with a concentration of stations near the Indian Point power plant. The sampling effort is distributed as follows:

	Region I	Region II	Region III	Ossining
Boundaries	Haverstraw Bay to Bear Mt. Bridge	Bear Mt. Bridge to Storm King Mountain	Storm King Mountain to Beacon New-burgh Bridge	See Fig. 1
Number Trawl Station	10	3	3	5
Number Seine Stations	8	4	3	3

This sampling effort continues in intensified form the fish population monitoring begun in the Raytheon Study in June 1969. Because of the continuity in sampling, site, and methods from the Raytheon Study to the present Indian Point Ecological Study, it will possible to contrast data from 1969, 1970, and 1972 - years free of Unit No. 2 effects - with data from 1973, 1974, and 1975, when Unit No. 2 is operative. At present it appears that Unit No. 2 may not go on line early enough in 1973 to affect fish populations significantly by entrainment, so the 1973 data may reflect either "pre-operational" or "operational" status of Unit No. 2, depending upon date of activation of the Unit and the nature of the fish population contrast being made.

In addition to the main body of data, two additional sources of information which provide some comparison of past conditions within the fish populations of the Hudson River exist. First, trawling stations have been established in the current Indian Point Ecological Study which correspond to some of the stations sampled in the Cornwall study in 1965 - 1968. Secondly, ancillary information is available from fishery studies on the lower Hudson by biologists from QLM, Vassar College, Dutchess Community College, Boyce-Thompson Institute, and New York Department of Environmental Conservation. While relevant to the assessment of fish stocks in the Hudson, the second group of studies does not integrate directly with the design of the Indian Point Ecological Study.

Mark-Recapture Population Estimate

Unlike the catch/effort data which are indices of relative abundance, the mark-recapture methods provide estimates of absolute numbers in the population, and subsequently withdrawing a sample to determine the proportion of the population marked, dates back to the latter years of the 19th Century in fishery work (Reference 8A-4). It has been applied to fish populations in almost every conceivable situation - small streams, large rivers, ponds, lakes, high seas. The same method is used to estimate the North American continental duck population, and has been applied to insect and mammal populations. The basic method has been elaborated and adapted to a variety of complex situations, including the occurrence of mortality, emmigration, and recruitment within the population being estimated (References 8A-5, -6, -7, -8, -9, -10). The same principles underlie the technique in the many forms used today. For example, assume that 1000 Age Group 0 striped bass are marked and released alive in the Hudson estuary in the vicinity of Indian Point. In subsequent trawling operations, 2000 striped bass of the same age are collected, of which 32 are recaptures of the previously marked fish. We then reason:

(1) 1000 marked fish are at large in the population

(2) Our subsequent sample indicates that 32/2000 = 1.6% of the total population are marked fish

(3) Therefore, the total population in the locality under study must consist of 2000/0.016 = 125,000 fish.

The basic assumptions underlying the valid application of this method are given by Ricker (Reference 8A-5). These have been examined during the fish collecting, marking and field trial work of 1972 at Indian Point in preparation for full scale mark-recapture estimates of the white perch and striped bass populations in 1973 and suceeding years. The only basic assumption which has been problematic is that marked fish be distributed at random in the population. However, by reintroducing marked fish to the population in proportion to the abundance of the population in different habits (as determined from trawling data and possibly from echo-sounding) and by distributing recapture fishing effort proportionally across all segments of the population, this requirement for the valid use of the mark-recapture method can be fulfilled.

The developmental work of 1972 has already proven that large numbers of young white perch and striped bass can be successfully marked and released in healthy condition in the Hudson estuary to provide a basis for estimates of population size. Tentative plans are to proceed with this method full-scale in 1973.

Separate population estimates will be made for different age groups and size groups of fish, and for zones extending various distances from the Indian Point power plant.

Through use of differential marking in different zones of the estuary, the origin of fish collected on intake screens at Indian Point can be determined. At present it is not known whether a very local area or an extensive area of the estuary is affected. Until reliable estimates of the absolute abundance of fish during the first twelve months of life are avilable, no accurate basis for assessing the importance of impingement losses is available. The absolute numbers of fish collected from intake screens of the Indian Point plant have been determined with suitable accuracy. What proportion of the stock from the estuary this loss represents can be directly determined from the population estimate data collected in the ongoing ecological study.

Collection of data from three successive years (1973,1974,1975) is important for two reasons:

(a) The first year will represent the influence of Unit #1 plus no influence or minimal influence of Unit #2 (depending upon the date of its activation); the second and third years will reflect full influence of Units #1 and #2.

