

**IN THE UNITED STATES DISTRICT COURT FOR THE SOUTHERN
DISTRICT OF ILLINOIS**

**UNITED STATES OF AMERICA,
Plaintiff,**

**v. ILLINOIS POWER COMPANY and DYNEGY MIDWEST GENERATION,
INC.
Defendants**

Civil Action No. 99-833-MJR

October 15, 2002

REBUTTAL REPORT OF BRUCE BIEWALD

On Behalf of the United States of America

In response to Michael King's and Gary Liberson's July 3, 2002 Expert Reports

Bruce Biewald

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Note: The acronym IPC is used to designate Illinois Power Company.

ATTACHMENTS

Attachment A - Bruce Biewald's Resume

Attachment B - Documents Considered

Attachment C - List of the modifications

Attachment D - List of IPC PROMOD model runs

Attachment E - Summary Charts of IPC's projections of unit operation

Attachment F - Summary Charts for IPC's analysis of the 1991 Baldwin 2 replacement of the boiler heater floor.

Attachment G - Impact of outage rate changes on capacity factors and emissions.

Documents required by Federal Rules of Civil Procedure

1. This report contains my opinions, conclusions, and the reasons therefore.
2. Statement of my qualifications is contained in Attachment A.
3. Attachment A includes listings of prior testimony in the last four years and publications in the last ten years.
4. Attachment B lists the data and other information considered in forming my opinions.
5. Attachment C lists the modifications of the Illinois Power Company units analyzed in this report.
6. Attachments D, E, F and G contain listings of model runs that I considered and analyses that I prepared in forming my opinions.
7. The compensation to Synapse Energy Economics, Inc. for my work in this matter is \$125 per hour for services of Bruce Biewald, plus staff support. The members of my staff who have aided me in this rebuttal are Michael Drunsic, who is compensated at \$85 per hour, Etienne Gonin, who is compensated at \$85 per hour, and Alex Moffett, who is compensated at \$85 per hour. Compensation is not contingent upon offering any specific opinion.

I reserve the right to supplement my report to incorporate additional information. I also reserve the right to use any exhibits or documents considered, relied upon, or used by any other witness in this case.

1. Qualifications and Experience

My name is Bruce Edward Biewald, and I am the President of Synapse Energy Economics Inc., a consulting company in Cambridge, Massachusetts specializing in analysis of electric power systems. I have twenty years of experience advising state agencies, consumer and environmental advocates, utilities and others on issues related to the production and consumption of energy. I have testified in more than eighty cases in utility regulatory followings in twenty-five states, and two Canadian provinces. I have co-authored approximately one hundred reports, including studies for the Electric Power Research Institute, the US Department of Energy, the US Environmental Protection Agency, the Office of Technology Assessment, the Ozone Transport Commission, the New England Governors' Conference, the New England Conference of Public Utility Commissioners, and the National Association of Regulatory Utility Commissioners. My papers have been published in the Electricity Journal, Energy Journal, Energy Policy, Public Utilities Fortnightly, and numerous conference followings.

As president of Synapse Energy Economics, I oversee a staff of ten individuals, conducting dozens of consulting assignments each year. Our work over the last five years includes consulting projects dealing with electric industry restructuring, stranded costs, system benefits, market power, mergers and acquisitions, generation asset valuation and divestiture, rate cases, power plant costs and performance, power supply contracts and performance standards, electric power system reliability, renewable power generation, demand-side management, air emissions from power plants, and electricity market simulation modeling for price forecasting and market power analysis. My work frequently involves applying economic, engineering and statistical techniques to electric system planning, policy and ratemaking. Synapse's governmental clients include federal agencies such as the Environmental Protection Agency, state Attorneys General (in ten states), Consumer Advocates (in eleven states), utility regulatory commissions (in four states), as well as variety of cities and towns. We also work for a number of non-governmental consumer advocates and environmental organizations, as well as associations of agencies, foundations, and private clients.

Prior to founding Synapse, I was with Energy Systems Research Group (later Tellus Institute) where I was the manager of the electricity program, and consulted on a wide range of electric system regulatory and economic issues. I have a B.S. from the Massachusetts Institute of Technology where I studied Architecture, Building Technology, and Energy Use in Buildings.

My experience with electric system simulation modeling began twenty years ago, on projects to evaluate the economics of power system expansion plans. My experience includes programming these computer models, applying them in various types of analyses, and critiquing the application of these models by others. My own modeling work has involved simulation modeling of electric systems throughout the United States, including the PacifiCorp system in the Northwest; the MAPP, MAIN, and ECAR regions of the Midwest; the MACC, New York, and New England system in the Northeast, the Entergy and Southern Company systems in the South; and a large number of smaller regions and utility systems.

In January of 2000, Synapse Energy Economics entered into a license agreement with Henwood Energy Services for the use of PROSYM. Synapse has applied PROSYM in eight different projects for clients including the US EPA, the Ozone Transport Commission, the Arkansas Public Service Commission Staff, the Vermont Department of Taxes, the Iowa Office of Consumer Advocate, and a number of environmental organizations.

I was contacted by the Department of Justice early in 2001 about the utility enforcement actions under the New Source Review program. My work for the DOJ in this matter has focused on computer simulation modeling and electric system operations and planning. I submitted an expert report with Philip Hayet on August 1, 2002 in the United States v. Duke case, analyzing the use of computer modeling by Duke in planning modifications of its units.

2. Summary of method and conclusions

2.1. Issues, Method, and Conclusions

IPC used and relied on dispatch models to forecast operations of its units at the time of the modifications under review in the USA v. IPC case. Mr. King's report concentrated upon these PROMOD runs.¹ My rebuttal report responds to Mr. King's presentation and analysis of these runs.

I extracted information from the inputs of these model runs and analyzed this information to come to the following conclusions. I also reviewed Mr. King's and Dr. Liberson's reports and analyses regarding the forecasting of the impacts of the modifications at the Baldwin units.

Mr. King states in his report that "predicting future emissions of a power plant clearly requires a forecast of generation from that power plant" and that "production cost models are commonly used to forecast the level of generation expected from a specific generation unit." He adds that "production cost modeling has been a widely used forecasting tool throughout the energy industry for over twenty-five years." I believe that these remarks are correct, but that, given the wide number of PROMOD base cases available for many of the modifications, it is difficult to determine, for each modification, a specific case to use in representing IPC's actual expectations. In my analysis I found several documents indicating whether and to what extent a run can be considered official.² In most of the cases, it has not been possible to identify with certainty the single official run that was used by the company in planning its post-modification operations. Consequently, for most of the modifications analyzed in this report, instead of examining only a single PROMOD run, I identified a group of runs that were performed in the three years prior to the modification. This subset of base cases shows the evolution

¹ Expert Report of Michael King, on behalf of Illinois Power Company and Dynegy Midwest Generation, Inc.; Civil Action No. 99-833-MJR, July 3, 2002.

² See for example the "Promod Audit" document, IPPRO-0107802 to IPPRO0143727, related to a March 1993 run I have identified.

of IPC's forecasts through time and does not lead to isolate one specific primary run on which to rely for emission calculations. This runs contrary to the methodology of Mr. King, who identifies, for each modification, a single representative run used in depicting IPC's post modification expectations.

This report also addresses the analysis by Mr. King of IPC's use of modeling to predict operations. I question the selection of runs that Mr. King chose in representing IPC's projections when performing his comparisons of achievable vs. projected and actual vs. projected emissions. I also question the legitimacy of his test of "achievable versus projected" (Section VII – H of his report) is intrinsically biased and inappropriate. Finally, I criticize the PROSYM run he made and his interpretation of its results, and propose an alternative PROSYM run in support of my comments.

I also criticize Dr. Liberson's report, and his claim that IPC lacked reason to believe that the Baldwin modifications would lead to an increase in emissions.

My main conclusions with regard to the simulation models and the reports by Mr. King and Dr. Liberson are the following:

- IPC used the PROMOD model to simulate the operation of its system including projections of the amount of generation from each of its units.
- IPC provided PROMOD results spanning the period from 1987 to 1999. A list of these PROMOD runs is provided in attachment D.
- I have information regarding 59 such PROMOD runs, 14 of which can be considered "base cases."
- Mr. King's analysis is unnecessarily and inappropriately limited in that he considered only 17 PROMOD runs, and narrowed that set down by rejecting all of the runs for which he did not have full input and output files. For his report, Mr. King relied upon only 3 PROMOD runs to represent IPC's projections related to the seven modifications that he addresses.
- Mr. King's analysis inappropriately focused upon a single PROMOD run for each modification.
- Mr. King did not rigorously follow his own criteria in selecting PROMOD runs. In some instances, the single run selected by Mr. King was done well after the planning for the modifications was complete. In one case, the run selected by Mr. King as representative was performed roughly 30 months after the modification had been completed.
- Mr. King could reasonably have selected other PROMOD runs as indications of IPC's thinking prior to the modifications. Given the existence of PROMOD base cases demonstrating different projections than those on which he relied, Mr.

