II. THE SITE AND ENVIRONS

II.A. Terrestrial Ecology of the Area

Question II.A.1

A vegetation survey listing species composition and relative abundance of major plant species within a 2-mile radius of the plant is required. All croplands, pasture areas, gardens, etc., occurring within a 5-mile radius of the plant site should be included. In addition, the approximate composition (species-%) of the proposed 80-acre natural area on the site should be provided.

Answer

A survey study of the vegetation in the Indian Point area, prepared for Con Edison by Dames and Moore, is attached. A 2-mile radius survey was conducted, as this is considered to be sufficiently distant to determine the maximum impact from cooling towers. No significant difference would be expected within a 5-mile radius. The composition of the 80 acre natural area is approximately the same as that described in the Dames and Moore report.

VEGETATION SURVEY OF THE INDIAN POINT ENVIRONS

prepared for

Consolidated Edison Company
4 Irving Place
New York, New York 10003

by

Dames & Moore
1730 Rhode Island Avenue, N. W.
Washington, D. C. 20036

March 1973

Job. No. 0874-032-27

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ILLUSTRATIONS

TABLES

INTRODUCTION

The Indian Point Nuclear Generating Station is situated among steep rolling hills on the Hudson River near Peekskill, New York. The plant site is located within an area of terrain ranging in elevation between 20 and 100 feet. Blue Mountain Reservation, a Westchester County park, is located 1-1/2 miles east of the plant and includes Blue Mountain, which has an elevation of 680 feet. This is the highest point in the vicinity of the site, east of the Hudson River. On the west side of the Hudson River, within a two-mile radius of the plant, the terrain varies in elevation from 20 feet near the river to over 1,000 feet on Dunderberg Mountain, which is part of the Palisades Interstate Park.

The predominant land use within a two-mile radius of the Indian Point Nuclear Generating Facility is residential, recreational and commercial. Residential areas flank the site on the north and south. Land used for recreational purposes covers large areas near the site and includes the Palisades Interstate Park and Blue Mountain Reservation. Very little of the land within a two-mile radius of the site is used for agriculture; however, there is some abandoned farm land immediately to the east.

VEGETATIVE DESCRIPTION

The Indian Point site is characterized by species of Eastern Deciduous Hardwood (Figure 1). The vegetation regionally is quite thick and has a dense canopy. The Eastern Deciduous forest is usually composed of several dominant stand types superior to an understory of less dense and well developed stands. The understory vegetation is moderately dense where breaks in the forest canopy permit the shade-intolerant species to become well established. The vegetation cover of the area has attained the codominant climax stand maturity characteristic of the Eastern Hardwood forest. Organic deposition in the form of leaf litter and decomposing humus provide a nutrient rich floor for the support of many diversified vegetation types.

The dominant and codominant trees found in this area are Eastern Hemlock, Red Oak, White Oak, Chestnut Oak, and Shagbark Hickory, among others. Dominant and codominant trees range from 55 to 65 feet in height with diameter at breast height (d.b.h.) ranging from 18 to 36 inches. The understory relationships in the Eastern Deciduous Hardwoods are a ground canopy of Witch-hazel, Flowering Dogwood and Hickories, and a second canopy of Eastern Hemlock and Witch-hazel. The forest floor is composed of up to a 2-inch layer of organic material and varying amounts of shrubs and herbs such as Witch-hazel, Indian Pipes and Virginia Creeper.

The remainder of the vegetation in the region surrounding the site consists of meadows, marshland and agricultural lands (Figure 1).

VEGETATIVE SAMPLING

Quantitative sampling was conducted at two locations (Areas 1 and 2) to the south and southeast of the site. The sampled areas are indicated by the triangles in Figure 1. An additional location (Area 3) was sampled qualitatively.

Area 1 is located 450 feet at 315° from the west corner of the small pond and is 10 feet square (Figure 1).

The major species identified are listed in Table 1, and the number of trees that have a 3-inch and larger diameter at breast height (d.b.h.) are:

Species	Common Name	Tally	Percent of Total
Hamamelis virginiana	Common Witch-hazel	3	9
Quercus alba	White Oak	1	3
Tsuga Canadensis	Eastern Hemlock	16	49
Fraxinus americana	White Ash	3	9
Betula nigra	River Birch	6	18
Quercus rubra	Red Oak	4	12

The canopy cover for the preceding stand types was estimated to be 95 percent. This canopy had a coniferous to deciduous ratio of 1:1. The height and average d.b.h. of the dominant and codominant trees within the sampling area was found to be:

Species	Name	Height	Average d.b.h.
Quercus alba	White Oak	64'	36"
Tsuga canadensis	Eastern Hemlock	64'	22"
Quercus rubra	Red Oak	61'	22"

The organic composition of the forest floor consisted of 1 inch of leaf and branch material over a layer of Hemlock needles over a thick 3/4 inch layer of partially decomposed humus. Five percent of the ground was occupied by shrubs and herbs. The ground cover species were Witch-hazel, Indian Pipes and Virginia Creeper. It was observed that towards more moist points in the area, the synusia becomes more densely composed of seedling and sapling Hemlocks.

In this sampling area, both Oak and Hemlock predominate as the overstory dominant stand types. This is based on relative tree numbers on the site in addition to the canopy dominance displayed by the Oak and the Hemlock species. Birch and Hickory are found on the site with the Hickory being more pronounced. The two understory relationships found were a ground canopy composed

Table 1: Botanical Species Found in Area One.

Vegetation	Scientific Name	Common Name
Trees	Hamamelis virginiana	Witch-hazel
	Quercus alba	White oak
	Quercus rubra	Red oak
	Tsuga canadensis	Eastern hemlock
	Fraxinus americana	White ash
	Betula nigra	River birch
	Platanus occidentalis	Sycamore
	Liriodendron tulipfera	Yellow poplar
	Carya ovata	Shagbark hickory
	Fagus grandifolia	American beech
Shrubs	Monotropa uniflora	Indian pipe
	Parthenocissus quinquefolia	Virginia creeper
	Prunus virginiana	Choke cherry
	Acer rubrum	Red maple
	Sassafras albidum	Sassafras
	Rhus radicans	Poison ivy
	Cayptograma crispa	Wood fern
	Lonicera villosa	Honeysuckle
	Rubus odoratus	Raspberry
	Rhus glabra	Smooth sumac

of Witch-hazel and Flowering Dogwood and a second canopy composed of Eastern Hemlock and Witch-hazel. New growth under the dominant stand canopy is limited to Hemlock saplings and seedlings and there is a high degree of homogeneity throughout this stand. Near the more mesic to hydric sites, there is an increase in the shrub and herbaceous plant development. The stand appears to be in a climax-service climax condition and has not been subject to recent alteration of a mechanical nature. There were no visible signs of thinning, cultivation or other manipulation in this sample area.

Area 2 is located approximately 2/10 mile southwest of the intersection of Broadway and Bleakley Streets on Broadway (Figure 1). All the species identified are listed in Table 2, and the number of trees 3 inches d.b.h. and greater are given as follows:

Species	Name	Tally	Percent of Total
Quercus primus	Chestnut Oak	2	25
Carya ovata	Shagbark Hickory	2	25
Quercus rubra	Red Oak	4	50

All the trees in this area were deciduous.

For the dominant tree, the Red Oak (Quercus rubra), the average height was 56 feet and the average diameter (d.b.h.) was 18 inches.

Sixty percent of the ground in this area was covered by vegetation in the form of shrubs and herbs. The floor litter was composed of 1/2 inch of partially decomposed leaf and twig material, 1/3 inch of decomposed humus supported by fibrous humus layer over a pure decomposed humus layer.

The overall density of overstory in this area is low, but the foliar growth is dense and has a shrubby thicket appearance. Species found were the Chestnut Oak, Flowering Dogwood and a few scattered Hickories. These species

Table 2: Botanical Species Found in Area Two.

Vegetation	Scientific Name	Common Name
Trees	Cornus alternifolia	Flowering Dogwood
	Quercus rubra	Red oak
	Quercus prinus	Chestnut oak
	Sasafras albidum	Sassăfras
	Quercus alba	White oak
	Carya ovata	Shagbark hickory
	Liriodendron tulipifera	Yellow poplar
	Populus grandidentata	Big tooth aspen
	Ulmus americana	American elm
	Catalpa bignonioides	Catalpa
	Betula nigra	River birch
	Tsuga canadensis	Eastern hemlock
	Carpinus caroliniana	Ironwood
	Acer saccharum	Sugar maple
	Prunus serotina	Beach cherry
	Populus deltoides	Eastern cottonwood
	Robinia pseudo-acacia	Black locust
	Platanus occidentalis	American sycamore
Shrubs	Rhus radicans	Poison ivy
	Vitis aestivalis	Wild grape
	Prunus virginiana	Choke cherry
	Selloginella spp.	Club moss
	Vaccinium caesariense	Blueberry
	Rose spp.	Wild rose
	Smilaciana stellata	False salmons seal
	Plantago rugelli	Plantain

Table 2: (Cont.)

Vegetation	Scientific Name	Common Name
Shrubs	Leucothoe racemosa	Swany sweetbells
	Rhus typhina	Staghorn sumac
	Achillea millefolium	Yarrow
	Oenothera biennis	Primrose
	Lithospermum canescens	Puccoon
	Poa arvense	Bluegrass

provide a homogeneous ground cover. The area is characterized by a lack of true tree reproduction (i.e., seedlings and saplings). The reproduction which can be found on the site is in the form of oak brush. This situation is common of the area to the southeast of Broadway. Where there is a break in the forest canopy the density of the shrub and wood vegetation increases. There is evidence of disturbance to the area in the form of thinning and clearing (10-20 years ago) and as a direct result of this, succession is not sequential. The development of a transmission line corridor through the area has served to provide a source for vegetation alteration. The section within Area 2 to the northwest of Broadway is a heterogeneous composition of hardwood species. This area is quite moist and there are several codominant species; Hemlock and Yellow poplar although River oak is still a prominent species.

Area 3 had no quantitative sampling, but vegetation types were noted. Basically, the area is a White pine plantation with a few other species also found such as Black ash, Red spruce, Black cherry and Maple. On the margin surrounding this area the occurrence of shrub and herb species increases. There was no occurrence of a synusia within the pure White pine plantation. Some ground cover, in the form of Virginia creeper and poison ivy was found underlying the dispersed deciduous species.

Table 3 is a combined species list for all the sampling areas. This list includes the major species found and, in addition, some of the specific understory vegetation.

Table 3: Major Species Found in Sampling Areas One, Two, and Three

Vegetation	Scientific Name	Common Name
Trees	Pyrus coronaria	Crabapple
	Pinus strobus	White pine
	Acer saccharum	Sugar maple
	Picea rubens	Red spruce
	Acer rubrum	Red maple
	Salix sp.	Willow sp.
	Robinia pseudo-acacia	Black locust
	Catalpa bignonioides	Catalpa
	Prunus serotina	Black cherry
	Carpinus caroliniana	Ironwood
	Fraxinus nigra	Black ash
	Pinus sylvestris	Scotch pine
	Populus deltoides	E. cottonwood
	Nyssa sylvatica	Sour-gum
Shrubs	Parthenocissus quinquefolia	Virginia creeper
	Cornus alternifolia	Flowering dogwood
	Rhus glabra	Smooth sumac
	Rhus radicans	Poison ivy
	Vitis aestivalis	Wild grape
	Ailanthus altissima	Tree of Heaven

Table 3: . (Continued).

Vegetation	Scientific Name	Common Name
Shrubs	Amelanchier intermedia	Swamp juneberry
	Aralia hispida	Sarsaparilla
	Daucus carota	Queen Anne's lace
	Vicia angustifolia	Vetch
	Artemisia tridentata	Sage
	Leucothoe racemosa	Swamp sweetbells
	Polygonum pensylvanicum	Smartweed
	Melliotus officinalis	Melilotus
	Smilax lasioneuron	Smilax

Question II.A.2

A survey of faunal composition including specific information relative to population densities and numbers of mammalian and avian species occurring within a 2-mile radius of the plant site is required. Information should include best estimates of occurrence of transient species, as well as information regarding any unusual habitat preferences which may be ascribed to the species mentioned.

Answer

No surveys of mammalian and avian species in the Indian Point area have been conducted. Furthermore, a survey of fauna taken at this time would be an invalid estimate of fauna after construction has been terminated because of construction activity, which has been going on nearly continuously for 7 years, and because Indian Point was an amusement park for many years before it was purchased for use by the applicant. There has been and will be little change in fauna that exists generally along the river in northern Westchester County. There are no known rare or unusual species in the area.

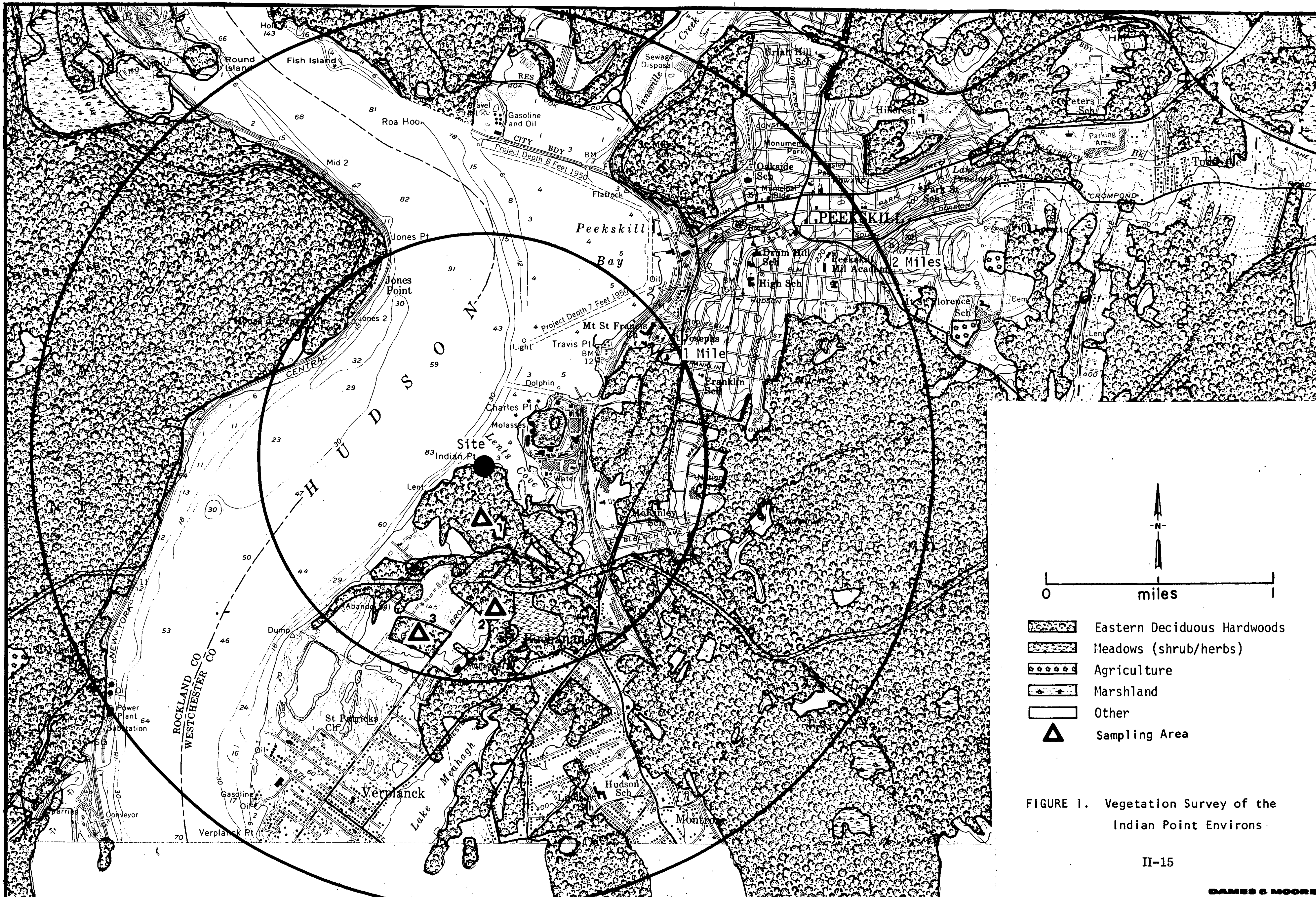


FIGURE 1. Vegetation Survey of the Indian Point Environs

Question II.A.3

A recent aerial photograph (scale approximately 1 inch equals 1000 ft) showing the site area and vegetation within a 2-mile radius of the plant site should be supplied. If possible, this should be at a time of full foliar development.

Answer:

A scale aerial photograph was supplied to the Atomic Energy Commission on March 30, 1973.*

*Letter from William J. Cahill, Jr., Vice President, Consolidated Edison Company of New York, Inc., to George W. Knighton, Chief, Environmental Projects Bureau Directorate of Licensing, U.S.A.E.C., March 30, 1973, Docket No. 50-286.

Question II.A.4

A large contour map of the area within a 10-mile radius of the Indian Point site showing site location, all other generating facilities (steam plants and hydro stations), improved and unimproved roadways, railroad rights-of-way, transmission line corridors, ecological and meteorological sampling stations, locations of substations and switching assemblies, population centers and airports should be supplied.

Answer:

A map, indicating the items listed above, was supplied to the Atomic Energy Commission on March 30, 1973.* The size of the map (approximately 5' x 5') prevented its inclusion in the Environmental Report.

*Letter from William J. Cahill, Jr., Vice President, Consolidated Edison Company of New York, Inc., to George W. Knighton, Chief, Environmental Projects Bureau Directorate of Licensing, U.S.A.E.C., March 30, 1973, Docket No. 50-286.

II.B. WATER CHEMISTRY

Question II.B.1

Monthly maximum, minimum, and average values of salinity and total dissolved solids for one recent calendar year for the Hudson River at a point and depth representative for the Indian Point Unit No. 3 intake should be supplied.

Answer:

a) Table II.B.1-1 presents the salinity data available for a sampling station near the Unit 3 intake.

b) Table II.B.1-2 presents the data on total dissolved solids available for a sampling station near the Unit 3 intake.

Table II.B.1-1 Mean salinity values for station 4, integrated through depth, for the time period 5/10/72 - 12/11/72 (ppt).

Date	Maximum Salinity	Minimum Salinity	Mean Salinity
5/10	0.0699	0.0575	0.0637
6/12	0.0660	0.0580	0.0633
7/10	0.0641	0.0564	0.0615
7/17	0.0575	0.531	0.0563
7/24	0.1082	0.0577	0.0807
7/31	0.0515	0.0515	0.0515
8/7	0.4962	0.3786	0.4746
8/14	1.720	1.720	1.716
8/21	4.3407	2.1225	3.2092
8/28	2.2189	2.1623	2.1906
9/5	2.6188	2.6188	2.6188
9/11	2.1515	2.0644	2.1225
9/18	4.4025	2.9460	3.5286
9/25	2.8589	2.7981	2.8316
10/2	4.3310	3.3307	4.4059
10/9	1.8139	1.749	1.7562
10/16	3.0214	2.6955	2.7376
10/23	2.2935	1.7866	2.1477
10/30	2.3378	1.4103	1.9614
11/6	1.4600	0.7635	0.9799
11/14	0.0949	0.900	0.0945
11/20	0.1390	0.1310	0.1350
11/27	0.0846	0.0776	0.0801
12/4	0.0811	0.0736	0.0801
12/11	0.0750	0.0736	0.0743

Table II.B.1-2 Mean values for total dissolved solids for station 4 integrated through depth (mg/1).

TDS:	10/72	11/72	12/72
	1906	144	92.2

Question II.B.2

Concentration levels of ammonia nitrogen, total organic carbon and copper already present in the Hudson River averaged over a monthly period for one year should be reported.

Answer:

a) Table II.B.2-1 (attached) presents the ammonia data available for a sampling station near the Unit 3 intake.

b) Table II.B.2-2 presents the data available on organic carbon for the Indian Point region of the Hudson River.

c) Table II.B.2-3 presents the data available on copper for the Hudson River at Indian Point. These samples were taken within 10 yards of the intakes of Indian Point Unit 1.

Table II.B.2-1 Mean ammonia values for station 4 integrated through depth ($\mu g/1$).*

	October (1972)	(November (1972)	December (1972)
Ammonia	167	1	1

Table II.B.2-2 Mean organic carbon values integrated through depth for the Indian Point region.

MONTH	STATION	MEAN	STANDARD DEV.	STANDARD ERROR
5	0	13.42	0.5364	0.1073
6	0	13.84	0.7792	0.1336
7	0	13.62	1.3428	0.2303
8	0	10.51	1.3682	0.2347
9	0	10.92	0.6267	0.1075
10	0	11.28	0.3307	0.0567
11	0	9.28	0.2756	0.0430
12	0	8.51	0.2856	0.0412

*See Figure II.B.2-1

Table II.B.2-3 Trace Element Concentrations μg/1 at Indian Point - East Shore* 1971-1972

Collection Date	Sample #	Cu
3/18/71	2	10.0
4/20/71	4	3.0
5/17/71	6	2.5
6/21/71	12	2.5
7/26/71	18	1.0
8/23/71	21	6.2
9/27/71	27	3.7
10/25/71	33	6.3
5/25/72	2	1.0
6/26/72	6	1.0
7/24/72	10	21.5
8/22/72	14	21.5
9/25/71	19	20.3
10/23/72	22	32.5
11/27/72	26	6.5

*New York University measurements

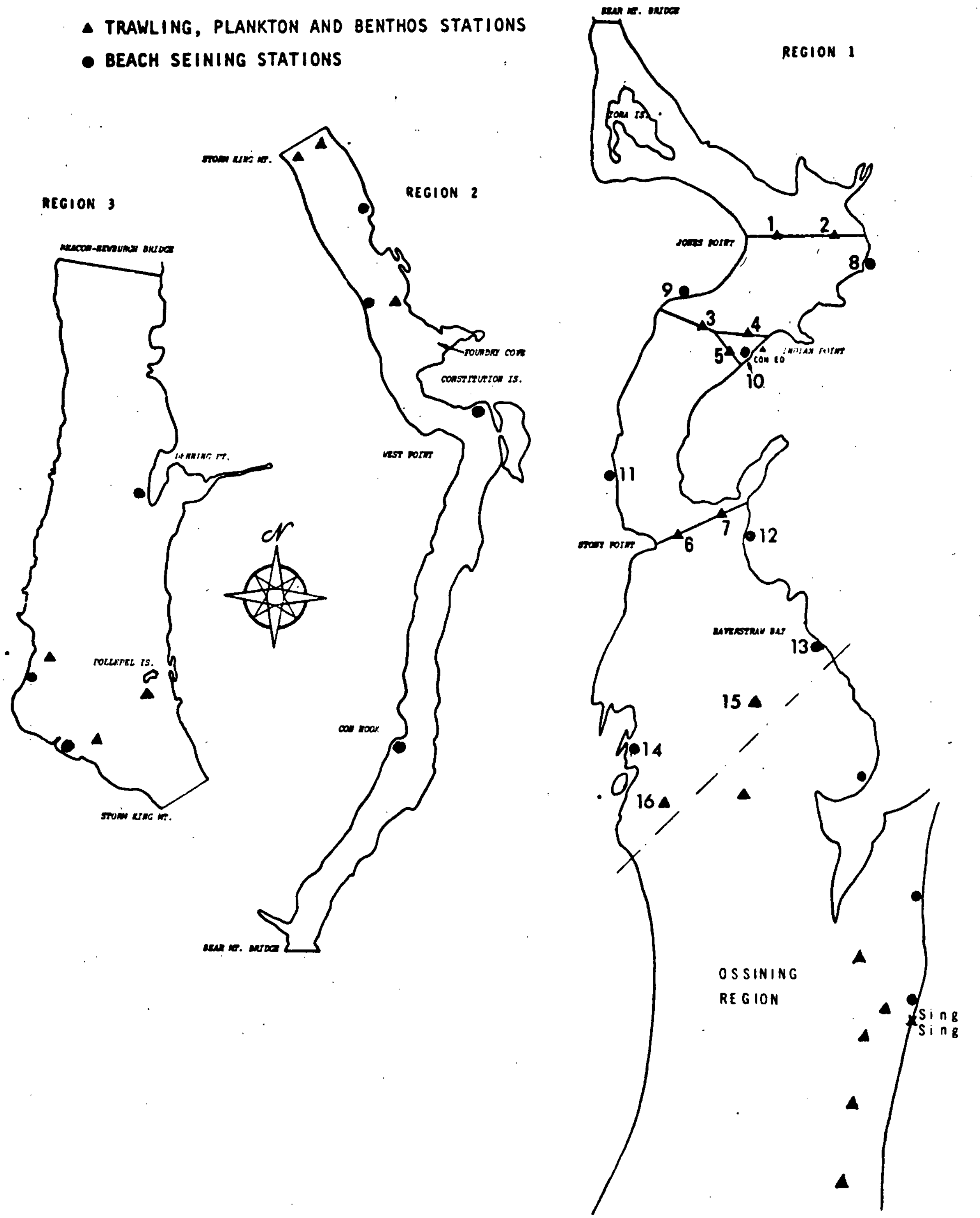


Figure II.B.2-1 Indian Point Ecological Study Regions

II.C Meteorology

Question II.C.1

With reference to Table 3.1.1 of the Benefit-Cost Section in Supplement 2 to the Environmental Report, information on the frequencies (number of hours annually) of fog naturally occurring in all of the specified sectors is needed.

