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STATE OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

In the Matter of a Renewal and Modification of a State Pollutant Discharge Elimination System ("SPDES") permit pursuant to Environmental Conservation Law ("ECL") Article 17 and Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York ("6 NYCRR") Parts 704 and 750, et seq.

- by -

Entergy Nuclear Indian Point 2, LLC and
Entergy Nuclear Indian Point 3, LLC,

Permittee.

DEC No.: 3-5522-00011/00004
SPDES No.: NY-0004472

In the Matter of the Application of

Entergy Indian Point Unit 2, LLC, and
Entergy Indian Point Unit 3, LLC

for a Water Quality Certificate pursuant to Section 401 of the Federal Clean Water Act and Section 608.9 of Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York.

DEC Application Nos.:
3-5522-00011/00030 and
3-5522-00105/0031

DIRECT TESTIMONY OF RONALD STANNARD

Chief, Stationary Source Planning Section

NYSDEC Bureau of Air Quality Planning
625 Broadway
Albany, New York 12233
Tel. (518) 402-8403

February 28, 2014

Name: Ronald Stannard

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

A. My name is Ronald Stannard. I am employed by the New York State Department of Environmental Conservation ("DEC" or "Department"), Division of Air Resources, as Chief of the Stationary Source Planning Section, Bureau of Air Quality Planning. My business address is 625 Broadway, Albany, New York 12233.

Q. Please describe your educational background, professional experience, any licenses held, and responsibilities at NYSDEC.

A. I have attached a copy of my professional resumé/curriculum vitae to the end of my prefiled direct testimony for this purpose. I am a licensed professional engineer in NY- license # 064524.

Q. Does the resumé/curriculum vitae attached to this testimony accurately reflect your background and experience?

A. Yes, it does.

Q. Please describe the purpose of your current testimony.

A. The purpose of my current testimony is to provide DEC's assessment of Department of Public Service ("DPS") Staff's forecasts of air emissions impacts from Indian Point outage scenarios.

Q. Please describe your review.

A. I reviewed the prefiled direct testimony of Leka P. Gjonaj and David V. Wheat ("Gjonaj-Wheat Testimony") regarding DPS's forecast of air emission impacts and references including *Indian Point Outage Scenario Definitions for GE-MAPS Simulations* ("Outage Scenarios") and *Year-2022 and Year 2016 Forecast Air Emissions and Generation Impacts from Indian Point Outage Scenarios* ("Air Impacts Forecast").

Q. Please describe your assessment.

A. Based on a review of the Gjonaj-Wheat Testimony and references, 1) the outage scenarios utilized by DPS to forecast of air emission impacts and presented in the Outage Scenarios are consistent with the scenarios proposed by DEC; and 2) the results of DPS's modeling analysis regarding its forecast of air emission impacts, which are presented in the Air Impacts Forecast, are consistent with results DEC would expect from the given scenarios.

Q. How would you characterize the projected air emissions impacts from the DPS forecast?

A. My testimony is concerned with the air emissions and impacts of this project. Therefore, I am focusing my comments on the results of Run 1 of DPS's Scenario Modeling because it is one of DEC's preferred scenario, as identified in the Gjonaj-Wheat Testimony, and it has the maximum emissions of any of the modeled runs. DPS's forecasted project-related increases of air emissions of sulfur dioxide ("SO_2") and oxides of nitrogen ("NO_x") appear to be relatively small. For example, DPS projects a statewide increase of about 1,500 tons of NO_x and 1,800 tons of SO_2 in 2022. The projected increase in NO_x represents less than 1% of the total emissions that DEC projected for the New York City non-attainment area ("NYC NAA") in 2025. DEC projected these emissions in the "*Redesignation Request & Maintenance Plan for the 1997 Annual and 2006 24-Hour PM2.5 NAAQS - Final Submission*" which was submitted to EPA in June 2013. DEC's projected emissions for the NYC NAA are presented in "Appendix A" which is attached to this prefiled direct testimony. See, http://www.dec.ny.gov/docs/air_pdf/sippm25rrmpfinal.pdf. For SO_2, the increase is about 3.5% when compared to the 2025 projected emissions for the NYC NAA. In addition, the projected construction outage is expected to be a relatively short duration (less than one year), further mitigating the projected air emissions impact.

Q. Was modeling conducted in support of recent revisions to the Regional Greenhouse Gas Initiative ("RGGI") program?

A. Yes. New York and the other states participating in RGGI utilized an Integrated Planning Model ("IPM") process, conducted by ICF International ("ICF"), as part of RGGI program review in 2012. Based in part on this IPM modeling, the Department promulgated revisions to its regulation that implements the RGGI program in New York, 6 NYCRR Part 242, CO_2 Budget Trading Program ("Part 242"), effective January 1, 2014 (http://www.dec.ny.gov/regulations/94802.html). Among other things, the Part 242 revisions implemented a reduction in the regional CO_2 emission cap under RGGI.

Q. What assumptions were made in the RGGI IPM modeling regarding the operation of Indian Point?

A. The RGGI IPM modeling analyses assumed, as part of the business as usual Reference Case, the permanent retirement of Indian Point 2 and Indian Point 3 upon their respective license expirations in 2013 and 2015. See, Regulatory Impact Statement ("RIS"), 6 NYCRR Part 242, CO_2 Budget Trading Program (http://www.dec.ny.gov/regulations/94802.html). Therefore, the recent reduction in the CO_2 emissions cap under RGGI already accounts for the assumed unavailability of both Indian Point 2 and Indian Point 3. This includes the associated CO_2 emission impacts of resulting increases in fossil fuel-fired generation, as projected by the RGGI IPM modeling.

Q. How do the forecasts of CO_2 emission impacts presented by Witnesses Gjonaj and Wheat compare to CO_2 emission projections in the RGGI IPM modeling?

A. The assumed permanent retirement of both Indian Point units in the RGGI IPM modeling can be expected to have larger CO_2 emission impacts than those in any of the outage scenarios modeled by DPS Staff. This is because retirement would make Indian Point unavailable for all 52 weeks of the year, rather than up to 42 weeks in the scenarios modeled by DPS Staff.

Even with the assumed permanent retirement of both Indian Point units, the RGGI IPM modeling still projects cumulative CO_2 emission reductions as a result of the reduction in the regional CO_2 emission cap under RGGI. For example, over the 2014 through 2020 period, the RGGI IPM modeling projects cumulative CO_2 emission reductions of 86 million tons across the RGGI region.

Q. Please summarize the information that you relied upon or considered for your prefiled direct testimony.

A. In addition to my education, experience, training, best professional judgment, and the references set forth in my testimony, my testimony is based on the following information:

- DPS. 2014. Prepared Direct Testimony of Leka P. Gjonaj and David V. Wheat.
- DPS. 2014. *Indian Point Outage Scenario Definitions for GE-MAPS Simulations.*
- DPS. 2014. *Year-2022 and Year 2016 Forecast Air Emissions and Generation Impacts from Indian Point Outage Scenarios.*

Q. Does this conclude your direct testimony on these topics?

A. Yes, it does.

Name: Ronald Stannard

Appendix A

Table 11. 2007 Base Year Inventory by Source Sector (Tons)

Sector	VOC	NOx	CO	PM10	PM2.5	SO2	NH3
Point	3,269.78	36,829.68	12,013.83	2,913.32	2,435.34	43,886.32	862.89
Point w/RE	3,707.01	38,195.94	13,137.41	3,206.28	124,750.31	43,886.32	862.89
Nonpoint	101,481.89	41,899.74	23,211.41	48,054.84	11,621.00	29,513.22	1,960.83
Nonroad	46,026.72	59,512.46	474,292.00	4,170.45	3,899.30	6,052.88	1.96
On-road	71,379.46	149,501.91	899,933.39	9,723.36	6,835.30	982.77	3,584.40
Road Dust	N/A	N/A	N/A	3,483.59	1,174.60	N/A	N/A
Total	**222,157.85**	**287,743.79**	**1,409,450.63**	**68,345.56**	**25,965.55**	**80,435.19**	**6,410.08**
Total w/RE	**222,595.08**	**289,110.05**	**1,410,574.21**	**68,638.51**	**148,280.52**	**80,435.19**	**6,410.08**

Table 12. 2017 Interim Projection Year Inventory by Source Sector (Tons)

Sector	VOC	NOx	CO	PM10	PM2.5	SO2	NH3
Point	3,242.86	35,729.48	12,269.28	2,882.25	2,417.29	43,484.27	867.60
Point w/RE	4,131.72	37,066.75	13,730.42	3,193.99	124,290.57	43,484.29	867.60
Nonpoint	93,790.95	36,640.38	22,438.48	34,306.76	9,403.95	4,412.25	1,915.00
Nonroad	26,408.16	45,197.21	392,576.80	3,040.77	2,809.06	4,212.42	1.12
On-road	33,083.83	68,362.66	502,543.63	7,171.83	3,897.71	939.20	2,340.95
Road Dust	N/A	N/A	N/A	2,959.46	954.01	N/A	N/A
Tappan Zee Project	N/A	457.00	N/A	N/A	N/A	N/A	N/A
Total	**156,525.80**	**186,386.73**	**929,828.18**	**50,361.08**	**19,482.01**	**53,048.15**	**5,124.68**
Total w/RE	**157,414.67**	**187,724.00**	**931,289.32**	**50,672.82**	**141,355.28**	**53,048.17**	**5,124.68**

Table 13. 2025 Projection Year Inventory by Source Sector (Tons)

Sector	VOC	NOx	CO	PM10	PM2.5	SO2	NH3
Point	3,261.75	36,306.85	12,455.94	2,889.47	2,423.51	43,591.03	872.33
Point w/RE	4,153.64	37,645.59	13,929.75	3,201.53	124,294.66	43,596.39	872.33
Nonpoint	94,698.56	35,467.73	22,764.61	38,066.67	10,126.70	4,389.48	1,924.66
Nonroad	24,737.31	42,773.21	430,459.94	2,519.12	2,290.95	4,599.34	1.05
On-road	26,911.17	51,260.81	482,010.40	6,952.22	3,291.09	935.40	2,443.53
Road Dust	N/A	N/A	N/A	3,184.31	960.05	N/A	N/A
Total	**149,608.78**	**165,808.60**	**947,690.89**	**53,611.79**	**19,092.30**	**53,515.25**	**5,241.57**
Total w/RE	**150,500.68**	**167,147.34**	**949,164.70**	**53,923.85**	**140,963.45**	**53,520.61**	**5,241.57**

Ronald Stannard, P.E.

Education

RENSSELAER POLYTECHNIC INSTITUTE, TROY, NY
BACHELOR OF SCIENCE, CHEMICAL ENGINEERING, 1981

Employment

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION *1982 to Present*

Environmental Engineer 3 *Division of Air Resources* *2003 to Present*
Chief, Stationary Source Planning Section

- Responsible for development of numerous Air Quality Regulations including:
    - Outdoor Wood Boilers
    - Distributed Generation
    - Consumer Products
    - Portable Fuel Containers
    - Architectural and Industrial Maintenance Coatings
    - Asphalt Pavement
- Responsible for preparation of emission inventories for Title V sources and "area" sources. Inventories are used to prepare State Implementation Plans (SIPs), fee bills. Inventories are also submitted to EPA for their use in the National Emission Inventory (NEI).
- Coordinate with DIS and other DAR staff to develop and implement an electronic emission statement reporting process.
- State lead on OTC Stationary and Area Source Committee, coordinates with Northeast States on development of model regulations for regional consistency
- Conduct technical review and comment on EPA proposed NAAQS revisions and other federal Air regulations.
- Coordinate Department review, comment, implementation and technical portion of legal review of federal interstate transport rules (ADRP, CAIR and CSAPR).

Environmental Engineer 3 *Division of Air Resources* *2001 to 2003*
Chief, New Source Review Section

- Responsible for development and implementation of New Source Review (NSR) Regulations
- Coordinate NSR program implementation with regional staff
- Review and comment on EPA proposed NSR modification – prepare documents for Attorney General's office to file lawsuit against EPA challenging the final rules.

Environmental Engineer 3 *DEC technical representative for 9/11 response* *Sept – Oct 2001*

- Acted as Department technical representative in Emergency Response Coordination Meetings (2/day).
- Attended meetings at Staten Island Landfill to ensure environmental issues were considered during the response.
- Coordinated Department expedited permit processing for various activities and reopening of landfill for the cleanup effort.

Environmental Engineer 2 *Division of Solid and Hazardous Materials* *1995 to 2001*
New York City Section

- Review and approve design, construction and closure activities at the Fresh Kills landfill in New York City; Specific engineering responsibilities include oversight of design and construction of five mile leachate collection trench and slurry wall around the landfill perimeter.
- Responsible for development, coordination and implementation of a new voluntary clean-up program in the Division of Solid and Hazardous Materials
- Supervisor of the Technology Outreach & Compliance Section - Jan '00 through Apr '00 and Sept '00 through Feb '01 - supervise 4 staff
- Section responsible for development and implementation of solid waste regulatory program
- Section responsible for compilation of Solid Waste annual reporting and coordination with neighboring States

Environmental Engineer 2 *Division of Solid Waste* *1987 - 1995*
Landfill Closure Section

- Review and approve closure plans for landfills throughout New York - specific responsibilities included all landfills in Long Island, New York City and the Hudson Valley
- Develop and implement Landfill Closure State Assistance Program which provided up to 50% of eligible landfill closure costs for municipally owned landfills.

Assistant Sanitary Engineer *Division of Solid and Hazardous Waste* *1984 - 1987*
Technology Development Section

- Develop regulations and policies to implement restrictions on disposal of specified hazardous wastes in landfills
- Serve on Hazardous Waste Advisory Committee to negotiate phased reductions of waste disposal in landfills.
- Develop other Hazardous Waste regulations to make the Department's program eligible for authorization from the USEPA.

Junior Engineer *Division of Water* *1982 - 1984*
Assistant Sanitary Engineer *Water Quality Assessment Section*

- Maintain and continue development of existing computer system for tracking oil spills throughout New York State
- Maintain and improve operation of computer system which compiled water quality data throughout New York to determine composite water quality for the State's lakes and streams
- Modify computer data storage methods to reduce costs and improve efficiency

STATE OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

In the Matter of Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC For a State Pollutant Discharge Elimination System Permit Renewal and Modification	DEC No.: 3-5522-00011/00004 SPDES No.: NY-0004472
In the Matter of Entergy Nuclear Indian Point 2, LLC, Entergy Nuclear Indian Point 3, LLC, and Entergy Nuclear Operations Inc.'s Joint Application for CWA § 401 Water Quality Certification	DEC App. Nos. 3-5522-00011/00030 (IP2) 3-5522-00105/00031 (IP3)

PREFILED TESTIMONY OF SAM BEAVER
IN SUPPORT OF ENTERGY NUCLEAR INDIAN POINT 2, LLC, ENTERGY NUCLEAR INDIAN POINT 3, LLC AND ENTERGY NUCLEAR OPERATIONS, INC.

CLOSED CYCLE COOLING

ENTERGY NUCLEAR INDIAN POINT 2, LLC, ENTERGY NUCLEAR INDIAN POINT 3, LLC, AND ENTERGY NUCLEAR OPERATIONS, INC.

By its attorneys,

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February 28, 2014

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PREFILED TESTIMONY OF SAM BEAVER

CLOSED CYCLE COOLING

I. INTRODUCTION

Q: Please state your name, current position, and business address.

A: My name is Sam Beaver. I am the Director of Project Management at Enercon Services, Inc. ("Enercon"), an engineering, environmental, and technical management services firm. My business address is 500 Townpark Lane, Kennesaw, Georgia 30144.

Q: Are you offering this testimony on behalf of Entergy in support of its application for renewal of State Pollutant Discharge Elimination System ("SPDES") Permit (DEC App. Nos. 3-5522-00011-00004 SPDES No. NY0004472) for Indian Point Units 2 and 3 and the corresponding issue in the associated Water Quality Certification ("WQC") proceeding, as it has been consolidated by this Tribunal (collectively, the "Proceedings")?

A: Yes. I am offering my testimony with respect to Issue for Adjudication No. 1 as it relates to the feasibility of constructing and operating closed-cycle cooling ("CCC") towers as proposed by NYSDEC Staff at Indian Point Energy Center ("IPEC"). I offer my expert testimony concerning whether NYSDEC Staff's proposed retrofits of Indian Point Units 2 and 3 with CCC towers can be constructed and operated efficiently and without material detriment impacts to the facilities' operation given the site specific constraints of IPEC.

Q: Have you previously submitted testimony in these Proceedings?

A: Yes. I previously submitted prefiled direct and rebuttal testimony in these Proceedings on July 22, 2011; September 30, 2011; May 30, 2012; June 29, 2012; May 31, 2013; and June 28, 2013. I testified in person before this Tribunal on October 17-18, 2011; August 1, 2012; and July 15-16, 2013.

Q: What is the purpose of this testimony?

A: This testimony describes the report prepared by Enercon entitled, *ENERCON Response to Tetra Tech's Indian Point Closed-Cycle Cooling System Retrofit Evaluation Report* ("2013 ENERCON CCC Response"), dated December 2013 (Entergy Ex. 296(A)), which is Appendix A to the TRC Environmental Corporation ("TRC") report entitled, *New York State Environmental Quality Review Act, Entergy Response Document to the Tetra Tech Report and the Powers Engineering Report* (Entergy Ex. 296). In addition, this testimony describes Enercon's report entitled, *Analysis of Closed-Loop Cooling Salinity Levels Indian Point Units 2 & 3*, with Appendices A-F, dated November 2010 (Entergy Ex. 310) ("Salinity Report"). I understand that the 2013 ENERCON CCC Response and the Salinity Report have been previously provided to the parties to the Proceedings, and I adopt both reports as part of my prefiled testimony.

Q: Please describe the purpose of the 2013 ENERCON CCC Response.

A: I understand that NYSDEC Staff has proposed the installation and operation of CCC as the best technology available to minimize adverse environmental impacts consistent with the requirements of 6 NYCRR § 704.5 and § 316(b) of the Clean Water Act. The purpose of the 2013 ENERCON CCC Response was to review the engineering feasibility of the CCC configurations selected by Tetra Tech in its report entitled, *Indian Point Closed-Cycle Cooling System Retrofit Evaluation*, dated June 2013 (the "Tetra Tech CCC Report"). The 2013 ENERCON CCC Response also assesses CCC proposals submitted by Powers Engineering on behalf of Riverkeeper, Inc., as presented in the *Revised Closed Cycle Cooling Feasibility Assessment for Indian Point Energy Center Unit 2 and Unit 3 for Best Technology Available Report*, dated October 24, 2012, and subsequently limited by the November 22, 2013 letter from Mark Lucas to ALJs Villa and O'Connell (the "Powers Report"). I understand that Riverkeeper has recently withdrawn the Powers Report and, in an email from Riverkeeper's counsel dated February 24 at 8:45 pm, declined to specify what CCC proposal it actually will be advancing. My testimony is therefore limited to addressing the Tetra Tech proposal. If Riverkeeper in fact advances some other CCC proposal, then to the extent necessary I will address such proposal in rebuttal.

Q: How did you go about preparing the 2013 ENERCON CCC Response?

A: I oversaw a team of engineers at Enercon that reviewed both reports submitted by NYSDEC Staff and Riverkeeper. The Enercon team consisted of twenty mechanical engineers, nuclear engineers, chemical engineers, civil engineers, and electrical engineers that were responsible for reviewing various aspects of each report within their specific area of expertise.

Under my supervision, the Enercon team conducted a thorough review of the reports submitted by NYSDEC Staff and Riverkeeper to determine whether those reports demonstrated the feasibility of retrofitting Unit 2 and Unit 3 with CCC and in addition, whether there existed any potential problems, errors, or omissions that (1) implicate essential equipment and/or nuclear station reliability; (2) represent high risk assumptions or unknowns; and (3) would significantly increase the estimated costs of construction or operation.

In addition to our in-house experts, Alden Research Laboratory ("Alden") was engaged by Entergy to conduct computational fluid dynamic ("CFD") modeling of Tetra Tech's proposed mechanical draft cooling towers and Burns and Roe Enterprises, Inc. ("Burns and Roe") was retained by Entergy to perform a review of the impacts of Tetra Tech's proposed cooling tower design on the Unit 2 and Unit 3 condensers.

II. <u>SUMMARY OF TETRA TECH'S CCC CONFIGURATIONS</u>

Q: Please describe the key elements of Tetra Tech's proposed conceptual design that were relevant to your review.