King's decision to focus on an extremely limited subset of runs as a result of the imposition of his own methodological requirements is unjustified. For example, Mr. King's decision to rely on only PROMOD runs for which complete input data files are available severely restricts the number of runs that he relies upon. In my view, it is not necessary to have full inputs in order to conclude that a PROMOD run has useful information about what the company was projecting in a particular time period. The *output* data of PROMOD include projections of unit specific generation and fuel use.

- The PROMOD run selected by Mr. King as representative of IPC's projections for the 1994 modifications at Baldwin Unit 3 was not typical. Other runs by IPC done prior to Mr. King's selected run show generation from Baldwin unit 3 that is about 50% higher. Actual generation was likewise much greater than that predicted by Mr. King's selected run.
- If Mr. King had selected other PROMOD runs than the three that he did select, then his results would have been different. For example, when analyzing the 1994 modifications at Baldwin unit 3, had he selected the run 9102 performed on April 10, 1992 Mr. King would have found IPC to have projected generation levels twice as great as the levels his own selected run projected. Moreover, he would have selected a run whose projections were far closer to the actual generation levels of Baldwin unit 3.
- An analysis of what I determined to be PROMOD base cases (see attachment E) shows that for at least some of the modifications, IPC could expect clear increases in operations at the specific Baldwin unit being modified.
- Despite Mr. King's description of his tests as "reasonable expectation tests," (page 17) his test is unreasonably pessimistic about the ability of system planners to make reasonable predictions.
- Mr. King questions the connection between improvements in component availability and the availability of the generating unit as a whole (pages 12, 13, and 14) but planners in practice actually do quite reasonably assume that component availability improvements will translate into unit availability improvements.
- Mr. King questions the connection between improvements in unit availability and the amount of generation from a unit (pages 14 and 15) but planners and production costing models actually do quite reasonably project that improvements in unit availability will translate into additional generation from the unit. This is demonstrated in PROMOD runs done by IPC (see Section 3.3.3. and Attachment F) and in PROSYM runs that I have done for this case using Mr. King's input data (see Attachment G).

- In at least one instance, IPC made specific runs analyzing the impact of the replacement of a component and how it would affect the operations of its unit and of its systems. Two February 27, 1990 PROMOD runs compare the five-year operations of its system with or without the replacement of the boiler floor at Baldwin unit 2 in 1991. Documents accompanying the runs show that the company expected better availability for Baldwin unit 2 due to the replacement of the boiler. In the case where the boiler floor is replaced, the coal use, generation (and logically emissions of air pollutants) are all forecast to be significantly higher than in the case where the boiler floor is not replaced. Moreover, the equivalent of about a third of the Baldwin 2 additional generation is forecasted to be sold off-system. Mr. King was not aware of this pair of PROMOD runs. This pair of runs shows that, contrary to Mr. King, IPC's planners did expect that an improvement in component availability would result in an improvement in unit availability, and that the improvement in unit availability would, in turn, result in an increase in generation and emissions. Moreover, a comparison of the two runs shows that there is a rather direct and linear relationship between unit availability and generation.
- Mr. King's analysis has as a final stage the application of a "causation tree" in which he explains any projected increases in emissions after a project, based upon other factors "extrinsic" to the project. This causation analysis is ad hoc and incomplete, in that Mr. King looks only at selected factors to explain the increases. He does not look at factors comprehensively or systematically, he does not look at factors that would cause emissions decreases, and he does not look at effect of the project itself.
- Dr. Liberson's conclusion that "before the cited maintenance projects, IPC could not have predicted a net increase in unit emissions above the threshold levels based upon any impact of such projects on unit reliability," is based upon an after-the-fact application of a statistical method that is not, should not, and could not be used for practical decision-making by utility planners.³ In practice, utility planners use engineering methods and simulation models to make reasonable projections in order to decide how to invest in power plants.

The preparation of this report is informed by my more than twenty years of experience working on electric system modeling and planning issues, including modeling analysis that I have done, utility modeling analyses that I have reviewed, and utility proceedings that I have been involved in, mainly at state utility regulatory commissions. A detailed listing of my testimony, reports, papers and presentations is provided as Attachment A. My report has also been informed by documents provided by IPC in this case, primarily the PROMOD runs that the Company did and the documents discussing the inputs and outputs of those PROMOD runs.

³ See page 2 of his report.

3. Analysis of IPC projections of operations after the modifications

3.1. Dispatch Models Used by IPC and Use of the Model Results by the Company

Illinois Power employed two dispatch models to project the future operation of its system: PROMOD and PROSCREEN.⁴ I extracted information from both models but focused my analysis on PROMOD, since it is a more detailed dispatch model, more likely to be used for corporate planning. PROSCREEN's system dispatch simulation can be described as a simplified version of PROMOD's, and PROSCREEN modelers use results from PROMOD base cases to create the PROSCREEN input data set.

PROMOD and PROSCREEN were used for various official planning documents, both within IPC and for public filings. The company relied on PROMOD for its official forecasts and for its filings to the Illinois Commerce Commission, as illustrated for example in the "1990 ICC Rider P Filing" (June 6, 1990, IPPRO-0158681 to 0158695) addressed by EF Stoneburg to Ms. B. A. Deed. This document gives a description of the use of PROMOD and mentions on the cover page of its attachments section that "the marginal costs are based on [the] 9001 PROMOD base case". I have been able to identify runs that most likely were used as reference cases, but I have not been able to comprehensively determine with certainty which of the runs were used as support for official documents. My analysis therefore presents more than a single base case result for each of the modifications.⁵

I extracted and plotted two different measures of plant operations from the company's model runs: capacity factors and coal use (in thousand of tons). Each of these is useful in its own way.

Capacity Factor is picked as a key variable of how much a unit is used, compared to its potential generation. Thus, it is directly proportional to the generation of a unit during a specified period of time (a month or a year) as long as the unit's capacity rating (in MW) remains constant. As the emissions of pollutants studied in the case (SO₂, NO_x and PM₁₀) are closely related to the amount of generation of the unit, I can say that capacity factors are a reasonable proxy of the variations of pollutants' emissions through time.

I also represented coal use (in tons) to allow a better comparison with the calculations performed by Michael King. Additionally, this allows me to control for the impact of variables such as the heat content of the coal, the unit's heat rate and changes in capacity ratings at the units. The evolution through time of coal use is generally very similar to the evolution of capacity factors.

⁴ The term PROVIEW can also be used for the PROSCREEN model.

⁵ In one case, there was only one base case PROMOD run available in the applicable time period, and so only one run is presented for that modification.

The graphs illustrating these data can be found in Attachment E, and are discussed in Section 3.2.

3.2. Analysis of Capacity Factors Graphs

3.2.1 Methodology

I extracted information from about 60 PROMOD runs (see the list and comments in Attachment D). From within this initial set of PROMOD runs, I identified a subset of base case runs performed by Illinois Power from 1988 onwards. For each of the modifications, I analyzed all of the PROMOD base case runs performed in the three years prior to the modification.⁶ I compared in a graph the capacity factors predicted by IPC for the 10 years post-modification (if available) to the actual capacity factors of the unit (from GADS data). I also indicated the average capacity factor of the unit in the 24 months prior to the modification outage, and the highest 24 consecutive month capacity factor average within the 60 months prior to the modification outage.

I presented similar graphs showing coal use (in thousands tons of coal) in place of capacity factors, for the same set of runs (when available).

In determining whether a run was a base case, I looked for:

- Indications in the title of the run that it is a base case (I eliminated runs that clearly, according to their titles, were testing a specific hypothesis).⁷ A key factor for determining base cases was the mention of “Base” in the name of the run, or phrase such as “B00M00” or “B00M06” in the name of the tape used to make the run. Phrases such as “Test” or “Min. Risk” were interpreted as signs that the run was not a base case.
- References about this run in accompanying documents from Illinois Power.⁸

The list of base cases is included in Column “Status” of Attachment D.

The graphs show what the company was forecasting at various points in time in the three years prior to the modification, how it expected its modified units to run post-

⁶ For the 1992 modification at Baldwin Unit 1, I extended my analysis to include PROMOD 8903, which was run on August 11th, 1989, just before the three year deadline. This extension was made on account of a memo from Y.M. Yegen which demonstrates that IPC was planning the modification in July of 1989, and at that time had begun to look at the impact on “reliability, environmental concerns, and corporate finance issues.” See IPPRO-0070067.

⁷ See columns “Indication in title” and “Indication in name of tape” in attachment D, listing all the PROMOD runs I identified in the IPC data.

