NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

In the Matter of a Renewal and Modification of a State Pollutant Discharge Elimination System ("SPDES") Permit Pursuant to article 17 of the Environmental Conservation Law And Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York parts 704 and 750 *et seq.* by Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC, Permittee,	**DEC # 3-5522-00011/00004** **SPDES # NY-0004472**
-and-	
In the Matter of the Application by Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC, And Entergy Nuclear Operations, LLC for a Certificate Pursuant to §401 of the Federal Clean Water Act.	**DEC # 3-5522-00011/00030** **DEC # 3-5522-00011/00031**

DIRECT TESTIMONY OF DR. FRANK ACKERMAN REGARDING PERMANENT FISH PROTECTION OUTAGES AT INDIAN POINT ENERGY CENTER ON BEHALF OF INTERVENORS RIVERKEEPER, INC., SCENIC HUDSON, INC., AND NATURAL RESOURCES DEFENSE COUNCIL, INC.

June 26, 2015

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1. INTRODUCTION AND QUALIFICATIONS

Q. Please state your name, employer, title, and business address.

A. My name is Dr. Frank Ackerman. I am a senior economist at Synapse Energy Economics, a consulting firm based in Cambridge, Massachusetts. I am also a lecturer in climate and energy policy in the Department of Urban Studies and Planning at the Massachusetts Institute of Technology. My business address is Synapse Energy Economics, 485 Massachusetts Avenue #2, Cambridge MA 02139.

Q. What is Synapse Energy Economics?

A. Synapse Energy Economics is a research and consulting firm specializing in electricity industry regulation, planning and analysis. Synapse works for a variety of clients, with an emphasis on consumer advocates, regulatory commissions, other state agencies, and environmental advocates.

Q. Please describe your educational and professional background and qualifications.

A. I received a B.A. in mathematics and economics from Swarthmore College and a Ph.D. in economics from Harvard University. I have 30 years of experience in research, teaching, and consulting on the economics of energy, climate change, and other environmental problems. I have directed studies and reports for a wide and diverse range of clients, including state agencies, international organizations, and leading environmental groups. I have testified as an expert witness in many utility regulatory proceedings, both in my past work at Tellus Institute (formerly Energy Systems Research Group), and in my current work at Synapse Energy Economics. I have published several books, about 50 peer-reviewed journal articles, and numerous other articles and reports. Prior to joining Synapse Energy Economics and in addition to my work at Tellus Institute, I was the director of the Stockholm Environment Institute's Climate Economics Group. I have also served as director of the Research and Policy Program at Tufts University's Global Development and Environment Institute. I have taught economics at the University of Massachusetts and at Tufts University, and as noted I am also a lecturer in climate and energy policy in the Department of Urban Studies and Planning, Massachusetts Institute

of Technology. My curriculum vitae, which fairly and accurately reflects my education and experience, is included herewith as **Riverkeeper Exhibit 186.**

Q. Please describe the purpose of your testimony.

A. The purpose of my testimony is to evaluate the cost aspect of Riverkeeper's proposed 118-day outage as an entrainment minimization technology at Indian Point for purposes of the Fourth Step of the so-called "BTA" (best technology available) analysis which is being conducted in this proceeding pursuant to Section 316(b) of the Clean Water Act and 6 NYCRR § 704.5.[1] My "Step Four" BTA analysis explains why the proportional costs of Riverkeeper's proposed outages are not wholly disproportionate to the proportional benefit to be gained from minimizing Indian Point's established[2] adverse environmental impact by way of such outages. My testimony also includes a discussion of the balancing of a range of environmental impacts with non-environmental social and economic considerations as may be required pursuant to New York's State Environmental Quality Review Act (SEQRA).

Q. Please describe the proposed outage that you have evaluated in your direct testimony.

A. I have evaluated the Riverkeeper's 118-day proposal for fish protection outages which is discussed in the accompanying prefiled direct testimony of Riverkeeper expert witness Dr. Peter A. Henderson.

This proposed outage includes the 92-day outage from May 10 through August 10 as initially proposed by the New York State Department of Environmental Conservation (DEC or the Department) Staff,[3] plus 26 days from February 23 through March 20, at both units every year.

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[1] *See* Ruling of the Regional Director, BTA Step 4 (November 28, 2012), at 7-8.

[2] I am informed by counsel that the August 15, 2008 Assistant Commissioner's Interim Decision determined conclusively that an adverse environmental impact exists as a result of the once-through cooling water system at Indian Point (*In the Matter of Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC*, Interim Decision of the Assistant Commissioner (August 13, 2008), 2008 N.Y. ENV LEXIS 52, *34 (herein referred to as Interim Decision).

[3] *See* DEC Staff, *DEC Staff Fact Sheet on Scheduled BTA Outages/Seasonal Protective Outages* (May 9, 2014) (DEC Staff Outages Fact Sheet).

Q. What specifically were you asked to do in preparing your direct testimony?

A. I was asked to estimate and analyze the proportional increased costs of Riverkeeper's proposed, 118-day annual permanent fish protection outage at Indian Point Energy Center Units 2 and 3 (collectively, IPEC or Indian Point) as compared to current operations (including but not limited to, a consideration of any installation, maintenance and operational costs of taking the outages as well as lost revenue from the outages themselves), and to offer my expert opinion as to the question of whether the costs of this dual unit, 118-day fish protection outage at Indian Point are wholly disproportionate to the environmental benefit to be gained from minimizing Indian Point's established[4] adverse environmental impact by way of such outages.[5] I was asked to utilize the Department's BTA[6] policy, CP-52,[7] and administrative precedent as guidance in addressing the fourth step of the BTA analysis.[8]

I was also asked to rely on the accompanying testimony of Dr. Peter A. Henderson, Pisces Conservation Ltd., with respect to the proportional increase in the protection of aquatic organisms of Riverkeeper's 118-day fish protection outages (the "benefit" side of the wholly disproportionate analysis), and to rely on the accompanying prefiled direct testimony of Riverkeeper expert witness Paul Blanch with respect to certain cost categories which might be expected to be associated with implementing such outages.