(b) Survival rates can be calculated for those year classes of fish included in two or more successive years' population estimates. Not only abundance of fish, but also their survival rates (an important component of population turnover rate) are important in assessing an increment of mortality, such as expected from operation of the Indian Point power plant. In addition to their direct use in assessing ecological impacts, these survival rate estimates will be most useful in "tuning" the parameters of the population dynamics model developed by QLM.

Because of greater abundance and vulnerability to collecting gear, the most precise population estimates will be obtained for the younger age groups of fish. It is planned to estimate the number of Age Group 0 and of Age Group I striped bass and white perch present in areas of the Hudson River adjacent to Indian Point. The best estimates will be for Age Group 0 in the fall. It is anticipated that the study will be able to discriminate a 25 percent change in abundance of these fish at the 5 percent probability level.

Estimates of absolute abundance of the fish stocks of the Hudson estuary are considered to be of great importance in assessing the ecological impact of the Indian Point power plant. Accordingly, during the initial planning of the Ecological Study an alternative to the mark-recapture method - the catch-removal method of estimating absolute population size - was defined for use in the event that mark-recapture procedures were unworkable. It consists of intenstively fish representative habitat types in the Hudson estuary with experimental gear and commercial gear under contract and removing all fish caught during a short interval of intensive fishing effort. The decline in catch-per-unit effort is plotted against cumulative catch and regression line fit to the data is extrapolated to 0 catch-per-unit effort, at which point the corresponding values for cumulative catch is an estimate of total population size in the area fished. The estimates for a selected set of "typical" Hudson estuary sampling plots would then be expanded to an estimate of fish population size for the entire estuary, or major regions thereof.

Developmental work on population estimation techniques indicates that the mark-recapture method will yield useable data, and the use of the catch-removal alternative is not now envisioned.

Combined Use of Catch/Effort Data and Mark-Recapture Population Estimates

During 1973, 1974, and 1975, catch/effort data will be collected in the same time periods and localities in which the mark-recapture population estimates are made. A relationship between these two types of population data can be developed where the two are collected in parallel, and this relationship can be applied to the catch/effort data of earlier years (1969, 1970, 1972) to calculate approximate values for absolute abundance of fish.

Egg Deposition and Pelagic Larvae Estimates

Additional estimates of the size of white perch and striped bass populations, completely independent of the mark-recapture work described above, will be made by estimating total egg deposition and abundance of the pelagic larvae for each species, and reconstructing (with the use of age structure, sex ratio, sexual maturation, and fecundity data) the adult population size required for the spawning observed. While the promise of success of mark-recapture population estimates rising from work to date makes these estimates based upon egg deposition less critical, they nevertheless will constitute a valuable independent check on the mark-recapture work, and increase overall confidence in the assessment, of fish population size. Evaluation of present development of methods indicates that in 1973 a good estimate of the white perch population can be obtained through the egg deposition method. A preliminary estimate will be obtained for striped bass in 1973, and refined estimates of the size of the striped bass population would be expected in 1974, and 1975.

The estimate of striped bass eggs, and both striped bass and white perch larvae will be made using improved collecting gear and appropriate stratification of samples in time and space to provide population estimates applicable to the Indian Point region in particular, and the entire main spawing area of striped bass in the Hudson estuary.

Egg densities of striped bass and white perch will be corrected to daily deposition rates/m^2 (Reference 8A-11) and summed over the season for stations spanning river miles 40 to 59. The areal deposition rates (eggs/m^2/day) will be compared for a first approximation of the importance of the various area for spawning of both species. The striped bass densities will be derived from plankton data due to the pelagic nature of their eggs, while benthic grabs will be used to obtain the demersal white perch eggs. The white perch egg data will then be applied to population parameters (sex ratio, age structure, and mean eggs per female) to derive an estimate of the total population in this area by an application of "backwards" population dynamics. Because mature females go into the breeding season with their full compliment of eggs and no rejuvenation of ovaries or eggs occurs during the breeding season, the observed decrease in mean female eggs per female from time t_o to t_1 in the population is a direct estimate of m_x (the mean number of female eggs produced by a female in a unit of time. A unity sex ratio is assumed, and the m_x value is multiplied by two and divided by the number of days between sampling for an estimate of the daily egg production rate (eggs/female/day). Parts of the two ratios cancel to yield females/m^2/day and eggs/female/day).

In addition to their use in estimating total fish population size, estimates of eggs and pelagic larvae are of prime importance in calculation of survival rates.

Some important relationships among the different population data being collected for the Hudson Estuary fishes, are:

(1) catch/effort data extend over the longest span of years; include the largest number of age groups of striped bass and white perch; and include comparative indices of relative

abundance for other fish species. For maximum value catch/effort data must be corrected for size and species selectivity by utilizing data collected during mark-recapture studies.

(2) catch/effort data for all years can be used to calculate approximate values for absolute size of fish populations by the use of conversion factors developed from those years in which catch/effort data were collected concurrently with mark-recapture population estimates.

