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BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

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| In re: Petition of Florida Power Corporation for determination that its plan for curtailing purchases from Qualifying Facilities in minimum load conditions is consistent with Rule 25-17.086, F.A.C. | DOCKET NO. 941101-EQ<br>FILED: April 10, 1995 |

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DIRECT TESTIMONY AND EXHIBITS

OF

KENNETH J. SLATER

ON BEHALF OF

ORLANDO COGEN LIMITED, L.P.

AND PASCO COGEN, LTD.


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**DOCKET NO. 941101-EQ**

**Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.**

A. My name is Kenneth J. Slater and my business address is 3370 Habersham Road, Atlanta, Georgia 30305.

**Q. BY WHOM ARE YOU EMPLOYED?**

A. I am president of my own consulting firm, Slater Consulting, which I founded in 1990.

**Q. PLEASE PROVIDE YOUR EDUCATIONAL BACKGROUND AND PROFESSIONAL EXPERIENCE.**

A. I hold a Bachelor of Science degree in Pure Mathematics and Physics and a Bachelor of Engineering degree in Electrical Engineering from the University of Sydney in Australia. I also hold a Master of Applied Science degree in Management Sciences from the University of Waterloo in Ontario, Canada. I have over thirty years of experience in the energy and utility industries of, collectively, the United States, Canada and Australia. I have appeared as an expert witness in regulatory hearings at FERC and in California, Florida, Georgia, Idaho, Indiana, Iowa, New Mexico, New York, Nova Scotia, Ontario, Prince Edward Island and Texas, and in civil arbitration proceedings in Louisiana and Pennsylvania. I have also been called upon as an expert examiner on many occasions for a Royal Commission in Ontario.

Prior to founding Slater Consulting, I was Senior Vice President and Chief Engineer at Energy Management Associates, Inc. (EMA) in Atlanta, where I worked from 1983 to 1990. At EMA, after initially contributing to the firm's utility software development functions, I became the head of its consulting practice, leading or making significant contributions to a number of important consulting engagements related to valuation or analysis of power supplies and power supply contracts, generation planning, damages assessments, operating reserve requirements, replacement power cost calculations, gas supply studies, utility merger valuations, operational integration of utility systems, power pooling, system reliability, ratemaking, and power dispatching.

From 1969 until 1983, I worked in the Canadian utility industry, initially at Ontario Hydro, where I headed the Production Development Section of the utility's Operating Department. There I developed computer models, including one which, for more than 20 years, produced the daily generation schedules for the

Ontario Hydro system, and another, the original PROMOD, which was used for coordination and optimization of production planning and resource management. Subsequently, I worked as Manager of Engineering at the Ontario Energy Board (the utility regulatory commission) and as Research Director for the Royal Commission on Electric Power Planning.

From 1976 to 1983, I ran my own firm, Slater Energy Consultants, Inc., and consulted widely in Canada and the United States for utilities, governments, public enquiry commissions, utility customers and other consulting firms. It was during this time and my time at EMA that I was a major developer of PROMOD III®.

Prior to 1969, I was employed by the Electricity Commission of New South Wales, the largest electric utility in Australia, where I was responsible for the day-to-day operation of one of the six regions comprising that system. My resume is attached as Exhibit No. __ (KJS-1).

Q. **WHAT IS THE PURPOSE OF YOUR TESTIMONY?**

A. I have been asked by Orlando Cogen Ltd. and Pasco Cogen Ltd. to comment on several aspects of Florida Power Corporation's (FPC) proposed curtailment plan.

Q. **HOW DOES YOUR TESTIMONY RELATE TO THAT OF DR. ROY SHANKER?**

A. Dr. Shanker and I coordinated our efforts, and our testimony is complementary. Dr. Shanker's conclusions stem largely from an analysis of legislative history, while my views are more deeply rooted in operational considerations. Dr. Shanker and I both stress the distinction between planning decisions (which do not support curtailments) and "operational circumstances" (which may support curtailments only if QF purchases would result in negative avoided costs).

**Q. PLEASE EXPLAIN WHAT YOU MEAN BY AN APPROACH ROOTED IN OPERATIONAL CONSIDERATIONS.**

A. I believe the analysis of FPC's proposed plan must begin with a fundamental identification of the nature and type of increased "costs" that justify curtailment. Only where operational circumstances cause a utility to experience increases in variable production costs as a result of accepting QF energy, can a utility curtail those QF purchases. The industry has coined the term "negative avoided costs" to recognize the correlation between what the utility would pay the QF for decreases in variable production costs as a result of accepting its energy under normal conditions and what the QF would logically be required to pay the utility, for its "as-available" energy deliveries, if variable production costs went up instead of down upon receipt of QF generation. I have assessed FPC's proposed plan as it relates to the existence of operational circumstances necessary to justify curtailment, and I have examined FPC's approach to quantifying what it sees as negative avoided costs.

Q. **WHAT CONCLUSIONS HAVE YOU REACHED REGARDING FPC'S PROPOSED PLAN AND THE LEGITIMACY OF CURTAILMENTS THAT IT HAS CONDUCTED PURSUANT TO THE PROPOSED PLAN TO DATE?**

A. I conclude that FPC's proposed plan is deficient in several respects. First, FPC's plan improperly subordinates firm QF purchases to FPC's purchases from other utilities. Second, FPC does not include any forward planning to eliminate minimum load problems through realistic unit commitment. Third, FPC's plan fails to require that FPC attempt to market excess generation at a price designed to ensure a sale, prior to curtailing firm QF purchases. Fourth, even if the Commission were to determine that "operational circumstances" were present and FPC had exhausted all avenues to balance load with generation, FPC has distorted the quantification of the avoided costs associated with its purchases of firm QF generation by performing the quantification for an unrealistically short duration of QF purchases. Finally, FPC exaggerates the operational costs by treating "unit impact costs" as production costs. If they exist, such costs are hardware and maintenance costs and are relevant only as to utility planning decisions. They should not affect short-term operational decisions.

<u>FPC'S PURCHASES FROM OTHER UTILITIES</u>

Q. **PLEASE DESCRIBE FPC'S PROPOSED TREATMENT OF FIRM PURCHASES FROM OTHER UTILITIES DURING LOW LOAD SITUATIONS.**

A. FPC has contracted to buy firm power from Southern Company under the terms of a unit power sales (UPS) agreement. Under the agreement, FPC has certain contractual "must take" obligations whenever informed by Southern that one or more of the units supplying the contracted power is at its minimum operating level. Under its proposed plan, FPC would subordinate firm QF purchases to its UPS obligations.

In two of the seven curtailment incidents encompassed by Mr. Southwick's testimony, actual hourly minimum takes for FPC's Southern Company purchases exceeded the hourly levels of curtailment.

Q. **DOES THIS TREATMENT COMPLY WITH THE CURTAILMENT REGULATIONS?**

A. No.

Q. **WHY NOT?**

A. Again, two considerations bear on the treatment that is required of FPC. Dr. Shanker has pointed out that, in terms of legislative policy, PURPA prefers cogeneration. Congress created a mandatory market for QF generation to overcome utilities' reluctance to purchase from cogenerators. From that standpoint alone, FPC's priorities violate the intent of PURPA.

My point is a related one, and again is based on operational considerations. The FERC rule (which the Commission's rule implements) authorizes curtailment only if QF purchases alter the utility's production costs. Minimum payments made to a selling utility -- even for energy not taken -- do not constitute production costs, and so are irrelevant to the measurement of FPC's avoided costs that are associated with purchases from QFs. FPC's plan is deficient because it contemplates curtailing QFs in order to accept this minimum level of power purchased from Southern Company.

In 1989, the New York Public Service Commission found proposed utility curtailment plans to be deficient for the same reason.

## INADEQUATE OPERATIONAL PLANNING

Q. **HOW DOES FPC'S CURTAILMENT PLAN FAIL TO USE FORWARD PLANNING TO AVOID THE MINIMUM LOAD PROBLEMS WHICH CAN DEGENERATE INTO IMBALANCES BETWEEN GENERATION AND LOAD?**

A. An examination of the unit commitment situations during the seven curtailment incidents described in Mr. Southwick's testimony plainly indicates that FPC failed to use forward planning to eliminate minimum load problems. Table 1, Exhibit No. ___ (KJS-2), displays the FPC generating units which were committed during each curtailment incident. In each case, at least four out of five of FPC's Crystal River base load units were committed, along with the University of Florida cogeneration unit. In four of the seven cases, all five Crystal River units were committed, and in two of these four cases, one or two cycling units were also on line.