Answer:

Fog measurements are not available for the Indian Point area. The nearest facility where measurements are taken hourly is Westchester County Airport at White Plains, N.Y. Extrapolated data from Westchester Airport to Indian Point is of dubious value. Reports are stated as an occurrence of fog, for the hour, and are not specified by sectors.

To document fog occurrence at Indian Point, at Indian Point, a continuously recording visibility instrument will be installed as part of the meteorological program.

Question II.C.2

One recent year's on-site data (or data from a nearby station along with sufficient correlative information to allow for estimating percentage of error associated with applying this data to the Indian Point site) should be supplied regarding:

a. monthly frequency distributions of saturation deficit versus time (percent)

b. monthly correlations of wind speed and direction with saturation deficit

Answer:

Monthly frequency distributions of saturation deficit are only available from Weather Bureau stations located at Poughkeepsee, New York City, and White Plains, N.Y. Correlations of saturation deficit with wind frequency are also available. However, extrapolation of data to the valley characteristics of the Indian Point site is an uncorrelated technique. The onsite meteorological program will provide continuous data on the vertical structure, from ground level to 400 feet above grade, of temperature, dew point and wind.

Question II.C.3

Information concerning vertical distance (s) at which prevailing regional wind direction patterns assume dominance over Hudson Valley regime should be provided.

Answer.

Part of the on-site meteorological program includes balloon releases to define the vertical extent of the valley wind system.

III. THE STATION HYDRAULICS, THERMAL AND CHEMICAL DISCHARGES

III. A. Hydraulics of the Station

Question III.A.1

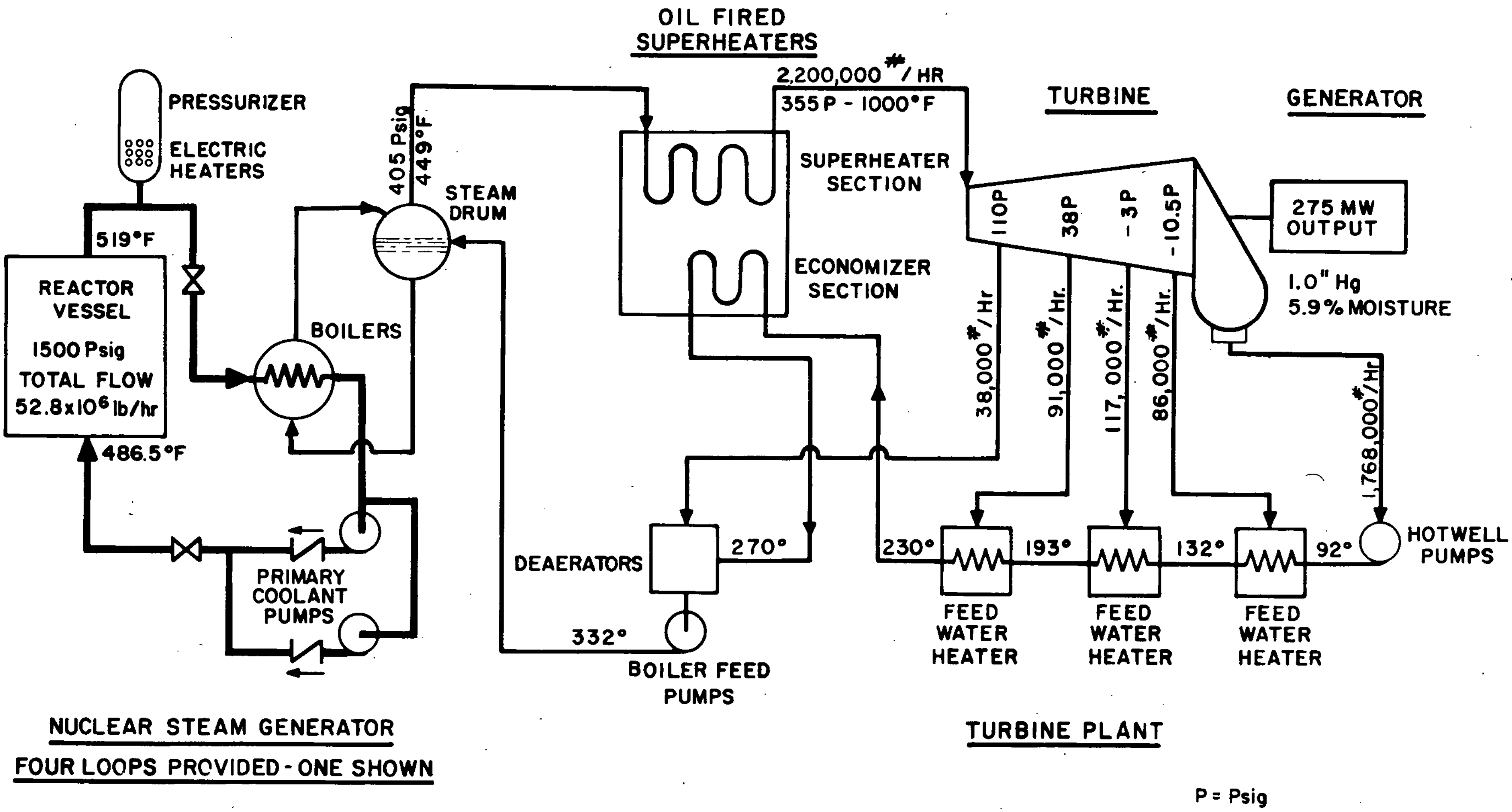
For Indian Point Unit No. 1 a schematic flow diagram (or equivalent description) for the steam and condensate systems and for the cooling and service water systems, showing flowrates and temperatures should be provided. Arrangement and flowrates in the deicing system should be indicated.

Answer:

The steam and condensate systems are illustrated schematically on Figure III.A. 1-1. Figure III.A.1-2* shows the relationship between steam and condensate systems and the circulating (cooling) water system. Figure III.A.1-3 illustrates both the circulating (cooling) and service water systems, as well as the deicing system. The flowrates and temperature changes for Unit 1 are tabulated in Table III.A.1-1. Reduced flow conditions (i.e., when the ambient river water temperature is less than 40^{o}F) is accomplished by throttling the pumps so that the circulating water flow is 60% of the full flow condition.

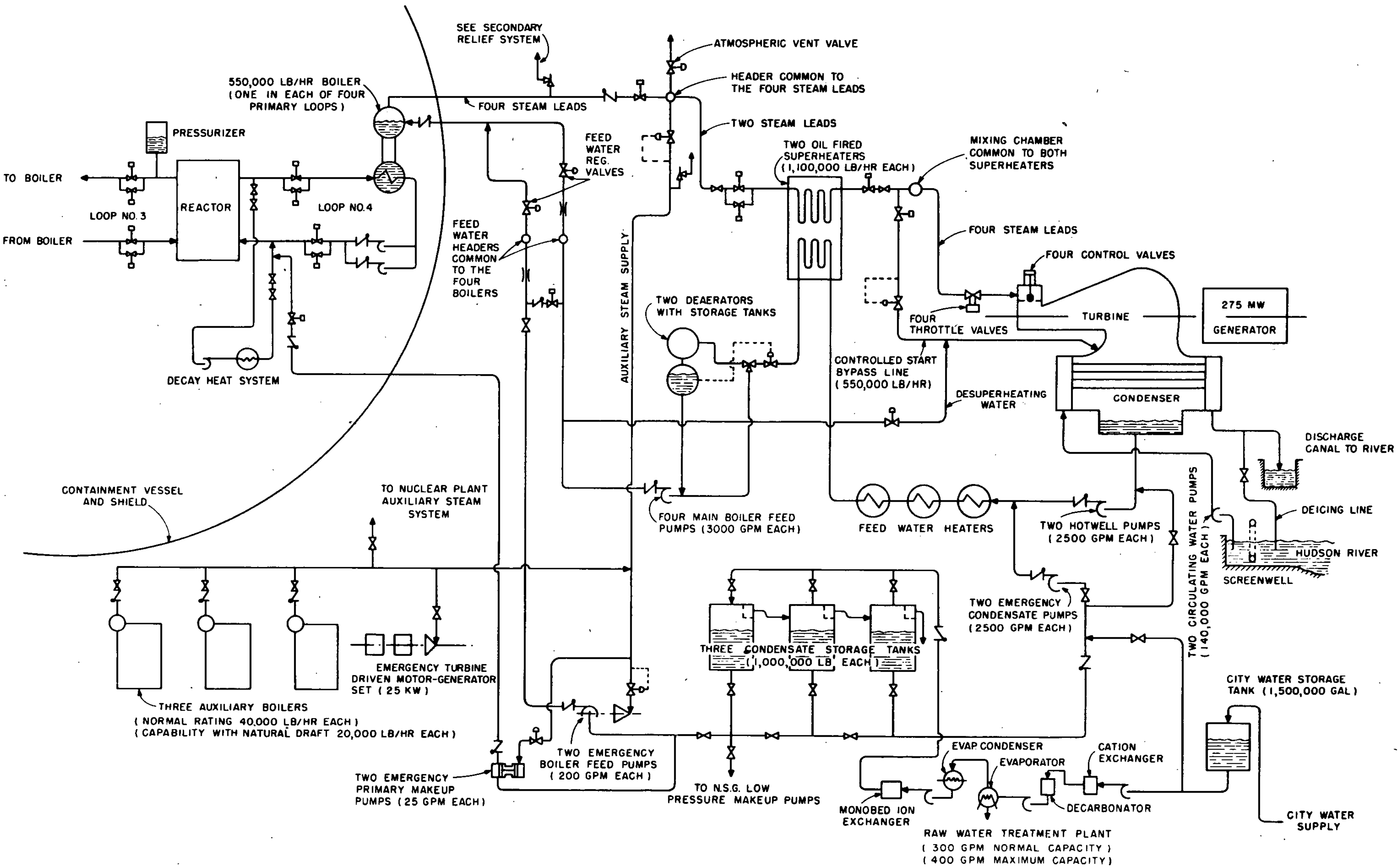
Deicing is accomplished, as seen in Figure III.A.1-3, by returning a portion of condenser discharge to the intake bays. Each deicing loop (there are two) is capable of returning up to 23,000 gpm.

*See "Supplementary Information on Plant Design of Consolidated Edison Nuclear Generating Station." August 1960; U.S. Atomic Energy Commission Docket No. 50-3, Exhibit K-5A11.



INDIAN POINT STATION
HEAT BALANCE DIAGRAM

Figure III.A.1-1



INDIAN POINT STATION
SIMPLIFIED PLANT FLOW DIAGRAM

Figure III.A.1-2

Table III.A.1-1

TEMPERATURE AND FLOW-RATES OF THE RIVER WATER SYSTEM: UNIT 1

	Full Flow	Reduced Flow*
Heat Load $\left(10^6 \frac{BTU}{hr}\right)$		
Condenser	1,765	1,765
Service	150	150
Total	1,915	1,915
Flow Rate (10^3 gpm)		
Condenser (Cooling Water)	280	168
Service	38	38
Total	318	206
Temperature Rise (^oF)		
Condenser (Cooling Water)	12.6	21.0
Service	7.9	7.9
Total	12.0	18.6

*60% of full flow through condenser.

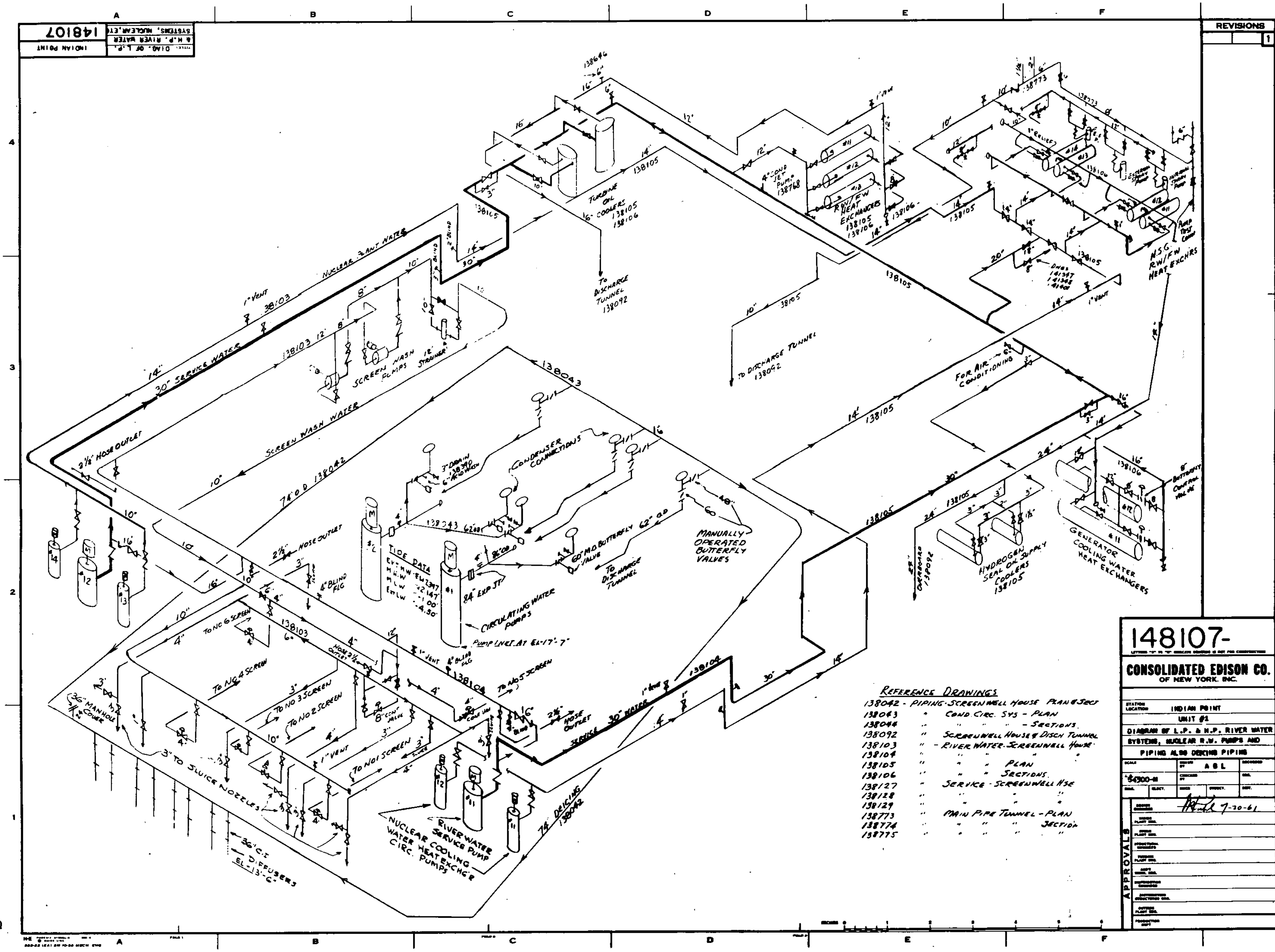


Figure III.A.1-3

Question III.A.2.

A block diagram of water usage with approximate inventory of water in the cooling and service water systems of each unit is required.

Answer:

Figure III.A. 2-1 is a schematic diagram of the circulating water system. Figure III.A.1-1 presents a line diagram of the service water system of Unit 1. Line diagrams of the service water systems and related information for Units 2 and 3 are available in Sections 9.6 of the Final Facility Description and Safety Analysis Report for Units 2 and 3, respectively.

The approximate inventory of the circulating water system is presented in Table III.A.2-1.

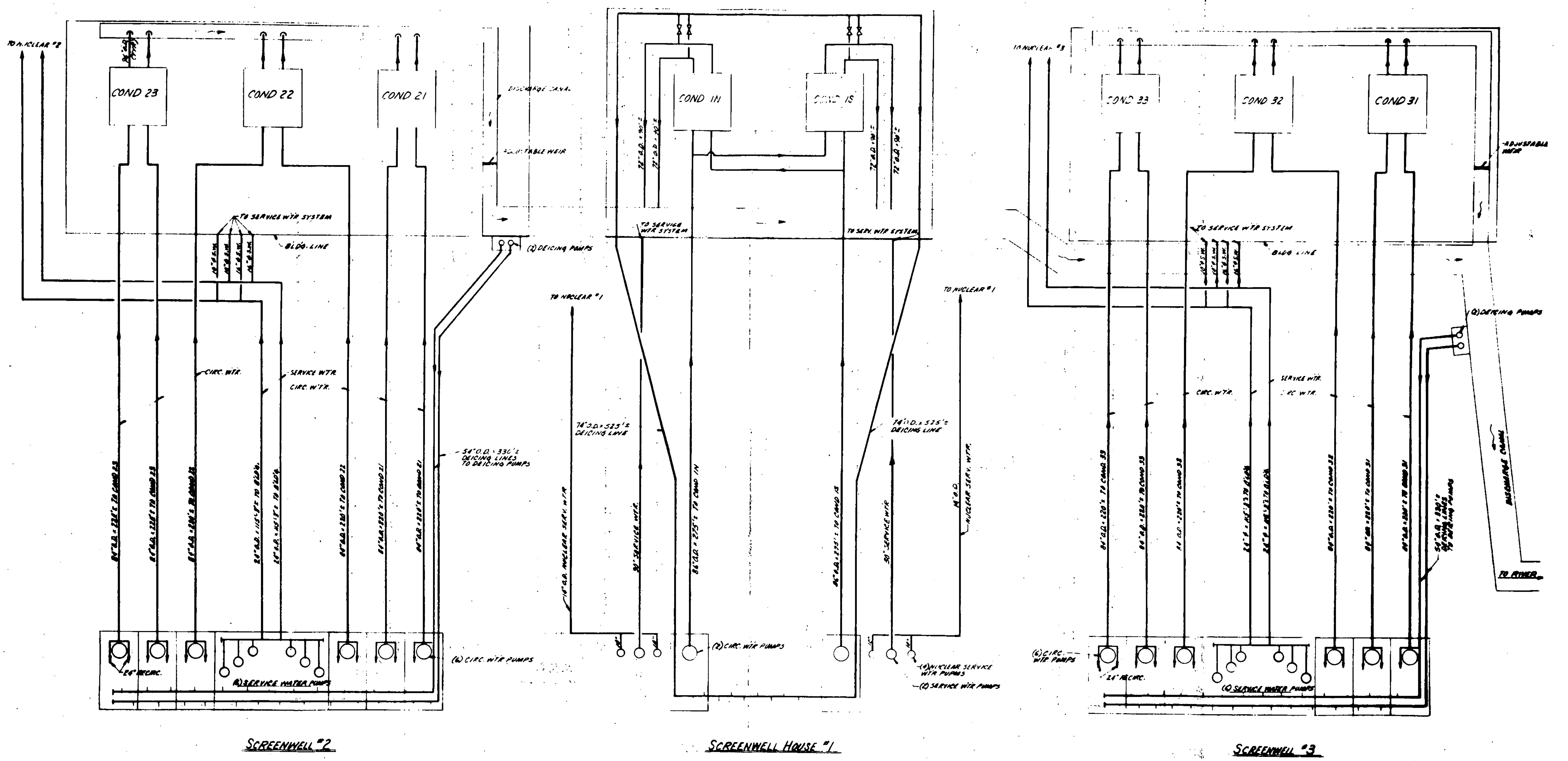


Figure III.A.2-1. Combined circulating water system of Indian Point Units 1, 2 and 3.

Table III.A.2-1

INVENTORY OF CIRCULATING WATER SYSTEM

VOLUME OF WATER (FT^3)

	Unit 1	Unit 2	Unit 3
Intake Forebay	5.9×10^4	1.1×10^5	1.1×10^5
Forebay to Outfall into discharge canal	2.7×10^4	8.1×10^3	8.1×10^3
Discharge Canal	1.7×10^6	1.7×10^6	1.7×10^6

Question III.A.3

For Units Nos. 1, 2 and 3, the dimensions should be provided of the cooling and service water conduits and canals and water velocities as required to estimate the water residence times in the various portions of the systems. Data on the recirculation capabilities which allow these units to pump water at reduced capacities should also be described.

