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STATE OF ILLINOIS
Pollution Control Board

BEFORE THE ILLINOIS POLLUTION CONTROL BOARD

IN THE MATTER OF :	)	
	)	
PROPOSED NEW 35 ILL. ADM. CODE, SUBPART W,	)	R01-9
THE NOx TRADING PROGRAM FOR	)	
ELECTRICAL GENERATING UNITS, AND	)	(Rulemaking-Air)
AMENDMENTS TO 35 ILL. ADM. CODE 211 AND 217	)	

CAM

NOTICE

TO: Dorothy Gunn, Clerk
Illinois Pollution Control Board
James R. Thompson Center
100 West Randolph, Suite 11-500
Chicago, IL 60601

Catherine Glenn, Esq.
Hearing Officer
Illinois Pollution Control Board
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SEE ATTACHED SERVICE LIST

PLEASE TAKE NOTICE that I have today filed with the Office of the Clerk of the Pollution Control Board the TESTIMONY OF RICHARD FORBES of the Illinois Environmental Protection Agency, a copy of which is herewith served upon you.

ILLINOIS ENVIRONMENTAL
PROTECTION AGENCY

By: _____
Laurel Kroack
Acting Associate Counsel
Division of Legal Counsel
Bureau of Air

DATED: August 18, 2000

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CLERK'S OFFICE
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STATE OF ILLINOIS
Pollution Control Board

IN THE MATTER OF:	)	
	)	
	)	
PROPOSED NEW 35 ILL. ADM. CODE 217, SUBPART W, THE NOx TRADING PROGRAM FOR ELECTRICAL GENEARTING UNITS AND AMENDMENTS TO 35 ILL. ADM. CODE PART 211 AND 217	)	R01-9 (RULEMAKING - AIR)

TESTIMONY OF RICHARD FORBES

Qualifications

My name is Richard Forbes. I am employed by the Illinois Environmental Protection Agency ("Illinois EPA") as the Manager of the Ozone Regulatory Unit, in the Air Quality Planning Section, Bureau of Air. I have been employed by the Illinois EPA in this capacity for 15 years. Prior to that, I served as Analysis Unit Manager, and New Source Review Unit Manager, both in the Permit Section of Illinois EPA's Bureau of Air. I have also served as an Environmental Protection Engineer in the Permit Section of Illinois EPA's Bureau of Water. In all, I have been employed by the Illinois EPA for 28 years. My educational background includes a Bachelor of Science Degree in General Engineering from the University of Illinois at Urbana-Champaign, and a Master of Science Degree in Environmental Engineering from Southern Illinois University at Carbondale. I am a licensed Professional Engineer in the State of Illinois.

Introduction

I was responsible for the overall preparation of the technical support document ("TSD") for the proposed rulemaking. As the TSD points out, the rotary motion of turbines through a magnetic field

generates the electricity that is produced by the utility industry. A large output of electricity, the amount that is required every day of the year, is ordinarily generated by turbines turned by a flow of steam produced in boilers. This more or less constant electrical load is termed "base load". Base load units are supplemented, as needed, by "cycling" units which may be gas- or oil-fired.

An extra amount of electricity, such as that required to run many air conditioners during very hot summer days, is generated in turbines turned by a flow of steam produced in gas- or oil-fired boilers that can be quickly brought on line, or in gas- or oil-fired gas turbines, wherein the same turbine that is making the electricity is turned by the flow of combustion gases produced from burning gas or fuel oil. Units producing electricity that are required only on high demand days are called "peaking units" or simply "peakers". Smaller coal-fired units are also sometimes used as peakers although they cannot come on line as quickly as gas- or oil-fired units.

Formation of NOx

Combustion of fuel in the boilers and gas turbines produces nitrogen oxides ("NOx"). The ambient air consists of about 20% oxygen which when heated to elevated temperatures will combine with the elements of coal, fuel oil, or natural gas, i.e. carbon and hydrogen, to yield carbon dioxide and water vapor, and to generate still more heat which will sustain combustion. Ambient air, however, also contains almost 80% nitrogen, which does not react with its oxygen component to form NOx at ambient temperatures, but will do so at the elevated temperatures that occur during a fuel's combustion. This reaction takes place at an increased rate as the temperature of combustion rises, and also with increasing amounts of excess air. In addition, coal and fuel oil contain appreciable amounts of nitrogen that can also combine with oxygen to form still more NOx at combustion temperatures.

