50

ORIGINAL

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Generic Investigation Into the Aggregate Electric Utility Reserve Margins Planned for Peninsular Florida	)))))	DOCKET NO. 981890-EU FILED: August 16, 1999

DIRECT TESTIMONY

OF

KENNETH J. SLATER

ON BEHALF OF

DUKE ENERGY NEW SMYRNA BEACH POWER COMPANY LTD., L.L.P.

AND

DUKE ENERGY NORTH AMERICA, L.L.C.

AFA 2
APP
CAF
CMU
CTR
~~EAG~~ Staff
LEG 1
MAS 5 Stray
OPC
PAI
SEC 1
WAW
OTH

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Generic Investigation Into the Aggregate Electric Utility Reserve Margins Planned for Peninsular Florida	DOCKET NO. 981890-EU FILED: August 16, 1999

DIRECT TESTIMONY

OF

KENNETH J. SLATER

ON BEHALF OF

DUKE ENERGY NEW SMYRNA BEACH POWER COMPANY LTD., L.L.P.

AND

DUKE ENERGY NORTH AMERICA, L.L.C.

FLORIDA PUBLIC SERVICE COMMISSION

DOCKET NO. 981890-EU, INVESTIGATION OF RESERVE MARGIN ADEQUACY

DIRECT TESTIMONY OF KENNETH J. SLATER

I. INTRODUCTION AND QUALIFICATIONS

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

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

Q. BY WHOM AND IN WHAT CAPACITY ARE YOU EMPLOYED?

A. I am President of Slater Consulting, which I founded in August 1990. The firm is a small engineering-economic and management consultancy with particular expertise in energy and public utility matters. The services, which the firm offers to various participants in the utility business, include analysis of supply/demand options, reliability, operating situations and events, new technologies and industry developments, strategic decisions, public policy matters and ratemaking issues.

Q. WHAT IS YOUR EDUCATIONAL BACKGROUND?

A. I obtained a Bachelor of Science degree in Pure Mathematics and Physics in 1960 and a Bachelor of Engineering degree in Electrical Engineering in 1962, both at the University of Sydney, Australia. I also received a Master of Applied Science degree in Management Sciences at the University of Waterloo in Ontario, Canada in 1974.

DIRECT TESTIMONY OF KENNETH J. SLATER

Q. PLEASE PROVIDE A BRIEF DESCRIPTION OF YOUR PROFESSIONAL EXPERIENCE.

A: I have over thirty seven years of experience in the energy and utility industries in the United States, Canada and Australia.

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 consulting engagements related to valuation or analysis of power supplies and power supply contracts, supply/demand planning, damages assessments, operating reserve requirements, replacement power cost calculations, utility merger valuations, operational integration of utility systems, power pooling, system reliability, ratemaking, power dispatching and gas supply studies. From 1969 until 1983, I worked in the Canadian utility industry. From 1976 to 1983, I ran my own firm, Slater Energy Consultants, Inc., in Toronto, Canada 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®, (now renamed PROMOD IV™), a widely recognized electric utility planning and reliability model.

From 1969 through 1974, I worked as an Engineer, and then as Senior Engineer 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. In 1974 and 1975, I worked as Manager of Engineering at the Ontario Energy Board (Ontario's utility regulatory commission) and in 1975 and 1976, I served as Research Director for the Royal Commission on Electric Power Planning (also in Ontario).

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. A copy of my resume' is included as Exhibit KJS-1.

Q. HAVE YOU TESTIFIED AS AN EXPERT WITNESS IN THE PAST?

A. Yes. I have provided expert testimony in regulatory proceedings in California, Florida, Georgia, Idaho, Indiana, Iowa, Louisiana, New Mexico, New York, Nova Scotia, Ontario, Pennsylvania, Prince Edward Island, South Carolina, Texas, Virginia, and Wisconsin, and at the Federal Energy Regulatory Commission. I have also appeared in Federal Bankruptcy Court and state courts in Florida, Nebraska, Texas and Virginia, and in civil arbitration proceedings in Louisiana, Nevada and Pennsylvania. I have also served on many occasions as an expert examiner for a Royal Commission in Ontario, which was charged with studying and evaluating electric power planning in the Province of Ontario.

II. PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. I am testifying on behalf of Duke Energy North America, L.L.C. and Duke Energy New Smyrna Beach Power Company Ltd., L.L.P. (collectively "Duke") to provide comment and opinions on the specific issues to be addressed by the Florida Public Service Commission ("PSC" or "Commission") in this proceeding, and to comment generally on the matter of generation reliability calculations for Peninsular Florida.

Q. WHAT MATERIAL HAVE YOU EXAMINED IN PREPARATION FOR YOUR TESTIMONY?

A. I have examined the Commission's July 1, 1999 order clarifying the scope of this proceeding, together with the 1998 Reliability Assessment prepared by the Florida Reliability Coordinating Council ("FRCC"), and the FRCC's 1999 Regional Load & Resource Plan. I have also reviewed the PSC Staff Handout entitled "Generic Investigation Into Aggregate Electric Utility Reserve Margins Planned For Peninsular Florida, and the FRCC's "Planning Principles and Guides," adopted on September 25, 1996. I have also read Section 366.055, Florida Statutes, and Sections 38-3-51 and 46-2-71 of the Georgia Code.

III. GENERAL CONCLUSION

Q. WHAT GENERAL CONCLUSION HAVE YOU REACHED ABOUT THE 1998 RELIABILITY ASSESSMENT?

A: I have concluded that the FRCC's 1998 Reliability Assessment fails to adequately address significant aspects and elements of Peninsular Florida's generation reliability. In particular:

1. The FRCC's 1998 Reliability Assessment does not appropriately recognize weather induced peak loads, which have caused supply-related reliability problems in Peninsular Florida in the past. This is the most serious deficiency.
2. The FRCC's 1998 Reliability Assessment does not adequately recognize the possibility that peak load conditions can occur at times when some units could be on planned maintenance.
3. The FRCC's 1998 Reliability Assessment does not include the concept or possibility of common mode failure among generating units, or the possible coincidence of such common mode failures with weather induced peak loads.
4. The sensitivity analyses included in the Reliability Assessment, dealing with SERC assistance, load forecast uncertainty, and inability to utilize interruptibility and load management, deal with matters which should be included in the base case analysis.