I was also asked to examine the economic considerations of Riverkeeper's outages proposal in order to help create a record which will assist the ultimate decision-maker in the balancing of environmental issues with social and economic considerations (as and if appropriate) pursuant to SEQRA with respect to the implementation of such outages.[9]

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[4] *See* footnote 2, *supra*, *citing* Interim Decision, 2008 N.Y. ENV LEXIS 52, *34.
[5] Ruling of the Regional Director, BTA Step 4, at 7-8.
[6] *See* 6 NYCRR 704.5; CWA § 316(b).
[7] DEC, Commissioner's Policy #52, Best Technology Available (BTA) for Cooling Water Intake Structures (July 10, 2011) at 4 (hereinafter referred to as CP-52).
[8] Ruling of the Regional Director, BTA Step 4, at 8.
[9] *See* NYSDEC, *The SEQR Handbook* (3rd ed.), **Entergy Exhibit 233**, at 81; *see also* CCC Hogan March 28, 2014 Rebuttal Testimony, at 4:5-16.

In preparing my testimony, I was asked to review and discuss as appropriate the following materials:

- DEC Staff, *DEC Staff Fact Sheet on Scheduled BTA Outages/Seasonal Protective Outages* (May 9, 2014) (DEC Staff Outages Fact Sheet);
- Letter from Mark L. Lucas, Riverkeeper, to Hon. Maria E. Villa, NYSDEC, re: Public Comments on Behalf of Riverkeeper, Inc. Concerning the Issue of Scheduled BTA Outages/Seasonal Protective Outages at Indian Point Energy Center (July 11, 2014) (Riverkeeper Outages Comments);
- Issues Ruling – Permanent Forced Outages (February 3, 2015) (Outages Issues Ruling);
- US EPA – New England, Clean Water Act NPDES Permitting Determinations for Brayton Point Station's Thermal Discharge and Cooling Water Intake in Somerset, MA (NPDES Permit No. MA 0003654) (July 22, 2002), Chapters 7-8, (Brayton Point Determinations Document), identified as **Riverkeeper Exhibit 188;**
- *The Status of Fish Populations and the Ecology of the Hudson River* (Pisces, 2015), identified as **Riverkeeper Exhibit 185**;
- *Entrainment, Impingement and Thermal Impacts at Indian Point Nuclear Power Station*, PISCES Conservation Ltd. (November 2007), **Riverkeeper Exhibit 3**;
- Prefiled Direct Testimony y of Dr. Peter A. Henderson (July 22, 2011);
- Prefiled Rebuttal Testimony of William C. Nieder (September 30, 2011);
- Prefiled Direct Testimony of Dr. Peter A. Henderson (June 26, 2015);
- Prefiled Direct Testimony of Robert Fagan (June 26, 2015);
- Prefiled Direct Testimony of John Hinckley (June 26, 2015);
- Prefiled Direct Testimony of Paul Blanch (June 26, 2015);
- Prefiled Direct Testimony of William C. Nieder (February 28, 2014);
- Nieder, Wholly Disproportionate Test Report (February 28, 2014) (DEC CCC Wholly Disproportionate Test Report), **Staff Exhibit 215**;
- DEC, *The SEQR Handbook* (3rd ed) (2010) (SEQR Handbook), **Entergy Exhibit 233**;

- Commissioner's Policy #52, Best Technology Available (BTA) for Cooling Water Intake Structures (July 10, 2011) (CP-52);
- Interim Decision of the Assistant Commissioner (August 13, 2008) (Interim Decision); and
- Ruling of the Regional Director (November 28, 2012) (Ruling of the Regional Director, BTA Step 4).

Q. Please summarize your direct testimony.

A. The BTA fourth step analysis involves determination of whether the costs of a proposed technology are wholly disproportionate to the benefits of minimizing the adverse environmental impacts at issue. DEC has developed a straightforward, transparent method of calculating proportional costs of the proposed BTA and proportional benefits of the reduced impingement and entrainment, for use in the wholly disproportionate test. For benefits, I rely on Dr. Henderson's testimony, which finds that Riverkeeper's proposed 118-day fish protection outage would eliminate 88 percent of entrainment at Indian Point – enough for the proposed outage to qualify as BTA. Following DEC's methodology, I calculate that the same outage would have a proportional cost of 29.9 percent of Indian Point revenue.

There is no fixed numerical standard for what constitutes wholly disproportionate cost, and there is little precedent in past DEC decisions. A relevant EPA decision, the EPA Region One permitting determination for the Brayton Point power plant in Massachusetts, emphasizes that more serious impacts justify more significant expenditures to reduce those impacts, that the same numerical losses represent more serious adverse impacts in an ecosystem that is already suffering from past impacts, and takes into consideration that the facility at issue in that case (the Brayton Point Station) had already gained substantial benefits from years of operating without an upgraded CWIS. All of these points are directly applicable to Indian Point as well. Based on the severity and duration of the impacts on aquatic life at Indian Point, I conclude that a proportional cost of about 30 percent is not wholly disproportionate to the proportional benefit of 88 percent reduction in entrainment and impingement.