Such high levels of capacity commitment appear to be inviting minimum load problems. Forward planning could have been used to eliminate these situations which led to curtailment incidents.

Q. **IF FPC HAD REDUCED ITS COMMITMENT OF BASE LOAD CAPACITY PRIOR TO EACH OF ITS CURTAILMENT INCIDENTS, WOULD ITS OPERATIONAL COSTS HAVE INCREASED?**

A. Operational costs could have increased as a result of committing a realistic level of base load capacity. To deliberately maintain a higher level of base load capacity commitment in order to achieve cost savings is a decision which the utility should make only if it recognizes that the consequences may precipitate a minimum load problem. Elimination of any subsequent minimum load in such a scenario should then become the responsibility of the utility without the involvement of its QF suppliers.

Any attempt to use curtailment in such cases of voluntary utility overcommitment of base load resources would be a misuse of the PURPA curtailment provisions.

Q. **WOULD THE NON-COMMITMENT OF ONE OF FPC'S BASE LOAD UNITS, DURING THE TIME OF EACH CURTAILMENT INCIDENT HAVE CAUSED FPC TO HAVE DIFFICULTY MEETING ITS PEAK LOAD ON THE SAME DAY?**

A. No. As Table 2, Exhibit No. ___ (KJS-3), demonstrates, there was abundant uncommitted cycling capacity, peaking capacity, and UPS energy from Southern Company available for use to meet FPC's peak load on each of the curtailment days, in place of one of its base load units.

INCREASED SALES TO OTHER UTILITIES OR CUSTOMERS

Q. **HOW DOES FPC'S PROPOSED PLAN FAIL TO REQUIRE FPC TO MARKET EXCESS GENERATION AS A MEANS OF BALANCING GENERATION AND LOAD?**

A. FPC can offer the excess generation for sale at any price that is zero or greater than zero without incurring negative avoided costs. Dr. Shanker has established that there is no impediment in the form of incremental cost concepts that prevents FPC from offering such a price.

Q. **PLEASE EXPLAIN HOW FPC CAN SELL POWER AT A PRICE OF ZERO**

**OR ABOVE WITHOUT INCURRING NEGATIVE AVOIDED COSTS.**

A. Again, it is essential to keep the limitations on the FERC's "special dispensation" firmly in mind. Only if purchases (during operational circumstances) would cause a utility to incur greater production costs than it would incur in the absence of purchases from QFs can the utility curtail those purchases. Therefore, if the utility can market an amount of power equal to the amount of power it would otherwise curtail, the QF deliveries have affected neither the utility's level of generation nor its production costs and the utility has experienced no negative avoided costs. In fact, any positive revenue from such sale results in the utility having a positive avoided cost relative to that energy which is sold.

Q. **PLEASE ILLUSTRATE YOUR POINT.**

A. I will do so by reference to Exhibit No. ___ (KJS-4). This exhibit is designed to illustrate the impact on production costs of a sale equivalent in amount to a utility's excess generation.

The left hand bar graph shows the excess condition prior to the sale. The utility's units are at minimum generating levels and QFs are delivering 200 MW of capacity. Together, generation by the utility and QFs exceed system load by 100 MW.

The middle bar graph shows the condition in which the utility has curtailed QF purchases by 100 MW to balance generation and load. The generation of QFs decreases: The utility's generation is unchanged.

The right-hand bar graph shows the condition in which the utility sells 100 MW to another utility, continues to purchase 200 MW from QFs, and achieves a balance between generation and load at the higher level of total generation. The QFs deliver their generation; the utility's generation is unchanged.

As Exhibit No. ___ (KJS-4) shows clearly, if the utility sells the excess 100 MW, the resulting amount of generation by the utility (and the associated costs of production) will be identical to the amount of the utility's generation in the curtailment scenario. Said differently, if the utility markets the excess generation, then deliveries by QFs do not affect the production costs that the utility would incur on its own units as compared to the alternative of curtailing QFs to the extent needed to match generation and load, except that the revenue from the sale of the excess energy results in a positive avoided cost for the utility for the QF deliveries which would otherwise be curtailed.

Q. **DOESN'T FPC'S PROPOSED PLAN RECOGNIZE THE ALTERNATIVE OF MARKETING EXCESS GENERATION?**

A. FPC's approach to this point is deficient in one crucial respect.

Q. **PLEASE EXPLAIN.**

A. FPC places a floor on the price it will quote for sales during low load situations equal to the incremental cost it would incur to generate during normal situations.

Q. **WHAT'S WRONG WITH THAT?**

A. As Dr. Shanker points out, in scenarios which involve excess generation due to must-run units and firm QF purchases, the utility's incremental cost of generating the excess is zero. My related operational point is that, for the purpose of determining whether QFs cause the utility to incur negative avoided costs, the price at which the excess is offered for sale is unrelated to costs incurred to produce and is therefore irrelevant to the calculation of avoided costs. The result of these two principles is that FPC can offer the excess generation at any price above zero without causing the avoided cost calculation to show a negative result. If it finds a buyer at any positive price, then it has matched generation and load without curtailing QFs and without incurring negative avoided costs.

Q. **ISN'T THE IDEA OF REQUIRING A UTILITY TO SELL ITS GENERATION AT ANY PRICE ABOVE ZERO A RADICAL CONCEPT?**

A. Not at all. It is no different than the concept of "dump energy," which is a fairly common, well documented utility practice.

Q. **CAN YOU ELABORATE?**

A. An excellent example of dump energy pricing occurs in the New York Power Pool where the pool pricing rule for intra-pool economy energy transactions is a "split-the-savings" arrangement. The selling price is half way between the average of the seller's incurred costs and the average of the buyer's displaced costs. When a utility is dumping excess generation during minimum load situations, the cost attributed to that seller is zero.

A further example of dump energy pricing is the procedure followed in the PJM Pool, whereby intra-pool economy energy transactions are priced at the pool "running rate", which is the <u>pool's</u> incremental generation cost. For a utility in a minimum load situation selling its excess generation, the selling price would be the incremental generation cost for the <u>pool's</u> marginal unit(s), which of necessity would be below the incremental generation cost of any of the <u>selling utility's</u> units.

Q. **WOULD LOW PRICED SALES HAVE ALTERED THE PERCEPTION OF FPC'S AVOIDED COSTS DURING THE CURTAILMENT INCIDENTS DISCUSSED IN MR. SOUTHWICK'S TESTIMONY?**

A. If the energy that was curtailed in each of Mr. Southwick's seven curtailment episodes had instead been sold, at any price above zero, then there would have been no curtailment and no possibility of negative avoided costs. There would also have been no "operational circumstances."

"UNIT IMPACT" COSTS

**Q. WHAT ARE THE "UNIT IMPACT COSTS" TO WHICH YOU REFER?**

A. In his testimony, FPC witness Mr. Lefton describes the impacts -- in terms of life cycle costs -- of a decision to change a generating unit's mode of operation. He purports to quantify such "unit impact costs" in terms of dollars per cycling event. Mr. Southwick then incorporates the costs developed by Mr. Lefton in certain of his comparisons of production costs with and without QF generation. Obviously, including such costs penalizes the QF purchase "scenario."

**Q. DO YOU DISAGREE WITH MR. LEFTON'S PREMISE?**

A. I don't disagree with the proposition that adopting a cycling mode of operation for a unit designed for non-cycling base load operation would ultimately affect capital and maintenance costs. However, it is grossly inappropriate to include the costs calculated by Mr. Lefton in the decision to curtail QF purchases or not to curtail them. (In this regard, the Commission should bear two things in mind. First, neither FPC nor Mr. Lefton attributes FPC's need to cycle units designed for base load operation to FPC's present, temporary low load situation. That change in operational modes has already occurred. Second, much of the "cycling activity" consists, not of shutting down and starting up units, but of changing their levels of output to track fluctuations in load. The decision to curtail or not will have very little effect on the extent to which FPC must engage in this form of cycling.)