On the matter of "combination sensitivities", the FRCC Resource Working Group fails to recognize the importance of proper assessment of coincidence of negative events and dismisses the subject with the following statement.

> *These sensitivities combined conditions that individually are not likely to occur. The probability of a combination of them occurring without an appropriate response from the affected utilities is very low and, as such, very unlikely.*

Such a statement coming from the authors of an adequacy assessment based on probability analyses is extremely troubling because there are non-zero probabilities associated with the combined conditions that the authors have dismissed.

I will deal with the above matters as I discuss the various issues that the PSC has proposed be covered in this proceeding.

IV. <u>THE FLORIDA PSC'S ISSUES</u>

Q: WHAT IS THE APPROPRIATE METHODOLOGY, FOR PLANNING PURPOSES, FOR CALCULATING RESERVE MARGINS FOR INDIVIDUAL UTILITIES AND FOR PENINSULAR FLORIDA?

A. Reserve margin is not an expression of system reliability. However, the method by which reserve margin is calculated is of some importance, as reserve margin values facilitate comparisons with other systems and can be used for tracking, over time, of the conditions on a particular system. Therefore, reserve margin should be calculated in a manner which is common with such calculations performed in other systems. The correct method for calculating reserve margin is set forth in the first paragraph of Section 2.1.3 of the FRCC's 1998 Reliability Assessment, but with two exceptions: (1) the methodology should use coincident rather than non-coincident firm peak load, and

(2) the methodology should recognize uncommitted capacity available from merchant plants. Thus, I would calculate reserve margin as follows.

> *Reserve Margin is calculated by subtracting the system coincident firm peak load from available firm capacity resources. The resulting difference is expressed in MW or as a percentage of firm load. The system coincident peak firm load is determined for the annual or seasonal coincident peak by subtracting the demand reduction effects of conservation, interruptible load, and load management programs from the projected total load. Available firm capacity includes the installed generation, reflecting the appropriate seasonally adjusted capability ratings of utility-owned generating units, merchant plants and Qualifying Facilities, as well as the firm net purchases and sales relative to Peninsular Florida.*

Q: FOR PLANNING PURPOSES, HOW SHOULD RESERVE MARGINS BE EVALUATED FOR PENINSULAR FLORIDA AND FOR INDIVIDUAL UTILITIES?

A: With regard to Peninsular Florida, the purpose of maintaining a reserve margin is to ensure that the power system can supply its demand under almost all circumstances almost all of the time. Because these circumstances occur randomly (stochastically), the only satisfactory way to evaluate the effectiveness of a particular reserve margin is by using a probability analysis to determine the probability that a given system, with its actual reserve margin, will be able to serve the firm power supply demands placed upon it. All circumstances which can reasonably be expected to affect the ability of the particular system under study to supply its load must be included in the probability analysis, not just an average set of conditions.

For example, in the past, one significant risk for the Peninsular Florida system has been the occurrence of abnormally cold weather during the winter period. Therefore, a reliability analysis of Peninsular Florida would be incomplete without the proper recognition of the probability of such an event. Known linkages between events which can together impact the ability of the system to serve its load also need to be included in the reliability analysis. For example, a frozen water line may have a very small contribution to the unavailability of a particular coal unit, but since frozen water lines can affect more than one unit simultaneously, and can only occur during abnormally cold weather, they can have a significant impact on system reliability. Therefore, it is not enough that a probabilistic reliability calculation be used to test the efficacy of a particular reserve margin. To be effective, the reliability calculation must include an appropriate assessment of all significant risks.

For any individual utility within Peninsular Florida, the determination of an appropriate reserve margin is not for the purpose of determining the supply reliability of Peninsular Florida. Rather, it is for the purpose of ensuring that the individual utility provides its appropriate contribution to the overall Peninsular Florida reserve margin.

Q: HOW SHOULD THIS APPROPRIATE CONTRIBUTION TO OVERALL PENINSULAR FLORIDA RESERVE MARGIN BE DETERMINED FOR AN INDIVIDUAL UTILITY?

A: It is easier to say how it shouldn't be determined, than it is to say how it should be determined. Still, it is clear that it would always be wise <u>policy</u> to rely on the same probabilistic calculation that is used to determine the appropriate reserve margin for the overall system.

In the past, I have used a procedure which I call the "N-Times Method" to allocate a system-wide reserve requirement among the member utilities. In short, this method scales up the load and number of individual resources of a member utility until it reaches the same size as the overall system, and matches the reliability of the overall system, in order to determine the appropriate reserve contribution of that member utility. A more complete description of this method is contained in Exhibit KJS-2.

Q: HOW SHOULD THE INDIVIDUAL COMPONENTS OF A RESERVE MARGIN CALCULATION BE DEFINED AND CONSIDERED?

A: When probabilistic reliability methods are used to determine appropriate reserves for a power system, the required percent reserve margin is simply a <u>result</u> of the procedure, not a determinant. Once the set of resources required to achieve the required reliability level is determined, the simple tabulation of the resultant reserve margin cannot influence the system reliability. However, the reasonable and consistent tabulation of the reserve margin is useful and necessary for understanding and tracking the relationship between reserve levels and system reliability over time.

The detailed information required to properly represent a load or resource within a reliability calculation cannot be included in a simple tabulation of a reserve margin. Therefore, the representation of resources in the tabulation of a reserve margin is a matter of capturing the salient features only. For example, a simple tabulation of reserve margin will reflect peak load under normal weather conditions rather than a distribution of peak loads corresponding to a distribution of seasonal weather conditions.

The important issue with respect to every element of load and resources is that each be represented accurately, realistically, and with the best available information within the probabilistic reliability calculation itself. For example, a probability could be used to represent the continued operation of a potentially uneconomic resource such as a poorly performing unit.

Demand-side resources should also be treated probabilistically as to their continuation over time, and to their effectiveness during times of system stress. For example, if there is a tendency for customers subscribing to an air-conditioning control program to abandon the program at a higher rate than normal during unusually hot weather, then this probability must be represented and linked to the occurrence of the high loads which would also result from unusually hot weather.

Q: IS AN HOURLY REPRESENTATION OF SYSTEM LOAD SATISFACTORY?

A: Most systems have found an hourly representation of load to be satisfactory, but if appropriate data were available and if the reliability evaluation models were appropriately specified, a shorter period could be used.

Q: HOW SHOULD LOAD DIVERSITY AMONG INDIVIDUAL UTILITIES BE REPRESENTED?