⁸ See the “Support document” column in attachment D, listing these documents (particularly if the run was used for an official filing).

modification, and how these projections compared to previous utilization of the unit. The graphs are included in Attachment E.

In the graphs, the “Actual” line represents the yearly average drawn from the GADS. For the capacity factors, this is calculated from the monthly Net Generation, Net Maximum Capacity and Period Hours. For the coal use, the value used is the coal’s “Quantity burned.”

The “24 months prior to mod” category represents the average of the 24 months just prior to the modification (from the GADS data). The “highest 24 of 60” is the highest average of 24 consecutive months of capacity factors or coal use. In the case of coal use, this is the number that Michael King used in his report as a baseline for coal use at the unit pre-modification.

The other lines represent calendar year data drawn from various PROMOD runs identified in the legends.

In all these graphs, I signaled the year of the modification with a vertical line on the graphs.

IPC itself compared unit per unit actual data and projected capacity factors drawn from PROMOD runs at various points in time in the early 1990s, as identified by at least two IPC memorandums (IPPRO-0159518 to 0159519 and IPPRO-0003689 to 0003697). In the first memorandum (dated March 27, 1990), Robert Reynolds (Director of Planning Analysis) introduces an analysis by E. F. Stoneburg representing “five years of historical and 20 years of forecast capacity factors for the electric generating plants”. It mentions, for example, that “Baldwin 2 [is] forecast to operate at a higher capacity approximately 10 percentage points higher than its average over the past 5 years”. The other document is a February 5, 1993 memorandum from D.R. Robinson to P.J. Themig “re: Capacity Factors Comparisons”. For the period 1988 to 1992, it compares capacity factors forecast from various runs to the actual calendar year capacity factors for the IPC units. This is this type of actual vs. forecast comparison which I am making in Attachment E.

I added coal projections in tons to allow for a more direct comparison with Mr. King’s calculations. Note that most of the variations in capacity factors are comparable to the variations in coal use at each unit. This is obvious when looking at two graphs compared on the same page for a modification: for the same run, the evolution of capacity factors and coal use are very similar. However, there might be some differences that can be explained by a few factors. The changes in heat content of the coal used, the heat rate of the unit, and the net maximum capacity of the unit can all explain why capacity factors and coal use series for the same run and unit can have a slightly different shape. This can also explain differences between the two pre-modification averages shown in the graphs.

As summarized by Themig in the February 5, 1993 memo, “differences in the forecasted

and actual capacity factors can be attributed to:

- Maintenance schedule variation
- Unit Outage variations
- Changes in the load forecast
- Variations in interchange sales will effect the marginal units
- Fuel costs”⁹

These reasons for difference should be kept in mind when analyzing the graphs in Attachment E. Furthermore, the same reasons can explain differences not only between actual and forecast values, but also between projections from various runs on our graphs.

3.2.2 Conclusions for Each Modification.

The following are comments on each of the modifications considered in the case (see the list and descriptions of the modifications analyzed, in Attachment C). So as to allow for the rebuttal of Mr. King’s testimony, this list is drawn from the list of modifications provided in Mr. King’s report.¹⁰

Baldwin 1 replacement of air heat tubes in 1985

No PROMOD data is available for this modification.

Baldwin 1 replacement of air heater tubes in 1990

In this case, four runs were considered. The capacity factors for all four runs show a somewhat similar pattern, with peaks in 1994 and lows in 1995. 1995 was a year with a January to March actual outage at Baldwin 1, and it seems that these four runs had a high maintenance included for 1995. Apart from 1995, for which the four runs have exactly the same capacity factors forecast, the April 89, August 89, and November 89 runs tend to show higher capacity factors than the March 88 run. The November 89 run stays above or equal to both average lines for the 4 post-mod years, whereas the April 89 run stays above the lowest average capacity factors “baseline” for the same period and above the highest average for two years. For this modification, there are calendar year coal use figures for two of the four runs. The coal use tends to be pretty stable between the two averages represented of the graph in the 10-year post-modification period.

For this modification, Mr. King looked at the PROMOD run Base Case 9002, which was performed by IPC on November 29th, 1990. The run thus occurred roughly 6 months after the modification itself had been completed. Mr. King acknowledges this defect in his selected run, and yet uses it anyway, asserting that it nonetheless provides the best data available. This is to say that, following his methodology, Base Case 9002 is the earliest available run containing both complete input and output information. The information presented in PROMOD Base Case 8802, PROMOD Base Case 8903, and PROMOD for PROVIEW (all runs I consider in my analysis) is ignored because Mr. King was unable to procure input data for the runs. Had Mr. King consulted these runs,

⁹ See IPPRO 0162268.

¹⁰ See Mr. King’s report, page 3.

he would have found far greater expectations of generation than the expectations depicted in PROMOD Base Case 9002. For example, the yearly data for PROMOD Base Case 8903, taken from the two calendar years directly following the modification, demonstrates an expected coal use of 3,056 thousand tons, 461 thousand tons greater than the two year total depicted by PROMOD run relied upon by Mr. King.

Table 1: Analysis of Generation for Baldwin Unit 1 as Projected by PROMOD 8903 and PROMOD 9002

| | PROMOD 8903 | PROMOD 9002 (Selected by Mr. King) | Difference |
|--------------------------------------------------------------------|--------------------|---------------------------------------|---------------------|
| Capacity Factor (Avg. annual capacity factor for 1991 and 1992) | 64% | 55% | 11% capacity factor |
| Coal Use (Sum of 1991 and 1992) | 3056 thousand tons | 2595 thousand tons | 461 thousand tons |

Baldwin 1 replacement of cyclones and furnace walls in 1992

Note in this case the oddity of the calculated averages, both for capacity factors and coal use graphs. They are above any of the calendar year averages in the five years prior to the modification. This is due to the fact that the 24 months just prior to the 1992 modification are between two long outages (modifications in 1990 and 1992); in this period, the unit was heavily relied on.

Four of the eight runs (made between July 91 and April 92) show rather similar patterns in 1993 and 1994. They show high capacity factors in 1993 (all of the six runs are above the averages in that year) but drop in 1994 and 1995. This drop seems to be due to higher than average maintenance days in 1994 and 1995 (a year of a more than two month-outage at Baldwin 1). 1997 also shows a drop in capacity factors for three of the eight runs, apparently due to high maintenance in that year. Note that coal use and capacity factors show comparable evolutions in the two graphs.

For this modification Mr. King looked at PROMOD Base Case 9102. The projections of this base case appear to be reasonably consistent with the projections made by most other PROMOD runs in the period preceding the modification.

Baldwin 2 replacement of cold end air heater tubes in 1988

Only capacity factor data is available from the one run that I selected as a base case. For

the two years after the modification, the capacity factors stay above both “baseline” averages. The drop in 1991 can be associated with the long outage during which two modifications were made at Baldwin 1. Note that IPC included this outage long in advance of its forecast, as illustrated in the February 5, 1990 memo in which it can be read that “the replacement of the boiler floor, which would require an eight-week outage, can be done in conjunction with the scheduled Unit 2 turbine-generator overhaul in 1991.”¹¹ The capacity factors increase starting in 1992 and stay above both averages from 1993 to 1995, decreasing after that date.

For this modification, Mr. King looked at PROMOD Base Case 9002. This PROMOD run was performed on November 29th, 1990, roughly 30 months after the completion of the modification. Mr. King justifies the use of this run by stating that it represents the best available data. Because PROMOD Base Case 9002 occurred so long after the completion of the modification, the run lacks projected information for the two years immediately following the modification. Mr. King is thereby forced to look only at projected information beginning in 1990, roughly 18 months after the modification had occurred. As a result, Mr. King posits a much lower projected level of generation than that which he would have projected had he analyzed PROMOD Base Case 8707 and focused his attention upon the time period immediately following the modification. Looking at yearly capacity factor information for PROMOD Base Case 9002, Mr. King identifies IPC to have projected capacity factors of 72% for the year 1990, and 62% for the year 1991. In contrast, PROMOD Base Case 8707 (which was run prior to the modification) projects the capacity factor for 1989 to be 77% with the capacity factor for 1990 staying the same at 77%. Averaging the two years and comparing the projections for the two runs, PROMOD Base Case 9002 projects the capacity factor for Baldwin Unit 2 to be 10% less than that presented by PROMOD Base Case 8707. Again, in determining IPC’s projections, Mr. King failed to consult PROMOD Base Case 8707 merely because the data he was able to collect regarding the run did not contain certain information which his methodology required.

Table 2: Analysis of Generation for Baldwin Unit 2 as Projected by PROMOD 8707 and PROMOD 9002

| Capacity Factor | PROMOD 8707 | PROMOD 9002 (Selected by Mr. King) |
|-----------------|-------------|------------------------------------|
| 1989 | 77% | |
| 1990 | 77% | 72% |
| 1991 | | 62% |

¹¹ See IPPRO 0162268. This memo is described in detail in section 3.3.