The SEQRA analysis, to be carried out at the conclusion of the public process by the Commissioner or his designee, to the extent necessary, involves balancing of environmental issues with social and economic considerations. As with the BTA fourth step analysis, there is no fixed numerical standard for SEQRA balancing, and there is no role for formal cost-benefit analysis – particularly since many of the significant environmental benefits of BTA proposals do not have well-defined monetary prices. SEQRA balancing, as applied to the proposed fish protection outages, should compare the near-complete elimination of entrainment and impingement, as reported in Dr. Henderson's testimony, to the minimal social and economic effects of the outages. Many impacts of other BTA proposals are avoided by outages: there are no construction impacts, visual or noise impacts, or disturbance to the river ecosystem. As Robert Fagan and John Hinckley explain in their accompanying testimony, there would be only modest, short-term effects of the fish protection outages on electric rates, electric system reliability, and air emissions from power production. Such impacts would dissipate, within a few years, as a result of longer-term developments in energy supply and demand. Thus there is nothing in the SEQRA balancing process that could outweigh the substantial environmental benefit of the proposed outages.

2. BTA FOURTH STEP ANALYSIS

Q. What is the fourth step of the Department's BTA analysis?

A. State regulations and Section 316(b) of the federal Clean Water Act mandate the adoption of BTA for cooling water intake systems (CWIS) on industrial facilities such as Indian Point. The Department is the agency responsible for implementing these rules in New York, and has issued guidance for implementing Section 316(b) in the form of Commissioner's Policy CP-52. In CP-52, the Department provides a minimum BTA

performance goal for existing facilities such as Indian Point[10] and mandates wet closed-cycle cooling or another technology capable of achieving equivalent reductions in impingement and entrainment (that is, at least 90 percent of the reductions that would be achieved by wet closed-cycle cooling).[11]

DEC has adopted a site-specific, four-step analysis for BTA determinations.[12] The first three steps analyze whether the facility's CWIS is causing adverse environmental impacts; whether the location, design, construction, and capacity of the cooling water intake structure reflect BTA for minimizing adverse environmental impact; and whether practicable alternatives are available to minimize adverse environmental effects.[13] The fourth step determines whether the costs of practicable technologies are wholly disproportionate to the resulting environmental benefits conferred by such measures.[14]

Q. Is a cost-benefit analysis required to determine whether costs are wholly disproportionate to benefits?

A. No. As the November 28, 2012 ruling of the DEC Regional Director on the fourth step analysis for Indian Point explained, "Nothing in section 316(b) of the Clean Water Act or 6 NYCRR 704.5 requires a cost-benefit analysis."[15] The ruling went on to cite DEC's CP-52 policy, which says that in BTA determinations, "The Department will not undertake a formal cost-benefit analysis whereby the environmental benefits would be monetized. Such an analysis is neither desirable nor required by law."[16]

Indeed, as CP-52 further explains, the fourth step analysis is

> neither a traditional cost-benefit analysis nor an economic analysis but simply a comparison of the proportional reduction in impact (benefit) as compared to the proportional reduction in revenue (cost) of installing and operating BTA technology to mitigate adverse environmental impact. This

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[10] CP-52 "applies to existing...industrial facilities designed to withdraw twenty (20) million gallons per day (MGD) or more of water from the waters of New York State, where at least twenty five (25) percent is used for contact or non-contact cooling, and that are subject to the requirements of Section 704.5 of 6 NYCRR." CP-52, at 1.
[11] CP-52, at 2.
[12] *See* Ruling of the Regional Director, BTA Step 4, at 2.
[13] *See* Ruling of the Regional Director, BTA Step 4, at 2.
[14] *See* Ruling of the Regional Director, BTA Step 4, at 2.
[15] Ruling of the Regional Director, BTA Step 4, at 6.
[16] Ruling of the Regional Director, BTA Step 4, at 7 (citing CP-52, at 6).

comparison does not monetize the resource and gives presumptive weight to the value of the environmental benefits to be gained.[17]

The aquatic resources to be conserved and protected are not monetized in connection with the BTA Step Four analysis; rather, presumptive weight is accorded to the value of the benefits to be gained from minimizing adverse environmental impacts.[18]

Q. As an economist, do you think that cost-benefit analysis would lead to greater objectivity or precision in BTA determinations?

A. No, this would not be the case. Key categories of benefits, such as reductions in mortality of aquatic organisms and reduction in damage to aquatic ecosystems, do not have well-defined monetary values. In practice, cost-benefit analysis would lead to reliance on intricate and controversial inferences about hypothetical monetary values of "priceless," often irreplaceable, resources and benefits. This would not improve the quality of public consideration of the disparate, non-commensurable categories of costs and benefits that are involved in decisions about cooling water intake systems.

A fundamental, although usually unstated, assumption of cost-benefit methodology is that the calculations of costs and benefits are similarly complete. Yet asymmetric knowledge is the rule, not the exception in environmental policy. In the environmental context, cost-benefit analysis typically offers a comparison of relatively complete costs versus incomplete benefits, which is of little value in decision-making. The asymmetric knowledge that a complete calculation of the costs of a proposal exceeds an incomplete calculation of its benefits does not constitute grounds for making an impartial or fully-informed decision. Unlike costs, which frequently involve well-defined market values such as hardware or operational costs, environmental benefits frequently involve protection of human life, health, and nature, which typically do not have meaningful prices.[19]

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[17] CP-52, at 4; *see also* Ruling of the Regional Director, BTA Step 4, at 7.
[18] *See* CP-52, at 4.
[19] *See* Heinzerling and Ackerman (2002).

Q. Please describe the methods of calculation used by the Department in the BTA fourth step to determine whether costs are wholly disproportionate to benefits.

A. DEC has developed a methodology for calculating the costs and the presumed benefits of entrainment and impingement reductions for the wholly disproportionate test which is set forth in CP-52 and which has been applied by Department Staff's expert witness William Charles Nieder. DEC's methodology is summarized in Mr. Nieder's February 28, 2014 direct testimony in this case, as well as the February 28, 2014 Wholly Disproportionate Test Report for closed-cycle cooling proposals, entered in these proceedings as **Staff Exhibit 215** (DEC CCC Wholly Disproportionate Test Report).