A: In a reliability calculation, load diversity should be represented as accurately as actual historical records permit. In a tabulation of reserve margin, it is often useful and certainly more explanatory to list the peak demands of individual utilities during the time period under consideration, and then to list the difference between the overall system coincident and non-coincident peaks as a load reduction.

Q: HOW SHOULD GENERATING UNITS BE RATED FOR INCLUSION IN A PERCENT RESERVE MARGIN PLANNING CRITERION CALCULATION?

A: Each generating unit should be represented as completely as possible in a probabilistic reliability calculation. For example, each unit's seasonal capability and its planned outage requirements, maintenance outage rate, and forced outage rate should be represented as accurately as possible. Of particular interest is the relationship between unit capability and weather conditions, because of the causal relationship between weather and system load. It is possible to construct reliability calculations to deal with this relationship, and I have included a simple numerical example in Exhibit KJS-3.

Q: HOW WOULD YOU RECOMMEND TREATING UNCOMMITTED CAPACITY, SUCH AS MIGHT BE AVAILABLE FROM A MERCHANT PLANT (OR ANY OTHER UTILITY) WHOSE OUTPUT WAS NOT FULLY COMMITTED, IN EVALUATING RESERVE MARGINS AND RELIABILITY FROM A PENINSULAR FLORIDA PERSPECTIVE?

A: Merchant plants and other non-committed capacity resources should be included in the reliability evaluation for Peninsular Florida as if they were committed resources. Merchant plants would simply be modeled in the same way as any other generating resource, with correct capacity and availability values.

From the perspective of an individual utility, a merchant plant can be relied on as firm reserves only to the extent that its capacity is under contract to the individual utility. Remember, however, that this is only important for understanding and evaluating whether the individual utility is making an appropriate (however that is determined) contribution to overall Peninsular Florida reliability. In evaluating the individual utility's reliability, uncommitted merchant capacity in Peninsular Florida can and should be recognized as being potentially available to assist the utility in meeting its peak, with appropriate account taken of the probability that the merchant plant's output will be available for purchase by the individual utility.

The point of this discussion is easily illustrated. Suppose that there were 10,000 MW of uncommitted merchant capacity in Peninsular Florida in addition to the other resources in place as of today. The PSC, in evaluating Peninsular Florida reliability, should readily conclude that the system is very reliable. It would not matter whether even one MW of the merchant capacity was under long-term contract to individual utilities, because this additional capacity would make the probability of a supply-related outage minuscule.

Q: HOW DOES ONE DETERMINE THE APPROPRIATE AMOUNT OF FIRM LOAD THAT AN INDIVIDUAL GENERATING UNIT CAN BE CONTRACTED TO SERVE?

A: This determination should recognize the individual capability and reliability of the particular unit, and not just employ average system results. One approach would be to apply the N-Times Method that I described earlier. Another approach, which has been used in the past, and which also relies on the same probabilistic reliability calculation which is used for the overall system, is to determine the "load meeting capability" of the subject unit. Using this approach, the amount of load that the system can serve at a specified reliability level, e.g., a loss of load probability (LOLP) of 0.1, with the subject unit is compared to the load that the system can serve at the same level of reliability without the subject unit. The increase in load that can be served at the specified reliability level with the subject unit represents the load meeting capability of the unit. Exhibit KJS-4 contains a simple numerical example of this approach.

Q: FROM THE PERSPECTIVE OF THE PSC IN CARRYING OUT ITS REGULATORY RESPONSIBILITY TO ENSURE THE AVAILABILITY OF RESERVES FOR GRID

RELIABILITY AND INTEGRITY, AND IN EXERCISING ITS AUTHORITY OVER THE PLANNING AND MAINTENANCE OF A COORDINATED POWER SUPPLY GRID, DOES IT MAKE ANY DIFFERENCE WHETHER A PARTICULAR POWER PLANT IS OWNED BY A RETAIL-SERVING UTILITY OR BY A WHOLESALE MERCHANT UTILITY?

A. No. From the Commission's perspective, it makes no difference whether a particular power plant is owned by a retail-serving utility or by a wholesale merchant utility. In the simplest terms, a power plant is a power plant.

Q: **HOW SHOULD INDIVIDUAL UTILITIES' RESERVE MARGINS BE INTEGRATED INTO THE AGGREGATED RESERVE MARGIN FOR PENINSULAR FLORIDA? IS SUCH INTEGRATION PROBLEMATIC?**

A: Again, it is important to remember that from the Commission's statewide (or Peninsular-wide) perspective, the reliability of the overall system, with whatever reserves are available to the overall system, is what counts. Individual utilities' reserve margins are primarily important for allocating reserve responsibilities.

I don't believe that "integrating" individual utilities' reserve margins into an aggregated reserve margin for Peninsular Florida is problematic. If the loads and resources behind the individual utility reserve margins are treated as I have described above, the only item of real interest is the diversity (or coincidence) between the individual utility peak loads. I have previously described how I believe this diversity-coincidence relationship should be addressed in reliability analyses.

Q: **SHOULD THERE BE A LIMIT ON THE RATIO OF NON-FIRM LOAD TO MW RESERVES? IF SO, WHAT SHOULD THAT RATIO BE?**

A: The answer to this question is "maybe," but a more complete answer from a reliability analysis perspective depends on other key features of the power supply system, including total reserves (including uncommitted capacity), and the capacity and availability of external assistance. The question of a "limit" on non-firm load or other demand-side resources from a reliability perspective depends in part on whether there is a fixed or maximum level of reserves, such as might be properly imposed on rate-based power plants in a conventional regulatory context without the prospect of merchant plants. If a regulatory authority determines that captive ratepayers should not be obligated to pay for more than 15 percent reserves, and the system is in fact planned and managed to approximate that target level, then the greater the percentage of the 15 percent that is represented by demand-side resources, the less reliable the system will be, and accordingly, a limit would be appropriate.

If, however, the operation of a robust competitive wholesale power market results in a system with non-rate-based merchant plants supplying additional significant "hardware" generation resources (i.e., power plants) above the hypothesized 15 percent reserve margin target, then the amount of non-firm load and other demand-side resources on the system is much less important from a reliability perspective. (This does have implications for the amount of demand-side resources that will be cost-effective, but that is a very different issue from reliability.)

