BEFORE THE WISCONSIN PUBLIC SERVICE COMMISSION

Point Beach Nuclear Power Plant Projects
Proposed by Wisconsin Electric Power Company

DOCKETS NOS. 6630-CE-197
and 6630-CE-209

# TESTIMONY OF
# DAVID A. SCHLISSEL
# ON BEHALF OF THE
# CITIZENS UTILITY BOARD

September 12, 1994

SCHLISSEL TECHNICAL CONSULTING, INC.
45 Horace Road
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Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is David A. Schlissel. My business address is Schlissel Technical Consulting, Inc., 45 Horace Road, Belmont, Massachusetts 02178.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS PROCEEDING?

A. I am testifying on behalf of the Citizens Utility Board.

Q. PLEASE SUMMARIZE YOUR EDUCATIONAL BACKGROUND AND RECENT WORK EXPERIENCE.

A. I graduated from the Massachusetts Institute of Technology in 1968 with a Bachelor of Science Degree in Engineering. In 1969, I received a Master of Science Degree in Engineering from Stanford University. In 1973, I received a Law Degree from Stanford University. In addition, I studied nuclear engineering at the Massachusetts Institute of Technology during the years 1983-1986.

Since 1983, I have been retained by governmental bodies, publicly- owned utilities, and private organizations in 21 states to prepare expert testimony and analyses on engineering and economic issues related to electric utilities. My recent clients have included the Staff of the California Public Utilities Commission, the Staff of the Kansas State Corporation Commission, the staff of the Arizona

Corporation Commission, the North Carolina Eastern Municipal Power Agency, municipal utility systems in Massachusetts, the Office of Public Utility Counsel of the State of Texas, and the New York State Consumer Protection Board.

I have testified before state regulatory commissions in Arizona, New Jersey, Connecticut, Kansas, Texas, New Mexico, New York, Vermont, North Carolina, South Carolina, Maine, Illinois, Indiana, Ohio, Massachusetts, and Missouri, and before an Atomic Safety & Licensing Board of the U.S. Nuclear Regulatory Commission.

A copy of my current resume is attached as Exhibit STC-1.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THIS COMMISSION?

A. No.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. Schlissel Technical Consulting, Inc., was retained by the Citizens Utility Board to perform the following tasks:

1. Perform an engineering analysis of the Company's proposal to replace the Point Beach Unit 2 steam generators and the alternatives.

2. Perform an engineering analysis of the potential impact of aging on plant equipment, components and systems.

My testimony presents the results of these engineering analyses.

Q. PLEASE DESCRIBE HOW YOU CONDUCTED YOUR ENGINEERING ANALYSES IN THIS PROCEEDING.

A. I have reviewed the Wisconsin Electric Company's (WEPCO) application to the Commission and both the Draft and the Final Environmental Impact Statements issued by the Commission Staff. I have also reviewed the information and documents provided by the Company and the Commission staff in response to data requests submitted by CUB, Tellus Institute and Schlissel Technical Consulting, Inc..

I have also examined the correspondence between WEPCO and the U.S. Nuclear Regulatory Commission (NRC) concerning steam generator related problems at Point Beach. In addition, I have reviewed the NRC and nuclear industry literature concerning steam generator related problems and replacements at other operating nuclear power plants. Finally, I have conducted a review of NRC and nuclear industry literature on the issue of nuclear power plant aging.

Q. PLEASE SUMMARIZE YOUR CONCLUSIONS.

A. My conclusions can be summarized as follows:

1. WEPCO's projected cost and schedule for the 1996

replacement of the Point Beach Unit 2 steam generators appear reasonable and achievable given the Company's experience with the replacement of the Unit 1 steam generators and the nuclear industry's overall experience with steam generator replacements.

2. The Final Environmental Impact Statement (EIS) examined the appropriate technical alternatives to steam generator replacement.

3. The Option 3 examined in the economic analyses in the Final EIS, i.e., construction of the dry cask storage facility and the shutdown of both Point Beach Units in 1998, was unrealistic in that, if the dry cask storage facility were built, Point Beach Unit 2 could operate until the year 2000 with continued plugging of degraded steam generator tubes and Unit 1 could operate through its scheduled retirement in the year 2010.

4. The economic analyses presented in the Final EIS did not include any option in which a dry cask storage facility was not built. Therefore, those analyses provide no insight as whether the construction of such a facility is economic.

