POWERPLANT PRODUCTIVITY IMPROVEMENT STUDY

Final Report:
Project 1, Task 3

Analysis of Costs and Benefits for Eight Powerplant Productivity Improvement Projects

June 8, 1979

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EXECUTIVE SUMMARY

In the last decade, the U.S. electric utility industry has faced substantial challenges brought about by rapid developments on several fronts. Increased load growth uncertainty, inflation, tight capital markets, licensing and siting delays, and stringent environmental constraints were further complicated in 1974 by the OPEC oil embargo and steeply rising fuel prices. As a result of these pressures, increased attention has been given to the more efficient use of existing generating units as an economic alternative to new construction, and as a mechanism for near-term reductions in scarce fuel consumption.

In March, 1975, a Federal Interagency Task Group recommended a thorough analysis of the benefits of improved powerplant reliability in terms of reduced consumption of scarce fuels, reduced utility capital requirements, deferred additions of new capacity, and reduced rates to consumers of electricity (Reference A). The US Department of Energy has since encouraged increased efficiency in the use of scarce fuels in the electric utility industry under a broad range of programs. The potential for reducing oil consumption nationwide through improvements in the productivity (availability) of baseloaded units has been shown to be significant. It has been estimated (Reference B) that a 5 percentage point improvement in forced and planned outage rates of large coal and nuclear units could result in a net reduction in oil consumption of 54 million barrels per year by 1985 in the Northeast and East Central Regions alone. A substantial cost savings potential was also reported.

In 1976, the Department of Energy (Federal Energy Administration) sponsored the development of a systematic methodology for the identification and

analysis of candidate projects which a utility might undertake to improve baseload unit reliability (Reference C). This methodology also enabled the user to estimate a project's effect on the future performance of the unit. It was applied by Mechanics Research, Inc. at three utilities.

In order to demonstrate and further validate that methodology, and to encourage increased powerplant productivity in the State of Illinois, in 1977 the Department of Energy sponsored a cooperative study project with the Illinois Commerce Commission. Technical assistance was provided to the Commission by the Energy Resources Center, University of Illinois at Chicago Circle, and Trident Engineering Associates, Inc., a subcontractor. The study (Reference D) consists of the following major tasks.

- o Identification and documentation of current utility approaches to powerplant productivity in Illinois, based on a study of the four largest privately owned utilities in the state.
- o Application of the DOE developed methodology at Illinois Power Company Wood River 5 and Commonwealth Edison Company Quad Cities 1 and 2 units. A total of eight improvement projects were analyzed by Trident for their effect on unit performance.
- o Estimation of costs and benefits to the utility of the eight productivity improvement projects.
- o Comparison of current utility approaches to improvement of productivity with the DOE developed methodology to determine strengths and weaknesses of each.
- o Survey of historic productivity performance of powerplants in Illinois.
- o Analysis of current regulatory incentives and disincentives to improved powerplant productivity in Illinois and development of candidate regulatory incentive policies for consideration by the Illinois Commerce Commission.
- o Estimation of benefits to utilities and ratepayers in Illinois which would result from modest improvements in powerplant productivity in the state.

Objective of This Task

The objective of this task is the development and presentation of costs and benefits at the unit level for each of the eight projects studied. The cost/benefit analysis completes the application of the DOE methodology at Quad Cities 1 and 2 and Wood River 5 units, and provides information to utility personnel on the economic feasibility of the projects. Further, it provides a basis for comparison of utility and DOE methodologies for the analysis of projects to improve powerplant productivity.

Methodology

The development and presentation of costs and benefits for the eight projects closely follow the procedures described in Reference C. These procedures involve the straightforward application of conventional engineering economics and do not differ substantively from procedures available at both Commonwealth Edison and Illinois Power Companies. Because of these similarities, the analyses in this task are presented as they would be prepared by the utilities.

Estimation of project costs was based almost solely on the engineering judgment of utility personnel most familiar with the units and projects studied. Resource limitations precluded an in-depth engineering analysis of the candidate projects and their costs. In the case of larger, costlier projects, such as the Quad Cities Cooling Towers, a major effort is generally applied by utilities to the development of sound cost estimates.

Benefits were estimated differently for the two utilities, reflecting differing procedures commonly in use at the utilities studied. For Commonwealth Edison the value of a 1 percentage point change in the equivalent availability of each of the Quad Cities units was calculated. This number was multiplied

by the improvement in equivalent availability (ΔEA) for each project to determine the value (benefits) of that project. Illinois Power Company employed their PROCOS production cost simulation model to determine the system production cost differential by running the model with and without the project, over the life of the project. These production cost differentials provided the economic values of the ΔEA 's for the projects.

Key Findings and Conclusions

Of the eight projects analyzed, four were found to be cost-justified, with benefit-to-cost ratios ranging from .46 to 1.4. Three projects were not cost justified under current assumptions, and one project involved the estimation of gross benefits only since a technical fix has not yet been identified. The results of the benefit cost analyses and the performance impacts for the projects are tabulated in Table 1.

Although electric utilities in Illinois have not customarily employed equivalent availability as a primary figure of merit in their engineering economic studies of improvement projects, this study has demonstrated the feasibility of that option.

Estimations of economic benefits (generally resulting from reduced consumption of oil and coal) revealed substantial differences for the two utilities. For either of the Quad Cities nuclear units, a 1 percentage point improvement in equivalent availability has a present value of \$9,013,500 for the remaining 23 years of plant life. For Illinois Power Company's Wood River 5 Coal unit, the PROCOS production cost simulation model produced a non-linear relationship between ΔEA and dollar benefits. Benefits ranged from a present value of \$1,082,000 for a ΔEA of 0.0194 to \$209,000 for a ΔEA of 0.00106. The differences for the two companies are largely due to different rankings of the units

in their system loading orders. The Quad Cities units have generation costs of 1.4¢/KWH below average fossil system generation cost, whereas Illinois Power reports that Wood River 5 generation costs are above average system costs. These generation cost differences arise from higher fuel costs and non-fuel O & M costs for the Wood River 5 unit.

Although a formal sensitivity analysis was not performed on the cost/benefit results presented, it is evident that uncertainties are present. Some of the assumptions and estimates were optimistic. For example :

- o No unit down time for implementation of plant improvement projects was assumed.
- o No future unit outages due to the improved component/system were assumed.

Other estimates were "most likely" point estimates, but considerable uncertainty is associated with these. Project costs in many cases were highly uncertain because resource constraints in this study precluded the solicitation of competitive bids for the plant improvement projects. One project involved questions of ultimate technical feasibility in addition to cost uncertainty.