There are two key issues or concerns with demand-side resources. First, when reserve margin calculations simply count demand-side resources as peak load reductions, demand-side resources can be overvalued. Limitations on the frequency with which demand-side resources may be used, on both a daily and a yearly basis, are such that when increasing amounts of demand-side resources are developed in a system, the overall reduction in firm peak capacity for each additional MW of demand-side resource declines. Only by recognizing these limitations in a properly constructed probabilistic reliability calculation, can the appropriate reliability value be placed on these resources. (Of course, this should also be considered in evaluating the cost-effectiveness of new demand-side programs.)

The second issue is that demand-side resources do not have the operational characteristics that are possessed by generating units within Peninsular Florida. They are not necessarily as useful in providing operating reserve, and they are certainly not capable of fulfilling frequency response and regulation functions. Therefore, in addition to economic reasons, there may be system operational reasons why there is a limit to the level of non-firm load and other demand-side resources that is <u>useful</u> to the system.

Q: SHOULD THERE BE A MINIMUM OF SUPPLY-SIDE RESOURCES WHEN DETERMINING RESERVE MARGINS? IF SO, WHAT IS THE APPROPRIATE MINIMUM LEVEL?

A: The answer to this question is "probably," because, as discussed above, there are particular concerns or problems with relying on demand-side resources. Again, the key issue is reliability, but it is entirely safe to say that a system that relies to a high degree on demand-side resources to provide a particular reserve margin will be less reliable (i.e., will exhibit a greater probability of being unable to meet firm load) than a system that relies to a higher degree on supply-side resources, i.e., power plants. Accordingly, it is fair to say that, considering reliability, there should be a minimum of supply-side resources in order to ensure adequate reliability.

Q: WHAT, IF ANY, PLANNING CRITERIA SHOULD BE USED TO ASSESS THE GENERATION ADEQUACY OF INDIVIDUAL UTILITIES?

A: From the perspective of evaluating a power system's reliability, it is unnecessary to assess the generation the adequacy of individual utilities. If there are sufficient resources to provide the required level of reliability to Peninsular Florida, it does not matter who has provided them. From an economic perspective, however, all load serving entities need to be responsible for an appropriate share of those resources which collectively provide that reliability. I have already discussed this matter in regard to Issue 2.

Q: SHOULD THE IMPORT CAPABILITY OF PENINSULAR FLORIDA BE ACCOUNTED FOR IN MEASURING AND EVALUATING RESERVE MARGINS AND OTHER RELIABILITY CRITERIA, BOTH FOR INDIVIDUAL UTILITIES AND FOR PENINSULAR FLORIDA?

A: Yes. Since the import capability is a resource which can be used to supply demand, it must be represented in any reliability analysis. The exact representation will depend on the firm resources which rely on the import capability (e.g., Scherer 4 and unit power sales contracts between Southern Company and Florida utilities), and the ability of the Southern Company System to provide additional capability when needed.

As a policy and general regulatory matter, it may be that authorized state officials or agencies, e.g., a state's governor or its public utility commission or emergency management agency, have the ability, during prescribed emergency situations, to require power plants within their jurisdictions to be made available to serve the needs within those jurisdictions. For example, this appears to be the policy reflected in Section 366.055, Florida Statutes, and in Sections 38-3-51 and 46-2-71 of the Georgia Code. I cannot comment on the legal capabilities of the Governor of Georgia or of the Florida PSC, but, as a general regulatory matter, it may be that the Florida PSC or its Georgia counterpart can, under certain emergency circumstances, cause power supply resources to be used to serve the needs of their respective states. Such considerations may affect the way that import capability is treated in Peninsular Florida reliability analyses.

Q: ISSUE 10 SEEKS INFORMATION ON HOW EACH PENINSULAR FLORIDA UTILITY ACCOUNTS FOR WEATHER CONDITIONS IN FORECASTING SEASONAL PEAK LOADS. PLEASE COMMENT.

A: I am unable at this time to comment on the specific utilities' treatment of historical winter and summer temperatures in forecasting seasonal peak demands. I do, however, have the following comments on the general issues of weather, load forecasts, and system reliability in Peninsular Florida. Perhaps the major risk to the reliability of electricity supply in Peninsular Florida is the potential for weather induced peak loads. Yet, the FRCC's reliability evaluation only models forecast load under normal weather conditions, not the extreme conditions which pose greater supply risks. Further, during the PSC Staff Workshop for this proceeding, the Staff's analysis of the inadequacy of the 15% reserve margin correctly targeted the fact that the FRCC's analysis of the 15% reserve margin ignored the greatest risks to supply by <u>averaging</u> past deviations from forecast to obtain expressions of load and resource uncertainty. Thus, the FRCC virtually ignores what is probably the greatest risk to electricity supply in Peninsular Florida.

Q: HAS THE FRCC'S 15 PERCENT RESERVE MARGIN PLANNING CRITERION, OR ANY OTHER PLANNING CRITERION, BEEN ADEQUATELY TESTED TO WARRANT USING IT FOR THE PLANNING OF ELECTRICITY SUPPLIES FOR PENINSULAR FLORIDA?

A: Based on the analyses available to date, the answer would have to be, "No."

Q: WHAT PLANNING CRITERION OR CRITERIA SHOULD BE USED?

A: As yet, the work necessary to select such a planning criterion or criteria has not been done.

Q: HOW SHOULD A PLANNING CRITERION BE DEVELOPED?

A: I believe that a planning criterion should be developed in the following way.

1. Construct a probabilistic reliability model of Peninsular Florida capable of fully representing all of the factors which either alone or in combination with others pose discernable risks to the supply reliability. This reliability model should be capable of calculating Loss of Load Probability (LOLP), Loss of Load Hours (LOLH) and Expected Unsupplied (or Unserved) Energy (EUE or % EUE).
2. Conduct an analysis of the costs, both actual and perceived, resulting from customers having their firm load interrupted. These costs can be related to both the frequency of interruption and the length of interruption and, of course, the cost for the total system is related to the overall magnitude of interruptions. Call these "unsupply" costs.
3. Use a generation planning model of Peninsular Florida that is capable of determining the overall costs of providing electricity supply.
4. Perform an iterative analysis by varying reserve margin values in order to obtain a range of reserve margins for which the total of supply costs and

unsupply costs is a minimum. The bottom of this range represents the minimum economic reserve margin, which, when considered along with practical system operating concerns (as I have already mentioned), should be considered the minimum practical reserve level. I have illustrated this range in Exhibit KJS-5. The top of the range should represent the maximum level which should be allowed in rate base.

