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# *Memorandum*

To: David Gordon, Esq. and Reed Super, Esq.

From: David Schlissel, David White and Geoff Keith

Date: November 3, 2003

***Subject: Entergy's Lost Revenues During Cooling System Conversion-related Outages***

The June 2003 Enercon Services study "Economic and Environmental Impacts Associated with Conversion of Indian Point Units 2 and 3 to a Closed-Loop Condenser Cooling Water Configuration," ("Enercon Study") claims that converting both Indian Point units would lead to Entergy's loss of nearly $630 million dollars in revenues during a simultaneous two unit outage in 2008. However, for the reasons explained in this memorandum, we believe that the Enercon study grossly overstates the lost revenues that Entergy would experience during the conversion-related outages.

In particular, based on an assessment by Powers Engineering, EPA estimates, trends in nuclear power plant outages, and fossil-fired plant experience, it appears that the conversion to a closed-loop cooling system, at most, would require several months of outage time to hook up each Indian Point unit to the new system. Conservatively, this might mean one month or two months of additional plant downtime in addition to a normal one-month long refueling outage. The lost revenues resulting from a one-month net conversion-related outage would be only $55 million, significantly less than the $630 million figure estimated by Enercon. The lost revenues from a two-month net conversion-related outage would be only $110 million.

## Cooling System Conversion Outage Durations – Enercon Study

Enercon claims that completion of the conversion would require a 42 week forced outage with both units shut down. Enercon also estimates that the duration of the lost generating capacity for the two units would be 38 weeks, assuming a normal 28 day refueling outage. Although Enercon claims that these estimates are "likely greatly conservative" we believe that they significantly overstate the necessary amount of time that each Indian Point unit would have to be shut down to allow the completion of the conversion to closed-loop cooling systems.

In fact, Enercon does not present any real evidence to support its claim that both Indian Point units would have to be shut down for simultaneous 42 week (i.e., 9.7 month) outages. At most, Enercon presents a series of Gantt Charts that show the duration of what it believes would be major outage tasks. But Enercon presents no evidence to show that its claimed durations for each of these tasks are reasonable. Nor does it discuss the levels of resources applied to these tasks and whether the tasks could be completed in less time if additional resources were available. In addition, Enercon presents no evidence that the major construction tasks which it says would have to be performed during the outage could not be completed while either or both units are in operation. Finally, Enercon does not present any evidence showing that its proposed design for the new closed-loop cooling system is optimal either in terms of cost, outage time, efficiency or constructability. Without such evidence, the Enercon schedule estimates are not credible.

**Cooling System Conversion Outage Durations – 1999 Study for Con Edison and NYPA**

By way of comparison, a 1999 Study by PowerTech for Con Edison and NYPA, who were the owners of Indian Point 2 and Indian Point 3 at that time, estimated that both units would have to be shut down for four months at the beginning of the project (during blasting activities) and for another four months at the end – in order to connect the new cooling towers and associated equipment. Assuming a one-month average refueling outage duration for each Indian Point unit, this would mean a total of 6 months of additional outage time for each unit as a result of conversion related work.[1] Such outages could be accommodated during the non-summer months, which would significantly reduce Entergy's lost revenues.

It is important to recognize that the 1999 PowerTech study assumed that there would be significant blasting required at the start of the construction of the new closed-loop system. However, Powers Engineering has identified several retrofit options that would require little or no blasting. Consequently, the 1999 PowerTech study would suggest that, at most, each Indian Point unit only would have to be shut down for three months beyond its normal refueling outage to complete the conversion-related hookup of the new towers and associated equipment.

**U.S. EPA Assessment of Cooling System Retrofit Outage Duration based on Experience at the Palisades Nuclear Power Plant in the years 1973 and 1974**

The U.S. Environmental Protection Agency ("EPA") has estimated the net downtime for retrofitting cooling towers at a nuclear power plant. The EPA originally estimated this net downtime as four weeks but later revised this estimate to seven months.[2] This revision was based solely on the claimed experience at one project: the addition of

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1 In this scenario, each Indian Point unit would be shut down for two four-month outages. Since each outage could be planned to coincide with a refueling outage, the additional duration of each outage attributable to cooling system conversion-related activities would be three months. Consequently, Indian Point Units 2 and 3 would each be shutdown for an extra six months for conversion-related outages.