Averaging the first two years of annual capacity factor data available for each of the two runs produces the following information.

Table 3: Comparison of Capacity Factors Projected by PROMOD 8707 and PROMOD 9002

| | PROMOD 8707 | PROMOD 9002 (Selected by Mr. King) | Difference |
|----------------------------------------------|-------------|---------------------------------------|------------|
| Capacity Factor (Two year annual average) | 77% | 67% | 10% |

Baldwin 2 replacement of cold end air heater and boiler floor in 1991

There are seven runs represented in the capacity factors graph and five available containing coal use information (three of which have exactly the same coal input data for the 1992-1995 period). In both the capacity factors graphs and the coal use graphs, all the projections stay above both averages for the four calendar years after the modification. The drops in 1996 are due to a major maintenance planned for that year (for some of the runs, the maintenance seems to be smoothed on two years, 1996 and 1997). For all the runs, projections are back at higher levels in 1998.

For this modification Mr. King looked at PROMOD Base Case 9002. Of the seven runs that I have analyzed containing capacity factor data, 4 of the runs project higher capacity factors for the two years immediately following the modification. The other two runs project identical capacity factors to those projected by the PROMOD Base Case 9002. Looking only at those runs containing coal data, 2 of the 5 runs project higher coal use than PROMOD Base Case 9002, while the other two runs offer the same projections as PROMOD Base Case 9002.

Baldwin 3 change-out of economizer in 1982

No PROMOD data is available for this modification.

Baldwin 3 replacement of reheater and addition to superheater surface area in 1994

In this case four of the analyzed runs show high capacity factors and coal use for the two years following the modification, well above the pre-modification averages. The early 1993 runs show moderate increases compared to 1993 and 1994 calendar year actual capacity factors and are near the level of the pre-modification averages; however, they remain lower than the averages for coal use. Note in this case the large increase in post-modification actual generation.

For this modification, Mr. King looked at PROMOD Base Case 9401. A more in depth discussion of this run is included in section 4.1. For now, I need merely point out that the

projections this run offers are not reflected in any of the other PROMOD runs I have analyzed for this modification. Indeed, for the two years immediately following the modification, PROMOD Base Case 9401 predicts a coal use that is roughly 50% that of the coal use predicted by the PROMOD Base Case 9102 runs which occurred on April 10th 1992 and April 22nd 1992. Comparing the projections for this run to the actual post-modification coal use presents a telling picture of its anomalous nature. In the two years following the modification, Baldwin Unit 3 used 1,575,900 tons of coal. PROMOD Base Case 9102 predicted the use of only 1,011,500 tons of coal. This disparity between the coal use projected by PROMOD Base Case 9102 and that actually used by Baldwin Unit 3 only grows in subsequent years. I in the following table I compare the coal use projections offered by PROMOD Base Case 9401 to those offered by PROMOD Base Case 9301 and the PROMOD Base Case 9102 performed on April 22, 1992. The coal use projections made by PROMOD Base Case 9301 were, of the runs I analyzed, the closest to those projections made by PROMOD Base Case 9401. The PROMOD Base Case 9102 performed on April 22, 1992 made the highest projections of the runs I analyzed.

Table 4: Analysis of Coal Use for Baldwin Unit 3 as Projected in PROMOD 9301, PROMOD 9102, and PROMOD 9401

| | PROMOD 9301 (Lowest Projected Coal Use of the Runs Not Selected by Mr. King) | PROMOD 9102 (Highest Projected Coal Use of the Runs Not Selected by Mr. King) | PROMOD 9401 (Run Selected by Mr. King) |
|---------------------------|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|----------------------------------------------|
| Coal Use (annual 1995) | 1149 | 1639 | 794 |
| Coal Use (annual 1996) | 1259 | 1585 | 894 |

3.3. One Time Pair of Runs Analyzing a Specific Hypothesis.

I analyzed one pair of runs that specifically tested the impact of a modification at a Baldwin unit. The title of this pair and the accompanying documents show that IPC did in fact use PROMOD to study the expected impact on unit generation of the replacement of a component at the Baldwin units. The results of this pair of runs show a greater use of the unit after the modification when compared to the case where the modification is not made, and therefore demonstrates that IPC should have expected an increase in emissions to accompany the modification.

Mr. King indicated in his deposition that he was unaware of this pair of PROMOD runs. In his July 7, 2002 report, Mr. King asserts that “production cost models do not model component level characteristics” and that “there is no direct link between individual component performance and long term units performance.”¹² Mr. King is correct that models such as PROMOD take unit availability information as input rather than component-level availability. However, the unit-level availability input to PROMOD reflects the effects of component-level performance. Replacement of a component can, for example, be represented in a PROMOD projection as a modified trend in the unit’s forced outage rate. Indeed, this is exactly what IPC did in creating this pair of runs in 1990.

3.3.1 Purpose of the February 27, 1990 Pair of Runs, as Identified in IPC Documents

The pair of runs performed on February 27, 1990 is of particular interest to me, as it shows a forecast of the replacement of the boiler floor at Baldwin unit 2. The printout of the pair of runs can be found in documents IPPRO0162274 to IPPRO0162357. I did not treat these runs as base cases and did not include them in the set of graphs discussed above, in section 3.3.

The headers of the pair of runs read as:

“Run Date 02/27/90 – PROMOD 15 Bld 2 Boilr Flr Replaced PDEF Col 24 – FPG9001I.Testv20y Fcst=Frpl Pdef Col 66 For Inv” (IPPRO0162275 to 0162314) and
“Run Date 02/27/90 – PROMOD 15 Bld 2 Boilr Flr Not Replaced PDEF Col 24 – FPG9001I.Testv20y Fcst=Frpl Pdef Col 66 For Inv” (IPPRO0162315 to IPPRO0162356)

The start and end page of the printout show that these two runs were printed in immediate succession of each other. “Bld 2” in the title can reasonably be interpreted as “Baldwin unit 2”, “Boilr flr replaced” as “Boiler Floor Replaced” and “Boilr Flr Not Replaced” as “Boiler Floor Not replaced”. This pair of runs thus seems to study specifically the impact of the boiler floor replacement at Baldwin unit 2. This modification actually occurred during an outage at Baldwin unit 2 from March 2 to May 13 of 1991 (according to the GADS event data). Note that another modification was performed during that same 1991 outage: the second phase of the cold-end air heater section replacement. This pair of runs, however, specifically tests for the boiler floor replacement.

A series of memorandums from the company, written in February and March 1990 provide further confirmation that the purpose of this February 27 pair of runs was to test for the boiler floor replacement.

The first memo, dated February 5, 1990, states the need for the boiler floor replacement at Baldwin unit 2. The signed document, entitled “Prior Approval – Work Order 24619 – Baldwin Power Station Unit 2 Boiler floor Replacement” is from J.S. Spencer and addressed to PJ Themig (IPPRO 0162268). Spencer mentions that ‘the replacement of the

¹² See pages 13 and 14 of Mr. King’s report.

boiler floor, which would require an eight-week outage, can be done in conjunction with the scheduled Unit 2 turbine overhaul in 1991.[...] If the floor replacement is not done, the thin tubes will start failing, leading to forced outages. [...] Based on the current condition, we cannot wait until 1996 to replace/refurbish the floor because the forced outage rate would become unacceptably high”.

The second memo, dated February 20, 1990, assesses the loss of availability due to problems with boiler floor at Baldwin 2. The signed document is from J.M. Yagen and addressed to PJ Themig (IPPRO 0162263-0164). Yagen states that “in 1989 Baldwin Unit #2 experienced a loss of availability of 2.3% due to tube leaks. Approximately one half of this loss was due to the boiler floor. Without replacement or significant refurbishment of the floor, the unavailability rate will increase. [...] We could expect an increasing rate of at least 2% (unit unavailability due to the floor alone) each year during the next five year period”.

The third memo, dated February 21, 1990 (IPPRO-0162258-0162259), is entitled “Baldwin 2 Boiler Floor Replacement – Economic Analysis – Mini-Scope” and states its purpose as to “Perform economic analysis of replacing boiler floor of Baldwin unit 2”. It is also mentioned in the introduction of this document that “Power Generation has requested Planning Analysis to evaluate economic feasibility of this investment based on production cost savings associated with availability improvement due to floor replacement.” The “Methodology and Assumptions” section contains the following excerpt:

“To estimate production cost savings two PROMOD runs will be made; one representing floor replacement and other without any replacement. In the “replacement case”, the availability rate will be maintained as shown in current PROMOD base case. In “no replacement case”, the availability reduction rate will be 2% each year i.e. 2% reduction in 1991, 4% in 1992, 6% in 1993, 8% in 1994 and 10% reduction in 1995 as compared to the “replacement case”. The difference in total production costs between the two cases represents savings due to the floor replacement.”