Guidance on Control of NOx Emissions

Today's proposal is to control NOx emissions from large fossil-fuel-fired electrical generating units ("EGU") that have nameplate capacities greater than 25 megawatts of electricity ("MWe"). As part of the evaluation of the control of NOx emissions from EGUs, the Illinois EPA identified several sources of guidance. The United States Environmental Protection Agency ("USEPA") published two Alternative Control Techniques ("ACT") documents regarding control of NOx emissions from utility boilers and gas turbines. These ACT documents contain detailed information which describe the sources of NOx emissions, various techniques for controlling NOx emissions, and the costs of these controls. The Illinois EPA used information contained in the ACTs as background information, but relied on the information contained in the Regulatory Impact Analysis for the NOx SIP Call published as part of the regulatory docket for the NOx SIP Call, 63 Fed. Reg. 57356 (October 27, 1998), the proposed Federal Implementation Plan ("FIP"), published at 63 Fed. Reg. 56394 (October 21, 1998), and USEPA's proposed findings on the various petitions filed under Section 126 of the CAA (Section 126 Petitions), published at 65 Fed. Reg. 2674 (January 18, 2000) for the costs and economic impacts of today's proposal.

NOx Budget for EGUs

In the NOx SIP Call, USEPA identified reductions that could be achieved from large existing NOx sources in the 23 jurisdictions affected by the NOx SIP Call using "highly cost-effective measures". Existing emission units under the NOx SIP Call are ones which commenced operation before January 1, 1995. USEPA established NOx emission caps for these large existing EGUs based upon an emissions cap achievable with the application of the highly cost effective measure of 0.15 lb NOx/mmbtu. Emissions from these units comprise the EGU inventory that serves as the basis for the

large EGU emissions budget. USEPA anticipated that initial allocations would be made to these units under the federal NOx trading program, and all other (new) EGU units would receive their allowances through the new source set-aside. To determine the budget allowances for the existing large Illinois EGUs, USEPA used the actual 1996 heat input data reported by the existing emissions units to the Acid Rain Division of the USEPA. The "heat input" of fuel burning equipment is the amount of heat energy, usually as measured in millions of British thermal units ("btu"), produced by the burning of the fuel for a given period of time, usually an hour. Base 2007 heat input values were calculated by multiplying actual 1996 heat input with a 1996 – 2007 growth factor of 1.08, as predicted by USEPA's Integrated Planning Model ("IPM"). The budget allowance for an EGU is calculated by multiplying the base 2007 heat input by the budget NOx emission rate of 0.15 lb/mmbtu and divided by 2,000 lb/ton. The total NOx allowances for all affected EGUs in Illinois are 30,701 tons. Appendix F of the proposed rulemaking, which is identical to Attachment A to the TSD, identifies each of the 103 impacted EGUs and each unit's associated NOx allowance.

Types of EGUs and Associated NOx Emissions

The largest number of units affected by the proposal are coal-fired units which can be classified as either dry bottom pulverized coal-fired boilers or as cyclone boilers, with the pulverized coal-fired boilers further classified as to firing method, i.e. either as tangentially-fired or as wall-fired. These classifications are important because each classification has different characteristic uncontrolled NOx emissions and control costs.

The units having the highest total NOx emissions in Illinois are cyclone boilers, having uncontrolled emission rates ranging from 0.80 to 2.0 lbs/mmbtu. Cyclone boilers are those in which

crushed coal is fed tangentially in a stream of primary air to a horizontal cylindrical furnace. In a cyclone boiler much of the ash forms a liquid slag on the furnace walls and must be drained to the furnace bottom where it can be removed through a slag tap opening. There are 22 cyclone boilers affected by the proposed regulations, having projected base 2007 NOx emissions of 58,146 tons during the May 1 through September 30 control period.