(3) mark/recapture data provide direct estimates of absolute abundance of fish. These estimates will be available from the three study regions and from 1973, 1974, 1975. The recapture on the water intake screens of the Indian Point power plant of fish differentially markedin zones of increasing distance from the plant will provide direct estimates of the fraction of the fish population in each zone which is impinged.

(4) estimates of the numbers of eggs spawned in the Hudson by the striped bass and white perch populations will provide a basis for calculation of the size of the parental stocks, and associated age groups of immatures. This reconstruction of population size will be used to verify the mark-recapture estimates.

(5) measurements of important environmental variables concurrently with fish population estimates will be used to account for the naturally occuring fluctuations in fish population size which tend to obscure the true effects of power plant operation.

II. ENTRAINMENT STUDIES

Summary

The biological significance of aquatic organisms being drawn or attracted into the intake canal is being quantitatively determined by measuring the longitudinal and vertical distribution of planktonic organisms on a diel basis, applying these densities to the actual water mass subject to entrainment on a diel basis, comparing these theoretical entrainment values to observed densities of entrained organisms, and finally establishing the immediate and delayed effects of entrainment (passage) of non-screenable organisms through the condensor system of the plant.

Program

Quantitative sampling is being done in the river, intake bays and discharge canal during all seasons of the year. Survivorship and behavior of zooplankton and fish larvae are immediately compared to see if any statistically significant differences are observed between the control group (intake bays) and the treated group (discharge canal) which passed through the condenser tubes. In addition, a series of experimental laboratory studies are keyed to combinations of ΔT, chemical discharges, and residence times through the system produced by various plant operational schemes. Effects measured are lethal, behavioral, and reproductive for zooplankton; lethal and behavioral for fish larvae; and photosynthetic capability, chlorophyl concentration, and cell damage for phytoplankton. Studies include sequential trials, trials of different size groups of key species, and multi-species trials. When possible, all life history stages of each organism are studied.

III. MORTALITY AND SURVIVAL RATES

Collections of white perch and striped bass obtained from the standard trawl and seine stations are separated into four size groups (50, 50-125, 125, 250 mm) and 15 individuals of each size (if available) are randomly picked for age determination by scale analysis. Both species show clear annuli and can be aged quickly and reliably so that relative age structure can be determined.

Both data on relative abundance of successive age groups, as obtained from cath/effort study, and data on absolute abundance, as obtained from mark-recapture, egg deposition, and fish larvae estimates can be used as a basis for calculating mortality rate, and its complement, survival rate.

Taking the data from the entrainment studies together with the survival data based on population estimates, the following sequence of calculations will be carried out:

(1) the <u>number of eggs spawned</u> in the estuary;

(2) the size of the <u>larval population</u>;

(3) from the entrainment study, the <u>density of eggs and larvae in the immediate vicinity of the power plant water intake</u>;

(4) from (1), (2), and (3) the <u>fraction of the population of eggs and larvae subjected to the influence of the water intake</u>;

(5) from the entrainment study, the number of fish entrained and the number passing alive through the cooling system - hence the <u>survival rate for entrained fish</u>; these data will be integrated with those from laboratory studies of the impact of the physical-chemical conditions of entrainment upon young fish;

(6) from (1), (2), and (5) the <u>fraction of the population killed during early life history stages by entrainment</u>;

(7) from (1), (2), and estimates of juveniles (J_{II}, J_{III}), and Age Group I fish obtained from mark-

recapture and catch/effort studies, the total mortality rates for each successive stage of the early life history; development of a survivorship curve will allow some useful interpolations, as for the J_I stage;

(8) from (6), and (7) by the use of standard actuarial calculations for survival under exposure to competing risks of death, the survival rate for each early life history stage in the absence of the operation of the power plant (note that Unit #1 and Unit #2 effects can be treated separately here and both can be differentiated from background natural mortality);

(9) from (7), and (8) the decrease in survival during the early life history due to operation of Indian Point Units #1 and #2.

The calculations of the fraction of the year class affected by entrainment are not sensitive to the natural fluctuations in year-class strength which complicate interpretation of population density changes. Entrainment affects a certain proportion of the fish population and is primarily a function of the fraction of the estuarine water withdrawn by the power plant cooling system. Appropriate allowance for non-random distribution of the fish and avoidance capability of the juveniles must be made, but again these phenomena are not believed to change because of year-class size.

The magnitude of natural mortality varies from year to year in the early life history stages, but is always quite high. The variations do influence the combined natural and power plant induced mortality, but the relationship can be predicted as in step (8) above for any observed or postulated natural mortality rate.

The spatial distribution of spawning and surviving young fish may vary, especially as a function of volume of freshwater discharge in the Hudson, and correlated physical and biological conditions. Such phenomena are casually related to variations in year-class size.