It seems reasonable to conclude that the pair of runs made on February 27, 1990 is the one described in the previous paragraph. The timing of the memos suggests it as much as the description found in the February 21, 1990 memorandum. Additionally, the 1991-1995 period covered by the pair of runs corresponds to the time span presented in the IPC memo. Also note that these memos are regrouped just before the printout of the two runs in the IPC documents.

Finally a memo dated the same day as the printout of the February 27 run (i.e. March 1, 1990) is a summary of the “Baldwin Unit 2 Boiler Floor Replacement Economic Analysis.”¹³. It was redacted and signed on March 1, 1990 by E.F. Stoneburg, at the attention of Mr. J.S. Spencer (with carbon copies to P.J. Womeldorff, R.D. Reynolds and M.G. Goel). According to this memo, “the investment appears to be economically attractive since the present value of production cost savings over the 5 year period 1991-

¹³ See IPPRO-0162239 to 0162240.

1995 exceeds the present value revenue requirements over the 30 year life of the capital investment by \$3.2 million.”

It seems clear that IPC made PROMOD runs for a specific economic study of the boiler floor replacement at Baldwin 2. The approval of the modification was apparently based on this analysis. The results of the two PROMOD runs used for this purpose shed additional light on what IPC could expect from the replacement of the boiler floor at Baldwin 2, as discussed in the following section.

3.3.2 IPC Could Predict from its Forecast Additional Generation and Emissions from the Baldwin Unit 2 Due to its Boiler Floor Replacement

The following table compares results from the two runs for the 1991-1995 aggregated period for unit-level outputs (unless noted, these are sums and not averages). Note that the units are out for the same period in 1991 (since phase 2 of the cold-end heater replacement happens in both cases).

Table 5: Comparison of Boiler Floor Replacement Scenarios

| | Run with “Boiler Floor Replaced” (1) | Run with “Boiler Floor Not Replaced” (2) | Difference between (1) and (2) (in %) |
|-----------------------------------------------------|--------------------------------------|------------------------------------------|---------------------------------------|
| Coal Input at Baldwin 2 (in thousands of tons) | 8906 | 8294 | + 7% |
| Coal Input at Baldwin 2 (in thousands of MMBtus) | 189,693 | 176,661 | + 7% |
| Total Generation at Baldwin 2 (in GWh) | 18,252 | 16,971 | + 8% |
| Baldwin 2 Maximum Capacity Rating (constant, in MW) | 564 | 564 | 0% |
| Average Capacity Factor (average 1991-1995, in %) | 73.8% | 68.7% | +8% |

Note that the capacity ratings of the Baldwin units do not change during either of the two runs. Thus, generation is exactly proportional to capacity factors in these two runs for

each calendar year.

The coal inputs (both in tons and in MMBtus) increase over the period in the case of the modification. This translates in an increase of about 8% (or 1,281 GWh) of the generation overall at Baldwin unit 2 in the case where the boiler floor is replaced. This measures the impact of the boiler floor replacement on the use of the Baldwin unit. Service hours (time the unit is connected to the electric grid) are also higher in the case of a modification.

There are also interesting conclusions to draw from the system-level data, as shown in this table (these are sums for the 5 years of projections, not averages):

Table 6: Effects of Boiler Floor Replacement on Off-System Sales

| | Run with “Boiler Floor Replaced” (1) | Run with “Boiler Floor Not Replaced” (2) | Difference between (1) and (2) (in %) |
|---------------------|--------------------------------------|------------------------------------------|---------------------------------------|
| Total System Demand | 111,509 Gwh | 111,104 Gwh | 0.4% |
| Off-System Sales | 9,248 Gwh | 8,843 Gwh | 4.6% |
| Native Load | 102,261 Gwh | 102,261 Gwh | 0% |

Note that the same native load figure is used in both runs. On the contrary, off-system sales vary between the two runs. It is clear from these tables that the company’s model predicted that about one third of the additional generation from Baldwin 2 (1,281 Gwh) would go toward supplying additional sales (405 Gwh) to neighboring systems. This additional generation sold off-system corresponds to additional emissions from the IPC system.

3.3.3. Unit Availability Has a Direct Effect on Generation in IPC’s 1990 PROMOD Runs

In Mr. King’s July 3, 2002 report, he raises questions about the connection between unit availability and the amount of output from the unit. He does not state that there is no relationship whatsoever, but he does state that “[t]he availability of the unit does not necessarily directly relate to the generation” (page 15) and provides a misleading example of how this might be the case. In the example, Mr. King creates a system dispatch for a single day in which hypothetical generating “unit E” is the “fifth most expensive unit and is dispatched second to the last.” It operates for only about 6 hours during the middle of the day, because this is the period where the customer demand for electricity is high. Mr. King posits a hypothetical improvement in availability of unit E,

from 70% to 90%, and yet finds that the generation from unit E would not have a corresponding increase.

This counterintuitive result occurs in the example, because it is unrealistic. In the hypothetical, the additional availability of unit E occurs strictly in the early morning hours – from about 2:00 am to 7:00 am – when the unit is not utilized for lack of demand. While this sort of example is conceivably possible, it is not likely to occur for a real generating unit on a real system. Forced outages often occur for much longer than 5 or 6 hours, and so will tend to occur during times of low and high demand. Moreover, on an expected basis looking forward, planners do not know when forced generating unit outages will occur. The planners and their models generally assume that forced outages will occur, and that their probability of occurring at any particular time during the simulation period is the same as their probability of occurring at any other time. For this reason, on an expected basis, generating unit availability does have a direct and nearly linear relationship to generating unit output and emissions.

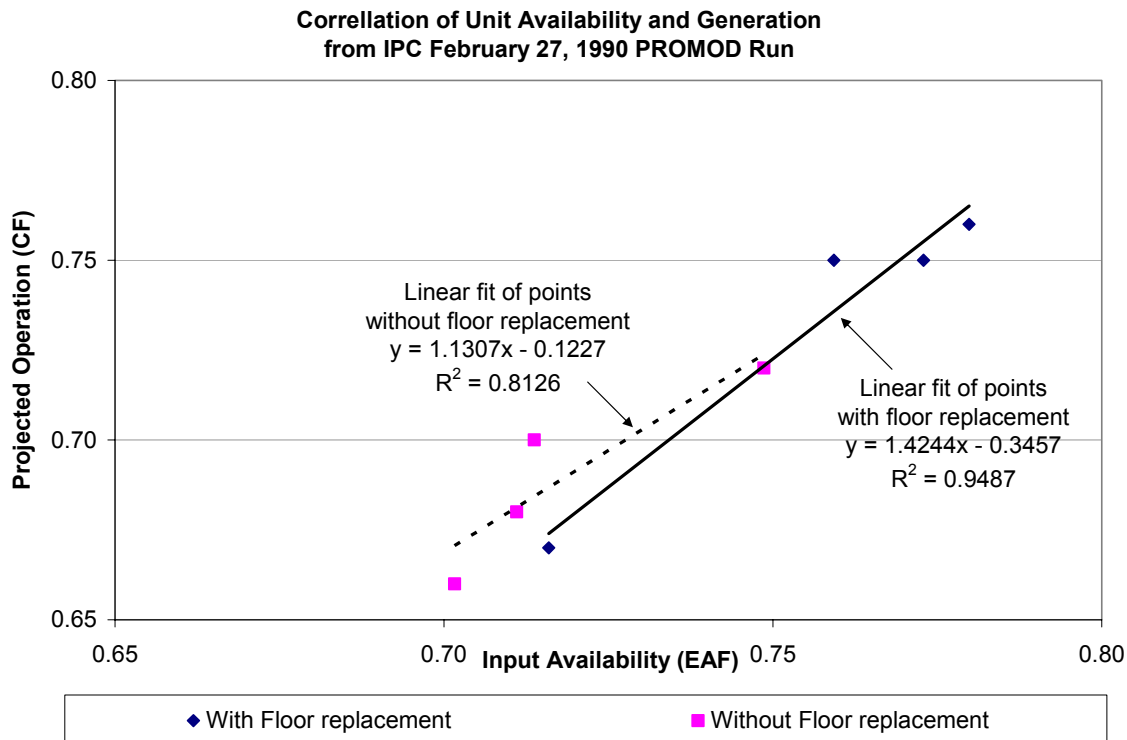
The pair of PROMOD runs done by IPC in 1990 shows this direct relationship between unit availability and output. This contradicts Mr. King’s analysis of the impact of unit availability upon operation, indicating that his hypothetical is not relevant to the operation of the Baldwin units on the IPC system. I have calculated the equivalent availability factors (EAF) for Baldwin 2 that I believe were input for the pair of runs.¹⁴ These are presented in the following table, along with the annual output predicted by IPC for Baldwin 2 in the pair of runs.