5. Once the reserve level range is determined, it should be converted to one of its corresponding reliability indices. The planning criterion can then be expressed as a reliability range, rather than a reserve margin range, because the reliability range is more meaningful.

In a robust competitive wholesale power market, the market itself will determine the upper end of the reliability range which both suppliers and consumers find acceptable. It would only be necessary for regulators, e.g., the Commission, to impose a lower limit if the operation of the wholesale power market produced a reliability level below the lower end of the range.

Q: ISSUE 12 SEEKS INFORMATION REGARDING THE CURRENTLY PLANNED RESERVE MARGIN FOR EACH PENINSULAR FLORIDA UTILITY. HAVE YOU ANY COMMENTS?

A: Not at this time.

Q: HOW DO THE RELIABILITY CRITERIA ADOPTED BY THE FRCC COMPARE TO THE RELIABILITY CRITERIA ADOPTED BY OTHER RELIABILITY COUNCILS?

A: In Exhibit KJS-6, I have tabulated the essential elements of each Reliability Council's criteria for generation adequacy. However, these criteria do not appear to be binding on the individual systems which comprise each reliability region. For example, in the Northeast Power Coordinating Council ("NPCC"), the stated generation reliability criterion for each of the Areas is as follows.

> *Each Area's resources will be planned in such a manner that after due allowance for scheduled maintenance, forced and partial outages, interconnections with neighboring areas, and available operating procedures, the probability of disconnecting non-interruptible customers due to a resource deficiency, on the average, will be no more than once in ten years.*

Yet, each Area within NPCC has its own interpretation of this criterion.

1. The New England Power Pool ("NEPOOL") professes to abide by the above stated criterion.
2. The New York Power Pool ("NYPP") says that it abides by the NPCC criterion and its own, and that 22% reserves over summer peak are required to achieve this.
3. Ontario Hydro's generation planning criterion is based on planning sufficient reserves to minimize total customer (supply and unsupply) costs.

4. Hydro Quebec has a similar criterion to that of NPCC, except that instead of "once in ten years" it uses "the equivalent of one day per ten years." Hydro Quebec applies this criterion such that the "equivalent of one day" means "24 hours."
5. New Brunswick uses a reserve margin equal to the greater of its largest unit or 20% of firm in-province peak demand.
6. Nova Scotia uses a reserve margin of 20% over Winter Firm Peak.
7. Prince Edward Island maintains generation reserves of at least 15% of its firm peak load.

It is clear that the NERC Reliability Regions and any autonomous Areas within them exercise considerable flexibility in defining, and abiding by, generation reliability criteria.

Q: ISSUE 14 ASKS ABOUT THE ADOPTION OF A RESERVE MARGIN STANDARD FOR INDIVIDUAL UTILITIES IN FLORIDA. WHAT IS YOUR VIEW?

A: As I stated regarding Issue 2, Peninsular Florida is the entity which needs to abide by a reliability criterion. Beyond that, again as I have already stated, it is only necessary to ensure that each utility makes a contribution to the required reserves which is appropriate. This contribution need not necessarily be through full ownership of the required resources. Contracts with other utilities including merchant utilities, could form part or all of a utility's needed capacity.

Q: SHOULD THE COMMISSION ADOPT A RESERVE MARGIN STANDARD OR OTHER RELIABILITY STANDARD FOR PENINSULAR FLORIDA? IF SO, WHAT WOULD BE THE APPROPRIATE RESERVE MARGIN CRITERIA FOR PENINSULAR FLORIDA?

A: The Commission should continually evaluate the reliability of Peninsular Florida, regardless of whether it ultimately adopts a standard. As a threshold matter, it is necessary to adopt a methodology for determining appropriate reserves, not just state a reserve margin or reliability criterion. Second, adverse weather is obviously one of the principal supply risks for Peninsular Florida, and any methodology which does not fully recognize this element in determining a minimum acceptable reliability level would be inadequate.

Q: SHOULD THE COMMISSION ADOPT A MAXIMUM RESERVE MARGIN CRITERION OR OTHER RELIABILITY CRITERION FOR PLANNING PURPOSES?

A: No. The Commission will likely always have regulatory responsibility to ensure the provision of reliable electric service in Florida, and accordingly, it will likely be necessary to have a <u>minimum</u> reliability standard. It will only be necessary to have a <u>maximum</u> standard, however, to limit the amount of generating plant investment allowed in utility rate base to that which is reasonably necessary and prudent to maintain acceptably reliable service. The Commission should not adopt or apply any form of maximum reserve margin or other reliability criterion that would limit the entry of merchant plants into Florida's wholesale power market. Merchant plants can only enhance Peninsular Florida's system reliability, without risk or cost to captive electric ratepayers.

Q: WHAT PERCENT RESERVE MARGIN IS CURRENTLY PLANNED FOR PENINSULAR FLORIDA, AND IS IT SUFFICIENT TO PROVIDE AN ADEQUATE AND RELIABLE SOURCE OF ENERGY FOR OPERATIONAL AND EMERGENCY PURPOSES IN PENINSULAR FLORIDA?

A: The FRCC's 1999 Load & Resource Plan shows summer reserve margins generally between 8 and 12 percent and winter reserve margins generally between 4 and 8 percent, without exercise of load management and interruptible resources, over the forecast period. The corresponding values with exercise of non-firm resources generally range between 16 and 21 percent. Based on the reliability analyses and related work done to date, of which I am aware, I believe that there is significant doubt as to the adequacy of currently planned reserve margins to maintain reliable service to Peninsular Florida under realistic weather scenarios. This is highlighted by the facts of last summer's heat events resulting in interruption of all available non-firm resources, which in turn resulted in massive defections from residential load management programs, and by the capacity shortage experienced just this past April, when unseasonably warm weather combined with generator outages to put the state in a relatively tight supply situation. Of course, one must also remember that in December 1989, projected reserves significantly greater than those currently projected proved seriously inadequate to maintain firm service.

The FRCC has adopted a dual requirement, a minimum 15% reserves and an LOLP of not more than 0.1 day per year. However, the two analyses performed by the FRCC are not at all persuasive. The Reliability Study ignores too many significant elements, such as weather induced load excursions and load management defections. And, as the PSC Staff have correctly demonstrated, the 15% reserve margin adequacy study "averages out" the possibility of negative margins. Therefore, I believe it to be very important that this proceeding lead to the determination of a complete methodology for evaluating generation adequacy.

