50-247

INDIAN POINT UNIT 2

Benefit-Cost Analysis of Alternative Operating Modes for the Period 1973 through 1977

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INTRODUCTION

This study is in response to the request by the board that the staff evaluate the Hudson River Fishermans Association proposed operating license condition to minimize operation of Indian Point Unit No. 2 during certain periods of each year prior to installation and operation of a closed cycle cooling system. The proposed condition, contained in the "Intervenors' Statement of Contention and Matters in Controversy Concerning Environmental Issues" filed on November 13, 1972, is as follows:

> "During the period before a closed cycle cooling system is installed and operating, the operation of Indian Point Unit No. 2, and in particular the pumps, will be minimized during the periods between December 15 and March 1 and between June 1 and July 31. The minimizing of plant and pump operation shall be achieved by (i) scheduling all shutdowns and maintenance for the periods of restricted operation and/or (ii) restricting the operation of the plant during the periods of restricted operation to hot shutdown except when, after all other available Con Edison plants are operating at full capacity and a good faith effort has been made to purchase power from other utilities, the production of power is essential to Con Edison consumers. Such essential operation shall be limited to the minimum period and amount of power necessary to meet the needs of Con Edison consumers. Reports on each such essential operation shall be filed daily with the Commission with service on the Intervenors in this proceeding."

Although not stated in the HRFA proposed condition, the staff has assumed that retirements of existing fossil units in New York City will be deferred until a closed cycle cooling system is installed and operating at Indian Point Unit 2. The staff further assumed that the applicant would receive its full share of the rated capacities of the Bowline Point and Roseton Units, regardless of their impact on the Hudson River biota.

The obvious intent of the above condition is to minimize the impact on aquatic organisms by reducing the cooling water withdrawal rate from the Hudson River during periods of maximum potential for impingement and entrainment of fish and organisms. Reduction of potentially severe environmental impacts by modifying a plant system or its mode of operation requires trade offs which increase capital and/or operating costs and may create other environmental impacts in the process. The staff's evaluation of the HRFA proposal will investigate the technical feasibility of the methods proposed, consider alternative cases utilizing these methods, and perform a benefit-cost analysis to determine which case, if any, can be justified. The period to be covered is from June 1, 1973 through December 31, 1977, which is in accordance with the proposed condition contained in the Final Environmental Statement permitting operation of the once-through cooling system until January 1, 1978.

Scheduled Shutdowns

Scheduled shutdowns for large power reactors are keyed to refueling and, in the case of Indian Point Unit 2, may or may not coincide with one of the periods of restricted operation specified by HRFA. To require that shutdowns be scheduled for one of these periods as HRFA has suggested would likely require refueling prior to core depletion and place an undue economic burden on the applicant.

Other complications involving the ability of the applicant's system to meet demand loads are likely to occur. As both summer and winter peak loads normally occur within the periods proposed for restricted operation, an unscheduled outage of one or more large fossil units during refueling of Unit No. 2 would reduce available capacity to such an extent that, even with purchased power and load shedding, curtailment of service to parts of the system would be required.

Hot Standby

Operation of Unit No. 2 in prolonged periods of hot standby (maximum of 2.5 months), except as required for peaking purposes when all other means of obtaining power have been exhausted, would cause serious problems resulting in unscheduled shutdowns. Hot shutdowns are usually employed for minor repair of instrumentation or some malfunctioning component. The duration of a hot shutdown is generally limited to 30 minutes or less. Failure to return to power operation within this time period may result in a forced shutdown of 1 or 2 days to permit xenon decay.[1,2] Depending upon the remaining fuel life, these times could be reduced by about one half by gradually bringing the reactor back to full power at the designed boron dilution rate. Delays of this magnitude would negate the use of Unit 2 as a peaking unit.

Other deterents to operation of Unit No. 2 as a peaking unit are the time required to bring the condenser cooling water flow to the required rate and for loading or unloading the steam turbine. These operations could consume as much as 2 hours depending upon the length of time the unit had been in hot standby. Expected turbine life is another important factor. The longest life is attained when the turbine is operated in the base load mode. When operated as a peaking unit, the expected life is reduced.

BENEFIT-COST ANALYSIS

The following assumptions were used by the staff to determine the benefits and cost of the proposed HRFA condition for restricted operation of Unit No. 2.

1. Critical periods to be assessed are between December 15 and March 1 (impingement) and between June 1 and July 31 (entrainment).