2 Federal Register, Vol. 68, No. 53, at page 13525.

cooling towers at the Palisades nuclear power plant in 1973/1974. We do not believe that this change is justified for the following reasons.

First, the EPA relied solely on what appears to be inaccurate information from Consumers Power Company, the owner of the Palisades plant:

> Based upon a site review of engineering, accounting and purchasing documents, we [i.e., Consumers Power Company] can infer that the conversion process spanned over a period from mid-1971 to May of 1974 when the cooling towers became operational. It appears that the outage time for the conversion took about 10 months from August 1973 to May 1974.[3]

Consumers Power also told the EPA the there were several maintenance-related tasks performed during Palisades' 1973/1974 extended outage. Nevertheless, Consumers Power claimed that "it appears that the outage was primarily for the purpose of installing the new circulating water system and the modifications necessary for its operation."[4]

We have reviewed contemporaneous nuclear industry and regulatory documents from 1973 and 1974. Contrary to what Consumers Power has told the EPA, it appears that the extended outage of the Palisades nuclear plant was primarily due to factors other than the installation of the new circulating water system and related modifications.

For example, the NRC has reported the following concerning Palisades August 1973 to April 1975 outage:

> An outage was initially estimated for 3 months to repair [the plant's steam generators]. Internal reactor problems and a waste gas release investigation prolonged the outage into 1974. The new cooling towers were completed and placed in operation and the turbine-generator was overhauled.... [Consumers Power] filed a suit against several vendors for startup problems with the condenser, [steam generators], and core internals. Turbine repairs and condenser-retubing extended the outage even further.[5]

According to an article in the October 1974 issue of Nuclear News, Consumers Power had said that the outage was "due principally to steam generator corrosion and damage caused by vibration of the reactor core internals, as well as defective main condenser design and tubing." As a result, Consumers Power sued Bechtel Corporation and four other companies who helped to build the Palisades nuclear plant because "equipment supplied [in 1966 and 1967] was defective" and that defective equipment had not been promptly and adequately repaired.[6]

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[3] Palisades Plant DCN#4-2529.

[4] Palisades Plant DCN#4-2529.

[5] NRC "Nuclear Power Plant Operating Experience Summary," NUREG/CR-6577, at page 243.

[6] *Nuclear News*, October 1974, at pages 59 and 60.

This information suggests that the Palisades plant remained shutdown during the period August 1973 through May 1974 (and, in fact, into 1975) as a result of serious problems unrelated to the installation of the new circulating water system and related modifications. Unfortunately, the EPA does not appear to have verified or confirmed what it was told by Consumers Power. Instead, it increased the additional plant downtime for a cooling tower retrofit by roughly 600 percent (from four weeks to seven months).

Second, even if work on the installation of the new circulating water system and related modifications began in August 1973 and was completed in May 1974, this work may well have been completed in less time if it had been the most critical work during the outage. For example, our review of more than 100 power plant outages has revealed that critical path projects are frequently worked seven days a week and sometimes 24 hours a day. Unfortunately, Consumers Power has not provided any information to enable the EPA or anyone else to determine whether the installation of the new circulating water system and related modifications was worked on such a schedule. Indeed, other, more critical projects during the 1973/1974 Palisades outage might have diverted management, engineering and manpower resources from the cooling tower retrofit and/or might have made the retrofit more difficult and, therefore, longer.

In addition, there is no evidence that the installation of the new circulating water system was even worked every day during the period August 1973 through May 1974. There may have been significant periods when little or no work was being performed on this project.

For this reason, it is unreasonable to judge how long a cooling tower retrofit project might now take at existing nuclear power plants based on at the start and finish dates at Palisades in 1973 and 1974.