Q: CAN OUT-OF-PENINSULAR-FLORIDA POWER SALES INTERFERE WITH THE AVAILABILITY OF PENINSULAR FLORIDA RESERVE CAPACITY TO SERVE PENINSULAR FLORIDA CONSUMERS DURING A CAPACITY SHORTAGE? IF SO, HOW SHOULD SUCH SALES BE ACCOUNTED FOR IN ESTABLISHING A RESERVE MARGIN STANDARD?

A: Based on what I know of the Peninsular Florida generation and transmission systems, and my experience in Florida regulatory proceedings over the past 15 years, I believe that the most realistic and practical answer to this question is "No." The need for power in Florida is great, and the value of power in Peninsular Florida is significantly greater than in SERC and other regions under almost all circumstances. Accordingly, I believe that the most probable and most realistic scenario is that all available power plants, including merchant plants, in Peninsular Florida will be serving Peninsular Florida loads during any serious peak conditions. Moreover, without commenting on legal matters, it does appear to be the policy of Florida to require that in-state resources be made available to serve in-state needs during defined emergency events.

V. FURTHER DISCUSSION

Q: HAVING DISCUSSED THE COMMISSION'S ISSUES, IS THERE ANYTHING FURTHER YOU WOULD LIKE TO ADD?

A: Yes. I believe that this is an appropriate time for consideration of generation reliability in Florida. Demand-side resources have reached a high level, the reliability of generating units has improved greatly, and, the use of electricity for personal comfort and convenience, as well as for economic production, is pervasive. This is an ideal time to evaluate reliability. In addition, merchant plants are already on the horizon in Florida (and on the ground in other states), and a truly open, robust competitive wholesale power market cannot be far behind. This proceeding represents an opportunity for the Commission to begin setting the ground-rules for the future determination and satisfaction of capacity needs.

Q: DOES THIS CONCLUDE YOUR TESTIMONY?

A: Yes, it does.

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Generic Investigation Into the Aggregate Electric Utility Reserve Margins Planned for Peninsular Florida	)	DOCKET NO. 981890-EU FILED: August 16, 1999

EXHIBITS

OF

KENNETH J. SLATER

ON BEHALF OF

DUKE ENERGY NEW SMYRNA BEACH POWER COMPANY LTD., L.L.P.

AND

DUKE ENERGY NORTH AMERICA, L.L.C.

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 in civil arbitration proceedings in Louisiana and Pennsylvania.

Mr. Slater continued to contribute to the development of E.M.A.'a 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, in Atlanta, where he heads a small corporation, Slater Consulting, which provides consulting services and expert testimony for various different participants in the utility industry.

Slater Consulting assignments, led by Mr. Slater, have included:

- Assistance to legal council for creditors of a bankrupt utility.
- Analysis and testimony for Texas - New Mexico Power Company regarding prudent alternatives to their decision to build TNP ONE Unit 2.
- Assistance and analysis for a utility and its legal counsel during litigation regarding damages sustained because of interference in a proposed merger of that utility with another utility.
- Analyses and testimony before the New York PSC for Sithe Energies, Inc., in certification proceedings and in numerous avoided cost and buy-back rate proceedings.
- Analyses and testimony for the Independent Power Producers of New York in QF curtailment, buy-back rate and back-up rate proceedings before the New York PSC.
- Analysis and testimony for Southwestern Public Service Co. at FERC and before the New Mexico Public Service Commission regarding the lack of production cost savings from the proposed merger of Central & South West Utilities with El Paso Electric Company.
- Analyses and testimony before the Public Service Commission for Independent Power Producers in Florida regarding QF curtailment.

- Analyses and testimony in Civil Court cases for Independent Power Producers in Florida regarding the correct implementation of contractual dispatchability provisions.

- Testimony before regulatory commissions in New York, Pennsylvania, Texas, Florida and Louisiana regarding various aspects of emerging competition.

- Analyses and testimony before the Georgia Public Service Commission on behalf of Mid-Geogia Co-gen and others regarding avoided costs on the Georgia Power / Southern Company system.

- Analysis and testimony before the Georgia Public Service Commission on behalf of Georgia Power Company regarding the Prudence of Georgia Power's 1978-1980 investment in the Rocky Mountain pumped storage plant.

- Testimony before the regulatory commissions of Texas, Virginia and Wisconsin regarding the fair allocation of utility revenue requirements to individual customer classes.

- Testimony before the United States Bankruptcy Court regarding the value of the non-nuclear assets of Cajun Electric Power Co-operative, Inc.

- Analyses for Sithe Energies, Inc. of the future dispatch and associated energy revenues for numerous generating resources in the Northeast United States.

- Operational planning analyses for Sithe Energies, Inc. regarding numerous existing and new generating resources in the Northeast United States.

- Analyses and testimony in Courts and before arbitrators for the non-operating owners of the South Texas Nuclear Project, the Cooper nuclear unit in Nebraska, and the Millstone 3 nuclear unit in Connecticut concerning the replacement power costs during extended outages.

In connection with these and other assignments, Mr. Slater has appeared as an expert in regulatory proceedings in Florida, Georgia, Louisiana, New Mexico, New York, Pennsylvania, South Carolina, Virginia, Wisconsin and Texas, and at the Federal Energy Regulatory Commission. He has also appeared in Federal Bankrupty Court, state courts in Virginia, Nebraska, Texas and Florida, and civil arbitration proceedings in Nevada and Pennsylvania.

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.

THE "N-TIMES METHOD"

The "N-Times Method" is used to allocate a system-wide reliability requirement among the individual and different utilities that constitute the total system.

The general premise of the method, is that if a member utility is "scaled-up" to the size of the whole system, a determination of the reliability requirement for that scaled-up system will yield, in percentage terms the appropriate reliability contribution of the individual utility to the whole system.

For Example:

Suppose a system of three utilities, 1, 2, and 3. Utility 1 has a load which is one sixth of the total system load, Utility 2 has a load which is one third of the total system load, and Utility 3 has a load which is half of the total system load.