5. The potential impact of aging of nuclear power plant structures, systems, and components raises significant uncertainties for future Point Beach operating performance,

O&M costs, and capital additions expenditures.

6. The economic analyses in the Final EIS should have been structured to reflect optimistic, conservative, and pessimistic capacity factor scenarios. WEPCO's assumption that future Point Beach capacity factors will remain at historical levels as the Units age would represent the optimistic scenario. The modest capacity factor reductions included in the Staff's Decreasing Capacity Factor Sensitivity Analyses would reflect the conservative scenario. More significant capacity factor reductions, reflecting prolonged maintenance outages or premature shutdown, would be assumed in the pessimistic scenario.

7. Staff incorrectly assumed in its continued sleeving, Option 2, economic analyses that Point Beach Unit 2 would experience a 113 day outage in 1996. An outage of that duration would not be required in 1996 if the steam generators were not being replaced.

8. The economic analyses in the Final EIS should reflect that Point Beach O&M costs will increase at between 2 and 4 percent above the overall rate of inflation throughout all of the remaining years of the Units' projected service lives.

9. The economic analyses in the Final EIS should reflect that Point Beach capital additions expenditures will increase at

between 2 and 4 percent above the overall rate of inflation throughout most of the remaining years of the Units' projected service lives.

Q. HOW IS THE REMAINDER OF YOUR TESTIMONY ORGANIZED?

A. The remaining sections of my testimony are organized as follows. Section I will discuss the reasonableness of WEPCO's current cost and schedule estimates for the replacement of the Unit 2 steam generators. Section II will then address the significance of the flawed assumption in Option 3 that both Point Beach Units would be shut down in 1998 even if a dry cask storage facility were built.

Section III will then examine the issue of the aging of Point Beach plant structures, systems, and components. Section IV will address the potential impact of aging on future Point Beach operating performance. Finally, Section V will address the potential impact of aging on future Point Beach O&M costs and capital additions expenditures.

## SECTION I.
## WEPCO'S CURRENT COST AND SCHEDULE ESTIMATES FOR THE UNIT 2 STEAM GENERATOR REPLACEMENT APPEAR REASONABLE

Q. WHAT IS YOUR CONCLUSION AS TO THE REASONABLENESS OF WEPCO'S CURRENT COST AND SCHEDULE ESTIMATES FOR THE REPLACEMENT OF THE UNIT 2 STEAM GENERATORS?

A. I have concluded that the Company's current estimate of 113 days for a 1996 steam generator replacement outage, with a total cost for the replacement of approximately $113 million, in mid-year 1992 dollars, is reasonable and achievable.

Q. PLEASE EXPLAIN THE BASIS FOR THIS CONCLUSION.

A. The Company's current cost and schedule estimates for the replacement of the Unit 2 steam generators are reasonable given (1) the Company's experience with the replacement of the Unit 1 steam generators, although there are certain differences between the Unit 1 steam generator replacement and the Company's current plans for the Unit 2 replacement, and (2) the nuclear industry's experience with the replacement of steam generators at more than 14 operating nuclear power plants.

Q. HAVE YOU IDENTIFIED ANY REASONABLE REPAIR ALTERNATIVES TO STEAM GENERATOR REPLACEMENT OTHER THAN THE PLUGGING, SLEEVING AND LASER REPAIR OPTIONS DISCUSSED IN THE FINAL EIS?

A. No. The Final EIS examined the reasonable technical alternatives to the replacement of the Unit 2 steam generators.

Q. HAVE YOU SEEN ANY EVIDENCE THAT CONTRADICTS OR RAISES QUESTIONS ABOUT THE DISCUSSION OF TECHNICAL REPAIR ALTERNATIVES TO STEAM GENERATOR REPLACEMENT IN THE FINAL EIS?

A. No. The evidence that I have reviewed suggests that the continued sleeving and plugging options, as described in the Final EIS and the Company's Application, are reasonable technical and regulatory alternatives for extending the operating life of Point Beach Unit 2 without replacing the steam generators.

## SECTION II.
## OPTION 3 EXAMINED IN THE FINAL EIS REPRESENTS AN UNREALISTIC AND INCORRECT SCENARIO

Q. DO YOU BELIEVE THAT OPTION 3 EXAMINED IN THE ECONOMIC ANALYSES IN THE FINAL EIS REPRESENTED A REALISTIC SCENARIO FOR WHAT THE COMPANY WOULD DO IF THE UNIT 2 STEAM GENERATORS WERE NOT REPLACED?