Of greatest significance, however, is the uncertainty associated with the estimation of AEA. As discussed in other reports in this project, the generally small number of observed failures, and the difficulty of identifying the underlying failure distribution required for projection of future failures combine to reduce confidence in the estimates of AEA. These difficulties, however, are present in some form regardless of the method employed in the analysis of plant improvement projects.

Since most key assumptions are either "most likely" or optimistic, the results

presented are useful for a first look at the candidate projects. If a project meets this initial test, a more conservative estimate of results should be developed to provide confidence limits on the range of possible outcomes.

Table 1

Summary of Benefit/Cost Analyses

Project (Unit)	Performance Impacts	Economic Benefits (Present Worth)	Project Cost (Present Worth)	Net Present Value	Benefit/ Cost Ratio
Moisture Separator Drain Tank Modification (Quad Cities 1)	$\Delta EA = 0.00131$ (maximum)	\$ 1,180,769	\$ 25,568	\$ 1,155,201	46
Electromatic Valve Modification (Quad Cities 1)	$\Delta EA = 0.0108$ (maximum)	\$ 9,734,580	Unknown	Unknown	Unknown
Cooling Towers (Quad Cities 2)	$\Delta EA = 0.0317$ (maximum)	\$28,572,795	\$119,740,580	-\$91,167,785	0.24
Amertap System (Quad Cities 2)	$\Delta EA = 0.00374$ (maximum) $\Delta OMC = \$6,700/\text{yr.}$ (typical)	\$ 3,371,049 <u>\$ 100,650</u> \$ 3,471,699	\$ 371,232	\$ 3,100,467	9.4
Feedwater Regulating Valve Modification (Quad Cities 2)	$\Delta EA = 0.0155$ (maximum)	\$13,970,925	\$ 351,979	\$13,618,946	40
Add Sixth Pulverizer (Wood River 5)	$\Delta EA = 0.0234$ (maximum)	\$ 1,082,000	\$ 4,004,000	-\$ 2,922,000	0.27
Replace Heater Tube Bundle (Wood River 5)	$\Delta EA = 0.00106$ (typical) $\Delta HR = 0.1\%$ (minimum)	\$ 209,000 <u>\$ 458,000</u> \$ 667,000	\$ 464,000	\$ 203,000	1.44
3 Shift Pulverizer Maintenance (Wood River 5)	$\Delta EA = 0.0194$ (typical)	\$ 1,210,000	\$ 2,423,000	-\$ 1,213,000	0.5

Key: ΔEA = Change in Unit Equivalent Availability ΔHR = Change in Unit Heat Rate ΔOMC = Change in Unit O & M Costs

INTRODUCTION

Background

In 1974, the Federal Energy Administration (FEA) led an Interagency Task Group which investigated the then current status of powerplant productivity. Based on that study, it was determined that large coal-fired and nuclear generating units were operating below expectation. A subsequent study in 1975 by Mechanics Research, Inc. identified some underlying causes of lost productivity and defined possible corrective actions. A more comprehensive study was sponsored by FEA with the following objectives:

- o Extension of existing methods to increase depth in determining underlying causes and corrective actions for lost productivity.
- o Development and verification of analytic methods for determining changes in equivalent availability which result from changes in specific system and equipment performance.
- o Development of analytic methods for the routine systematic analysis of cost and improved plant performance associated with plant improvement programs.
- o Development of improvement programs and prioritizing according to cost effectiveness in achieving improved powerplant performance.

The systematic analytic methods developed under the above program were applied at Duke Power Company, Florida Power and Light Company, and Tennessee Valley Authority units.

In order to further validate that methodology and simultaneously encourage improved powerplant productivity at utilities in the State of Illinois, the U.S. Department of Energy sponsored a cooperative study with the Illinois Commerce Commission (ICC). Under the DOE/ICC program, the methodology previously

developed was applied at Commonwealth Edison Company's Quad Cities 1 and 2 nuclear units and Illinois Power Company's Wood River 5 coal unit by Trident Engineering Associates, Inc., a subcontractor. Based on predicted improvements in unit equivalent availability for eight projects developed by Trident, this report presents engineering economic analyses of costs and benefits. Technical assistance was provided to the Illinois Commerce Commission by the Energy Resources Center, University of Illinois at Chicago Circle.

Selection of Projects for Analysis

Although Phase A of Reference C provides detailed procedures for the identification of causes of lost productivity based on failure modes and effects and fault tree analyses, time constraints precluded their application in this study. Instead, the following criteria were established by the Illinois study team for use in the selection of projects.

IMPROVEMENT PROJECT SELECTION CRITERIA

Essential Criteria	Desirable Criteria
1. Hardware problem	1. Significant to plant operation
2. Repetitive problem	2. Undertaken or about to be undertaken by utility
3. Suitable to DOE methodology	3. Outage cause well understood
4. Technically feasible	4. Availability of improvement project
	5. Studied or recommended by utility
	6. Analyzed by a utility improvement project method

As a result of these constraints on the choice of projects, no argument can be offered that the projects represent the highest priority claims on utility resources. Nor are the projects selected necessarily the most serious cause of lost productivity. However, they constitute a considerable range of problem

types to which the DOE methodology can be applied.

The actual selection was accomplished by a detailed review of unit and component outage histories and station operating logs, performed by Trident Engineering Associates, Inc. Details of that selection process are provided in Reference D.

Estimation of Performance Impacts

After selecting eight projects for analysis, Trident Engineering Associates, Inc. applied the DOE developed methodology and estimated the probable change in future unit equivalent availability (EA) due to implementation of each project. Details of that procedure are presented in Reference C, and Trident's application may be found in Reference D. A summary of projects and associated unit performance impacts is provided below.

Summary of Performance Impacts		
Unit	Project	Performance Change
Wood River 5	3 Shift Mill Maintenance	Increased EA = 0.0194
"	Add Sixth Pulverizer	Increased EA = 0.0234
"	Replace Heater Tube Bundle	Increased EA = 0.00106 Reduced Heat Rate = 0.1%
Quad Cities 1	Electromatic Valve Modification	Increased EA = 0.0108
"	Construct Cooling Towers	Increased EA = 0.0317
"	Moisture Separator Drain Tank Modification	Increased EA = 0.00131
Quad Cities 2	Install Amertap System	Increased EA = 0.00374 Reduced O&M Expenditures = \$6,700/year
"	Feedwater Regulating Valve Modification	Increased EA = 0.0155

In addition to EA improvements estimated by Trident, one project was also found to improve unit heat rate, and another to reduce annual O & M expenditures. These latter impacts were established through consultation with utility engineering personnel.