Q. **WHY DO YOU BELIEVE IT IS INAPPROPRIATE TO INCLUDE THESE COSTS?**

A. First, any such "unit impact costs" are the results of planning choices made years ago. Whether they are the result of conscious long-term economic trade-offs or simply of poor choices, any such impacts should be borne by the utility, not the QFs with whom it has contracted to buy firm power.

Next, it is fundamentally improper to incorporate many of Mr. Lefton's "unit impact costs" into the calculation of the utility's short term avoided energy cost.

Finally, even if one were to regard these "unit impact costs" as relevant to the exercise, Mr. Lefton's computations are too speculative and too methodologically unsound to serve any purpose in this proceeding.

Q. **PLEASE EXPLAIN YOUR STATEMENT THAT ANY "UNIT IMPACT**

**COSTS" ARE THE RESULT OF PLANNING CHOICES.**

A. In planning generation resources to meet its future loads, a utility has to plan to meet a load which varies considerably over the months of the year and particularly over the hours of each day and week. The utility recognizes that its generation resources need to have the ability to vary the amount of generation to match daily load variations, as well as provide the ability to economically commit appropriate amounts of generation to meet the varying peak loads throughout the year.

In developing its plan for future resources, a utility can choose from an array of different types of resources to match its overall "cycling" capabilities to the natural variations in the demands of its customers. However, it is fair to say that the ability to cycle results in higher total costs for the utility.

Although a utility might endeavor to make the appropriate choices of generation resources, the results of its planning, whether due to poor forecasting or bad choices, may not always turn out well, or may deliberately contain significant compromises, which attempt to balance cycling ability against operational economies.

Whatever the reason, when a unit which has not been designed for cycling duty is called upon to perform cycling on a regular basis, additional long-term maintenance and/or capital costs, "unit impact costs", can result.

Q. **DO YOU HAVE ANY PARTICULAR CHOICE BY FPC IN MIND WHEN YOU DISCUSS THIS POINT?**

A. Yes, I have in mind the decision by FPC not to include "dispatchability" or "schedulability" provisions in its contracts with QFs resulting from the 1991 "Annual Planning Hearing" (Docket No. 910004-EG). Such dispatchability or schedulability of QF generation would have added to FPC's overall cycling capabilities and reduced or eliminated FPC's current minimum load difficulties.

Q. **WHY IS IT INAPPROPRIATE TO FACTOR MANY OF MR. LEFTON'S "UNIT IMPACT COSTS" INTO THE CALCULATION OF A UTILITY'S SHORT-TERM AVOIDED ENERGY COST?**

A. In calculating utility avoided costs, it is wholly appropriate to capture all recognizable costs associated with the utility meeting the demands of its customers. Once recognized, these costs can be incorporated in the appropriate avoided cost which is calculated for purposes such as determining economic levels of DSM as well as determining payments to QFs.

Avoided costs are generally grouped into two main categories--avoided capacity costs and avoided energy costs. Avoided capacity costs include those costs associated with financing, constructing and owning the generating plants of the utility, including O&M costs which are deemed to be independent of the utilization of the individual generating units, i.e., "fixed" O&M costs. Avoided energy costs include fueling costs and O&M costs which are deemed to be dependent on the utilization of the individual generating units, i.e., "variable" O&M costs. The variable O&M costs are often collected and expressed as an adder to avoided fueling costs.

It is important to include all O&M costs in either the fixed or variable category, but it is not easy, nor has it ever been easy, to correctly differentiate between fixed and variable "labels" for many O&M expenses, or between various categories of variable O&M expenses.

For a firm QF energy supply, it is not truly necessary to be precise in the differentiation between fixed O&M, commitment-related variable O&M and dispatch-related variable O&M. However, for energy payments to suppliers of non-firm as-available energy, it is important to include only those dispatch-related variable O&M costs which are avoided. Similarly, in short term economy energy transactions, only appropriate variable O&M costs need to be recognized.

In dealing with Mr. Lefton's "unit impact costs", the largest single category of these costs relate to plant capital expenditures and plant lives. Such costs are included in avoided capacity costs, not avoided energy costs. Others relate to costs of ongoing analyses, studies and computer software. These are general overhead expenses included in construction costs and fixed O&M costs, and are included in the avoided capacity costs.

Mr. Lefton has attempted to collect all cycling-related costs and assign them on a per-start basis to be used in short-term operational decision making. This is clearly inappropriate.

Q. **WHAT O&M COSTS DOES FPC UTILIZE IN ITS NORMAL DAY-TO-DAY OPERATIONAL DECISION MAKING?**

A. FPC utilizes only fuel costs and certain immediate "out-of-pocket" operational expenses associated with unit start-ups.

Q. **WHY DO YOU BELIEVE MR. LEFTON'S APPROACH IS SPECULATIVE AND METHODOLOGICALLY UNSOUND?**

A. Mr. Lefton's analyses appear to rely on long-term extrapolations from poorly conditioned short-term data.

Q. **CAN YOU PROVIDE SOME EXAMPLES OF MR. LEFTON'S RELIANCE ON THESE EXTRAPOLATIONS?**

A. Yes. Consider Figure 4 on page 17 of Mr. Lefton's Exhibit No. ___ (SAL-2). Mr. Lefton provides a 40-year projection from only 20 years of actual data. Further, if one looks at the available data behind the plotted data points, one can see how sparse the data really is. The 15-year point comes from a potential population of 47 units. The one to ten-year points have potential populations of between 127 and 174 units that are even newer. However, the 20-year point comes from a potential population of only nine units. Obviously, the moderate portion of the graph is heavily anchored by data from large populations, while the upward tilt in the Equivalent Forced Outage Rate (EFOR) v. age relationship upon which Mr. Lefton's premise depends is heavily influenced by the nine or less units which are 20 years old. In addition, the analysis does not even attempt to account for vintage as a factor influencing EFOR. The nine units at age 20 were the earliest prototypes in their size range. To ignore the impact of technological maturity on the EFORs is foolish. Without conditioning for vintage, the analysis and its extrapolation are poorly founded.

Q. **CAN YOU PROVIDE ANOTHER EXAMPLE OF THIS SPECULATIVE EXTRAPOLATION?**

A. Certainly. Consider Figure 5 on page 18 of Mr. Lefton's Exhibit (SAL-2). The available pool of data for the 400 MW units graph only extends to about year 33. The available pool of data for the 600 MW units graph only extends to about year 30. The specific unit data relatirg to the Illinois Power Baldwin Units, which were a large part of this analysis, could only extend to about year 23, since the first Baldwin unit only entered service in 1970. The information on the 600 MW units contained in Figure 5 is repeated in Figure 1 on page 36 of Exhibit No. ____ (SAL-2). In Figure 1, the additional information on Capital Infusion Effects all lies beyond the period of possible actual data and therefore has not been derived from any actual operating experience.

Q. **HAVE YOU EXAMINED MR. LEFTON'S REPORT ON THE STUDIES HE PERFORMED FOR FPC ON CYCLING COSTS ASSOCIATED WITH ITS UNITS?**

A. Yes.

Q. **DOES THAT REPORT PROVIDE ANY BETTER SUPPORT FOR HIS CONCLUSIONS THAN YOU HAVE DISCUSSED ABOVE?**

A. No. The report describes an incomplete exercise resulting in what the authors describe as preliminary and uncertain results. The report is replete with disclaimers and caveats and dwells more on the work which remains to be done than it does on the quality of the results so far presented. To illustrate these points, I have assembled several excerpts from the report as Exhibit No. ___ (KJS-5).

The lack of supportable results is not at all surprising given that FPC only funded three out of the eleven phases of the study originally proposed by Mr. Lefton. See Exhibit No. ___ (KJS-6). The three completed phases amount to little more than superficial preparatory exercises.

<u>The Proper Measurement of Avoided Costs</u>

Q. **WHAT IS THE APPROPRIATE TIME FRAME THAT SHOULD BE TAKEN INTO ACCOUNT IN ASSESSING WHETHER QF PURCHASES WOULD HAVE CAUSED FPC TO INCUR NEGATIVE AVOIDED COSTS?**

A. The appropriate time frame for evaluating the avoided costs for a block of QF power, which may or may not be curtailable depending on whether operational circumstances and negative avoided costs are shown to exist, is the same time frame that is used for the evaluation of the commitment of the base load unit that would have to be shut down as the alternative to curtailment of a QF generation or the sale of excess generation.