A. No. The Final EIS listed four alternatives to the replacement of the Unit 2 steam generators in 1996.[1] These were: continued plugging through retirement of Unit 2 in the year 2000; massive sleeving of the Unit 2 steam generator tubes through the early shut down of the Unit in the year 2005; derating of the Unit by 25 percent; and laser repair. Of the four alternatives, the Staff economic analyses presented in the Final EIS only examined the continued sleeving alternative.

The early shutdown of both Point Beach Units in 1998 was not cited in the Final EIS as an alternative to the replacement of the Unit 2 steam generators in 1996. Indeed, if the dry cask storage facility (ISFSI) were built, neither Unit 1 nor Unit 2 would have to shut down in 1998 due to the unavailability of spent fuel storage

[1] Final EIS, pages 135 through 137.

capability.[2] Moreover, as was noted in the Final EIS, WEPCO currently projects that even if it continued to plug degraded steam generator tubes, Unit 2 would be able to continue to operate through the year 2000.

Consequently, the Option 3 examined by Staff in the Final EIS was not a realistic future scenario for Point Beach because it assumed that both Units would be shut down in 1998 if the Unit 2 steam generators were not replaced <u>despite</u> the existence of the dry cask storage facility. For this reason, the comparison between Options 1 and 3 was irrelevant to the question of whether replacement of the Unit 2 steam generators is the more economic alternative.

Q. WHAT OPTIONS SHOULD HAVE BEEN EXAMINED IN THE FINAL EIS TO DETERMINE WHETHER THE ISFSI AND THE REPLACEMENT OF THE UNIT 2 STEAM GENERATORS WERE ECONOMIC?

A. The economic analyses in the Final EIS should have been structured to first determine whether it would be economic to construct the dry cask storage facility. This would have been accomplished by comparing the early retirement of both Point Beach Units, assuming that the dry cask storage facility was not built, with scenarios reflecting (a) the construction of the dry cask

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[2] The Final EIS noted that Unit 2 would have to be shut down in 1998 <u>if</u> the dry cask project were not authorized. (Page 135)

storage facility and the replacement of the Unit 2 steam generators and (b) the construction of the dry cask storage facility without the replacement of the Unit 2 steam generators.

Then, if construction of the dry cask storage facility had been found to be economically justified, the economic analysis in the Final EIS could have compared the economics of steam generator replacement versus the continued plugging and the sleeving repair scenarios. As noted above, the continued plugging scenario should assume that, even if the Unit 2 steam generators were not replaced or massively sleeved, Unit 2 would operate through the year 2000 and Unit 1 would operate through its scheduled retirement in the year 2010. The massive sleeving scenario would assume, as Staff has done, that Unit 2 would operate through the year 2005 and Unit 1 would operate through its scheduled retirement in the year 2010.

Q. WHAT WOULD BE THE IMPACT OF CORRECTING OPTION 3 IN THE MANNER YOU HAVE JUST DESCRIBED?

A. The economics of Option 3 versus Option 1 would be substantially improved, i.e., the economic advantage shown in the tables in Chapter 4 of the Final EIS for Option 1 would be significantly reduced or, perhaps, even eliminated entirely in some sensitivity analyses.

## SECTION III.
## NUCLEAR POWER PLANT AGING

Q. PLEASE EXPLAIN WHAT YOU MEAN BY THE TERM "NUCLEAR POWER PLANT AGING."

A. As defined by the U.S. Nuclear Regulatory Commission, aging is "the cumulative, time-dependent degradation of a system, structure, or component in a nuclear power plant that, if unmitigated, could compromise continuing safe operation of the plant."[3]

The impact of aging is universal. Normal aging occurs in all large engineered structures and equipment. No complex equipment or structures, including nuclear power plants, can be considered to be immune from its effects. For reliable and continued operation of complex facilities, age-related degradation processes must be addressed and managed.

Q. DOES THE NRC CONSIDER AGING TO BE A SERIOUS ISSUE FOR OPERATING NUCLEAR POWER PLANTS?

A. Yes. The NRC has stated that aging is a serious problem for the equipment, components, and structures of nuclear power plants. For example, in 1992, the NRC informed Congress that:

> Aging is a vital concern with currently operating

[3] NUREG-1144, REV. 2, "Nuclear Plant Aging Research (NPAR) Program Plan," U.S. Nuclear Regulatory Commission, June 1991.