The spatial distribution of early stages of striped bass and white perch would influence the fraction of each year-class exposed to entrainment. By utilizing the population data discussed above in the model of the Hudson estuary striped bass population developed by Dr. John Lawler of QLM, Reference 8A-3, the effects of any observed or postulated change in spatial distribution of spawning fish and early life stages of the progeny on the entrainment phenomenon can be readily predicted.

The simulation model is simply a device for assessing the outcome of joint operation of the many population phenomena described individually through the field studies. This comprehensive assessment of an integrated biological system to impact is complementary to assessments of the individual population phenomena empirically studied in the field.

Criteria for Assessing Impacts on Fish Populations

Based upon the population data detailed in this section, the following criteria for assessing the impact of Indian Point Units #1 and#2 upon populations of striped bass and white perch are established. Each criterion is stated in terms of the symptoms of adverse impact.

(1) Decline in density of Juvenile II, Juvenile III, and Age Group I fish coincident with startup of Unit #2 and not accounted for by changes in egg production by parental stock or by natural environmental fluctuations.

(2) Large fraction of the population of eggs, larvae, or Juvenile I fish entrained and high mortality rate of entrained organisms.

(3) Substantial reduction in survival rate from egg stage to Juvenile II, etc. accounted for by entrainment.

(4) Substantial percentage of stock from significant area of estuary impinged on intake screens.

(5) Lack of compensatory increase in survival rate among Juvenile II and Juvenile III fish following fulfillment of criterion (4).

(6) Lack of compensatory increase in survival rate among Juvenile III to Age Group I fish following fulfillment of criterion (5).

(7) Increase in growth rate of fish. Note that increased growth rate is both a classical indicator of a substantial decrease in stock density (hence an indicator of adverse impact) and a compensatory response to reduction in density (hence an indicator of some capability of the fish stock to sustain itself in the face of increased mortality).

(8) Attainment of sexual maturity at an earlier average age. The note in (7) above identifying the criterion as an indicator of both adverse impact and compensatory capability of the population applies here as well.

(9) Continuing decline in population size or stabilization at an undesirably low level following a period of decline, as predicted by a simulation model of the fish population which integrated the empirical data from the ecological studies.

IV. BIOLOGICAL CHARACTERISTICS OF FISH POPULATIONS

Racial Composition

Food Habits

Age Composition

Growth Rate

Reproductive Rate

Identification of sub-populations and study of ecological relationships of major fish species will be completed in 1973. These two studies will provide additional information on the resident or migrating nature of the subpopulations (vital to estimates of population size) and their respective food habits. The report on this phase of work is to be completed by May 1, 1974.

The study of biological characteristics and health of fish populations reached full scale in April 1973 and will continue until January 1, 1976. This is a continuation of efforts begun in 1972, which will provide information as to the age and growth of fishes in the area, sexual maturation, sex rate, fecundity and any possible effects by the once through cooling employed at Indian Point. Data of very high precision are being obtained in this part of the study. Many of the important uses of these data in reconstructing the dynamics of the fish populations have been described in the preceding sections.

Changes in age composition, growth rate, age at first sexual maturation, and fecundity are classical indicators of important changes in the mortality experience of fish stocks. The first two of these tend to have a historical character, often being detectable in the fish population for some time after their first occurrence. Additional comparative data on age composition and growth rates predating 1969 is available from New York University studies and from the New York Conservation Survey of 1936. All of these population parameters, when closely monitored, are useful in predicting population decline in advance of critical depletion. The first report of this phase of the work will be completed by May 1, 1975. The data are being collected and analyzed in such a way as to provide continuous monitoring of the fish populations with minimal lag time between field collection and examination against previous population trends.

V. IMPACT OF THERMAL AND CHEMICAL EFFLUENTS ON ESTUARY

Summary

Measurements of the physical-chemical correlates of biological parameters are being made starting with April 1972 and continuing until January 1, 1976. It is essential that this information be gathered as supporting data relating to the condition, behavior and distribution of fish life. This information will be analyzed and factored into the final report issued from the study.

Program

Thermal studies, attraction of fish to the discharge canal, infra-red mapping of thermal plume, acute and chronic effects of temperature on survival and behavior of fish and benthic invertebrates will be investigated during the period from April 1, 1972 to October 1, 1975. These studies are important to the success of the overall program but are not considered as critical in time as the population estimation part of the program. Studies of thermal preferences and the impact of thermal shocks on fish and invertebrates can be carried out simultaneously in the facilities available, and are planned for completion in 1973. They require a full year of effort due to seasonal changes in reactions of the organisms. The temperature avoidance study, which also required one year to complete, will be carried out in calendar year 1974. Assay of chronic temperature effects through study of biological energetics will require two full years for completion. This work will extend through 1974 and 1975.