Q. **WHY IS THIS THE PROPER TIME FRAME TO ANALYZE?**

A. The burden is on the Company to demonstrate that the mix of units that are committed to serve the system load at the time FPC experiences a low load situation is the appropriate (feasible least cost) set of resources needed to serve the Company's load. Whether a unit is part of the least cost feasible formula depends on costs incurred during <u>all</u> hours for which FPC scheduled the unit to be in service. Normally, for a system such as FPC's, this time frame would cover the period of time for which the unit was originally committed. Approximately one week is the time between normal commitment decisions for base load resources.

Q. **WHY HAVE YOU USED THE QUALIFIER "FEASIBLE" WHEN DESCRIBING THE LEAST COST UNIT COMMITMENT?**

A. The unit commitment developed to serve FPC's load must respect all of the constraints imposed by the contractual obligations FPC has to its various electricity and fuel suppliers, as well as any physical constraints of FPC's own generating units.

As far as firm QFs are concerned, this means that any FPC commitment which deliberately creates a potential curtailment situation would be considered infeasible.

Q. **THEN, IS THE ANALYSIS OF NEGATIVE AVOIDED COSTS A TWO-STEP PROCESS?**

A. Yes. The first step is to determine that the FPC unit commitment schedule for the curtailment period was part of the least cost feasible unit commitment schedule.

The second step is to evaluate the avoided costs for a block of QF power equal in size to the maximum curtailment over the period for which the unit, whose shutdown would be the subject of the negative avoided cost calculation, was intended to be committed, or for the weekend-to-weekend interval, whichever is the lesser.

Q. **IF THE UNIT COMMITMENT MUST BE FEASIBLE, WOULDN'T IT FOLLOW THAT THERE WOULD BE NO NEED TO EXPERIENCE THE MINIMUM LOAD CONDITIONS WHICH COULD LEAD TO CURTAILMENT?**

A. In almost all cases that would be correct. However, occasionally it could happen that conditions would change during the period for which commitment decisions had already been made, such that a previously feasible commitment becomes infeasible, leading to the minimum load situation with the attendant possibility of curtailment. As examples, a change in load forecast or a change in QF production expectations would represent such a change in conditions.

Of course, any minimum load situation which is foreseeable at the time commitment decisions are being made for that time frame, and which the utility does not take appropriate steps to avoid, does not represent a valid curtailment occasion.

Q. **HAVE YOU EXAMINED FPC'S CALCULATIONS OF NEGATIVE AVOIDED COSTS?**

A. Yes.

Q. **WHAT LENGTH OF TIME DID FPC USE IN ITS CALCULATIONS OF NEGATIVE AVOIDED COSTS?**

A. FPC evaluated avoided energy costs for only those individual hours during which the QF curtailments occurred. To these costs FPC added the avoided start-up costs, whenever they occurred. FPC analysis is carried out over such a short time frame that the dominant cost effect is the unit start-up cost, not replacement energy costs as contemplated by the PURPA example.

**Q. HAVE YOU DETERMINED WHAT THE RESULT WOULD BE IF THESE CALCULATIONS WERE CARRIED OUT OVER A MORE APPROPRIATE TIME FRAME?**

A. Yes. For each curtailment episode, I have performed a conservative analysis which shows that if the period of analysis for each episode was increased to as little as two days all negative avoided costs would vanish.

**Q. HAVE YOU COMPLETED YOUR ANALYSIS OF FPC'S CALCULATIONS OF NEGATIVE AVOIDED COSTS?**

A. Up to this time, I have received from FPC, data files and output reports for computer runs of their "Unit Commit" software for periods of one to three days encompassing each of the seven curtailment episodes in Mr. Southwick's testimony. For each period of one to three days, there are two runs. The first represents the system meeting the actual remaining FPC load after considering the actual QF generation, reflecting curtailment, using the base load generating units which were committed, plus the available non-base load resources. The second run modified the remaining FPC load by using a transaction which added back the curtailed QF generation and then recommitted and redispatched the system.

In addition, I received the Fortran source code and executable code for the "Unit Commit" software used by FPC. Because my computing facilities are not the same as FPC's, I was not able to utilize the executable code. Instead, I have been required to compile and link the source code, using my Fortran compiler on my computer, into an executable load module and then "de-bug" the program prior to being able to commence complete studies of FPC's analyses of negative avoided costs.

It may appear strange that I have to "de-bug" an existing, working program. The "de-bugging" is necessary because the PC 386/486 computers I am using provide a much less forgiving computing environment for the Fortran code of "Unit Commit" than does the IBM machine FPC uses.

I have reviewed the input files and output reports underlying Mr. Southwick's assertions. At this point, I have also been able to replicate several of the FPC runs. However, because of various delays, including not receiving the correct version of the source code until late on Tuesday, April 4, I have yet to complete my studies of FPC's negative avoided cost calculations. I intend to complete my work with the program and will seek to supplement my testimony if warranted.

<u>However</u>, my analysis to date has allowed me to reach and support the conclusions that I have delineated above.

Q. **IN YOUR ONGOING EXAMINATION OF FPC'S NEGATIVE AVOIDED COST CALCULATIONS HAVE YOU DISCOVERED ANYTHING UNUSUAL?**

A. Yes. In examining FPC's Unit Commit runs, I found a number of significant problems.

In the January 2, 1995 episode, I found that the 258 MW of curtailment was 161 MW too much.

In the January 7 and January 8, 1995 episode, I found that the system, with 281 MW of curtailment on the morning of January 7 was still in an excess generation situation by 36 MW. This resulted in the "without curtailment" run shutting down both CR 4 and CR 2, when one of them should have already been shut down in the base case.

In the January 14, 1995 episode, I found that the 50 MW of curtailment still left the system in an excess generation situation by 11 MW.

Q. **PLEASE SUMMARIZE YOUR TESTIMONY.**

A. At this time, I have determined that, for each curtailment episode, alternative unit commitment arrangements were available to FPC which would have avoided the minimum load problems which led to FPC curtailing QF generation. Therefore, only if the minimum load situations were the result of unexpectedly low loads or unexpectedly high QF output could they be considered legitimate potential curtailment events.

I have also determined that if indeed the curtailment events were legitimate, they could have been avoided by making sales of the excess generation at any price above zero.

Further, I have conservatively determined that, if the evaluations were made over periods of time comparable to the commitment periods associated with the unit or units which would incur the shutdowns (in fact, for periods of less than two days), then there would be no negative avoided costs.

Lastly, I have noted that FPC's acceptance of "must-take" energy from Southern Company UPS purchase is entirely responsible for the excess generation in two of the seven cases.

Q. **DOES THIS CONCLUDE YOUR TESTIMONY?**

A. Yes, at this time.

EXHIBITS

OF

KENNETH J. SLATER

# Technical Qualifications and Professional Experience

**Kenneth John Slater**

## EDUCATION

| | | |
|---|---|---|
| B.Sc., | Pure Mathematics and Physics, | Sydney University, 1960 |
| B.E., | Electrical Engineering, | Sydney University, 1962 |
| M.A.Sc., | Management Sciences, | University of Waterloo, 1974 |

## PROFESSIONAL AFFILIATIONS

Association of Professional Engineers of Ontario

- Registered Professional Engineer

Institute of Electrical and Electronic Engineers

- Member of Power Engineering Society
- Past member of Power System Engineering Committee
- Past member of System-Economics subcommittee and working group

## EXPERIENCE

1957-62 Mr. Slater was a Junior Professional Officer at the Electricity Commission of New South Wales attending university and undergoing on-the-job training in power station and substation design, construction, protection, maintenance, and operation.

1962-67 Mr. Slater was a Professional Engineer Grades 1 and 2 at The Electricity Commission of New South Wales, engaged in a variety of functions within the areas of Power Station Construction, Generation Planning, System Operation and Load Dispatch.

1967-69 As Assistant Engineer Area Operations/Sydney West (Professional Engineer, Grade 3) with the Electricity Commission of New South Wales, Mr. Slater was responsible for the day-to-day operation of the Sydney West Area (approximately 20% of the State System).

He supervised the day-to-day work of more than 18 operators as they provided safe working conditions for Commission staff and others on system apparatus, and as they provided safe, secure, reliable and economic operation of this portion of the State System.