> plants and will clearly be crucial to any assessment of the safety implications of license renewal. Aging affects all reactor structures, systems, and components. If unmitigated, it has the potential to increase risks to public health and safety. There are significant uncertainties about age-related degradation processes and about whether time-related degradation can be detected and managed before safety is impaired. Specifically, there is concern that multiple failures of age-related components could occur during transients or accidents and result in core damage and release of radiation. In the past, failures of safety-related components have occurred because of such degradation processes as corrosion, radiation, and thermally induced embrittlement of electrical insulation, pitting of electrical contacts, surface erosion, metal fatigue, oxidation, creep, binding, and wear. A number of these phenomena also cause deterioration of mechanical components.[4]

Similarly, the NRC's June 1991 report on the progress of its "Nuclear Plant Aging Research Program Plan" emphasized that:

> As the population of U.S. [Light Water Reactors] has aged, problems have occurred as a result of time-dependent degradation mechanisms such as stress corrosion, thermal aging, radiation embrittlement, fatigue, and erosion. These problems have included failures in pumps, valves, and relays, embrittlement of cable insulation, and cracking of the heat-treated anchor heads for post-tensioning systems in containment. Although progress is being made to mitigate the degradation that has already been identified, significant questions concerning age-related degradation of [systems, structures, and components] remain because of the variety of components in a commercial power reactor, the complexity of the

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[4] U.S. Nuclear Regulatory Commission "Annual Report to Congress for 1992," NUREG-1145, Vol. 9, page 160.

aging process, and the limited experience with prolonged operation of these power plants.[5]

This same NRC report also noted that research at the Pacific Northwest Laboratory had revealed that the aging of nuclear power plant components may result in a significant increase to the overall risk of plant accidents.[6]

Q. PLEASE GIVE SOME EXAMPLES OF AGE-RELATED DEGRADATION OF NUCLEAR POWER PLANT STRUCTURES, SYSTEMS AND COMPONENTS.

A. The steam generator tube problems and reactor vessel embrittlement issues discussed in the Final EIS are two examples of time related degradation issues of concern to the NRC and the nuclear industry. However, aging affects many more plant structures, systems, and components. Exhibit STC-2 consists of the Table of Contents from the proceedings of the NRC's March 1992 Aging Research Information Conference. The broad range of topics addressed at this conference show that aging related degradation can affect pumps, valves, motors, electrical cables and

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[5] NUREG-1144, Rev. 2, "Nuclear Plant Aging Research (NPAR) Program Plan," U.S. Nuclear Regulatory Commission, June 1991, page 1.5.

[6] NUREG-1144, Rev. 2, "Nuclear Plant Aging Research (NPAR) Program Plan," U.S. Nuclear Regulatory Commission, June 1991, pages 4.3 and 6.21.

other active and passive structures, systems and components.[7] Among the time-related degradation processes that can affect this equipment are corrosion, erosion, fatigue and radiation and thermal embrittlement.

Q. IS THERE ANY SIGNIFICANT OPERATING EXPERIENCE WITH OLDER NUCLEAR POWER PLANTS?

A. No. There is almost no operating experience with any commercial nuclear power plants operating after the age of 25. This is especially true for plants with designs the most similar to that of Point Beach.

Point Beach Unit 1 began commercial operations in December 1970. Consequently, the Unit has been operating for approximately 23.5 years of its projected 40 year service life. Similarly, Unit 2 began commercial operations in October of 1972. Thus, it has been operating for approximately 22 years of its projected 40 year service life.

Table STC-1 below shows the dates when the domestic and foreign two loop pressurized water reactor nuclear plants (PWRs) with Westinghouse designed Nuclear Steam Supply Systems (i.e., those plants most similar to Point Beach) began commercial

[7] See also Exhibit STC-3 which consists of the cover page, the table of contents and the foreword from NUREG/CR-5643, "Insights Gained from Aging Reseach," published by the NRC in March 1992 and distributed at the Aging Research Information Conference.

operations. Of these plants, only the Beznau 1, Ginna and Mihama 1 plants are older than Point Beach Unit 1. However, none of these plants is more than one year older than Point Beach.