Mr. Nieder's testimony and the DEC CCC Wholly Disproportionate Test Report explain how DEC measures the proportional cost and benefit of a new technology, using the following equations for the fourth step of the BTA wholly disproportionate analysis:[20]

$$\text{Proportional cost} = \frac{\text{Annual cost of mitigative technology}}{\text{Annual gross revenue}}$$

$$\text{Proportional Benefit} = \frac{\text{Number of organisms protected with mitigative technologies}}{\text{Number of organisms at risk of impingement or entrainment mortality}}$$

I agree with Mr. Nieder's explanation that this offers a straight-forward methodology to calculate the proportional costs and benefits of a proposed BTA which is consistent and transparent.[21] As the Department has stated, DEC's fourth step methodology not only allows for non-economic staff to undertake this analysis, but also allows for the public to understand it.[22]

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[20] *See*, respectively, CCC Nieder February 28, 2014 Direct Testimony, at 5:9-17; DEC CCC Wholly Disproportionate Test Report, **Staff Exhibit 215**, at 9 of 19 (proportional cost) *and* CCC Nieder February 28, 2014 Direct Testimony, at 7:22 to 8:9; DEC CCC Wholly Disproportionate Test Report, **Staff Exhibit 215**, at 11 of 19 (proportional benefit).

[21] CCC Nieder February 28, 2014 Direct Testimony, at 6:3-8; DEC CCC Wholly Disproportionate Test Report, **Staff Exhibit 215**, at 7 to 8 of 19.

[22] *See*, e.g., DEC CCC Wholly Disproportionate Test Report, **Staff Exhibit 215**, at 7 to 8 of 19.

Q. For what technology did you carry out these calculations?

A. I undertook a BTA fourth step wholly disproportionate analysis, following the DEC methodology described above, for Riverkeeper's proposed 118-day outage that I mentioned earlier.

Q. What is the proportional benefit of Riverkeeper's 118-day proposed outage?

A. According to Dr. Henderson, the proposed outage would eliminate 88 percent of both impingement and entrainment of all species typically entrained or impinged by Indian Point's CWIS.[23]

Q. What is the proportional cost of Riverkeeper's 118-day proposed outage?

A. I have calculated the proportional costs using DEC's method of calculation, as explained above. I estimate that the 118-day outage would have a proportional cost of 29.9 percent of facility revenues.

Q. Please identify the cost factors which could be affected by Riverkeeper's 118-day outages for Indian Point.

A. During the outages, Indian Point will not be able to generate and sell electricity. The lost revenues from the outages are the principal cost for outages, which I have included in my calculation.

Additional cost factors, which I have not included in my calculation, include some that would increase and some that would decrease the estimated costs of outages. For example, under Riverkeeper's outages proposal, each unit would have to start up and shut down twice per year, compared to only once every two years for refueling at present. Thus the outages might entail any costs associated with the need for an additional 1.5 startups and shutdowns per year at each unit, compared to current conditions. I understand from the accompanying testimony of Paul Blanch, however, that outages,

[23] Outages Henderson June 26, 2015 Direct Testimony, at 24:13-20.

other than those for refueling, do not require additional personnel or effort beyond the routine maintenance normally conducted by plant personnel.[24]

On the other hand, the shutdown of the plant for almost one-third of each year would reduce fuel use. This would lower the annual average costs of fuel. As an incidental effect of DEC's restriction of the amount of cooling water available, the reduced fuel use might allow less frequent refueling, and hence a reduction in the average annual costs of refueling.[25] I understand from Mr. Blanch's testimony there are significant additional labor requirements for refueling outages.[26] Any reduction in the frequency of refueling would reduce the average annual level of costs associated with the labor needed for refueling.

I also understand from Mr. Blanch's testimony that the Riverkeeper outages proposal might allow reduction in the level of some general facility operations and maintenance costs during the shutdown periods.[27]

Q. Why did you omit these additional cost factors in your calculation?

A. I am not aware of any public source of information on these cost factors. It is my understanding that Entergy considers many or all of the data on operating costs to be confidential business information (CBI). I am advised by counsel that Entergy disclosed some CBI documents less than a week ago, but I have yet to see any CBI documents with respect to Indian Point operating costs, if they have been produced. With the current, limited data availability, I can only note that some omitted factors would increase, while others would decrease, the proportional cost of outages.

Q. Please explain your calculation of the proportional costs of Riverkeeper's 118-day proposed outage.

A. My calculation uses DEC's formula, as cited above:

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[24] *See* Outages Blanch June 26, 2015 Direct Testimony, at 13:12-13; *see also id.* At 6:19-21, 6:27 to 7:2.
[25] *See* Outages Blanch June 26, 2015 Direct Testimony, at 6:24-25; *id.* at 10:25-26; *id.* at 13:22-24.
[26] *See* Outages Blanch June 26, 2015 Direct Testimony, at 5:4-14.
[27] *See* Outages Blanch June 26, 2015 Direct Testimony, at 13:22-24.

$$\text{Proportional cost} = \frac{\text{Annual cost of mitigative technology}}{\text{Annual gross revenue}}$$

To calculate the revenues lost during outages, DEC uses average annual generation from the past five years and the average price per MWH for a recent 12-month period. I downloaded annual generation for both Indian Point units for 2010-2014, using data from the Energy Information Administration's Electricity Data Browser.[28] The result was 16,931,792 MWH/year for both units combined, as shown in the following table.