He performed the liaison function with head office staff, other divisions and customers on all operating activities, directed the performance of complicated operating procedures and trained both regular and emergency operators.

While he was in this and his previous position, Mr. Slater was responsible for the design and manufacture of the live line testing devices used by the Commissions' operators and linemen.

As well, he assumed responsibility for the preparation and execution of "black start" exercises and for the arrangement and detailing of complicated switching for major rearrangements and commissionings on the State System. He also developed original computer applications.

1969-74 As Engineer, and then Senior Engineer, heading the Production Development Section of Ontario Hydro's Operating Department, Mr. Slater was engaged in developing computational procedures and computer programs for Production Economics and Resource Management.

Major contributions included (1) the development and implementation of the computer program which, for more than 20 years, produced the daily generation schedule for the Ontario Hydro System, (2) the formulation of a Stochastic System Model to coordinate and optimize the production planning, maintenance planning, interchange planning and resource management of the Ontario Hydro System, and (3) the development of PROMOD, a Probabilistic Production Cost and Reliability model, the first version of the "core" of the Stochastic Model in (2) above.

As a member of the project group implementing the Operating Department's Data Acquisition and Computer System, he headed a work unit responsible for providing the application programs related to generation scheduling, power interchange and resource management. Also, he held responsibilities in the areas of policy determination, analytical techniques and the planning of future applications.

1974-75 As Manager of Engineering at the Ontario Energy Board. Mr. Slater was heavily involved in public hearings into Ontario Hydro's System Expansion Plans and Financial Policies, and into Ontario Hydro's Bulk Power Rates.

During this time, he provided much of the power system engineering input necessary for the start-up and formulation of the public hearing process related to Ontario Hydro. He also provided the engineering input for the regulation of Ontario's three major investor owned gas utilities.

1975-76 For 12 months, Mr. Slater was a private consultant contracted to the Royal Commission on Electric Power Planning, in Ontario, as its Research Director. During this time, he directed and participated in various studies of different aspects of electricity supply. He was also a member of the panel of expert examiners in a number of the Royal Commission's public hearings.

1976-83 As President of Slater Energy Consultants, Inc., in Toronto, Mr. Slater performed or made major contributions to a number of important assignments at the forefront of the electrical energy industry. These included:

- The Export of Electrical Power
  .... a study for the Ontario Ministry of Industry and Tourism.

- Load Management Studies
  .... for the Detroit Edison Company.

- California Utilities Increased Integration Study
  .... for San Diego Gas & Electric Company, Southern California Edison Company, Los Angeles Department of Water and Power, and Pacific Gas and Electric Company.

- Bradley-Milton 500 kV Transmission Lines
  .... a study for the Ontario Ministry of Energy and the Interested Citizens Group (Halton Hills).

- Solar Energy and the Conventional Energy Industries
  .... a study for the Canadian Ministry of Energy, Mines and Resources.

- The Expert Examiner for the Ontario Royal Commission on Electric Power Planning during hearings into Priority Projects.

- Various Studies into Unconventional Electrical Resources
  .... for the P.E.I. Institute of Man and Resources and the P.E.I Energy Corporation.

- Analysis and Expert Testimony in Support of Lower Demand Rates for Lake Ontario Steel Company Limited, Ivaco Industries Limited and Atlas Steels.

- Claims for Consequential Damages of the Roseton Boiler Implosions
  .... for Consolidated Edison Company, Central Hudson Power Company and Niagara Mohawk Power Corporation.

- A study of the Potential for Megawatt Scale Wind Power Plants in Electrical Utilities
  .... for the Canadian Ministry of Energy, Mines and Resources.

These studies have included the need to create special and unique power system models and solution techniques and have addressed significant issues of major importance in the electricity supply industry. Mr. Slater also has carried out assignments for the following clients:

Nova Scotia Power Corporation.
The Government of Prince Edward Island.
The New Brunswick Electric Power Commission.
Ontario Energy Corporation.
Ontario Energy Board.
Go-Home Lake Cottagers Associations.
Saskatchewan Power Corporation.
FMC Corporation.
FMC of Canada Limited.
ERCO Industries Limited.
Canadian Occidental Petroleum Ltd.
State Energy Commission (Western Australia).
Toronto District Heating Corporation.

In connection with his consulting activities, Mr. Slater gave expert testimony in the state of Idaho and in the provinces of Ontario and Prince Edward Island.

Mr. Slater also was a principal developer of PROMOD III, a proprietary electric utility production cost and reliability model owned by Energy Management Associates, Inc.. This model was used by over seventy utilities in Canada, the United States, Japan and Australia. Its wide acceptance made it the "Industry Standard" in the U.S..

1983-90 As Vice President and Chief Engineer for Energy Management Associates, Inc., Mr. Slater was responsible for giving technical direction for the development and maintenance of Energy Management Associates, Inc., state-of-the-art software products. As Senior Vice President and Chief Engineer, Mr. Slater was head of the Energy Management Associates, Inc.'s utility consulting practice. He led or made significant contributions to a number of important consulting engagements, including:

- Study and regulatory testimony concerning the value to the Idaho Power Company system of the interruptibility provisions in F.M.C.'s supply contract.

- Generation planning studies for Cincinnati Gas and Electric Company, San Diego Gas & Electric Company and the City of Austin Electric Utility Department.

- Assistance to legal counsel during regulatory litigation regarding the hostile takeover of a major Canadian gas utility holding company (Union Enterprises), including definition and examination of issues, selection of witnesses, and analysis of the opposing case.

- Development and demonstration of a method for the allocation of the Inland Power Pool's operating reserve requirement among its members.

- Analysis of replacement power costs during the outage of Niagara Mohawk Power Corporation's Nine Mile Point #1 nuclear unit.

- Reserve margin assessments for Public Service Company of Indiana, Allegheny Power System Inc., Iowa Electric Light & Power Company, San Diego Gas & Electric Company, and El Paso Electric Company

- Examination of the gas supply situation in Southern California and regulatory testimony regarding the "unbundling" of storage service.

- Evaluation of the operational, planning and financial impacts of merging two large Eastern U.S. electric utilities.

- Study and regulatory testimony regarding the value and appropriate level of interruptible demand for the Union Gas system.

- Evaluation of the benefits of increased operational integration of a group of electric utilities.

- Assistance for Tucson Electric Power Co. and its legal counsel during arbitration of its dispute with San Diego Gas and Electric Company regarding the operation of a large power sale agreement.

- Analysis of the economics of a third A/C transmission line linking California and Oregon.

- A seminar on "Power Pooling and Inter-Utility Interconnections" for the management of the Central Electricity Generating Board and other parties involved in U.K. privatisation.

- Determination of the benefits of pool membership for two electric utilities in the Northeast U.S..

- Assistance for Riley Stoker Corporation and its legal counsel with the arbitration of direct and consequential damages arising out of the late completion and early poor performance of two major coal-fired generating units. The work included case examination and development, detailed reconstruction of events, analysis of all financial and economic consequences of project delay and performance with separation of fault, analysis of opponent's case and assistance with cross-examination, direct and rebuttal testimony, and assistance with oral and written argument.

Mr. Slater's consulting assignments included the areas of power system planning, operations, reliability, economics, ratemaking and assessment of the worth of unconventional resources. He appeared as an expert witness in regulatory hearings in Idaho, Iowa, Indiana, Florida, California, Texas, Ontario and Nova Scotia and also in civil arbitration proceedings.

Mr. Slater continued to contribute to the development of E.M.A.'s utility software products. His contributions included being a principal developer of SENDOUT, E.M.A.'s proprietary supply model for gas utilities.

1990- In August 1990, Mr. Slater returned to working in his own practice and has now founded Slater Consulting, in Atlanta, where he provides his services to various different participants in the utility industry.

Recent assignments include:

- Determination, from operating records, of the cause of, and responsibility for, a lengthy outage of the generating facilities of an IPP and calculation of the consequent business losses.
- Assistance to legal council for creditors of a bankrupt utility.
- Analysis of possible employment discrimination regarding a position in a high voltage environment.
- Assistance to a utility in analysing the benefits of joint operation with a second utility.
- Analysis and testimony for Texas - New Mexico Power Company regarding prudent alternatives to the decision to build TNP ONE Unit 2.
- Assistance to a utility and its legal counsel during litigation regarding damages sustained because of interference in a proposed merger of that utility with another utility
- Analysis and testimony before the New York PSC for Sithe Energies Inc., regarding the Independence Project.
- Analysis and testimony for the Independent Power Producers of New York in response to the petitions of NMPC, NYSE&G and Con. Ed. for approval of curtailment procedures.