TABLE STC-1

| Unit | Start of Commercial Operations |
|---|---|
| Beznau 1 | December 1969 |
| R.E. Ginna | July 1970 |
| Mihama 1 | November 1970 |
| Mihama 2 | July 1972 |
| Point Beach 1 | December 1970 |
| Beznau 2 | March 1972 |
| Point Beach 2 | October 1972 |
| Prairie Island 1 | December 1973 |
| Kewaunee | June 1974 |
| Prairie Island 2 | December 1974 |
| Kori 1 | April 1978 |
| Doel 1 | February 1975 |
| Doel 2 | December 1975 |
| Krsko | January 1983 |
| Angra 1 | January 1985 |

Table STC-2 below shows the dates when other small domestic and foreign PWRs (i.e., those PWRs between 200 Mwe and 700 Mwe which are not Westinghouse two-loop plants) began

commercial operations. This Table also shows that none of these plants are significantly older than Point Beach.

TABLE 2

| Unit | Start of Commercial Operations |
|---|---|
| Haddam Neck | January 1968 |
| Obrigheim | March 1969 |
| Robinson 2 | March 1971 |
| Stade | May 1972 |
| Fort Calhoun | September 1973 |
| Borssele | October 1973 |
| Genkai 1 | October 1975 |
| Ikata 1 | September 1977 |

Of all of the plants included on Tables STC-1 and STC-2, only one plant, Haddam Neck, is more than 25 years old. Consequently, there is almost no actual service experience upon which to project how well plants like Point Beach will operate as they age during the second half of their service lives. In fact, there is no actual experience on how well plants like Point Beach will operate after they reach the age of 26 years.

Q. WHAT IMPACT CAN AGING REASONABLY BE EXPECTED TO HAVE ON PLANTS SUCH AS POINT BEACH?

A. The impact of aging can be expected to be very plant-specific, varying between plants depending upon individual designs and conditions. However, in general, aging can be expected to have the following impacts on nuclear plants including Point Beach.

First, increasing numbers of plant structures, systems, and/or components will degrade and require replacement. In addition, utilities will be required to implement expanded monitoring, testing, and preventive maintenance programs (a) to identify degraded structures, systems, and components before they affect plant safety and (b) to mitigate or arrest, where possible, the degradation of plant structures, systems, and components important to plant safety.

Research sponsored by the NRC has already identified needed improvements in utility monitoring, testing, and preventive maintenance programs to address age-related degradation. For example, a March 1992 aging assessment of circuit breakers and relays prepared for the NRC by Wyle Laboratories concluded that:

> These evaluations of degradation conditions showed that generally accepted current nuclear plant maintenance practices do not always detect the effects of significant aging mechanisms. This provides insight into the reason failures of safety-related relays have occurred in service in spite of a comprehensive maintenance program.[8]

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[8] NUREG/CR-5762, "Comprehensive Aging Assessment of Circuit Breakers and Relays," Wyle Laboratories, March 1992:

Similarly, an assessment of the impact of aging on the control rod systems in Westinghouse-designed power plants reported that:

> The findings and recommendations of this aging study may be summarized as follows:
>
> 1. Aging-related degradation of the Westinghouse CRD system can compromise the intended function of the system.....
>
> * * * *
>
> 3. The preventive maintenance, including inspection and testing of the in-containment cables, connectors, and coils should be increased as these components age.[9]

Other research sponsored by NRC has also led to additional recommendations for addressing and managing the aging of nuclear power plant structures, systems, and components before safety margins were reduced. For example, a study by the Brookhaven National Laboratory evaluated the effectiveness of current utility maintenance programs in managing aging in nuclear power plants. The study's general conclusion was that:

> the management of aging is typically not adequately addressed by existing maintenance programs. This conclusion is reached by considering the overall lack of specific aging management programs and notable deficiencies in preventive and predictive maintenance, post-maintenance testing, failure trending, and root cause analysis. We believe that widespread

[9] NUREG/CR-5555, "Aging Assessment of the Westinghouse PWR Control Rod System," Brookhaven National Laboratory, March 1991:

implementation of the many positive maintenance activities highlighted in this report, as well as a direct effort to improve the management of aging, would enhance the effectiveness of maintenance programs, and thereby, further improve the level of safety of nuclear power plants.[10]

Q. IS IT POSSIBLE TO PRECISELY QUANTIFY THE IMPACT THAT AGING WILL HAVE ON FUTURE POINT BEACH OPERATING PERFORMANCE AND OPERATING COSTS?