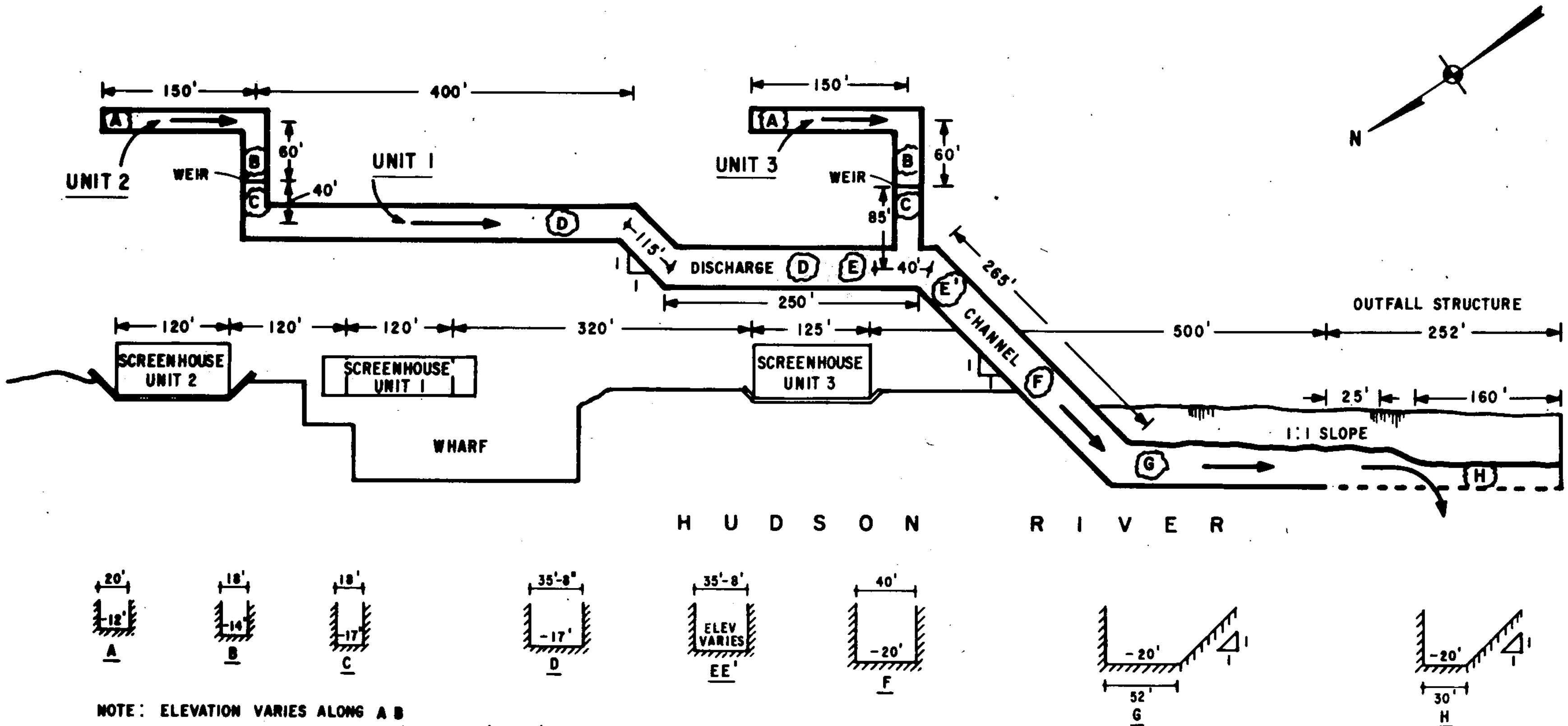
Answer:

A dimensioned drawing of the discharge canal is presented in Figure III.A.3-1. Figure III.A.2-1 provides the necessary dimensions for the circulating water pipes to the condenser.

Figures III.A.3-2, -3, and -4 present cross-sectional views and plan views of the intake structures of Units 1, 2 and 3 respectively.

Reduced flow on Unit 1 is achieved by throttling the pump. Reduced flow on Units 2 and 3 is achieved through the use of a return line (located immediately downstream of the circulating water pump) to the intake forebay.

DISCHARGE CANAL – THREE UNIT OPERATION



NOTE: ELEVATION VARIES ALONG A B
ELEVATION VARIES ALONG EE' FROM 20' TO 17'

SCALE 1" ≈ 165'

Figure III.A.3-1

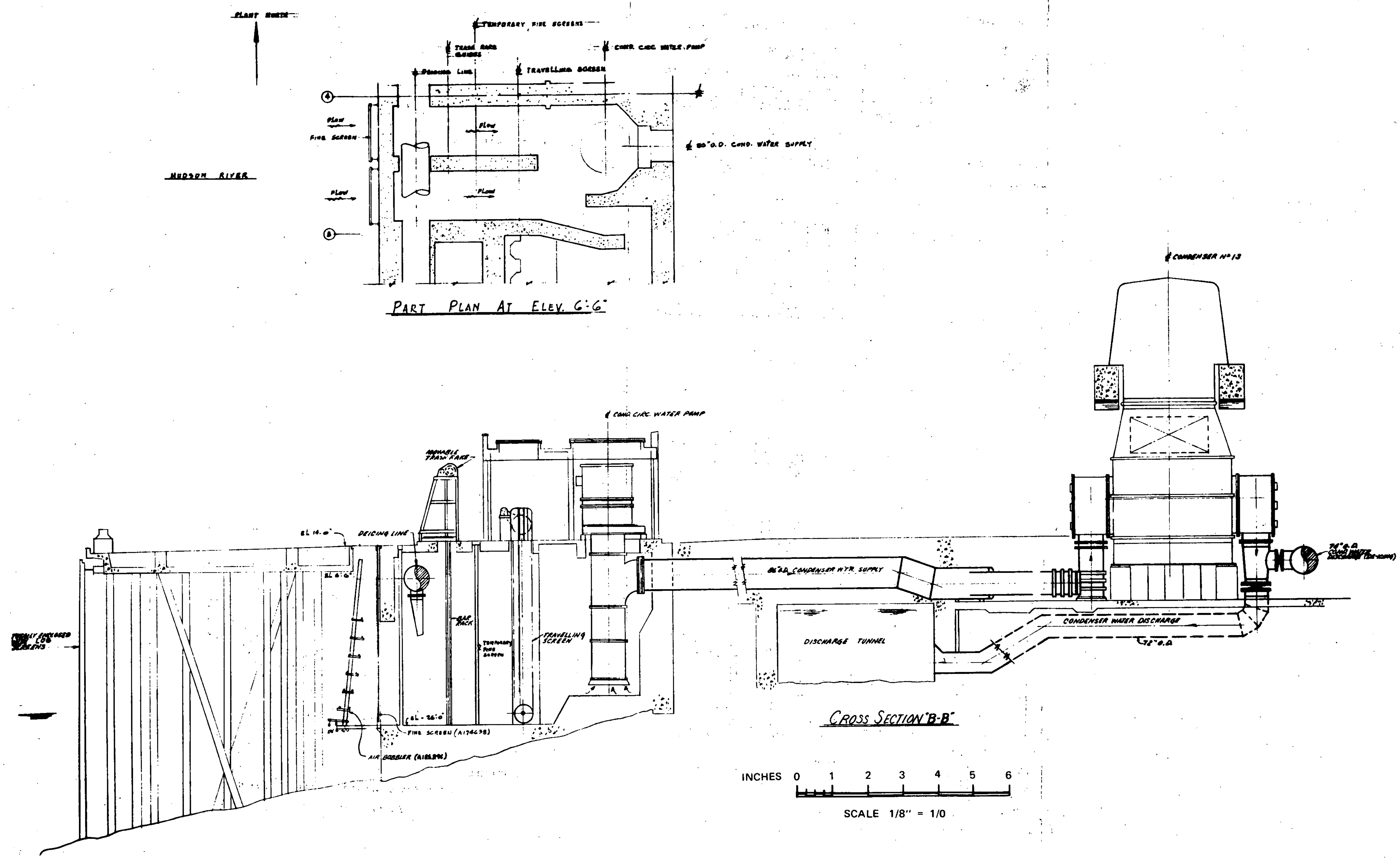
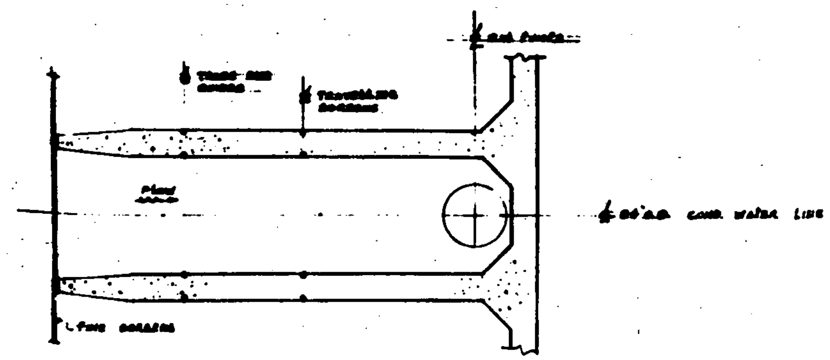
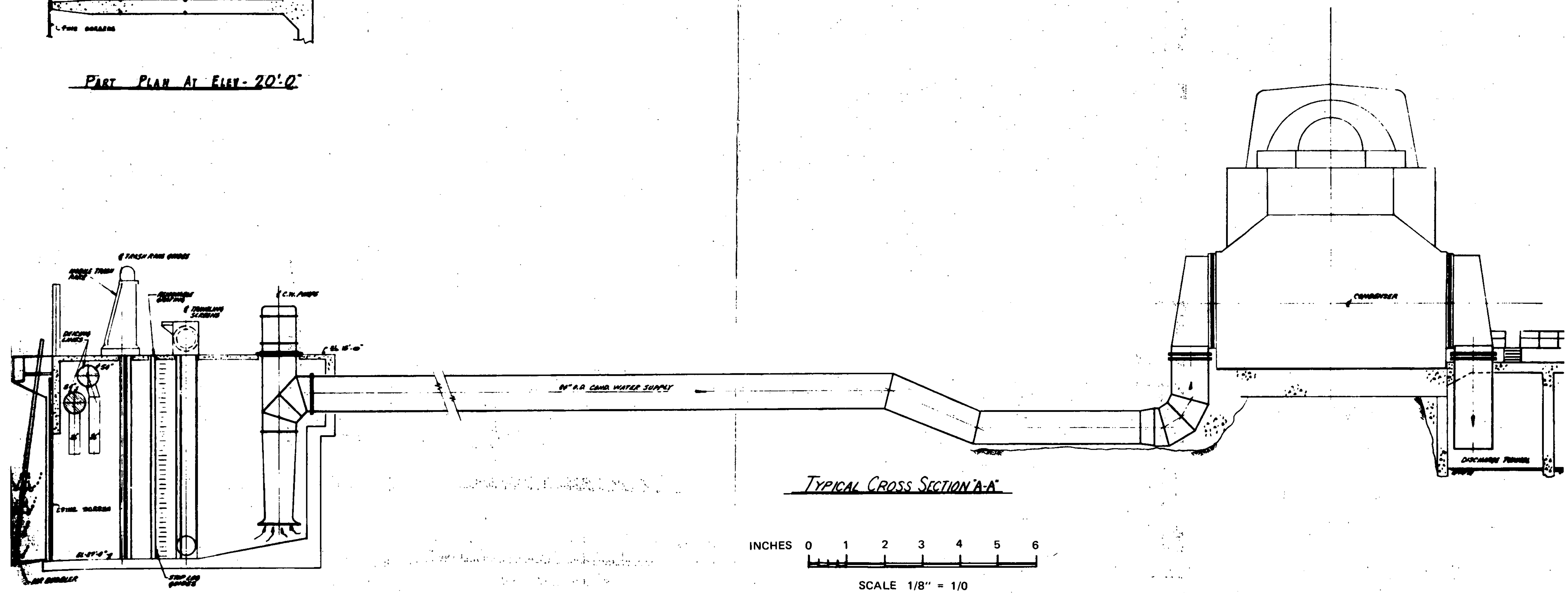


Figure III. A. 3-2. Plan View and Cross Section Through Intake Structure of Unit 1



PART PLAN AT ELEV - 20'-0"



TYPICAL CROSS SECTION "A-A"

Figure III.A.3-3
Plan View and Cross Section Through
Intake Structure of Unit 2

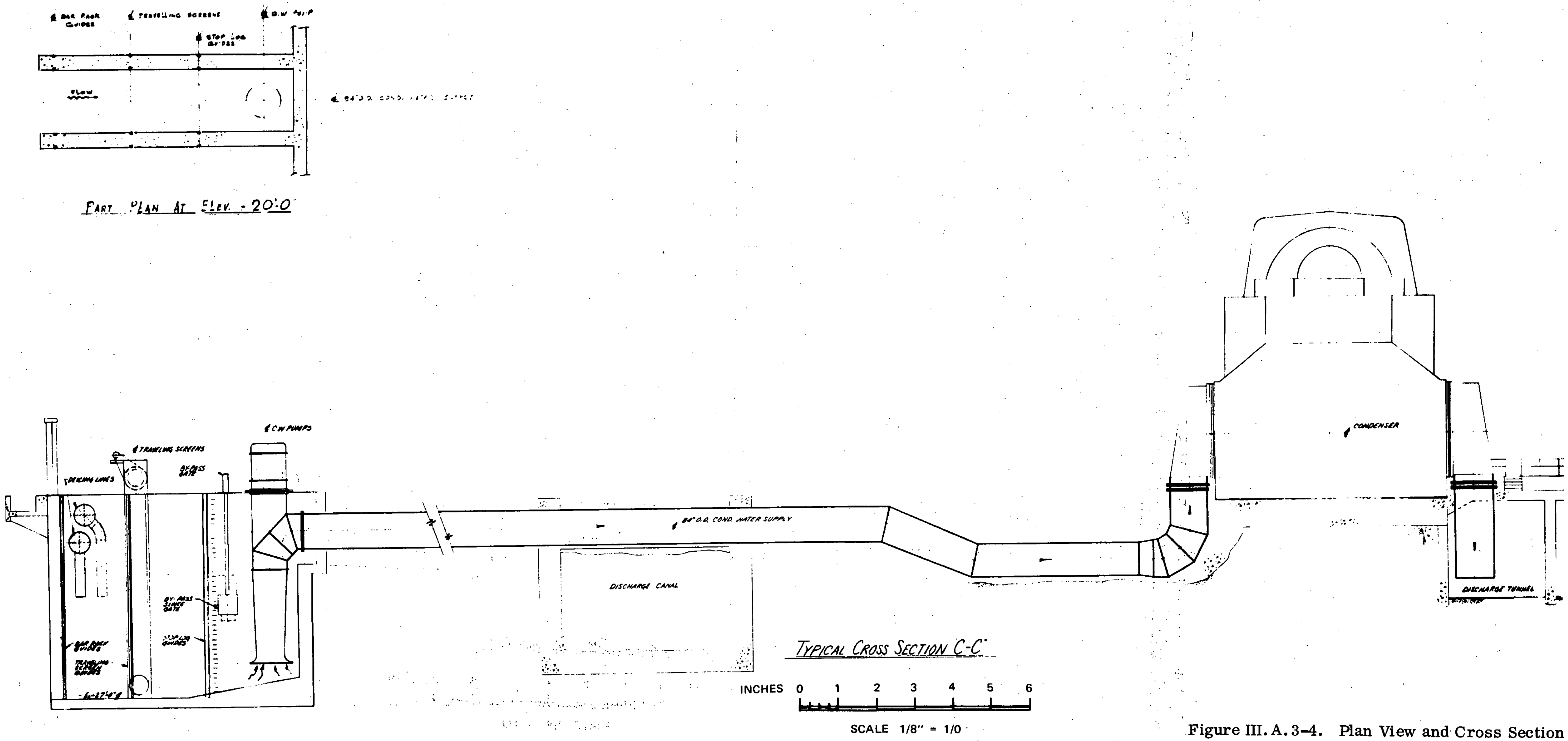


Figure III. A. 3-4. Plan View and Cross Section Through Intake Structure Of Unit 3

Question III.A.4

The surface area for the steam turbine condenser tubes, and the expected corrosion rates in Units Nos. 1, 2 and 3 should be described. Other major materials of construction in the cooling and service water systems, and the typical pressures, temperatures and water velocities they are exposed to should be provided.

Answer:

Following is a tabulation of the requested data:

Cooling Water System	Unit 2/Unit 3	Unit 1
Total Cooling Surface Sq. Ft.	918,000	212,000
Materials of Construction:		
Condenser Tubes	Admiralty Type B	Admiralty
Condenser Tube Sheets	Silicon Bronze	Silicon Bronze
Condenser Shells	Carbon Steel	Carbon Steel
Condenser Tube Supports	Carbon Steel	Carbon Steel
Condenser Water Boxes	Carbon Steel	Cast Iron
Circulating Water Pump Inlet Casing	Cast Iron*	Cast Iron
Circulating Water Pump Discharge Elbow	Carbon Steel*	Cast Iron
Circulating Water Pump Propeller/Impeller	Stainless Steel	Bronze
Circulated Water Pump System Piping	Carbon Steel*	Carbon Steel
Velocities: FPS		
Circulating Water System Piping	8.0	8.0
Condenser Tubes	6.0	6.0
Pressures: PSIG		
Circulating Water Pump Discharge	18	18
Condenser	0	0
Temperatures: ^{o}F		
Intake Water Box	32-75	32-75
Outlet Water Box	49-92	45-88

*Epoxy Lined

Service Water System	Unit 2/Unit 3	Unit 1
Materials of Construction:		
Pump Casing	Cast Iron	Cast Iron
Pump Impeller	Bronze	Stainless Steel
Piping -		
Heat Exchanger Tubes	Admiralty	Aluminum Bronze
Velocities: FPS		
Heat Exchangers	7	8
Piping	10	7
Pressure: PSIG		
Pump Discharge	100	50
Temperatures: °F		
Heat Exch. In	32-75	32-75
Heat Exch. Out	42-85	40-83

Expected Corrosion Rates less than .0005" per year.

Question III.A.5

Reference is made on page 9-6 and in Figure 18 of Supplement 3 to the Environmental Report to a possible common intake structure for fixed fine screens for Units Nos. 1, 2 and 3. The firm plans for use of the common intake screens should be presented.

Answer:

The common intake structure described in the Unit 3 Environmental Report will use vertical traveling screens positioned in a line parallel to the river flow. Preliminary design and hydraulic modelling of the common intake have been completed. The implementation of this concept is contingent upon the outcome of the ecological studies, intake testing and legal proceedings currently in progress. If the common intake structure is found to be the best practicable solution to the impingement problem and is compatible with other ecological aspects of plant operations, it will be implemented.

III.B. Thermal Discharges

Question III.B.1

In Supplement 3 of the Environmental Report, on page 9-14 it is stated that "The feasibility of developing a more effective effluent discharge scheme, such as a submerged thermal diffuser, will be explored." The results and conclusions drawn from the exploration should be provided.

Answer:

The deep-water thermal diffuser study has just commenced. We have commissioned Alden Research Laboratory to conduct a physical model test and Quirk, Lawler and Matusky Engineers to develop a mathematical model study. Preliminary data are expected to be available for review by the end of May, 1973.

Question III.B.2

Any additional field or model data that have been developed since preparation of the Environmental Report on Indian Point Unit No. 3, and Supplements 1 through 3 thereto, should also be furnished, that would add to the knowledge of dilution flows, degree of vertical mixing, thermal stratification factors, dispersion coefficients, etc., in the Hudson River at Indian Point.

Answer:

We do not have any additional field or model data since the completion of Supplement 3 in October, 1972. We are planning to obtain field data when Indian Point 2 is in operation.

Question III.B.3

For each of the capacity levels (1) rated and (2) design (stretch) for Units Nos. 1, 2, and 3, give: reactor thermal output, net electrical output, gross electrical generation, thermal heat rejection to environment, circulating water flowrates and temperatures rise through the condensers; for the service water system give heat rejection, water flowrates and temperature rises through the systems.

Answer:

Tables III.B.3-1,-2, and -3, delineate the various thermal data for Units 1, 2 and 3, respectively.

TABLE III.B.3-1

THERMAL DATA FOR INDIAN POINT UNIT 1

		Design Rating
1.	Plant Net, MWe	265
2.	Turbine Net MWe (@1.5" Hg backpressure)	285
3.	Condenser Heat Load, 10^6 Btu/hr	1,765
4.	Condenser Coolant flow, gpm	280,000
5.	Condenser Δ t, ^oF	12.6
6.	Service water heat load, 10^6 Btu/hr	150
7.	Service water flow, gpm	38,000
8.	Service water Δ t, ^oF	7.9

TABLE III.B.3-2

THERMAL DATA FOR INDIAN POINT UNIT 2

		Initial Guaranteed	Maximum Guaranteed	Maximum Calculated
1.	Reactor Power, MWt	2,758	3,087	3,217
2.	Plant Net MWe	873	986	1,033
3.	Turbine Net MWe (@1.5" Hg backpressure)	906	1,021	1,068
4.	Condenser Heat Load, 10^6 Btu/hr	6,250	7,050	7,350
5.	Condenser Coolant flow, gpm	840,000	840,000	840,000
6.	Condenser Δ t, ^oF	14.9	16.8	17.5
7.	Service water heat load, 10^6 Btu/hr	100	120	140
8.	Service water flow, gpm	30,000	30,000	30,000
9.	Service water Δ t, ^oF	6.7	8.0	9.4

TABLE III.B.3-3

THERMAL DATA FOR INDIAN POINT UNIT 3

		Initial Guaranteed	Maximum Guaranteed	Maximum Calculated
1.	Reactor Power, MWt	3,025	3,087	3,217
2.	Plant Net MWe	965	986	1,033
3.	Turbine Net MWe (@1.5" Hg backpressure)	1,001	1,021	1,068
4.	Condenser Heat Load, 10^6 Btu/hr	6,840	7,050	7,350
5.	Condenser Coolant flow, gpm	840,000	840,000	840,000
6.	Condenser Δ t, ^{o}F	16.1	16.8	17.5
7.	Service water heat load, 10^6 Btu/hr	100	120	140
8.	Service water flow, gpm	30,000	30,000	30,000
9.	Service water Δ t, ^{o}F	7.3	8.0	9.4

III.C. Chemical and Other Discharges

Question III.C.1

The details of the usage of the flash evaporator to distill river water for make-up need clarification. The average volume of water distilled, the concentration factor and the estimated average amount of H_2SO_4 used should be presented.

Answer:

Make-up will be from the Hudson River estuary at an expected rate of 131,250 lbs/hr. The distillate used for plant makeup will be 87,500 lbs/hr., and the blowdown 43,700 lbs/hr. The concentration factor is about 3. At this load, approximately 20 lbs/hour of concentrated sulfuric acid is used. These figures indicate the maximum values which would be found in the plant's operation.

Question III.C.2

The method for determining the residual chlorine discharge should be discussed. A description of the different forms of chlorine included in the term "residual" should be provided. Methods used to reduce the amount of chlorine used and discharged should be considered.

Answer:

Residual Chlorine (or Chlorine Residual): The amount of available chlorine present at any specified period, subsequent to the addition of chlorine.

Free Available Chlorine Residual (or Free Chlorine or Free Available Chlorine): Residual chlorine consisting of hypochlorite ions (OC1), hyperchlorous acid (HOC1), or a combination thereof.

Combined Available Chlorine Residual (or Combined Chlorine or Combined Available Chlorine: Residual chlorine consisting of chlorine combined with ammonia, nitrogen or nitrogenous compounds.

Methods: Orthotolidine (colorimetric) and starch-iodide methods are used for residual chlorine determinations. These methods are found in "Standard Methods for the Examination of Water and Wastewater" or "ASTM Standards - Part 23."

The Environmental Report for Indian Point 3 stated that the condenser would be chlorinated three times a week. Since the preparation of that report, Con Edison embarked on a program to determine if the amount of chlorination could be reduced. At present, the Company has reduced the amount of chlorine discharged by eliminating any chlorination when the river water temperature is below 45°F, unless excessive fouling occurs. Extensive investigation to further reduce the chlorination schedule during other periods is also planned.

Question III.C.3

If the filter beds in the sewage system are overloaded and chlorination becomes necessary, the amount of chlorine to be used should be estimated and the method to be used for monitoring the chlorinated effluent as well as the point of discharge into the river should be presented.

Answer:

At the present time the sewage treatment facilities at Indian Point are more than adequate for the station personnel and the Company does not intend to discharge any effluents from the system into the river. Con Edison is, however, looking into the possibility of expanding the present facility to accomodate a larger population which may be present at Indian Point at a future date.

Question III.C.4

The source of potable water and its treatment, volume, etc. should be described.

Answer:

The source of domestic water for the plant is the Catskill Reservoir via the local water supply system. The water coming in is not treated by Con Edison. The plant uses 450,000 gallons per day for normal plant usages and sanitation although the amount used for drinking and sanitation is not specifically measured.

Question III.C.5

Details on the primary system demineralizers such as the maximum amount of NaOH to be used, amount of water flow, etc., should be provided. This should also include the amount of NaOH used for each ion exchange regeneration cycle.

Answer:

At Indian Point, there are Anion Demineralizers of two different sizes: (2) - 30 ft^3 and (2) - 12 ft^3 exchangers. The 30 ft^3 exchanger will require a maximum of 300 gallons of 10% NaOH and approximately 5,000 gallons of water to complete a regeneration. The 12 ft^3 exchanger will require a maximum of 120 gallons of 10% NaOH and approximately 3,000 gallons of water to complete a regeneration.