Analysis of Costs and Benefits

Projects to improve the productivity of a generating unit by increasing its reliability or some other performance measure are attractive only if the value of the improved performance exceeds the cost of the project. The benefit/cost analysis in this study consists of assigning a dollar value to the unit performance changes brought about by implementation of the project, and comparing that value to the estimated cost of implementation.

Project cost estimates were developed largely by utility engineering personnel familiar with the problems, the unit, and prevailing rates for making engineering modifications. In many cases, estimates presented are preliminary, since utilities had not previously examined some projects. A greater resource commitment would be required to refine these estimates than was available for this task. Nonetheless, for several projects benefits so greatly exceeded estimated costs that even large errors in cost estimation would not alter the attractiveness of the project.

In order to translate improved plant availability benefits into dollar benefits it is necessary to make assumptions and projections concerning future unit loading and other variables, such as fuel costs and labor escalation rates. This is usually done through a production cost simulation model, which was used to estimate benefits for the Illinois Power Company Wood River 5 unit. For Commonwealth Edison's Quad Cities units, a straightforward estimate of replacement power costs (based on cost of power in the system's fossil units) was made.

The analyses yielded benefit to cost ratios ranging from 46 to 0.24, reflecting the influence of project selection criteria as well as opportunities for cost-justifiable improved productivity.

Participation of Utilities

Engineering and management personnel at both Illinois Power and Commonwealth Edison played a significant role in the development of cost estimates for the projects at their respective units and in providing clarification on internal procedures and assumptions used in performing engineering economic analyses. That participation greatly facilitated the preparation of this report and contributed substantially to the usefulness and accuracy of results.

Organization of Task Report

A general description of the approach followed in estimating costs and benefits and in presenting the results for the eight projects is provided in Section I, METHODOLOGY. This is followed by a brief technical description of the projects and their total cost, total benefits, Net Present Value, and benefit-to-cost ratio in Section II, PROJECT DESCRIPTIONS. Detailed cost and benefit summaries for each project are presented in Section III, PROJECT BENEFIT/COST ANALYSES. A DISCUSSION OF RESULTS, Section IV, provides some interpretive comments and concludes the task report.

Summaries of financial data and assumptions for Commonwealth Edison and Illinois Power which were used in the analyses of projects constitute Appendixes B and C, respectively.

I. METHODOLOGY

Procedures for performing engineering economic studies of industrial projects (i.e., benefit/cost analyses) are well developed and can be found in any standard textbook on the subject. This task follows the general approach described in Reference C with some minor exceptions which reflect internal differences between Commonwealth Edison and Illinois Power companies. Both companies follow generally accepted industry practices in conducting engineering economic studies and the presentations in this task report parallel those which would be prepared by the utilities if they were evaluating the projects described. The distinguishing characteristic of this report is the use of equivalent availability as the major focus of analysis, rather than capacity factor which is more traditionally used by utilities. Figure 1 is reproduced from Reference C and presents an overview of the process followed in this task.

1.1 Estimation of Costs

In the judgement of the utilities, all non-recurrent costs for the eight projects would be treated as capitalized expenditures, and this assumption is reflected in the analyses. Also, it was assumed that all projects could be implemented either during scheduled unit downtime or with no effect on unit operation; therefore, the cost of outage time for the improvements is not considered. For the remainder of the cost categories, Illinois Commerce Commission and Energy Resources Center personnel relied heavily on the engineering judgements of representatives of the two utilities who were familiar with the projects themselves and the units at which they would be implemented.

The quality or precision of the resulting cost estimates necessarily varies with the types of projects considered. In the case of three shift maintenance

Figure 1

on the Wood River 5 mills, estimation of future labor costs is relatively straightforward. For the addition of a sixth pulverizer at Wood River 5, however, cost estimates are very preliminary. This is largely due to questions concerning the technical feasibility and ultimate performance of the project. Since there is no source of data on how that project might have performed at other utilities, the estimates presented here are subject to considerable change. Of particular significance is the cost to the utility of obtaining more accurate estimates of probable project costs. In practice, depending on the outcome of a preliminary analysis as presented here, the utility would consider the option of further analysis and refinement of data.

In the case of the Electromatic Relief Valve project at Quad Cities, no cost data are provided. During the selection of candidate projects, the Electromatic Relief Valve case was proposed as a problem (cause of lost productivity) for which an appropriate or optimal technical fix had not yet been identified. It was agreed nonetheless that the maximum cost-justified expenditure on the problem would be useful information for the utility. This information could be of immediate value to plant engineers in eliminating from consideration those candidate solutions which exceed the cost-justified level. As was noted in the Trident report, however, the calculation of ΔEA for this project was predicated on the assumption that the solution actually adopted would contribute insignificantly to future unit forced outages. Since a perfect (outage-free) fix may not exist, the resulting dollar estimate of gross benefits must be viewed as a firm upper bound. In fact, if the Trident "no future outage" assumption fails significantly, then the corresponding estimate of ΔEA and the associated dollar benefits should be recalculated.

1.2 Estimation of Benefits

The development of dollar estimates of benefits resulting from project implementation involved two major steps. First, the impacts of the projects on future unit performance had to be identified and then quantified. The second step involved translating these performance impacts into economic terms. The scope of Trident Engineering Associates' contribution to this study was limited to providing estimates of project effects on future unit equivalent availability. Estimates of performance impacts on other variables, such as heat rate, average capacity, and O & M cost were established through discussions with plant engineering personnel knowledgeable about the projects under consideration. In only two of the eight projects were these variables found to be significant, one involving reduced heat rate and the other resulting in lower O & M costs. Quantification of these impacts consisted in direct application of engineering judgement; no formal modeling was used. Translation of these performance impacts into economic terms paralleled the procedure used for changes in unit equivalent availability.

Two different approaches were followed in translating performance impacts into dollar values, reflecting different procedures commonly in use at Illinois Power and Commonwealth Edison. Illinois Power ran the PROCOS production cost simulation model, first with base case (no project) assumptions about Wood River 5 availability, and then with the improved availability assumptions (with project). By running the model over the lives of the projects, differential production costs were determined for each project. These annual cost differentials, essentially due to fuel use differences, were discounted to 1978 dollars and summed. The production cost simulation approach was particularly appropriate for Illinois Power since a large nuclear unit is planned to commence operations

in the near future. This additional capacity is expected to materially influence the future loading of the Wood River 5 unit and the PROCOS simulation run accounts for this development.