A: For its conceptual design, Tetra Tech has selected SPX ClearSky™ ("ClearSky") plume-abated cooling towers for use at IPEC based on the claim that the ClearSky cooling towers were the only practical alternative for a CCC-retrofit apart from circular hybrid cooling towers. *See* Tetra Tech CCC Report at 11. For each Unit, Tetra Tech has proposed that the towers would operate at a flow rate of 700,000 gallons per minute, a design wet-bulb temperature of 77°F, and an approach to wet-bulb temperature of 12°F. *See id.* at 13. Tetra Tech's cooling towers are configured "back-to-back," meaning that towers for each unit would be 2 cells wide and 22 cells long for a total of 44 cells per tower. *Id.* The overall dimensions of each tower block would be 1,408 ft x 151 ft (or approximately 5 acres). *Id.* The locations that Tetra Tech proposes to site the cooling towers would make the cooling water basins in the cooling towers 52.5 feet above mean sea level. *See id.* at 15. Finally, Tetra Tech assumes that the cooling towers would operate at three cycles of concentration, which means that the chemical or biological constituents in the Hudson River water will be raised to three times their initial levels in the close-cycle system, before being blown down or released from the tower. *See id.* at 13.

Q: What is a "design wet bulb temperature"?

A: The wet bulb temperature is a meteorological measurement which incorporates both moisture content and the temperature of the ambient air (referred to as the "dry bulb temperature"). Cooling tower performance depends on the wet bulb temperature of the air entering the cooling tower inlets because it determines the lowest temperature that the circulating water can be cooled using cooling towers, which reject heat through evaporation. When selecting cooling towers at a particular facility, the "design" wet bulb temperature should reflect the highest wet bulb temperature experienced in the area where the cooling towers will be sited allowing a small margin for infrequent exceedances (typically less than 1%).

Q: What is an "approach to wet bulb temperature"?

A: No cooling tower is capable of cooling water to the wet bulb temperature. Therefore, the approach to wet bulb temperature describes the number of degrees above the ambient wet bulb temperature by which the cooling tower can be expected to reduce the temperature of the cooling water after it passes through the condensers. It is a value based on the size and efficiency of the cooling towers and it represents the cooling ability of the towers. For example, Tetra Tech's selected cooling towers would be capable of cooling the CCC water to 89°F (77°F design wet bulb + 12°F approach) when the ambient wet bulb temperature at the cooling towers is 77°F. To understand how the approach temperature changes with changes to the wet bulb temperature, engineers use cooling tower performance curves. A single point is not adequate to determine the operational impacts of CCC over the entire range of expected wet bulb temperatures.

Q: How does the "approach to wet bulb temperature" affect cooling tower design?

A: There is an inherent trade-off between the size of a cooling tower and its ability to cool the circulating water. Increasing the approach to wet bulb temperature decreases the cooling tower size, but results in greater circulating water temperatures. Power plants operate less efficiently—that is, it will detrimentally affect power plant performance—when the temperature of the circulating water is increased, and indeed may result in a plant shut down if the temperatures exceed the condenser's operational limits.

III. ENERCON RESPONSE TO TETRA TECH'S CCC REPORT

Q: What conclusion, if any, did Enercon reach in its review of Tetra Tech's CCC Report?

A: There are two primary conclusions that Enercon reached after its review of the Tetra Tech CCC Report and which are discussed in detail in the 2013 ENERCON CCC Response. First, based on my and my team's experience and best professional judgment, NYSDEC Staff's proposed configuration for a CCC retrofit at IPEC as presented by Tetra Tech <u>cannot</u> be considered feasible. In particular, it is my opinion that NYSDEC Staff's proposed cooling towers cannot be installed and function efficiently within the operating constraints of IPEC. Second, at a minimum, Tetra Tech's CCC Report does not contain fundamental design detail that demonstrates that CCC are feasible at IPEC.

Q: What is your understanding of what it means for a technology to be feasible?

A: A technology is feasible where it can be installed and operated at a particular site, based on the relevant considerations at that site, with a reasonable level of engineering certainty.

Q: Please summarize the reasons for your conclusion that NYSDEC Staff's CCC proposal cannot be considered feasible at IPEC.

A: As set forth in the 2013 ENERCON CCC Response, there are three primary reasons Tetra Tech's proposal cannot be considered feasible from an engineering perspective.

First, ClearSky cooling towers are not a demonstrated, available technology for a large baseload nuclear power plant such as IPEC because there is inadequate design, construction, and operational history for ClearSky towers—measured both in the total number of installations of ClearSky towers and the diversity among the limited installations that do exist—to conclude they would be viable with a reasonable level of confidence. No nuclear stations designed solely for once-through cooling have been converted to closed-loop cooling, let alone converted using ClearSky cooling towers. In fact, there is only one very small ClearSky installation with any measurable operational experience (five years)—a one test cell cooling tower in New Mexico. Nowhere does Tetra Tech provide any operational history for that test cell operating in the New Mexico desert. After the submission of the 2013 ENERCON CCC Report three additional ClearSky cells became operational, two at a biomass facility in Wisconsin and one "demo" tower in South Korea. There are no ClearSky cooling towers operating at a nuclear power plant, and all three of the ClearSky configurations—in New Mexico, Wisconsin, and South Korea—are for in-line ClearSky cooling towers, not the back-to-back configurations selected by Tetra Tech for use at Units 2 and 3. Given the absence of any practical history of CCC retrofits at nuclear facilities using ClearSky cooling towers, engineering observations and conclusions regarding any such conversion are purely speculative and inherently subject to unforeseen challenges during the detailed design phase and the subsequent implementation. Indeed, the lack of installation and operational history presents a large potential risk, and under these circumstances, should have eliminated ClearSky cooling towers from serious consideration. Adding to the inherent risk of the ClearSky towers is the fact that they are only available in fiberglass and are therefore (1) susceptible to fire damage and (2) not necessarily designed to withstand the wind loading requirements at a nuclear facility like IPEC.

Second, there are several construction and siting issues that were not addressed by Tetra Tech. Most notably, there are existing, essential plant components and structures already located where Tetra Tech proposes siting the cooling towers. Among the structures and components that would need to be relocated are the Algonquin Natural Gas Pipeline, which is displaced by the proposed Unit 3 cooling tower; components containing radionuclides (in the form of spent nuclear fuel and low level radionuclide material); high voltage power transmission lines; and various security towers, fencing and facilities. In fact, with respect to radionuclide management, Tetra Tech acknowledged, "[i]f an acceptable method cannot be identified, construction and excavation could not proceed in this area, where the CT2 [Unit 2 cooling tower] pipe corridor would be sited. In this case, the proposed Unit 2 retrofit would be infeasible." *See* Tetra Tech CCC Report at 28. As set forth in the 2013 ENERCON CCC Response, many of the structures that would need to be relocated are currently relied upon for safe, secure and efficient power generation at IPEC. Taken together, the essential structures and components that are impacted by the Tetra Tech configuration represent major detrimental impacts to the IPEC site and raise serious concerns about the plant's ability to generate power in a safe and efficient manner. Further, the overall cost and schedule impacts of relocating these essential structures was not addressed by Tetra Tech, hence making its report substantially lacking relative to overall impacts of the proposed conversion.

Third, operation of Tetra Tech's ClearSky cooling towers would have a detrimental impact on plant operations. Tetra Tech's proposed ClearSky towers will discharge saturated salt-laden mist that will be concentrated and localized at ground levels rather than discharged and dispersed higher in the atmosphere, as is the case with round hybrid cooling towers. This will lead to increased salt deposition and moisture on the power blocks and electrical transmission facilities, creating a known risk of electrical arcing (discharging of current through the air) in the switchyard. The risk of electrical arcing is a workplace safety hazard, and may lead to a shutdown of the nuclear reactor via a reactor scram, which is the sudden shutting down of a nuclear reactor, usually by rapid insertion of control rods. Unplanned reactor scrams upset plant stability and challenge critical safety functions during power operations. In addition, the plume from Tetra Tech's proposed ClearSky tower configuration would have an adverse impact on the electrical switchyard, heating/ventilation/air conditioning (HVAC) systems, and major outdoor equipment at IPEC that creates operability concerns. Finally, the low level plume would create significant recirculation of the saturated air which would increase operational power losses. In fact, operational and parasitic power losses combined due to the ClearSky CCC conversion represent as much as a 6% reduction in IPEC's net power output.

Q: Please summarize the basis for your conclusion that the Tetra Tech CCC Report did not demonstrate the feasibility of CCC at IPEC.

A: In addition to the known problems and risks associated with Tetra Tech's ClearSky proposal described above, important detail is missing from the Tetra Tech CCC Report, without which Tetra Tech's proposal cannot be considered feasible. Indeed, the missing information creates considerable uncertainty and raises fundamental reliability concerns that are unacceptable for any large-scale construction project in the nuclear industry. For example, the Tetra Tech CCC Report acknowledges that "[a] massive volume of blasting spoils, approximately 2 million cubic yards, will need to be removed from the site" over the course of a "3 to 4 year blasting and excavation period." *See* Tetra Tech CCC Report at 33. The Tetra Tech CCC Report, however, did not include any blasting plans for rock excavation, a detailed construction schedule, or a sufficiently robust assessment of expected plant impacts associated with such blasting and excavation. And, although Tetra Tech acknowledged that the Algonquin Pipeline would need to be relocated before blasting could begin for the Unit 3 tower, it did not identify how or where to relocate the pipeline. Without resolving this siting conflict, Tetra Tech's proposed location for the Unit 3 cooling towers cannot be considered feasible.

In addition, Tetra Tech failed to perform any transient or accident analysis for IPEC post-CCC retrofit. A review of the transient and accident analysis is necessary for any significant plant change to ensure that there are no potential impacts to the operation of any nuclear power plant. In fact, as set forth in 2013 ENERCON CCC Response, Burns and Roe identified and analyzed one transient condition—high pressure steam dump (50% load rejection) at Unit 3—that would exceed the condenser's operational limits and would require either additional ClearSky cells or other substantial means to reject additional heat load. The transient condition analyzed by Burns and Roe is just one of several transient conditions that must be evaluated prior to reaching a feasibility determination. Without identifying and resolving potential transient and accident conditions, the feasibility and operability of the Tetra Tech's CCC configuration has not been demonstrated.

Further, Tetra Tech did not provide basic details needed to validate whether its assumptions about the number of cells and size of its proposed cooling towers are valid. Most notably, Tetra Tech did not identify the type of fill material and/or address fill degradation impacts over time for the proposed ClearSky towers. "Fill" is installed into the cooling towers themselves and is used to increase the surface area and the contact time between the heated water and the cooling air. In other words, fill is the medium that facilitates and determines the heat transfer from the towers, and the selection and identification of the proper fill is one of the most critical components in any cooling tower design. In addition, the fill selected by Tetra Tech may be susceptible to fouling, which will degrade cooling tower performance and potentially jeopardize the structural integrity of the cooling towers. The potential for fill fouling is a particular concern with Tetra Tech's proposal because, as I stated above, it proposes to operate the cooling towers at three (3) cycles of concentration, which means that the level of total dissolved solids ("TDS") in the cooling water will be three times as high as the level in the Hudson River, thereby increasing the risk for fouling and operational impacts. Without a cooling tower fill selection, it is simply not possible to determine if the cooling towers proposed by Tetra Tech are feasible for continuous operation at IPEC or if the size, performance, cost and schedule information for the cooling towers is appropriate.

Finally, there is the potential for detrimental operational impacts on the plant that were not adequately analyzed by Tetra Tech. Tetra Tech's report did not include any Performance Evaluation of Power System Efficiency (PEPSE) model results or Seasonal Annual Cooling Tower Impact (SACTI) model results. PEPSE is the industry standard heat balancing and hydraulic modeling software used at nuclear power plants to evaluate potential operational impacts associated with changes to the design of the plant. SACTI is a modeling software used to model where the cooling tower plume migrates after being exhausted from the towers and therefore allows better understanding of the operational impacts of that moist, hot plume. While other models can be employed, Tetra Tech used no modeling to establish the scope and scale of operational impacts, a real concern—particularly at a nuclear facility—that must be addressed before feasibility can be determined. Moreover, with respect to Tetra Tech's claim that the ClearSky towers are "plume abated," ClearSky towers rely on novel and proprietary PVC heat exchanger packs to re-condense moisture that would otherwise exit in the exhaust. Tetra Tech failed to provide any information regarding the tower's heat exchangers or associated maintenance history, and no corroborating information has been provided that such plume-abatement technology would be an appropriate choice at IPEC.

IV. SALINITY REPORT AND CONCLUSIONS

Q: Please describe the purpose of the Salinity Report.

A: Generally speaking, the purpose of the Salinity Report was to evaluate how the salt content of the Hudson River at IPEC would lead to exceedances of applicable air quality limits based on the operation of the circular hybrid mechanical draft cooling tower arrangement discussed in the reports entitled, *Economic and Environmental Impacts Associated with Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water Configuration*, dated June 2003 (Entergy Ex. 7A) and *Engineering Feasibility and Costs of Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water Configuration,* dated February 12, 2010 (Entergy Ex. 7). I understand that no party to the Proceedings is advancing the circular hybrid mechanical draft cooling towers discussed in those reports. However, because no air quality impact analysis has been conducted by Tetra Tech or provided by NYSDEC Staff, here I summarize the conclusions in the Salinity Report that Enercon drew with respect the site-specific barriers to large-scale CCC conversion at IPEC based on the relevant, available information concerning the salinity of the Hudson River.

Q: Why would the salt content of the Hudson River affect cooling tower performance at IPEC?

A: Although conversion of Unit 2 and Unit 3 to CCC would reduce the water intake currently required by the facilities, a continuous supply of water would still need to be withdrawn from the Hudson River for CCC makeup and blowdown requirements. I understand from Theodore Main at TRC that the salinity of the makeup water in a CCC system is a primary contributing factor to air emissions, which can lead to violations of national ambient air quality standards ("NAAQS") and Significant Impact Levels ("SIL"). In addition, the manufacturer of the cooling towers evaluated in Enercon's 2010 CCC report, SPX, recommends that the TDS (i.e., salt) concentration remain below 5000 ppm, and notes that concentrations above those levels can affect thermal performance of the cooling towers. *See* Entergy Ex. 310 at 52.

Q: How was the concentration of salt in the Hudson River in the vicinity of IPEC calculated in the Salinity Report?

A: As set forth in Appendix F to the Salinity Report, Applied Science Associates, Inc. (now RPS ASA) ("ASA/RPS") provided a long-term data set of Hudson River salinity in the vicinity of IPEC based upon 10 years of modeled Hudson River salinity data for the period 2000 – 2009 in one hour increments. Because direct measurements of salinity at IPEC are not made, ASA/RPS developed a statistical analysis of data collected every 15 minutes by the U.S. Geological Survey (USGS) at three locations: Hastings-on-Hudson, Tomkins Cove, and West Point. The Hastings station is located 21 miles downstream of IPEC and has been continuously operating since 1992. The West Point station is located 9 miles upstream of IPEC and has been operating since 1991. The Tomkins station was located 1 mile downstream of IPEC, but was discontinued in 2001. Based on that statistical analysis, a decadal (2000-2009) salinity time series at IPEC (which was assumed to be equivalent to that at Tomkins) was generated to provide a long-term estimate of salinity under a variety of environmental conditions.

Q: What did Enercon do with the results from ASA/RPS's salinity analysis?

A: First, Enercon determined that the most practical flow scenario for CCC would utilize 1.5 cycles of concentration (not the three cycles of concentration selected by Tetra Tech). Second, TRC calculated the maximum salt concentration of CCC water that would allow cooling tower emissions at a drift rate of 0.001% to not violate PM_{10} and $PM_{2.5}$ NAAQS and SILs. Enercon then used the information provided by ASA/RPS and TRC to determine whether CCC could be operated in a manner to keep the concentration of salinity in the cooling water below the thresholds identified by TRC.

Q: Briefly summarize the conclusions of the Salinity Report.

A: Based on the salinity information provided by ASA/RPS and the emissions limits provided by TRC, CCC cannot be operated year round at IPEC without violating air emission limitations. For purposes of our analysis, we assumed that it would be feasible to revert from closed-loop to once-through operation when salinity levels would lead to air quality exceedances and that such a determination could be made on a weekly basis—although the Tetra Tech CCC Report does not contemplate that type of switch-over mechanism and a weekly switch-over would be impractical for actual station operation based on input from Entergy. Nevertheless, and with those assumptions, the Salinity Report concluded that in order to avoid exceeding the $PM_{2.5}$ NAAQS and $PM_{2.5}$ SIL, operation of closed-loop cooling would be expected to occur no more than 43% and 13% of the year, respectively. Although it would be operationally and economically infeasible to run a nuclear facility under such restrictions, Dr. Young has used this information to update the estimated reductions in entrainment and impingement losses that would be achievable under these scenarios, provided as Appendix D to the Salinity Report.

V. QUALIFICATIONS AND SUFFICIENCY OF METHODS, DATA AND CONCLUSIONS

Q: Please describe your educational and professional qualifications, including relevant professional activities.

A: I previously described my academic background, relevant specializations and work experience in prefiled direct testimony that I have submitted in these Proceedings during administrative hearings in Albany, New York on October 17, 2011. I refer to and incorporate that testimony by reference in this prefiled testimony. In addition, I have previously provided a copy of my curriculum vitae (Entergy Ex. 49).

Q: In your professional opinion, did Enercon's review of Tetra Tech's proposed CCC configuration reliably apply procedures and methodologies generally

accepted in the engineering community concerned with evaluating the ability to successfully install and operate a technology?

A: Yes, the engineering review performed by Enercon of Tetra Tech's proposal was no different than numerous other engineering reviews Enercon has performed for nuclear facilities in the past.

Q: In your professional opinion, did the Salinity Report reliably apply scientifically accepted principles to estimate CCC operational limitations due to air quality exceedances based on the salinity of the Hudson River?

A: Yes, as is typical in engineering projects, the Salinity Report relies on input from specialized experts—TRC (air quality and regulations), ASA/RPS (salinity in the Hudson River) and Enercon (operation of CCC)—to reach a conclusion concerning the limitations with operating CCC due to Hudson River salinity and air quality regulations.

Q: In your professional opinion, did the Salinity Report have sufficient data to reach reliable and scientifically sound conclusions to estimate CCC operational limitations due to air quality exceedances based on the salinity of the Hudson River?

A: Yes.

Q: Do you hold your opinions to a reasonable degree of engineering certainty?

A: Yes.

END OF TESTIMONY

Appendix A

ENERCON Response to Tetra Tech's Indian Point Closed-Cycle Cooling System Retrofit Evaluation Report
(Enercon Services, Inc.)

APPENDIX A

ENERCON Response to Tetra Tech's Indian Point Closed-Cycle Cooling System Retrofit Evaluation Report

Prepared for Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC

Prepared by:

Enercon Services, Inc.
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December 2013

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ATTACHMENTS

EXECUTIVE SUMMARY

Indian Point Energy Center (IPEC), owned by Entergy Nuclear Indian Point 2, LLC, and Entergy Nuclear Indian Point 3, LLC (collectively, Entergy), retained Enercon Services, Inc. (ENERCON) to prepare an engineering feasibility response to the Tetra Tech, Inc. (Tetra Tech) Closed-Cycle Cooling (CCC) System Retrofit Evaluation Report, dated June 2013, prepared for the New York State Department of Environmental Conservation (NYSDEC) Staff. ENERCON's response contained herein is the engineering response to the Tetra Tech report.

Tetra Tech's conceptual design does not provided sufficient information to resolve the challenges, several identified by Tetra Tech as "potential fatal flaws" [Ref. 12.1, p. 28], of ClearSky cooling towers and the significant adverse impacts of the closed-cycle cooling (CCC) configuration selected in the Tetra Tech report in order to support a feasibility conclusion on a site-specific basis for IPEC. Tetra Tech's report does not contain the level of engineering design information presented in ENERCON's 2003 CCC report [Ref. 12.4]. Subsequently, ENERCON conducted additional engineering design and determined in ENERCON's 2010 CCC report that several additional design issues would challenge the feasibility of a closed-cycle cooling retrofit at IPEC [Ref. 12.12]. It is expected that Tetra Tech would similarly identify additional challenges to feasibility if they performed a more detailed engineering design.

ENERCON has concluded, based on the available information, that Tetra Tech's closed-cycle cooling configuration cannot be considered feasible at IPEC. As discussed at length in ENERCON's 2010 CCC report, conversion of operating nuclear stations to a closed-cycle cooling configuration is unprecedented, and at IPEC represents an incredibly complex engineering and construction undertaking, with significant uncertainty around the cost, schedule, and forced outage duration required. Large scale construction activities at nuclear power plants have routinely experienced significant construction schedule overruns, and conversion to closed-cycle cooling at IPEC may consume the entire license renewal period [Ref. 12.31].