The units having the second highest total NOx emissions are tangentially-fired dry bottom pulverized coal boilers having uncontrolled NOx emissions ranging from 0.40 to 1.0 lbs/mmbtu. Tangentially-fired units fire fuel in burners mounted in a corner, or in opposite corners, of a furnace with a rectangular cross section. The fuel is called "pulverized" coal because the coal is pulverized to the consistency of talcum powder in mills designed for that purpose. The term "dry bottom" refers to the fact that the furnace is designed so that no ash collects in a liquid state on its walls. (There are no wet bottom pulverized coal boilers in Illinois.) Projected base 2007 NOx emissions from the 34 tangentially-fired dry bottom pulverized coal boilers affected by the regulatory proposal total 44,239 tons during the control period.

Wall-fired dry bottom pulverized coal boilers are the third largest NOx emitting category of units affected by the regulatory proposal. Wall-fired units are similar to tangentially-fired units except that the burners are mounted in a wall, or in opposite walls, of the furnace rather than in the corners. The wall-firing configuration causes a higher uncontrolled NOx emission rate than for tangential-firing, in the range of 0.60 to 1.2 lbs/mmbtu. There are only eight wall-fired dry bottom pulverized coal boilers affected by the proposal with projected base 2007 control period NOx emissions of 9,383 tons.

The fourth NOx emitting category of EGUs affected by the regulatory proposal is gas- and oil-fired boilers. There are 25 gas- and oil-fired boilers impacted by the proposal and which account for 2,294 tons of 2007 base control period NOx emissions.

The last category of EGUs affected by the regulatory proposal is gas turbines. There are 14 existing gas turbines affected by the proposal and they are generally used to meet peak electricity demand. The total NOx emissions from this category are 2,416 tons per 2007 base control period.

The locations of the existing units that would be affected by the regulatory proposal are indicated as shown on the attached map (Attachment 1). Their total projected 2007 base case control period NOx emissions are 116,478 tons and the 2007 budget case control period emissions are 30,701 tons. Thus an average NOx emissions reduction of 74% would be needed from the 2007 base control period to meet the 2007 emissions budget.

Types of NOx Emission Controls and Associated Costs

While the proposed regulations do not require every individually affected unit to reduce its NOx emissions, an overall reduction equal to the magnitude of the difference between the overall baseline and the overall budget emissions is required, and such reduction can be achieved only by either combustion controls or post combustion controls as applied to the affected units. Combustion control consists of changing the circumstances of boiler or turbine combustion so as to minimize the amount of NOx generated during that combustion, while post combustion control treats already generated combustion gases so as to reduce those gases' NOx component to nitrogen and water vapor.

Most combustion controls work by designing boiler configurations so as to prolong combustion at lower temperatures rather than quickly completing it at higher temperatures ("staging" the combustion), by creating combustion zones that are fuel rich and thus oxygen poor, and by creating lower overall temperatures. Combustion control techniques include taking burners out of service ("BOOS") to maintain a staging atmosphere within the furnace, using low excess air ("LEA") so as to limit the contact between oxygen and nitrogen, and staging combustion via biased firing ("BF") of air-fuel ratios in some burners, flue gas recirculation ("FGR") which lowers peak flame temperature by adding a large mass of cool, inert gas to the fuel air mixture, reducing air to the primary burners and adding ports for overfire air ("OFA"), and providing for "reburning" wherein a portion of the fuel is burned in a second combustion area above the main combustion area.

The most common single combustion control technique, however, is the low NOx burner ("LNB"), a burner especially designed to stage combustion and to provide for lower combustion temperatures. LNBs can achieve a 35 to 45% NOx reduction when installed on tangentially-fired pulverized coal boilers, a 40 to 50% reduction when installed on wall-fired pulverized coal boilers, and a 30 to 50% reduction when installed on gas- or oil-fired boilers. Its NOx reduction efficiency can be improved still further when used in conjunction with other combustion control techniques such as OFA. LNBs, however, are not available for cyclone boilers.

The only other single combustion control technique that can equal, or even exceed, the efficiency of the LNB is reburn. Reburn with natural gas is usually a more suitable technique than reburn with coal or oil, even if those latter fuels are the boiler's primary fuel. Reburn alone is capable of achieving a 50 to 60% NOx reduction from gas-, oil- and coal-fired boilers, including cyclone boilers.