Commonwealth Edison elected to estimate the system fossil replacement power cost for a one percentage point change in the equivalent availability of the Quad Cities units in current annual dollars. An average capacity factor of 0.60 was used in the estimate, so that only 60% of any increased generation availability is assumed to be used. In other words, $1\% \Delta EA \times 789 \text{ MWH} \times 0.60 \text{ CF} \times 8760 \text{ hrs} = 41,469 \text{ MWH/year}$ would be generated by each Quad Cities unit for each 1% increase in equivalent availability. When multiplied by the average fossil system replacement power costs, the current annual worth of that 1% improvement is obtained. That amount (\$600,000) was treated in this report as an average annual benefit, and was escalated at 6% and discounted at 10.1216% per year over the remaining life of the unit to obtain a present worth (1978\$) of \$9,013,500 per percentage point increase in equivalent availability. Average fossil system replacement costs are appropriate since any change in Quad Cities availability would not affect the other baseloaded nuclear units in the system. Assuming that for small changes in equivalent availability, the relationship between unit EA and system replacement power cost is approximately linear and symmetrical, this estimate provides a useful approximation to the desired benefit. Also, the Quad Cities units are expected to remain high on the company's loading order and thereby maintain historic capacity factors well into the future. It is interesting to note that an estimation of the value of ΔEA in terms of deferred capacity for Commonwealth Edison yielded comparable results. This lends additional confidence to the estimate of benefits.

Both methods of translating ΔEA 's into dollars have merit under the proper conditions. For relatively short project lives, the replacement power cost estimate

is almost always available. For longer term analyses, especially when substantial structural changes in the system are anticipated, a production cost simulation model run will generally yield more reliable results. In practice, utility engineering economic studies often start with rough first approximations to determine order of magnitude results and then proceed to more refined estimates as required.

1.3. Discussion of Benefit-Cost Comparisons

The comparison of benefits and costs as discussed in Reference C is accomplished through computation of a benefit-to-cost (B/C) ratio. This ratio is reproduced in this study because it is occasionally used in engineering economic analyses. The preferred figure of merit, however, is the Net Present Value (NPV) of the project, which is the net of present valued benefits minus present valued costs. This measure is considered preferable to the benefit/cost ratio for two reasons: (1) It yields the same numerical result whether a negative AO & M item (i.e., a reduction in O & M expenditures due to the project) is treated as a positive benefit or a negative cost. Depending on how a AO & M item is treated, the benefit/cost ratio method yields different results.* Since intuitively, identical results are expected regardless of treatment, this is a decided disadvantage of the benefit/cost ratio method. (2) Differences can arise in the ranking of projects depending on whether NPV or B/C criteria are used. Although under certain conditions project ranking is identical, NPV is preferred since it relates directly to the dual objective of maximizing stockholder position and providing minimum cost service to ratepayers.

* As an illustration of this problem, consider a project with costs of \$50 and benefits of \$25 in reduced O & M expenditures and \$100 due to other factors. If the \$25 is treated as a reduction in the cost of the project, $B/C = \$100/(\$50 - \$25) = 4$. But if the \$25 is considered a benefit instead $B/C = (\$100 + \$25)/\$50 = 2.5$. Note that the NPV method gives $\$125 - \$50 = \$75$ for both treatments.

However, since both criteria are used in industry, both are calculated and presented in this report for all of the projects except the Electromatic Relief Valve project, for which cost data were not available.

Addition of Sixth Pulverizer

Wood River 5

Project Description:

Wood River 5 currently uses five pulverizers to attain its maximum dependable capacity of 390 MW. Maximum unit output falls to approximately 340 MW if any of the pulverizers fails. Although environmental restrictions now limit output to 360 MW, addition of a sixth pulverizer would remove an historical source of unit load curtailments and increase unit equivalent availability if and when environmental constraints are lifted. This project involves adding a sixth pulverizer which would supply coal to the boiler in a dense phase (ten to one coal/air ratio) and thus require only a small diameter pipe with little boiler modification. Technical feasibility of this project is claimed by Combustion Engineering, although there appear to be some uncertainties associated with it. Assuming no failures of the sixth pulverizer, Trident Engineering Associates Inc. has estimated a maximum improvement in equivalent availability (ΔEA) for the project of 0.0234.

Estimated Project Costs (Present Worth): \$4,004,000

Estimated Project Benefits (Present Worth):

Due to ΔEA: \$1,082,000

Benefit/Cost Comparison:

Net Present Value of Project (NPV): -\$2,922,000

Benefit to Cost Ratio (B/C): 0.27

Three Shift Maintenance of Mills

Wood River 5

Project Description:

- Current practice at Wood River 5 is to use one or two shift maintenance for the repair of mill outages. This causes greater than minimum outage duration. When repairs are postponed over holidays and weekends, outage durations are further extended. This project involves continuous repair of mills, extending into three shifts and weekends and holidays when necessary. Trident Engineering Associates, Inc. has estimated an improvement in unit equivalent availability (AEA) of 0.0194 for this project.

Estimated Project Cost (Present Worth): \$2,423,000

Estimated Project Benefits (Present Worth):

Due to AEA: \$1,210,000

Benefit/Cost Comparison:

Net Present Value of Project (NPV): -\$1,213,000

Benefit to Cost Ratio (B/C): 0.5

Installation of New Tube Bundles in High Pressure Heaters

Wood River 5

Project Description:

High pressure feedwater heater tube leaks have degraded unit performance and have resulted in outages for repairs. This project consists of installing new tube bundles in the high pressure heaters. Assuming an equivalent meantime-to-outage equal to the expected tube lifetime, Trident Engineering Associates, Inc. has estimated a maximum improvement in unit equivalent availability (AEA) of 0.00106. This project is currently under serious consideration by Illinois Power Company. Analysis assumes replacement after 14 years.

Estimated Project Cost (Present worth): \$464,000

Estimated Project Benefits (Present Worth):

Due to AEA:	\$209,000	
Due to Improved Heat Rate:	<u>458,000</u>	
Total		\$667,000

Benefit/Cost Comparison:

Net Present Value of Project (NPV):	\$203,000
Benefit to Cost Ratio (B/C):	1.44

Moisture Separator Drain Tank Modification

Quad Cities 1

Project Description

Instrumentation currently mounted on the moisture separator drain tank is subject to intense vibration and has on previous occasions fallen off, resulting in faulty level signals being given to drain valves, causing them to close. This results in water backing up into the moisture separator itself, causing a turbine trip. The improvement project involves locating the transmitters elsewhere and installing now, faster acting valves. The upper limit on equivalent availability improvement (ΔEA) was estimated by Trident Engineering Associates, Inc. to be 0.00131, for the case in which no further outages occur in connection with the moisture separator drain tank instrumentation.