**Trends in Nuclear Power Plant Outage Durations**

For a number of reasons, including improved outage management and planning, nuclear power plant outages have been significantly shorter in recent years than they were back in the 1970s, 1980s and even the early 1990s. Therefore, the amount of time it took to retrofit cooling towers at the Palisades nuclear power plant 30 years ago is not persuasive evidence of how long it would take to complete similar work at nuclear power plants today.

For example, the durations of refueling/maintenance outages at nuclear power plants have been significantly reduced during the past decade: the median duration of nuclear power plant refueling outages was 83 days in 1989 and 78 days in 1990.[7] The median duration of refueling outages was reduced to 40 days by the first half of 1999[8] and 32 days by the first half of 2002.[9] Similar improvements can be expected in the amount of additional plant downtime that would be required for the installation of cooling towers and related plant modifications at nuclear power plants.

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7 *Power*, Vol. 139, No. 12, January 1996, at page 39

8 *Nucleonics Week*, August 19, 1999, at page 1.

9 *Nucleonics Week*, October 10, 2002, at page 1.

The durations of nuclear power plant repair/maintenance outages to complete major, non-routine maintenance activities also have decreased dramatically since the 1980s and early 1990s. For example, steam generators are major pieces of equipment in pressurized water reactor nuclear power plants like Indian Point Units 2 and 3. These steam generators are located in the very heart of the power plant's containment, along with the reactor vessel and other related plant components. The original steam generators installed in almost every pressurized water reactor have had to be replaced due to tube degradation.

Replacing a steam generator is a major modification at a power plant. The old steam generators, which often weigh tens of tons, have to be removed from the plant's containment and the new steam generators installed in their place. Tolerances for moving steam generators out of and into containment buildings are very tight. In a number of instances, holes have had to be cut in the walls of the containment buildings to allow the removal of the old steam generators and the entrance of the new equipment. In other instances, the steam generators have been cut into several pieces to fit through existing equipment hatches.

The first steam generator replacement outages, at the Surry nuclear power plants in Virginia and the Turkey Point plants in Florida, lasted for 150 – 260 days, i.e., five to nine months. The durations of steam generator outages have decreased over time, however, with outages in the mid-1990s lasting only 70 to 100 days, an improvement of 50 percent to 66 percent over the durations of the initial steam generator replacement outages. More recent steam generator replacement outages have lasted approximately 70 to 90 days.

Although outage durations depend on plant specific designs and circumstances, similar improvements can be expected in the amount of additional plant downtime that would be required for the installation of cooling towers and related plant modifications at Indian Point as compared to the ten months claimed for the Palisades nuclear power plant back in 1973/1974.

**Cooling System Conversion Outage Durations – Fossil Plant Experience**

Enercon claims that the changes that would be involved in the conversion to the closed-loop cooling system "involve the very heart of the plant."[10] Although it is correct that cooling systems are important, it is not true to claim they involve the very heart of a nuclear power plant. The changes that would be involved in converting to a closed-loop cooling system and retrofitting cooling towers would not involve the nuclear-related facilities inside the units' containment buildings or their spent-fuel pool related equipment. Instead the modifications would be on the non-nuclear side of the plants. Therefore, the experiences of converting to closed-loop cooling systems at fossil-fired plants provide insight into how long such conversions might be expected to take at Indian Point.

According to the EPA's 316(b) Phase II Technical Development Document, Units 1 and 2 at the Canadys Station in South Carolina were each shut down for four weeks in 1992

[10] Enercon Study, at page ii.

in order to complete the hookup of its new cooling towers.[11] The Jefferies Coal Station, also in South Carolina, was shut down in 1983 for one week for the hookup of the new closed-loop cooling system.[12]

In addition, recent studies prepared for the EPA examined the costs and reliability impact of converting the Brayton Point fossil facility to closed cycle system with cooling towers. The units at Brayton Point have a total of 1,500 MW of capacity. Based on a detailed construction review, these studies project that each of Brayton Point's individual units would be shut down during the conversion process for an outage of four months in duration.[13]