The biological significance of thermal and chemical discharges from the plants will be determined by establishing the rate, quantity, and distribution of these discharges, and relating these to the densities and distributions of zooplankton, phytoplankton, fishes, and benthos in the study area on a seasonal basis. The population dynamics, turnover rates, productivity, and species diversity of plankton organisms are being determined and will be used to evaluate the significance of any observed effects on the ecosystem. Energy budgets will also be used to evaluate the effect of predicted thermal discharges on secondary production rates of selected fish and benthos. These rates will be determined through laboratory experiments. Additional laboratory experiments will be performed to determine the acute and chronic effects of temperature on the life stages of key aquatic species, the effect of temperature on the behavior of these organisms, the upper and lower temperature tolerances of these organisms, and the relationship of these data to plant operations.

Computer simulation, hydraulic modeling, aerial infrared measurements at all tidal stages (correlated with control measurements in the river), and a 25 station thermal grid are being used to derive the intensity and extent of thermal discharges (Units 1 & 2). Thermal infrared imagery will be collected during four overflights to coincide as close as possible to the major phases of the tidal cycle (e.g. high and low slack, maximum ebb and flood). These overflights will be replicated with Unit 1 operating alone, Units 1 and 2 together, and Units 1, 2 and 3 as a battery. The thermal imagery will be used to compile isothermal maps with $1^{\circ}C$ contour intervals from Stony Point to Annsville Creek and indlusive. The

25 station thermal grid is placed in the river once a month to permit the construction of axial and cross-section isothermal plots of the thermal plume. The grid system will be located in the vicinity of the Indian Point station. The exact location will depend on biological needs and findings.

Plant production records provide data on the frequency of chlorination, concentrations and durations by season as related to organic build-up in various water passages, and efficiency losses in order to establish the minimum amounts of chlorination that are absolutely necessary. Physical and chemical parameters are being measured in the intake bays and effluent canal and also at three transects (Figure 8A-1): one from Verplanck southwest to Stony Point, one from Jones Point to Peekskill, and the third, a Y-shaped transect, at Indian Point. Each transect includes a main channel (deep) and a bay area (shallow) which allows for evaluations in different habitats. The northern transect serves as the control and the southern will show the effects of passing through the plant's influence. The middle transect is designed to sample close to the nuclear facility itself. The physical-chemical measurements (along with previous data) will define those physical and chemical properties of the estuary which have important influences on the biota. (Table 8A-1)

The end result of this measurement program will be an atlas, which presents a multidimensional picture of the pertinent variables in the Indian Point area of the lower Hudson River. This reference will serve as a data base, in a readily usable format, which will allow investigators to quickly recognize the onset of unusual conditions of water quality. Current velocity (as a function of season and wind conditions) is being measured with depth for six tidal cycles spanning one lunar month. Dissolved ion ratios are being measured to ascertain the location of the migratory "salt wedge" which is a critical factor in several species' distributions. These data, along with temperature and specific conductivity, are used to define "salinity." Dissolved oxygen is measured to assist in the identification of water inputs that degrade water quality and will be included in the atlas via a grid system as will pH. Turbidity is also included because of its relationship to photosynthesis. Inorganic and organic carbon are monitored as indicators of organic pollution and because of their relationship to secondary production of filter feeders and dissolved oxygen levels. Chlorine demand, residual chlorine concentrations, and organo-chlorines are also measured as a direct chemical perturbation.

Fish density and distribution data come from the standard stations, catch per unit effort program (beach seines, bottom and surface trawls) and are supplemented by the sonar echo integration studies. If the latter technique proves reliable, a very thorough small scale dispersion analysis will be made. The benthos densities are being enumerated via replicated Peterson bottom grabs while macro and microplankton densities are derived from appropriate sized plankton nets.

Laboratory experiments will be performed to establish the influence of ambient and elevated water temperatures on the physiology of key fish species. The temperature at which these species suffer equilibrium loss and death will be defined (i.e. thermal tolerance studies). The effects of short term exposure to "shock" temperatures (above or below ambient) will also be determined. A bioenergetic budget (Reference 8A-12) will be determined to define the chronic effects of temperature on key fish species. Measurement of internal energy transfers and utilization at specific temperatures will be used (food consumption, assimilation, active respiration, and growth).

Key benthic invertebrates will also be subjected to temperature tolerance and shock experiments and will be used to determine the long term effect of temperatures experienced in the effluent canal and discharge area on life table processes and growth rates. In addition these species will be used for <u>in situ</u> cage experiments comparing long term survivorship in the intake and effluent canals.