## PUBLICATIONS & PRESENTATIONS

"Meeting System Demand"
Canada-USSR Electric Power Working Group Electrical Seminar, Montreal, March, 1973.

"Stochastic Model for Use in Determining Optimal Power System Operating Strategies."
Power Devices and Systems Group, Electrical Engineering Department, University of Toronto - 1973.

"Economy-Security Functions in Power System Operations"
IEEE Power System Economic Subcommittee Work Group Paper
IEEE Special Publication 75 CH0960-6-PWR-1975.

"Economy-Security Functions in Power System Operations - A Summary Introduction."
IEEE Power System Economics Subcommittee Working Group Paper
IEEE T.P.A.S. Sept/Oct 1975 p. 1618.

"A Large Hydro-Thermal Scheduling Model"
TIMS/ORSA
Miami, November 1976.

"Generation System Modeling for Planning and Operations"
Atlantic Regional Thermal Conference
Charlottetown, June 1978.

"The Feasibility of Electricity Export from CANDU Nuclear Generation"
Canadian Nuclear Association
Ottawa, June 1978.

"Evaluation of the Worth of System Scale Wind Generation to the Prince Edward Island Electrical Grid."
IEEE Canadian Conference
Toronto, October 1979.

"The Results of a Study Examining The Possible Impact of Solar Space Heating on the Electrical Utility in New Brunswick."
The Potential Impacts of the Deployment of Solar Heating on Electrical Utilities - A workshop sponsored by the Canadian Department of Energy, Mines and Resources
Ottawa, May 1980.

"Reliability Indices: Their Meanings and Differences"
Planmetrics/Energy Management Associates, Inc. 8th Annual National Utilities Conference
Chicago, May 1980.

"Description and Bibliography of Major Economy-Security Functions
Part I - Description
Part II - Bibliography (1959-1972)
Part III - Bibliography (1973-1979)"
IEEE Power System Economics Subcommittee Working Group Papers(3).
IEEE TPAS January 1981, p.211, p.214. p.224.

"PROMOD III Evaluation of the Worth of Grid Connected WECS."
Fifth Annual Wind Energy Symposium, Ryerson Polytechnical Institute
Toronto, December 1982.

"Probabilistic Simulation in Power System Production Models"
China-U.S.A. Power System Meeting, Electrical Power Research Institute of China
Tianjin, China, June 1985.

"Computer Modeling of Wheeling Arrangements"
Electricity Consumers Resource Council Seminar
Washington, D.C. September 1985.

"Power Systems Reliability Improvement Benefits - A Framework for Analysis"
ASME Energy-Sources Technology Conference
Dallas, February 1987.

## FPC Committed Capacity During Curtailment Incidents

| Date of Curtailment Incident | Committed Base Load Units | Other Committed Units |
|---|---|---|
| October 10, 1994 | CR 1, 2, 3, 4, 5 | University of Florida<br>Bartow 2<br>Anclote 3 |
| January 1, 1995 | CR 1, 3, 4, 5 | University of Florida |
| January 2, 1995 | CR 1, 3, 4, 5 | University of Florida<br>Suwanee 1 |
| January 7, 1995 | CR 1, 2, 3, 4, 5 | University of Florida |
| January 8, 1995 | CR 1, 2, 3, 4, 5 | University of Florida |
| January 14, 1995 | CR 1, 3, 4, 5 | University of Florida |
| January 30, 1995 | CR 1, 2, 3, 4, 5 | University of Florida<br>Bartow 3 |

**TABLE 1**

**Source:** Unit Commit files provided by FPC.

**NOTE:** While Unit Commit runs were provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential.

## FPC Uncommitted Generating Resources Available for Use at the Time of Peak Load on Each Curtailment Day

| Date | Uncommitted Resources | | | | | Capacity of Crystal River Units Which Could Have Been Not Scheduled |
|---|---|---|---|---|---|---|
| | Cycling | Peaking | UPS Purchases | Excess Spinning Reserve | Total | |
| October 17, 1994 | 242 | 1990 | | 140 | 2,372 | 750 |
| January 1, 1995 | | | | | | Curtailment Unnecessary |
| January 2, 1995 | 1648 | 2626 | | | 4274 | 400 |
| January 7, 1995 | 1684 | 2493 | 344 | 357 | 4878 | 1150 |
| January 8, 1995 | 1340 | 2493 | | | 3833 | 400 |
| January 14, 1995 | 1464 | 2493 | 258 | | 4215 | 400 |
| January 30, 1995 | 850 | 2361 | | 15 | 3226 | 750 |

TABLE 2

Source: Unit Commit files provided by FPC

NOTE: While Unit Commit runs were provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential.

Exhibit No ___ (KJS-3)
Docket No. 941101-EQ
Orlando CoGen Limited
Page 1 of 1

Effect of Sale In Lieu of Curtailment on Utility Production

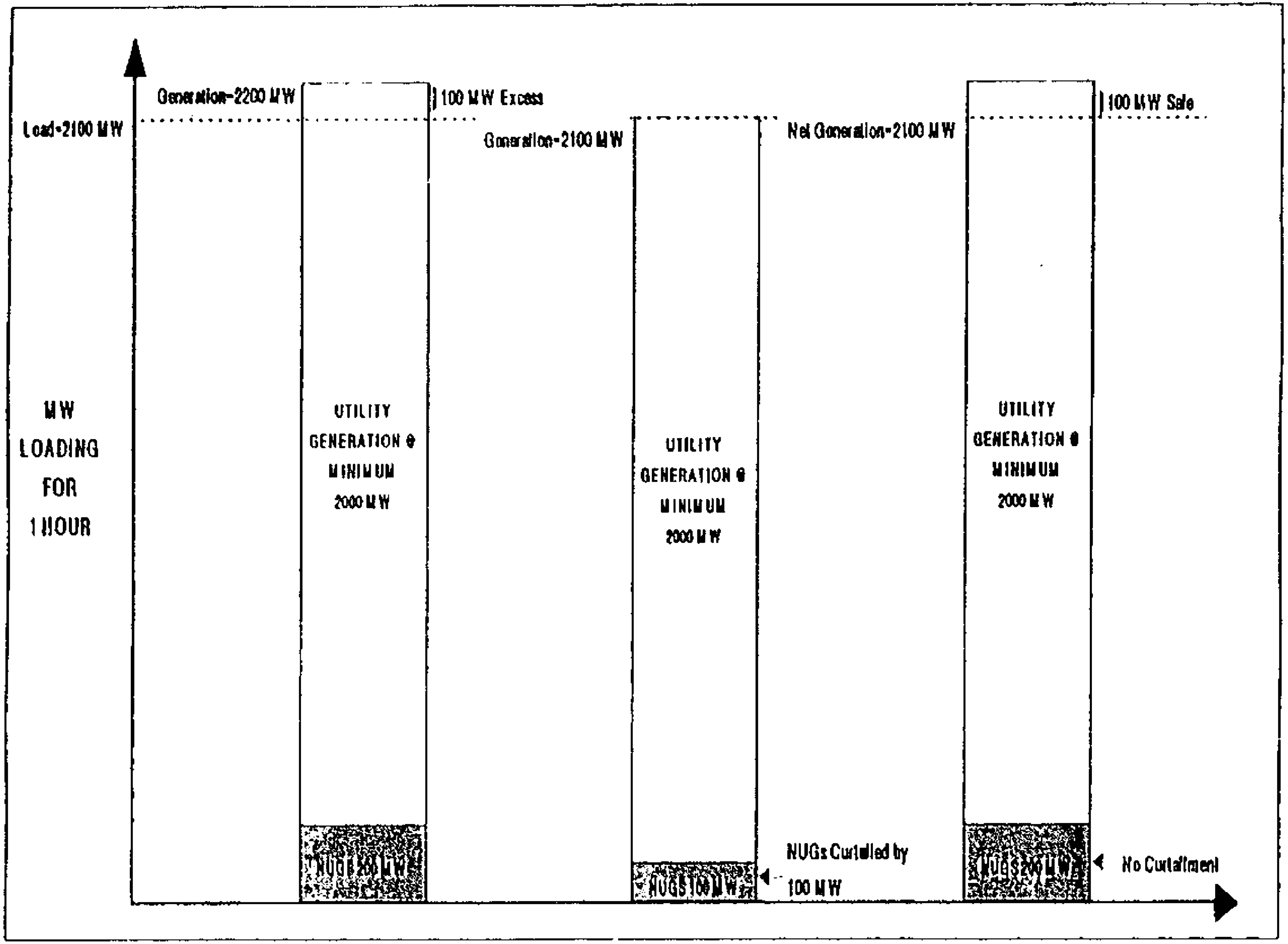


Exhibit No. ___ (KJS-4)
Docket No. 941101-EQ
Orlando CoGen Limited
Page 1 of 1

APTECH IS APPLIED TECHNOLOGY

AES 94052187...