A. No. As noted by the NRC, there are "significant uncertainties about time-related degradation processes." That is why it is important when performing economic analyses such as those in the Final EIS to examine a range of possible scenarios for future plant capacity factors, O&M costs, and capital additions expenditures which reflect both optimistic and more conservative (or pessimistic) assumptions about the impact of the aging of plant structures, systems and components.

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[10] NUREG/CR-5812, "Managing Aging in Nuclear Power Plants: Insights from NRC Maintenance Team Inspection Reports," Brookhaven National Laboratory, December 1993, page xii.

## SECTION IV.
## CAPACITY FACTORS

Q. DO YOU BELIEVE THAT IT IS REASONABLE TO EXPECT THAT THE PERFORMANCE OF POINT BEACH UNITS 1 AND 2 WILL REMAIN AT HISTORICAL LEVELS THROUGHOUT THE REMAINING SIXTEEN TO EIGHTEEN YEARS OF THE UNITS' PROJECTED SERVICE LIVES?

A. No. I believe that some reductions in capacity factors can be expected as the Units age.

Q. IS IT POSSIBLE TO QUANTIFY WHAT REDUCTIONS IN CAPACITY FACTOR CAN BE EXPECTED AS THE UNITS AGE?

A. No. I do not believe that it is possible to precisely quantify what reductions in the Point Beach Units' capacity factors will be experienced as the plants age due to (1) the significant uncertainties about age-related degradation processes and the possible impacts of those processes on plants such as Point Beach and (2) the fact that there is no actual operating experience with nuclear power plants similar to Point Beach beyond the age of 26. For this reason, I believe that it is essential to examine a range of capacity factors reflecting optimistic, conservative and pessimistic scenarios.

Q. WHAT CAPACITY FACTORS SHOULD BE ASSUMED FOR POINT BEACH IN THE OPTIMISTIC SCENARIOS?

A. The use of WEPCO's projection that future Point Beach capacity factors will remain at about 85 percent as the Units age would certainly represent an optimistic scenario as it reflects the continuation of the extremely low forced outage rates experienced by the Units in recent years.

Q. WHAT CAPACITY FACTORS SHOULD BE ASSUMED FOR POINT BEACH IN THE CONSERVATIVE SCENARIOS?

A. The capacity factors assumed by Staff in the Decreasing Capacity Factor Sensitivity Analysis would be a conservative scenario in which the Units begin to experience more severe equipment problems as they age. Thus, I do not agree with Staff that the reductions in capacity factors assumed in this sensitivity analysis are "unlikely."[10]

The capacity factors assumed in the Decreasing Capacity Factor Sensitivity Analyses average only 10 to 12 percentage points lower than the Staff's Base Case capacity factors over the remaining years of the Units' service lives. This means that both

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[10] Interestingly, in the Draft EIS, Staff rejected its Declining Capacity Factor Sensitivity Analysis as being "highly unlikely." (page 22) However, in the Final EIS, the capacity factor reductions assumed in the Declining Capacity Factor Sensitivity Analysis had become only "unlikely," rather than "highly unlikely." (page 27)

Point Beach Units would continue to achieve, on average, capacity factors above 70 percent throughout the years 1994-2013, even in the Declining Capacity Factor Sensitivity Analyses.

Q. WHAT CAPACITY FACTORS SHOULD BE ASSUMED IN THE PESSIMISTIC SCENARIOS?

A. More pessimistic capacity factor scenarios should be examined in which the Point Beach Units experience long outages during their later operating years and/or are forced to shut down early due to currently unanticipated or unforeseen technical problems, even if the steam generators are replaced in 1996. In recent years, a number of nuclear power plants, e.g., the Calvert Cliffs, Palo Verde, Pilgrim, Nine Mile Point 1, and Brunswick nuclear plants, have experienced very extended maintenance outages lasting for a year or longer. Similarly, the Rancho Seco, San Onofre 1, Yankee Atomic, and Trojan Nuclear Plants have been shut down years before their scheduled retirements due to technical and/or economic problems.

I have recommended that Tellus examine the impact of slightly lower capacity factors in a mildly pessimistic scenario in which the Units' capacity factors would decrease to 68 percent from 1998 through 2007 and to 60 percent from 2008 through 2013. Significantly, this does not represent a worst case scenario in which either Point Beach Unit experiences a very extended maintenance outage or is shut down prematurely due to currently unforeseen technical problems.