Estimated Project Cost (Present Worth): \$ 25,568

Estimated Project Benefits (Present Worth):

Due to ΔEA	\$1,180,769
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Benefit/Cost Comparison:

Net Present Value of Project (NPV):	\$1,155,201
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Benefit to Cost Ratio (B/C):	46
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Modification of Electromatic Relief Valves

Quad Cities 1

Project Description:

The electromatic relief valves are components of the main steam line piping and suffer from two design problems. On some of the valves, the locking arm has broken off or fallen off. Also, the disc retainer threads have shown minor indications of fretting, which may have caused nonoperation of the valves. This project differs from the others examined in that although several engineering fixes have been identified, none is certain to correct the problem. As a result, analysis of this project is limited to estimation of potential ΔEA benefits in dollar terms. Knowing the potential economic payoff will assist plant personnel in searching for a fix which does not exceed the value of the benefits. Assuming that electromatic relief valve related outages can be eliminated by the fix, a unit improvement in equivalent availability (ΔEA) of 0.0108 was estimated by Trident Engineering Associates, Inc.

Estimated Project Cost (Present Worth):

Unknown. Technical fix for problem has not yet been identified.

Estimated Project Benefits (Present Worth):

Gross benefits only, due to ΔEA:	\$9,734,580
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Benefit/Cost Comparison:

N/A

Modification of Feedwater Regulating Valves

Quad Cities 2

Project Description:

Each Quad Cities unit has two feedwater regulating valves to maintain reactor vessel water levels within prescribed limits. The original valves have a short (2") stroke and produce high turbulence with poor flow regulation. This problem has resulted in reactor scrams at both units. One of the short-stroke valves has been replaced with a drag valve at each unit. Drag valves, consisting of a series of discs and orifices, produce smooth flow characteristics. This project involves replacement of the remaining short-stroke valve at Quad Cities 2 with a drag valve. The maximum potential improvement in unit equivalent availability (ΔEA) from this project was estimated by Trident Engineering Associates, Inc. to be 0.0155. That estimate assumes a very large equivalent meantime-to-outage for the drag valve, which is confirmed by experience at Quad Cities. Plant personnel are currently evaluating performance of hydraulic and pneumatic actuated drag valves before changing the short-stroke valves.

Estimated Project Cost (Present Worth): \$ 351,979

Estimated Project Benefits (Present worth):

Due to ΔEA : \$13,970,925

Benefit/Cost Comparison

Net Present Value of Project (NPV): \$13,618,946

Benefit to Cost Ratio (B/C): 40

Install Amertap System

Quad Cities 2

Project Description:

Scale build-up fouling of condenser tubes has resulted in numerous unit deratings at Quad Cities 2. The Amertap system reduces condenser fouling with the continuous circulation of sponge balls through the condenser tubes. This improvement project consists of installing a commercial Amertap system. The improvement in unit equivalent availability estimated by Trident Engineering Associates for the Amertap system is 0.00374. This estimate assumes no outage hours or deratings due to the Amertap installation, since the Amertap equipment can be serviced with the unit on line without any deratings of the unit. It is noted that the Amertap system must be installed below all condenser lines and a major component of its cost is excavation and concrete work in an area dense with underground lines. Plant personnel are currently examining a Chemical water treatment approach to the reduction of condenser tube fouling as an alternative to the Amertap system.

Estimated Project Cost (Present Worth): \$ 371,232

Estimated Project Benefits (Present Worth):

Due to AEA: \$3,371,049

Due to Reduced
O&M Costs: 100,650

Total \$3,471,699

Benefit/Cost Comparison:

Net Present Value of Project (NPV): \$3,100,467

Benefit to Cost Ratio (B/C): 9.4

Installation of Cooling Towers

Quad Cities 2

Project Description:

Currently, the Quad Cities plant is cooled through a spray canal. As a result of non-emergency environmental restrictions on direct Mississippi River water cooling, Quad Cities 2 has suffered numerous deratings due to poor performance of the spray canal. This project involves installation of cooling towers to provide additional cooling. Assuming that no unit deratings occur due to the cooling towers (a reasonable assumption given the spray canal and river as backup), Trident Engineering Associates Inc. estimated a maximum improvement in equivalent availability (AEA) of 0.0317. It may be noted that an in-depth examination of the option of installing cooling towers at Quad Cities is currently underway by Commonwealth Edison.

Estimated Project Cost (Present Worth): \$119,740,580

Estimated Project Benefits (Present Worth):

Due to AEA: \$ 28,572,795

Benefit/Cost Comparison:

Net Present Value of Project (NPV): -\$91,167,785

Benefit to Cost Ratio (B/C): 0.24

III. PROJECT BENEFIT/COST ANALYSES

Cost Summary

Wood River 5 Improvement Project

Sixth Pulverizer

<u>Cost Item</u>	<u>Amount</u>
Materials (1981\$)	\$2,166,000
Contracted Work (1981\$)	1,889,000
Company Labor (1981\$)	<u>48,000</u>
Total Installation	\$4,103,000
AFDC ^a & Loadings ^b	<u>557,000</u>
Total (1981\$)	\$4,660,000

Levelized Carrying Charge Rate: 14.4%^c

Total Present Value of Revenue Requirements (1978\$): 4,004,000^d

Notes:

- (a) Allowance for Funds used During Construction
- (b) General and Administrative costs
- (c) 14.4% represents levelized annual carrying charge rate for the study period (through 1998). This rate is based on a composite life of the equipment of 34 years. See Illinois Power Company Data, page 52 for detail on composition of carrying charges.
- (d) Multiplying project cost (1981\$) by levelized carrying charge rate yields a uniform annual cost for the project. The total present value of revenue requirements (1981\$) is the sum of these annual amounts over 17 years, discounted at a 9.44% annual rate. This amount is discounted at 9.44% for 3.67 years to yield 1978\$.