# TOTAL COST OF CYCLING FOSSIL POWER PLANTS
Florida Power Corporation

Prepared by

Steven A. Lefton
G. Paul Grimsrud
Phillip M. Besuner
James J. Yavetak

Aptech Engineering Services, Inc.
Post Office Box 3440
Sunnyvale, California 94088-3440

Prepared for

SPECIALLY RESTRICTED

Florida Power Corporation
3201 34th Street South
St. Petersburg, FL 33711

Attention: Mr. Gary L. Norman

SL2408

November 1994

Confidential Information Restricted to Florida Power Corporation Personnel Only

APTECH ENGINEERING SERVICES, INC.
1282 REAMWOOD AVENUE ☐ SUNNYVALE ☐ CA 94089
POST OFFICE BOX 3440 ☐ SUNNYVALE ☐ CA 94088-3440 ☐ (408) 745-7000 ☐ FAX (408) 734-0445
OFFICES ☐ UPPER MARLBORO, MD ☐ (301) 596-2301 ☐ HOUSTON, TX ☐ (713) 558-3200
CHATTANOOGA, TN ☐ (818) 499-3777 ☐ GASTONIA, NC ☐ (704) 866-6318

Source Aptech Report furnished by FPC during discovery

NOTE While the Aptech Report was provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential.

iii

The results in Table 2 include conservative upper and lower bound cost estimates since it is recognized that there is a significant amount of uncertainty in the estimates



$124.2

Source Aptech Report furnished by FPC during discovery

NOTE. While the Aptech Report was provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential

## 2.5 SUMMARY OF REGRESSION ANALYSIS RESULTS AND DISCUSSION OF UNCERTAINTY

The information shown in Tables 2-1 and 2-2 indicate that there remains significant uncertainty in the cost of cycling figures. There are many sources of uncertainty in the cycling cost estimates. To reflect these sources, statistically based upper and lower bounds were used. These were calculated using the following steps:

- For each of the seven main cycling cost components, make an estimate of the uncertainty

  — Do not be afraid to estimate a large uncertainty toward the lower (conservative) end of the range.





SL-4-25

Source: Aptech Report furnished by FPC during discovery

NOTE: While the Aptech Report was provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential.

To relate these temperature changes to relative cyclic damage is beyond the current scope and is not straightforward because the plastic strain range (which produces cyclic damage to the tubing, for a given temperature change is nonlinear and is dependent on the design of the wall panels and firing behavior of the unit. Thus, no further analysis was performed in this phase of the project.





Source Aptech Report furnished by FPC during discovery.

NOTE: While the Aptech Report was provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential

# Section 4

# CONCLUSIONS AND RECOMMENDATIONS

This work has focussed on past costs and on future maintenance, capital costs, and outage rates that are projected to be similar to the past. This is the best that can be done in a project that does not include cycling condition assessments of unit hardware.

We have made the following recommendations, in order of their importance:

1. Cycling condition assessments should be conducted at selected units during normal plant outages. This would give us a better understanding of the life shortening effects of cycling and reduce the uncertainty in our cost estimates. Details of this





Source: Aptech Report furnished by FPC during discovery

NOTE: While the Aptech Report was provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential

recommendations are in our first report entitled "Technical Scoping Study to Determine the Effects of Cycling on Fossil Plant Production Cost and Availability at the Florida Power Corporation — Draft Program Scope and Plan"[1]

2. Advanced instrumentation and analytical procedures are needed to monitor cycling damage on boiler tubes, turbines, components of selected fossil units as stated in our first report[1].

3. Using information from Recommendations 1 and 2, improvements to the definition of component damage (equivalent hot starts) and the correlation of damage with capital and maintenance spending should be made.

4. So far, we have examined a limited amount of relevant NERC summary data. Further analysis of NERC data, such as EFOR, planned outage rate, and the more specific component event data should be done on similar but smaller more well defined groups of units with the same design attributes as selected FPC units. We propose to look at independent variables in addition to EFOR, such as planned outage rate, and a reasonable surrogate for capital and maintenance spending.

5. A detailed analysis is needed of the cost of low load cycling down to LL1, LL2 and LL3. We know that each load point has a different cost and identification of these costs can lead to a low load dispatch optimization and significant operating cost reductions.

6. Analyze the nuclear unit CR3 and the gas turbine/combined cycle units cycling costs to ensure proper system dispatch decisions.

7. The cost of high forced outage rates are currently relatively small, as the current market allows for low replacement capacity and energy costs. However, in future years as capacity reserve margins get small, replacement energy and capacity costs will likely increase dramatically. Thus, the total cost of cycling should more than keep up with inflation. For this reason alone, we recommend that these cost of cycling estimates should be updated annually, or at least biennially.

8. The total costs of cycling each unit should be incorporated into FPC's long-term planning models (e.g., PROMOD, PROSCREEN), as we suspect that the true cost of cycling will greatly affect how generation units should be operated, maintained, and, thus, what should be the optimal mix of generation units in the future. Analyses should also be made of the penalty for using the wrong cycling costs in load dispatch decisions (see our Task 1 report for detailed recommendations.

---

[1]Lefton, S.A., "Technical Scoping Study to Determine the Effects of Cycling on Fossil Plant Production Cost and Availability at the Florida Power Corporation — Draft Program Scope and Plan" Aptech Engineering Services, Inc., Report AES 94032144-2-1 (April 1994).



Source: Aptech Report furnished by FPC during discovery





NOTE: While the Aptech Report was provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential.

9. The plant signature data and other test data should be completed and used to optimize and ensure minimum cycling damage is occurring during startup, transient operations and especially during unit shut downs/trips. There is also an optimum rate of cycling which should be determined. The rate best balances the cost of the opportunity to supply power versus the cost of rapid transients that cause excessive component damage and high resulting cycling costs. The APTECH loads model has this capability, however it needs the additional data and analysis of the plant signatures.

10. Install thermocouples on the outlet headers and steam lines of Bartow 1 and 2 to monitor unit cycling. These data should be used to eliminate condensate buildup and damage to headers, piping, and the turbine.

11. Review and improve plant operating procedures to minimize plant cycling damage. This can be accomplished by acquiring the plant signature data and analysis in Recommendations 2, 3, 9, and 10. Then use this data to set up plant cycling guidelines/procedures.





Source: Aptech Report furnished by FPC during discovery

NOTE: While the Aptech Report was provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential

Appendix A

# THE APTECH LOADS MODEL

## A.1 GENERAL MODEL OF TOTAL DAMAGE

Despite the wide scope of this model, all work herein must be viewed as preliminary for a variety of reasons. Most important is that we are using only hourly loads data to compute damage and that we are normalizing the loads for each unit only by its capacity. This normalizing fails to account for the varying abilities of unit types and designs to sustain loading cycles and starts.

The preliminary analyses described in Section 5.1 are first steps to fill in the gaps in our Loads Model.







Source Aptech Report furnished by FPC during discovery

NOTE: While the Aptech Report was provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential

## 4.5 RECOMMENDATIONS FOR INTERPRETATION AND FURTHER WORK

This damage model is of very wide scope and capability but it is only a starting point.