Q. HAVE YOU SEEN ANY OTHER ANALYSES WHICH ALSO ASSUMED THAT FUTURE NUCLEAR PLANT CAPACITY FACTORS WOULD DECREASE FROM HISTORICAL LEVELS AS THE UNITS AGE?

A. Yes. In a 1991 proceeding before the California Public Utilities Commission investigating the cost-effectiveness of the continued operation of San Onofre Unit 1 the Southern California Edison projected that the Unit would achieve between a 60 percent and an 80 percent capacity factor over the remaining years of its service life, with 70 percent being the most likely figure. However, the Commission's Division of Ratepayer Advocates (DRA) recommended that the unit's historical 56.4 percent capacity factor be used as a base case instead of the Company's "unreasonably optimistic" capacity factors. Moreover, Staff also believed that a capacity factor of 44 percent should also be considered to take into account the potential for prolonged outages due to plant aging, increasing NRC requirements or plant-specific problems.[11]

Interestingly, the ten to twelve percentage point reduction in future plant capacity factors due to aging rejected by the Commission staff in the Final EIS as being "unlikely" is approximately the same as the twelve point six percentage point reduction assumed as reasonable by the CPUC staff in its analyses

[11] "Report on the Cost-Effectiveness of Continued Operation of the San Onofre Nuclear Generating Station Unit No. 1," issued in CPUC Investigation 89-07-004 on September 25, 1991, pages 9-10.

of the future operating performance of San Onofre Unit 1.

Q. HAVE YOU IDENTIFIED ANY ERRORS CONCERNING THE CAPACITY FACTORS USED BY STAFF IN THE ECONOMIC ANALYSES PRESENTED IN THE FINAL EIS?

A. Yes. The Staff economics analyses relied upon the mistaken assumption that Point Beach 2 would experience a 113 day outage in 1996 in both the steam generator replacement (Option 1) and the continuing sleeving (Option 2) scenarios.

Q. PLEASE EXPLAIN.

A. A review of the ENPRO computer output used in Staff's economic analyses has revealed that Staff assumed in the Option 1 scenarios that there would be a 113 day outage in 1996 during which the Unit 2 steam generators would be replaced. This outage was projected to be approximately 71 days longer than the normal refueling outage.[12] However, the ENPRO output for the Option 2 scenarios (i.e., computer cases SLVSG and SLVSGP) also reflected this same 113 day outage for Unit 2 in 1996. This was incorrect. Such a long outage would not be necessary in 1996 if the steam generators were not being replaced at that time. In fact, Staff correctly modeled a shorter 1996 Unit 2 outage in the Shutdown in 1998 (Option 3) scenarios.

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[12] Page 124 of the Final EIS.

Q. WHAT WOULD BE THE IMPACT OF REFLECTING THE SHORTER UNIT 2 OUTAGE IN 1996 IN THE CONTINUED SLEEVING OPTIONS?

A. The economics of Option 2 versus Option 1 would improve by several million dollars.

# SECTION V.
# O&M COSTS AND
# CAPITAL ADDITIONS EXPENDITURES

Q. WHAT HAVE BEEN THE COMPANY'S ANNUAL OPERATIONS AND MAINTENANCE EXPENSES FOR THE POINT BEACH PLANT?

A. Point Beach's annual Operations and Maintenance expenditures (O&M) for Point Beach have grown from approximately $7.4 million in 1978 to $76.5 million in 1993. As shown on Figures 4-1 through 4-4 of the Final EIS, this represents, on average, real growth of approximately three to four percent above the overall rate of inflation.

Q. WHAT HAVE BEEN THE COMPANY'S ANNUAL CAPITAL ADDITIONS EXPENDITURES FOR THE POINT BEACH PLANT?

A. The Company's annual capital additions expenditures for Point Beach have grown from approximately $2.6 million in 1978 to approximately $8.8 million in 1992 although, as shown on Figure H-10, this growth has not been as consistent as the real growth of O&M expenditures. Instead, the capital additions expenditures peaked in the early 1980's, then decreased dramatically before rising again between the late 1980's and the early 1990's.

Q. WHAT FACTORS HAVE LED TO THESE INCREASES IN O&M AND CAPITAL ADDITIONS EXPENDITURES?

A. There have been two primary reasons for increased O&M and capital additions expenditures at operating nuclear power plants since the early 1970's: (1) to address a wide variety of previously unidentified technical problems that were identified from nuclear power plant operational experiences, and (2) to respond to a dramatic growth in the scope and number of NRC regulations.