	Net generation (MWH)	
	IP 2	**IP 3**
2010	7,325,923	8,994,713
2011	8,788,096	8,228,766
2012	7,934,995	9,002,057
2013	8,784,643	8,291,512
2014	8,330,556	8,977,699
Average	8,232,843	8,698,949
Two-unit average	16,931,792	

I also downloaded and averaged the day-ahead electricity prices for Indian Point 2 and 3 throughout 2014, from the New York ISO website.[29] The result was $59.851/MWH for both units combined. The data are too voluminous to tabulate in my testimony (there are 8,760 hourly prices for each unit), but they are presented in the spreadsheet that documents my calculations, attached to this testimony and identified as **Riverkeeper Exhibit 187**.

Using these assumptions, average gross revenue from energy sales for Indian Point Units 2 and 3 combined is (16,931,792 MWH * $59.851/MWH), or $1,013,382,673. This is the denominator in the proportional cost equation used by DEC and cited above.

[28] Annual generation for Indian Point 2 and 3, calendar years 2010-2014, downloaded on June 11, 2015 from the Energy Information Administration, http://www.eia.gov/electricity/data/browser.

[29] Day-ahead location-based marginal prices (LBMP) for Indian Point 2 and 3, calendar year 2014, downloaded on June 11, 2015 from New York ISO, http://www.nyiso.com/public/markets_operations/market_data/custom_report/index.jsp?report=dam_lbmp_gen.

I then assumed that the principal cost of the proposed outage was the loss of revenues for the days of the outage, net of the cost of refueling outages.

Enercon's 2010 report to Entergy, "Evaluation of Alternative Intake Technologies at Indian Point Units 2 & 3," entered in these proceedings as **Entergy Exhibit 8**, states that "maintenance and refueling outages (i.e., scheduled outages) are currently scheduled to occur approximately every 24 months for each Unit, and are anticipated to last approximately 25 days."[30] Based on this report, I assumed a 25-day refueling outage at each unit every two years, or one 25-day refueling outage per year at the two units combined. With these assumptions, the 118-day annual outage at both units amounts to a net loss of (118 * 2 – 25), or 211, unit-days of production and revenues.

In the absence of fish protection outages, a year of operation consists of 340 days (that is, 365 - 25 for refueling) at one unit and 365 days at the other, for a total of (340 + 365), or 705 unit-days.

Therefore, annual revenues amount to an average of ($1,013,382,673 / 705), or $1,437,422 per unit-day. Since that outage causes a net loss of 211 unit-days of revenue, it represents a loss of ($1,437,422 * 211), or $303,296,091 of revenue. This is the numerator in the proportional cost equation used by DEC and cited above.

In conclusion, using DEC's BTA Fourth Step methodology, the proportional cost of Riverkeeper's proposed 118-day outages is (outage cost / gross revenue), which equals ($303,296,091 / $1,013,382,673), or 29.9 percent.

Q. Why are refueling outages included in this calculation?

A. Indian Point has periodic refueling outages, during which it does not earn revenues. These are a cost of operation under any scenario for the plant, with or without fish protection outages. Based on my best professional judgment, I assumed that under Riverkeeper's proposal, all refueling activity could be scheduled to occur during the fish

[30] Enercon Services Inc., Evaluation of Alternative Intake Technologies at Indian Point Units 2 & 3 (February 12, 2010), **Entergy Exhibit 8** (Enercon Alternative Technologies Report), at 18.

protection outages.[31] As a result, the net new cost to Indian Point for the proposed 118-day outage is the gross cost of losing the plant's revenue on the days on those 118 days, minus the cost that would have been incurred for refueling one unit per year in the absence of the fish protection outages.

3. APPLYING THE WHOLLY DISPROPORTIONATE COST TEST

Q. How has the Department applied the BTA Fourth Step wholly disproportionate cost test in reported decisions?

A. General descriptions of the wholly disproportionate cost test are relatively common. CP-52, for example, echoing similar language found elsewhere, describes the wholly disproportionate test in the words I have quoted above, calling for a comparison of the proportional benefit to the proportional cost of BTA technology, giving presumptive weight to the value of the environmental benefits to be gained.[32]

Explicit, written calculations of the wholly disproportionate test are less common. DEC's *Athens* decision, which introduced New York's framework for BTA analysis, including wholly disproportionate test, noted that the annualized cost of the recommended CWIS option in that case was only $1.9 million greater than the alternative.[33] It did not, however, carry out calculations of proportional cost and proportional benefit, in the manner described more recently by Mr. Nieder.

Some other DEC rulings involving BTA for CWIS, such as the Bowline and Danskammer decisions, have focused entirely on site-specific design and engineering issues – in effect making decisions based on the first three steps of the BTA process, without any quantitative discussion of the fourth step.[34]

As Department Staff has elsewhere observed, the Athens and Bowline BTA decisions addressed new facilities which had not yet been built and were not operating when the

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[31] *See also* Outages Blanch June 26, 2015 Direct Testimony, at 13:26-30.
[32] CP-52, at 4.
[33] *See Matter of Athens Generating Co.* (Interim Decision, June 2, 2000), **Entergy Exhibit 506,** at 15 of 25.
[34] *See, e.g., Matter of Dynegy Northeast Generation, Inc. (Danskammer Generating Station)*, Decision of the Deputy Commissioner, 2006 N.Y. ENV LEXIS 23 (May 24, 2006); *Matter of Mirant Bowline, LLC*, Hearing Report and Recommended Decision, 2001 N.Y. ENV LEXIS 52 (November 30, 2001).