The other combustion control technique besides reburn is LNB which can allow gas- and oil-fired boilers to meet the proposed regulatory requirements, but it is doubtful that any combination of combustion controls for coal-fired boilers will similarly suffice. Coal-fired boilers not acquiring extra allowances through purchase or trade will likely have to rely on post combustion techniques in order to comply with the proposal.

Gas- or oil-fired gas turbines can be controlled by the injection of either water or steam into the intake of the turbine. This control technique retards NOx formation by lowering the operating temperature of the turbine and can provide a 70 to 90% reduction in NOx emissions, which may be sufficient to meet the requirements of the regulatory proposal. A special retrofit firing configuration, known as the "low NOx combustor" is available for some gas turbines. This technique can provide a 60 to 90% reduction in NOx emissions.

Two post-combustion control techniques that are available for fossil-fuel-fired boilers are selective non-catalytic reduction ("SNCR") and selective catalytic reduction ("SCR"). Both these techniques are called "reduction" techniques because the NOx is reduced back to elemental nitrogen and oxygen, with the oxygen combining with hydrogen to form water in the process.

Both techniques are called "selective" because both specifically select NOx for reduction unlike the catalytic reduction that is applied to the exhaust of motor vehicles and which reduces a wide variety of pollutants. In both SNCR and SCR, ammonia, a compound of nitrogen and hydrogen, is made to react with NOx in order to liberate the nitrogen from each reactant and produce gaseous

nitrogen and water. In SNCR, urea, another nitrogen and hydrogen compound which also contains carbon, is often used instead of ammonia.

The advantage of SNCR over SCR is cost, because the SNCR reactions take place without the use of a catalyst, the chief component of the cost of an SCR system. The disadvantages of SNCR are that it effectively operates over a rather narrow range of temperatures which may not be appropriate for some boilers, that it is difficult to control the loss of ammonia, an air pollutant in its own right, to the ambient atmosphere, and that its NOx removal efficiencies, 30 to 60%, compare unfavorably with SCR's 75 to 85% NOx removal efficiencies for coal-fired boilers.

In general, gas- and oil-fired boilers SNCR's reduction efficiencies are even poorer, 25 to 40%, while SCR's efficiencies are even better, 80 to 90%. SNCR may not be suitable for gas turbine applications, while SCR is capable of providing 90% NOx reductions for such turbines.

The TSD for this proposal has a summary of the costs of various NOx control technologies and their combinations under various "load" conditions based on the information contained in the ACT documents. The costs of combustion controls for gas- and oil-fired boilers vary widely depending upon the size of the unit, the load conditions, and the type of control technology employed. Table 5-2 in the TSD provides a summary of the large variety of cost effectiveness values for the NOx control options for these boilers. For gas turbines that continue to operate as peakers, the most likely control that would be utilized is water and steam injection. The cost effectiveness range for this control option is $1,210 to $2,350 per ton of NOx removed. (If these units are used more often than as peaking units, the cost per ton would be less.)

Control costs for coal-fired boilers relying on SNCR technology also vary widely for base load units with an average range of cost effectiveness of $725 to $880 per ton of NOx reduced. Control costs relying on SCR technology have a similar average range of cost effectiveness of $1,035 to $2,035 per ton for base load units.

Federal NOx Trading Program

In order to allow the most cost effective emission reduction alternatives to be implemented, the proposal provides for participation in the federal NOx Budget Trading Program administered by the USEPA. Each of the States subject to the NOx SIP Call is encouraged to participate in this NOx Budget Trading Program and thereby provide a mechanism for sources to achieve more cost effective NOx reductions. In the NOx SIP Call, USEPA projected a compliance cost effectiveness for EGUs of $1,468/ton when trading was included. Illinois EPA made its own estimate of the cost effectiveness of the proposal and found it to be $1,486/ton. Further, the U.S. Department of Energy completed a separate analysis of the compliance cost impact to the 23 states affected by the NOx SIP Call and found the cost effectiveness to be $1,460/ton. All three analyses included trading in their assessments.