Question III.C.6

Details on the type of monitoring to be carreid out for the heavy metal ions in the effluent, including type of analysis, sensitivity etc., should be presented.

Answer:

Since chromium is the only heavy metal for which a discharge is anticipated, heavy metal monitoring will be limited to chromium. As in all effluent monitoring, standard analysis methods will be used.

Question III.C.7

The chemicals, quantities and disposal of all degreasing and cleaning solutions used prior to start-up should be indicated.

Answer:

These chemicals and reagents will not be discharged to the river. They will either be drummed, trucked or barged away by a private contractor.

Question III.C.8

The methods of disposal of oil and grease leakage from the various components should also be presented.

Answer:

All oil and grease leakage occurring on the conventional side is collected, drummed and picked up by outside contractor for disposal off-site.

All oil and grease leakage occurring on the nuclear side is collected, drummed, solidified as with liquid radioactive waste, and shipped off-site for disposal.

Question III.C.9

The Environmental Report for Indian Point Unit 3 gives the metal boron discharged as 900 lbs/day from all 3 units with Unit No. 3 discharging 300 lbs/day. The ER for Unit No. 2 cites 600-lbs/day discharged from each Unit No. 1 and Unit No. 2. The apparent discrepancy need explanation.

Answer:

In this instance the Unit No. 3 Environmental Report is incorrect. The maximum sustained lbs/day from Unit No. 3 is 600 lbs/day. It should be noted that this discharge of 600 lbs of boron is based upon the release of the entire primary coolant system borated to 2,000 ppm. This release is therefore very unlikely to occur. Each of the three units could discharge 600 lbs/day but it would be even more unlikely that more than one unit would discharge at these conditions at the same time.

Question III.C.10

The apparent differences in usage (lbs/day) and concentrations of hydrazine, morpholine, and cyclohexylamine discharged from each of the 3 Units should be explained.

Answer:

1. Morpholine will not be used in any of the systems of Units 1, 2, and 3.
2. The maximum sustained releases are the same for Units 2 and 3, i.e., hydrazine 5 lb/day, cyclohexylamine 12 lbs/day each. Unit No. 1 only uses hydrazine when the feed water system is saturated with oxygen and only during a start-up, hence the larger 24 lbs/day. This is not a sustained release. The difference between Units No. 2 and 1 in the lbs/day cyclohexylamine is based on the discharge flow rate. Blowdown is 5 times greater in Unit No. 2 than in Unit No. 1, thus 12 lbs/day to to 2.5 lbs/day.

Question III.C.11

In regards to Unit No. 1, information is needed on the frequency and amount of chemical additions to and discharges from the different water systems and on where they are introduced and discharged. Include the chemical analysis of the boiler blowdown.

Answer:

See Table III.C.11-1

TABLE III.C.11-1

UNIT 1 CHEMICALS

Source	Chemical	Frequency of Addition	Frequency of Discharge	Max lb/day Addition (Place of Addition)	Max lb/day Discharge (Place of Discharge)	Additional Tests
Service Boilers	Phosphate (PO_4)	Continuous	Continuous	15 (To Drum	15 (To Discharge Canal)	TDS; NaOH (ppm); Na_3PO_4 (ppm)
	Sodium Hydroxide (NaOH)	Continuous	Continuous	30 (To Drum)	30 (To Discharge Canal)	
Nuclear Boilers	Cyclohexylamine	Continuous	Continuous	2.5 (To Feedwater)	2.5 (To Discharge Canal)	pH; Conductivity; Chloride; N_2H_4 (when treated)
	Hydrazine	Batch	Batch	24 (At start-up)	24 (To Discharge Canal)	
Primary Coolant	Lithium Hydroxide (LiOH)	Not used at present time, but may be used in the future. Added to maintain a concentration of 0.22 to 2.2 ppm Li. Discharged only following evaporator break-down.		2.5 (To Clean Water Storage Tank)	2.5 (Only if Evaporator Breaks Down; To Discharge Canal)	
	Boric Acid (B)	Concentration maintained between 0 ppm B and 2,000 ppm B, depending on core life. Only discharged during evaporator breakdown.		600 (To Clean Water Storage Tank or directly into Loop 14)	600 (only if Evaporator Breaks Down; To Discharge Canal)	
Condenser	Chlorine	See Answer to Question III. C. 2		(To Travelling Screen Effluent)	(To Discharge Canal)	
Laundry	Detergent	Batch	Batch	3 (To Washing Machines)	3 (To Laundry Waste Tank and then to Discharge Canal)	
Water Treatment plant*	Sodium Hydroxide (NaOH)	Batch	Batch	120 (One regeneration per day average added to Exchangers)	120 (One regeneration per day average Effluent to Discharge Canal)	
	Sulfuric Acid (H_2SO_4)	Batch	Batch	450 (One regeneration of Cation and Mixed Bed Ion Exchangers Added to Exchangers	450 (One regeneration of Cation & Mixed Bed Ion Exchangers. Effluent to Discharge Canal)	
Evaporator	Sodium Hydroxide (NaOH)	Continuous (when in svc.)	Continuous (when in service)	6 (To Evaporator)	6 (To Discharge Canal)	
Preheater Baskets (Washings)	Soda Ash	2-4 / year	2-4 / year	1000 (From Settling Tanks)	1000 (To Discharge Canal)	

*A system to neutralize these effluents in now being designed

Question III.C.12

Details of the chemical treatment of plant service water should be supplied.

Answer:

The plant service water is from the river and will be treated in the same way as the main condenser cooling water.

Question III.C.13

Information regarding the expected dilution of chemical discharges in the Hudson River should be supplied. Dilution contours for factors of 10 extending 1000 ft. from the discharge point at high and low tides are desired. Data on concentration of chlorine along the length of the discharge canal and out into the plume and how this curve changes with time following chlorination should be provided.

Answer:

This question should be examined in parts. First, assuming that the first two sentences apply principally to chlorine, the ability to predict chlorine concentrations in the river requires the following data:

- The rate of exertion of demand with respect to NH_xCl_{3-x} concentration for chloramines by unchlorinated River water entrained in the plume.
- The rate of decay of chloramines in the absence of demand.
- The rate of exertion of demand for free chlorine by the river water entrained in the plume.

Comprehensive data on these items are not available at present. Therefore, without these data, any predictions of chlorine and chloramine concentrations in the river would be unreliable. However, limited field determinations by NYU of chlorine and chloramine in the plume have shown no detectable concentrations of either with Unit 1 only operating.

With respect to the second portion of the question, on the expected concentrations of chlorine in the discharge canal and plume, some predictions are possible. These predictions are based on an average immediate chlorine demand in Hudson River water of 0.8 mg/1 at 2.5 mg/1 feed (determined by Indian Point operating personnel), and the assumed linear relationship between chlorine demand and chlorine feed.

Based on the stated control procedure of maintaining a 1.0 mg/1 total chlorine residual at the end of the condenser, which implies a demand of 0.47 mg/1 before this point, the combination of chlorine demand and dilution will reduce the total active chlorine as follows, assuming no chloramine formation:

a. Mixing with the unchlorinated half of Unit No. 3 flow chlorine remaining = 0.50 mg/1 before demand

$$\text{Demand} = \frac{0.8\ (\text{unchlor.}) + 0.33\ (\text{chlor})}{2} = 0.57\ \text{mg/1 at } 2.5\ \text{mg/1 feed}$$

$$\text{Demand exerted} = \frac{0.5 \times 0.57}{2.5} = 0.11\ \text{mg/1}$$

Therefore, chlorine remaining after demand = 0.39 mg/1

b. After mixing with the other side of Unit 3, travel time to the confluence with Units 1 & 2 is 30 seconds, which is too short for any appreciable self-activated reduction of free chlorine.

c. Mixing with Units 1 & 2 gives:

$$\text{Chlorine Demand} = \frac{0.8 \times 1120 + 0.46 \times 840}{1120 + 840} = 0.65 \text{ at } 2.5\ \text{mg/1 feed}$$

Chlorine concentration (before demand) = 0.167 mg/1

$$\text{Chlorine concentration (after demand)} = 0.167 - \frac{.167 \times .65}{2.5} = 0.124$$

Chlorine Demand Remaining = 0.60 mg/1 at 2.5 mg/1

d. Reduction in the discharge canal after mixing is according to the relationship:

$$C = C_o e^{-kt}$$

where:

t = time in seconds

k = self-activated rate constant

Travel time from the point of confluence of Units 1, 2 & 3 to the discharge is 180 seconds.

$$C = C_o e^{kt} = 0.124e^{(-.0002 \times 180)}$$

$$= 0.119\ \text{mg/1 at end of discharge canal}$$

e. Reduction in the plume is more subject to previously discuss ed uncertainties regarding demand. Based on the above calculations for chlorine reduction in the canal, the chlorine concentration at the point where the top of the jet strikes the surface may be as high as 0.04 mg/1 (assuming 1:2 dilution) or as low as 0.027, if linear demand continues in the plume.

The previously stated assumption of no chloramine formation is necessitated by the lack of data on chloramine uptake and decay mentioned in the discussion of the first part of the question, which would cause higher discharges of the total. Also, assumption of linearity of demand, regardless of dilution, is not necessarily valid, especially at lower concentrations such as in the plume, also driving the plume concentration upward. If the chlorine demand is not considered, dilution alone will result in conservative estimates of concentrations of:

0.5 mg/1 after mixing with the other side
0.21 mg/1 after mixing with Units 1 and 2
0.07 mg/1 in plume, assuming 1:2 dilution.

Question III.C.14

Information regarding gaseous and liquid non-radioactive discharges from nearby plants (within a 1.5 mi. radius of the plant site) and possible synergistic effects with discharges from the plant should be supplied.

Answer:

The Lovett Generating station is the only electric plant within 1.5 miles of Indian Point. Data concerning the liquid effluent from the Lovett plant has been considered in the preparation of the Environmental Report and its appendices. Section 9.3 of the Report shows the effects of thermal effluents while Appendix Z deals with chemical discharges.

Prevailing meteorology in the Hudson Valley reduces the probability of interaction between gaseous effluents emitted from Unit 3 and from the Lovett plant to a very low level. Additionally, releases from the Lovett fossil fuel facility are elevated, while Unit 3 releases are at ground level.

IV. ENVIRONMENTAL IMPACTS OF PLANT OPERATION

IV.A. Impact of Transmission Facilities

Question IV.A.1

Any information available regarding the purchase of additional rights-of-way for transmission lines to Millwood or Sprain Brook should be provided.

Question IV.A.2

Plans for clearing vegetation and maintenance of rights-of-way should be described.

Answer:

Power from Indian Point connects to Con Edison's major transmission grid at the Buchanan substation. From that point on, power from Indian Point cannot be separately identified. Accordingly, regulation of transmission lines beyond the Buchanan substation is outside of the jurisdiction of the Atomic Energy Commission. Con Edison will furnish the AEC information concerning transmission lines which run from the Indian Point plants to the Buchanan substation only, for purposes of determining system transmission capability for purposes of analyzing the company's need for a nuclear plant.

New transmission lines are subject to extensive regulation by the New York Public Service Commission pursuant to Article VII of the New York Public Service Law. Maintenance of the transmission lines from the station to the Buchanan substation is done under the regular maintenance program of Consolidated Edison.

IV.B. Radiological Impact

Question IV.B. 1

Insufficient information is presented in the Environmental Report or Supplements to reproduce the dose rates on biota. Specifically, a table of biological accumulation factors should be provided as well as the necessary information to reproduce the dose rates given in Table 14-3 in Supplement 2.

Answer:

I. Calculation of Dose to Sediments and Benthos

Assumptions

a. Highest dose will be to benthic organisms in the top two inches of sediment where higher radionuclide concentrations occur.

b. Estimated sediment doses are calculated as ratio of projected releases to past releases multiplied by the present dose rate (for Cs-137, Cs-134, Co-60, and Mn-54).

c. Core and dredge sample data from Lent's Cove and Green's Cove were used in estimating the surface sediment accumulations.

Calculations

$$\text{Dose Rate } D_{\beta\gamma} = \sum_i 18.65\ C_i \left[E_{\gamma i} F_{\gamma i} + E_{\gamma i} F_{\beta i} \right] \quad \frac{\text{mrads}}{\text{year}}$$

C_i = concentration of i^{th} nuclide in sediment - pCi/gm

$\bar{E}_{\gamma i}$ = average gamma energy per disintegration of i^{th} nuclide, MeV/dis

$E_{\beta i}$ = average beta energy per disintegration of i^{th} nuclide, MeV/dis

$F_{\gamma i}$ = fraction of γ energy absorbed (0.3 for slab geometry one inch thick)

$F_{\beta i}$ = fraction of β energy absorbed (assumed = 1.0)

The radionuclide concentration in the top inch of sediment from Lent's Cove, base based on measurements as of August 26, 1971 were:

Cs-137	Cs-134	Co-60	Mn-54
8 pCi/gm	9 pCi/gm	2 pCi/gm	12 pCi/gm

Dose rate to Benthos - top inch:

Cs-137	Cs-134	Co-60	Mn-54
60 mrad/yr	110 mrad/yr	30 mrad/yr	60 mrad/yr

Projected Dose Rate Increases

It was assumed that radionuclide concentrations in sediments measured in Lent's Cove were due to Indian Point Unit No. 1 releases between January 1, 1970 and August 30, 1971:

	Cs-137	Cs-134	Co-60	Mn-54
Cumulative Releases 1/1/71-8/30/72	13.12 Ci	10.66 Ci	5.8 Ci	8.68 Ci
Ratio Top Inch Lents Cove to Releases	0.6 pCi/pm / Ci released	0.8 pCi/gm / Ci released	0.3 pCi/gm / Ci released	1.4 pCi/gm / Ci released

II. Calculation of Doses to Fish

Assumptions

a. Fish resides in mixing zone of reactor outfall for extended periods of time.

b. Fish is assumed to be a flat ellipsoid with axis ratios 1:2:4 and a mass = 1.0 kg.

c. Radi onuclides are distributed uniformly in fish.

d. For Cs-137, Cs -134, Co-60, Co-58, Mn-54 original relationships between the concentrations in fish and reactor releases established for environmental measurements were us ed to estimate the expected radionuclide content in fish.

For all other nuclides, stable element concentration factors were utilized for purposes of calculation. The dose was calculated using the following formulae:

$$D_T = \sum D_i = \sum (D_{\beta i} + D_{\gamma i})$$

where: D_T = Total Dose

D_i = Dose from nuclide i

$D_{\beta i}$ = β dose from nuclide i

$D_{\gamma i}$ = γ dose from nuclide i

and: $D_{\beta i}$ (mrad/yr) = $A_i \times \bar{E}_{\beta i} \times 1.87 \times 10^{-2}$

$D_{\gamma i}$ (mrad/yr) = $A_i \times \bar{E}_{\gamma i} \times 1.87 \times 10^{-2}$

where: A_i = Activity of nuclide i in fish (pCi/kg).

$\bar{E}_{\beta i}$, $E_{\gamma i}$ = Effective β or γ energy observed per disintegration of nuclide i, (MeV/dis).

and: $A_i = R_i \left(\frac{\mu Ci}{yr}\right) \times (MF)_i$

where: $(MF)_i$ = pCi/kg of nuclide i observed in fish per Ci/yr released.

Activities in Fish From Plant Operation

The expected activities of each nuclide in fish at Indian Point were calculated by methods (1) and (2)

(1) A_{fish} (pCi/kg) = R_e (μCi/yr) x MF $\left(\frac{pCi/yr}{Ci/kg}\right)$

This method was used for (Mn^{54}, Co^{60}, Cs^{137}, Cs^{134}). The MF was calculated by dividing the average concentration of each nuclide in fish samples in the Indian Point vicinity during 1969 and 1970 (N.Y.U. measurements) by the total release of each nuclide from Indian Point Unit No. 1 during 1969. Activities in fish were then calculated by multiplying the expected release rates (R_e) from Unit No. 1 and 3 by the MF.

(2) A_{fish} (pCi/kg) = C_d (pCi/1) x D.F. x C.F.

C_d = Expected concentration of radionuclide in discharge

D.F. = dilution factor for mixing zone = 0.26 (base on the ratio of condenser coolant flow to average monthly fresh water flow from June to October.

C.F. = concentration factor for radionuclide in fish (UCRL)
I-131, I-133 = 1.0
H-3 = 10
Mo-99 = 100
Sr = 10

C. <u>Source Terms</u>

a) R_e: Unit No. 1 - expected R_e for each nuclide was calculated from the measured composition of waste releases (Unit No. 1) for 1969

$$R_{ei} := \left(\frac{R_i\ (1969)}{R_T\ (1969)}\right) \times R_{et};\quad R_{ei} = \text{expected annual release of nuclide i}$$

R_i (1969) = 1969 release of nuclide i

R_i' (1969) = 1969 summed releases of CS^{137}, CS^{134}, Mn^{54}, Co^{60}, Co^{58}, I^{131}

R_{et} = expected total activity of liquid releases (non-tritium)

This calculation tends to overestimate the expected releases of each longer-lived nuclide since the release of small amounts of short-lived nuclides has been neglected in the calculation of R_T 1969.

b) C_d: Unit No. 1 - H^3 concentration was obtained from Table 2-3-7 of the Indian Point Unit No. 2 Environmental Report. I^{131} concentration was obtained as follows:

$$C_{I\text{-}131} = \left(\frac{R_{131}\ (1969)}{R_T (1969)}\right) \times C_{et}$$

where: C_{et} = expected total non-tritium concentration in discharge Unit No. 1.

The following table shows how the values of MF (units (pCi/yr)/(Ci/kg) were obtained:

Calculation of MF

Nuclide	Release Ci 1969	Fish Conc. (pCi/kg)	MF $\frac{pCi/yr}{Ci/kg}$
Cs-137	5.8	41	7×10^{-6}
Cs-134	5.5	37	7×10^{-6}
Co-60	4.2	7	2×10^{-6}
Co-58	5.8	5	8×10^{-7}
Mn-54	5.4	20	4×10^{-6}
I-131	4.6	not detected	---
	31.3 Ci		

The annual average dose rates in Table 14-3 were computed from the annual average releases reported in Table 14-2. The doses are in units of millirem per year. This was inadvertantly omitted from the table. Whole body doses due to the absorption of gamma rays from the noble gases (Kr, Xe) were calculated by the conservative semi-infinite cloud method.

$$D\ (\text{mRem}) = 246\ Q\ (\text{Ci/yr}) \times \frac{\chi}{Q}\ (\text{sec/m}^3) \times E_\gamma\ (\text{MeV})$$

The term Q, as mentioned above, is found, by isotope and release path, in Table 14-2. The dispersion coefficient, χ/Q, represents annual average measured meteorological statistics in the worst sector around the plant. This χ/Q assumes a ground release of all gases. The value assumed, as reported in Technical Specification 3.9, is 2.6×10^{-5} sec/m^3. The energy released, E_γ , is the gamma energy of each isotope. Beta doses were not computed since their biological effect would be minimal. Betas at the energies involved would not appreciably penetrate to any organ of the body. Absorption in the skin would also be small since the outer 0.07 mm of skin is nonradiosensitive and would provide some attenuation and a great deal of attenuation is provided by any clothing that may be worn. The effects of exposure to small unprotected areas of the body are much less than the effects of the same exposure to the skin of the whole body.

The gamma energies assumed are:

Kr-85	.003 MeV	Xe-133	0.081 Mev
Kr-85m	.129 MeV	Xe-133m	0.233 Mev
Kr-88	1.067 MeV	X3-155	0.264 Mev
Kr-88	2.069 MeV	Xe-135m	0.53 Mev
		Xe-138	0.42 Mev

Thyroid doses due to inhalation of radioactive iodines were calculated as follows:

$$D\ (\text{mRem}) = 10^3\left(\frac{\text{mRem}}{\text{Rem}}\right) \times Q\left(\frac{\text{Ci}}{\text{Yr}}\right) \times \frac{X}{Q}\left(\frac{\text{sec}}{\text{m}^3}\right) \times B\left(\frac{\text{m}^3}{\text{sec}}\right) \times K\left(\frac{\text{Rem}}{\text{Ci}}\right)$$

The term Q again is from Table 14-2 by isotope and release path. The breathing rate, B, was assumed to be 2.32×10^{-4} m^3/sec, the average breathing rate of a standard man. K is the dose conversion factor from Table III on Page 25 of TID-14844. The dispersion factor, X/Q, is, for all paths but those due to steam generator blowdown, the annual average Technical Specification X/Q of 2.6×10^{-5} sec/m^3 mentioned above. Gaseous iodine due to steam generator blowdown can be released through either of two paths. When Indian Point Unit No. 1 is on the line, flashed steam from the Unit No. 1 Blowdown Flash Tank (to which Unit No. 3 blowdown will be routed when radioactive) is sent to the Unit No. 1 main condenser for ultimate release from the superheater stack via the condenser air ejector. In this case, the X/Q assumed is 5.8×10^{-7} sec/m^3, the Technical Specification annual average value.

When Unit No. 1 is not on the line (the assumption is that this will be six weeks per year), flashed steam will exit via the Blowdown Flash Tank vent from atop the Chemical Systems Building. The annual average X/Q from this point, assuming a ground release, is 3.4×10^{-5} sec/m^3 in the worst meteorological sector.

Question IV.B.2

In addition, a discussion of any direct exposure that may be incurred by the off-site population from on-site radioactivity is also lacking.

Answer:

Doses to the off-site population from other than radioactive releases were calculated for three sources - the direct dose from possible contamination in the Refueling Water Storage Tank (RWST), and both the direct and the skyshine doses from sources within containment, PAB and Turbine-Generator Building.

The dose from the RWST was calculated with the following assumptions:

(i) RWST water is well mixed with that of the primary system but not mixed with the Fuel Storage Pit water.

(ii) All fission and corrosion product activities in the primary coolant have reached equilibrium.

(iii) 0.25% fuel defects.

(iv) Cylindrical volume source to represent RWST.

(v) Detector point 350 meters from the RWST and on the same plane with it.

(vi) No shielding except air between source and detector.

(vii) Six week decay of all isotopes since shutdown.

(viii) RWST water has not been treated by available demineralizers.

The total does rate has been calculated to be about 0.001 mRem/hr. The activities assumed in the RWST water are as follows:

Isotope	Activity (μCi/cc)
Mn-54	5.45×10^{-5}
Co-58	1.54×10^{-3}
Fe-59	3.77×10^{-5}
Co-60	1.93×10^{-4}
Sr-89	1.47×10^{-4}
Y-91	2.94×10^{-3}
Mo-99	1.73×10^{-1}
I-131	9.17×10^{-2}

Isotope	Activity (μCi/cc)
Cs-134	1.2×10^{-2}
Cs-136	1.16×10^{-3}
Cs-137	1.17×10^{-3}
Ba-140	3.13×10^{-5}
Ce-144	1.1×10^{-5}

The total dose when integrated over a year's period of time is 0.16 mRem. The dose would actually be much less than this since there is no direct line of sight between the off-site property and the RWST.

The direct and skyshine doses off-site due to sources in containment, the Primary Auxiliary Building and the Turbine-Generator Building were calculated to be about 0.09 mRem annually.