Retrofitting to closed-cycle cooling with ClearSky cooling towers is even more challenging as a function of the technology selected, including its defining attributes and the siting configurations that Tetra Tech has proposed. First, ClearSky cooling towers employ a novel technology with limited operating experience on only one in-line cooling tower test cell, and no operating experience in the back-to-back configuration proposed by Tetra Tech. This lack of operational history typically would eliminate ClearSky cooling towers from serious consideration at a large baseload nuclear plant, such as IPEC. Large baseload power plants are essential power sources and provide grid stability, and as such, reliable long-term operation is essential and must be an important element of the decision process. This is because nuclear and electric-system reliability considerations caution against the adoption of novel technologies for large-scale facilities, particularly those facilities that are dedicated, essential power sources for a major metropolitan area. Proven technology is always preferred. Second, conversion to a closed-cycle cooling configuration would represent an incredibly complex and difficult engineering and construction undertaking. Conversion to closed-cycle cooling with ClearSky cooling towers would involve additional design, construction and installation, and operational risk for IPEC, none of which Tetra Tech has resolved in a manner that demonstrates feasibility.

The feasibility issues and operability concerns of the Tetra Tech closed-cycle cooling configurations on an IPEC site-specific basis, based on the information provided in the Tetra Tech report, are summarized below.

Feasibility Issues

1. Cooling Tower Siting Conflicts: Based on a site walkdown observation and review of Figure 3-3 in Tetra Tech's report, the cooling towers locations would require relocation and/or demolition of several existing structures, including essential plant components and components containing radionuclides (in the form of spent nuclear fuel and low level radionuclide material). Tetra Tech did not address the impacts to essential plant equipment and structures, including whether these structures are capable of being moved. If capable of being moved, Tetra Tech did not account for the cost and schedule impacts of doing so. The number and significance of the siting conflicts unresolved by Tetra Tech's report would result in a detrimental effect to IPEC, and as such the Tetra Tech cooling tower configuration cannot be considered an available technology as defined in the Indian Point Interim Decision [Ref. 12.35].

2. Algonquin Pipeline Considerations: Although Tetra Tech acknowledged in its report that the pipelines would have to be relocated, it did not identify how or where to relocate the pipeline. It is not feasible to conduct construction involving blasting directly on top of and around active gas pipelines. Further, Tetra Tech neither acknowledged, nor evaluated the proposed expansion of the pipelines currently planned by the pipeline owner, which may make relocation even more complicated, as well as affect cost and schedule.

3. Power Transmission Line Impacts: Tetra Tech's proposed cooling tower location directly interferes with the overhead 345 kV main transmission lines (and one of the transmission line towers) to the power grid and the 138 kV auxiliary power lines from the Buchanan Substation to the station. The relocation of these lines (with appropriate clearances) and any underground control cables, including the cost and schedule impacts, are not addressed in the Tetra Tech report. See Attachment 1, Figure 2 of this response, Transmission Line Overlay on Tetra Tech Proposed Indian Point Closed-Cycle Cooling Configuration.

4. Radionuclide Management: Tetra Tech acknowledged in its report that evaluation and management of the radionuclide conditions is necessary along the riverfront in order to determine feasibility, and has not yet been performed. Tetra Tech states on page 28 of their report, "If an acceptable method cannot be identified, construction and excavation could not proceed in this area, which is where the CT2 [Unit 2 cooling tower] pipe corridor would be sited. In this case, the proposed Unit 2 retrofit would be infeasible."

5. Closed-Cycle Cooling Retrofit Impact on Condenser: Tetra Tech did not perform any transient or accident analysis for IPEC post closed-cycle cooling retrofit. A review of the transient and accident analysis is necessary for any significant plant change to ensure that there are no potential impacts to the operation of a nuclear power plant. Burns and Roe Enterprises, Inc. (BREI) reviewed one transient condition in their report, identifying that the increased condenser backpressure would be higher than the low vacuum alarm setpoint during a high pressure steam dump at Unit 3 and would trip the Unit. The BREI analysis was limited to one transient condition and emphasizes the need to identify and resolve any impacts to the transient or accident analysis before concluding the feasibility of such a significant plant modification.

Operational Concerns

1. Site Impact of Cooling Tower Plume: Although plume-abated cooling towers would produce an invisible plume under most meteorological conditions, the discharge plume of saturated salt-laden mist still exists. This condition, based on the ClearSky configuration proposed by Tetra Tech, is highly localized over the IPEC power blocks and nearby environment. As a result, Tetra Tech's proposed cooling towers configuration would lead to increased salt deposition and moisture on electrical equipment. Specifically, the close proximity of the cooling towers to the power blocks and electrical transmission facilities, creates a known risk of electrical arcing (discharge of current through air) in the switchyard. This is a workplace safety hazard, and may lead to a reactor scram (or shutdown of the nuclear reactor) resulting in forced outages, the implications of which Tetra Tech has not evaluated and may substantially impact electric-system function.

2. Cooling Tower Recirculation Effects: As a result of the long rectangular configuration of the ClearSky cooling towers, these cooling towers would be subject to significant plume recirculation. Recirculation would have a direct adverse impact on the operational efficiency of the plant. At conditions occurring in June, the combined peak[1] operational and parasitic power losses of Tetra Tech's closed-cycle cooling configuration would be 137.5 MWe. This is approximately 15% higher than what Tetra Tech lists as the combined peak operational and parasitic power losses and represents a greater than 6% reduction in IPEC net power output, and would worsen under wind conditions more conducive to recirculation.

3. Fiberglass Cooling Tower Design Constraints: The Tetra Tech report does not address the known structural susceptibility of fiberglass cooling towers to wind damage, wind-generated missiles and fire. Significant new equipment and structures, like the fiberglass SPX ClearSky cooling towers proposed by Tetra Tech, have the potential to introduce a new missile case. Since it is not known if this new missile case will exceed the current site design, detailed analysis and potentially configuration changes must be conducted to eliminate this design concern.

Considerations that may affect Tetra Tech's cooling tower sizing and are unmentioned in the Tetra Tech report include the following:

1. Tetra Tech did not identify in its report the type of fill material and/or address fill degradation impact overtime for the proposed ClearSky cooling towers.

2. Tetra Tech did not provide any transient or accident analysis in the report to determine what the proposed closed-cycle cooling retrofit would have on the operation of IPEC, nor did Tetra Tech incorporate the expected cooling tower recirculation effects.

Increasing the number of cooling tower cells to address these issues would increase the impacts noted in the feasibility issues and operability concerns above and would result in additional excavation, pipe routing, and likely introduce new feasibility issues or operability concerns.

[1] "Peak" is defined as the maximum operational power loss over a 1-hour period for an increase in wet-bulb temperature due to recirculation at the average site wind speed (as measured from 2004 to 2008).

In sum, the novelty of the ClearSky cooling tower, feasibility issues and operability concerns listed above are unresolved by Tetra Tech, and as such the configuration as presented in the Tetra Tech report cannot be considered feasible. The cost and implementation schedule, which would need to be adjusted to account for the feasibility issues and operational concerns identified above, would also likely be impacted by significant schedule overruns typical of large-scale construction activities at nuclear power plants.

The Powers Engineering Revised Closed Cycle Cooling Feasibility Assessment for Indian Point Energy Center Unit 2 and Unit 3 for Best Technology Available Report, dated October 24, 2012, and supplemental information submitted in September 2013 does not provide a reasonable engineering review and technology evaluation insomuch as it lacks essential detail required to establish feasibility. Riverkeeper's selected cooling tower configuration would result in increased circulating water temperature and reduced flow rate, which would impact IPEC's ability to generate electricity and may exceed condenser operational limits during both normal and transient conditions. The Riverkeeper selected closed-cycle cooling configuration would utilize a circulating water flow rate of 600,000 gpm, approximately 29% less than the current IPEC circulating water flow rate of 840,000 gpm. Without sufficient evaluation to conclude that condenser operational limits will not be exceeded, the Riverkeeper selected closed-cycle cooling configuration cannot be considered feasible. For these reasons, the Powers Engineering report and Riverkeeper selected closed-cycle cooling configuration is only briefly discussed in Section 1.8 of this response. An assessment of the difference in operational power losses between the Tetra Tech and Riverkeeper configurations at design wet-bulb temperature, and a discussion of the engineering design required for technology selection, is provided in Attachment 4.

1 Tetra Tech Closed-Cycle Cooling Report Overview

1.1 Tetra Tech Report Summary

Tetra Tech, Inc. (Tetra Tech) was retained by the New York State Department of Environmental Conservation (NYSDEC) Staff to evaluate potential cooling system alternatives for the Indian Pont Energy Center (IPEC) consisting of Entergy Nuclear Indian Point 2, LLC (Indian Point Unit 2), and Entergy Nuclear Indian Point 3, LLC (Indian Point Unit 3). Tetra Tech documented their findings in the Indian Point Closed-Cycle Cooling System Retrofit Evaluation (dated June 2013). Enercon Services, Inc.'s (ENERCON) response contained herein is the engineering response to the Tetra Tech evaluation. Tetra Tech's proposed closed-cycle cooling configuration is summarized in this section, along with a discussion of general inconsistences and missing information.

Tetra Tech states that their report "constitutes a feasibility-level study that assess the technical soundness of the proposed project while developing a conceptual design that can be used to estimate initial capital costs" [Ref. 12.1, p. 1]. However, Tetra Tech does not provide sufficient information to resolve the challenges, several identified as "potential fatal flaws" [Ref. 12.1, p. 28], of ClearSky cooling towers and the significant adverse impacts of the CCC configuration selected in the Tetra Tech report in order to support a feasibility conclusion on a site-specific basis for IPEC.

Tetra Tech's report does not contain the level of engineering design information presented in ENERCON's 2003 CCC report [Ref. 12.4]. Amongst other items, the ENERCON's 2003 CCC report included Performance Evaluation of Power System Efficiency (PEPSE) model results, Seasonal Annual Cooling Tower Impact (SACTI) model results, a blasting plan for rock excavation, a detailed construction schedule, and a more robust assessment of expected plant impacts. ENERCON conducted further engineering design and determined in the 2010 CCC report that several additional design issues would challenge the feasibility of a closed-cycle cooling retrofit at IPEC [Ref. 12.12]. It is expected that Tetra Tech would similarly identify additional challenges to feasibility if they performed a more detailed engineering design.

In addition to the lack of engineering design, the Tetra Tech Report includes a number of discrepancies (omission and errors) which undermine the ability of any reviewer to understand what Tetra Tech is proposing, as well as whether it is feasible and can be operated at IPEC.

1.2 Cooling Tower Selection and Sizing

In Section 1.3.4, (Page 11), Tetra Tech selected SPX ClearSky™ (hereafter ClearSky) plume-abated cooling towers for use at IPEC (also referred to as Indian Point) based on the claim that the ClearSky cooling towers were the only practical alternative for a closed-cycle retrofit apart from circular hybrid cooling towers. The assertion was that the ClearSky cooling towers would have lower maintenance costs with fewer moving parts and would involve a lower initial capital cost. The proposed cooling tower configuration would be in a back-to-back linear configuration, 2 cells wide and 22 cells long for a total of 44 cells per tower. The overall dimensions of each tower would be 1,408 ft x 151 ft (or approximately 5 acres). The ClearSky cooling tower plume abatement technology is proprietary to SPX/Marley and does not use a traditional coil-based system. The tower relies on PVC heat exchanger packs to re-condense moisture that would typically exit in the exhaust. The cooling towers would be designed for 700,000 gallons per minute (gpm) each. No information was provided regarding the tower's heat exchangers or maintenance history. No information was provided to substantiate the assertion that the ClearSky plume-abated cooling towers would be a practical choice for a closed-cycle cooling retrofit at IPEC.

1.3 Cooling Tower Fill Selection

Tetra Tech did not identify the type of fill material and/or fill degradation susceptibility for the proposed ClearSky cooling towers in its report. Certain fill designs have well documented issues regarding clogging (sometimes within a short time of cooling tower startup) and degradation over time. There have been many cases, including at large baseload nuclear power plants, of clogged fill materials which have led to reduced tower thermal efficiency and even cooling tower failure [Ref. 12.27].

Hence, due to the lack of design information regarding the ClearSky cooling tower, it is unknown whether the Tetra Tech proposed cooling towers utilize an appropriate fill choice for IPEC. Without a cooling tower fill selection, it is not possible to determine if the cooling tower proposed by Tetra Tech is feasible for continuous operation at IPEC, or if the cost and schedule information for the cooling towers are appropriate.

Furthermore, fill choice directly impacts cooling tower sizing. As a result, depending on the fill choice for the proposed ClearSky cooling towers, and whether thermal efficiency over time due to clogging and degradation was considered in the Tetra Tech design, the cooling towers' size potentially would have to increase to account for these design considerations.

Absent this essential information and analysis, the feasibility, operability, schedule and cost of retrofitting the ClearSky technology at IPEC have not been demonstrated.

1.4 Cooling Tower Siting

Several figures are provided in the Tetra Tech report depicting the closed-cycle cooling configuration. Figure 3-3 of the Tetra Tech report is considered throughout this response to represent the Tetra Tech closed-cycle cooling configuration as it provides a consistent cooling tower clearance around both the Unit 2 and Unit 3 towers. The proposed design calls for the removal of approximately 2 million cubic yards of blasting spoils to site the cooling towers at an elevation of 52.5 feet above Mean Sea Level (MSL), but provides no detailed analysis. Tetra Tech does not provide the necessary information to determine feasibility, including a blasting plan for the excavation required, a blasting vibration analysis to determine any resulting impact on sensitive plant equipment, or the availability and cost of the insurance to provide the necessary coverage to conduct blasting with Indian Point Units 2 and 3 online.

The design also identifies no alterations to the existing main condensers, even though the Unit 3 main condenser pressure will exceed alarm set points resulting in a turbine trip for a 50% load rejection condition given the design flow rate of 700,000 gpm (refer to Section 6.2.2 of this response for further information).

In Section 2.2.8.1, (Page 16), Tetra Tech states that SPX/Marley provided an appropriate allowance for recirculation, but no recirculation value was specified in Appendix A of the Tetra Tech report (Hatch Engineering Feasibility Study). Thus, Tetra Tech does not appear to have included recirculation in determining cooling tower sizing or operational power losses. Without specifying the recirculation value and bases for that value, sizing and siting of the tower in relation to the prevailing wind direction cannot be validated. If recirculation occurs and has not been properly factored into tower sizing, the towers will not remove the design heat load and unit operational efficiency will not be as predicted, with the result that IPEC will not be able to produce its rated power.

Another issue regarding the proposed ClearSky cooling tower siting is that the Unit 3 cooling tower directly interferes with the Unit 3 transmission lines and is in the immediate vicinity of the Unit 2 transmission lines (refer to Attachment 1, Figure 2). The proposed Unit 3 cooling tower siting is situated in the transmission line right-of-way, and would directly interfere with the Unit 3 power transmission line. Tetra Tech has not provided for the relocation of the transmission lines, nor have they adequately provided for the potential costs or schedule impacts of relocation.

Additionally, several inconsistences exist between Figure 02 and Figure 3-3 in the Tetra Tech report. Figure 02 cooling tower #3 has a clearance distance of 75 ft on one side and 150 ft on the other, and Figure 3-3 has a clearance distance of 150 ft on both sides of the proposed cooling tower. If adequate clearance is not provided on both sides of the cooling tower, design airflow will be restricted and cooling tower performance will be affected. Additionally, there is a noticeable discrepancy between Tetra Tech's cut volumes identified in Figures 02 and 3-3. Based on the figure layouts, the cut volumes indicated on the drawings should be consistent. However, for the Unit 2 cooling tower and piping the cut volume (cooling tower and corridor) indicated on Figure 3-3 is approximately 37% less than that indicated on Figure 02 (892,521 cubic yards versus 1,429,586, respectively). The Unit 2 cooling tower configuration appears similar between Figures 02 and 3-3, and Tetra Tech provides no basis for the dramatic difference in their cut volume values. Additionally, the Unit 3 cooling tower and piping cut volume (cooling tower and corridor) indicated on Figure 3-3 is approximately 20% more than that indicated on Figure 02 (931,119 cubic yards versus 1,164,674, respectively).

1.5 Conversion Costs

In Section 2.4, Page 22, Table 2-4, Tetra Tech provided the estimated cost of construction, excluding costs associated with loss of power generation during the construction outage, as $1,009,331,000. The primary contributors to the estimated cost are $310 million in civil/structural construction work and $250 million for the cooling towers. The estimate includes a reported 25% contingency. The Tetra Tech estimate does not include an expected accuracy range.

The Tetra Tech estimated cost of construction does not include all costs associated with conversion of IPEC Unit 2 and Unit 3 to closed-cycle cooling. The Tetra Tech evaluation identified other areas of work associated with the conversion, but did not include costs or schedule impact for that work. As identified throughout this response, other areas of work that were not adequately accounted for in the above Tetra Tech cost include the following:

- Cooling towers sized to accommodate fill clogging and degradation, recirculation, and transient requirements (cost and schedule implications)
- Algonquin gas pipeline relocation (cost and schedule implications)
- Relocation of the 345 kV main transmission lines (cost and schedule implications)

- ISFSI facility impact (cost and schedule implications)
- Relocation of the various other structures, systems and components impacted by the conversion. (cost and schedule implications)
- Management of spoils (cost and schedule implications).

1.6 Parasitic and Operational Power Losses

In Section 2.3.4, Page 19, Table 2-3, and Section 2.6, Page 25, Table 2-6, Tetra Tech estimates parasitic and operational power losses. Each cooling tower requires power to operate the mechanical fans above each cell, which Tetra Tech estimates will require 8.6 MWe per Unit. Power is also required to pump the circulating water from the newly created pump houses (located within the current discharge canal) up to the water distribution system within the cooling towers, which Tetra Tech estimates will require 11.6 MWe per Unit. Tetra Tech's estimated parasitic losses for Units 2 and 3 is 20.2 MWe each, for a combined total of 40.4 MWe.

Since the cooled water from the cooling towers would be warmer than the river water currently used for plant cooling, Tetra Tech estimates annual average operational losses of 16 MWe and 4 MWe and summer peak operational losses of 49 MWe and 29 MWe for Units 2 and 3, respectively. Taking parasitic and operational losses together, Tetra Tech estimates that in summer peak conditions Unit 2 would lose a total of 69.2 MWe and Unit 3 would lose a total 49.2 MWe to operate with closed-cycle cooling. The combined power losses of Tetra Tech's closed-cycle cooling configuration would be 118.4 MWe, and represents a greater than 5% reduction in IPEC net power output when electricity demand is high.

1.7 Identified Project Challenges

In Section 3.1, Page 27, Tetra Tech notes that "the proposed project's scope and complexity combined with the inherent obstacles of working in and around an active nuclear plant, present significant, but not insurmountable, challenges." However, as presented herein the Tetra Tech Report does not fully document the scope for this type of project nor the challenges and risks inherent with a project of this scale. The challenges that are stated to not be insurmountable do not receive appropriate vetting and are not fully quantified with regard to impact or cost.

The following is taken directly from the Tetra Tech report's own list of the key considerations and potential permitting and approval fatal flaws.

<u>Key Considerations</u>

- *Public Involvement: IPEC is a high profile facility given its proximity to New York City. Numerous public interest groups (e.g., RiverKeeper, Natural Resources Defense Council, Clearwater) and public officials, including the current governor, have publicly stated their desire to see IPEC cease operation when the operating licenses expire. It is not unreasonable to expect that most, if not all, required permits and approvals would be vigorously contested by IPEC's opponents, up to and including litigation.*
- *Radiological Plume: Contaminated areas along the riverfront will need to be excavated to allow for the Unit 2 return pipes. Contaminated spoils would be treated and/or transported to an approved disposal facility. Limited options are available to treat the tritium contaminated groundwater produced during construction. GZA GeoEnvironmental, under*

contract to Entergy, proposed to discharge this water to the Hudson River but note that the NYDEC opposes this option (Enercon 2010a, Attachment 3).