**Conclusion Concerning Outage Durations**

The expected duration of the conversion-related outages at Indian Point Units 2 and 3 need to be determined based on an objective site-specific engineering assessment. However, based on the assessment by Powers Engineering, EPA analyses, trends in nuclear power plant outage durations, and the experience at fossil-fired units, we believe that the 42 week outages (38 week net of refueling) claimed by Enercon are unreasonable. It is more reasonable to expect that each Indian Point unit would have to be shut down for no more than one or two additional months of down time (in addition to a one month normal refueling/maintenance outage) to complete conversion-related work and hook the units into the new cooling system.

**Lost Output during the Outages**

Enercon overstates the MWh output from Indian Point Units 2 and 3 that would be lost during the conversion-related outages due to several incorrect assumptions. First, as we noted above, Enercon's projected 38 week net outage duration is far too high. Second, Enercon calculates the net output lost from each unit by multiplying what it claims as the unit's net generator capacity by this 38 week period. For example, Enercon calculates the lost output from Indian Point 3 by multiplying the number of hours the plant would be out of service (38 weeks x 7 days per week x24 hours per day) by a 1,035 MWe net capacity for the facility.

However, this calculation overstates the lost output because (1) it fails to reflect the possibility that either or both Indian Point units would have experienced some forced outages or power reductions if they had been operating for the 38 week period instead of being shutdown for the conversion-related outages and (2) Enercon used capacity figures for Indian Point 2 and Indian Point 3 that are too high.

First, all power plants can be expected to experience some level of forced outages and/or unplanned power reductions over time. Instead of assuming that each Indian Point unit would have operated for 100 percent of the hours during the 38 week period, Enercon's calculation should have reflected some relatively low forced outage rate. For example, a

[11] At page 4-6.

[12] At page 4-6.

[13] Abt Associates, *Cost Analysis of Alternative Technology Options*, April 5, 2002, at pages 20 and 36.

five percent forced outage rate would have been reasonable based on the operating performance of large pressurized water reactor nuclear plants ("PWRs") like Indian Point Units 2 and 3 during the years 1998-2002.[14]

At the same time, Enercon assumed for its calculation of the lost revenues during the conversion-related outages that the typical Indian Point 2 full power output was 1015 MWe and the typical Indian Point 3 full power output was 1035 MWe.[15] These full power output figures are higher than Entergy and others have reported for the Indian Point units. In fact, Enercon itself reports earlier in its study that Indian Point 2 has a net capacity of 940 MW and that Indian Point 3 has a net capacity of 970 MW.[16] Each of these net capacity figures is 65 MW lower than the figures Enercon uses in its lost revenue calculations.

Although there are some differences in the reported power levels for the Indian Point units, Entergy has said that the Indian Point units have net power outputs of 970 MW (Unit 2) and 980 MW (Unit 3).[17] However, since late last year, both Indian Point units have received permission from the U.S. Nuclear Regulatory Commission to increase their power levels by 1.4 percent. Increasing the power levels reported by Entergy for each unit by this 1.4 percent figure results in a projected net full power output of 984 MW for Indian Point Unit 2 and 995 MW for Indian Point Unit 3.

These net power output figures are 31 MW lower than the 1015 MW net generator output used by Enercon for Indian Point 2 and 40 MW lower than the 1035 MW figure used by Enercon for Indian Point 3.

**Avoided Costs**

Enercon calculates the revenues that Entergy would lose during conversion-related outages but does not reflect the plant costs that would be avoided if the units were shutdown. Although nuclear power plant non-fuel operating and maintenance ("O&M") costs are generally considered to be mainly fixed costs, plant fuel costs can be considered to be variable. Therefore, the fuel costs for the Indian Point units during 2008 would be reduced if the plants were shutdown for the conversion-related outages. These avoided fuel costs also should be considered when examining how the conversion of Indian Point to closed-loop cooling systems would affect Entergy.