The first job is to collect more engineering data. Our experimental program to measure key temperature excursions under cycling would contribute heavily. Unit-specific thermal stress analyses that would remove our major weakness, a reliance only on loads data as normalized to unit capacity would also contribute heavily.

The statistical correlation of future damage models with outage data and maintenance expenditures is just as important. Several of the coefficients (and even some equations) assumed in this initial model can be improved dramatically by "brute force regression fits" against equipment failure and maintenance spending histories.

Good engineering data (like FPC has started to collect through Mark Pratt and others) will minimize statistical extrapolation. Meaningful correlations of



Source: Aptech Report furnished by FPC during discovery.

NOTE: While the Aptech Report was provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential.

the damage models with historical data will minimize the chance of leaping to wrong conclusions from engineering models of complex phenomena.





Source Aptech Report furnished by FPC during discovery

NOTE: While the Aptech Report was provided under terms of confidentiality, counsel for FPC has confirmed that the information shown on this exhibit is not confidential

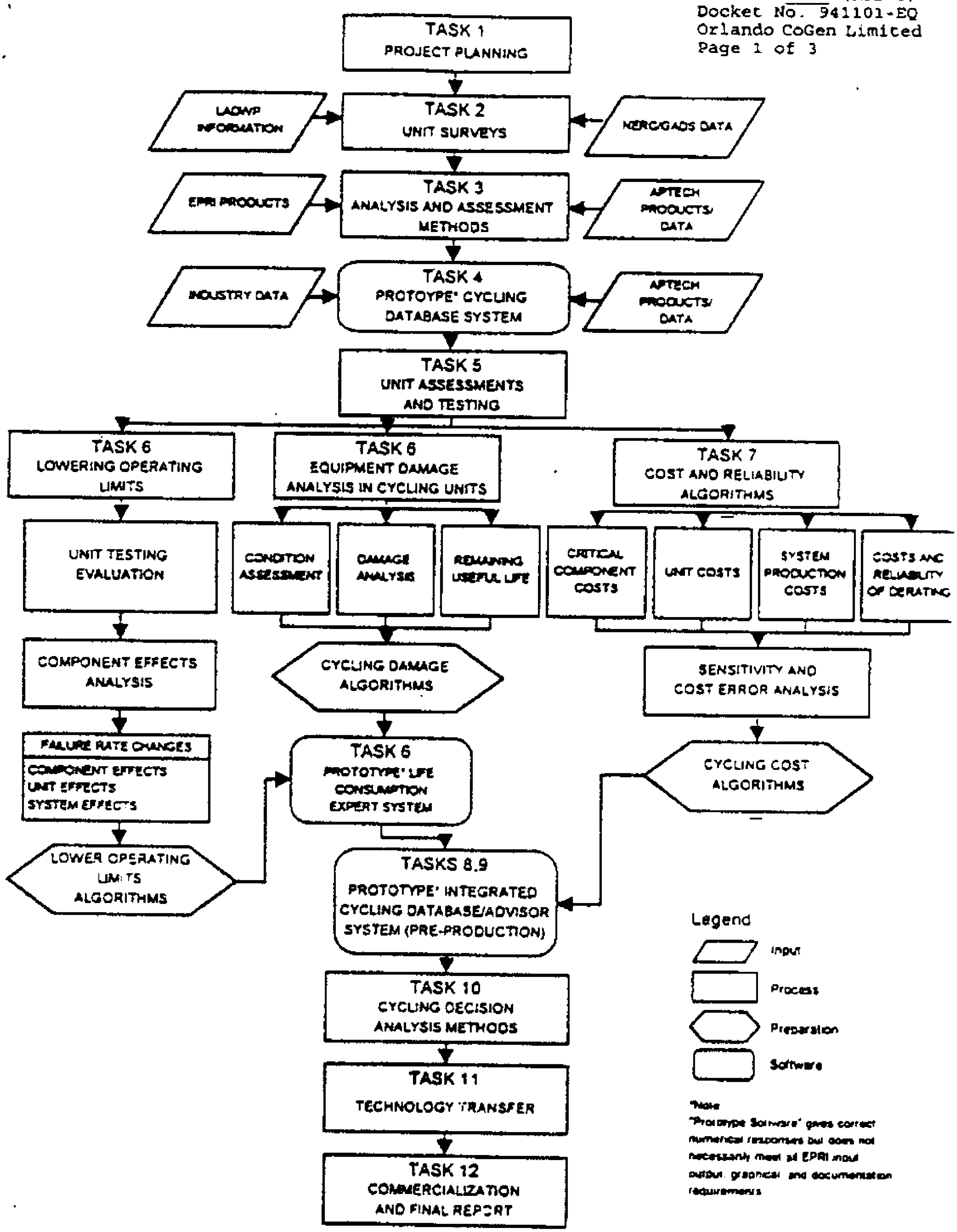


Figure 4-1 Project Flowchart

Exhibit _____ (KJS-6)
Docket No. 941101-EQ
Orlando CoGen Limited
Page 2 of 3

**APTECH** IS APPLIED TECHNOLOGY

**FACSIMILE: 813/866-5991**

May 25, 1994

Mr. Gary Norman
Florida Power Corporation
3201 Thirty-Fourth Street South
Post Office Box 14042
St. Petersburg, Florida 33733

Dear Mr. Norman:

RE: Florida Power Corporation Vender 012427
Florida Power Corporation Contract G4000054, Phase II
Engineering Study to Determine the Effects of Cycling on Fossil Plant Production Cost and Availability (APTECH Report AES 94032144-2-1, Revision 2)
Cycling Study of FPC System (APTECH Proposal AES-P-94-02-2892-2)

This letter will confirm your verbal authorization of May 16, 1994, to proceed with the above Phase II of the contract. This Phase II work will include:

- Task 2 — Unit Survey
- Task 3 — Develop Preliminary Damage Model and Cost of Cycling Estimates
- Addition of the Coal-Fired Cycling Unit to be Specified by Black & Veatch
- Portion of Task 11 — Project Management

The cost of these tasks are currently estimated to be as follows:

| | |
|---|---|
| Task 2 — Unit Survey | $110,000 |
| Task 3 — Develop Preliminary Damage Mode and Cost of Cycling Estimating | $110,000 |
| Cost of Cycling Estimates for the Coal-Fired Cycling Unit | $25,000 |
| Task 11 — Project Management | $24,500 |
| TOTAL COST ESTIMATE FOR PHASE II | $269,500 |

We have not included costs for an elaborate report per Task 10. At this time, we are planning a smaller letter-type report that documents the preliminary estimates of the cost of cycling, our conclusions, and recommendations.

In order not to delay this work, we need a formal contract addition by June 1, 1994. These costs assume that FPC works with APTECH and provides APTECH cost and operational data, plant data collection, and some data reduction of operational cycling data.

SL1625

Florida Power Corporation
May 25, 1994
Page 2

Should you have any questions on the above, please contact Mr. Harry Stengele, Vice President, Finance and Administration, or me, the Project Director. We look forward to continuing to be of service to you and FPC.

Very truly yours,

Steven A. Lefton
Vice President, Special Projects

SAL/msb

cc: B. Golden

## CERTIFICATE OF SERVICE

I HEREBY CERTIFY that a true and correct copy of the Direct Testimony and Exhibits of Kenneth J. Slater, on behalf of Orlando CoGen Limited, L.P. and Pasco CoGen, Ltd., has been furnished by hand delivery*, by Federal Express**, or by U.S. Mail to the following parties of record, this 10th day of April, 1995.

Martha Brown*
Division of Legal Services
Florida Public Service Commission
101 East Gaines Street
Fletcher Building, Rm. 212
Tallahassee, FL 32399

James A. McGee**
Florida Power Corporation
3201 34th Street, S.
St. Petersburg, FL 33733

Ansley Watson**
MacFarlane, Ausley, Ferguson & McMullen
111 Madison Street, Suite 2300
First Florida Tower, 23rd Floor
P. O. Box 1531
Tampa, FL 33601

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Aviation Division
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Joseph A. McGlothlin

Joseph A. McGlothlin

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that a true and correct copy of the Direct Testimony and Exhibits of Kenneth J. Slater, on behalf of Orlando CoGen Limited, L.P. and Pasco CoGen, Ltd., has been furnished by hand delivery*, by Federal Express**, or by U.S. Mail to the following parties of record, this 10th day of April, 1995.

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