- *Site Complexity: Fully integrating the proposed retrofit with existing facility operations will require additional site investigations (e.g., groundwater characterization, geotechnical analyses) before moving forward with a final design. IPEC is a compact facility, particularly along the riverfront where multiple systems intersect. Blasting, excavation, canal modification, final tie-in, and testing require a comprehensive implementation schedule involving multiple disciplines.*
- *NEPA/SEQR: The NRC has conducted an [Environmental Impact Statement] EIS for IPEC, including the ENRCON retrofit option, although final action is still pending. Certain analyses would be applicable to the proposed retrofit scenario, although it is unclear whether a supplemental action would be required. Likewise, analyses conducted under NEPA could be expected to satisfy, at least in part, the environmental impact assessment requirements under [State Environmental Quality Review] SEQR.*
- *Air Permit: A wet cooling tower retrofit will create a new source of particulate emissions in an area designated as non-attainment for $PM_{2.5}$. NYDEC is conducting a separate analysis of potential air emission impacts.*

Permitting and Approval Fatal Flaws

- *SEQR/NEPA: Compliance with SEQR and NEPA, if required, would depend on the project's final design, required permits, and the potentially affected resource areas.*

  While this report evaluates impacts to some critical resource area (visual, noise, recreation), it may not address additional impacts that would only be identified during the scoping process.
- *Radionuclide Management: GZA GeoEnvironmental, under contract to Entergy, evaluated options for managing the radionuclide plume in contaminated areas along the riverfront (Enercon 2010a, Attachment 3), but a disposal method has not yet been approved by NYDEC. If an acceptable method cannot be identified, construction and excavation could not proceed in this area, which is where the CT2 pipe corridor would be sited. In this case, the proposed Unit 2 retrofit would be infeasible. The Unit 3 retrofit is not affected by the radionuclide plume.*
- *NRC Approval: Tetra Tech did not engage the NRC to determine whether the proposed design would adversely impact any cooling system safety or redundancy features. None of the design elements would be considered atypical of standard engineering practices, but the relicensing process involves NRC approval of modifications to the cooling system.*

In addition to these key considerations and challenges identified by Tetra Tech for the proposed ClearSky cooling tower configuration, other challenges have been identified with this use of the Tetra Tech proposed cooling towers as identified throughout this response.

1.8 Powers Engineering Closed-Cycle Cooling Report

The Powers Engineering report is insufficient to establish feasibility, operability, cost or schedule, and is so lacking that it challenges review [Ref. 12.28]. The potential construction and operation of closed-cycle cooling is discussed only in general terms, and various essential items of information are omitted. The Powers Engineering report lacks the engineering design necessary to establish feasibility, or to conduct a meaningful engineering review of the closed-cycle cooling configuration selected by Riverkeeper as best technology available (BTA) [Ref. 12.29].

For example, Powers Engineering's September 11, 2013 supplement provides a 17°F approach to wet-bulb temperature at the design point of 76°F for the SPX and GEA[2] plume-abated cooling towers; however, the only cooling tower performance curves (i.e., the curve necessary to determine the approach to wet-bulb temperature over the range of anticipated wet-bulb temperatures) provided in Attachment B of the Powers Engineering report are for a much smaller SPX cooling tower configuration operating at 110,000 gpm, at a 13°F approach to wet-bulb at a 76°F design point, and without a listed plume point (i.e., presumably a non-plume abated cooling tower) [Ref. 12.30]. Without a cooling tower performance curve for each selected tower, it is not possible to calculate the operational power losses for IPEC, except for the rare instance when the wet-bulb temperature is 76°F.

Riverkeeper's selected cooling tower configuration for IPEC utilizes a 28-cell in-line, plume-abated, mechanical draft cooling tower for each Unit. The Riverkeeper selected cooling tower would operate with a flow rate of 600,000 gpm, a design wet-bulb temperature of 76°F, and an approach to wet-bulb temperature of 17°F [Ref. 12.29]. For comparison, Tetra Tech's cooling tower configuration utilizes a 44-cell back-to-back ClearSky cooling tower for each Unit, operating at a flow rate of 700,000 gpm, a design wet-bulb temperature of 77°F, and an approach to wet-bulb temperature of 12°F. The increased circulating water temperature and reduced flow rate specified by Riverkeeper's cooling tower configuration impacts IPEC's ability to generate electricity, would result in Unit load reduction during times in excess of the condenser operational limits, and does not take into account transient or accident analysis.

It should be noted that Consolidated Edison (ConEd) completed closed-cycle cooling evaluations for Indian Points Units 2 and 3 in 1974 and 1976, respectively, selecting natural draft cooling towers in the process [Refs. 12.32 and 12.33]. These reports utilized a circulating water flow rate of 600,000 gpm and either natural draft cooling towers with an approach to wet-bulb temperature of 16°F or mechanical draft cooling towers with an approach to wet-bulb temperature of 17°F (both at a design wet-bulb temperature of 74°F). Significant modifications to Indian Point Units 2 and 3 have occurred since the mid-1970s. These modifications are accounted for in the PEPSE model used in ENERCON's analysis. While the ConEd reports provide general background information on closed-cycle cooling technologies, they do not reflect the current configuration of Indian Point Units 2 and 3. As presented in Attachment 4, for the current plant configuration closed-cycle cooling utilizing a 600,000 gpm circulating water flow rate and a cooling tower with an approach to wet-bulb temperature of 17°F would impact IPEC's ability to generate

[2] Page 1 of the Powers Engineering September 11, 2013 supplement lists a 17°F approach temperature at a 78°F wet-bulb design temperature; however, a 17°F approach temperature at a 76°F wet-bulb design temperature is assumed in accordance with the values listed by GEA in Attachment 2 of the supplement.

electricity and may exceed condenser operational limits during both normal and transient conditions. Without sufficient evaluation to conclude that condenser operational limits will not be exceeded, the Riverkeeper selected closed-cycle cooling configuration cannot be considered feasible.

For comparison purposes, operational power losses at a wet-bulb temperature of 76°F were calculated for the Tetra Tech and Riverkeeper selected closed-cycle cooling configurations following the methodology outlined in Section 9.3 of this response. The Riverkeeper closed-cycle cooling configuration resulted in an additional operational power loss of 41.6 MWe above that of the Tetra Tech configuration. Again, this comparison is limited to a wet-bulb temperature of 76°F, as Powers Engineering does not provide a cooling tower performance curve for the Riverkeeper selected closed-cycle cooling configuration.

Since the engineering design necessary to conduct a meaningful review of the closed-cycle cooling configuration selected by Riverkeeper is not included in the Powers Engineering report, it is not discussed further within the main body of this response. An assessment of the difference in operational power losses between the Tetra Tech and Riverkeeper configurations at a wet-bulb temperature of 76°F and a discussion of the engineering design required for technology selection are provided in Attachment 4.

2 Novelty of ClearSky Cooling Tower Technology

2.1 Statement of Issue

The ClearSky cooling tower that has been selected by Tetra Tech for the closed-cycle cooling configuration retrofit at IPEC Unit 2 and Unit 3 represents a unique and untried technology for the scale of operation that is being proposed. The ClearSky cooling tower has no operational experience at a nuclear facility.

2.2 ClearSky Cooling Tower Technology Overview

ClearSky cooling towers are designed, manufactured, and installed by SPX. Similar to other linear multi-cell mechanical draft cooling towers, multiple ClearSky cooling tower cells are combined together to create a cooling tower configuration for each Unit.

The ClearSky cooling tower technology employs a unique approach to visible plume reduction. Typical plume-abated towers utilize a coil-based heat exchanger in the dry section to reduce visible plume (Figure 2-1). In the ClearSky plume abatement system (Figure 2-2) the coils in the dry section are replaced with a passive condensing module. As hot water is not required to be pumped up through a heat exchanger, the use of condensing modules theoretically reduces the pumping power required, compared to a similar tower configuration utilizing a coil-based dry section. Air flow to the passive condensing modules is controlled by a series of dampers. With the dampers open, a portion of the induced air flow is drawn through the condensing modules rather than through the wet zone. Doing so theoretically reduces the direct air-water interaction and slightly decreases the overall cooling capacity of the tower (Tetra Tech Evaluation, Section 1.3.4).

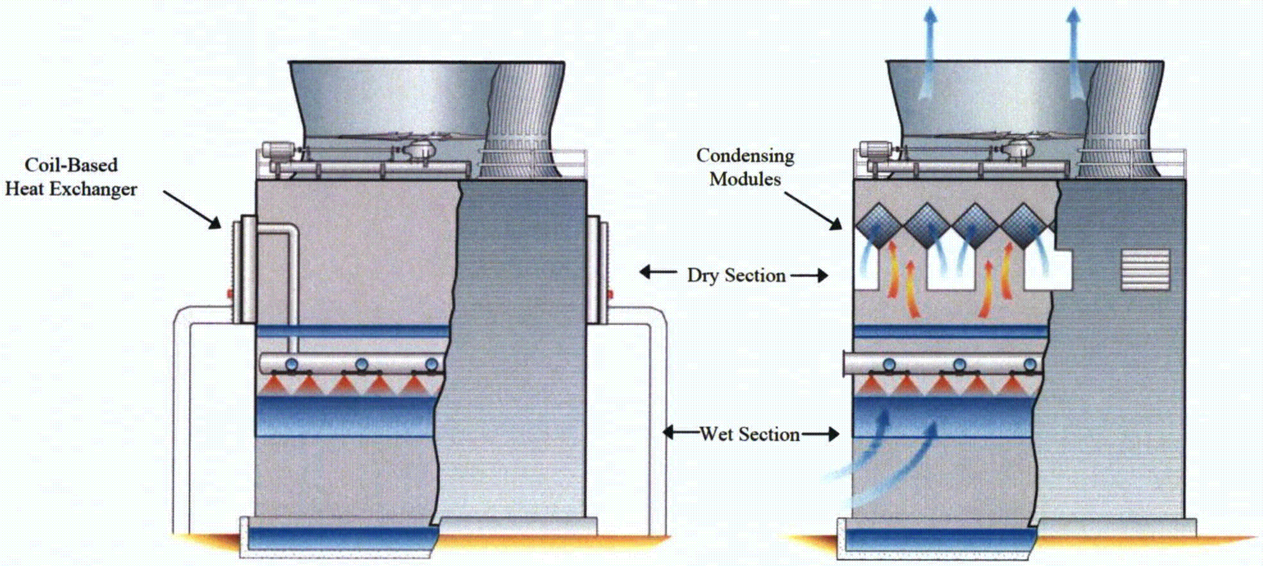

Figure 2-1: Coil-Based Hybrid Tower

Figure 2-2: ClearSky Tower (SPX)

2.3 Novelty of ClearSky Cooling Tower Technology

ClearSky cooling towers employ a novel technology with limited operating experience. Only one very small installation, a one cell (test) cooling tower, is currently operating and has only been operation for five years, and no data regarding the operational performance of this test cell has been provided by Tetra Tech [Ref. 12.26]. A two cell cooling tower has been constructed for a biomass facility in Wisconsin [Ref. 12.26], but has not begun operation (it is expected to begin operation by the end of the year) [Ref. 12.26]. A 12 cell cooling tower is currently being constructed for the Hess Newark Energy Center in New Jersey [Ref. 12.26]. During the five year operation of the original ClearSky cooling tower cell, only two additional cooling towers have been commissioned, demonstrating that widespread adoption of ClearSky cooling towers has not occurred. Moreover, all three of these cooling tower installations are for in-line ClearSky cooling towers, not the back-to-back configuration selected by Tetra Tech for use at Indian Point Units 2 and 3. As such, there is no operation or maintenance history for a back-to-back configuration, nor implementation lessons-learned for an installation that is as large and complex as is being proposed for Indian Point Units 2 and 3 [Ref. 12.26].

ClearSky cooling towers rely on unique plastic condensing modules (heat exchangers) and are composed primarily of fiberglass. The original ClearSky cooling tower cell was constructed in New Mexico, an area with significantly different meteorological conditions than IPEC. The cooling tower manufacturer projects equipment lifespan to be approximately 30 years [Ref. 12.26]. However, with such short operating history it is difficult to assess whether lifespan projections are accurate, particularly under IPEC's operating environment.

This lack of operational history presents a large potential risk that would likely eliminate ClearSky cooling towers from serious consideration. Large baseload plants, such as IPEC Units 2 and 3, are essential power sources and provide grid stability, and subject to extensive regulation and oversight by the NRC. As such, dependability during the operating cycle is critical and reliable long term operation is essential, and will be an important element of the decision process for closed-cycle cooling retrofit alternatives. Without the benefit of a substantial operating and maintenance history, new technologies that could have substantial adverse impact on the operations of both Units of a site are typically not considered. Proven technology always is the preferred course of action.

Typical configuration of ClearSky cooling tower compared to another mechanical draft cooling tower is shown in Figure 2-3 below.

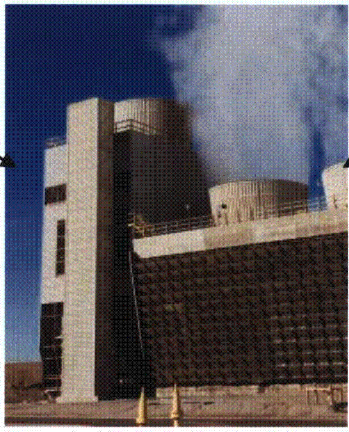

Figure 2-3: ClearSky Cooling Tower Installation (SPX)

2.4 Response

No conversions of existing operating nuclear plants from once-through to closed-cycle cooling[3] have been performed. Conversion to a closed-cycle cooling configuration would represent a complex and difficult engineering and construction undertaking. Plant conversion to closed-cycle cooling would be very costly and would need to reflect technology that has the least risks and challenges for implementation and operation [Ref. 12.12]. Due to the uncertainty of installation and operation of a relatively unproven cooling tower design represented by ClearSky, conversion to closed-cycle cooling using this technology would involve additional design, installation, operational, and maintenance challenges and risks for IPEC. Substantially more information, including design and analysis, is needed to identify with reasonable assurance all potential concerns with the technology.

For instance, no operational information is available regarding the functionality of a large scale back-to-back ClearSky cooling towers installation. The ClearSky cooling tower plume abatement technology, which is proprietary to SPX, does not use a traditional coil-based system. Functionality of a novel technology cannot be presumed in a feasibility evaluation, particularly for retrofitting on the scale proposed at IPEC. Rather, it must be demonstrated with extensive operations experience. In the absence of any such demonstrated successful operating experience, an unproven technology cannot be seriously considered.

[3] Palisades Nuclear Generating Station (PNGS), which was originally designed for closed-loop cooling, e.g., its circulating water system components were sized to accommodate the expected heat rejection capability provided by cooling towers.

3 Cooling Tower Siting Conflicts

3.1 Statement of Issue

The cooling towers proposed by Tetra Tech for the closed-cycle cooling configuration directly conflicts with existing IPEC permanent plant structures and equipment. Identified below are structures and equipment that will be significantly impacted as a result of the Tetra Tech proposed cooling tower siting.

3.2 Siting Conflict

A walkdown and review of Tetra Tech Report Figure 3-3 by Entergy personnel indicates that a variety of major on-site structures and components may be impacted by the proposed closed-cycle cooling design. The extraordinary level of site impact from Tetra Tech's closed-cycle cooling configuration is wholly unaccounted for in the Tetra Tech report.

3.2.1 Essential Structures and Components

- Both Unit 2 and Unit 3 345/138 kV high voltage lines and possibly one Unit 3 tower (height concern during construction and after installation with respect to operating clearance requirement for a 345 kV line)
- Buchanan breaker control cable trench for all units
- Security Towers (see 3.2.4)
- Security fencing and Access building (MAC) to secondary control areas (see 3.2.4)
- Independent Spent Fuel Storage Installation (ISFSI; see 3.2.3)
- Dry Cask Storage roadway for Unit 2 and Unit 3
- Unit 3 Primary Water Storage Tanks
- Unit 2 Substation A and IP3 Substation C, 13W92, 13W93 and 13W94 – 13.8 kV underground feeders
- Utility Tunnel and Monitoring House (i.e. all of City Water/Fire Protection Water for Unit 1, Unit 2 and Unit 3)
- Underground 138 kV High voltage feeders 33332
- City Water Access

The functionality of essential structures, components and systems is relied upon for safe, secure and efficient power generation at IPEC. The Tetra Tech proposed ClearSky cooling tower configuration conflicts with the existing security, electrical, access, and spent fuel storage components listed above, all of which are important to site operations and electrical power generation.

For instance, the Tetra Tech proposed cooling tower configuration conflicts with major electrical components essential to power generation at IPEC. One of the most disruptive of such conflicts is with the Unit 2 and Unit 3 345/138 kV high voltage lines. The proposed Unit 3 cooling tower is situated in the transmission lines right-of-way (owned by Entergy), and would directly interfere with a Unit 3 power line tower. Absent relocation, this eliminates the plant's ability to deliver its generated power to the grid. Rerouting these transmission lines is non-trivial, and would require design and approval of the new routing, and a plant outage. The new route must be cleared and graded, which likely conflicts with other existing components on- and off-site. Once again, the Tetra Tech report does not acknowledge or address these challenges inherent in its design, as well as adequately address the implications to the schedule and cost for these activities.

3.2.2 Independent Spent Fuel Storage Installation

The excavation for Tetra Tech's proposed cooling tower and piping for Unit 2 from Figure 3-3 directly interferes with the existing ISFSI facility. The ISFSI is a critical component of the IPEC site for dry cask spent nuclear fuel storage. Post-permitting construction of the current ISFSI lasted approximately three years and cost over $13 million. Interference with the ISFSI requires the decommissioning of an existing, newly constructed facility, the displacement of the existing spent fuel casks containing high level nuclear materials. The Tetra Tech report does not address this aspect of the proposed design configuration. Design, licensing, and relocation to a new ISFSI would need to occur prior to blasting operations near the existing ISFSI location. Again, the Tetra Tech report did not adequately address the significant implications to the schedule and cost for these activities.

3.2.3 Structures and Components Containing Radioactive Material

- Unit 3 Radioactive Machine Building (RAMS)
- Unit 3 Waste Storage Tank Area

The Tetra Tech configuration also displaces facilities containing low level radionuclides, which requires equipment / structure removal and storage, designation of new location and permitting and construction of new facilities. Changes to the Unit 3 waste storage tank would require evaluation to determine if the waste processing system would be capable of servicing the new location, and, if not capable, additional modifications to the waste processing system would be required. The Unit 3 waste storage tank area is located adjacent to the fuel storage building, and relocation would be complicated by the concrete surrounding the tank and the associated underground piping. The Tetra Tech report does not address these challenges, but simply displaces facilities containing these materials without identifying the implications or adequately addressing the significant implications to the schedule and cost for these activities.

3.2.4 IPEC Site Security

- Security Towers
- Security fencing and Access building (MAC) to secondary control areas
- Unit 3 Secondary Security Access Facility

A significant conflict caused by the Tetra Tech proposed ClearSky cooling tower configuration is with security towers and fencing. The proposed cooling tower locations interfere with existing security towers while increasing the demand for security by adding new facilities. Tetra Tech did not address the significant security changes that will need to be developed before the ClearSky design in the report is acceptable.

Relocating security towers is non-trivial, and will require new security tower design evaluation. The report does not address security risks inherent in the proposed design. Without a functional security plan a nuclear plant cannot safely or legally operate [Ref. 12.34].

3.2.5 Other Structures and Components

- Algonquin Natural Gas Pipeline
- Two maintenance and construction buildings
- Unit 3 Trailer complex
- Unit 3 Outage Support Building

The Tetra Tech cooling tower configuration impacts major utilities and components on- and off-site. The most significant off-site impact is the siting conflict with the Algonquin Natural Gas Pipeline. The Algonquin Pipeline runs along the southern perimeter of the IPEC site and is displaced by the proposed Unit 3 Cooling Tower. Excavation in this area would be substantially below grade and would require blasting. It is not feasible to conduct construction involving blasting directly on top of and around an active gas pipeline. Without resolution of this siting conflict, Tetra Tech's closed-cycle cooling configuration cannot be considered feasible. A discussion of Tetra Tech's proposed cooling tower configuration conflict with the Algonquin pipeline is contained in Section 4.

The Unit 3 Outage Support Building is also displaced by the cooling tower configuration in the report. Outages are necessary for major site modifications, such as the conversion to closed-cycle cooling with the installation of cooling towers. An outage support building functions to stage fabrication, repairs and storage of site equipment and construction materials during an outage. Construction of the Unit 3 cooling tower requires a Unit 3 outage, but its location in the Tetra Tech report conflicts with the existing Unit 3 Outage Support Building.

3.3 Response

Based on walkdown observations and review of Figure 3-3, the proposed cooling towers impact several existing structures, including essential plant structures and components. Furthermore, additional existing structures and plant access could be affected during construction of the Tetra Tech proposed cooling towers, which is not addressed in this response. Many facilities would need to be demolished and/or relocated under Tetra Tech's proposed design, which would add significant cost to the project. Several plant systems could be affected by siting conflicts, which could adversely impact outage schedules due to additional work while the impacted facilities, components, and utilities are relocated or reworked to accommodate the proposed cooling towers.