2. Retirements of existing fossil units in the applicant's system (Cases I, II, and III only) are as follows:

1973	223 MW
1974	706 MW

3. New capacity added as follows:

1973 - Share of Bowline Point Unit No. 1 (400 MW)
Share of Roseton Units Nos. 1 & 2 (480 MW)

1974 - Astoria Unit No. 6 (800 MW)

1975 - Share of Bowline Point Unit No. 2 (400 MW)

1976 - Joint Fossil Unit, Site Undetermined (500 MW)
Combined Cycle Plant, Site Undetermined (300 MW)

1977 - P.A.S.N.Y. Pumped Storage Plant (500 MW)
Fossil Unit, Site Undetermined (800 MW)
Reduce Share of Roseton Units (-120 MW)

4. Estimated Peak Loads (MW)

	1973	1974	1975	1976	1977
Summer	8950	9400	9850	10,300	10,750
Winter	7400	7850	8300	8750	9200

5. Availability factor for fossil units located in New York City is 78%.

6. Alternative Cases

Case	Critical Period	Percent Rated Capacity Indian Point Unit No. 1	Indian Point Unit No. 2
I	Summer	100	100
	Winter	100	100
II	Summer	100	Hot Standby
	Winter	100	100*
III	Summer	100	Hot Standby
	Winter	100	50*
IV	Summer	100	Hot Standby
	Winter	100	Hot Standby
V	Summer	0	0
	Winter	0	0

*With deicing loop recirculation.

7. Unit Production Costs (dollars per Kilowatt-hour)

	1973	1974	1975	1976	1977
Nuclear					
Fuel	0.00142	0.00142	0.00142	0.00142	0.00142
O & M	0.00040	0.00042	0.00044	0.00046	0.00048
Total	0.00182	0.00184	0.00186	0.00188	0.00190
Oil-fired					
Fuel	0.00840	0.00860	0.00890	0.00910	0.00930
O & M	0.00074	0.00078	0.00082	0.00086	0.00090
Total	0.00914	0.00938	0.00972	0.00996	0.01020
Combined Cycle					
Fuel	NA	NA	NA	0.0082	0.0084
O & M				0.0020	0.0021
Total				0.0102	0.0105
Gas Turbines					
Fuel	0.0097	0.0100	0.0102	0.0104	0.0107
O & M	0.0028	0.0029	0.0039	0.0032	0.0034
Total	0.0125	0.0129	0.0132	0.0136	0.0141
Pumped Storage					
(1.5 x oil-fired)	0.01371	0.01407	0101458	0.01494	0.01530
(1.5 x Nuclear)	0.00273	0.00276	0.00279	0.00282	0.00285

Purchases of supplemental or emergency power was not considered when computing generating costs as the staff had no method for determining what supplemental power would be available or what the requirements would be for emergency power during the critical periods. Should such purchases be required to maintain Unit No. 2 in hot standby, the unit cost would probably exceed the unit production cost for gas turbines as the applicant paid 15.7 mills per kilowatt hour for purchased power during the period from June 1, 1971 to September 30, 1971.[3]

The alternative cases selected for evaluation range from Case I, which would produce the maximum impact on fish and organisms in the Hudson River, to Case IV, the HRFA proposal, to Case V which would have zero impact on the

river. In Cases II and III, a minimum of 50% rated capacity (with recirculation) was used. As the reduction in impingement and entrainment is related to withdrawal rates, this represents the lowest rate possible for any load equal to or less than 50 percent.

BENEFITS

The primary benefit to be achieved by Cases II through V is the reduction of the impacts on the aquatic biota associated with impingement on the intake screens and entrainment in the cooling water systems. The entrainment benefits are equal to the reduction in withdrawal rates and are expressed in Table 1 as the percent of Case I. Approximately the same values would apply for impingement unless the decrease in intake velocity caused by recirculation has a noted effect. Figure V-3 in the Final Environmental Statement indicates little, if any, effect.

Thermal discharges to the river are governed by the thermal power levels at which both units are operating. The benefits derived from reduced power levels are also shown in Table I expressed as a percentage of Case I which represents the "plant as is" operating mode.

ECONOMIC AND ENVIRONMENTAL COSTS

Table 1 summarizes increased generating costs and stack emissions by year of operation and the cooling water withdrawal rate and thermal discharges to the river expressed as a percent of the base case for each of the alternative cases.

Economic Costs

The generating costs in Table 1 assume that in all cases where Unit No. 2 is in standby, it remains in standby for the entire critical period. Purchased

TABLE 1

SUMMARY SHEET

Item	1973	1974	1975	1976	1977
1. Generating Costs ($millions)					
Case I (Base)	204.1	225.0	259.9	268.8	166.1
Case II	213.2	235.0	266.3	277.5	182.7
Case III	220.1	242.5	274.4	285.7	185.8
Case IV	224.5	246.6	278.7	290.0	185.9
Case V	231.7	253.5	289.9	299.3	184.0
2. Increase in Generating Cost ($millions)					
Case I	Base	Base	Base	Base	Base
Case II	9.1	10.0	6.4	8.7	16.6
Case III	22.0	23.3	20.4	23.1	22.8
Case IV	20.4	21.6	18.8	21.2	19.8
Case V	27.6	28.5	30.0	30.5	17.9
3. Increased Stack Emissions in New York City (Tons)					
Case I (Base)	0	0	0	0	0
Case II					
Particulates					
Summer	39	39	39	39	39
Winter	186	186	189	186	42
SO_2					
Summer	786	786	786	786	786
Winter	3733	3733	3783	3733	834
NO_x					
Summer	858	858	858	858	858
Winter	4076	4076	4130	4076	911
Case III					
Particulates					
Summer	39	39	39	39	39
Winter	115	115	117	115	26
SO_2					
Summer	786	786	786	786	786
Winter	2314	2314	2344	2314	517
NO_x					
Summer	858	858	858	858	858
Winter	2526	2526	2560	2526	564