Source strengths were generally computed by assuming:

a) Full power of 3216 MWt.

b) 0.25% fuel defects.

c) 20 gpd steam generator leak.

d) Point source geometry.

e) Isotropic photon scattering in air with peak (straight-ahead) magnitude

f) Site boundary, 300 meters from any source

A summary of the results of the calculations for sources in each of the three structures is presented below:

I. Containment Sources

Sources due to fission product and corrosion product activity in the primary coolant and N^{16} activity due to the 0^{16} (n, p) N^{16} reaction in the primary coolant were considered. The only gamma shielding considered was the 3-1/2 foot concrete dome roof of containment.

a) Fission Products and Corrosion Product Activity

From the Indian Point Unit No. 3 FSAR, Table 9.2-5 of primary coolant activity adjusted to reflect 0.25% failed fuel and a 20 gpd steam generator leak, an annual average dose of 2.6×10^{-6} mRem was calculated.

b) N-16 activity in the primary coolant: Based on a maximum concentration of 83 μCi/cc (Indian Point Unit No. 3 FSAR, Page 11.2-5), the yearly average does was calculated to be 0.067 mRem.

II. Primary Auxiliary Building Sources

Per the Indian Point Unit No. 3 Technical Specifications, no tank containing radioactive gases may contain more than 16,500 curies of Xe-133 equivalent. The extremely conservative assumption that fifteen such maximum activity tankfulls exist yearly in the PAB (having a concrete roof of two feet minimum thickness) yields an annual dose of 2.5×10^{-6} mRem.

III. Turbine-Generator Building Sources

Two general sources of activity in the T-G Building were considered - the activity in the water in the three condensers (IP2 FSAR, Quest. 11.2-7) and the activity in the steam in the feedwater heaters, the moisture separator reheaters and the pipes from these MSR's to the low pressure turbines (IP2 FSAR, Quest. 11.2-5).

a) Condenser Sources

The annual dose at the site boundary from activity in the three condensers (covered by the low pressure turbines) has been calculated to be 7.5×10^{-3} mRem.

b) Main Stream Activity

The annual dose from gamma sources in the feedwater heaters, MSR's and piping to the low pressure turbines was calculated to be .014 mRem.

The annual total direct and skyshine dose at the site boundary from radioactive sources in the containment, PAB and T-G Buildings, therefore, has been calculated to be 0.088 mRem.

Question IV. B. 3

In addition, the distances from the point of release of gaseous effluent to the nearest milk cow and site boundary in each of the 16 sectors are required. Also, the distance, from the point of release of gaseous effluents to the nearest residences in the different sectors surrounding the site particularly along the east bank of the Hudson River are needed.

Answer:

Sector	Distance to Nearest Milk Cow (miles)	Distance to Nearest Point on Site Boundary (meters)	Distance to Nearest Residence (meters)
N	16	River	1950
NNW	10	River	1740
NW	13	River	1830
WNW	7	River	1830
W	7	River	1890
WSW	7	River	2135
SW	None Detected	350	2745
SSW	7	380	1525
S	7	580	1280
SSE	None Detected	595	1220
SE	7	580	1100
ESE	7	580	1070
E	7	625	730
ENE	10	760	1370
NE	7	790	1525
NNE	7	River	3050

Question IV.B.4

In determining doses from plant accidents, the detailed assumptions used in calculating the consequences of each class of accidents are required. Details of the meteorology used in determining the estimates of doses at the site boundary and the integrated man-rem dose to 50 miles are needed.

Answer:

In general, for the calculations of doses from plant accidents reported in the Environmental Report Section 19, the assumptions of the proposed Annex to Appendix D of 10CFR50 were used. In many cases, where source strength assumptions are not clearly indicated, additional assumptions had to be made as described below. The meteorological assumptions are as presented in the proposed Appendix D. The dispersion factor, χ/Q, which was used is 1/10 of the Safety Guide 4 value or about 10^{-4} sec/m^3 at 350 meters.

ACCIDENT 3

3.1

Based on maximum expected releases from the Gaseous Waste Disposal System discussed in the FSAR Question 11.6, it was assumed that the equivalent of about 300 curies of Xe-133 would be in the largest gas storage tank at any time. This presumes that there would be one month holdup of each tank before release. Twenty-five percent of this, or 75 Ci of Xe-133, were thus assumed to be released for this accident. Gamma whole body and beta skin doses were completed with the semi-infinite cloud method. Beta skin doses were calculated at the outer surface of the skin with no attentuation due to clothing assumed.

It was assumed that 7050 gallons would be in a liquid holdup tank. Twenty-five percent of this, or 1760 gallons, are released with this accident. Source strengths were circulated by assuming that activities in the tank were equal to 10% of the primary coolant equilibrium activities reported in the FSAR Table 9.2-5. It was further assumed that 10% of the iodines that were released in the liquid would be released as gases. This would amount to 3.7×10^{-3} curies of I-131 released to the atmosphere after passing through the 99% efficient charcoal filters.

3.2 AND 3.3

All the above assumptions hold true for these accidents except that the source strengths are four times those assumed above.

ACCIDENT 5

5.2

In order to compute the total amount of gases released from the condenser air ejector, it was assumed that ten minutes passed before action was taken to shut the plant down and that it took six hours to terminate all releases. During this time, the full steam flow to the condenser of $1,3 \times 10^7$ lb/hr was assumed to gradually decrease to zero. Activities released are:

I-131	10 μCi	Kr-85	320 μ Ci
I-132	15 μCi	Kr-85m	1.7×10^4 μ Ci
I-133	24 μCi	Kr-87	3.1×10^4 μ Ci
I-134	25 μ Ci	Kr-88	4.7×10^4 μ Ci
I-135	22 μ Ci	Xe-135	2.5×10^4 μ Ci
		Xe-138	6.2×10^4 μ Ci
		Xe-133	8.9×10^4 μ Ci

5.3

The same time dependent assumptions as in 5.2 were used for this accident in addition to those presented in the proposed Annex to Appendix D of 10CFR50. Activities released are:

I-131	2.9×10^4 μ Ci	Kr-85	1.3×10^8 μ Ci
I-132	1.0×10^4 μ Ci	Kr-85m	3.8×10^7 μ Ci
I-133	4.7×10^4 μ Ci	Kr-87	2.2×10^7 μ Ci
I-134	6.1×10^3 μ Ci	Kr-88	6.7×10^7 μ Ci
I-135	2.5×10^4 μ Ci	Xe-133	5.1×10^9 μ Ci
		Xe-135	1.1×10^8 μ Ci
		Xe-138	1.2×10^7 μ Ci

ACCIDENT 6

6.1

The gap activity in one row of fuel pins was computed to be 405 curies of I-131. There are 193 fuel assembiles in the core and 225 fuel pins per assembly in a 15 x 15 array. A peak-to-average power factor of 1.35 was assumed to treat the activity released as the maximum expected. All five charcoal filter units are expected to be in operation after such an accident with a total flow rate through the units of 40,000 cfm. A containment leak rate of 0.1% of containment free volume was assumed for the duration of the release (two hours).

6.2

For this accident, the gap activity in an entire assembly (225 pins) was assumed released to the water. This amounted to about 5.5×10^3 Curies. All other assumptions (except the different decay times listed in Appendix D) remain the same as for 6.1.

7.1

This accident is similar to 6.1 except that activity is released through the "once-through" charcoal filters at a rate of 20,000 cfm.

7.2

This accident is similar to 6.2 except that activity is released through the "once-through" charcoal filters at a rate of 20,000 cfm.

ACCIDENT 8

8.1 (Small Break)

The activities in the primary coolant (0.5% failed fuel) which were used to compute the doses from this accident are:

I-131	0.82 μCi/cc	Xe-133	96 μCi/cc
I-132	0.3 μCi/cc	Xe-133m	1.1 μCi/cc
I-133	1.33 μCi/cc	Xe-135	2.1 μCi/cc
I-134	0.19 μCi/cc	Xe-135m	0.065μCi/cc
I-135	0.72 μCi/cc	Xe-138	0.23 μCi/cc

Kr-85	2.5 μCi/cc
Kr-85m	0.72μCi/cc
Kr-87	0.42μCi/cc
Kr-88	1.3 μCi/cc

The volume of primary coolant is 12,600 ft^3 or $3,6 \times 10^8$ cc.

8.1 (Large Break)

Doses due to this accident are to be computed assuming that primary coolant activity (with 0.5% failed fuel) and 2% of the core inventory of halogens and noble gases are released. Primary coolant activities are shown above. Two percent of the core inventory is:

I-131	1.6×10^6 Ci	Xe-133	3.6×10^6 Ci
I-132	2.4×10^6 Ci	Xe-133m	9.8×10^5 Ci
I-133	3.6×10^6 Ci	Xe-135	1.0×10^6 Ci
I-134	4.4×10^6 Ci	Xe-135m	9.8×10^5 Ci
I-135	3.3×10^6 Ci	Xe-138	3.4×10^6 Ci
		Kr-85	1.3×10^4 Ci
		Kr-85m	7.1×10^5 Ci
		Kr-87	1.4×10^6 Ci
		Kr-88	2.0×10^6 Ci

8.2(a) Rod Ejection

By the assumptions given in the proposed Annex to Appendix D of 10CFR50, the consequences of this accident would be 10% of those calculated for 8.1 (large break) above.

8.3(a) Steamline Breaks

For this accident, the volume of one steam generator (82,000 lbs) is assumed released to the atmosphere. The assumptions in the proposed Annex to Appendix D to 10CFR50 yield the following iodine activities released:

I-131	.0014 Ci
I-132	.00019 Ci
I-133	.00062 Ci
I-134	.0000045 Ci
I-135	.00013 Ci

By the Assumption (b) in the proposed Annex, the small steamline break would yield doses at least 20% of, but no more than the large break.

IV.C. Biological Impact

Question IV.C.1

The location of sampling points 5 and 6 in Fig. 1 in the February 5, 1973 testimony, "Effect of Indian Point Units 1 and 2 Operation Hudson River Dissolved Oxygen Concentrations" (J. P. Lawler) should be provided.

Answer:

Point 5 was at 0' - 2' depth and 10' depth, approximately 100' from discharge ports (in plume). Point 6 was at 0' - 2' depth, approximately 50' from discharge ports.

Question IV.C.2

A methodology for predicting impingement at the intake to Unit No. 3, including consideration of a loss factor for fish impinged but not collected and consideration of local reduction in stock should be provided.

Answer:

The method proposed for predicting impingement at the intake to Unit 3 is the same as the method described in "The Estimation of Fish Impingement at Indian Point Units 1 and 2," Testimony of Ronald A. Alevras, Frebruary 5, 1973. The same method is used because Units 2 and 3 have the same flow rate and therefore the same relationship to Unit 1 flow rate. The loss factor applied to samples collected at Unit 3 should be less than the 25% applied to intake sampling at Unit 1 because of differences in the screening and collection systems at the two units. Vertical traveling screens are the outermost screens at Unit 3 and will remove the fish from the water, therefore the losses associated with cleaning fixed screens will not occur at Unit 3. In addition, by running the traveling screen continuously at Unit 3, fish will be removed quickly and returned to the river thereby reducing mortality due to impingement. The collecting procedure at Unit 3 avoids debris clogging of the collecting gear by replacing the sluice screen with a catch basket which can handle a much larger debris load. In addition, with the traveling screen running continuously there will not be a buildup of debris and impinged fish which can occur on a fixed screen. A loss factor of 5% is proposed for fish collections made at Unit 3.

Local reduction in stock is not taken into consideration in the above prediction method because data are not available on the diel and seasonal movement patterns of local fishes and the population dynamics studies are not yet completed.

Question IV.C.3

A figure comparable to Figure V-3, page V-29 of the FES for Unit No. 2, including least-squares curve, the regression model used, r^2, and a tabulation of the impingement and velocity values in the figure should be provided.

Answer:

Con Edison has not yet prepared a figure comparable to Figure V-3, page V-29 of the FES for Unit No. 2. Data are still being collected in a series of tests at varying velocities at Indian Point 2. The collections are expected to be completed by April 30 and the data reduced and analyzed by May 31 at which time we shall be pleased to furnished the information.

Question IV.C.4.

A tabulation should be provided of the data corresponding to the histogram in Fig. 2, page 6 of the February 5, 1973 testimony, "Effects of Entrainment on Morone sp. (striped bass and white perch) eggs and larvae at Indian Point" (G.J. Lauer).

Answer:

The following table provides the data which corresponds to the histogram in Figure 2, page 6 of the February 5, 1973 testimony by Dr. G.J. Lauer.

Morone saxatilis

Dates	Number	Size (mm)
June 4-10	1	4
	1	6
	2	7
	1	8
June 11-17	1	5
	17	6
	16	7
	33	8
	55	9
	38	10
	24	11
	15	12
	1	13
June 18-24	3	6
	12	7
	22	8
	21	9
	5	10
	2	11
	1	12
	1	13
	1	14
	1	15
June 25-July 1	2	8
	1	10
	2	12
	1	19
July 2-15	1	8
July 16-22	1	8
	2	9

Dates	Number	Size (mm)
July 23-29	2	8
	8	9
	4	10
	4	11
	2	12
	1	14
July 30-Aug. 5	1	6
	1	7
	1	8
	6	9
	5	10
	13	11
	22	12
	15	13
	8	14
	8	15
	6	16
	2	17
	3	19
Aug. 6-12	2	12
	1	15

Morone americana

June 4-10	2	4
	1	5
	1	6
June 11-17	3	4
	14	5
	26	6
	18	7
	5	8
	6	9
	1	10
June 18-24	1	4
	7	5
	16	6
	9	7
	7	8
	13	9
	2	10
	2	11
	3	12
	1	13
	1	14

Dates	Number	Size (mm)
June 25-July 1	4	4
	3	5
	1	9
	2	10
	2	12
July 2-15	2	4
	3	5
	1	6
July 16-22	2	5
	1	7
July 23-29	12	4
	9	5
	1	6
	3	7
	2	8
	3	9
	4	10
	11	11
	5	12
	1	13
July 30-Aug. 5	1	9
	5	10
	6	11
	12	12
	6	13
	3	14
	2	15
	2	16
	2	17
	1	18
Aug. 6-12	1	13
	1	14
	1	16
	1	17
	2	18
	2	19
	2	20
	2	21
	1	23
	1	24
Aug. 13-19	1	26

Question IV.C.5

The ΔT values (T at station D2 or discharge ports minus T at intake) and residence times to stations D1, D2, and the discharge ports should be provided for the following 7 combinations of Units at 60% flow and at 100% flow: each Unit alone, Unit Nos. 1 and 2, Units Nos. 1 and 3, Units Nos. 2 and 3, and Units Nos. 1, 2, and 3. See testimony of February 5, 1973, "Effects of Entrainment on Morone sp. (striped bass and white perch) eggs and larvae at Indian Point" (G. J. Lauer) for location of stations D1 and D2. How were these residence times calculated and what assumptions were made?

Answer:

This question will be answered in two parts, first temperature, and then residence times.

(a) Temperature

The total temperature differential between the intake forebay and the confluence of the outfall structure with the river for the combinations listed above are presented in Table IV.C.5-1.

Station location D1 "sees" only the discharge from Units 1 and 2. Therefore, the temperature at this location is the average temperature (weighted to account for the difference in flow rates and heat load between the Units) of Unit 1 and 2, at the flow rates of interest. This is a reasonable assumption because:

(i) There is negligible heat transfer to the surroundings along the length of the discharge canal; and

(ii) There is complete mixing in the discharge canal (characteristic Reynolds Number is $\gg 4,000$).

Station location D2 "sees" the combined effluent of all three units, since it is downstream of the confluence of the Unit 1, 2 and 3 condenser discharge into the canal. This location therefore, has the same temperature rise that one would obtain at the confluence of the discharge canal with the river.

(b) Residence Times

As above, the average residence time to station D1 reflects Units 1 and 2 only, while station D2 reflects all three units. These residence times are presented in Table IV.C.5-2. This table was calculated for a river level of 1.5 feet above MSL and a height differential of 1.5 ft across the discharge gate.

TABLE IV.C.5-1

TEMPERATURE DIFFERENTIALS BETWEEN INTAKE FOREBAY AND VARIOUS LOCATIONS IN DISCHARGE CANAL

Temperature Differential (°F)

	Discharge Ports		Station D1		Station D2	
Unit (s)	Full Flow	Reduced Flow	Full Flow	Reduced Flow	Full Flow	Reduced Flow
1	12.0	18.6	12.0	18.6	12.0	18.6
2	14.6	23.8	14.6	23.8	14.6	23.8
3	16.0	27.5	--*	---*	16.0	27.5
1+2	13.9	22.3	13.9	22.3	13.9	22.3
1+3	14.9	23.9	12.0	18.6	14.9	23.9
2+3	15.3	24.9	14.6	23.8	15.3	24.9
1+2+3	14.8	23.9	13.9	22.3	14.8	23.9

Basis:	Unit 1	Unit 2	Unit 3
Heat Load $\left(10^6 \frac{Btu}{hr}\right)$			
Condenser	1765	6250	6840
Service	150	100	110
Flow Rate (10^3 gpm)			
Condenser	280	840	840
Service	38	30	30

*Location upstream of Unit 3

TABLE IV.C.5-2

AVERAGE RESIDENCE TIMES OF WATER IN SYSTEM*

	Intake to Outfall (Min)		Intake to D1 (Min)		Intake to D2 (Min)	
Units	Full Flow	Reduced Flow	Full Flow	Reduced Flow	Full Flow	Reduced Flow
1	33.8	52.4	3.45	5.42	10.8	16.8
2	15.4	25.2	4.30	6.10	6.97	11.5
3	10.9	17.71	----------------		2.43	4.00
1+2	11.7	18.6	4.15	6.82	5.55	8.72
1+3	10.8	17.5	3.45	5.42	4.67	7.57
1+3	8.93	14.6	4.30	6.10	4.72	7.73
1+2+3	7.80	12.6	4.15	6.82	4.23	6.90

*Based on river water level of 1.5 above MSL and height differential of 1.5 feet
*across the discharge gates.

Question IV.C.6

Velocity contours should be provided at station D2 for all three units operating at 100% and at 60% flow and for Unit No. 1 alone operating at 100% and 60% flow. How would residence time of a passive particle vary depending upon lateral and vertical position in the effluent stream?

Answer:

The only available data on the velocity profiles at station D2 were obtained at a reduced flow for Unit 1 (171,000 gpm), and are presented in Table IV.C.6-1. The channel at this point is 40 feet wide, with the bottom at 20 feet below M.S.L. With a high slack tide of 3.0 feet above MSL, the average velocity through the channel is 0.42 feet/sec which is consistent with the values in the aforementioned table.

The characteristic Reynolds Number of the channel is 1.7×10^6, which is in the turbulent range (> 4,000). Turbulent flow is characterized by a uniform velocity distribution over much of the channel, except near the walls where there is a sharp decrease. It is seen from Table IV.C.6-1 that the velocities in the bulk of the channel are around (and slightly greater than) the average velocity of 0.42 feet/sec.

At 100% flow for Unit 1, one therefore would expect the same turbulent condition, with an average velocity of 0.77 ft/sec.

With all three units operating, the average velocities are 5.0 and 3.1 ft/sec, at full and reduced flow, respectively.

Because of the high Reynolds Numbers encountered the flow under all conditions would be fully turbulent. Therefore, since turbulent flow is characterized by excellent mixing, there should not be any correlation between a particle's lateral and vertical position and its residence time.

TABLE IV.C.6-1

Velocity Profile at Station D2

Data taken at 11 a.m. on 12/22/72
Tide Stage: High slack

Depth (ft)	Velocity (fps) East wall	10' out	Mid channel	10' out	West wall
0	0.37	0.37	0.42	0.27	0.24
5	0.46	0.40	0.44	0.41	0.35
10	0.46	0.46	0.42	0.41	0.35
15	0.34	0.49	0.49	0.38	0.19
Bottom	0.34 (@16')	0.45 (@17')	0.46 (@19')	0.38 (@19')	0.19 (@16')

Channel Width = 40 feet

Question IV.C.7

A tabulation should be presented of the daily temperature data (minimum and mean) corresponding to the values plotted in Fig. 2 and Fig. 3 of the February 5, 1973 testimony, "Expected Water Temperature at Indian Point During Entrainment Period" (J.P. Lawler).

Answer:

See Tables IV.C.7-1 and -2.

TABLE IV.C.7-1

OPERATING DATA - INDIAN POINT INTAKE TEMPERATURE 1967-1972

MAY				JUNE				JULY			
Date	Max.	Avg.	Min.	Date	Max.	Avg.	Min.	Date	Max.	Avg.	Min.
1	57	51.5	46	1	65	62.5	60	1	71.5	71.5	69
2	57	51.5	46	2	66	63	60	2	74	71.5	69
3	55	51	47	3	66	63.5	61	3	74	72	70
4	55	51	47	4	66	63.5	61	4	74	71.5	69
5	54	51	48	5	67	64.5	62	5	74	71.5	69
6	57	52	47	6	67	65	63	6	75	72	69
7	57	52.5	48	7	68	65.5	63	7	75	72.5	70
8	55	52	49	8	69	66	63	8	74	72	70
9	55	52	49	9	69	66	64	9	74	72.5	71
10	59	54.5	50	10	68	66	64	10	74	72.5	71
11	55	53	51	11	69	67	65	11	75	73	71
12	60	55.5	51	12	70	67.5	65	12	75	73	70
13	60	56	52	13	70	68	66	13	75	72.5	70
14	60	56	52	14	70	68	66	14	75	73.5	72
15	60	56.5	53	15	70	68	66	15	75	74	73
16	61	57	53	16	70	68	66	16	77	75.5	74
17	60	57	54	17	70	68	66	17	77	75.5	74
18	61	57.5	54	18	71	68.5	66	18	77	75	73
19	61	58	55	19	71	69	67	19	78	76.5	75
20	61	58	55	20	72	70	68	20	77	76	75
21	63	59.5	56	21	72	70	68	21	77	76	75
22	61	59	57	22	71	69.5	68	22	78	76.5	75
23	62	59.5	57	23	71	69	67	23	79	77	75
24	63	60.5	58	24	71	69.5	68	24	78	76.5	75
25	62	60.5	58	25	71	69.5	68	25	79	77	75
26	62	60	58	26	71	69.5	68	26	79	77	75
27	63	60.5	58	27	72	58.5	65	27	79	77.5	76
28	65	60.5	56	28	74	71.5	68.5	28	79	77.5	76
29	64	60	56	29	74	71.5	69	29	80	78	76
30	65	61	57	30	74	71.5	69	30	79	77.5	76
31	65	62	59					31	79	77	75

TABLE IV.C. 7-2

GOVERNMENT & PRIVATE TEMPERATURE DATA
USCG STATION AT CHARLES PT.
1960-65; 66-69

MAY				JUNE				JULY			
Date	Max.	Avg.	Min.	Date	Max.	Avg.	Min.	Date	Max.	Avg.	Min.
1	57	52.5	48	1	67	61.5	56	1	76	72.5	70
2	57	53	49	2	67	62	57	2	76	72.5	70
3	57	53.5	50	3	67	62.5	58	3	76	72.5	70
4	57	53.5	50	4	67	63	59	4	76	72.5	71
5	57	52.5	48	5	67	63	59	5	75	73	72
6	57	52	47	6	67	63.5	60	6	75	72.5	72
7	57	52	47	7	68	64	60	7	75	73	72
8	57	52.5	48	8	68	64	60	8	76	73	72
9	58	53	48	9	68	65.5	63	9	77	74	73
10	58	54.5	51	10	70	66.5	62	10	76	74	73
11	59	55	51	11	70	67	62	11	76	74	73
12	59	55	51	12	70	67	64	12	77	74.5	73
13	59	55	51	13	70	67.5	65	13	75	74.5	73
14	59	55	51	14	70	67.5	65	14	80	75.5	74
15	59	55	50	15	70	68	65	15	80	75.5	74
16	60	56.5	53	16	72	69	66	16	77	75.0	74
17	60	56	52	17	72	69	67	17	78	75	73
18	60	56.6	53	18	71	69	67	18	78	75.5	73
19	60	58	56	19	71	69	67	19	80	76	74
20	62	59.5	57	20	71	69.5	68	20	80	76.5	74
21	61	57.5	54	21	71	70	68	21	81	77	74
22	61	58	55	22	71	70	68	22	79	76.5	75
23	62	59	56	23	72	70.5	68	23	79	76.5	75
24	62	59.5	57	24	72	70.5	68	24	79	76.5	73
25	65	60.5	56	25	72	70.5	68	25	78	76.5	75
26	65	60	55	26	72	70.5	69	26	78	76.5	74
27	65	60	55	27	72	71	69	27	78	76.5	74
28	65	60	55	28	73	71	68	28	79	76.5	74
29	65	60.5	56	29	74	72	70	29	79	76.5	74
30	65	60.5	56	30	75	72.5	70	30	79	77	73
31	65	60.5	56					31	79	77	74

Question IV.C.8

Data and analysis should be supplied from the study on the growth rate (both length and weight) of white perch during the past nine years.