The trading currency in the federal NOx Budget Trading Program is a NOx Allowance, equal to one ton of emitted NOx. Under the federal NOx Budget Trading Program, each emissions unit would be given a certain quantity of NOx allowances. If a unit's actual NOx emissions exceed its allocated NOx allowances, the unit may purchase additional allowances from any other unit participating in the NOx trading program. Conversely, if a unit's actual NOx emissions are below its allocated NOx allowances, then it may sell the additional NOx allowances to other participating units.

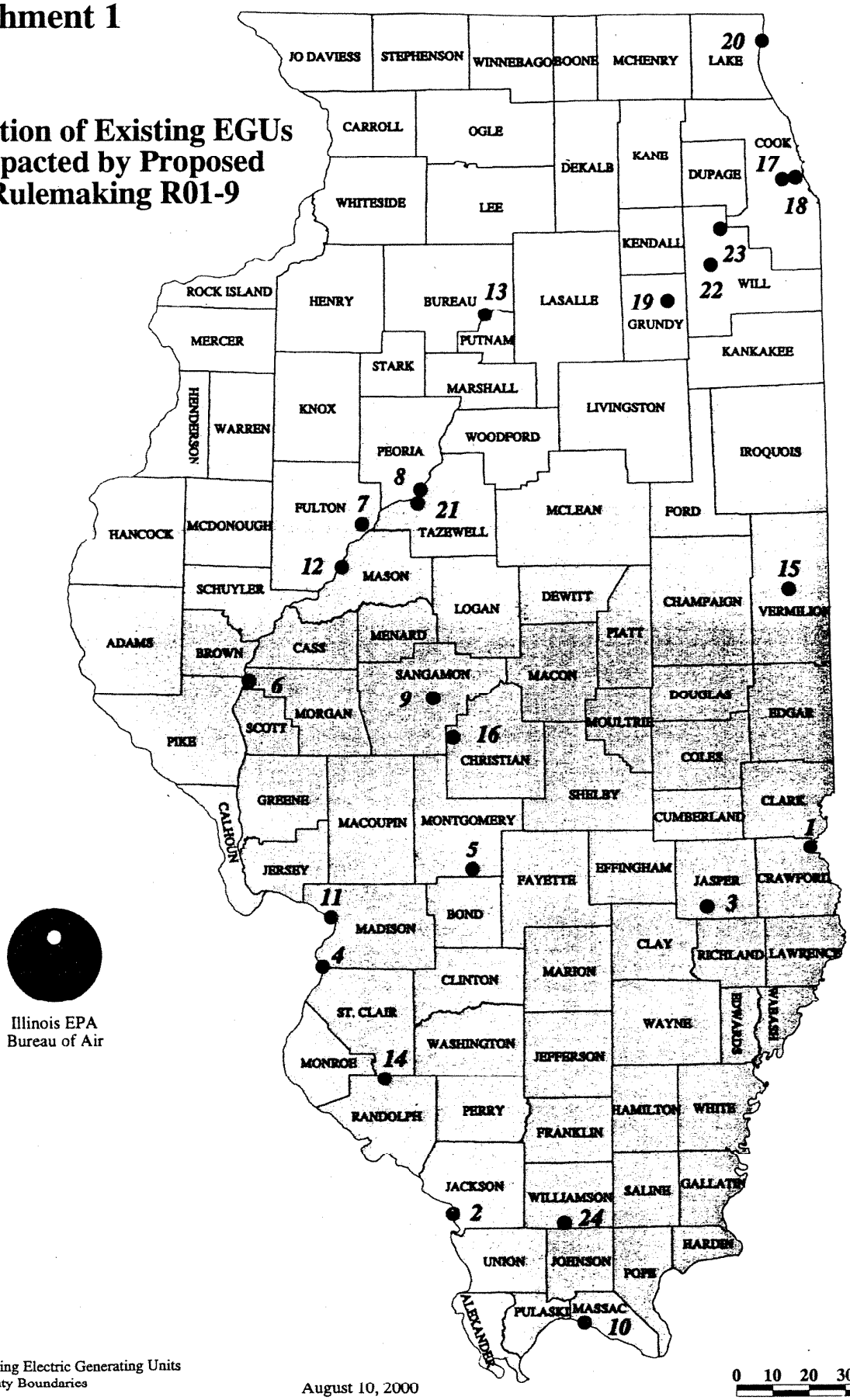
Such a program creates a competitive market for NOx allowances that encourages the use of the most efficient means for reducing NOx emissions. The federal NOx trading program allows units that do not use their NOx allowances for a given year to save or bank them for later use, subject to flow control measures. Trading may occur among any of the units within the SIP Call region participating in the federal NOx trading program. A detailed description of the federal NOx trading program is contained in the Federal Register Notice of October 27, 1998, and proposed as 40 CFR Part 96.