The Tetra Tech report offers no plan to resolve conflicts of the proposed cooling tower configuration with the IPEC site layout and impacted site facilities. Several essential components are displaced with no evaluation of impact to the plant's ability to function as a result (particularly as plant functionality is clearly impacted). The proposed Tetra Tech design does not fully vet the changes being made to the site nor the plant's ability to generate power in a safe and efficient manner.

On a cumulative basis, the essential structures and components that are impacted by the Tetra Tech configuration represent major detrimental impacts to the IPEC site and to IPEC operations. The section of the Indian Point Interim Decision which defines the availability of technology based on its ability to be installed and operated at a site is included below.

> *The third step of the BTA analysis addresses whether practicable alternate technologies are available to minimize impingement and entrainment. Availability of a technology is analyzed in the context of its suitability for the particular application, including its ability to be installed and operated at the site. In this regard, for example, the impacts of a technology on a facility's operation (that is, can it be engineered such that the facility will operate efficiently) are part of the BTA analysis. See, e.g., Matter of Dynegy, Decision of the Deputy Commissioner, May 24, 2006, at 14 (where cooling tower configurations could not be effectively integrated into facility's operations without detrimental effect, such configurations were not available technology). Whether adequate space exists to construct and operate the technology, or whether physical or other site constraints are present, are similarly relevant to the consideration of whether a technology is available. See id. at 8-14; see also Matter of Dynegy, Issues Ruling, at 17, 60-62 (where a component of a retrofit configuration would not fit on the site, the configuration is not available for consideration of the BTA determination)* [Ref. 12.35].

In summary, a technology is only available if the impacts of a proposal on a facility will allow the facility to operate efficiently and can be effectively integrated without detrimental effect. The number and significance of the siting conflicts unresolved by Tetra Tech's report would result in a detrimental effect to IPEC, and as such the Tetra Tech cooling tower configuration cannot be considered an available technology.

4 Algonquin Pipeline Considerations

4.1 Statement of Issue

Tetra Tech's proposed cooling towers for a closed-cycle cooling retrofit at IPEC directly impact the Algonquin natural gas transmission pipelines running adjacent to Unit 3. Information below identifies the most significant aspects regarding impacts to the Algonquin pipeline, as it currently is configured, which are documented in Attachment 6 of ENERCON's 2010 CCC report [Ref. 12.12]. Expansion of the Algonquin pipeline where it crosses the IPEC site has been announced [Ref. 12.37]. Since the Tetra Tech's proposed closed-cycle cooling configuration is significantly larger than that presented by the round hybrid cooling tower in ENERCON's 2010 Closed-Cycle Cooling Feasibility Report and thus affects more gas pipeline (which itself may be expanded), the issues identified below from ENERCON's report will necessarily be exacerbated by Tetra Tech's proposed closed-cycle cooling configuration.

4.2 Tetra Tech Siting Conflicts with Algonquin Pipeline

As noted by Tetra Tech and shown in Figure 3-3 of the Tetra Tech report, the current Algonquin pipeline is located within the area that would be excavated for the Unit 3 cooling tower. Excavation in this area would be substantially below grade and would require blasting. It is not feasible to conduct construction involving blasting directly on top of and around an active gas pipeline. Without resolution of this siting conflict, Tetra Tech's closed-cycle cooling configuration cannot be considered feasible.

4.3 Algonquin Pipeline Considerations

Although Tetra Tech indicated in its report that the Algonquin pipeline will need to be relocated [Ref. 12.1, Section 2.8], Tetra Tech did not discuss the feasibility issues associated with the relocation.

The complete feasibility evaluation for the Algonquin pipeline relocation can be found in Attachment 6 of Reference 12.12. Assuming the Algonquin pipeline, either currently or after a planned expansion, could be feasibly relocated, the listing below summarizes the critical requirements for blasting and construction near the Algonquin pipeline right-of-way.

- Permission must be obtained from the company owning the pipeline, Spectra Energy Corporation, before construction near the pipeline (as defined by the owner) could be conducted.
- Spectra Energy would also need to approve any pipeline relocation considered, and the right-of-way adjusted accordingly.
- The relocated pipeline facilities would need to be constructed and tied-in to Algonquin's existing facilities in a staged manner during the months of June through September when the typical Algonquin system demands may allow for an approximate seven (7) day outage for each relocated pipeline to be tied-in and connected to Algonquin's existing system.
- Relocation requires roughly 24 months for field work, design, permitting construction, and in-service tie-in.

- A restrictive zone or "Blasting Offset" is required by Spectra Energy from the location of the nearest pipeline to edge of the excavated slope. The required Blasting Offset from the nearest pipeline is 46.8 ft (rounded to 50 ft).
- An environmental impact evaluation would be required in accordance with relevant issues outlined in 18 CFR Part 380.12 [Ref. 12.24] as part of the Prior Notice application that would be required to be filed with the Federal Energy Regulatory Commission [FERC].

4.4 Response

Tetra Tech does not contest the impact of a Unit 3 cooling tower on the current Algonquin pipeline and does not acknowledge the expansion, but provides no details for resolution of the conflict. It is not feasible to conduct construction involving blasting directly on top of or in the immediate vicinity of an active gas pipeline. The gas pipeline must first be relocated a safe distance from the construction area. Attachment 6 of Ref. 12.12 highlights the hurdles to and difficulties of relocating the pipeline. Given the increased footprint of Tetra Tech's proposed linear multi-cell hybrid cooling tower configuration as compared to the round hybrid cooling tower assessed in the 2010 ENERCON CCC report, the detrimental impacts resulting from relocation of the Algonquin pipeline due to the Tetra Tech proposed cooling tower siting and configuration would be extensive and may be exacerbated by pipeline expansion. Without resolution of this siting conflict, Tetra Tech's closed-cycle cooling configuration cannot be considered feasible.

5 Power Transmission Line Impacts

5.1 Statement of Issue

The Tetra Tech proposed siting for the Unit 3 cooling tower directly interferes with the Unit 3 transmission line and is adjacent to the Unit 2 transmission line. The Tetra Tech report does not discuss the impact of Unit 3 cooling tower proposed siting on the existing Unit 2 and Unit 3 generator output 345 kV transmission lines.

5.2 Analysis

Tetra Tech proposed Unit 3 cooling tower directly interferes with the 345 kV transmission lines. The Unit 2 and 3 generator output 345 kV transmission lines are routed from the Units to the electrical distribution substation located across Broadway southeast of the plant (Attachment 1 Figure 2). Each of the transmission lines delivers the total electrical output of the respective Unit to the electrical distribution grid via the substation.

Each of the transmission lines is routed above grade on transmission towers. The minimum 345 kV line clearance above grade is approximately 24 ft (2012 National Electrical Safety Code). Section 2.2.2 of the Tetra Tech closed-cycle cooling report states that the cooling tower individual cells rise 91 ft above grade. Tetra Tech's Unit 3 proposed cooling tower location thus directly interferes with the overhead 345 kV main transmission lines (and one of the transmission line towers).

In addition to the direct interference between the Unit 3 cooling tower and the transmission lines, the Tetra Tech report did not evaluate the potential adverse effects that would be caused by the close proximity of the transmission lines to the cooling tower plume given the Unit 2 transmission lines are immediately north of the cooling tower. Plume exacerbated icing and salt deposition effects on transmission lines that are located in cooling tower plumes should have been evaluated.

Installation of the Unit 2 and Unit 3 cooling tower will require using the existing plant's parking areas for construction laydown and staging areas. This will necessitate the construction of a new parking structure (see Figure 3-2) to replace the lost parking areas (Tetra Tech Report, Section 3.4.4). Tetra Tech's location for the new employee parking structure is in the transmission line right of way, creating yet another siting conflict. Site feasibility for the parking structure has not been evaluated in detail and either the parking structure or the transmission lines need relocation due to the proposed siting of the Unit 3 cooling tower.

The Tetra Tech report does address electrical power requirements and the power source for the cooling towers. The route for power lines from the Buchanan switchyard to the cooling towers is not addressed in the Tetra Tech evaluation.

5.3 Response

Tetra Tech did not evaluate the cooling tower proposed locations in relationship to existing transmission lines. The proposed linear multi-cell ClearSky cooling towers have a massive footprint and will affect existing plant structures, especially the 345 kV transmission lines and transmission towers for Units 2 and 3. The cooling tower footprint, including the required stand-off distance (clearance around the cooling towers) to plant structures needs to be established for proper evaluation of cooling tower siting acceptability. Impacted plant structures and equipment (i.e., transmission lines and transmission towers) need to be identified and evaluated to determine feasibility of the cooling tower location. See Section 7.2.3 of this response for a discussion of the impact from ClearSky cooling towers on electrical equipment at IPEC.

Tetra Tech's proposed cooling tower location directly interferes with the overhead 345 kV main transmission lines (and one of the towers) to the power grid and the 138 kV auxiliary power lines from the Buchanan Substation to the station. The relocation of these lines and any underground control cables, including the cost and schedule impacts, is not addressed in the Tetra Tech report. Without resolution of this siting conflict, Tetra Tech's closed-cycle cooling configuration cannot be considered feasible.

6 Closed-Cycle Cooling Retrofit Impact on Condenser

6.1 Statement of Issue

The increase in cooling tower basin elevation for the Tetra Tech proposed cooling towers has an impact on the pressure applied to the existing circulating water piping and main condensers. This higher pressure is compared against the current and maximum pressures allowed by the existing condenser design. The main condenser system components are assessed to determine the potential impact from the proposed ClearSky cooling towers.

6.2 Impact on Condenser

6.2.1 Intake Side Circulating Water Piping Evaluation

Tetra Tech's report does not provide detailed information regarding the tie-in between the proposed circulating water piping and the existing circulating water piping. Due to the relatively shallow burial depth of the existing piping near the tie-in points (approximately 2 to 5 ft), the proposed piping would need to be at a lower elevation than the existing piping to allow for the proper configuration of thrust blocks. Concrete thrust blocks would be necessary at the tie-in points to resist the thrust load developed where piping changes direction. One potential configuration is to use a 90 degree vertical elbow and then "tee" into the existing piping as shown in Figure 6-1.

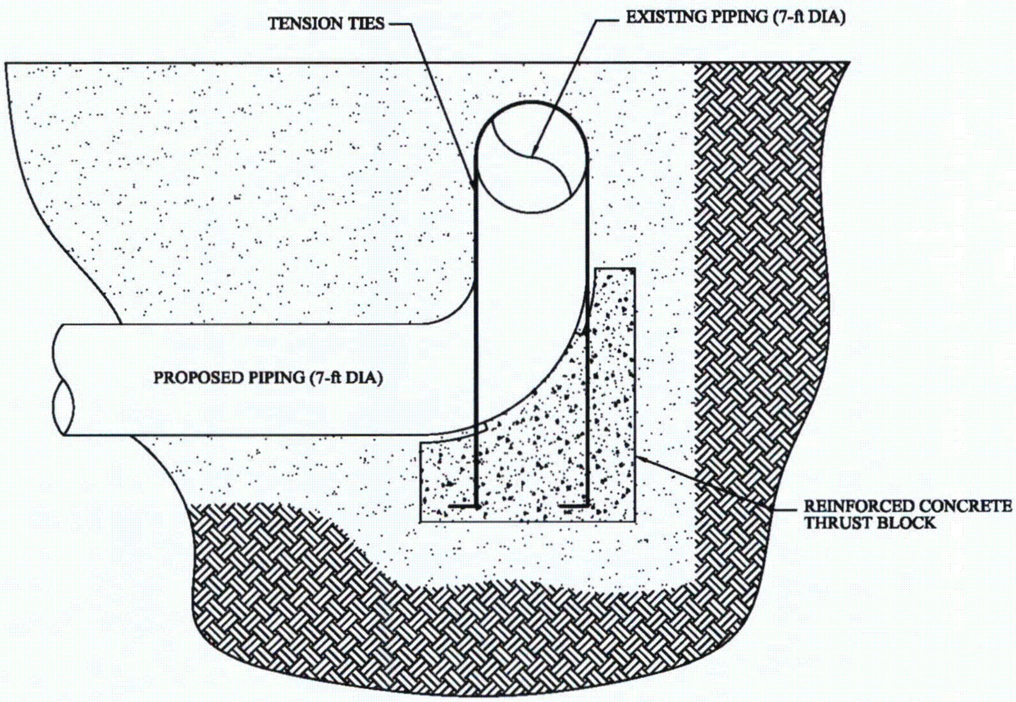

Figure 6-1: Preliminary Thrust Block Configuration for Tie-In to Existing Piping

The design operating pressure for the existing circulating water pipe intake is 35 pounds per square inch (psi) per Drawing 9321-F-22623-13 [Ref. 12.21]. The pipe internal pressure at the tie-in point is based on the elevation difference between the cooling tower basin water elevation (H_b = cooling tower elevation + basin water level = 52.5 ft + 4 ft = 56.5 ft) and the assumed centerline elevation of the 90° elbow (H_{90} = -7.5 ft) shown in Figure 6-1. The centerline elevation of the "tee" into the existing piping shown in Figure 6-1 would vary between 6.5 ft and 9 ft depending on the specific tie-in point per Ref. 12.21. The pipe internal pressure at the 90° elbow is calculated as follows:

$$Pipe\ Internal\ Pressure = (H_b - H_{90})\rho_w = [56.5\ ft - (-7.5\ ft)] \cdot \frac{62.4\ pcf}{144\ \frac{in^2}{ft^2}} = 27.7\ psi$$

The estimate of the pipe internal pressure at the 90° elbow is 27.7 psi which is less than the design operating pressure for the existing circulating water pipe; therefore, the pipe will be acceptable for the pressure.

It is assumed that the circulating water system startup will be gradual allowing the pressure to increase steadily to operating levels. If this is not the case, and the system is started up abruptly, a water hammer could develop causing tremendous thrust loads where the pipe from the cooling tower ties in with the existing intake pipe and potentially at the condenser. While not mentioned in the Tetra Tech report, it is imperative that procedures be written to require gradual system startup. For a Unit 3 piping 90° tie-in and considering the nominal pipe diameter of 84 in (actual inside diameter is slightly less), the potential thrust force given peak operating pressure is:

$$Thrust\ Force = Pipe\ Section\ Area \cdot Internal\ Pressure$$
$$= \frac{\pi}{4}(84\ in)^2 \cdot (27.7\ psi) = 153{,}507\ lb$$

The preliminary sizing of the rectangular concrete thrust block for the configuration shown in Figure 6-1 is 16 ft high, 14 ft wide, and 11 ft thick (into the page) – for each of the six pipes on a per Unit basis. A void would be left approximately 8 ft thick (into the page) to account for the piping. The section cut in Figure 6-1 is taken to show the piping and the associated void. To resist the uplift of the pipe at the "tee" connection between the proposed and existing piping, steel tension ties would be required such that the concrete thrust block would serve as a dead-weight anchor. The preliminary sizing results in a concrete volume of 63 cubic yards, or roughly seven concrete trucks, for just one tie-in to the existing circulating water piping. As 12 tie-ins are required for both Units (six tie-ins per Unit), a total of 756 cubic yards of concrete, or roughly 84 concrete trucks, would be required.

The thrust loading could be reduced by adjusting the angle of the tie-in point to a shallower angle. The shallower angle would most likely reduce the volume of concrete, but would complicate the thrust block configuration, design, and construction. A more detailed analysis of the concrete thrust block would be needed during a detailed design. The piping configuration, and, therefore, the thrust block configuration, would need to consider existing interferences, flow, construction, subgrade conditions, etc. to determine an optimized configuration. No matter what the final configuration of the thrust blocks, the total excavation volume would be greater than required for the pipe tie-in alone, a consideration that Tetra Tech has not accounted for in its report (both with respect to schedule and cost). Tetra Tech's report does not resolve the significant interference and excavation issues associated with the 12 thrust blocks required at tie-in points (six per Unit), and as such, the Tetra Tech closed-cycle cooling configuration cannot be confirmed as feasible.

6.2.2 Condenser Analysis

Burns and Roe Enterprises, Inc. (BREI) was retained by Entergy to perform an independent review of the structural impact of Tetra Tech's proposed cooling tower design on the existing condensers. See the complete BREI report (Attachment 3) for their detailed analysis and results. BREI examined a variety of issues including:

- Condenser Structural Impact
  - New tube flow, pressure and temperature
  - Tube minimum wall thickness
  - Tube vibration and support plate spacing
  - Tubesheet joints (4 per shell) torqueing requirements to seal
  - Waterbox flow, pressure and temperature
  - Tubesheet to waterbox joint torqueing requirements to seal
  - Circulating water piping to waterbox expansion joint stress
- Plant Safety/Operational Function Impact
  - High pressure steam dump impact on turbine trip setpoints

Issues discussed in the BREI report (Attachment 3) include:

- Modification of the Unit 3 condenser seal water system to relocate the seal water head tank to a higher elevation.
- Rechecking the tubesheet joint closure torque, especially when there is vacuum on the Unit and no circulating water in the waterboxes, is necessary.
- Evaluation of the Unit 3 Condenser for a 50% load rejection condition given a total flow rate of 700,000 gpm and cooling water inlet temperature of 89 °F. Evaluation identified an average absolute pressure of 5.07 inches of mercury (in-Hg). This pressure is higher than the low vacuum alarm set point of 4.0 in-Hg. Site procedure requires a manual trip of the turbine at 4.5 in-Hg and the steam dump valves are prohibited from opening at pressure greater than 5.0 in-Hg. Therefore, the absolute condenser pressure of 5.07 in-Hg is unacceptable and measures need to be taken to reduce it below 4.0 in-Hg or, at least, 4.5 in-Hg, in order for the plant to operate. Reducing the pressure requires additional ClearSky cells or other substantial means to reject additional heat load.

6.2.3 Turbine Side Piping Evaluation

As detailed in the BREI report, the condenser backpressure acting on the turbine side piping due to ClearSky cooling tower operation may exceed the low vacuum alarm set point for a 50% load rejection condition. Were this to occur, procedure requires the plant to shut down to prevent turbine overpressure. Therefore, the turbine side piping would not experience unacceptable pressure. Furthermore, during normal operation, the pressure is not expected to exceed the existing design values. As a result, turbine side piping will not require modification.

6.3 Response

The increase in cooling tower basin elevation to 52.5 ft (water elevation 56.5 ft) has an impact on the pressure applied to the existing circulating water piping and condensers. The existing piping is expected to sustain the stress induced from the increased pressure based on the current allowables, but calculations, drawings, technical specifications, and procedures associated with the piping system are affected by the change.

Tetra Tech's design introduces thrust loads on the order of 154,000 lb (refer Section 6.2.1). The preliminary sizing of the rectangular concrete thrust block for each tie-in is 16 ft high, 14 ft wide, and 11 ft. As 12 tie-ins are required for both Units (six tie-ins per Unit), a total of 756 cubic yards of concrete, or roughly 84 concrete trucks, would be necessary. Tetra Tech's report does not resolve the significant interference and excavation issues associated with the thrust blocks required at the tie-in points, and as such, the Tetra Tech closed-cycle cooling configuration cannot be confirmed as feasible.

Per the BREI report, the calculated average absolute pressure during a high pressure steam dump (50% load rejection) at Unit 3 is higher than the low vacuum alarm set point and must be reduced for the design to be acceptable. Tetra Tech did not perform any transient or accident analysis for IPEC post closed-cycle cooling retrofit. A review of the transient and accident analysis is necessary for any significant plant change to ensure that there are no potential impacts to the operation of a nuclear power plant. BREI reviewed one transient condition (a high pressure steam dump) and identified an unacceptable condition. The BREI analysis was limited to one transient condition and emphasizes the need to identify and resolve any impacts to the transient or accident analysis. Without identifying and resolving potential transient and accident conditions, the feasibility and operability of the Tetra Tech closed-cycle cooling configuration has not been demonstrated.

7 Site Impacts of Cooling Tower Plume

7.1 Statement of Issue

The plume from Tetra Tech's proposed closed-cycle cooling linear multi-cell ClearSky cooling tower will have an adverse impact on the electrical switchyard, Heating/Ventilation/Air Conditioning (HVAC) systems, and major outdoor equipment at IPEC that creates an operability concern. The impacts evaluated included icing and periodic fogging, temperature and humidity, and salt deposition on electrical equipment, HVAC and other plant components. The close proximity of the cooling towers to the power blocks and electrical transmission facilities creates a known risk of electrical arcing (discharge of current through air) in the switchyard. This presents a serious workplace hazard, and may lead to a reactor scram (or shutdown of the nuclear reactor), resulting in forced outages, the implications of which Tetra Tech has not evaluated and may substantially impact electric-system function. Tetra Tech has not adequately addressed these risks or accounted for the cost of equipment maintenance (or replacement) resulting from plume impacts.