Answer:

Age and growth studies are continuing and are scheduled to be completed in 1976. The current status of these studies will be described in the Annual Report of Texas Instruments, which will furnished by the AEC as soon as it is available. A logic diagram showing the schedule of these and other studies is given in figure 13-6 of the Indian Point Unit 3 Envirnmental Report. This figure was submitted to the AEC in February, 1973 as part of Supplement 4 to the report.

Question IV.C.9

Monthly estimates of the number of striped bass migrating past Indian Point between October and May should be provided.

Answer:

We do not have adequate data at present to estimate the number of striped bass migrating past Indian Point on a monthly basis between October and May.

Question IV.C.10

Data on the number, size distribution and stomach contents of the white catfish in the discharge canal should be presented.

Answer:

Attached is a summary of data pertaining to white catfish collected from the discharge canal at Indian Point.

Introduction

Information for determining the biological significance of attraction of aquatic organisms to or into the effluent canal (third major objective) is being collected by sampling in the dischange canal and the thermal plume. An extensive fish trapping program was conducted in the discharge canal during summer and fall, 1972, to determine species composition, indicate relative abundance and show short-term variability of fish distribution in the canal. Field investigation will continue during the operation of Indian Point Units 1, 2 and 3.

Materials and Methods

The discharge canal sampling programs for summer and fall were conducted from July 14 to August 28 and from November 10 to December 15, respectively, near the southern end of the discharge canal. This corresponds to a station (d2) employed by New York University. During both seasons sampling was conducted primarily with a fyke net lacking wings or a lead. Two deep water traps (box nets) were used occasionally to supplement fyke net catches and a 91.4 x 2.4 m nylon experimental gill net with mesh sizes varying from 2.5 to 6.4 to 10.2 cm was utilized during fall sampling.

During both seasons the fyke net was fished next to the east wall of the canal in about 6.0 m of water with the mouth facing downcurrent. This assured that all fish in the net has swum in and had not been carried in by the current. The deep water traps were fished periodically on the bottom and mid-water at center channel and next to the west wall to capture species which may have been present but were not obtained in fyke net catches. The gill net sampled from the surface to a depth of 2.4 m and was fished only on December 5 and 6. Night-time hook-and-line fishing was performed once during July, but no fish were caught.

Upon capture, fish were rapidly transferred to 70 liter plastic containers of canal temperature water. During the November - December sampling, the transfer time was very critical because of the water - air temperature differential. Portable aerators supplied oxygen to the holding containers.

Fish were measured, marked and released into the canal at the point of capture. Catfish over 140 mm total length received a Dennison anchor tag or Petersen disc tag. The disc tag was utilized only on November 6. Right pelvic fins of white catfish less than 140 mm were clipped during the summer. Left pelvic fins were clipped from November 6 to 24 and anal fins were removed from November 27 to December 12. Recovery of fin clipped fish supplemented tag return information in determining the time between capture and recapture and also assisted in estimating the population for the size class less than 140 mm.

Dissolved oxygen, salinity and pH were measured at standard sampling stations in the river at mile 42 by the water quality group and the same environmental parameters for the canal were read from the AES when it was operative. Effluent canal and ambient river temperatures were measured by an armored field thermometer (0.2°C accuracy) and canal surface flow was estimated by timing a float as it passed under the sampling platform.

Results

a. July - August Sampling

A one week study with the fyke net from July 14 to 21 indicated the catch per unit effort was four times greater from 1700 to 0830 than from 0900 to 1630. On this basis, the night-time sampling conducted almost exclusively during succeeding sampling.

The percent composition of the total catch (n = 1281) for each species from July 14 to August 28 was: white catfish, 86.5%; white perch, 7.5%; brown bullhead, 3.6%; American eel, 1.2%; carp, 0.7%; pumpkinseed sunfish, 0.2%; striped bass, 0.2% and bluegill sunfish, 0.1%. (Table IV.C.10-1.) White catfish exhibited a predominant size class of 101-150 mm. (Figure IV.C.10-1.) Two Dennison anchor tags were recovered (Table IV.C.10-1) from adult white catfish. These fish had been released 8 and 13 days prior to recapture. Twenty-two white catfish with a right pelvic fin clip were also recovered.

TABLE IV.C.10-1

Fish caught in discharge canal (July 14 to August 28, 1972)

	No. Caught	No. Tagged	No. Tagged Returns	No. Fin Clipped	No. Fin Clip Returns
White catfish	1108	100	2	459	22
White perch	98	30	0	2	0
Brown bullhead	46	7	0	24	0
Eel	16	13	0	0	0
Carp	9	8	0	0	0
Pumpkinseed	3	2	0	1	0
Striped bass	2	0	0	2	0
Bluegill	1	1	0	0	0
Blue crab	1	0	0	0	0

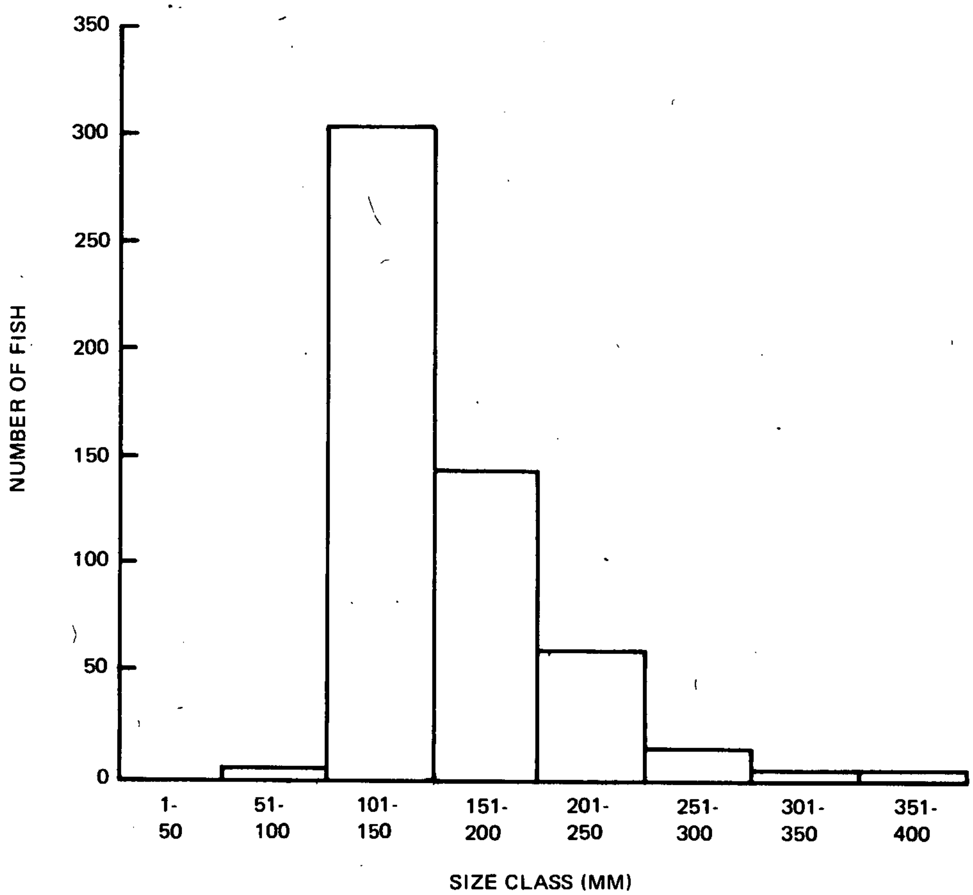


Figure IV.C.10-1. Length-frequency distributions of white catfish from the discharge canal (July 14 to August 15, 1972).

b. <u>November-December Sampling</u>

The percent composition of the total catch (n = 2413) for each species from November 3 to December 15 was: white catfish, 98.1%; American eel, 0.7%; brown bullhead, 0.5%; tomcod, 0.5% and pumpkinseed sunfish, 0.1%. Bluegill sunfish, common white sucker, goldfish and golden shiner together represented less than 0.1% of the total catch (Table IV.C.10-2). Thirty mud crab, <u>Rhithropanopeus</u> <u>harrisii</u>, and two sand shrimp, <u>Crangon</u> <u>septemspinosa</u>, were captured incidently. White catfish exhibited predominant size classes of 51-100 mm. and 151-200 mm. (Figure IV.C.10-2.)

c. <u>Population Estimate</u>

Of the 2267 captured white catfish, 573 were tagged with Dennison anchor tags and two were market with a Petersen disc tags. Left pelvic fins were removed from 613 and anal fins were clipped from 300 fish less than 140 mm in total length. Ten tagged, 10 annal clipped and 20 left pelvic fin clipped catfish were recovered during the sampling period.

The population of white catfish in the discharge canal was estimated by the Schumacher and Eschmeyer technique (Ricker, 1958). The estimated population of white catfish less than 140 mm was 28,646 with 95% confidence limits of 19,364 to 55,019. The population estimate of white catfish longer than 140 mm was 42,886 with 95% confidence limits of 28,566 to 85,992.

Tagged white catfish were recaptured a minimum of nine days after tagging. Five of the eleven recaptured tagged fish returned nine to eleven days after tagging. No fish returned after 24 days.

d. <u>White Catfish Food Habits</u>

A limited food habit study was conducted to understand how the canal supports the large white catfish population. Stomach content analysis indicated that the primary food item of 17 fish ranging from 88 to 241 mm total length was <u>Gammarus</u>. Other food items included lesser numbers of <u>Chiridotea</u> (Isopoda) and calanoid copepods. Fish were captured on November 24 and December 13. Two

TABLE IV.C.10-2

Fish Caught in Discharge Canal (November 3 to December 15, 1972).

Species	Number Caught	Number Tagged	Number Tag Return	Number with Left Pelvic Fin Clip	Number With Left Pelvic Fin Clip Return	Number With Anal Fin Clip	Number With Anal Fin Clip Return
White catfish	2367	577	10	613	20	300	10
American eel	17	16	2*	0	0	0	0
Brown bullhead	11	4	0	2	0	1	0
Tomcod	11	0	0	1	0	0	0
Pumpkinseed	3	3	0	0	0	0	0
Bluegill	1	0	0	0	0	0	0
Common White sucker	1	0	0	0	0	0	0
Goldfish	1	1	0	0	0	0	0
Golden shiner	1	0	0	1	0	0	0
Mid crab	30	0	0	0	0	0	0
Sand shrimp	2	0	0	0	0	0	0

* One eel captured with tag 3 times. Considered as 1 tag return.

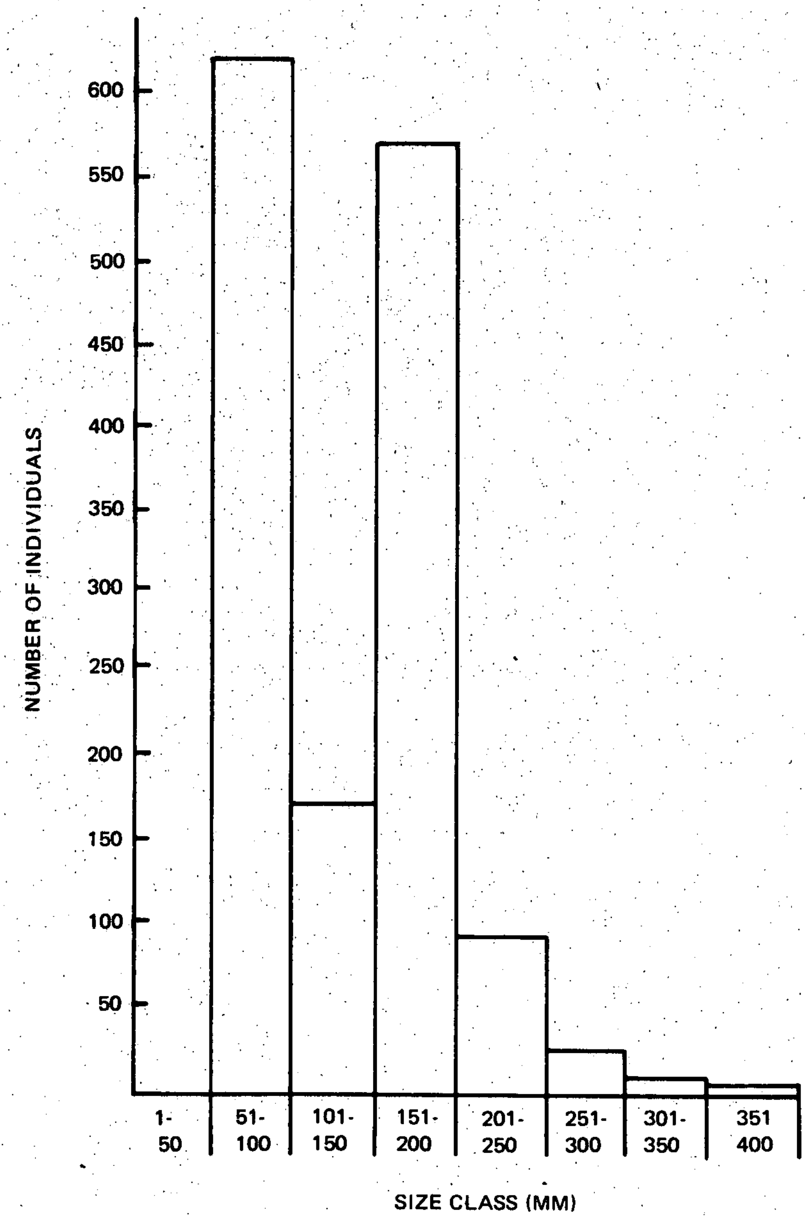


Figure IV.C.10-2. Length-frequency distributions of white catfish from the discharge canal (Nov. 10 to Dec. 13, 1972).

fish captured during July were found to have eaten numerous barnacles. Partially digested spottail shiners and small striped bass, white perch and catfish were found regurgitated on two occassions in holding containers during fall sampling.

Question IV.C.11

Copies of all Texas Instrument reports since April 1972 and continuing for the duration of the Indian Point Unit No. 3 evaluation should be supplied.

Answer:

Texas Instruments' 1972 semi-annual report on the Hudson River Ecological Study has been submitted to the AEC under separate cover. Their 1972 annual report and all future semi-annual and annual reports will be made available to the AEC as they are published.

*Letter from William J. Cahill, Jr., Vice President, Consolidated Edison Company of New York, Inc., to George W. Knighton, Chief, Environmental Projects Bureau Directorate of Licensing, U.S.A.E.C., April 18, 1972, Docket No. 50-286.

Question IV.C.12

An estimate of the monthly ranking by number and by biomass of the top ten fish species in the Indian Point area from January 1970 to December 1972 should be presented. Include absolute and relative (i.e., percentages) number and biomass values.

Answer:

An estimate of the monthly ranking by number and by biomass of the top ten fish species in the Indian Point area can be done for most of the time period. This estimate will be provided when it is available. This should be sometime during the summer of 1973.

Question IV.C.13

Concentration levels of dissolved oxygen concentration in the thermal plume should be predicted with Units Nos. 1, 2, and 3 operating at 100% flow at slack low tide and an ambient river temperature of 80°F under the following conditions:

a) With and without the bubblers in operation on Units Nos. 1 and 2

b) Day versus night

Assumptions and model parameters used in making the predictions should be provided.

Answer:

I. Problem and Assumptions

Because of the 80°F ambient condition is not representative of average or even extreme summer conditions, the analysis was conducted at a more representative summer daily average value of 75°F ambient temperature as requested by Con Edison. However, the difference between 75° and 80° ambient will be discussed further on. Implicit within the statement of the question are three further assumptions by the AEC Staff. These assumptions are:

- That there is a diurnal oxygen pulse in the Hudson River at Indian Point.
- That there is a difference in dissolved oxygen in the River between high water slack (HWS) and low water slack (LWS).
- That there is a diurnal temperature variation in the Hudson River.

Before beginning analysis, it was necessary to consider these implicit assumptions. The first, concerning diurnal oxygen cycles, may not be characteristic of the Hudson Estuary. Reid (1) states that:

> "In deep, turbid estuaries lacking the contribution from an abundant bottom flora, diurnal oxygen pulses are apt to be relatively slight"

This would appear to apply to the Hudson River. In certain reaches, such as the Kingston area, where rooted aquatics abound, diurnal oxygen cycles may be present, but in the relatively deep Indian Point areas this pulse may not be as great.

Concerning the combination of diurnal variation and differences between HWS and LWS in dissolved oxygen, data were obtained from Con Edison for the period February 23-26, 1971. Analysis of these limited data gave the following values for dissolved oxygen:

	Day	Night	Average
High water slack	10.9	10.9	10.90
Low water slack	11.0	10.9	10.95
Average of Slacks	10.95	10.9	10.93

From this, no difference is apparent between day and night or between HWS and LWS. However, since the model results are in terms of tidal average values and in the absence of more comprehensive data, we have reduced the tidal average predictions by 0.1 mg/1 to obtain conservative estimates of the LWS condition.

The third assumption, of diurnal temperature variation, has been documented. The diurnal cycle of temperature has a variation of 1° to 3°F between daily extremes, based on continuous data from the U.S.G.S. monitoring station at Jones Point (2). This monitor was operated from 1966 to 1969, and continuously measured the water temperature 5' below the surface with 30' total depth.

Summarizing the conditions to be tested, the analysis was conducted for tidal average and low water slack river D.O., day and night intake temperatures, and with or without bubbler operation.

II. Solution Method

Because of the interrelationship between ambient concentration of dissolved oxygen, salinity, temperature and oxygen loss through the plant, the following methodology was developed:

A. Determination of Hudson River dissolved oxygen using both the QL&M 28 segment steady state model of the Hudson River (4) and the constant parameter model (7), including the effect of temperature but not the loss of oxygen through the plant, and the effect differences between tidal average and LWS values.

B. Determination of the dissolved oxygen loss through each unit under the various conditions.

C. Determination of the dissolved oxygen loss through each unit under the various conditions.

D. Determination of river D.O. as in Step A, except that the plant gains and loss from Steps B and C were included.

E. Determination of dissolved oxygen in the plume based on discharge canal and river dissolved oxygen levels.

III. Solution

Each of the above steps can be further developed as follows:

Step A. Determination of river dissolved oxygen under conditions of heating was done using both the QL&M constant parameter model and the QL&M 28 segment model. The latter model includes oxygen gains and losses in other reaches of the river. Conditions applicable to both models were:

- Freshwater flow of 3500 cfs
- Salinity of 7 ppt at Indian Point
- Waste loads as obtained in the QL&M 1967 survey (3), which are similar to present loads.

After computation, tidal average and low water slack dissolved oxygen concentrations were developed for the following conditions:

Oxygen Concentration, mg/1 at Indian Point

	Tidal Average	Low Water Slack
No Heating	7.20	7.10
Heating by Bowline, Units 1 & 2 Lovett 1-5 and Roseton 1 & 2 and Danskammer 1-4	7.16	7.06
Heating by Bowline, Lovett, Roseton, Danskammer, and Indian Point Units 1-3	7.11	7.01

These values are used to calculate inplant gains and losses in the next step. Inplant losses from other plants may have some local effect but no effect at Indian Point. Therefore, the only effects of other plants which were considered were those of heating.

Step B. Determination of the oxygen added by the fish protection bubbler was as follows:

- Rates of air and water flow were furnished by Con Edison.
- Using the methodology presented by Barnhart (5), several bubble sizes were assumed and oxygen transfer was calculated. Because the actual bubble size is not known, several possible rates of oxygen transfer were used.
- Using the several bubble sizes, oxygen transfer was determined as a function of the difference between actual and saturation oxygen concentration (C_s-C). These values are:

Bubble Size	Oxygen Addition in mg/1	
	Unit 1	Unit 2
1/32"	0.275(C_s-C)	0.263(C_s-C)
3/32"	0.138(C_s-C)	0.125(C_s-C)
5/32"	0.050(C_s-C)	0.030(C_s-C)

Step C. Determination of dissolved oxygen loss through each unit, the central topic of this report, was performed using the QL&M inplant oxygen loss model developed in February 1972 (6). To apply this model to the several cases of ambient conditions, the following steps were taken:

- Con Edison personnel were contacted on 3/26/73 to find the pressure losses through Unit 3. It was stated that Unit 3 was identical to Unit 2 with respect to pressures within the cooling water system. The design temperature rise of the Unit 3 cooling water is 16.3°F, i.e., by about 1.7°F greater than that of Unit 2. The length of the portion of the discharge canal between the Unit 3 discharge and the outfall structure is approximately one half of the total length between the Unit 2 discharge and the outfall structure.

- o Cases for which dissolved oxygen loss through each unit were calculated are shown in Table IV. C. 13-1, along with the model results in each case. The additions of dissolved oxygen from Step B above were determined for the cases of 1/32" and 3/32" bubble size, using the difference between actual and saturation dissolved oxygen for day and night and tidal average and conditions.
- o Conditions shown in Tables IV. C. 13-1 and -2 reflect both tidal average and low water slack and the diurnal fluctuation of temperature as previously discussed.

Step D. In this step the effect of inplant dissolved oxygen gains and losses from Steps B and C are superimposed on the river dissolved oxygen from Step A. All conditions previously used in Step A are carried into this step unchanged. Cases used for this determination are those previously used as follows:

- Daytime conditions without bubbler operation
- Nighttime without bubbler
- Daytime conditions with 1/32" bubble diameter in the bubbler system
- Nighttime conditions with 1/32" bubble diameters in the bubbler system

As previously noted in the section describing the solution of Step B, 1/32" bubble diameter yields the optimum condition of oxygen transfer. Since the actual hole size is 1/32" this represents an optimistic view with the actual oxygen addition probably being between 0.1 and 0.2 mg/1. The difference between oxygen loss at lower levels of transfer efficiency and without bubblers are negligible. Results of model analysis are given in Table IV. C. 13-3.

Because of the small (less than 1%) difference, it is not necessary to recompute inplant losses, but rather only to apply the change in D. O. found in Step C to the new concentrations which is also done in Table IV. C. 13-3. This is conservative, since lowering the dissolved oxygen concentration in the River will cause lowered inplant losses.