Benefit Summary

Wood River 5 Improvement Project

Sixth Pulverizer

Performance Impacts:

$\Delta EA = 0.0234$

$\Delta HR = \text{None}$

Results:

Present Value of ΔEA : \$1,082,000^a

Net Present Value of Project (NPV)^c: -2,922,000^b

Benefit to Cost Ratio of Project (B/C): 0.27

Comments:

- (a) Represents 20 year differential production costs obtained by running PROCOS model with and without project.
- (b) Analysis shows project is not cost-justifiable.
- (c) PV Benefits minus PV Costs.

Cost Summary

Wood River 5 Improvement Project
Three Shift Pulverizer Maintenance

<u>Cost Item</u>	<u>Amount</u>
Annual Maintenance(1978\$)a	\$150,000/year
Total Present Value of Revenue Requirements:	\$2,423,000 ^b

Notes:

- (a) Assumes 12 persons at 50% time.
- (b) Based on 20 year remaining unit life, 8% annual labor cost escalation rate and 9.44% discount rate.

Benefit Summary

Wood River 5 Improvement Project
Three Shift Pulverizer Maintenance

Performance Impacts:

$\Delta EA = 0.0194$

$\Delta HR = \text{None}$

Results:

Present Value of ΔEA : \$1,210,000^a

Net Present Value of
Project (NPV)^c: -\$1,213,000^b

Benefit to Cost Ratio
of Project (B/C): 0.5

Comments:

- (a) Represents differential production costs obtained by running PROCOS model with and without project over 20 years.
- (b) Analysis shows project is not cost-justifiable.
- (c) PV Benefits minus PV Costs.

Cost Summary

Wood River 5 Improvement Project

Heater Bundle Replacement

<u>Cost Item</u>	<u>Amount</u>	
	<u>1979\$</u>	<u>1993\$^a</u>
Materials	200,000	514,000
Contracted Labor	90,000	231,000
Totals	290,000	745,000

Heater Bundle Replacement in 1979:

Levelized Carrying Charge Rate based on 14 year life: 15.6%^b

Present Value of Revenue Requirements for 1979 Replacement:

<u>1979\$</u>	<u>1978\$</u>
\$343,000 ^c	\$313,000 ^d

Heater Bundle Replacement in 1993:

Levelized Carrying Charge Rate Based on 6 year life: 17.7%^b

Present Value of Revenue Requirements for 1993 replacement:

<u>1993\$</u>	<u>1978\$</u>
\$586,000 ^c	\$151,000 ^d

Total Present Value of Revenue Requirements for Project (1978\$): \$464,000

Notes:

- (a) Escalated at 7% annual rate for 14 years.
- (b) See Illinois Power Company Data, Page 52 for LCCR detail.
- (c) Present Value of Project cost is multiplied by levelized carrying charge rate to yield uniform annual cost of project over its life. These annual amounts are discounted at 9.44% and summed to give PVER.
- (d) Discounted to 1978\$ at 9.44% annual rate.

Benefit Summary

Wood River 5 Improvement Project

Heater Bundle Replacement

Performance Impacts:

$\Delta EA = 0.00106$

$\Delta HR = 0.1\%$

Results:

Present Value of ΔEA : \$209,000^a

Present Value of ΔHR : \$458,000^b

Total \$667,000

Net Present Value of Project (NPV)^d: \$203,000^c

Benefit to Cost Ratio of Project (B/C): 1.44

Comments:

- (a) Represents 20 year differential production costs obtained by running PROCOS model with and without project.
- (b) Represents 20 year differential production costs obtained by running PROCOS model with and without project. Assumes 40% capacity factor and \$1.50/MBTU fuel cost.
- (c) Analysis shows project to be cost-justifiable.
- (d) PV Benefits minus PV Costs.

Cost Summary
 Quad Cities 1 Improvement Project
 Moisture Separator Drain Tank Modification

<u>Cost Item</u>	<u>Amount</u>	
Materials (1978)	\$ 5,000	
Company Labor (1978)	<u>10,000</u>	
Total	\$15,000	
Present Value of Carrying Charges ^a (PVCC Multiplier = 1.7045)		\$ 25,568
Total Present Value of Revenue Requirements		\$ 25,568

Notes:

- (a) See Commonwealth Edison Company Data, page 51 for PVCC multiplier detail.

Benefit Summary

Quad Cities 1 Improvement Project
Moisture Separator Drain Tank Modification

Performance Impacts:

$\Delta EA = 0.00131$

$\Delta HR = \text{None}$

Results:

Present Value of ΔEA : \$1,180,769^a
($0.131 \times \$9,013,500$)

Net Present Value of Project (NPV): \$1,155,201

Benefit to Cost Ratio of Project (B/C): 46

Comments:

- (a) Currently, a 1 percentage point improvement in Quad Cities equivalent availability is valued at \$600,000 per year. For a 6% annual fuel cost escalation rate and a 10.1216% discount rate, a 1 percentage point improvement in EA has a present value of \$9,013,500 for the remaining 23 years of plant life.
- (b) Project could possibly reduce O&M costs on tank level instrumentation which would further increase cost effectiveness of project. Project is decidedly cost effective.
- (c) PV Benefits minus PV Costs.

Benefit Summary

Quad Cities 1 Improvement Project

Electromatic Relief Valve Modification

Performance Impacts:

$\Delta EA = 0.0108$

$\Delta HR = \text{Unknown}$

Results:

Present Value of ΔEA : \$9,734,580^a
(1.08 x \$9,013,500)

Net Present Value of Project (NPV)^c: Unknown^b

Benefit to Cost Ratio of Project (B/C): Unknown^b

Comments:

- (a) Currently, a 1 percentage point improvement in Quad Cities equivalent availability is valued at \$600,000 per year. For a 6% annual fuel cost escalation rate and a 10.1216% discount rate, a 1 percentage point improvement in EA has a present value of \$9,013,500 for the remaining 23 years of plant life.
- (b) A specific technical fix for this project has not yet been identified. Since cost data are not available, NPV and B/C cannot be calculated. This analysis provides an upper bound on justifiable costs for use by plant engineering personnel, however.
- (c) PV Benefits minus PV Costs.

Cost Summary

Quad Cities 2 Improvement Project
Feedwater Regulating Valve Modification

<u>Cost Item</u>	<u>Amount</u>
Company Labor (1978\$)	\$ 1,500
Materials (1978\$)	90,000
Contracted Work (1978\$)	115,000
	<hr/>
Total	\$206,500
Present Value of Carrying Charges ^a (PVCC Multiplier = 1.7045)	\$351,979
Total Present Value of Revenue Requirements	\$351,979

Notes:

- (a) See Commonwealth Edison Company Data, page 51 for PVCC multiplier detail.