The ClearSky towers discharge at lower velocities, at lower height, and with less thermal buoyancy than the round hybrid towers. For these reasons, the ClearSky towers have more concentrated and localized plumes at ground level, thus increasing the likelihood for salt deposition, and temperatures and humidity effects in-close proximity to the towers [Ref. 12.26]. More specifically, the drift from ClearSky cooling towers would contain dissolved minerals (i.e., salt from the brackish Hudson River), which would become entrained in critical IPEC HVAC equipment and deposited on sensitive switchyard components.

The NRC has issued a notice on storm-related loss of off-site power events to nuclear power plants located close to a large body of salt water due to salt contamination of switchyard insulators [Ref. 12.7].

A figure indicating the expected salt deposition across IPEC from the proposed closed-cycle cooling configuration has been provided by TRC and is incorporated in Attachment 1, Figure 3, of this response.

7.2 Plume Impact Analysis

7.2.1 Temperature and Humidity

Tetra Tech did not consider the potential impacts on the Unit 2 Central Control Room (CCR) ventilation system from increased temperature and humidity from a cooling tower plume. Impacts from the cooling tower plume could create a habitability issue at the Unit 2 CCR as there is minimal cooling margin available. Any upgrade to the Unit 2 CCR ventilation system would not be trivial and would require additional engineering design and construction not accounted for in Tetra Tech's cost and schedule.

The margin for Unit 3 CCR cooling is not as restrictive as Unit 2 CCR cooling; however, any margin reduction would need analysis and evaluation for acceptability.

7.2.2 Salt Deposition on Electrical Equipment

Salt deposition on electrical equipment at IPEC presents a real and material risk of component failure. Two common types of cooling tower drift and salt deposition impacts that are frequently documented in industry operating experience are excessive electrical arcing and security system nuisance alarms. It has been reported by the NRC that storm related salt contamination at switchyard insulators have caused offsite power loss events at nuclear power plants that are located close to a large salt water body [Ref. 12.7], a condition less problematic than cooling tower plume distributed salt deposition. As a consequence, it is reasonable to conclude that some arcing may occur, despite increased maintenance.

7.2.3 Electrical Arcing

Electrical arcing, a discharge of current through the air, is a serious issue that presents a workplace hazard and can lead to a reactor scram. A reactor scram is the sudden shutting down of a nuclear reactor, usually by rapid insertion of control rods. Unplanned reactor scrams upset plant stability and challenge critical safety functions during power operations [Ref. 12.36]. As such, the NRC monitors the number of unplanned reactor scrams, along with several other performance indicators, and increases regulatory attention based on unplanned reactor scram frequency.

Industry operating experience highlights the frequency and severity of equipment damage caused by electrical arcing. Cooling tower drift has repeatedly been linked to switchyard arcing at River Bend Nuclear Generating Station (RBS). Audible crackling and arcing has been observed, which has eventually led to a plant scram. The arcing was attributed to fouled insulators caused by excessive cooling tower drift. It has been documented that the intensity and amount of arcing is directly proportional to the amount of cooling tower drift present. Due to this impact, substantial maintenance efforts and modifications are required to minimize the effects of cooling tower drift at RBS, but provide no definitive assurance against arcing.

Similarly, closed-cycle cooling at Brayton Point Power Station Unit 4 utilizing a salt water spray cooling canal operated for less than one month before a succession of flashovers on the resistance grade insulators occurred.

Periodic salt deposition during storm events has caused electrical arcing at several plants located close to a large body of salt water, including the following power plants.

- Crystal River Nuclear Power Plant
- Brunswick Nuclear Generating Station
- Pilgrim Nuclear Power Station
- Salem Nuclear Power Plant
- Hope Creek Nuclear Power Plant

At Salem Nuclear Power Plant, high winds and rough surf from a hurricane deposited salt on the insulating bushings causing electrical arcing in the switchyard that prompted the shutdown of both units. During the same hurricane, Hope Creek Nuclear Power Plant scrammed following an electrical transient in the switchyard distribution system due to salt deposition.

The installation of ClearSky cooling towers at IPEC would lead to increased salt deposition and moisture on electrical equipment as a result of cooling tower drift. Industry operating experience indicates the salt deposition causes increased risk of arcing, which presents a workplace hazard and can result in a reactor scram. Tetra Tech's report did not address the significant operational concerns associated with electrical arcing, particularly as the cooling tower configuration selected is susceptible to localized plumes at ground level, thus increasing the likelihood for salt deposition in-close proximity to the towers.

An example of the explosive energy associated with high voltage switchyard electrical arcing is seen in Figure 7-1 below.

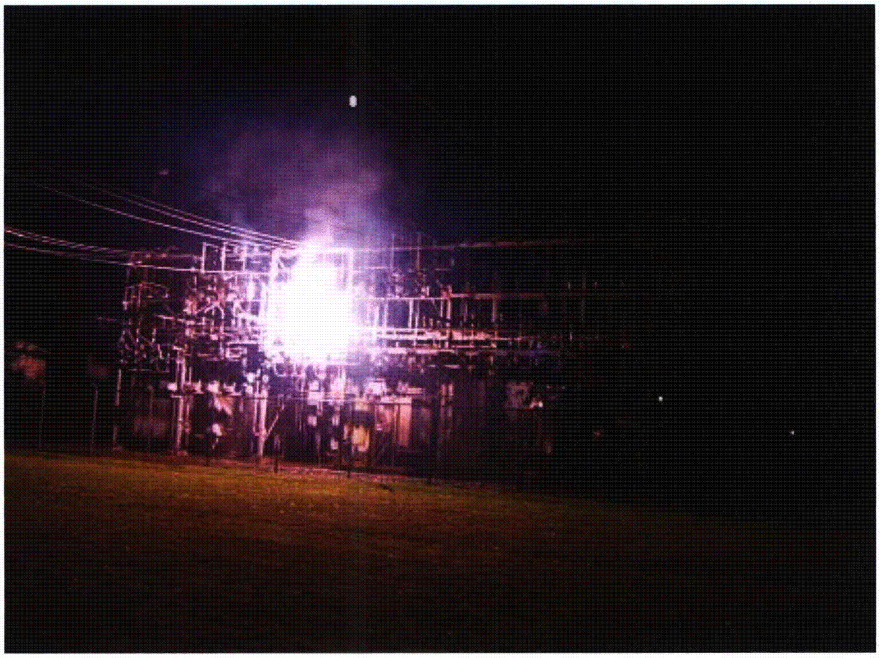

Figure 7-1: High Voltage Switchyard Electrical Arcing

7.2.4 Nuisance Alarms

Nuisance alarms can be generated by cooling tower drift and salt deposition on the electronic field (E-field) intrusion detection system (IDS) wires. The E-field IDS consists of a series of wires that generate an electrostatic field; when an object enters the electrostatic field, the field's characteristics are changed. An alarm is generated if the system processor determines that the change in the electrostatic field is large enough to imply an intruder. It is possible that the salt deposited by the cooling tower drift would change the characteristics of the electrostatic fields and cause nuisance alarms.

Cooling tower drift at RBS has generated numerous alarms from the E-field IDS. The alarms were attributed to excessive moisture and chemical residue on the insulators, which creates a ground fault type condition. To date, this has caused two NRC reportable events.

Similar impacts have been observed at Columbia Generating Station (CGS), where cooling tower drift caused multiple nuisance alarms. CGS noted that cooling tower drift/mist would freeze on the E-field wires. Eventually, the security system was replaced due to excessive nuisance alarms and operability concern.

7.2.5 Salt Deposition on HVAC and Other Plant Components

The impact to major IPEC ventilation intakes would be primarily long term in nature. This includes increased burden on maintenance and inspection to assure equipment longevity, specifically High Efficiency Particulate Air (HEPA) and charcoal filters, where most salt particulates would be filtered. The largest impact to the plant would be to those buildings that require continuous operation of the ventilation system, such as the Primary Auxiliary Building (PAB) and Fuel Storage Building (FSB). The continuous operation of units with HEPA filters can result in a larger accumulation of salt particulates in the filter which would lead to more frequent filter replacement.

7.2.6 Icing and Periodic Fogging

Moisture in the cooling tower plume could lead to ground level icing during the winter months. Ground level icing was discussed in ENERCON's 2003 CCC report and a SACTI model was run to determine the potential frequency of icing [Ref. 12.4]. With a high release height and high velocity forced exiting airflow, the modeling showed that the cooling tower plume from the round hybrid cooling towers was not expected to circulate to the ground and cause ground level icing. As discussed in Section 8 and Attachment 2 - Alden Research Laboratory, Inc. CFD Analysis to Determine Cooling Tower Recirculation Effects, the Tetra Tech cooling tower configuration results in significant recirculation and low level plumes under the defined conditions. SPX also notes that the ClearSky towers discharge at lower velocities, at lower height, and with less thermal buoyancy than the round hybrid towers. For these reasons, the ClearSky towers have more concentrated and localized plumes at ground level, thus increasing the likelihood for salt deposition, and temperatures and humidity affects in-close proximity to the towers [Ref. 12.26].

Ground level icing poses serious workplace safety and maintenance concerns, with the potential to render certain areas of the site treacherous during winter months. Icing can result in an adverse impact on plant operation if significant accumulation of ice occurs on plant components (e.g., additional loading on transmission lines). Tetra Tech has not addressed these operability concerns or performed any analysis to determine the frequency and the accumulation of ice expected.

Although plume-abated cooling towers would produce an invisible plume under most meteorological conditions, fogging would occasionally occur on the site due to the cooling tower plume. In fogging conditions, reduced visibility could affect plant security and cause safety hazards. The proposed location of the cooling towers could cause fogging near the existing facilities' power blocks and electrical transmission facilities (i.e., transformers, switchyard). Based on the close proximity of the Tetra Tech proposed cooling tower configuration to the power blocks and electrical transmission facilities, fogging due the cooling tower plume would be expected to have an adverse impact on the Stations' operation.

7.3 Response

Tetra Tech did not address the impact of a cooling tower plume at IPEC in its report. Based on a discussion with SPX, operation of ClearSky cooling towers at IPEC would lead to increased salt deposition and moisture in the vicinity of the cooling towers [Ref. 12.26]. Industry operating experience indicates the potential for cooling tower drift to cause arcing at IPEC. Cooling tower drift has repeatedly been linked to switchyard arcing at RBS and other power plants, which has led to reactor scrams. Further, it has been documented that the intensity and amount of arcing is directly proportional to the amount of cooling tower drift present. Tetra Tech's report did not address the significant operational concerns associated with electrical arcing, particularly as the cooling tower configuration selected is susceptible to localized plumes at ground level, thus increasing the likelihood for salt deposition in-close proximity to the towers.

Moisture in the cooling tower plume could also lead to ground level icing during the winter months. Ground level icing poses serious workplace safety and maintenance concerns, with the potential to render certain areas of the site treacherous during winter months. Icing can result in an adverse impact on plant operation if significant accumulation of ice occurs on plant components (e.g., additional loading on transmission lines). Tetra Tech has not addressed these operability concerns or performed any analysis to determine the frequency and accumulation of ice expected.

The cooling tower plume would also result in the following conditions, which would have an impact on IPEC HVAC performance:

- Increased ambient temperature and humidity, hence negative impact on system performance margins
- Elevated salt deposition

The increased temperature and moisture content resulting from the ClearSky cooling tower plumes would have an adverse impact on plant operations. See Attachment 1, Figure 3, TRC figure on salt deposition across IPEC based on Tetra Tech closed-cycle cooling for Units 2 and 3, for 0.001% drift.

8 Cooling Tower Recirculation and Interference Effects

8.1 Statement of Issue

As a result of the long linear multi-cell configuration of the ClearSky cooling towers, the towers would be subject to recirculation effects not addressed in the Tetra Tech report. Recirculation is where a portion of the saturated plume leaving the tower is entrained and re-introduced into the tower air inlets. Recirculation impacts cooling water temperature (more recirculation will result in warmer cooling water), which impacts power production capability of the Unit. In Section 2.2.8.1, (Page 16), Tetra Tech states that SPX/Marley provided an appropriate allowance for recirculation but no recirculation value was specified in Appendix A of the Tetra Tech report (Hatch Engineering Feasibility Study). Thus, Tetra Tech does not appear to have included recirculation in determining cooling tower sizing or operational power losses. In the absence of any analysis by Tetra Tech, ENERCON requested that Alden Research Laboratory, Inc. (Alden) perform a computational fluid dynamics analysis to determine the recirculation and interference impacts from Tetra Tech's closed-cycle cooling configuration (see Attachment 2 - Alden Research Laboratory, Inc. CFD Analysis to Determine Cooling Tower Recirculation Effects). As noted in Section 8.2.4 of this response, Alden's analysis was conducted at the two most frequent wind directions at the average site wind speed. Under conditions where the wind direction is closer to perpendicular to the cooling tower and/or wind speed is higher than the average site wind speed, recirculation effects would be increased. ENERCON evaluates the operational power losses of Tetra Tech's closed-cycle cooling configuration, including the recirculation values provided by Alden, in Section 9.3 of this response.

8.2 ClearSky Cooling Tower Recirculation Impact

8.2.1 Recirculation and Interference

Cooling tower performance is based on ambient meteorological conditions, which are locally affected by recirculation and interference effects. Recirculation describes the effect where a portion of the saturated plume leaving the tower is induced back into the tower air inlets. Recirculation effect will impact cooling water temperature; more recirculation will result in warmer cooling water leaving the tower, which will reduce the power production capability of the Unit. Interference is the effect where a portion of the saturated effluent of an upwind tower is induced into the air inlets of an adjacent cooling tower, with similar impacts as identified for recirculation. Recirculation and interference effects are illustrated in Figure 8-1. Images from Alden's CFD analysis (included in Attachment 2) are provided as Figure 8-2 to demonstrate the prevalence of a low level cooling tower plume (indicative of cooling tower recirculation) at the conditions analyzed for the Tetra Tech configuration.

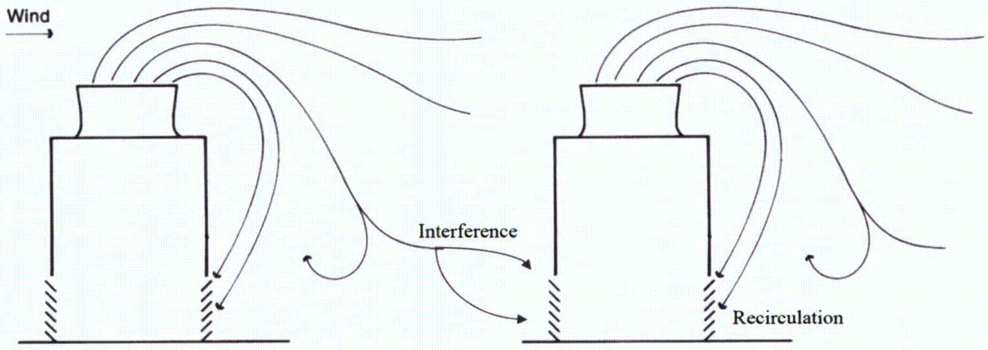

Figure 8-1: Tower Recirculation and Interference

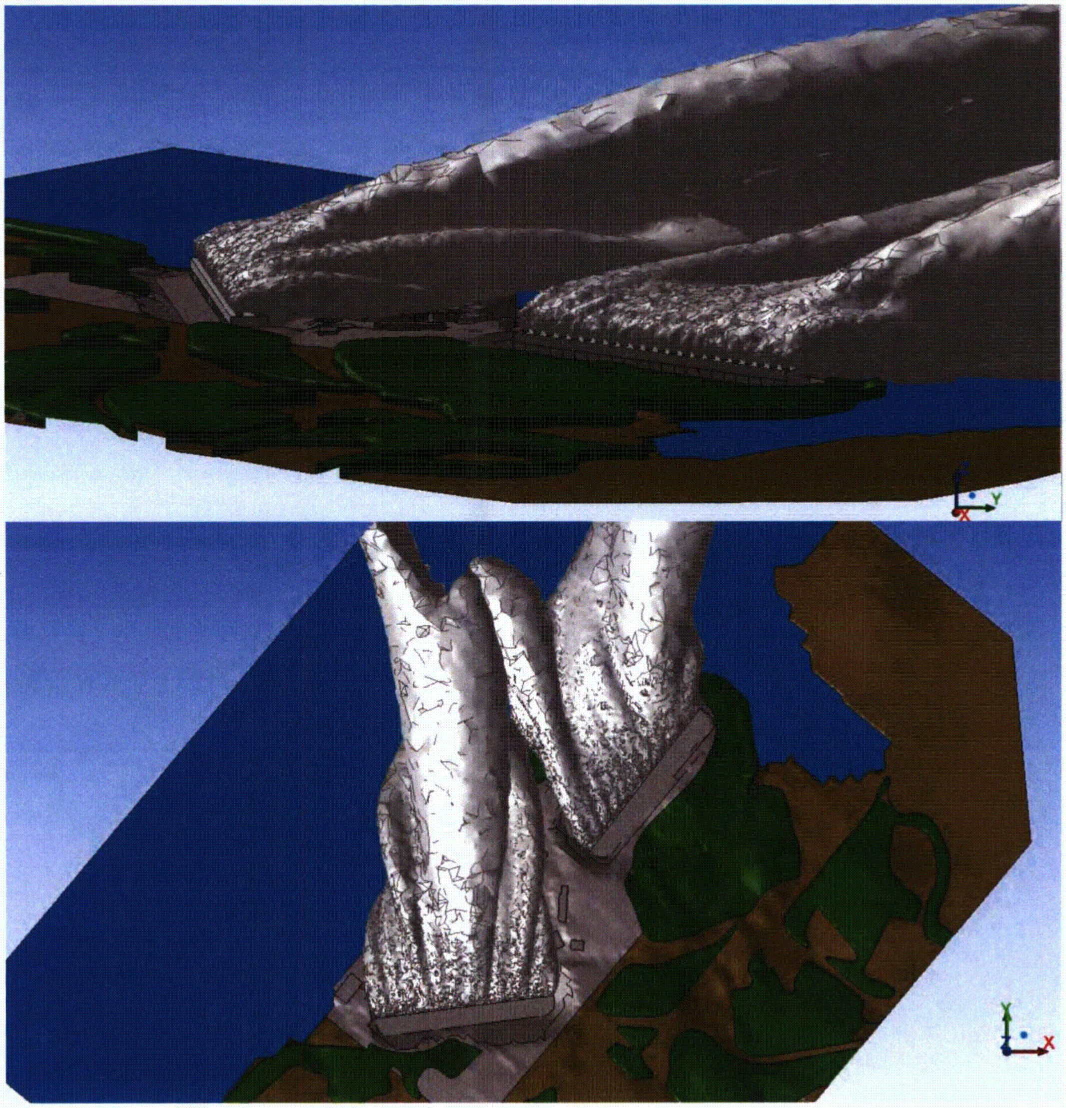

Figure 8-2: Plume of Gas at Wet Bulb Temperature of 79 °F and Greater with Wind from the South (Not Visible Plume); View from East (top), View from Above (bottom) (Figure 9 of Attachment 2)

8.2.2 Shape and Configuration

As air flows around an obstruction, a low-pressure zone forms on the downwind side of that obstruction. Air then rushes into that low-pressure zone by the shortest route possible. If the obstruction is relatively low, flat, and wide (e.g., a linear cooling tower such as ClearSky), the shortest route is over the top of the obstruction. Therefore, any broadside wind increases the potential for recirculation in a linear tower. For this reason, linear cooling towers must be carefully oriented with respect to the prevailing onsite wind. However, if the obstruction is round (e.g., a round cooling tower), the resulting downwind low-pressure zone is almost negligible from the streamlined flow around the obstruction (see Figure 8-2).

Therefore, the linear multi-cell cooling tower (e.g., ClearSky) will be more susceptible to wind direction with corresponding loss of efficiency due to recirculation. As wind direction varies from the primary axis of the linear multi-cell cooling tower, more recirculation will be created.

8.2.3 Air Discharge Velocity

At any given atmospheric condition, the cooling tower discharge plume velocity depends on the kinetic energy imparted by the fan, and the buoyant energy (decrease in density) imparted by the cooling tower heat load. The initial velocity and buoyancy of the cooling tower plume affects the rate at which it will rise above the tower. A plume of greater initial velocity and buoyancy rises more quickly and will be less susceptible to recirculation.

The potential for recirculation in a tower under specific wind conditions can be described by the recirculation ratio, which is the percent of total effluent air that is reintroduced into the tower air inlets through recirculation. The recirculation ratio is related to the velocity ratio, which is the plume discharge velocity (V_j) divided by the velocity of the ambient wind (V_a). At any given wind condition, the velocity ratio will decrease if the plume velocity is decreased, resulting in an increase in the recirculation ratio. As shown below, for a given velocity ratio ClearSky cooling towers will be subjected to higher recirculation than round hybrid towers (see Figure 8-3).