Then, the n-times factor for Utility 1 is determined as $n_1 = 6$,
the n-times factor for Utility 2 is determined as $n_2 = 3$,
and, the n-times factor for Utility 3 is determined as $n_3 = 2$

Suppose further that a reliability evaluation performed on the total system results in a system-wide reserve requirement for a particular year of 1500 MW. Then, in order to allocate that 1500 MW among the three member utilities, three more similar reliability evaluations are performed.

For Utility 1, the load is multiplied by 6, and each generating resource is represented 6 times, each representation being identical to the original resource. The reserve requirement is then determined for this n_1 multiple of Utility 1. Suppose this requirement is 1200 MW. The appropriate contribution from Utility 1 towards the total system reserve requirement would then be (1200 / 6) or 200 MW.

For Utility 2, the load is multiplied by 3, and each generating resource is represented 3 times, each representation being identical to the original resource. The reserve requirement is then determined for this n_2 multiple of Utility 2. Suppose this requirement is 1800 MW. The appropriate contribution from Utility 2 towards the total system reserve requirement would then be (1800 / 3) or 600 MW.

For Utility 3, the load is multiplied by 2, and each generating resource is represented 2 times, each representation being identical to the original resource. The reserve requirement is then determined for this n_3 multiple of Utility 3. Suppose this requirement is 1400 MW. The appropriate contribution from Utility 1 towards the total system reserve requirement would then be (1400 / 2) or 700 MW.

Thus, the 1500 MW system reserve requirement would be allocated to the three utilities in the following manner. 200 MW would be required from Utility 1, 600 MW from Utility 2 and 700 MW from Utility 3.

Real situations would not be quite so neat. The "n" factors would not be convenient whole numbers, leading to approximations in the scaling of the numbers of each resource. Also, there would be some diversity between the loads which would have lead to a small mismatch between the total system requirement and the sum of the allocated requirements, which would need to be prorated.

EXAMPLE OF WEATHER IMPACT ON LOAD & CAPACITY

Suppose a sample generating system of 22 units ranging from 250 MW to 10 MW, with availabilities ranging from 0.90 to 0.96 has a total capacity of 2400 MW under normal summer weather conditions. Its capacity availability table is as follows.

Capacity MW	Probability of Having That Capacity or more	
2400	0.22185	
2390	0.25018	
2380	0.26957	
2370	0.29042	
.	.	
.	.	
.	.	
1900	0.93411	
1890	0.94087	
1880	0.94438	
1870	0.94781	
1860	0.94873	
1850	0.95297	******
1840	0.95915	
1830	0.96058	
1820	0.96149	
1810	0.96210	
.	.	
.	.	
.	.	

If the normal weather summer load is 1850 MW, then the sample system has a 0.95297 probability of serving that load.

Now suppose that there is;

- a 30% probability of adverse weather conditions which cause both a 150 MW increase in system load, and, coincidentally a deration of 10 MW on each of 5 generating units, compared to normal summer conditions.
- a 40% probability of normal summer conditions as described above.
- a 30% probability of favourable weather conditions which cause both a 100 MW decrease in system load, and, coincidentally a capacity increase of 10 MW on each of 5 generating units, compared to normal summer conditions.

Under adverse weather conditions, the capacity availability table is as follows.

Capacity MW	Probability of Having That Capacity or more	
2350	0.22185	
2340	0.25018	
2330	0.26957	
2320	0.29042	
.	.	
.	.	
.	.	
2050	0.78222	
2040	0.78729	
2030	0.79073	
2020	0.79346	
2010	0.79625	
2000	0.79797	******
1990	0.79855	
1980	0.82759	
1970	0.86015	
1960	0.86659	

Under favourable weather conditions, the capacity availability table is as follows.

Capacity MW	Probability of Having That Capacity or more	
2450	0.22185	
2440	0.25018	
2430	0.26957	
2420	0.29042	
.	.	
.	.	
.	.	
1800	0.98050	
1790	0.98131	
1780	0.98149	
1770	0.98228	
1760	0.98417	
1750	0.98555	******
1740	0.98592	
1730	0.98620	
1720	0.98633	
1710	0.98686	

Now, the probability of meeting the weather sensitive load, is determined as:

0.30 x 0.79797

+ 0.40 x 0.95297

+ 0.30 x 0.98555

That is, the probability of meeting load drops to 0.916244. Or, stated as we are accustomed to see it, the probability of failing to meet load increases from 0.047 to 0.094 once the effects of weather variations on load and capacity are considered.

LOAD MEETING CAPABILITY OF A GENERATOR

This methodology compares the load meeting capability of a generating system before and after the addition of a new generating unit. The difference is imputed to be load meeting capability of the added generating unit.

Example

A sample generating system of 22 units ranging from 250 MW to 10 MW, with availabilities ranging from 0.90 to 0.96 has a total capacity of 2400 MW. Its capacity availability table is as follows.

Capacity MW	Probability of Having That Capacity or more	
2400	0.22185	
2390	0.25018	
2380	0.26957	
2370	0.29042	
.	.	
.	.	
.	.	
1900	0.93411	
1890	0.94087	
1880	0.94438	
1870	0.94781	
1860	0.94873	
1850	0.95297	******
1840	0.95915	
1830	0.96058	
1820	0.96149	
1810	0.96210	
.	.	
.	.	
.	.	

If my reliability criterion is 0.95, then the highest load that can be served with a reliability of 0.95 or better is 1850 MW. The load meeting capability of the system is 1850 MW.

If a 200 MW unit with an availability of 0.92 is added to the system, then the capacity availability of the augmented system is as follows.

Capacity MW	Probability of Having That Capacity or more	
2600	0.20411	
2590	0.23016	
2580	0.24800	
2570	0.26718	
.	.	
.	.	
.	.	
2080	0.93182	
2070	0.93525	
2060	0.93627	
2050	0.94024	
2040	0.94614	
2030	0.94988	
2020	0.95334	******
2010	0.95443	
2000	0.95510	
1990	0.95601	
1980	0.96283	
.	.	
.	.	
.	.	

Now with the additional unit, the highest load that can be served with a reliability of 0.95 or better is 2020 MW. And, the load meeting capability imputed for the additional 200 MW unit is (2020 – 1850) or 170 MW.

Of course, with such a small system and using a single load level, the results for this example are rather "lumpy". However, it still serves as a simple illustration of the methodology.