Laboratory findings from temperature preference and avoidance experiments of white perch and striped bass will be compared with field results (fish and temperature distributions). Pertinent temperatures for these experiments have been chosen from actual or predicted temperatures for the Indian Point area of the Hudson River (ambient and changed by plant operations).

The significance of attraction into the effluent canal and plume area is primarily directed at fish species. Fish traps, beach seines and electro-shocking are used to provide data on species composition, abundance, size, age, fecundity, and general condition in these areas. These are supplemented by the sonar studies. Temperature profiles are determined to verify the extent and location of the thermal plume itself. Similar data from Objective 1 (catch per unit effort) are used for comparative purposes. The results of the laboratory experiments on temperature preference and avoidance will be compared to aggregations of fish found in the effluent canal and plume area. A fish tagging program in the discharge canal and plume area will be used to determine residency periods and local dispersal. Tagging procedures will follow those found most efficient in the population dynamics studies.

Survival experiments will test the immediate effects of chlorine dosages routinely added by plant operations to fish residing in the vicinity of the effluent canal.

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TABLE 8A-1

ECOLOGICAL SURVEY

WATER QUALITY MEASUREMENTS

Parameter	Frequency
Temperature	Weekly
pH	Weekly
Conductivity (salinity)	Weekly
Turbidity	Weekly
Alkalinity	Monthly
Bicarbonate	Monthly
Ammonia	Monthly
Orthophosphate	Monthly
Nitrates	Monthly
Carbon (inorganic and organic)	Monthly
Chlorine demand	Weekly
Free Chlorine	Weekly
Residual Chrlorine	Weekly

Table 8A-1. Population Data for Assessment of Impact of Indian Point Unit #2 Upon Population Density of Striped Bass and White Perch in Hudson Estuary

Year	Power Plant Impact: Unit #1	Power Plant Impact: Unit #2	Data on Fish Populations, Age Group 0: Eggs	Age Group 0: Larvae	Age Group 0: Juvenile I	Age Group 0: Juvenile II	Age Group 0: Juvenile III	Age Group I	Age Group II III IV
1969	Entrainment Impingement	None	—	—	—	△1 ○1	△1 ○1	△1 ○1	△1 ○1
1970	Entrainment Impingement	None	—	—	—	△1 ○1	△1 ○1	△1 ○1	△1 ○1
1971	Entrainment Impingement	None	—	—	—	—	—	—	—
1972	Entrainment Impingement	None	—	—	—	△1 ○1	△1 ○1	△1 ○1	△1 ○1
1973	Entrainment Impingement	Impingement	◇1	◇1	—	△1 ○1 □1	△1 ○1	△1 ○1 □1	△1 ○1
1974	Entrainment Impingement	Entrainment Impingement	◇2	◇2	—	△2 ○2 □2	△2 ○2	△2 ○2 □2	△2 ○2
1975	Entrainment Impingement	Entrainment Impingement	◇2	◇2	—	△2 ○2 □2	△2 ○2	△2 ○2 □2	△2 ○2

Legend for Table 8A-1

△1̸ Raytheon — Trawl Catch/Effort — Unit 1 effect only

△1̸ Texas Instruments — Trawl Catch/Effort — Unit 1 effect only*

△2 Texas Instruments — Trawl Catch/Effort — Unit 1 + Unit 2 effect

○1̸ Raytheon — Seine Catch/Effort — Unit 1 effect only

○1 Texas Instruments — Seine Catch/Effort — Unit 1 effect only*

○2 Texas Instruments — Seine Catch/Effort — Unit 1 + Unit 2 effect

□1 Texas Instruments — Mark Recapture population estimate — Unit 1 effect only

□2 Texas Instruments — Mark Recapture population estimate — Unit 1 + Unit 2 effects

◇1 Texas Instruments — Population estimate eggs and larvae — Unit 1 effect only

◇2 Texas Instruments — Population estimate eggs and larvae — Unit 1 + 2 effects

* Impingement effects of Unit #2 if operational during last half of 1973.