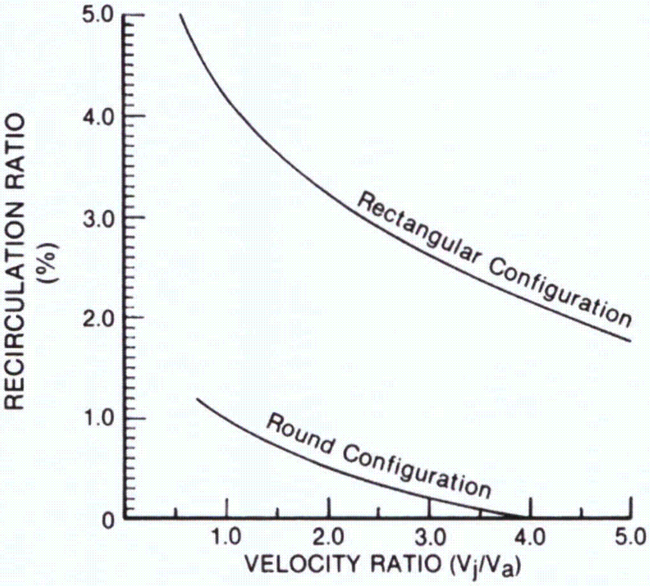

Figure 8-3: Recirculation Ratio/Velocity Ratio

8.2.4 Computational Fluid Dynamics

Using Computational Fluid Dynamics (CFD) analysis of IPEC including the proposed cooling towers, Alden (see Attachment 2) determined the increase in wet-bulb temperature due to recirculation at the inlet of the cooling towers of each Unit for the two most common wind directions (North northeast (NNE) and South (S)) at a wind speed of 2.12 m/s (average wind speed for data from 2004 to 2008) (Refer to Attachment 2 for the Wind Rose wind speed data). For the NNE direction (22.5° east of north), the results show that the wet-bulb temperature rise is 0.1 °F and 3.0 °F for Units 2 and 3, respectively (See Attachment 2). For the S direction (180° from north), the results show that the wet-bulb temperature rise is 1.8 °F and 1.9 °F for Units 2 and 3, respectively (see Attachment 2).

8.3 Response

As a result of the long linear multi-cell configuration of the ClearSky cooling towers, the towers would be subject to significant recirculation effects not addressed in the Tetra Tech report. These effects result in reduction in cooling tower performance and will result in operational power losses. The results show that the wet-bulb temperature rise is 0.1 °F and 3.0 °F for Units 2 and 3, respectively. For the S direction (180° from north), the results show that the wet-bulb temperature rise is 1.8 °F and 1.9 °F for Units 2 and 3, respectively. Alden's analysis was conducted at the two most frequent wind directions at the average site wind speed. Under conditions where the wind direction is closer to perpendicular to the cooling tower and/or wind speed is higher than the average site wind speed, recirculation effects would be increased.

In Section 2.2.8.1, (Page 16), Tetra Tech states that SPX/Marley provided an appropriate allowance for recirculation but no recirculation value was specified in Appendix A of the Tetra Tech report (Hatch Engineering Feasibility Study). Thus, Tetra Tech does not appear to have included recirculation in determining cooling tower sizing or operational power losses. Without specifying the recirculation value and bases for that value, the sizing and siting of the tower in relation to the prevailing wind direction cannot be validated.

9 Parasitic and Operational Power Losses

9.1 Statement of Issue

Tetra Tech's proposed closed-cycle cooling configuration would result in both parasitic and operational power losses. Parasitic loads are those associated with the tower operation (e.g., fans and pumps) and occur whenever the cooling towers are in operation. Operational power losses are those associated with reduced plant efficiency from warmer circulating water temperatures in closed-cycle cooling as compared to the current once-through cooling circulating water temperatures. Closed-cycle cooling operational power losses vary based on ambient wet-bulb temperatures, and increase substantially during warmer humid months. As identified in Section 8, recirculation effects increase the local wet-bulb temperature at the cooling tower, exacerbating operational power losses. The recirculation effects identified in Section 8, used to determine the operational power losses herein, were only conducted at the two most frequent wind directions at the average site wind speed. Under conditions where the wind direction is closer to perpendicular to the cooling tower and/or wind speed is higher than the average site wind speed, recirculation effects would be greater.

9.2 Parasitic Power Loss

Each cooling tower requires power to operate the mechanical fans above each cell, which Tetra Tech estimates will require 8.6 MWe per Unit. Power is also required to pump the circulating water from the newly created pump houses (located within the current discharge canal) up to the water distribution system within the cooling towers, which is estimated to require 11.6 MWe per Unit. Tetra Tech's estimated parasitic loss for Units 2 and 3 is 20.2 MWe per Unit, a combined total of 40.4 MWe.

9.3 Operational Thermal Efficiency Loss / PEPSE Model Analysis

The same methodology used in the ENERCON 2010 CCC report [Ref. 12.12] to determine the operational power losses was used to determine the operational power losses for ClearSky cooling towers including the effect of cooling tower recirculation. Appendix A of the Tetra Tech report (Hatch Engineering Feasibility Study) includes a quote from SPX listing the cooling tower performance at the design wet-bulb temperature of 77 °F, but does not include a cooling tower performance curve (i.e., the curve necessary to determine the approach to wet-bulb temperature over the range of anticipated wet-bulb temperatures).

Because both the round hybrid cooling tower discussed in ENERCON's 2010 CCC report and the ClearSky cooling tower selected by Tetra Tech have the same design point at a 77 °F air wet-bulb temperature with a 12 °F approach temperature (89 °F cold water temperature), have the same flow rate, and provide plume abatement, the ClearSky cooling towers are assumed to have the same performance curve as the round hybrid cooling towers used in Attachment 4 of the ENERCON 2010 CCC report [Ref. 12.12]. However, without a cooling tower performance curve specific to the ClearSky cooling towers selected, particularly given the novelty of ClearSky cooling towers, there is uncertainty as to whether the Tetra Tech selected cooling towers would operate with this performance.

A discussion of the CFD analysis and the results for the wet-bulb temperature rise is presented in Section 8.2.4. For wind directions closer to S than NNE (101.25° - 281.25°), the S wet-bulb temperature rises were added to the historical wet-bulb temperature for each Unit. For wind directions closer to NNE than S (0° - 101.25° and 281.25° - 360°), the NNE wet-bulb temperature rises were added to the historical wet-bulb temperature for each Unit. The net result is that all wet-bulb temperatures rise for each Unit, raising the cooling tower cold water temperature, and decreasing the operating power generation.

Input from the CFD was used in the PEPSE model analysis to generate the operational and recirculation losses. Table 9-1 below shows the average operational power losses on a monthly basis.

Table 9-1: Units 2 and 3 Average Closed-Cycle Cooling Operational Power Generation Losses

Month	Power Loss (MWe)	
	Unit 2	**Unit 3**
January	5.6	0.2
February	5.2	0.1
March	8.2	0.3
April	16.3	3.3
May	23.5	11.2
June	26.4	18.9
July	18.0	16.6
August	13.5	13.5
September	14.4	12.7
October	17.1	8.9
November	15.1	3.4
December	8.0	0.4

As shown in Table 9-1 above, the overall effect of a closed-cycle conversion on plant operation, examined using the methodology from Attachment 4 of the ENERCON 2010 CCC report [Ref. 12.12] and including the effect of cooling tower recirculation (See Attachment 2), would be an average continuous loss in power generation of approximately 14.3 MWe and 7.4 MWe for Units 2 and 3, respectively, for a total of 21.7 MWe. However, power loss would vary both seasonally, daily, and intraday depending on the difference between river water and ambient wet-bulb temperature. Intraday variability is significant as the ambient wet-bulb temperature changes from day to night. Information on typical intraday variations is provided in Attachment 4 of the ENERCON 2010 CCC report [Ref. 12.12]

Over the historical data analyzed (2001 – 2008), the peak[4] combined operational power loss of 97.1 MWe (PEPSE model result with Units 2 and 3 combined) would have occurred in June, when electricity demand is high. It is important to note that operational power losses provided in the table and text above are based on average wind conditions, and instances with increased wind velocity and/or more perpendicular wind directions to the cooling towers would result in increased recirculation, and thus increased operational power losses.

9.4 Response

In Section 2.2.8.1, (Page 16), Tetra Tech states that SPX/Marley provided an appropriate allowance for recirculation, but no recirculation value was specified in Appendix A of the Tetra Tech report (Hatch Engineering Feasibility Study). Thus, Tetra Tech does not appear to have included recirculation in determining cooling tower sizing or operational power losses.

As a result of the long rectangular configuration of the ClearSky cooling towers, these cooling towers would be subject to significant plume recirculation. Recirculation would have a direct adverse impact on the operational efficiency of the plant.

At conditions occurring in June, the combined peak operational and parasitic power losses of Tetra Tech's closed-cycle cooling configuration would be 137.5 MWe. This is approximately 15% higher than what Tetra Tech lists as the combined peak operational and parasitic power losses and represents a greater than 6% reduction in IPEC net power output, and would worsen under wind conditions resulting in increased recirculation.

As discussed in Section 3.3, the Indian Point Interim Decision states that a technology is only available if the impacts of a proposal on a facility will allow the facility to operate efficiently and can be effectively integrated without detrimental effect. The combined parasitic and operational power losses of the Tetra Tech closed-cycle cooling configuration will impact IPEC's ability to efficiently generate electricity, and as such the Tetra Tech configuration cannot be considered an available technology [Ref. 12.35].

[4] "Peak" is defined as the maximum operational power loss averaged over a 1-hour period for an increase in wet-bulb temperature due to recirculation at the average site wind speed (as measured from years 2004 to 2008).

10 Fiberglass Cooling Tower Design Constraints

10.1 Statement of Issue

The Tetra Tech proposed ClearSky cooling towers are fabricated from fiber reinforced plastic (FRP), fiberglass. Fiberglass cooling towers are susceptible to damage in high wind loading conditions (i.e., hurricane or tornado wind loading) [Ref. 12.26]. This section compares the design wind loading for IPEC structures against what is typically acceptable for fiberglass cooling towers, including whether or not the use of fiberglass cooling towers creates a new wind-generated missile design condition, and the susceptibility of fiberglass cooling towers to fire.

10.2 Design Constraints

10.2.1 Susceptibility to Wind Damage

ClearSky cooling towers are only available in fiberglass and are not typically designed against wind-generated missile loads. SPX can design the physical structure of a fiberglass cooling tower to withstand high wind forces; however, there may be damage that would prevent operation of the cooling tower after a high wind event.

Cooling Tower Fundamentals [Ref. 12.2] states for SPX cooling towers that *"A uniform wind load design of 30 pounds per square foot is standard, with higher values either dictated or advisable in some areas."* The SPX Marley Class F400 Cooling Tower Product Specifications[5] [Ref. 12.19] states the following about design wind loads:

"The tower and all its components shall be designed to withstand a wind load based on ASCE-7 and a seismic load based on UBC...Fan decks and other work levels shall be designed for a uniform load of 60 [pounds per square foot], or a concentrated live load of 600 [pounds] lbs. Allowable deflection at 60 psf shall be 1/180 of span. Fill and fill supports shall be capable of withstanding a 40 psf live load."

The specification further explains, *"The indicated design values are the minimum allowable under normal design standards. If your geographic location dictates higher wind load, seismic load, or deck loading values, please make the appropriate changes."*

The design criteria for IPEC (and any other U.S. Nuclear Plant) are far more restrictive than "normal design standards" [Ref. 12.18, Section 1.11.5]. The design of any SPX ClearSky Cooling Towers at IPEC would require design according to the site design criteria. However, as seen in the specification, the SPX Marley Class F400 cooling towers are typically not designed for enhanced wind loading.

It is not apparent that the design presented in the Tetra Tech report is designed for increased wind loading. Given that ClearSky cooling towers are a novel technology, which is much taller than traditional non-plume abated mechanical draft cooling towers, and thus more

[5] Section 2.2.1 of the Tetra Tech report proposes counter-flow mechanical draft cooling towers with plume abatement (F400 series/ClearSky). The primary construction material is fiber reinforced plastic (FRP).

susceptible to wind damage, structural analysis needs to be provided to validate that the towers meet the design criteria for IPEC.

10.2.2 Wind-Generated Missile Potential

Section 1.11.5 of the Indian Point Unit 2 UFSAR [Ref. 12.18] defines the two bounding wind-borne missiles considered for safety-related equipment. These design basis wind-borne missiles were compared to the impact due to a single fan blade off of a 28 ft HP7000 fan from SPX, which is the standard fan used for the ClearSky cooling tower. Preliminary comparative analysis indicates that more detailed analysis is required to determine whether the ClearSky cooling tower fan blade constitutes a new bounding condition that would need to be considered for wind-borne debris.

10.2.3 Susceptibility to Fire Damage

Fiberglass cooling towers are more susceptible to fire than concrete cooling towers and require a sprinkler system. A fiberglass cooling tower like the ClearSky model installed at a nuclear power plant would typically include a sprinkler system. This would add cost and complexity to the project, and prolong the implementation schedule. The potential need for additional protection for a fiberglass cooling tower was not addressed in the Tetra Tech report. Even with the sprinkler system, installation of fiberglass cooling towers like the ClearSky model involves a greater risk of fire than concrete cooling towers.

10.3 Response

The Tetra Tech report does not address the structural susceptibility of fiberglass cooling towers to wind damage, wind-generated missiles, or fire. A fiberglass cooling tower at IPEC must be designed according to site criteria, which will present design and constructability challenges not discussed in the Tetra Tech report.

Significant new equipment and structures, like the fiberglass ClearSky cooling towers proposed by Tetra Tech, have the potential to introduce a new missile case. It is not known if this new wind-generated missile case will exceed the current site design basis because sufficient information was not provided in the Tetra Tech report. Detailed analysis must be conducted to eliminate this potential design concern.

The potential risk of fire needs to be properly factored into the specification of the type of cooling tower and the subsequent design.

11 Conclusions

Tetra Tech's conceptual design does not provide sufficient information to resolve the challenges, several identified by Tetra Tech as "potential fatal flaws" [Ref. 12.1, p. 28], of ClearSky cooling towers or the significant adverse impacts of the closed-cycle cooling configuration presented in the Tetra Tech report in order to support a feasibility conclusion on a site-specific basis for IPEC. Tetra Tech's report does not contain the level of engineering design information presented in ENERCON's 2003 CCC report [Ref. 12.4]. Subsequently, ENERCON conducted additional engineering design and determined in ENERCON's 2010 CCC report that several additional design issues would challenge the feasibility of a closed-cycle cooling retrofit at IPEC [Ref. 12.12]. It is expected that Tetra Tech would similarly identify additional challenges to feasibility if they performed a more detailed engineering design.

ENERCON has concluded, based on the available information, that Tetra Tech's closed-cycle cooling configuration cannot be considered feasible at IPEC. As discussed at length in ENERCON's 2010 CCC report, conversion of operating nuclear stations to a closed-cycle cooling configuration is unprecedented, and at IPEC represents an incredibly complex engineering and construction undertaking, with significant uncertainty around the cost, schedule, and forced outage duration required. Large scale construction activities at nuclear power plants have routinely experienced significant construction schedule overruns, and conversion to closed-cycle cooling at IPEC may consume the entire license renewal period [Ref. 12.31].

Retrofitting to closed-cycle cooling with ClearSky cooling towers is even more challenging as a function of the technology selected, including its defining attributes and the siting configurations that Tetra Tech has proposed. First, ClearSky cooling towers employ a novel technology with limited operating experience on only one in-line cooling tower cell, and no operating experience in the back-to-back configuration proposed by Tetra Tech. This lack of operational history typically would eliminate ClearSky Cooling Towers from serious consideration at a large baseload plant such as IPEC. Large baseload power plants are essential power sources and provide grid stability, and as such, reliable long term operation is essential and must be an important element of the decision process. This is because nuclear and electric-system reliability considerations caution against the adoption of novel technologies for large-scale facilities, particularly those facilities that are dedicated, essential power sources for a major metropolitan area. Proven technology is always preferred. Second, conversion to a closed-cycle cooling configuration would represent an incredibly complex and difficult engineering and construction undertaking. Conversion to closed-cycle cooling with ClearSky cooling towers would involve additional design, construction and installation, and operational risk for IPEC, none of which Tetra Tech has resolved in a manner that demonstrates feasibility.

The identified feasibility issues and operability concerns of the Tetra Tech closed-cycle cooling configuration on an IPEC site-specific basis, , based on the information provided in the Tetra Tech report, are summarized below.

<u>Feasibility Issues</u>

- Cooling Tower Siting Conflicts: Based on Entergy personnel walkdown observations and review of Figure 3-3 in the Tetra Tech report, the proposed cooling towers impact several existing structures, including essential structures and components, the independent spent fuel storage installation, structures and components containing radionuclide material, and

IPEC site security. The Tetra Tech report offers no plan to resolve these conflicts and several essential components are inexplicably displaced with no mention of the impact to the plant's ability to function. The proposed design compromises the plant's ability to generate power as well as its safe and secure operation. Tetra Tech did not address whether these structures are capable of being moved. If capable of being moved, Tetra Tech did not account for the cost and schedule impacts of doing so. The number and significance of the siting conflicts unresolved by Tetra Tech's report would result in a detrimental effect to IPEC, and as such the Tetra Tech cooling tower configuration cannot be considered an available technology as defined in the Indian Point Interim Decision [Ref. 12.35].

- Algonquin Pipeline Considerations: Tetra Tech does not contest the impact of a Unit 3 cooling tower on the Algonquin pipeline, but provides no details for resolution of the conflict. It is not feasible to conduct construction involving blasting directly on top of and around active gas pipelines. Tetra Tech neither acknowledged, nor evaluated the proposed expansion of the pipelines currently planned by the pipeline owner. Attachment 6 of ENERCON's "Engineering Feasibility and Cost of Conversion of Indian Point Units 2 and 3 to a Closed-Loop Cooling Water Configuration" [Ref. 12.12] highlights the difficulties of relocating the pipeline. Given the increased footprint of Tetra Tech's configuration compared to the round hybrid cooling tower presented in the 2010 report, the impacts would have more extensive effects, as well as affect cost and schedule, which were not discussed in the Tetra Tech report.

- Power Transmission Line Impacts: Tetra Tech's proposed cooling tower location directly interferes with the overhead 345 kV main transmission lines (and one of the towers) to the power grid and the 138 kV auxiliary power lines from the Buchanan Substation to the station. The relocation of these lines (with appropriate clearances) and any underground control cables and the cost are not addressed in the Tetra Tech report. See Attachment 1, Figure 2 of this response, Transmission Line Overlay on Tetra Tech Proposed Indian Point Closed-Cycle Cooling Configuration.

- Radionuclide Management: Tetra Tech acknowledged in its report that evaluation and management of the radionuclide conditions was necessary along the riverfront in order to determine feasibility, and has not yet been performed. Tetra Tech states on page 28 of their report, "If an acceptable method cannot be identified, construction and excavation could not proceed in this area, which is where the CT2 [Unit 2 cooling tower] pipe corridor would be sited. In this case, the proposed Unit 2 retrofit would be infeasible."

- Closed-Cycle Cooling Retrofit Impact on Condenser: Tetra Tech did not perform any transient or accident analysis for IPEC post closed-cycle cooling retrofit. A review of the transient and accident analysis is necessary for any significant plant change to ensure that there are no potential impacts to the operation of a nuclear power plant. BREI reviewed one transient condition in their report, identifying that the increased condenser backpressure would be higher than the low vacuum alarm setpoint during a high pressure steam dump at Unit 3, which would be in excess of the operational limits and would trip the Unit. The BREI analysis was limited to one transient condition and emphasizes the need to identify and resolve any impacts the transient or accident analysis before concluding the feasibility of such a significant plant modification.

Also several calculations, drawings, technical specifications, and procedures associated with the piping system will be affected by this change which will affect the cost, design and construction schedule. Substantial design detail is currently missing; for example, the Tetra Tech closed-cycle cooling configuration introduces the need for a thrust block at the tie-in points to existing piping, which is not addressed in the Tetra Tech report.

Operational Concerns

- Site Impacts of Cooling Tower Plume: ClearSky towers discharge plumes at lower velocities, at lower height, and with less thermal buoyancy than round hybrids. For these reasons, the ClearSky towers have more concentrated and localized plumes at ground level, thus increasing salt deposition, temperatures, and humidity in close proximity to the towers which could adversely impact electrical equipment. Specifically, the close proximity of the cooling towers to the power blocks and electrical transmission facilities, creates a known risk of electrical arcing (discharge of current through air) in the switchyard. This is a workplace hazard and may lead to a reactor scram (or shutdown of the nuclear reactor) resulting in forced outages, the implications of which Tetra Tech has not evaluated and may substantially impact electric-system function.