OPTIMAL GENERATION RESERVE MARGIN

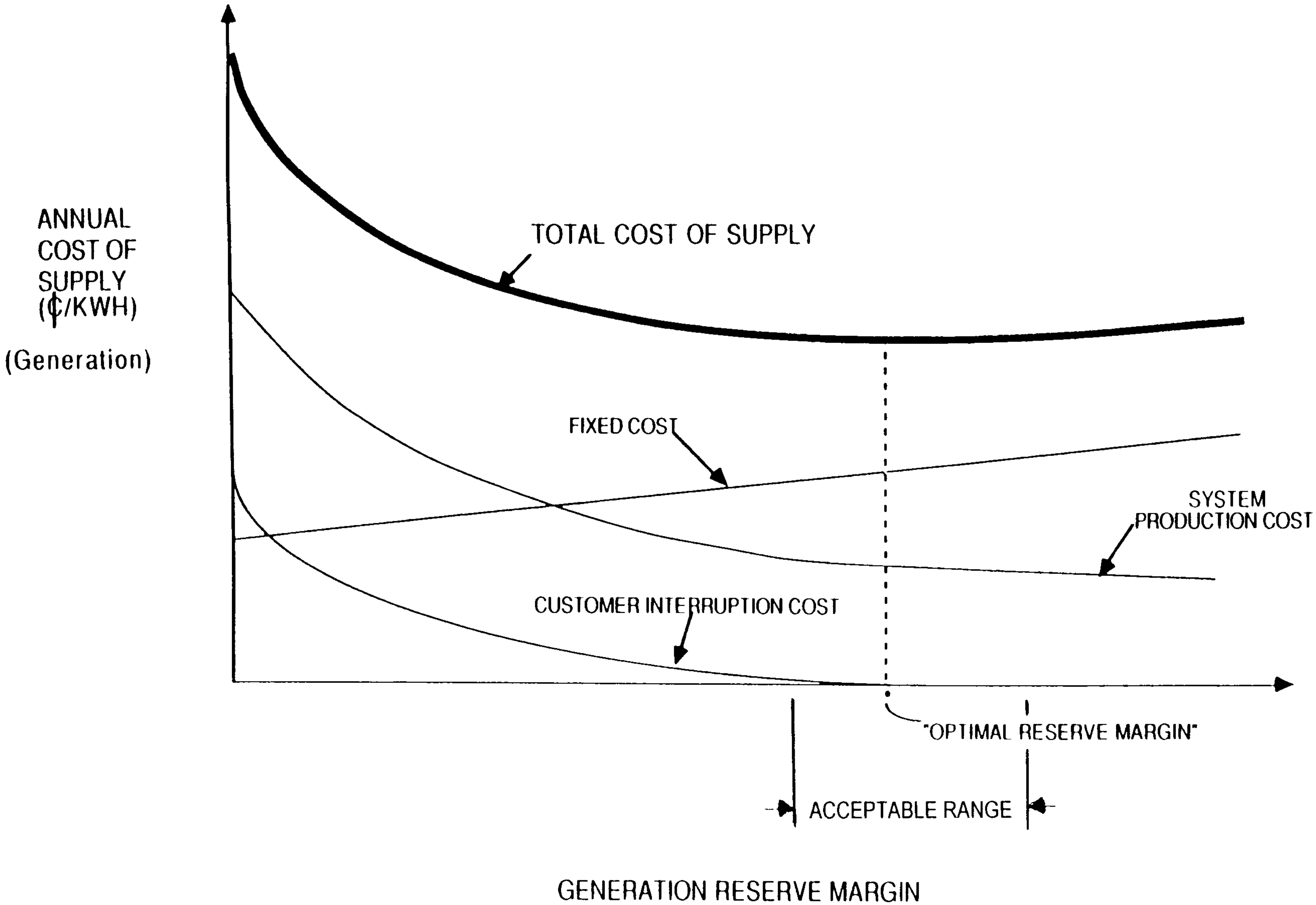

FIGURE 1

REGIONAL RELIABILITY COUNCIL GENERATION ADEQUACY CRITERIA

The following North American Electric Reliability Council (NERC) Regional Councils have published continuing generation adequacy criteria.

Northeast Power Coordinating Council

The NPCC defines an adequacy criterion to be used by each of its areas. These areas are New England Power Pool (NEPOOL), New York Power Pool (NYPP), Ontario, Quebec, New Brunswick, Nova Scotia and Prince Edward Island.

The generation adequacy criterion specifies a probability of disconnecting non-interruptible customers, due to resource deficiencies, of not more than once in ten years.

Mid-Atlantic Area Control

MAAC is essentially PJM, whose Reliability Committee sets a pool-wide reserve margin requirement for each planning period.

East Central Area Reliability Coordination Agreement

The resource adequacy criterion for ECAR requires that its "Dependence on Supplemental Capacity Resources" (DSCR) index be between one and ten days per year. ECAR's DSCR index is the number of actual or forecasted days per year that the ECAR region has to rely on,

(a) capacity resources outside ECAR,
(b) directly controlled load management or interruptible loads within ECAR, or,
(c) reducing area demand to the extent that such supplemental resources are not available.

Southeastern Electric Reliability Council

SERC does not appear to public an adequacy criterion.

Mid-America Interconnected Network

MAIN uses a region-wide Loss of Load Expectation (LOLE) of 0.1 days per year.

Mid-Continent Area Power Pool

MAPP specifies a minimum reserve margin for each of its member systems. Currently this minimum is 15%, (10% for a hydro system).

Southwest Power Pool

The SPP requires that each Load Serving Member maintain a capacity margin (not reserve margin) of 12% except that if the member's system capacity is at least 75% hydro-based the required capacity margin is 9%.

Electric Reliability Council of Texas

ERCOT requires that each load entity provide a reserve margin of at least 15%.

Western Systems Coordinating Council

The WSCC recommends that each area or system should meet or exceed at least one of the following criteria.

(1) Monthly reserve capacity after deducting scheduled maintenance equal to the greater of,
   (a) the largest risk, plus 5% of load responsibility, or,
   (b) a percentage of the monthly load responsibility between 5% and 15%. The actual percentage being determined by weighting the fraction of monthly capacity, (after planned maintenance), that is hydro, by 5%, and the fraction, that is thermal by 15%.

(2) Monthly reserve capacity after deducting scheduled maintenance equal to the sum of the two largest risks.

(3) Reliability based on a loss of load probability of one day in ten years, or a probability of meeting all loads in a year of 0.90.