Table 7: Baldwin 2 EAF and CF for the 1990 pair of IPC PROMOD runs

| | Equivalent Availability Input for Baldwin 2 | | Capacity Factor Projected for Baldwin 2 | |
|------|---------------------------------------------|-------------------------------|-----------------------------------------|-------------------------------|
| | PROMOD without floor replacement | PROMOD with floor replacement | PROMOD without floor replacement | PROMOD with floor replacement |
| 1991 | 70% | 72% | 66% | 67% |
| 1992 | 75% | 78% | 72% | 76% |
| 1993 | 71% | 76% | 70% | 75% |
| 1994 | 71% | 77% | 68% | 75% |

The relationship between the availability inputs and capacity factor outputs in the table above is clearer when plotted in a graph.

¹⁴ This calculation is based upon PROMOD run inputs for the May 11, 1990 run, and the changes in forced outage rate indicated in the IPC memos discussing the runs noted in the text.



The graph shows lines fit to each of the two cases. These least squares lines do not fit the data perfectly, since there are other factors in the PROMOD runs that influence the output of the generating unit. The graph does, however, show that the input forced outage rate (as reflected in unit availability) is clearly an important factor in determining the amount of generation predicted for Baldwin unit 2, and that the relationship is close to linear.

3.3.4. Conclusions

By comparing these two runs (with or without the boiler floor replacement at Baldwin 2), the planning department at Illinois Power could and did conclude that the 1991 modification would lead, for the period of study (91-95) to higher coal use, generation, emissions than without the modification. This was directly due to the improvement of the unit availability following the modification, as demonstrated by IPC memorandums written at the time.

This is a demonstration that PROMOD was used in the analysis of the impact of a modification, as a unit-specific planning tool. Even more precisely, the impact of the change of a single component in the unit was studied with the PROMOD model. This contradicts Mr. King's assertions that "there is no direct link between individual component performance and long-term unit performance."¹⁵ It also contradicts Dr. Liberson's assertion that IPC could not have predicted the change in operations of a unit

¹⁵ Page 14 of King's report.

due to a modification of this unit.¹⁶ IPC ran PROMOD in this case and could conclude that the replacement of the boiler floor would change the 5-year post-modification production of the unit.

¹⁶ See Liberson, G.L. *Expert Report of Dr. Gary L. Liberson On Behalf of the Illinois Power Company and Dynegy Midwest Generation Inc.* July 3, 2002. Page 4

4. Critique of Mr. King's analysis of IPC's modeling

In his expert report, Michael King analyzes PROMOD runs done by IPC. He selects three runs, and uses them to analyze seven of the modifications. He uses data from these runs to conduct his own tests as to whether IPC could predict increases of emissions caused by projects at the Baldwin plant under review in the case. He concludes that “there was no increase in emissions, either projected or actual, caused by any project” (page 6 of his report). In my above discussion of the projections related to specific modifications, I identified the runs chosen by Mr. King in forming his opinions, and compared those runs to the wider selection of runs that I was able to identify. In this section I critique the methodology that Mr. King employed in choosing to analyze certain runs over others. I likewise critique Mr. King's use of PROSYM in rejecting the increase in post-modification emissions projected by in the years following the cyclone and furnace wall replacements on Baldwin Unit 1.

4.1. Critique of Mr. King's Choice of PROMOD Runs

Mr. King was apparently unaware of many of IPC's PROMOD runs. Of the 59 PROMOD runs that I was able to identify, Mr. King cites only 17 runs in his list of documents considered. Mr. King fails even to consider two of the base cases that I was able to consult in producing my report: the November 15, 1989 version of the PROMOD for PROVIEW run (IPPRO 0173368-0173469), and the April 10, 1992 version of the 9102 PROMOD run (IPPRO 0170220 to 0170311).

Furthermore, there are several problems with the methodology used by Mr. King in selecting his runs.

First, Mr. King states that he “preferred a PROMOD run dated (or run) closest to and prior to the commencement of the project to demonstrate the “expectation” prior to the specific projects commencement.”¹⁷ However, for two of the seven modifications he studies, he uses PROMOD runs performed after the modification, and draws very firm, though questionable, conclusions even from these post-modification runs. In his analysis of the 1990 modification at Baldwin 1 (which happened in a Spring outage), in determining the pre-modification expectations of IPC, he relies on a November 1990 PROMOD run. However, this run occurred just over 6 months after the modification. The problem is even more pronounced with regard to the 1988 modification at Baldwin unit 2. Here Mr. King uses the same 1990 PROMOD runs to draw all his conclusions about the projected coal use and emissions of the company. He thus considers a late 1990 forecast as the best representation of what the company was forecasting prior to a mid 1988 modification, even though the run itself took place roughly 2 and one half years after the modification. In my analysis, I have only used runs performed prior to the modification, acknowledging Mr. King's own remark in his report: “a pre-project case would have been more desirable” (page 18 of Mr. King's report).

¹⁷ Page 18 of King's report.

Second, his choice of base cases is questionable. I found that one of the three runs he selected as a base case for his analysis displayed characteristics that make its use by IPC as a reliable base case very unlikely. This is the Base Case 9401B00 run on November 8, 1993 and used by King to analyze the 1994 modifications at Baldwin 3.

This run is unusual in its treatment of sales, SO₂ emissions, and variable operations and maintenance cost. The graphs for coal use and capacity factor averages show that this run is clearly out of the range of any other base case runs performed either in the three years prior to the modification or in the time following the modification. In addition, it is very far from any actual annual capacity factors at Baldwin unit 3. The validity of a PROMOD run should not necessarily be determined by its position relative to the actual generation. However, as Mr. King states in the analysis of his actual to actual comparisons, “in determining the validity of any model, benchmarking the results can provide or discount credibility.”¹⁸ It is telling to note that the actual coal use of Baldwin 3 in 1998 was about 2.5 times higher than the coal use projected for 1998 for Baldwin 3 in the November 1993 run used by Mr. King.

Third, he claimed to use PROMOD runs that only had monthly data per unit available. However one of his key runs (11/29/90 run, used to analyze 4 modifications) does not have monthly unit-specific coal data, forcing Mr. King to use an interpolation to derive unit-specific monthly data.

Fourth, his comparison of achievable versus projected coal use is questionable, since these are not comparable variables. Achievable coal consumption is based on a generating unit producing the maximum amount of generation, assuming that a unit is always run when it is available. However, dispatch models also take into account whether it is economical for the company to run the unit or not. Thus, the projected coal use calculation takes into account that there are periods during the year when it is not economic for the unit to be used. Because King’s achievable calculations do not take into account the requirements of economic dispatch, I believe there to be a built-in bias within King’s methodology which makes achievable coal use and emissions necessarily greater than projected coal use and emissions.¹⁹ Electric power systems are dispatched to minimize fuel and operating costs, subject to various physical constraints, such as transmission limitations and generator ramp rates. Economic dispatch is widely used in the industry, and is used by IPC in operating its system. State statutes and state utility commission rules have effectively required economic dispatch. For example, the Illinois Public Utilities Act states in Section 1-102 on “findings and intent” that “The General Assembly finds that the health, welfare and prosperity of all Illinois Citizens require the provision of adequate, efficient, reliable, environmentally safe *and least-cost public utility services* at prices which accurately reflect the long-term cost of such services and which are equitable to all citizens.” (emphasis added) The Act defines efficiency as “the provision of reliable energy services at the least possible cost to the citizens of the State.”

¹⁸ Page 34 of King’s report.

¹⁹ See King’s conclusions, page 25 of his report.

During the period in which generation was regulated, if IPC were to have operated its system in a way that violated economic dispatch (subject to constraints) then the ICC would likely have found that the extra costs incurred were unreasonable and excessive, and such costs would have been disallowed from regulated rates. In 1997 Illinois began electric industry restructuring, a process that has involved separating generation from the regulated portions of the utility businesses, and freezing retail prices. In this environment, the companies owning generation have an economic incentive to comply with an economic dispatch, in order to minimize costs thereby maximizing profits. The computer simulation models used by IPC and other companies to simulate the operation of their systems (e.g., PROMOD and PROSYM) are designed to dispatch the available generating units in economic dispatch order. This is a fundamental feature of the models, because it is a fundamental characteristic of actual system operation. The use of “achievable emissions” as a baseline by Mr. King, entirely disregards economic dispatch. In this hypothetical baseline, he has inefficient generators operating at their full availability despite the fact that in many hours they are uneconomic to operate, would not be operated, and are simply not needed to meet customers’ demand for electricity. I therefore find Mr. King’s achievable test to be inappropriate, and do not take its results to have any bearing upon determining IPC’s emissions projections.