Benefit Summary

Quad Cities 2 Improvement Project

Feedwater Regulating Valve Modification

Performance Impacts:

$\Delta EA = 0.0155$

$\Delta HR = \text{None}$

Results:

Present Value of ΔEA : \$13,970,925^a
(1.55 x \$9,013,500)

Net Present Value of Project (NPV)^c: \$13,618,946

Benefit to Cost Ratio of Project (B/C): 40

Comments:

- (a) Currently, a 1 percentage point improvement in Quad Cities equivalent availability is valued at \$600,000 per year. For a 6% annual fuel cost escalation rate and a 10.1216% discount rate, a 1 percentage point improvement in EA has a present value of \$9,013,500 for the remaining 23 years of plant life.
- (b) Project could result in some reduction in O&M expenditures which would further increase its cost effectiveness.
- (c) PV Benefits minus PV Cost.

Cost Summary

Quad Cities 2 Improvement Project

Installation of Amertap

<u>Cost Item</u>		<u>Amount</u>
Initial Expenditures:		
Materials (1978\$)		\$30,000
Contracted Work (1978\$)		60,000
Total		<hr/> \$90,000
Present Value of Carrying Charges ^a (PVCC Multiplier=1.7045)		\$153,405
Recurrent Costs:	<u>Per Year</u>	<u>PV (1978\$)^b</u>
Operations (Labor)	\$7,500	\$112,669
Maintenance		
Materials	2,000	30,045
Labor	5,000	75,113
Totals	<hr/> \$14,500	<hr/> \$217,827
Total Present Value of Revenue Requirements		\$371,232

Notes:

- (a) See Commonwealth Edison Company Data, page 51 for PVCC multiplier detail.
- (b) Based on 10.1216% incremental cost of money and 6% annual escalation rate for 23 years.

Benefit Summary

Quad Cities 2 Improvement Project

Installation of Amertap

Performance Impacts:

$\Delta EA = 0.00374$

$\Delta HR = \text{Negligible}$

$\Delta OMC = \$6,700 \text{ per year}$

Results:

Present Value of ΔEA : $\$3,371,049^a$
($0.374 \times \$9,013,500$)

Present Value of ΔOMC : $\$100,650^b$

Total Present Value of Benefits: $\$3,471,699$

Net Present Value of Project (NPV)^d: $\$3,100,467$

Benefit to Cost Ratio of Project (B/C): 9.4

Comments:

- (a) Currently, a 1 percentage point improvement in Quad Cities equivalent availability is valued at \$600,000 per year. For a 6% annual fuel cost escalation rate and a 10.1216% discount rate, a 1 percentage point improvement in EA has a present value of \$9,013,500 for the remaining 23 years of plant life.
- (b) Based on 10.1216% incremental cost of money and 6% annual escalation rate for 23 years.
- (c) Project is clearly cost effective.
- (d) PV Benefits minus PV Costs.

Cost Summary

Quad Cities 2 Improvement Project

Cooling Towers

<u>Cost Item</u>	<u>Amount</u>
Initial Expenditures:	
Contracted Labor & Materials (1978\$)	\$63,000,000
• Present Value of Carrying Charges ^a (PVCC Multiplier = 1.8458)	\$116,285,400
Recurrent Costs:	
	<u>Per Year</u> <u>PV (1978\$)</u>
Operations	\$30,000 \$450,676
Maintenance (Materials and Labor)	200,000 3,004,504
	<hr/>
Totals	\$230,000 \$3,455,180
<hr/>	
Total Present Value of Revenue Requirements	\$119,740,580

Notes:

- (a) See Commonwealth Edison Company Data, page 51 for PVCC multiplier detail
- (b) Based on 10.1216% incremental cost of money and 6% annual escalation rate for 23 years.

Benefit Summary

Quad Cities 2 Improvement Project

Cooling Towers

Performance Impacts:

$\Delta EA = 0.0317$

$\Delta HR = \text{Negligible}$

Results:

Present Value of ΔEA : \$28,572,795^a
($3.17 \times \$9,013,500$)

Net Present Value of Project (NPV)^c: $-\$91,167,785^b$

Benefit to Cost Ratio of Project (B/C): 0.24

Comments:

- (a) Currently, a 1 percentage point improvement in Quad Cities equivalent availability is valued at \$600,000 per year. For a 6% annual fuel cost escalation rate and a 10.1216% discount rate, a 1 percentage point improvement in EA has a present value of \$9,013,500 for the remaining 23 years of plant life.
- (b) Project implementation was assumed to be immediate. Actual construction time is likely to exceed 3 years, increasing costs and delaying benefits. As analyzed, project assumed use of spray canal as back-up cooling. Such use may not be cost effective due to high O&M costs of spray canal and relatively small improvement in unit EA provided by spray canal backup. !
- (c) PV Benefits minus PV Costs.

IV. DISCUSSION OF RESULTS

As a result of the foregoing analyses, it can be seen that the DOE methodology (Reference C) provides a workable, systematic framework for the estimation of costs and benefits of candidate productivity improvement projects. The use of equivalent availability as a performance measure does not appear to present any serious problems when compared, for example, with capacity factor. In fact, the traditional practice of evaluating projects in terms of their impact on unit capacity factor requires some assumptions about future unit availability.

There is a second-order interaction between equivalent availability and capacity factor which is not captured by the method used to estimate benefits for the Quad Cities units. A purely baseloaded unit (no load following) is assumed to be required to meet load at rated capacity on a continuous basis. For such units, equivalent availability and capacity factor are numerically equal, and an increase in equivalent availability translates directly into an equal increase in capacity factor. This occurs because any increase in availability can be fully used in serving load--the question of temporal coincidence of availability and load requirements does not arise. However, the Quad Cities units are to some degree load following. The extent to which an increase in equivalent availability results in increased capacity factor depends entirely on whether it occurs when it can be economically used by the system. In general, at least some increased availability will coincide with load requirements during a period of a year, thereby raising capacity factor by some amount. From the definitions of capacity factor and equivalent availability, it follows that for a given percentage point improvement in equivalent availability, capacity factor can increase by a maximum of the same number of percentage points. Any numerical difference between equivalent availability and capacity factor

is accounted for entirely by noncoincidence of unit load and availability.