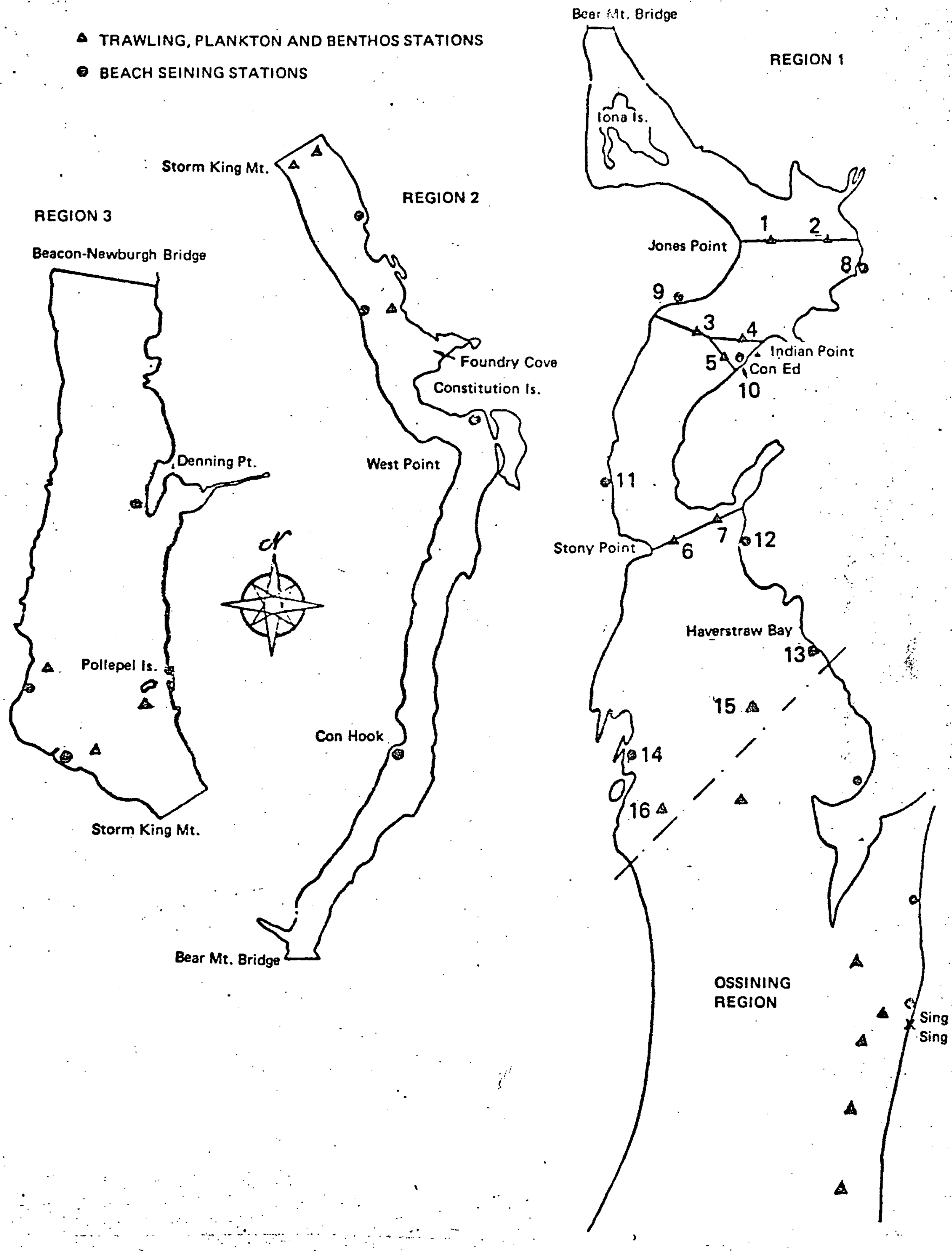

Figure 8A-1. Indian Point Ecological Study Regions

8B. ECOLOGICAL MONITORING

I. Objectives

If the Atomic Energy Commission has determined that a closed-cycle cooling system must be constructed for Indian Point Unit No. 2, then the ecological survey described in this section shall be conducted until commencement of operation of the closed-cycle cooling system to determine if operation of the plant extending completion of the closed-cycle cooling system is causing irreversible harm to the environment.

II. Program

1. Monitor fish collections at the Indian Point Unit No. 2 intakes. Impingement figures will represent a composite of collections during the regular washings of the travelling screens on that counting day. The number of collections will be limited to the minimum required for statistical validity in order to permit rapid return to the river of most of the impinged fish. The total number, species distribution, lengths and weights will be calculated from a statistical subsample of the total collection.

2. Monitor entrainment of striped bass eggs and larvae by Indian Point Unit No. 2 by sampling at one intake forebay station and one discharge canal station on a once weekly basis for the duration of the spawning season (approximately May 1-June 30). Collections will be made every two hours, at each station for a total sampling cycle of 24 hours. Abundances at the intake forebay and discharge canal (in #/1000 cu. m) diel variations, survival rates and size distribution of entrained larvae will be obtained.

3. Physical and chemical parameters such as ambient temperature, temperature difference between intake and discharge, dissolved oxygen, pH and salinity, will be measured at the time each entrainment sample is taken. A grab sample to measure the above parameters will be taken during periods of impingement monitoring.

4. Monitor fish population densities in Haverstraw Bay by obtaining catch effort trawl data during the month of September at trawling station used during the 1969-1970 survey and the present ecological survey. Physical and chemical parameters will also be collected at the time of sampling.