TABLE IV.C.13-1

TIDAL AVERAGE CONDITIONS
DISSOLVED OXYGEN LOSS THROUGH INDIAN POINT UNITS 1, 2 & 3

			Conditions		Influent Conditions			Effluent Conditions***		Inplant Loss (-) or gain (+) in D.O.
						Dissolved Oxygen				
Case	Unit	Time	Bubbler Oxygen Transfer mg/1	River D.O.* mg/1	Temp., °F**	Actual mg/1	Saturation mg/1	Temp. °F	D.O. mg/1	mg/1
110	1	Day	0	7.11	76°F	7.11	8.15	88.6	6.91	-0.20
120	2	Day	0	7.11	76	7.11	8.15	90.9	6.88	-0.23
130	3	Day	0	7.11	76	7.11	8.15	92.2	6.87	-0.24
210	1	Night	0	7.11	74	7.11	8.29	86.6	6.92	-0.19
220	2	Night	0	7.11	74	7.11	8.29	88.9	6.89	-0.22
230	3	Night	0	7.11	74	7.11	8.29	90.2	6.88	-0.23
311	1	Day	.14	7.11	76	7.25	8.15	88.6	7.04	-0.07
312	1	Day	.29	7.11	76	7.40	8.15	88.6	7.18	+0.07
321	2	Day	.13	7.11	76	7.24	8.15	90.9	6.99	-0.12
322	2	Day	.27	7.11	76	7.38	8.15	90.9	7.12	+0.01
411	1	Night	.16	7.11	74	7.27	8.29	86.6	7.07	-0.04
412	1	Night	.32	7.11	74	7.43	8.29	86.6	7.22	+0.11
421	2	Night	.15	7.11	74	7.26	8.29	88.9	7.02	-0.09
422	2	Night	.31	7.11	74	7.42	8.29	88.9	7.16	+0.05

*Background D.O. (Heated Condition)

**Includes 1°F temperature rise due to recirculation

***Condenser only, service water not included

TABLE IV.C.13-2

LOW WATER SLACK CONDITIONS
DISSOLVED OXYGEN LOSS THROUGH INDIAN POINT UNITS 1, 2, & 3

		Conditions			Influent Conditions			Effluent Conditions***		
			Bubbler Oxygen Transfer	River D.O.*		Dissolved Oxygen				Inplant Loss (-) or gain (+) in D.O.
Case	Unit	Time	mg/1	mg/1	Temp., °F**	Actual mg/1	Saturation mg/1	Temp. °F	D.O. mg/1	mg/1
110	1	Day	0	7.01	76°F	7.01	8.15	88.6	6.82	-0.19
120	2	Day	0	7.01	76	7.01	8.15	90.9	6.79	-0.22
130	3	Day	0	7.01	76	7.01	8.15	92.2	6.78	-0.23
210	1	Night	0	7.01	74	7.01	8.29	86.6	6.83	-0.18
220	2	Night	0	7.01	74	7.01	8.29	88.9	6.80	-0.21
230	3	Night	0	7.01	74	7.01	8.29	90.2	6.79	-0.22
311	1	Day	.16	7.01	76	7.17	8.15	88.6	6.97	-0.04
312	1	Day	.31	7.01	76	7.32	8.15	88.6	7.11	+0.10
321	2	Day	.14	7.01	76	7.15	8.15	90.9	6.91	-0.10
322	2	Day	.30	7.01	76	7.31	8.15	90.9	7.06	+0.05
411	1	Night	.18	7.01	74	7.19	8.29	86.6	6.99	-0.02
412	1	Night	.35	7.01	74	7.36	8.29	86.6	7.15	+0.14
421	2	Night	.16	7.01	74	7.17	8.29	88.9	6.94	-0.07
422	2	Night	.34	7.01	74	7.35	8.29	88.9	7.10	+0.09

*Background D.O. concentration (Heated Conditions)

**Includes 1°F temperature rise due to recirculation

***Condenser water only, service water not included

TABLE IV.C.13-3

EFFECT OF POWER PLANT OPERATION ON HUDSON RIVER DISSOLVED OXYGEN IN THE VICINITY OF INDIAN POINT

		River Dissolved Oxygen under Heated Conditions		Effect of Indian Point+ on River D.O.		Multiplant++ Effect on River D.O.	
Conditions	River Ambient** D.O., mg/1	Without Indian Point Plant mg/1	With Indian Point Plant* mg/1	mg/1 C-D	%C-D / C	mg/1 B-D	%B-D / B
I. Tidal Average	7.204	7.164					
A. Day							
1. Without Bubblers			7.060	.104	1.4	.144	2.0
2. With Bubblers			7.092	.072	1.0	.112	1.5
B. Night							
1. Without Bubblers			7.063	.100	1.4	.141	1.9
2. With Bubblers			7.099	.065	0.9	.105	1.5
II. Low Water Slack	7.104	7.064					
A. Day							
1. Without Bubblers			6.960	.104	1.5	.144	2.1
2. With Bubblers			6.992	.072	1.0	.112	1.6
B. Night							
1. Without Bubblers			6.963	.100	1.4	.141	2.0
2. With Bubblers			6.999	.065	0.9	.105	1.5

* Including Effect of Inplant Losses
**No plants operating
+Base (background) condition is with all plants operating except Indian Point
++Base (background) condition is with no plants operating

Step E. Previous staff documents on two unit operation at Indian Point have used a 1:3 dilution in the discharge jet. As an extension to three unit operation, we will use a conservative dilution value of 1:2 in the jet. Dissolved oxygen concentrations in the discharge canal, jet and river are shown in Table IV.C.13-4.

IV. Discussion

Certain points used in the above analysis should be restated or clarified, including the basic assumptions and the effect of changes in ambient conditions:

- o Conditions for analysis were; tidal average and low water slack conditions, day and night temperatures, with and without bubbler operation.
- o Dissolved oxygen values under ambient and heated conditions with and without Indian Point heating are based on the QL&M 28 segment model, which is more sophisticated than the constant parameter model used in previous reports (6, 7) on oxygen changes caused by Indian Point.
- o Although the dissolved oxygen values for the River are somewhat higher than previous estimates (6), because of model refinements, this is conservative because the higher values tend to increase the inplant losses and losses due to heating.

Because the original question was in terms of an 80°F ambient river temperature, it may be germane to discuss the differences between the foregoing analysis at 75°F and the 80°F level, although 80°F is not useful as an average summer condition. At this higher temperature, the difference between river ambient and heated conditions would not change radically and inplant losses would also be similar because the major source of inplant losses is through pressure reduction in the condenser. See Table IV.C.13-5 for a comparison of one case of 75° and 80° ambient conditions.

In any case, as has been shown in connection with two unit operation, the greatest inplant and river oxygen reductions occur under the highest conditions of oxygen concentration. Therefore, in the event that dissolved oxygen levels were reduced toward critical levels due to adverse conditions of flow and waste loading, the effect of Indian Point on dissolved oxygen would be correspondingly reduced.

As a final summary, the expected reductions are shown in Table IV.C.13-6.

TABLE IV.C.13-4

DISSOLVED OXYGEN CONCENTRATIONS IN THE INDIAN POINT THERMAL EFFLUENT

CONDITION	RIVER DO	RIVER DO**	DISCHARGE CANAL EFFLUENT DO	DISCHARGE CANAL EFFLUENT DO**	DISCHARGE PLUME* DO	DISCHARGE PLUME* DO**
	DISSOLVED OXYGEN CONCENTRATION, mg/1					
I. Tidal Average						
A. Day						
1. Without Bubbler	7.06	-0.14	6.83	-0.37	6.95	-0.25
2. With Bubbler***	7.09	-0.11	7.00	-0.20	7.05	-0.15
B. Night						
1. Without Bubbler	7.06	-0.14	6.84	-0.36	6.95	-0.25
2. With Bubbler***	7.10	-0.10	7.04	-0.16	7.07	-0.13
II. Low Water Slack						
A. Day						
1. Without Bubbler	6.96	-0.14	6.74	-0.36	6.85	-0.25
With Bubbler***	6.99	-0.11	6.93	-0.17	6.97	-0.13
B. Night						
1. Without Bubbler	6.96	-0.14	6.75	-0.35	6.85	-0.26
2. With Bubbler***	7.00	-0.10	6.96	-0.14	6.98	-0.12

*Assuming 1:2 dilution

**Decrease with respect to river ambient concentration of DO (no plants operating) reflects the multiplant effect on Bowline, Roseton, Lovett, Danskammer and Indian Point on river DO.

***Reflects most optimistic case of bubbler efficiency. Lower efficiencies are similar to the case without bubblers.

TABLE IV.C.13-5

DIFFERENCE BETWEEN 75°F AND
80°F AMBIENT TEMPERATURE FOR TIDAL AVERAGE,
DAYLIGHT WITHOUT BUBBLER OPERATION

Value	75°F Ambient	80°F Ambient
Ambient D.O. with no plants operating	7.204 mg/1	6.838 mg/1
D.O. with all plants including IP 1, 2 & 3 (including inplant losses)	7.060 mg/1	6.725 mg/1
Percent reduction below ambient	2.0%	1.6%
Percent reduction at 80°F ambient as a percentage of reduction at 75°F ambient	80%	

TABLE IV.C.13-6

SUMMARY OF EFFECT OF HEATING AND INPLANT LOSSES ON HUDSON RIVER DISSOLVED OXYGEN

CONDITION OF HEATING AND INPLANT LOSS	TIDAL AVERAGE DISSOLVED OXYGEN AS CROSS-SECTION AVERAGE AT INDIAN POINT*	Percent below Ambient
Ambient (No Heating)	7.20 mg/1	
Heating by Danskammer, Roseton, Bowline & Lovett	7.16 mg/1	0.6%
Heating by Danskammer, Roseton, Bowline, Lovett and Indian Point Units 1-3	7.11 mg/1	1.3%
Heating by all Plants as Above and Inplant Loss at Indian Point (No bubbler)	7.06 mg/1	2.0%
Heating by all Plants and Inplant Loss at Indian Point (Average bubbler oxygen transfer)	7.075 mg/1	1.7%

* Under 1967 (Present) Conditions of Organic Loading.

REFERENCES

1. Reid, G.K., Ecology of Inland Waters and Estuaries, Reinhold, 1961 p. 173-4.

2. U.S. Geological Survey, Water Resources Data for New York, Part 2, Water Quality Records, 1969.

3. Quirk, Lawler & Matusky Engineers, Hudson River Water Quality and Assimilative Capacity, #129-0, December, 1970.

4. Quirk, Lawler & Matusky Engineers, Additional Testimony of John P. Lawler, Ph.D., on the Cumulative Effects of Bowline, Roseton, and Indian Point Generating Stations on the Hudson River.

5. Barnhart, E.L., Transfer of Oxygen in Aqueous Solutions, No. SA3, Proc. ASCE, June 1969.

6. Quirk, Lawler & Matusky Engineers, Effect on Indian Point Plant on Hudson River Dissolved Oxygen, #115-19, February, 1972

7. Quirk, Lawler & Matusky Engineers, Effect of Indian Point Cooling Water Discharge on Hudson River Temperature Distribution, January 1968.

Question IV.C.14

An explanation should be provided for the dissolved oxygen deficit of the intake water alluded to in testimony of February 5, 1973, "Effect of Indian Point Units 1 and 2 Operation on Hudson River Dissolved Oxygen Concentrations" (J.P. Lawler).

Answer:

The explanation behind depressed dissolved oxygen values is that organic wastes from Hudson River industrial facilities remove oxygen from the river through bacterial activity.

Question IV.C.15.

Data on impingement should be provided as a function of diurnal cycle and of tidal cycle for the four periods December - February, March - May, June - August, and September - November.

Answer:

Data are not available on the relationship of fish impingement to diurnal cycle or tidal cycle for each season. However, data for limited periods of time are available from Indian Point Units 1 and 3.

Unit 1

Table IV.C.15-1 presents data collected at Unit 1 during daylight and darkness when the fixed screens were kept raised.

Table IV.C.15-2 presents data on fish collections and tide stage at Unit 1 when the fixed screens were kept raised.

Unit 3

Hourly counts of fish collected at Unit 3 are available for the period January 7 to February 17, 1972. The mean number of fish/hour for flood and ebb conditioning and for day and night conditions is presented in Table IV.C.15-3

TABLE IV.C.15-1

Comparison of 4 hr. impingement at Unit 1 during the month of Aug. 1972 when fixed screens at bays 11 & 12 were lifted permanently.

Dark on *

41 44 48 52 72 84 90 93 112 139 207 222 287 310 381 407 993 1062 — $\bar{x}$ Total = 258

Dark off *

0 4 6 14 16 17 22 34 37 42 43 45 48 51 52 52 53 55 58 61 62 68 84 92 — $\bar{x}$ = 82.6

98 110 113 114 120 130 138 149 155 247 300 354

Day on

9 12 12 12 14 14 19 19 24 27 29 29 29 29 32 32 33 39 66 102 131 — $\bar{x}$ = 34.5

Day off

0 4 5 7 8 10 11 12 13 13 13 15 16 17 19 19 20 20 22 22 23 24 25 28 30 — $\bar{x}$ = 25.22

33 33 34 40 42 46 53 63 65 78

*Refers to status of air bubbler in front of bay 12

Table IV.C.15-2 Correlation of tide stage to number of fish impinged at Unit 1 during August.

Tide	Stage	Treatment Maxtrix				Ranked Matrix			
		Low 1	Flood 2	High 3	Ebb 4	Low 1	Flood 2	High 3	Ebb 4
Number of fish Impinged / Ranking of Fish Impinged		4.0	2.0	0.	4.0	3.5	2.0	1.0	3.5
		2.0	5.0	3.0	5.0	1.0	3.5	2.0	3.5
		12.0	8.0	8.0	12.0	3.5	1.5	1.5	3.5
		15.0	47.0	15.0	33.0	1.5	4.0	1.5	3.0
		7.0	10.0	21.0	35.0	1.0	2.0	3.0	4.0
		100.0	21.0	14.0	13.0	4.0	3.0	2.0	1.0
		13.0	30.0	20.0	26.0	1.0	4.0	2.0	3.0
		5.0	9.0	20.0	14.0	1.0	2.0	4.0	3.0
		10.0	14.0	9.0	9.0	3.0	4.0	1.5	1.5
		14.0	11.0	5.0	7.0	4.0	3.0	1.0	2.0
		10.0	18.0	20.0	26.0	1.0	2.0	3.0	4.0
		6.0	23.0	16.0	10.0	1.0	4.0	3.0	2.0
		3.0	22.0	14.0	5.0	1.0	4.0	3.0	2.0
		12.0	10.0	7.0	18.0	3.0	2.0	1.0	4.0
		43.0	38.0	16.0	28.0	4.0	3.0	1.0	2.0
		17.0	10.0	12.0	42.0	3.0	1.0	2.0	4.0
		18.0	24.0	6.0	28.0	2.0	4.0	1.0	3.0
		10.0	14.0	15.0	5.0	2.0	3.0	4.0	1.0
		0.	6.0	2.0	5.0	1.0	4.0	2.0	3.0
		2.0	2.0	3.0	0.	2.5	2.5	4.0	1.0
		9.0	4.0	10.0	18.0	2.0	1.0	3.0	4.0
		15.0	11.0	10.0	28.0	3.0	2.0	1.0	4.0
		8.0	12.0	8.0	17.0	1.5	3.0	1.5	4.0
		6.0	6.0	4.0	25.0	2.5	2.5	1.0	4.0
		3.0	4.0	21.0	15.0	1.0	2.0	4.0	3.0
		0.	15.0	2.0	10.0	1.0	4.0	2.0	3.0
		3.0	24.0	0.	18.0	2.0	4.0	1.0	3.0
TOTAL		347.0	400.0	281.0	444.0	57.0	77.0	57.0	79.0
MEAN		12.9	14.8	10.4	16.4	2.1	2.9	2.1	2.9

Table IV.C.15-3 Mean number of fish per hour collected at Indian Point Unit 3, from January 7 to February 17, 1972.

Condition	Number of Fish/Hour
Flood	64.9
Ebb	66.2
Night	68.4
Day	61.8

Question IV.C.16

a) Is the distribution of impinged fish on the fine screens of Units Nos. 1 and 2 positively correlated with the velocity distribution at the fine screens?

b) How is the velocity distribution altered by the bubble screen?

Answer:

a) No attempt has been made to correlate the distribution of impinged fish with the distribution of velocity at the fine screens. Fish are not collected directly from the fixed screens nor can the distribution of impinged fish be observed under the present operating conditions.

b) Model tests have indicated a reduction of intake velocity at the bottom of the screen due to the vertical component of velocity induced by the air curtain and an increased velocity toward the top of the screen. The vertical components which induces a return flow to the river at the surface contributes to keeping the screens free of debris and may reduce the rate of entrainment of pelagic organisms. We are attempting to obtain evidence on the effect of the air curtains on pelagic organisms.

Question IV.C.17

Icthyoplankton data obtained from intake and discharge canal sampling should be provided as related to: a) survival with and without bubble curtain; b) estimates of % survival of the entrainable stages of striped bass, white perch, tomcod and any other commonly entrained species.

Answer:

a) To date the data on survival with and without bubble curtain have not been analyzed. They will be provided when available.

b) Dr. Gerald J. Lauer's testimony of February 5, 1973, in the Indian Point 2 licensing proceeding "Effects of Entrainment on *Morone sp.* (striped bass and white perch) eggs and larvae at Indian Point," contains the estimates of percent survival of the entrainable stages of striped bass and white perch. Data are not available on entrainalbe stages of tomcod.

See also Appendix AA of the Indian Point Unit 3 Environmental Report dated April 6, 1973, "the Biological Effects of Entrainment at Indian Point."

Question IV.C.18

Any data available and model predictions relating to the possibility that impingement may be reduced during the winter due to warmer than ambient water temperatures at the intakes should be supplied.

Answer:

As yet there are no data or model predictions available relating to the possibility that impingement may be reduced during the winter due to warmer than ambient temperatures at the intakes. This is one of the objectives of the Hudson River Ecology Study. Data collection is dependent upon the operation of Indian Point 2 in the winter time.

Question IV.C.19

A comparison of faunal collections (invertebrates and vertebrates) in the discharge canal during the day versus night and during chlorination versus no chlorination should be presented.

Answer:

a) Invertebrates - Dr. Gerald J. Lauer's testimony of February 5, 1973, "Effects of Entrainment on Morone sp. (striped bass and white perch) eggs and larvae at Indian Point" contains comparisons of collections of eggs and larvae of fishes in the discharge canal with and without chlorination. Attached are two plots of the abundances of Gammarus sp. including comparisons of collections made in the discharge canal during day and night and with and without chlorination. Dr. Lauer's April 5, 1972 testimony in the Indian Point 2 licensing proceedings, "Effects of Elevated Temperature and Entrainment on Hudson River Biota" contains information on collections of microinvertebrate zooplankton from the discharge canal. See also Appendix AA of the Indian Point Unit 3 Environmental Report dated April 1973, "The Biological Effects of Entrainment at Indian Point."

b) Vertebrates - A trap net was fished primarily from 1700 to 0830 each day during sampling in summer and fall, 1972. Night time collection was based on results of a comparative study (July 14-21, 1972) during which the trap was fished during both day and night periods. Catch per unit effort (C/f) from 0900 to 1630 was found to be approximately one-fourth that from 1700 to 0830.

Chlorination occurred primarily on Tuesdays at night and on Fridays during the day time. The C/f of night catches was 31.5 for 11 net sets without chlorination and 11.0 for 4 net sets after chlorination during summer, 1972. During fall, C/f was 28.9 for 10 net sets without chlorination and 75.7 for 4 sets after chlorination (Table IV.C.19-1).

Table IV.C.19-1 Total numbers of fish caught in the discharge canal at Indian Point.

Date	Period fished	No. Fish	Date	Period fished	No. fish
7/14-17	D+N	13	11/3-6	D+N	5
7/17	D	0	11/10-13	D+N	1144
7/18	N	2	11/15	N	128
7/18	D	1	11/16	N	0
7/19	N	11	11/17	N	45
7/19	D	1	11/17-20	D+N	52
7/20	N	9	11/21	N	126
7/21	D	1	11/22	N	29
7/21-24	D +N	8	11/22-24	D+N	256
7/25	N	24	11/24-27	D+N	51
7/26	N	11	11/28	N	2
7/26	D	1	11/29	N	52
7/27	N	7	11/30	N	31
7/28-31	D+N	99	12/1	N	20
8/1	N	10	12/1-4	D+N	136
8/2	N	9	12/5	N	9
8/3	N	6	12/6	N	94
8/4	N	10	12/7	N	19
8/4-7	D+N	71	12/8	N	16
8/8	N	1	12/8-11	D+N	0
8/9	D	4	12/12	N	21
8/10	N	7			
8/11	N	0			
8/11-14	D+N	16			
8/14	D	9			
8/15	N	271			
8/16	N	13			

Periods: D = day fishing; N = night fishing;
D+N = fishing through days and nights.
Underlined values represent catches
the morning after night time chlorination.

Question IV.C.20

Any bioassay data available on fish eggs and larvae collected at the plant site including: a) organism and life stage, b) size and origin, c) physical data (temperature, DO, salinity, pH, d) duration of test, and e) conclusions and logic should be provided.

Answer:

No data are available on bioassays on fish eggs and larvae collected at the plant site. Bioassays were conducted using Monck's Corner Hatchery stock. However, that data have not yet been prepared for presentation except on temperature sensitivity.

See Dr. Lauer's testimony, "Effects of Operations of Indian Point Unit 1 and 2 on Hudson River Biota," dated October 30, 1972 and Appendix AA of the Indian Point Unit 3 Environmental Report dated April 6, 1973.

Question IV.C.21

With reference to Tables 2 and 3 in testimony of February 5, 1973, "Effects of Indian Point Units 1 and 2 on Hudson River Fish Populations" (J. T. McFadden), the error mean square for each of the 16 regression analyses and the 95% confidence interval about each of the values in these two tables should be provided. What is the logic involved in extrapolation from the data and analyses used to generate Table 2 and 3 to cause-effect conclusions concerning compensatory growth?

Answer:

The information presented in Tables 2 and 3 was taken from original publications or from similar tables included in several manuscripts. The error mean square for each of the regression analyses and the 95% confidence intervals about each of the calculated lengths in the tables was not presented in the original manuscripts and we are therefore not able to supply them.

The attached tables present the 95% confidence intervals for white perch and striped bass collected from the Hudson River from April to September 1972. An error mean square term is not available for these data.

No cause and effect conclusions are advanced on the basis of the subject data concerning compensatory growth. The data are advanced to refute the possible argument that striped bass and white perch exhibited normal growth rates in the Hudson River in comparison with other similar environments. Further, we believe that growth rates for these species in the Hudson River are evidence of a potential to compensate for reductions in abundance through increased growth rate. These species are growing at rates well below their physiological maxima and well below ecological norms.

TABLE IV.C.21-1 Striped Bass:
Calculated mean total length at annulus formation (sexes combined with immatures). Hudson River, April-September 1972, miles 40-60

Age* Group	No. Males	No. Females	No. Immature	Total No. in Sample	$\bar{X}$ Total Length mm Combined Sex	$\bar{X} \pm$ 95% CI
I	44	31	267	342	119.7	5.77
II	30	20	48	98	241.6	5.77
III	20	8	8	36	333.6	5.77
IV	11	4	3**	18	431.7	5.77
V	9	4	2**	15	509.9	5.78
VI	7	4	1**	12	585.0	5.78
VII	7	3	1**	11	649.0	5.78
VIII	2	3	-	5	731.5	5.79
IX	1	3	-	4	805.6	NC
X	1	2	-	3	799.2	NC
IX		2	-	2	871.6	NC
XII		2	-	2	900.3	NC
XIII		1	-	1	927.	NC

* Denotes age group and not year class

** Tagged fish, no sex determination

NC - Not calculated

Region 1 204 fish

Region 2 71 fish

Region 3 67 fish

TABLE IV.C.21-2 White Perch:
Calculated mean total length at annulus formation (sexes combined with immatures). Hudson River, April-September 1972, miles 40-46.