Commissioner's BTA decisions were made (and thus neither facility had a revenue stream to compare with benefits).[35] Danskammer was an existing facility, but, as the Commissioner's Decision in that case explained, the Applicant in that case had agreed to the BTA technology required by the draft State Pollutant Discharge Elimination System (SPDES) permit, and thus BTA Step Four cost considerations were not at issue in the Danskammer case.[36]

In contrast to Athens and Bowline 3, Indian Point has operated in once-through cooling mode for over forty years, so that it is possible to calculate both proportional benefit and proportional cost according to the DEC methodology.

A review of the DEC SPDES Permit Fact Sheets for various CWISs (as supplied by the Department through discovery in these proceedings) confirms that, even when a wholly disproportionate determination is made, the DEC rarely presents an explicit calculation supporting the wholly disproportionate analysis. What emerges from an analysis of Department precedent is that BTA determinations, including the wholly disproportionate test, are site-specific and require a separate determination reflecting the unique circumstances of each application.[37]

Q. Please explain your understanding as to why Indian Point presents a unique set of circumstances for the application of the wholly disproportionate test.

A. I am informed that Indian Point annually entrains more than one billion aquatic organisms[38] - and that both Department Staff and Dr. Henderson are in agreement that the adverse environmental impact of Indian Point's forty-plus years of operations in once-through cooling mode has contributed to the long-term and significant declines in the

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[35] CCC Nieder February 28, 2014 Direct Testimony, at 7:1-5.
[36] *Matter of Dynegy Northeast Generation, Inc. (Danskammer Generating Station)*, 2006 N.Y. ENV LEXIS 23, *196.
[37] *See Matter of Mirant Bowline, LLC,* 2001 N.Y. ENV LEXIS 52, *91.
[38] I understand that Indian Point annually entrains roughly 1.2 billion fish per year (DEC Staff Outages Fact Sheet, at 8, *citing* **Entergy Exhibit 8**, Enercon 2010 Alternatives Report, Attachment 6, Table 3, at p. 20).

populations of a number of Hudson River fish species such as Atlantic tomcod, American shad, white perch, river herring, and bay anchovy.[39]

Q. Please explain how your wholly disproportionate analysis accounts for the duration and magnitude of Indian Point's adverse environmental impacts.

A. My analysis considers the nature and duration of Indian Point's adverse environmental impact in connection with an assessment of the costs of Riverkeeper's proposed fish protection outages. Chapters 7 and 8 of the Environmental Protection Agency, Region One's Brayton Point Determinations Document[40] explained that the magnitude or seriousness of the adverse impacts from entrainment and impingement should be assessed on a case-by-case basis, and "that more serious adverse impacts warrant more serious expenditures for reductions based on a 'wholly disproportionate' cost test. . .".[41] As EPA Region One explained, "Where to 'draw the line'" as to when the cost is wholly disproportionate to the environmental benefit of reductions in entrainment and impingement "is a policy judgment left to the sound discretion" of the decision-making agency on a case-by-case basis in reaching a particular § 316(b) decision.[42]

The Brayton Point Determinations Document cites an earlier EPA document explaining that, with respect to the "wholly disproportionate" cost test, "the more serious the adverse

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[39] *See* **Riverkeeper Exhibit 2,** The Status of Fish Populations and the Ecology of the Hudson River (Pisces, 2008), at 15-16; 24; 25-26 and Figure 22; 27; 28-29; 31, Figure 28; 32 and 38; CWW Nieder September 30, 2011 Rebuttal Testimony, at 44:15-18; CWW Henderson July 22, 2011 Direct Testimony, at 9:6-9 and 9:35-36, Table 1 (same as DEIS Appendix VI-1-D-2, Table 2); CWW Henderson July 22, 2011 Direct Testimony, at 3:4-12; **Riverkeeper Exhibit 3**, *Entrainment, Impingement and Thermal Impacts at Indian Point Nuclear Power Station*, PISCES Conservation Ltd. (November 2007) at 44-45, *quoting* **Entergy Exhibit 120,** NYSDEC FEIS for the Hudson River Power Plants [2003] at 54 of 93; *see also* CWW Henderson July 22, 2011 Direct Testimony, at 8:21 to 9:2; Outages Henderson June 26, 2015 Direct Testimony, at 10:25 to 11:4 and 20:10-22; Interim Decision, 2008 NY ENV LEXIS 52, *32-33; *see also* **Riverkeeper Exhibit 185,** The Status of Fish Populations and the Ecology of the Hudson River (Pisces 2015).

[40] US EPA – New England, Clean Water Act NPDES Permitting Determinations for Brayton Point Station's Thermal Discharge and Cooling Water Intake in Somerset, MA (NPDES Permit No. MA 0003654) (July 22, 2002), Chapters 7-8, *available at* http://www.epa.gov/region1/braytonpoint/pdfs/BRAYTONchapters7-8.PDF, a copy of which is included herewith as **Riverkeeper Exhibit 188** (herein referred to as Brayton Point Determinations Document).

[41] **Riverkeeper Exhibit 188,** Brayton Point Determinations Document, at 7-13, *citing* 41 Fed. Reg. 17388 (April 26, 1976); EPA May 1977 Draft § 316(b) Guidance,11-15.