Fifth, I question the criteria adopted by Mr. King in the selection of his Runs. As described in section 3.2.3 and presented in attachment E, IPC performed a number of different PROMOD runs in the years preceding most of the modifications. Many of these runs present different emissions projections for the years following the modification. As such, I find Mr. King’s decision to impose criteria that limit his analysis to only three runs, while ignoring the data contained in all other runs, to be unjustified. The three criteria are: (1) only analyze PROMOD runs which are identifiable as base cases (2) only analyze those PROMOD runs which contain input and output information along with a projection of fuel usage (3) only analyze the PROMOD run which occurred closest to the beginning of the modification, utilizing a run that has occurred after the modification only if it is the only run which fits the other requirements.

I agree with Mr. King that only base cases should be taken into consideration as representing the opinions of IPC, and have followed this requirement in my own analysis. However, as mentioned above in point two, I question Mr. King’s selection of bases cases.

I disagree with Mr. King’s second requirement, that for a run to be taken into consideration one need have full input and output data along with fuel usage information. A number of the runs I analyzed did not come equipped with either input data or coal usage. However, these runs are still base cases performed by IPC in the time preceding the modification for the purpose of projecting future generation. As such, I find that the information they present should be evaluated in determining IPC’s expectations. The output report from PROMOD contains unit-specific information on generation and this is sufficient to indicate the company’s expectations for the future operation of its generating units. Mr. King stated in his deposition that he required the PROMOD input data in order to apply his “causation tree” methodology. I disagree with Mr. King’s method for causation analysis and I disagree with his requirement that PROMOD runs need contain input data along with fuel usage.

I likewise find fault with Mr. King's third requirement, his decision to look only at the base case performed closest to and prior to a modification. I have found documents demonstrating that in at least one case, IPC began planning a modification more than three years before the modification itself was performed.²⁰ Moreover, given that the task of filing for NSR certification takes some time, it is unreasonable to think that IPC considered future emissions only in the PROMOD runs directly preceding the modifications. To present a more comprehensive and accurate picture of the projections IPC used in the time preceding the modifications, I have attempted to look at a multiple runs for each modification. Mr. King's decision to focus solely on a single run for each modification makes it appear as if the information presented in that run represents the single, official expectation of IPC. However, as my analysis demonstrates, for many of the runs, IPC in fact projected a wide variety of different projections, none of which appear necessarily to take official precedence over the others. The decision to focus only upon the run performed closest to the modification prevents one from adequately understanding the full extent and complexity of IPC's projections. I therefore reject the third requirement of Mr. King's methodology in so far as it prevents the development of the balanced view necessary to adequately understand these projections.

4.2. Critique of Mr. King's Use of PROSYM and His Causation Arguments

Mr. King's approach is summarized in his Figure 4 on page 22 of his Expert Report. That figure shows that for all three of the tests that he considers, if he finds an emissions increase, he then subjects the modification to a "causation tree" which has three steps:

- First he "investigates possible/potential factors causing emission increases;"
- Then he "develop[s] PROSYM runs to evaluate effects of causation factors;" and
- Finally he "evaluate[s] reasonableness of causation factors to explain emission increase."

He only uses a PROSYM analysis for one of the modifications for which he found emission increases – the Baldwin 1 1992 cyclone and furnace wall replacements. I have already discussed this modification in section 3.2.3, above, here I focus on Mr. King's application of PROSYM and his approach to causation.

By examination of IPC's PROMOD run, Mr. King calculated that NO_x and SO₂ were both projected to increase by 1 percent. Because he identified an increase, he then proceeded with his investigation of possible/potential factors causing the increase. He apparently identified demand growth (peak and total energy) as the potential cause, and then ran a pair of PROSYM runs: one with the demand growth as projected by IPC in the PROMOD run that the Company actually did in April 1992 (PROMOD Base Case 9102B00M00) and a second with demand growth entirely flattened, but holding all other inputs equal in order to isolate the effect of demand growth. He found that in the second

²⁰ For example, see the memo from J.M. Yagen (IPPRO 0070067).

run, with total energy requirements reduced by 8 percent relative to the first run, Baldwin 1's projected fuel use decreased by 2.9%. This decrease of about 3% serves to change the 1% increase in emissions previously identified into a 2% decrease.

Mr. King does not, apparently, consider any other factors. One obvious other factor to consider as a "possible/potential" cause of the increase is the improvement to Baldwin's forced outage rate as a result of the modification. In Attachment G, I describe the PROSYM model runs that have been made to analyze the causal relationship between forced outage rate and generation, using Baldwin unit 1 as an example. This analysis shows a clear and nearly linear relationship between the availability of a generating unit as measured by EFOR or EAF and the output of the unit as measured by generation (MWH), capacity factor, fuel consumption (MMBTU or tons of coal), and air emissions. Specifically for Baldwin 1 in 1994 I find that each one percentage point improvement in forced outage rate results in a .65 percentage point increase in capacity factor and a 871 tons per year increase in SO₂ emissions. This analysis is presented in some detail in attachment G which includes an example related to the 1992 modification at Baldwin Unit 1.

In addition to using PROSYM to determine the causes behind emissions increases, Mr. King also provides a number of qualitative analyses with the explicit objective of attributing emissions increases to factors unrelated to the modifications. This is the "causation tree" portion of his methodology. For the actual vs projected analysis of projects 5 and 6, he attributes the increases in NO_x, SO₂, and PM at Baldwin Unit 2 to decreases in availability at the other Baldwin units. This causal attribution is based upon a hypothetical scenario and results in the conclusion that "a decrease in the available generation for the plant can cause an increase in generation for a specific unit."²¹ A similar analysis is provided for the increase determined by the prior actual vs. post actual test for project 1.²² Mr. King claims that the actual increase in emissions following the 1994 projects on unit 3 were due to demand growth along with decreasing fuel costs.²³

Mr. King's causation analysis is ad hoc and somewhat arbitrary. It is explicitly formulated so as to require the construction of causal arguments explaining away any possible emissions increases. As such, the analysis is insufficiently objective in that it is produced with a specific conclusion in mind. Moreover, because Mr. King's analysis terminates as soon as a potential explanation has been found, it fails to present a comprehensive picture of the causal forces at work. While some factors serve to increase emissions rates, other factors serve to decrease these rates. Mr. King's analysis fails to consider those causal factors serving to decrease emissions rates and therefore does not consider the possibility that external causes could serve to offset one another. Mr. King's analysis looks only for one type of causal factor and therefore fails to present an accurate and complete picture of the sum total of causal forces at work.

²¹ See page 33 of King's report.

²² Ibid page 35.

²³ Ibid page 39

5. Critique of Dr. Liberson's Report

5.1 Summary of Dr. Liberson's Runs Test Analysis

Dr. Liberson, in his July 3, 2002 report on behalf of IPC, claims that IPC had no reason to believe that the Baldwin modifications would lead to an increase in emissions.

This claim rests upon the argument that:

"If, as the Government argues, IPC should have been able to predict an improvement in EFOR as a result of the cited projects, we would expect EFOR to have a pattern that indicated that a component or system was breaking down and once repaired would return EFOR to its historically lower value. If no such pattern appears during the periods prior to the initial cited projects at Baldwin, then IPC could not have predicted a change in EFOR as a result of the cited projects."²⁴

Dr. Liberson then claims that, prior to the initiation of each of the modifications, there was no pattern of change in the equivalent forced outage rates of the three Baldwin units. To demonstrate this, Dr. Liberson conducts a series of Runs tests on the equivalent forced outage rates of the three Baldwin units. As a result of the tests, Dr. Liberson concludes that the equivalent forced outage rates for the Baldwin units fail to demonstrate any underlying pattern. According to Dr. Liberson, the rates themselves are purely random and, therefore, have no predictable trend. Hence, according to Dr. Liberson, prior to the Baldwin modifications, IPC could not have identified a trend of decreasing reliability, and as such, could not have predicted that the Baldwin modifications would serve to increase unit reliability. Dr. Liberson concludes that because of this, IPC could not have predicted the Baldwin modifications to result in an increase in emissions.

Dr. Liberson's claim that equivalent forced outage rates are random rests upon the statistical results of his Runs test. This test is used to determine the randomness of statistical samples. It works by counting the number of "runs" present in a sequence of binary values. For example, the sequence

11111000001111

contains three runs. The initial sequence,

11111

counts as one run, while the sequence

00000

marks the end of the first run while itself counting as an additional run. The third run counts as the final sequence of 1s. The test identifies the number of runs within a sequence, and then compares this actual value with the expected distribution of runs. If the sequence contains either a very high or a very low number of runs, one can reasonably conclude that it is not random.

²⁴ See Liberson, G.L. *Expert Report of Dr. Gary L. Liberson On Behalf of the Illinois Power Company and Dynegy Midwest Generation Inc.* July 3, 2002. Page 17.