Age* Group	No. Males	No. Females	No. Immature	Total No. in Sample	$\bar{X}$ Total Length mm Combined Sex	$\bar{X}$ ± 95% CI
I	411	492	281	1184	74.7	1.25
II	296	346	22	664	131.6	1.93
III	199	232	-	431	161.3	2.31
IV	114	148	-	262	177.4	2.52
V	54	89	-	143	189.0	2.67
VI	18	39	-	57	198.6	2.80
VII	4	13	-	17	206.2	2.89
VIII	-	7	-	7	216.9	3.03
IX	-	2	-	2	240.2	3.34

* Denotes age group and not year class.

TABLE IV.C.21-3 White Perch:
Calculated mean total lengths at annulus formation, females only.
Hudson River miles 40-46. April-September, 1972.

Age* Group	± Total Length (mm)	± 95% CI	No. in Group
I	76.5	1.26	492
II	133.3	1.95	346
III	164.1	2.34	232
IV	181.2	2.57	148
V	192.9	2.72	89
VI	201.4	2.83	39
VII	210.0	2.94	13
VIII	216.9	3.03	7
IX	240.2	3.34	2

* Denotes age group and not year class.

V. COMMITMENT OF RESOURCES

Question V.1

What are your plans for use of the site when operation of the nuclear plant finally terminates? The structures that will be removed should be identified. Other action that will be taken to clear the site should be described. Any licensable quantities of radioactive materials that would be stored on site, the term of such storage, and arrangements for custodial care should also be identified. Estimate the cost of decommissioning on the basis of the present economy. If decisions on these measures have not yet been made, provide this information for each alternative that you believe to be practicable.

Answer:

Following the completion of operation, Applicant will permanently shut down the facility. The precise nature of the shutdown process is difficult to fix at present, in view of the likelihood of regulatory and technological changes in the coming years. However, the process will probably involve removal of the spent fuel from the reactor vessel and shipment off-site; decontamination of the facility through appropriate chemical cleaning and flushing, treatment and disposal of any contaminated water, disposal of resins, filters, and miscellaneous radioactive materials, sealing of the containment and adjustments to alarm systems in anticipation of post shutdown security monitoring, and completion of a final post-shutdown radiation check. During these procedures, security forces at the facility will be maintained at or near full operational levels.

Following the shutdown process, Applicant will conduct, in perpetuity if necessary, a security and radiological monitoring program. This will involve a round-the-clock guard to insure against intruders. An alarm system, telephone communications, locked doors and windows, a lighting system and the perimeter fence will be maintained for this purpose. In addition regular monitoring of radioactivity in the vicinity of the facility will be performed. Applicant estimates the annual cost of such a program in 1973 dollars and using 1973 technology, to be approximately $300,000 dollars. Applicant estimates that decommissioning of the facility will require 9 months to complete, and will cost approximately $3,000,000, in 1973 dollars, based on 1973 technology.

Question V. 2

For components in the primary coolant system radioactive waste treatment system, reactor shielding, and other systems that are expected to be sufficiently radioactive at the termination of operation (and terminal decontamination) that use or possession would require a specific Atomic Energy Commission license:

a. Each type of component should be identified.

b. Any material constitutents and quantities in metric units (Identification of metals by specific alloy type is preferable) should be presented. Quantities less than 100 metric tons of steel not containing materials on the list of strategic and critical materials, 37F.R.4123, February 26, 1972, should be neglected.

c. State whether it is expected that each type of component could be decontaminated.

Answer:

The only components greater than 100 metric tons of steel that are expected to be sufficiently radioactive at the termination of operation that use or possession could require a license such as a byproduct Atomic Energy Commission license are the reactor pressure vessel and the steam generators. The steam generators could be decontaminated to such a degree that such a specific license may not be necessary. Chemical cleaning and flushing methods could be used to remove all or essentially all of the radioactive crud adhering to surfaces of the steam generator tubes and walls. Such decontamination would render the steam generators essentially non-radioactive with respect to current AEC definitions.

Such decontamination of the reactor pressure vessel would not yield the same results. After having been neutron irradiated for the life of the plant, a large percentage of the radioactivity in the pressure vessel would be due to activation products formed by the following reactions in steel:

Ni^{58} (n, p) Co^{58} (71 day half-life)

Cr^{50} (n, γ) Cr^{51} (28 day half-life)

Fe^{58} (n, γ) Fe^{59} (45 day half-life)

Co59 (n, γ) Co^{60} (5.27 year half-life)

Because of its long half-life, the Co-60 in the pressure vessel may be abudant enough to warrant the need for a specific AEC use or possession license for the pressure vessel.

Question V.3

The quantities (in kg) for Unit No. 3 of the following materials that will be utilized during the term of the operating license for initial and replacement loadings of the reactor core should be estimated.

a. Fuel input to the reactor in the form of the initial and replacement core loadings should be directed as follows:

   1. U - The quantity of contained uranium at each enrichment introduced in new fuel elements and the assumed reloading schedule should be presented.

   2. Pu - The quantity and isotopic composition of contained fissionable plutonium and other fissile and fertile materials introduced in new fuel elements and the assumed loading schedule should be estimated.

b. Fuel recycle - The assumed fuel burnup at time of discharge, in megawatt-days per metric ton of initially contained fissile and fertile material, for each type of fuel is needed. For each type of new fuel, the quantities of each fissile or fertile isotope recoverable from the spent fuel removed from the reactors should be estimated.

Answer:

1. Uranium

   Initial Content

Region 1	2.25 w/o	29,530 kg U
Region 2	2.8 w/o	28,950 kg U
Region 3	3.3 w/o	28,830 kg U
Region 4 & Reloads	3.3 w/o	28,830 kg U

   The first cycle will last approximately 21 months at 80% capacity factor. The second and subsequent cycles will last about 12 months at an 80% capacity factor.

2. Plutonium

   There is no plutonium contained in the new fuel elements of the initial core. At present, there are no plans to recycle plutonium in the future or to introduce plutonium in new fuel elements of reload regions.

Region	Burnup (MWD/MTU)	Recoverable U (kg)	Recoverable U^{235} (kg)	Recoverable Fissile Pu (kg)	Recoverable Total Pu (kg)
1	16,900	28,216	251.	149.	202.
2	28,300	27,293	207.	178.	250.
3	34,700	26,954	205.	186.	259.
4 and Reloads*	32,700	27,039	216.	181.	255.

*No plutonium recycle

VII. ALTERNATIVES

Question VII. 1

If available, the cooling tower proposed as an alternate cooling method for Unit No. 2 should be described, including the following design data: type of tower, state whether counterflow or crossflow, location, water flowrate, cooling range, approach temperature, design wet bulb temperature, tower dimensions, exit area, exit velocity, direct capital cost of tower and of piping and appurtenances, blowdown rate, blowdown concentration, chlorination rate, any other chemical additions, water inventory in tower basin, and dilution rate planned for tower blowdown before discharge into the river.

Answer:

The preliminary design data of closed-cycle natural draft tower for Unit 2 are stated in the testimony of Mr. Carl L. Newman on Alternative Closed-Cycle Cooling Systems at Indian Point Unit 2, dated October 30, 1972, and are as follows:

1. Water flowrate=590,000 gpm (approx. 70% of 840,000 gpm).
2. Cooling range = 25°F.
3. Approach = 21.5°F.
4. Design wet bulb temp=74°F, design R.H.=55%
5. Dimensions: 445 ft base diameter
220 ft exit diameter
450 ft overall height.
6. Air exit velocity: approx. 13.8 fps at design condition
7. Direct capital cost: approx. 32 million dollars.*
8. Blowdown rate: approx. 12,000 gpm.
9. Water inventory in tower basin: approx. 5.85×10^6 gallon.
10. Blowdown concentration: two.
11. Chemical treatment: The chemical treatment will include intermittent chlorination and possibly sulfuric acid feeding. Chlorine additions will be controlled by maintaining a residuce chlorine in the blowdown of less than 0.5 ppm and a sulfuric acid feed would be in the order of 1/4 gpm during the summer when the chemical concentration of Hudson River reaches maximum.

*The latest design for a cooling tower for Unit 2 has a direct cost of $36,000,000. Detailed design data for this design are not available. See testimony of Carl L. Newman on Alternative Closed-Cycle Cooling Systems at Indian Point 2, dated April 9, 1973 on the Unit's licensing proceeding.

12. The 318,000 gpm circulating water from I. P. 1 and the 30,000 gpm service water from I. P. 2 could be utilized for blowdown dilution before discharge into the river.

13. Tower location: approx. 500 feet north of I. P. 2 containment building. Basin elevation in approx. 35 ft. (above mean water level).

Question VII.2

If available, indicate for the cooling tower proposed as an alternate cooling system how the exit air temperature and velocity varies with ambient air relative humidity, and wet bulb temperature.

Answer:

We have no detailed thermodynamic data on the I. P. 2 natural draft cooling tower. At the design conditions, the exit velocity is about 13.8 fps and the exit temperature is about 109°F.

Question VII. 3

If an alternate natural draft cooling tower arrangement for Units Nos. 2 and 3 were utilized, the maximum salt concentration in the circulating cooling water should be estimated.

Answer:

A two-concentration closed-cycle operations is tentatively designed for Unit 2 and is anticipated for Unit 3. The maximum anticipated salt concentration in the circulating cooling water would be exactly twice of that in the river.

Question VII.4

Information on the approximate rates of natural salt deposition over the site area in lb/acre/year is required.

Answer:

A program to measure ambient salt concentration and deposition at several locations in the Indian Point area will be initiated with the meteorological program. Samples will be analyzed for sodium and chloride content.

Question VII. 5

Information on the increase in noise level at various distances from the plant site during the operation of Unit No. 3 as proposed and with alternate cooling methods is required.

Answer:

As indicated in the Unit 3 Environmental Report (page 4.2-6, Benefit-Cost Analysis), operation of Unit 3 as proposed will cause no apparent increase in noise levels in the surrounding areas.

> "...the design of the Indian Point 3 facility is such that no significant noise sources are expected to be introduced by its operation so that existing noise levels in the surrounding areas are expected to be virtually the same with Indian Point 3 in operation."

The Unit 3 Environmental Report states that expected natural draft cooling tower noise levels will be 50 dB(A) at 2500 feet from the center of the tower, while noise emissions from the center of the mechanical draft tower complex will be 50 dB (A) at 5000 feet. With consideration of the location of proposed alternate cooling systems, as shown in Unit 3 Environmental Report, projections of noise emissions can be made to the Broadway property line. These estimates of noise levels and projections at the Broadway property line are based on preliminary information. Source noise levels and attenuation rates of natural draft towers and large clusters of mechanical draft towers, proposed as alternate cooling systems, are approximate.

Emissions from the natural draft cooling tower are estimated to be a maximum of 51 dB (A) at the Broadway property line, while for mechanical draft towers, a maximum level of 66 dB(A) is estimated at the Broadway property line. Community noise levels were measured at residences along Broadway, hence, a comparison between the measured community noise and expected noise emissions can be made. Measured community noise exceeded 60 dB (A) 50% of the time along Broadway, as reported in the Unit 3 Environmental Report.

Therefore, emissions from a natural draft tower are estimated to be 9 dB or more below the measured average community level along Broadway. Emissions from mechanical towers are estimated to be a maximum of 6dB above the measured average community noise level along Broadway. As this average measured community noise level of 60 dB (A) represents data taken when vehicular traffic was present, it is reasonable to suggest that noise emissions from either alternate cooling system may exceed community noise levels when no traffic is present.

Because insufficient information is available regarding spray ponds, no estimates of noise emissions can be reasonably made. A cooling tower noise study is presently in progress which intends to more accurately delineate source noise levels and attenuation rates and gage the impact of resultant noise emissions on the community surrounding the Indian Point facility. Independent consultants will be engaged to perform the study. As part of an environmental study for Indian Point cooling towers, this noise study is scheduled for completion in April 1974.

Question VII. 6

The possible effects of discharges from the cooling tower proposed as an alternate cooling system on the air quality in the lower Hudson Valley should be supplied. Possible interactions with discharges from nearby fossil-fuel power plants and the expected damage to vegetation as a result of plume interaction with atmospheric oxidants should be discussed.

Answer:

Discharges from the proposed cooling tower will be mathematically modeled to account for humidity and salt distributions. Possible interactions of various fossil-fuel plumes with the cooling tower plume will be investigated after sufficient onsite meteorological data are collected to assess the plume behavior and concentration. Any expected damage to vegetation resulting from plume interaction processes will be determined after isopleths of the concentrations are analyzed.

VIII. BENEFIT-COST ANALYSIS

Question VIII. 1

The size of the operating force expected for Unit No. 3 should be estimated.

Answer:

41.

Question VIII. 2

The expected total annual salary that will be paid to the Unit No. 3 operating personnel should be provided.

Answer:

$700,000.00

Question VIII. 3

A breakdown of expenditures to date on Unit No. 3 should also be furnished.

Answer:

INDIAN POINT UNIT NO. 3 - EXPENDITURES TO 12/31/72

Payments to Westinghouse on "Turnkey" Contract	$110,695,349
Con Edison Costs	38,183,863
TOTAL	$148,879,212

Question VIII. 4

Has a standard 40-hour work week been used during construction work to date?

Answer:

The standard 40-hour week has occasionally been exceeded. The standard working week for some trades is as low as 35 hours. Others are working 45 hours per week or more.

Question VIII. 5

What escalation rate(s) has been used during construction?

Answer:

The escalation rate used for Indian Point Unit No. 3 Project has varied. This subject can be subdivided into the following:

a) Escalation on Westinghouse Contract:

The escalation clause in the original Westinghouse contract states that escalation is only applicable on the construction portion ($68,044,364 of the total contract price of $111,303,404). This escalation was to be computed from the "Engineering News Record Construction Cost Index for New York City" published by McGraw-Hill. The base index for computation was the October 1966 value of 1338.07.

Fluctuation of the index resulted in payment to Westinghouse of $12,627,335 through the fourth quarter of 1971. Because of Contract reformulation in the fourth quarter of 1971, which was retroactive to April 1971, a credit for $4,492,676 for escalation was made to our account by Westinghouse. The reformulated contract is fixed priced.

b) Escalation on other contracts:

Other contracts covering additional work not included in the original capital work estimate have not been of significant duration to consider escalation. Current company guidelines for escalation (labor and material combined) is 7% per year.

Question VIII. 6

The exact date when the nuclear steam supply was ordered should be stated?

Answer:

A separate order was not placed by Con Edison for NSS since Con Edison ordered a complete turnkey power plant for Unit No. 3 on December 20, 1966.

Question VIII. 7

What cost of land was assumed in arriving at the total capital cost for Unit No. 3?

Answer:

Cost of land for Unit No. 3 is not included in capital cost for that Unit. Land costs for Indian Point site have been charged as capital costs for Unit No. 1.

Question VIII. 8

A new page B. 1. 4-1 in the Benefit Cost Analysis should be furnished.

Answer:

A new page B. 1. 4-1 follows.

B.1.4 Summary of Benefits From the Proposed Facility

Direct Benefits

Expected Average Annual Generation in Kilowatt-Hours	5,950,000,000
Capacity in Kilowatts	965,000
Proportional Distribution of Electrical Energy Expected	
Annual Delivery in Kilowatt-Hours:	
Industrial	
Commercial	3,189,200,000
Residential	1,795,000,000
Other	975,800,000
Expected Average Annual Btu (in millions) of Steam Sold from the Facility	0
Expected Average Annual Delivery of Other Beneficial Products (appropriate physical units)	0
Revenues from Delivered Benefits:	
Electrical Energy Generated	223,720,000
Steam Sold	0
Other Products	0

Indirect Benefits (as appropriate)

Taxes (Local State, Federal) (Local Real Estate)	6,980,000
Research	
Regional Product	
Environmental Enhancement:	
Recreation	
Navigation	
Air Quality: (Tons/year, June 1974-May 1975)	
SO_2	9,707
NO_x	11,811
Partioulates	486
Other	
Employment	
Education	
Others	

Question VIII. 9

On p. B.2.1-1, line 9 of the Benefit-Cost Analysis, the applicant used a discount rate of 9.75%. In order to achieve consistency of treatment in environmental statements, a discount rate of 8.75% is to be employed.

Answer:

Generating Costs

Based on original Cost-Benefit Analysis with the only change being the reduction of the Discount Rate to 8.75%.

Plant as is

Remaining Capital Cost: $172,901,000
Discount rate: 8.75%
Future Worth of Capital Cost (1974): $173,352,000
Plant Life: 30 years
Present Worth factor (9.75% and 30 years) = 9.627
Present Worth factor (8.75% and 30 years) = 10.506

$$\text{Multiplier} = \frac{10.506}{9.627} = 1.091$$

Co = $172,252,000
Ft = ($122,260,000 x 1.091) = $133,386,000
Ot = ($21,400,000 x 1.091) = $ 23,347,000
TC_g = $330,085,000
Annualized = $31,420,800

Incremental Generating Costs

Present Worth factor - 8.75%
(28 years - 3rd year thru 30th year) = 8.741
Present Worth factor - 9.75%
(28 years - 3rd year thru 30th year) = 7.886

$$\text{Multiplier} = \frac{8.741}{7.886} = 1.108$$

Natural Draft Closed Cycle Alternate

($90,460,000 x 1.108) = $100,230,000
Annualized = $ 9,540,000

Mechanical Draft Closed Cycle Alternate

($96,980,000 x 1.108) = $107,454,000
Annualized = $ 10,228,500

Spray Pond Closed Cycle Alternate

($111,720,000 x 1.108) = $123,786,000
Annualized = $ 11,783,200

This answer is furnished solely to comply with the Staff's request. The figure of 9.75% is more representative of Con Edison's actual cost of capital.

Question VIII. 10

On Page 1.1-2 and associated text, the total weight of fish lost should be that of the number of adult fish. This procedure is stipulated in the AEC cost-benefit guide of May 1972. The resulting changes in the values given in Tables 1.1-1 and 1.1-2 would be in orders of magnitude. These values thus need to be reevaluated. Even though total survival will not occur in nature, it should be possible to make a reasonable estimate of what the actual loss will be in terms of harvestable fish.

Answer:

In computing the estimated weight of fish impinged annually on the Unit 3 intake screen, assumptions were made regarding the age distribution of fishes collected and the natural survival rate of the young of each species. In addition, an average weight of a mature individual of each species was selected. The method used to compute the weight of adult fish impinged annually is as follows:

1. Compute the number of each species expected to be impinged at Unit 3 (Table VIII. 10-1). For this analysis, it is assumed that 100% of the white perch, striped bass and herrings are young-of-the-year averaging 75 mm total length and that the tomcod, bay anchovy and other species are 50% mature and 50% young-of-the-year.

2. The survival of the young-of-the-year to maturity is computed, using a range of survival values.

3. A selected mean weight of an adult of each species is multiplied by the number of survivors for each survival value.

Con Edison has provided the above information in response to the stipulated procedures of the benefit-cost guidelines. However, because these procedures do not incorporate the mechanism of compensation, we do not believe this is a reasonable estimate of the actual loss in terms of harvestable fish. Compensation will reduce the projected loss of equivalent adult fishes and in some species may negate the loss equivalent entirely.

TABLE VIII. 10-1

Species	Estimated Annual Impingement At Indian Pt 1	Estimated Annual Impingement At Indian Pt 3	Survival Values	Estimated Equivalent Adult fish	Weight of an Adult Fish (lb)	Weight of Equivalent Adult Fish (lb)
White Perch	263,614	722,302	.01	7223	0.5	3612
			.05	36115		18058
			.10	72230		36115
			.15	108345		54173
			.25	180576		90288
Striped Bass	11,559	31,672	.01	317	10	3170
			.05	1584		15840
			.10	3167		31670
			.15	4751		47510
			.25	7918		79180
Atlantic Tomcod	30,948	42,399 (adult)	.01	424	0.5	21412
		42,399 (y-o-y)	.05	2120		22260
			.10	4240		23320
			.15	6360		24380
			.25	10600		26500
Herrings	47,726	130,769	.01	1038	0.5	654
			.05	6538		3269
			.10	13077		6539
			.15	19615		9808
			.25	32692		16346
Bay Anchovy	8,203	11,238 (adult)	.01	112	0.06	682
		11,238 (y-o-y)	.05	562		708
			.10	1124		741
			.15	1686		775
			.25	2810		841
Other	10,813	14,814 (adult)	.01	148	0.5	7481
		14,814 (y-o-y)	.05	741		7778
			.10	1481		8148
			.15	2222		8518
			.25	3704		9259

Question VIII. 11

a) On page 1. 1-2, based on the weight of other species in the table provided ranging from 1/20 to 1/5 of an ounce, the number of fish impinged becomes 55,000 to 220,000 fish rather than the 10,813 cited. This should be clarified.

b) In reference to page 1. 2-2, documentation for the method of extrapolating the weight of food organisms to the weight of fish is needed. Based on conversion factors between tropic levels of 1/10 which is normally used ranther than 1/1000, the loss of fish calculated from loss of food organisms could be at least one order of magnitude greater than the applicant's estimate. This discrepancy needs clarification.

Answer:

a) The number of fish reported in the category "other" of Table 1. 1-1 was computed independently of the weight of an individual fish in this category. The number was computed by applying the species composition of the collections at Unit 1 to the computed totals for Units 1 and 2. The total weight of fish for this category was based on an estimated mean weight of 1. 0 oz. per fish. This weight was chosen because within this category are some large specimens of infrequency collected species.

b) Additional studies conducted by Dr. G. J. Lauer of New York University ("Effects of Operations of Indian Point Units 1 and 2 on Hudson River Biota" October 30, 1972, Docket No. 50-247) indicate that a loss of microzooplankton will occur only during chlorination of the once through cooling system. With an average density of 3000 copepods per cubic meter and with chlorination occurring 40 hours per year a total of 866, 613, 000 zooplankters will be lost. At an estimated weight of 1.14×10^{-5} gm per zooplankter, a total of 21. 8 lbs of zooplankton will be lost with Alternative A. Assuming that fish are two trophic levels removed from the zooplankton, the equivalent weight of fish would be 0. 22 lbs/yr.

The answer to item (b) was prepared in conformamce with the guidelines for the preparation of Benefit/Cost Analysis. Con Edison studies of microzooplankton populations of the Hudson River near Indian Point have indicated that plant operations have had no discernable effect on these populations.

Question VIII. 12

On page 1.2-3.4-5 although entrainment losses of juvenile and larval fish are discussed, no estimates of what the losses would be. This information is required because of the importance of this environmental cost of the facility. In addition there should also be information concerning losses of fish eggs.

Answer:

Dr. Gerald J. Lauer has presented estimates of losses due to entrainment at Indian Point Unit 1 in his Oct. 30, 1972 testimony in the Indian Point Unit 2 proceedings (Effects of Operations of Indian Point Units 1 and 2 on Hudson River Biota; Docket No. 50-247). The results presented in this testimony represents the analysis to date of data on entrainment of the first year of a two year study of entrainment effects. Refer also to Rebuttal Testimony of Dr. Lauer dated February 5, 1973 (Docket No. 50-247). See Appendix AA of the Indian Point Unit 3 Environmental Report dated April 6, 1973, "The Biological Effects of Entrainment at Indian Point."

Question VIII.13.

On page 1.3-9 section of fish migration the applicant's allegations of no impairment to fish migration needs far more support than presented here. Details for each significant species along with illustrative maps or diagrams should be presented.

Answer:

Con Edison has not collected additional data on fish migration in the vicinity of Indian Point. There is no information available to permit maps or diagrams of the pathway of migration of each fish species past the Indian Point site. See transcript pages 5822 to 5899 (June 19, 1972) and pages 5965-6004 (June 20, 1972) of the Indian Point Unit 2 hearing in which Dr. Edward C. Raney discusses migrations of fishes past Indian Point and Connecticut Yankee.

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