[42] **Riverkeeper Exhibit 188,** Brayton Point Determinations Document, at 7-18.

impacts, the more significant the costs that would be justified to reduce those impacts."[43] As EPA Region One further explained:

> For example, the loss to a CWIS of a certain number of organisms, or a certain percentage of a population organisms, might be a more serious adverse impact in an environment already suffering from other adverse impacts than it would be in an otherwise healthy ecosystem.[44]

As noted, I defer to Dr. Henderson's testimony and the record in these matters with respect to the status of the fish populations of the Hudson River species whose billions of individual members have been killed by Indian Point's CWIS over the last four decades.[45] Dr. Henderson's opinion, which I understand is supported by an extensive fish population dataset gathered by Indian Point and other Hudson River generating facilities, is that the mortality caused by Indian Point's CWIS has contributed to the long-term declines in the populations of most of the "Resident Important Species" of fish identified by Entergy.[46] I further understand that Dr. Henderson's analysis in the best usages portion of these hearings has shown that the abatement of Indian Point's unnatural mortality of aquatic organisms is necessary in order to give the ecosystem of the Hudson River a chance to recover from decades of Indian Point's adverse environmental impacts.[47]

As EPA also noted with respect to the long-delayed compliance of Brayton Point, a facility which operates for decades while avoiding compliance with Section 316(b) of the Clean Water Act has "clearly reaped substantial economic benefit over the years from

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[43] **Riverkeeper Exhibit 188**, Brayton Point Determinations Document, at 7-20.
[44] **Riverkeeper Exhibit 188**, Brayton Point Determinations Document, at 7-22.
[45] *See* **Riverkeeper Exhibit 2,** The Status of Fish Populations and the Ecology of the Hudson River (Pisces, 2008), at 15-16; 24; 25-26 and Figure 22; 27; 28-29; 31, Figure 28; 32 and 38; CWW Nieder September 30, 2011 Rebuttal Testimony, at 44:15-18; CWW Henderson July 22, 2011 Direct Testimony, at 9:6-9 and 9:35-36, Table 1 (same as DEIS Appendix VI-1-D-2, Table 2); CWW Henderson July 22, 2011 Direct Testimony, at 3:4-12; **Riverkeeper Exhibit 3**, *Entrainment, Impingement and Thermal Impacts at Indian Point Nuclear Power Station*, PISCES Conservation Ltd. (November 2007) at 44-45, *quoting* **Entergy Exhibit 120,** NYSDEC FEIS for the Hudson River Power Plants [2003] at 54 of 93; *see also* CWW Henderson July 22, 2011 Direct Testimony, at 8:21 to 9:2; Outages Henderson June 26, 2015 Direct Testimony, at 10:25 to 11:4 and 20:10-22; Interim Decision, 2008 NY ENV LEXIS 52, *32-33; *see also* **Riverkeeper Exhibit 185,** The Status of Fish Populations and the Ecology of the Hudson River (Pisces 2015).
[46] *See id.*
[47] Best Usages Henderson July 22, 2011 Direct, at 10:21-23.

avoiding upgrading the once-through cooling system . . .".[48] Such is the case with Indian Point.

Q. Do you consider the cost of Riverkeeper's proposed 118-day fish protection outage to be wholly disproportionate to its benefits?

A. No, I do not. According to my calculations, the proportional cost of the 118-day outage is roughly 30 percent of facility revenues. Dr. Henderson has calculated the proportional benefit of the 118-day outage to be 88 percent.[49] Given the magnitude and duration of Indian Point's serious adverse impacts, substantial costs would be justified in the light of the significant and long-term impact which Indian Point has had on the aquatic resources of the Hudson River. The question of where to draw the line on what constitutes a "wholly disproportionate" increase in costs must, as EPA has explained, be evaluated in the light of the magnitude of the impacts at issue. An evaluation of the environmental impacts at issue involves biological and policy considerations of the magnitude and duration of the impacts, as well as policy considerations of both conscience and justice. In that regard, moreover, the operators of Indian Point "have clearly reaped substantial economic benefit over the years from avoiding upgrading the once-through cooling system until this time."[50] As well, DEC concluded long ago that "inadvertent mortality of fish by utilities is *not* a legitimate use" of resources.[51]

Thus, in my opinion a proportional cost of 30 percent is not wholly disproportionate to a proportional benefit of an 88 percent reduction in entrainment and impingement at Indian Point.

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[48] **Riverkeeper Exhibit 188**, Brayton Point Determinations Document, at 7-180.
[49] Outages Henderson June 26, 2015 Direct Testimony, at 23:4 to 24:20.
[50] *See* **Riverkeeper Exhibit 188**, Brayton Point Determinations Document, at 7-178, 7-180.
[51] *See* **Staff Exhibit 97**, Letter from Thomas C. Jorling, DEC, to Mr. Bayne (April 29, 1991), at 1 (emphasis in original).

4. SEQRA ANALYSIS OF PROPOSED OUTAGE

Q. Please explain the role that economic considerations should play with respect to the State Environmental Quality Review Act (SEQRA) evaluation of Riverkeeper's outages proposal as BTA for Indian Point.

A. According to SEQRA, "the protection and enhancement of the environment, human and community resources shall be given appropriate weight with social and economic considerations in public policy. Social, economic, and environmental factors shall be considered together in reaching decisions on proposed activities."[52] As the Department's regulations further explain, "the protection and enhancement of the environment, human and community resources should be given appropriate weight with social and economic considerations in determining public policy" and such factors should be considered together in reaching decisions on proposed activities.[53]

Thus economic considerations are one among many factors that are to be considered together. There is no stand-alone requirement to meet any fixed economic threshold; rather, SEQRA involves "the balancing of environmental issues with social and economic considerations in planning and decision making."[54] And as DEC Staff witness Christopher Hogan explained in these proceedings, any such consideration of economic factors is part of final balancing analysis under SEQRA to be performed by the Commissioner or his designee at the conclusion of the public process.[55] I am also informed by counsel that the SEQRA balancing (if any) would follow upon the ultimate decision-maker's selection of what entrainment controls are legally required for Indian Point.

My testimony addresses such considerations in order to provide some context to the ultimate decision-maker in these matters.