Item	1973	1974	1975	1976	1977
Case IV					
Particulates					
Summer	39	39	39	39	39
Winter	49	49	50	49	11
SO_2					
Summer	786	786	786	786	786
Winter	979	979	993	979	219
NO_x					
Summer	858	858	858	858	858
Winter	1069	1069	1084	1069	239
Case V					
Particulates					
Summer	149	149	149	149	149
Winter	186	186	189	186	42
SO_2					
Summer	2995	2995	2995	2995	2995
Winter	3733	3733	3783	3733	834
NO_x					
Summer	3270	3270	3270	3270	3270
Winter	4076	4076	4130	4076	911

4. Total Cooling Water Withdrawal Rate

	Summer		Winter	
	10^3 gpm	% Case I	10^3 gpm	% Case I
Case I	1170	100.0	1170	100.0
Case II	450	38.5	1010	86.3
Case III	450	38.5	590	50.4
Case IV	450	38.5	450	38.5
Case V		0.0	0	0.0

5. Thermal Discharge to River

	Summer		Winter	
	10^9 Btu/hr	% Case I	10^9 Btu/hr	% Case I
Case I	8.34	100.0	8.34	100.0
Case II	2.06	24.7	8.34	100.0
Case III	2.06	24.7	5.15	61.8
Case IV	2.06	24.7	2.06	24.7
Case V	0.00	0.0	0.00	0.0

power is not included in the costs for the reasons stated previously. If purchased power is required, these costs would increase. If Unit No. 2 must be brought on line, these costs could decrease depending upon the amount of power purchased. For comparison purposes, the incremental generating costs have been reduced to 1973 dollars using a discount rate of 8.75%.

Incremental Generating Costs in Millions of 1973 Dollars

Case I	Base
Case II	42.3
Case III	71.2
Case IV	86.8
Case V	115.6

These figures represent the tradeoff costs for reducing the environmental impact of Unit No. 2 on the Hudson River during the summer and winter critical periods ignoring possible increased maintenance and capital replacement costs resulting from the hot standby operating mode.

Increased Stack Emissions

Increased stack emissions were computed on the basis that the existing base load fossil units in New York City would be used to generate makeup power for the Indian Point Station. The values in Table 1 represent the environmental cost of this mode of operation by adding to the existing air pollution in the city.

Release of Radioactivity in Liquid Effluents During a Hot Standby Status

Total radioactivity in liquid effluents during a hot standby status may be greater than during normal operation for an equivalent period. This anomaly may arise should increased volumes of waste water from maintenance activities reduce in-plant holdup times thus offsetting an expected gain from radioactive decay. In any case the concentration limits imposed by the Rules and Regulations set forth in 10 CFR Part 20 would be in effect.

Chemicals in Plant Effluents During Hot Standby Condition

The water treatment procedures employed during full power operation are not expected to be altered, with minor exception, when the station is placed in a hot standby status. Even though the concentration of chemicals in the service water discharge is expected to be below the maximum proposed limit, steps should be taken to keep chemicals in the plant effluent to a minimum. Particular attention would have to be given to the monitoring of total residual chlorine (free residual chlorine and combined residual chlorine) during the chlorination of the service water system in the summer critical period.[4]

CONCLUSIONS

The staff concludes that the motion submitted by HRFA for limited operation of Unit No. 2 is unacceptable for the following reasons:

1. Scheduling all shutdowns and maintenance for the periods of restricted operation will likely result in uneconomic use of fuel and reduced system reliability.
2. Maintaining Unit No. 2 in hot standby for 4.5 months per year, except when needed for peaking purposes, would be a gross misuse of a high capital investment plant designed for base load operation. The ability to function as a peaking unit is highly questionable and thermal cycling would reduce the economic life of the steam turbine.
3. The incremental generating costs ($86.8 million for the HRFA motion), environmental cost of increased stack emissions in New York, increased

capital equipment replacement costs, and reductions in system reliability cannot be balanced by the environmental benefits that would accrue to the Hudson River biota as a result of the proposed mode of operation.

The staff position remains the same as stated in the Final Environmental Statement; that in the short-term (until January 1, 1978), no irreversible damage would occur to the Hudson River biota and that the benefits of meeting an urgent need for power in the New York area outweigh the estimated corresponding environmental costs incurred over this short-term period.

REFERENCES

1. Murray, Raymond L., "Nuclear Reactor Physics", pp 226-230, Prentice-Hall, Inc., 1957.

2. McLain, Stuart and Martens, John H., Eds., "Reactor Handbook", pp 173 and 427, Vol. IV, John Wiley & Sons, 1964.

3. Consolidated Edison Company of New York, Inc., Supplement No. 2 to the Environmental Report for Indian Point Unit No. 2, September 11, 1972.

4. Consolidated Edison Company of New York, Inc., Testimony Supporting Motion to Test Up to 50% Power in the Hearing Before the Atomic Safety and Licensing Board, October 19, 1971, presented in the Hearing on Indian Point Unit No. 2, (Docket No. 50-247) on November 17, 1971.