9. FISH COLLECTION

Objective

To establish a schedule for immediate reporting of data on fish collected at the site's intake screens in order to enable determinations to be made in accordance with the objectives of 10CFR50, Appendix D, of the need and the means for corrective actions to reduce the numbers of fish collected.

Specification

I. Applicability

Applies to the reporting and evaluation of data on collection of fish at the site's intake screens.

II. Limit

A. A monthly report shall be forwarded to the Director of Regulatory Operations, Region 1, containing the data on the number, size, and species of fish collected at the intake screens (except for collections made during testing of the structure). The number of counts during any month will be the number required for proper statistical analysis of fish collection. This report may be the same monthly report submitted to the New York State Department of Environmental Conservation.

B. No less often than once every 90 days, the environmental significance of these and other plant operating data will be jointly evaluated by Con Edison and the AEC Regulatory Staff.

Basis of Specification

The collection of additional data will permit a more definite assessment of (a) the environmental significance of collections of fish at the intake screens, and (b) what a significant collection consists of.

The number of counts made will be limited to those required for a valid statistical analysis to permit the rapid return to the river of most of the impinged fish.

These studies described in Section 8 (ECOLOGICAL SURVEY) are intended to provide such data. Pending development of this information, Specification 9A provides a mechanism for the AEC's Regulatory Staff to be kept currently advised of the number of fish being collected at the intake screens so that determinations can be made whether measures to reduce these numbers should be instituted.

The baseline provided by Specification 9A will aid in the development of interim operational procedures and corrective actions to be taken in order to minimize the Station's impact on the fisheries resource.

10. ADMINISTRATIVE CONTROLS

Objective

To describe the administrative controls that relate to management procedures, record keeping and reporting that are considered necessary to provide the assurance and evidence that the plant will be managed as prescribed by the Environmental Technical Specifications.

Specifications

I. Action to be taken in the Event of an Abnormal Environmental Occurrence:

A. Any abnormal environmental occurrence shall be promptly investigated by the Station Manager.

B. The Station Manager shall promptly notify the Manager of the Nuclear Power Generation Department of any abnormal environmental occurrence.

C. The Station Manager shall prepare and submit promptly a report in writing to the Manager of the Nuclear Power Generation Department following the observation of an abnormal environmental occurrence. Such report shall describe the circumstances leading up to, and resulting from the occurrence, and shall recommend appropriate action to prevent or reduce the probability of a repitition of occurrence.

D. The Vice President of Power Supply shall report the circumstances of any abnormal environmental occurrence to the AEC as specified in Section 10. B. "Plant Reporting Requirements."

II. In addition to reports required by applicable regulations, the following information shall be provided to the Atomic Energy Commission:

A. Events requiring notification within 24 hours (by telephone or telegraph) to the Director of Regulatory Operations, Region 1, followed by a written report within 10 days to the Director, Directorate of Licensing USAEC, Washington, D.C. 20545; with a copy to the Director of Regulatory Operations, Region 1:

1. Abnormal Environmental Occurrence as Specified in Section 1.

The written report, and to the extent possible the preliminary telephone or telegraph report, shall describe, analyze and evaluate the environmental effect and outline the corrective actions and measures taken or planned to prevent recurrence of A. above.

B. A Semi-Annual Station Operations Report shall be prepared and submitted to the Director, Directorate of Licensing, USAEC, Washington, D.C. 20545 within 60 days after the end of each reporting period in accordance with the additional requirements of Appendix B to said license. The report shall provide the following information (summarized on a monthly basis) and shall cover the six-month period or fraction, thereof ending June 30 and December 31. The due date for the first report shall be calculated from the date of initial critically.

I. Non-Radioactive Effluent Releases.

Information relative to the quantities of liquid, gaseous and solid non-radioactive effluents released from the plant and the dilutent volumes used in maintaining the releases within the limits of appropriate regulations shall be provided as follows:

a. Chlorination of Cooling Water

- The dates on which chlorination was performed.
- Amount of sodium hypochlorite consumed during each chlorination.
- Concentration of sodium hypochlorite used.
- Analytical results of chlorine tests.
- Cooling water flow rate during chlorination.

b. Calculated flow rate per intake screen, specifically indicating the dates when reduced flow takes place.

c. Measured head loss across the outer fixed screens prior to and immediately after screen wash.

d. Number of fish collected on the intake screens.

C. A Progress Report shall be submitted at six month intervals to the Director, Directorate of Licensing, USAEC, Washington, D.C. 20545 describing activities of the Ecological Survey Program for the prior six month interval.

III. Long Term Survey

Upon completion of each of the following:

(1) Thermal survey

(2) Ecological Survey

which were described in Section 7 and 8, a summary report will be submitted to the Director, Directorate of Licensing, USAEC, Washington, D.C., 20545.

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