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[52] ECL § 8-0103(7).
[53] 6 NYCRR §§ 617.1(c), (d).
[54] **Entergy Exhibit 233**, SEQR Handbook, at 101. I am informed by counsel, that this balancing is only necessary in those circumstances where adverse environmental impacts of a proposed project are not fully avoided or mitigated.
[55] *See* CCC Hogan March 28, 2014 Rebuttal Testimony, at 4:5-16; *see also* **Entergy Exhibit 233**, SEQR Handbook, at 81.

Q. Are cost-benefit analysis and monetization of environmental benefits appropriate or helpful for balancing of environmental issues with social and economic considerations in decision making under SEQRA?

A. No. I am not aware of any requirement for cost-benefit analysis or monetization of benefits under SEQRA, nor would such analyses be reliable or helpful in the SEQRA context. Due to the limitations on cost-benefit analysis, which I discussed earlier in connection with the BTA Fourth Step wholly disproportionate cost test, it is frequently impossible to develop complete, meaningful monetary valuations of environmental benefits – and therefore impossible to evaluate the relative magnitude of costs and benefits in monetary terms.

Q. In your opinion, what factors should be considered in the balancing of environmental issues with social and economic considerations in decision-making under SEQRA with respect to Riverkeeper's proposed permanent fish protection outages?

A. According to Dr. Henderson's testimony, the proposed outage would eliminate almost all of the baseline levels of entrainment and impingement at Indian Point.[56] In other words, it would nearly eliminate a substantial, long-standing and demonstrably harmful environmental impact (the death of a billion early life stage fish per year) which has persisted for over forty years. Moreover, DEC has concluded that such losses are "*not* a legitimate use" of resources.[57]

Riverkeeper's proposed outages would avoid many of the impacts which I understand Entergy and others have claimed might be caused by other BTA options such as cooling towers (e.g., visual impacts, construction impacts, and noise impacts).[58] Outages would also avoid many of the impacts which I understand that Riverkeeper is concerned about

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[56] Outages Henderson June 26, 2015 Direct Testimony, at 23:4 to 24:20.

[57] *See* **Staff Exhibit 97**, Letter from Thomas C. Jorling, DEC, to Mr. Bayne (April 29, 1991), at 1 (emphasis in original).

[58] *See* DEC Staff Outages Fact Sheet, at 3-4 ("From a technical stand point, protective outages have certain advantages over a full closed-cycle cooling retrofit. Protective outages can be implemented immediately thereby providing direct reductions in the ongoing, established adverse environmental impact caused by IPEC's CWIS (*see* Interim Decision of the Assistant Commissioner, Aug. 13, 2008, at pp. 16-18, including footnotes 10, 11 and 12). Implemented on their own, protective outages would not cause any on-site physical disturbances or construction impacts, or off-site visual, noise, or traffic impacts associated with retrofitting IPEC with a closed-cycle cooling system.").

with respect to installation of Entergy's cylindrical wedgewire screen system in the Hudson River (e.g., construction and operational impacts such as disturbance to the riverbed, impacts to the benthic ecosystem, and increased turbidity and pollution in the water column).[59]

Any potential impacts to electric system reliability and any potential increased emissions from power plants which would be called upon to replace Indian Point during fish protection outages are addressed in the accompanying testimonies of Robert Fagan and John Hinckley. I defer to Mr. Fagan and Mr. Hinckley on those issues but I understand that their testimony and analyses show that taking permanent fish protection outages at Indian Point would not result in undue adverse effect to either the electric system or to air quality.

Moreover, Mr. Fagan has also investigated potential economic factors associated with the proposed outages to some extent, within the context of his overall testimony. Based on Mr. Fagan's testimony, I understand that that any annual reduction in electricity generation from Indian Point would be replaced by some combination of additional generation at other New York plants, increased imports into New York, and expanded energy efficiency efforts.[60] The results might include a slight increase in electricity prices in the near term; substitution from other supply and demand-side resources, along with increases in New York transmission capacity, mitigates these effects in the longer term.[61]

Q. What is your overall assessment of the weighing and balancing of various considerations under SEQRA?

A. Based on the accompanying testimony of Mr. Fagan, I conclude that any potential effects on electricity consumers (and any potential corresponding increase in wholesale electricity and/or capacity prices) associated with Riverkeeper's 118-day fish protection outages appear relatively small. Nor is it my understanding, based on the accompanying testimony of Mr. Hinckley, that there would be any undue impact on air quality associated with Riverkeeper's proposed outages. However, the environmental benefit and

[59] May 31, 2013 Direct Testimony of Dr. Peter A Henderson at 2:10-13.
[60] Outages Fagan June 26, 2015 Direct Testimony, at 12:13-13:2 (including Table 2).
[61] Outages Fagan June 26, 2015 Direct Testimony, at 16:19-19:31.

demonstrated necessity of implementing outages as BTA at Indian Point, in the event that closed-cycle cooling is infeasible, would significantly tip the scales in favor of permanent outages. I find nothing in the balancing of environmental impacts with social and economic considerations under SEQRA that outweighs the substantial environmental benefits of Riverkeeper's 118-day fish protection outages.

In conclusion, based on the testimony of Dr. Henderson, Mr. Fagan, and Mr. Hinckley, and in the light of the 2008 Interim Decision,[62] it is clear that the imposition of fish protection outages would not involve any avoidable or unmitigated adverse environmental impacts. Even if there were any modest environmental harm resulting from the imposition of permanent outages at Indian Point (which, in my opinion, there is not), it would be significantly outweighed by the public need for and benefits of minimizing Indian Point's illegitimate and excessive fish kills.

Q. Does this complete your direct testimony?

A. Yes, it does.

[62] My assessment does not address any legal requirements for Indian Point to reduce cooling water flows, but instead simply addresses the impacts of Indian Point's operations insofar as that impact has been identified by the Assistant Commissioner's 2008 Interim Decision.

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