Summary

In summary, the Illinois EPA has relied on the NOx control information provided by USEPA and its cost estimates of the various control alternatives to reduce NOx emissions from large EGUs to meet the federal NOx SIP Call EGU budget for Illinois. The USEPA has determined that NOx budget trading in 2007 at a uniform emission rate of 0.15 lb/mmbtu is highly cost effective. The average cost effectiveness of this alternative, assuming trading among the NOx SIP Call region sources, was determined to be $1,468 (1990 dollars) per ton of NOx reduced. A total of 103 emission units will be impacted by the proposal which have projected base 2007 NOx emissions of 116,478 tons per control period. The proposal will require a total reduction of 85,777 tons of NOx per control period in 2007, equivalent to a 74% reduction, resulting in a 2007 NOx budget of 30,701 tons.

Attachment 1

Location of Existing EGUs Impacted by Proposed Rulemaking R01-9



Existing EGUs Impacted by Proposed Rulemaking R01-9

MAP_NUMBER	NAME	COUNTY	CITY_TOWN
1	Hutsonville (Ameren EGC)	Crawford	Hutsonville
2	Grand Tower (Ameren EGC)	Jackson	Grand Tower
3	Newton (Ameren EGC)	Jasper	Newton
4	Venice (U. Elec.)	Madison	Venice
5	Coffeen (Ameren EGC)	Montgomery	Coffeen
6	Meredosia (Ameren EGC)	Morgan	Meredosia
7	Duck Creek (AES C/O CILCO)	Fulton	Canton
8	E. D. Edwards (AES C/O CILCO)	Peoria	Bartonville
9	CWLP	Sangamon	Springfield
10	Electric Energy	Massac	Joppa
11	Wood River (DMG)	Madison	East Alton
12	Havana (DMG)	Mason	Havana
13	Hennepin (DMG)	Putnam	Hennepin
14	Baldwin (DMG)	Randolph	Baldwin
15	Vermilion (DMG)	Vermilion	Oakwood
16	Kincaid Generation (Dom. Energy)	Christian	Kincaid
17	Crawford (Midwest Generation)	Cook	Chicago
18	Fisk (Midwest Generation)	Cook	Chicago
19	Collins (Midwest Generation)	Grundy	Morris
20	Waukegan (Midwest Generation)	Lake	Waukegan
21	Powerton (Midwest Generation)	Tazewell	Pekin
22	Joliet (Midwest Generation)	Will	Joliet
23	Will County (Midwest Generation)	Will	Romeoville
24	Southern Illinois Coop	Williamson	Marion

STATE OF ILLINOIS)
) SS
COUNTY OF SANGAMON)

PROOF OF SERVICE

I, the undersigned, on oath state that I have served the attached TESTIMONY OF RICHARD FORBES upon the person to whom it is directed, by sending a copy by facsimile to the (312) 814-3669 and by placing it with a courier for overnight delivery to the following:

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(Overnight Mail)

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Hearing Officer
Illinois Pollution Control Board
James R. Thompson Center
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Chicago, Illinois 60601
(Overnight Mail)

SEE ATTACHED SERVICE LIST

from Springfield, Illinois on August 18, 2000.

Cynthia Sims

SUBSCRIBED AND SWORN TO BEFORE ME

This 18th day of August, 2000

Cynthia L. Wolfe
Notary Public

OFFICIAL SEAL
CYNTHIA L. WOLFE
NOTARY PUBLIC, STATE OF ILLINOIS
MY COMMISSION EXPIRES 3-30-2003

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