To use the Runs test in the evaluation of generation reliability, Dr. Liberson begins by quantifying reliability in terms of an equivalent forced outage rate. This rate provides a measure of the amount of time a unit is prevented from running on account of system failure. It is defined by the Generating Availability Data System as

$$\frac{(\text{Forced Outage Hours} + \text{Equivalent Forced Derated Hours})}{(\text{Forced Outage Hours} + \text{Service Hours} + \text{Equivalent Forced Derated Hours During Reserve Shutdown})} \times 100^{25}$$
.

The equivalent forced outage rate of a unit can be measured in terms of any time period. Dr. Liberson measures the reliability of the Baldwin units in terms of months. Reliability over a period of time is therefore measured by identifying the equivalent forced outage rate for each month in that period of time.

In measuring reliability prior to each of the modifications, Dr. Liberson analyzes varying amounts of data. The number of months analyzed ranges from 138 for Baldwin modifications 8 and 9, to 24 for Baldwin modification 7. In each case, Dr. Liberson either begins his period of observation with the month directly following the unit's most recent modification, or simply uses data starting in 1982, which marks the beginning of the Generating Availability Data System database. In no case does the period of observation exceed 12 years. The median number of years analyzed for the 7 different modifications that Dr. Liberson analyzes is 3.

Because the Runs test is capable of analyzing only sequences of binary values, the sequence of monthly equivalent forced outage rates must be altered before the test can be performed. This is done by identifying the median rate for each sequence and then transforming each equivalent forced outage rate into either a 1 or a 0 depending upon whether or not it is greater than the median. The resulting sequence of 1s and 0s is then counted in determining the number of runs.

It is through this process that Dr. Liberson distills a sequence of binary values from an initial data set consisting of forced outage hours and equivalent forced derated hours. The Runs test can be performed only after this distillation process has been completed.

I find unjustified Dr. Liberson's decision to use the Runs test as a means of evaluating IPC's decision to implement the Baldwin modifications. The proper discipline through which to decide whether IPC should reasonably have predicted the modifications to lead to an increase in emissions is that of engineering, not statistics. In questioning the likely effects produced by a replacement of a component of a power plant, companies should and do look to engineers, not statisticians. The conclusions arrived at in Dr. Liberson's report are based upon statistical methods that are not and should not be used for power plant decision making. Rather, utilities project on a reasonable expectations basis using engineering analysis and system simulation modeling.

²⁵ See North American Electric Reliability Council; *GADS Data Reporting Instructions*, Appendix F: Performance Indexes and Equations. October 2000.

5.2 Relationship Between Engineering Calculations and Dr. Liberson's Report

Information is available from GADS and from system models (both PROMOD and PROSCREEN) that indicates that emissions could reasonably have been predicted to increase following at least some of the modifications. For example, one pair of PROMOD runs performed by IPC in 1990 tested the replacement of a boiler floor at Baldwin unit 2.²⁷ The test produced two versions of data, one in which the modification had been made, and the other in which the modification had not. Analyzing the two versions, one can see that emissions were predicted to increase if the modification were made. IPC had this data in its possession. IPC chose to use the PROMOD and PROSCREEN dispatch models that produced this data, and used results from both the PROMOD and PROSCREEN models in official planning documents and in public filings,²⁸ thereby demonstrating trust in its PROMOD and PROSCREEN models

The Statistical Runs test used by Dr. Liberson is not in actual practice used to predict emissions. IPC has not presented any information demonstrating that Runs tests, of the type performed by Dr. Liberson, were actually carried out by IPC prior to the Baldwin modifications. Dr. Liberson did not attempt to determine the actual processes used by IPC in deciding to implement the modifications.²⁹ Dr. Liberson is not aware of whether or not IPC ever used a Runs test. The Runs test is not a standard test used in the calculation of future emissions. Indeed, Dr. Liberson does not know of any other individuals who have used the Runs test in projecting future reliability of generating units.³⁰ The Runs test is not a statistical test used by the electric industry. As a result, there is little reason to rely upon such statistical testing to determine IPC's actual expectations, as IPC's actual expectations were most likely not influenced by such testing.

Dr. Liberson's analysis does not provide an adequate representation of the type of reasoning employed by IPC. Dr. Liberson argues that reliability is random and that because of this, maintenance should not have been expected to increase reliability. This makes IPC's decision to implement the modifications appear irrational. Dr. Liberson's analysis raises the unanswered question of why the Baldwin modifications were actually initiated. If IPC believed that reliability were randomly determined and that the Baldwin modifications were to have no positive effect upon reliability, why were the modifications actually performed? If Dr. Liberson's analysis is correct, then IPC's actions are mysterious.

²⁷ See section 1.3 of this report.

²⁸ See section 1.1 of this report.

²⁹ Deposition of Gary L. Liberson (USA v. Illinois Power Company) September 9, 2002, page 163.

³⁰ Ibid, page 86.

The power industry does not use Runs testing of the type applied by Dr. Liberson. Dr. Liberson's statistical approach ignores the methods of prediction actually utilized by the power industry. Dr. Liberson's techniques identify the complexity of an electric generating unit and the subsequent difficulty of determining, with a high degree of certainty, the effects of future actions. He concludes, in effect, that because events cannot be predicted with a 95% level of confidence, they should be taken as random. If this were accepted as standard then attempts at producing change within electric generating units would accordingly be identified as most likely ineffective, and the accepted course of action would generally be no action at all. If Dr. Liberson's techniques are taken seriously, then it would follow that if there are a significant number of forced outages caused by a malfunctioning boiler floor, then fixing that boiler floor will most likely fail to increase reliability. This is counterintuitive and incorrect. The adoption of this type of thinking by power plant owners would create problems in the utility industry.

Take the example of the replacement of a boiler floor. If a planner knows that the company plans to replace the boiler floor, then she can use this information (not information regarding past sequences of reliability values) to predict changes in reliability. Were predictions made solely based on past sequences of data, then a statistician might be the individual most appropriate for the task of predicting future emissions. Because this is not the case, Dr. Liberson's report fails to speak properly to the problem at hand, which is one of reasonable expectation and causation within the system of an electrical generating unit. Dr. Liberson's report, however, does not accept the possibility of projecting future reliability rates through anything other than a statistical analysis of past reliability rates. As he states in his deposition, "the assumption for the coal fired units, was this, what had occurred in the past was the best predictor of what was going to occur in the future."³¹ This assumption needlessly limits the potential methods available for projecting future reliability. It explicitly prevents the use of engineering calculations and simulation analysis of the type performed, for example, by PROMOD and PROSYM models, calculations which do not attempt to simply plot future trends from past values, but instead attempt to construct representations of systems so as to determine the impact of future changes to the system.

The inadequacy the Runs test is particularly well demonstrated by an examination of the use which Dr. Liberson makes of it in forming his opinion. The Runs test is a statistical test performed to evaluate a null hypothesis. In this case, Dr. Liberson's null hypothesis is that the equivalent forced outage rates for the Baldwin units are randomly distributed. What the Runs test determines, for each of the modifications, is that Dr. Liberson cannot, as a result of the Runs test, reject his null hypothesis. It is extremely important to note that this is all the Runs test itself demonstrates. The Runs test does not demonstrate that the equivalent forced outage rates for the Baldwin units are random. As Dr. Liberson acknowledges in his deposition, there is a difference between failing to reject his null hypothesis and demonstrating that the equivalent forced outage rates are in fact random.³² Dr. Liberson's conclusion goes beyond what his statistical analysis actually demonstrates. The proper conclusion to draw from the Runs test is that no recommendation can be

³¹ Deposition of Gary L. Liberson (USA v. Illinois Power Company) September 9, 2002, page 44.

³² Ibid, page 99.

made, that information is limited and other sources of analysis will be needed to determine future reliability.

In addition to questioning the conclusions he draws from the Runs test, I also question Dr. Liberson's decision to implement a Runs test. In particular, I question the type of data used by the Runs test, finding that the requirements of the test serve merely to cloud the available reliability information. As mentioned above in the description of Dr. Liberson's methodology, Dr. Liberson measures his equivalent forced outage rates in terms of months. However, the month itself is an arbitrary period of time determined by historical chance. Moreover, trends within the particular months are ignored by averaging reliability over the entire month's time. An understanding of trends in outages is thereby impaired through generalization as particular failure events are lost when examined from the perspective of overall reliability. The accuracy of Dr. Liberson's results grows even more questionable in the methodology's next step as he proceeds to convert the monthly equivalent forced outage rates into binary values. Precision is limited as widely different values, if in the same position with regard to the median, are made identical. In order to use the Runs test on a particular unit, Dr. Liberson must simplify detailed data on the unit's reliability history, clouding over relevant information so as to produce a data set with which he can perform his desired test. Instead of inquiring into the engineering principles behind the reliability of the Baldwin units, Dr. Liberson elects to simplify the available data.