**Conclusions**

Table 1 below presents what we believe is a more realistic estimate of the net revenues that Entergy would lose if each of the Indian Point units were shut down to complete the

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[14] See the North American Electric Reliability Council's GADs Brochure for 1998-2002 which reports that PWRs of between 900 and 999 MW experienced an average 4.94 percent forced outage rate during this five year period. PWRs larger than 1,000 MW experienced a 7.38 percent forced outage rate during this same period.

[15] *Enercon Study*, at page 14.

[16] *Enercon Study*, at page 1.

[17] *Entergy Corporation and Subsidiaries 2002 Annual Report*, at pages 33 and 76.

conversion to closed-loop cooling systems for no additional outage time or for additional one, two, three and nine month outages beyond their normal one-month planned refuelings. The lost revenue figures in Table 1 reflect net power levels of 984 MW for Indian Point Unit 2 and 995 MW for Indian Point 3; a five percent forced outage rate; and the $48/MWh average market price projected by Enercon.

**Table 1: Gross Lost Revenues during Conversion-Related Outages**

| Unit | No Additional Outage Time (Millions) | Net 1 month Outage (Millions) | Net 2 Month Outage (Millions) | Net 3 Month Outage (Millions) | Net 9 Month Outage (Millions) |
|---|---|---|---|---|---|
| Indian Point 2 | $0 | $32 | $65 | $97 | $286 |
| Indian Point 3 | $0 | $33 | $65 | $98 | $290 |
| Total | $0 | $65 | $130 | $195 | $576 |

Table 2 below then presents the fuel costs that would be avoided if the Indian Point units were shut down for the conversion-related outages. These avoided costs reflect fuel costs of $7.52/MWh for Indian Point 2 and $7.10/MWh for Indian Point 3. These fuel costs are based on the historic fuel costs at Indian Point for the years 1995 through 2000, escalated through 2008 at the overall rate of inflation.

**Table 2: Avoided Fuel Costs Revenues during Conversion-Related Outages**

| Unit | No Additional Outage Time (Millions) | Net 1 month Outage (Millions) | Net 2 Month Outage (Millions) | Net 3 Month Outage (Millions) | Net 9 Month Outage (Millions) |
|---|---|---|---|---|---|
| Indian Point 2 | $0 | $5 | $10 | $15 | $30 |
| Indian Point 3 | $0 | $5 | $10 | $14 | $29 |
| Total | $0 | $10 | $20 | $30 | $59 |

Finally, Table 3 presents net lost revenue estimates which reflect both the gross lost revenues shown in Table 1 and the avoided fuel costs shown in Table 2.

**Table 3: Net Lost Revenues during Conversion-Related Outages**

| Unit | No Additional Outage Time (Millions) | Net 1 month Outage (Millions) | Net 2 Month Outage (Millions) | Net 3 Month Outage (Millions) | Net 9 Month Outage (Millions) |
|---|---|---|---|---|---|
| Indian Point 2 | $0 | $27 | $54 | $82 | $256 |
| Indian Point 3 | $0 | $28 | $56 | $84 | $261 |
| Total | $0 | $55 | $110 | $165 | $517 |

Thus, at most, Entergy could reasonably be expected to lose between $55 million and $165 million dollars in revenues if the Indian Point units were shut down in order to complete the conversion to closed-loop cooling systems. These figures are significantly lower than the nearly $630 million in lost revenues claimed by Enercon. Even Enercon's claimed net nine month (38) outage would have less of an impact on Entergy's revenues than Enercon has calculated in its Study.

However, even these figures exaggerate Entergy's lost revenues because they reflect an average $48/MWh price for the output that would be lost during the conversion-related outages. This $48/MWh price reflects market prices during both summer-peak months and non-summer-months. However, the conversion-related outages of the Indian Point units likely could and would be scheduled during the non-summer months which can be expected to have lower market prices. This would further reduce Entergy's net lost revenues from the conversion of Indian Point to closed-loop cooling systems with towers.