- Cooling Tower Recirculation Effects: As a result of the long rectangular configuration of the ClearSky cooling towers as sited by Tetra Tech, the ClearSky cooling tower would be subject to significant recirculation. Recirculation would have a direct adverse impact on the operational efficiency of the plant. Over the historical meteorological data analyzed (2001 – 2008), the peak combined operational power loss would be 97.1 MWe and would have occurred mid-afternoon in June when the electricity demand is high. At these peak conditions, the combined parasitic and operational power losses of Tetra Tech's closed-cycle cooling configuration would be 137.5 MWe. This is approximately 15% higher than what Tetra Tech lists as the combined peak operational and parasitic power losses and represents a greater than 6% reduction in IPEC net power output, and would worsen under wind conditions more conducive to recirculation.

- Fiberglass Cooling Tower Design Constraints: The Tetra Tech report does not address the known structural susceptibility of fiberglass cooling towers to wind damage, wind-generated missiles, and fire. Significant new equipment and structures, like the fiberglass SPX ClearSky cooling towers proposed by Tetra Tech, have the potential to introduce a new missile case. Since it is not known if this missile case will exceed the current site design, detailed analysis and potentially configuration changes must be conducted to eliminate this design concern.

- Permitting and Potential Fatal Flaws: Tetra Tech acknowledges in Section 3.1 on page 27 of its report that the permitting process is "likely to be contentious" and "further notes that the uniqueness of a closed-cycle retrofit at an active nuclear facility makes it problematic to draw direct comparison with other retrofit projects." Tetra Tech will need to address the feasibility issues and operational concerns identified in this response and may uncover additional fatal flaws or need to re-evaluate those currently identified.

Considerations that may affect Tetra Tech's cooling tower sizing and are unmentioned in the Tetra Tech report include the following:

1. Tetra Tech did not identify in its report the type of fill material and/or address fill degradation impact overtime for the proposed ClearSky cooling towers.
2. Tetra Tech did not provide any transient or accident analysis in the report to determine what the proposed closed-cycle cooling retrofit would have on the operation of IPEC, nor did Tetra Tech incorporate the expected cooling tower recirculation effects.

Increasing the number of cooling tower cells to address these issues would increase the impacts noted in the feasibility issues and operability concerns above and would result in additional excavation, pipe routing, and likely introduce new feasibility issues or operability concerns.

In sum, the novelty of the ClearSky cooling tower, feasibility issues, and operability concerns listed above are unresolved by Tetra Tech, and as such the configuration as presented in the Tetra Tech report cannot be considered feasible. The cost and implementation schedule, which would need to be adjusted to account for the feasibility issues and operational concerns identified above, would also likely be impacted by significant schedule overruns typical of large scale construction activities at nuclear power plants.

The Powers Engineering report and supplemental information does not provide a reasonable engineering review and technology evaluation insomuch as it lacks essential detail required to establish feasibility. Riverkeeper's selected cooling tower configuration would result in increased circulating water temperature and reduced flow rate, which would impact IPEC's ability to generate electricity and may exceed condenser operational limits during both normal and transient conditions. The Riverkeeper selected closed-cycle cooling configuration would utilize a circulating water flow rate of 600,000 gpm, approximately 29% less than the current IPEC circulating water flow rate of 840,000 gpm. Without sufficient evaluation to conclude that condenser operational limits will not be exceeded, the Riverkeeper selected closed-cycle cooling configuration cannot be considered feasible. For these reasons, the Powers Engineering report and Riverkeeper selected closed-cycle cooling configuration is only briefly discussed in this response; however, an assessment of the difference in operational power losses between the Tetra Tech and Riverkeeper configurations at design wet-bulb temperature and a discussion of the engineering design required for technology selection is provided in Attachment 4.

12 References

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12.4 Enercon Services, Inc. Economic and Environmental Impacts Associated with Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water Configuration. Kennesaw, GA. June 2003.

12.5 Brown, R.E., Electric Power Distribution Reliability, Second Edition 2009, Page 127.

12.6 Indian Point Energy Center, IP-RPT-06-AMM15, IPEC Aging Management Review Report, Rev. 2.

12.7 NRC Information Notice 93-95: Storm-Related Loss of Offsite Power Events Due to Salt Buildup on Switchyard Insulators.

12.8 Indian Point Energy Center, Unit 3, 9321-05-45-12, Specification for Roughing, HEPA and Carbon Filter for Containment Building Purge System, Primary Auxiliary Building Exhaust System, Fuel Storage Building Exhaust System, Control Room Air Conditioning System, Containment Building Iodine Removal System, 1972.

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12.10 Consolidated Edison Company of New York, Inc. Economic and Environmental Impacts of Alternative Closed-Cycle Cooling Systems for Indian Point Unit 2, Volume No. 1. December 1, 1974.

12.11 Enercon Services, Inc. Evaluation of Alternative Intake Technologies at Indian Point Units 2 & 3, February 12, 2010.

12.12 Enercon Services, Inc. Engineering Feasibility and Costs of Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water Configuration, February 12, 2010.

12.13 TRC Figure on Salt Deposition across IPEC from Tetra Tech CCC Configuration (Attachment 1, Figure 3).

12.14 Alden Research Laboratory, Inc., CFD Analysis to Determine Cooling Tower Recirculation Effects (Attachment 2).

12.15 Enercon Services, Inc. Phase IB Archeological Investigation of Potential Cooling Tower Construction Sites at Indian Point Energy Center, Westchester County, New York. July 2009.

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12.22 Indian Point Energy Center, Calculation FCX-00087, Rev. 1, "Determine Stress On Buried, Pressurized Steel Pipe With Concentrated Load On Grade."

12.23 Autodesk, AutoCAD Civil 3D, Civil Engineering Design Software.

12.24 Code of Federal Regulations, 18 CFR Part 380.12, "Conservation of Power and Water Resources: Regulations Implementing the National Environmental Policy Act: Environmental Reports for Natural Gas Act Applications," February 2012.

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12.26 Teleconference Memo between Enercon Services, Inc., Entergy – Indian Point Energy Center, and SPX Cooling Technologies, Inc., occurred August 20, 2013, "Indian Point Cooling Tower Discussion."

12.27 John Cooper and Associates, P.A., Cooling Tower Thermal Upgrade Projects 2003 Update.

12.28 Powers Engineering, "Revised Closed Cycle Cooling Feasibility Assessment for Indian Point Energy Center Unit 2 and Unit 3 for Best Technology Available Report," for Riverkeeper, Inc., October 24, 2012.

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12.31 Yamayee, Zia A., and Anderson, David V., "Nuclear Unit Construction / Fuel-Loading Duration," IEEE Transactions on Power Apparatus and Systems, Vol. PAS-201, No. 12, December 1983.

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12.35 State of New York Department of Environmental Conservation, "Entergy Nuclear Indian Point 2, LLC and Entergy Nuclear Indian Point 3, LLC (SPDES) – Interim Decision," August 13, 2008.

12.36 Nuclear Energy Institute, "Regulatory Assessment Performance Indicator Guideline," NEI 99-02 Revision 7, August 31, 2013.

12.37 Spectra Energy, "Algonquin Incremental Market (AIM) Project – Fact Sheet," September 25, 2013.

ATTACHMENT 1

Figures

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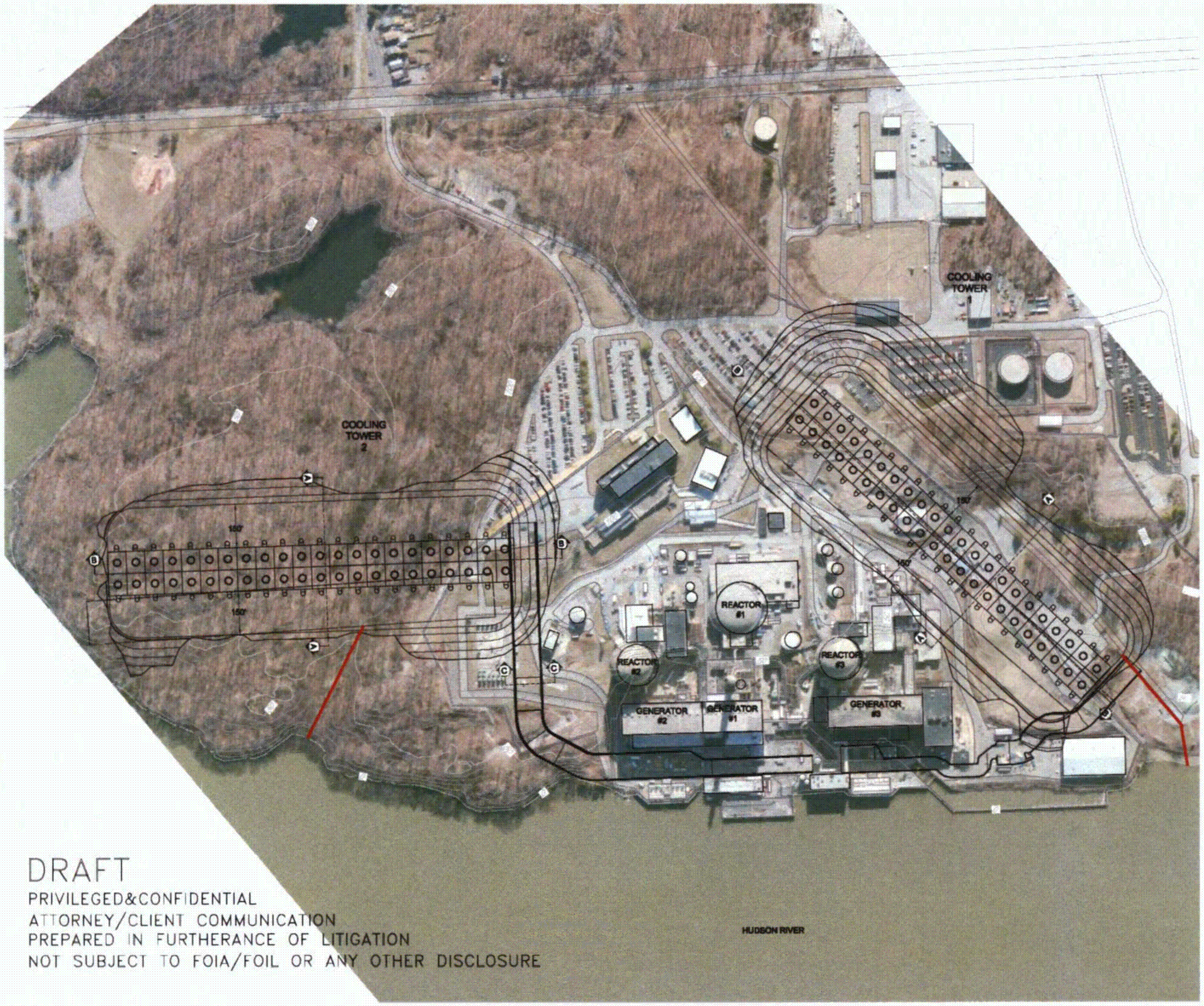

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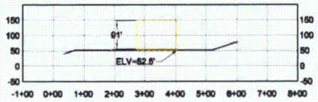

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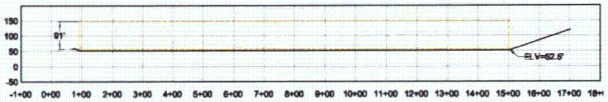

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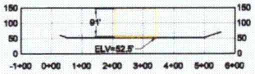

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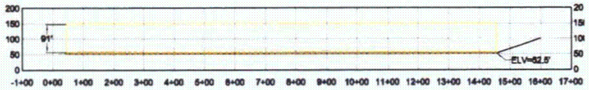

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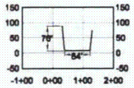


TYPICAL CORRIDOR SECTION
GRADING SECTION - C
N.T.S.

VOLUMES			
NAME	CUT (Cu.YD.)	FILL (Cu.YD.)	NET (Cu.YD.)
COOLING TOWER 1	1,077,835	37,473	1,040,367 CUT
CORRIDOR 1	86,839	0	86,839 CUT
COOLING TOWER 2	576,400	13,929	562,471 CUT
CORRIDOR 2	316,121	0	316,121 CUT

SCALE
200' 0 200' 400'
CONTOUR INTERVAL 10'

REFERENCE	ENGINEER'S SEAL	REVISIONS (Rev / Description / BY / Date)	Scale: Designed by: Drawn by: Checked by: Approved by:	Issued for:	Issued by: TETRA TECH	Project: Project no. Location: Date:	REVISION	Figure 3-3 SHEET OF

TETRA TECH
350 Indiana Street, Suite 500
Golden, Colorado 80401

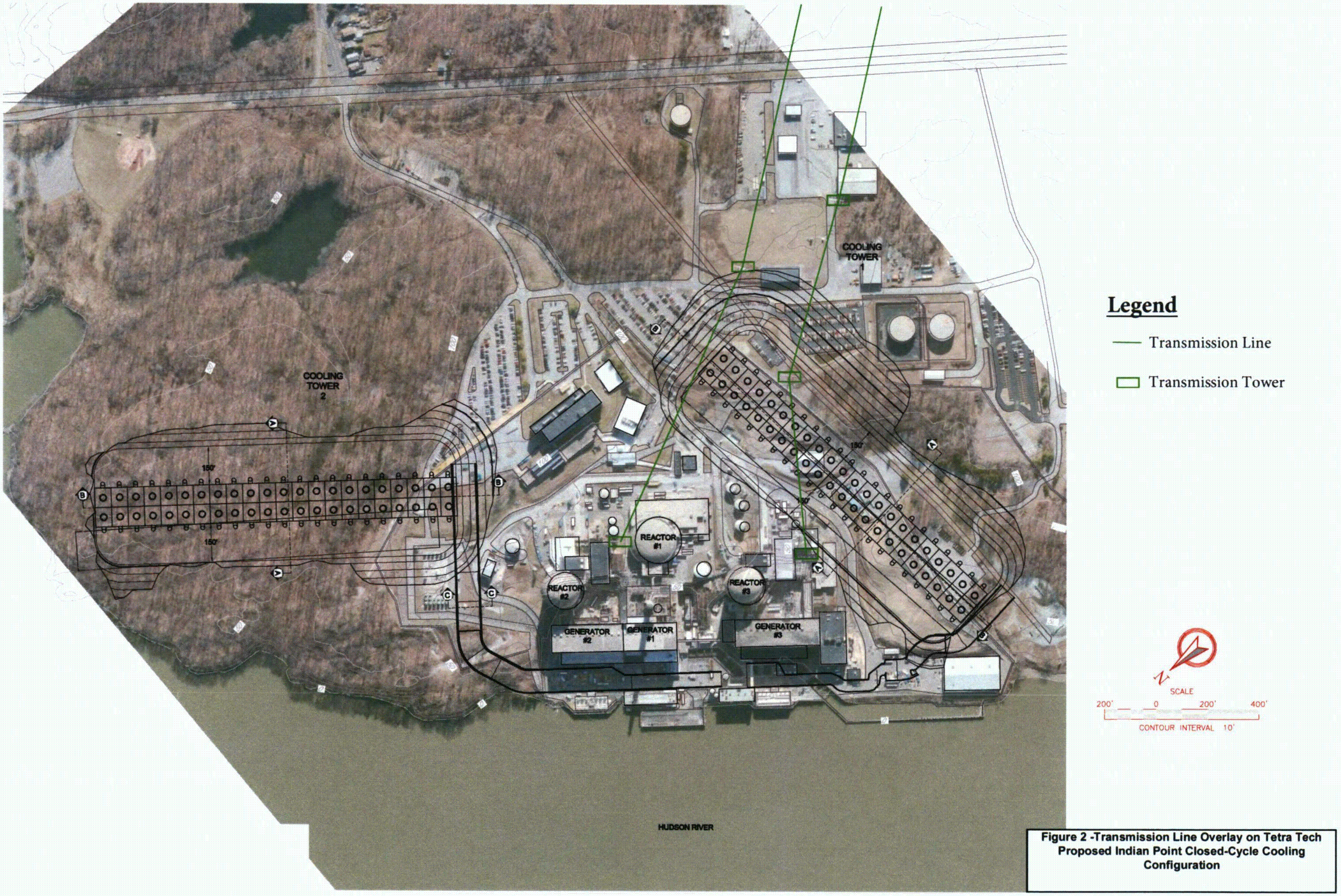
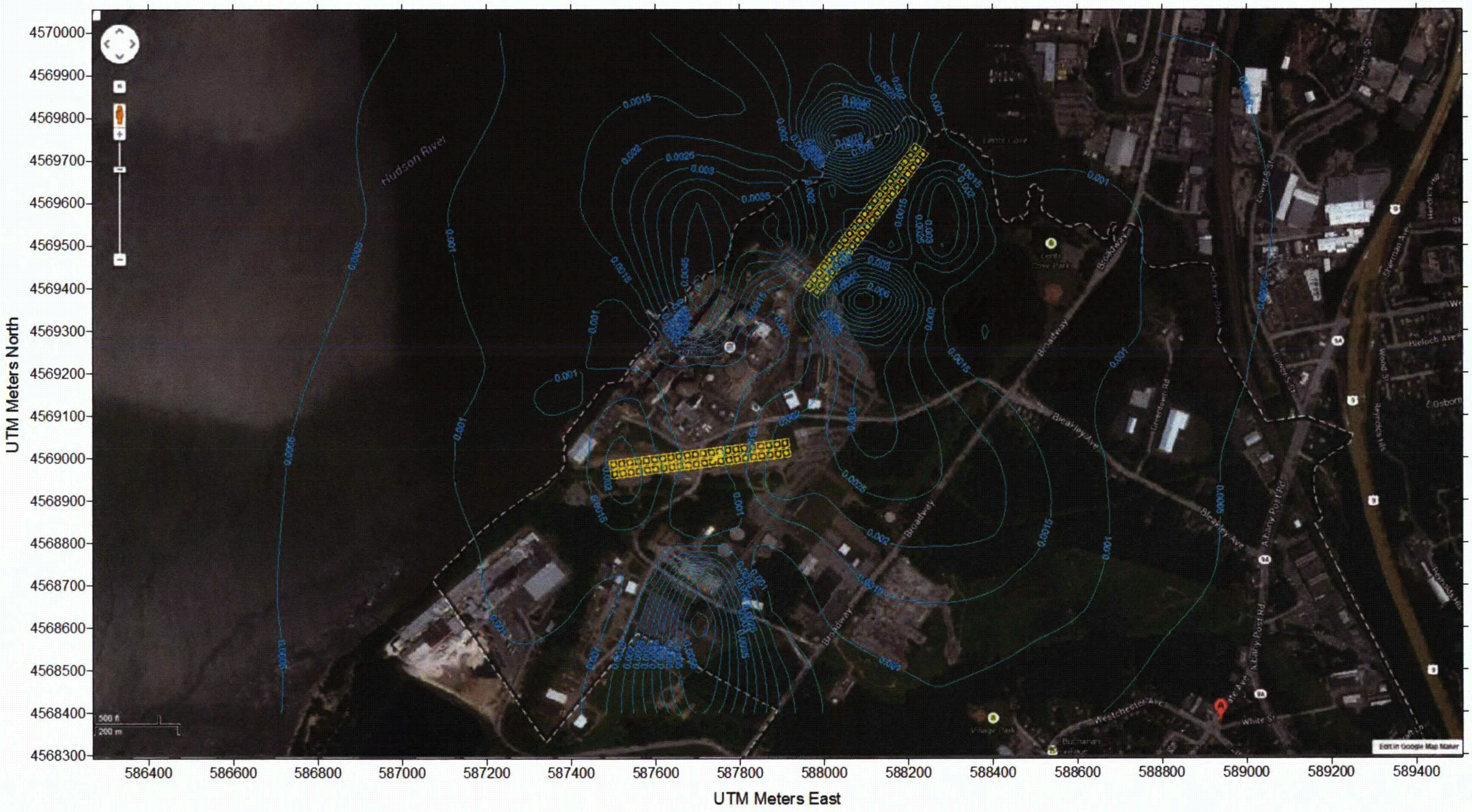


Figure 2 -Transmission Line Overlay on Tetra Tech Proposed Indian Point Closed-Cycle Cooling Configuration

Salt Deposition TetraTech Clearsky Towers for Units 2 & 3 - (mg/cm2/month)
0.001% Drift with 11,010 ppm maximum basin salinity



ATTACHMENT 2

Alden Computational Fluid Dynamics (CFD) Analysis to Determine Cooling Tower Recirculation Effects