This measure, or alternatively the ratio of capacity factor to equivalent availability, could be used as an index of the degree to which a unit approaches a purely baseloaded status. A similar index was suggested in Reference E, based on the ratio of capacity factor to availability factor. This ratio was called Output Factor and was suggested as a measure of the disparity between capacity factor and availability factor, possibly brought about by unit deratings. By using equivalent availability in the denominator in place of availability factor, the effects of any deratings are eliminated, since they affect both terms equally.

In estimating the benefits of a 1 percentage point improvement in the equivalent availability of the Quad Cities units, a capacity factor assumption of 0.60 was used. That is, 60% of the increased generation availability was assumed to occur at a time when it could be economically used to serve load. However, 0.60 was the pre-improvement capacity factor. After the improvement (i.e., because of it) the capacity factor could rise as high as 0.61, in which case 61% of the increased generation availability would be used. As a first approximation, for small changes in equivalent availability, it is a reasonable and conservative simplification to assume no change in capacity factor. The result is to understate benefits at most by a factor of ΔEA . For a project offering a large improvement in equivalent availability, this effect could be significant. A production cost simulation model should be capable of automatically adjusting unit capacity factor in response to improved equivalent availability. This is usually accomplished by spreading the increased unit availability uniformly over the period of interest. If it is known that the improved availability will occur at specific times (e.g., during load peaks) this information could also be utilized by the model.

It is noteworthy that the dollar value of even a modest improvement in unit equivalent availability at Wood River 5 and Quad Cities 1 and 2 is substantial. Table 2 summarizes the value of a 1 percentage point improvement in unit EA in 1978\$.

Table 2

Unit	Project	Cumulative Present Worth of a 1 %-age Point Improvement in Equivalent Availability (1978\$)
Quad Cities 1	All	\$9,013,500
Quad Cities 2	All	\$9,013,500
Wood River 5	Heater Bundle	\$1,971,968
Wood River 5	Sixth Pulverizer	\$ 462,393
Wood River 5	Three Shift Maintenance	\$ 623,711

A range of values resulted for the Wood River 5 unit. From the data in Table 2, it appears that the Sixth Pulverizer project with a AEA = 0.0234 yields smaller benefits than the 3 Shift Maintenance Project which has a AEA = 0.0194. This inconsistency is explained completely by considering that Three Shift maintenance would begin immediately and thus benefits would also begin immediately. The Sixth Pulverizer, however, would not be completed until 1981, at which time benefits would begin. By accounting for this difference, it has been verified that the dollar value of a 1 %-age point improvement in equivalent availability is close agreement for the two projects, as was expected.

Differences between Three Shift Maintenance and the Heater Bundle projects are more difficult to account for. Illinois Power Company representatives suggested that the Wood River 5 unit is a borderline unit in the company's loading order. Small changes in generation cost or availability produce large changes in the loading of that unit, thereby showing the impact of system interaction produced by the use of a production costing model. Of greater interest, however, are the differences between Table 2 values for the Quad Cities and Wood River 5 units. These differences can be illuminated by comparing the role of the units in their respective systems. The Quad Cities units are relatively new nuclear units operating in essentially baseloaded modes. If any change in the equivalent availability of these units should occur, the effect will be to increase or reduce the load on the Commonwealth Edison fossil system units, since the other nuclear units in the system are baseloaded. Since the average fossil system generation costs are higher than the Quad Cities generation costs (approximately 1.4¢/kwh differential), equivalent availability improvements in the Quad Cities units have high dollar values. In addition, each of the Quad Cities units has a capacity of 789 MW, in contrast to 360 MW for the Wood River 5 unit. The Wood River 5 unit is ranked relatively low on the Illinois Power Company loading order, and any change in the equivalent availability of that fossil unit would affect only fossil units of approximately the same ranking (i.e., with approximately the same generation costs). This results in a relatively small differential which is reflected in the lower entries in Table 2. These results confirm that for small improvements in unit equivalent availability, potential dollar benefits are greatest for the most efficient (economical) units in the system. For a system with a coal/nuclear mix, nuclear units could be

expected to achieve greater potential savings than coal units. For a fossil system with approximately uniform generation costs for all large units, potential benefits of improved equivalent availability are likely to be less, but not necessarily insignificant.

APPENDIX A

REFERENCES

- A. A Report on Improving the Productivity of Electric Powerplants, Federal Energy Administration, March, 1975
- B. Phase 2 Report: "Analysis of Two Utility Systems and Regions", Center for Energy Systems, General Electric Company, Washington, D.C. December 1977
- C. Powerplant Productivity Improvement Study, U.S. Department of Energy, February, 1978. HCP/B60830.
- D. Powerplant Productivity Improvement Study, Trident Engineering Associates, Inc., Annapolis Maryland, Draft Final Report, September 14, 1978.
- E. Use of Nuclear Plant Operating Experience to Guide Productivity Improvement Programs, Electric Power Research Institute, November 1975.

APPENDIX B

Commonwealth Edison Company Data

Quad Cities 1 and 2

Unit Net Capacity: 789 MW each

Remaining Useful Life: 23 Years ^a

Start of Commercial Operations: QC1 - April, 1972; QC2 - May 1972

Unit Loading: Baseloaded

Escalation Rates: 6% per year, all cost categories

Composite Incremental Cost of Money (for calculating present value): 10.1216%

Present Value of Carrying Charges (PVCC) Multiplier ^b:

For Construction Schedules greater than 2 years: 1.8458

For Construction Schedules less than 2 years: 1.7045

a Based on assumed 30 year initial useful life. This assumption is currently under company review and is likely to be changed to 40 years for engineering economic studies.

b PVCC multiplier is based on 10.1216% incremental cost of money, 52% Federal and State Income Tax rate, Straight Line tax and book depreciation. Gross salvage value is assumed to be 10% or less of investment cost. Indirects, Real Estate tax, Personal Property Tax, State Capital Stock tax and insurance cost are not included.

APPENDIX C

Illinois Power Company Data

Wood River 5

Wood River 5 Maximum Dependable Capacity: 398 MW

Average Maximum Capacity: 360 MW

Remaining Useful Life: 20 Years

Start of Commercial Operations: July, 1964

Unit Loading: Semi-baseloaded

Escalation Rates:

Capital: 8% per year

Non-fuel O&M: 9.7% per year

Coal: 10.5% per year

Oil: 10.9% per year

Labor: 8% per year

Minimum Acceptable Return (MAR) for calculating present value: 9.44%

Levelized Carrying Charge Rates are based on: Depreciation Switching, Federal and State Income Taxes, Investment Tax Credit, Local Property Taxes, Insurance, Gross Receipts Tax, Company Debt Ratio, and projected interest rates.