Technical problems have adversely affected plant operations and have led to utility initiated plant modifications, equipment replacements, and structural improvements. To a significant degree, these problems have been the result of inadequate plant designs, complex plants, poor maintenance practices, and component or structural degradation caused by any one of a variety of phenomena such as erosion, corrosion, wear, fatigue, vibration, and internal debris and corrosion product buildup. The precise set of technical problems experienced has varied between units based on plant-specific circumstances. However, unanticipated component, system or structural problems generally have affected all nuclear plants.

In addition, all areas of nuclear power plant operation have been affected by the growth in NRC regulation. For example, new regulations concerning fire protection measures and control room designs and instrument requirements have meant increased O&M and capital additions expenditures for utilities operating nuclear power plants.

Significantly, many of these technical problems and regulatory changes were unanticipated by utilities when the nuclear power plants entered commercial service. For example, in 1983, Mr. Cordell Reed, a Vice President of Commonwealth Edison Company, acknowledged that:

> I can recall, following the startup of Dresden Unit 2, [i.e., in approximately 1970] we felt that all we had to do was clean up a punch-list and the modifications would be few and far between. Based on that assumption, we felt that much of the engineering work could be done in house....Time has shown that we were dreaming.[13]

Although there has been a slackening in the rate of technical and regulatory changes affecting nuclear power plant operating costs in recent years, it is reasonable to expect that future regulatory and industry activities and the impact of nuclear power plant aging will continue to lead to real increases in O&M and capital additions expenditures at Point Beach. In fact, representatives of nuclear utilities have complained that the NRC continues to issue so many new regulations that it is, in effect, managing nuclear power plant resources rather than regulating the industry.[14]

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[13] Nucleonics Week, "Special Supplement, the Nuclear Services Business in the 1980's," a report on a conference held May 17-20, 1983, page S-8.

[14] NUREG-1135, Industry Perceptions of the Impact of the U.S. Nuclear Regulatory Commission on Nuclear Power Plant Activities, U.S. Nuclear Regulatory Commission, March

Q. WHAT EVIDENCE HAS LED YOU TO CONCLUDE THAT THESE SAME FACTORS WILL LEAD TO FURTHER REAL GROWTH IN O&M COSTS AND CAPITAL ADDITIONS EXPENDITURES AS NUCLEAR POWER PLANTS AGE?

A. The NRC currently has a long list of unresolved generic issues, with new issues being added as older issues are resolved. In addition, there are a number of NRC regulatory issues and initiatives which have the potential for affecting O&M and capital additions expenditures at Point Beach. Specific examples of these issues include:

* The NRC's July 1991 issuance of a Maintenance Rule which will probably expand the NRC's oversight of utility maintenance programs and activities.

* The NRC's increasing concerns since 1987 over the potential for serious accidents while power plants are in shutdown or low power conditions.

* The NRC's concerns over the erosion/corrosion of secondary side systems.

* The NRC's concern over the potential adverse safety consequences of the aging of nuclear power plant structures, systems and components and the results of the NRC-sponsored research into aging processes and consequences.

It is reasonable to expect that these issues and initiatives will result in increased O&M and capital additions expenditures at

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1990, page xiii.

operating nuclear power plants like Point Beach. For example, as noted in an October 1991 paper by Dr. James G, Hewlett, who has analyzed the reasons for O&M cost and capital additions expenditure growth for the U.S. Department of Energy, the level of regulatory activity will probably increase in the future as the current generation of nuclear power plants ages:

> More importantly, NRC regulatory activity probably will increase in the future, causing regulatory-induced capital additions costs to increase. In particular, the NRC is funding a multimillion dollar aging research program, which is currently examining the aging of 30 major systems. Except in the area of license renewal, the NRC has yet to formulate a regulatory policy in the area of plant aging. At some point, this research program will result in additional regulatory-induced aging-related repairs. Moreover, as more information about the aging process becomes available, it is possible that the level of regulatory induced retrofits of older plants will increase.

Moreover, the NRC is not the only organization whose activities will impact future plant operating costs. The activities of the nuclear industry's Institute of Nuclear Power Operations (INPO) also will lead to future O&M and capital additions expenditures.

In addition to setting standards of performance for the industry, INPO conducts periodic evaluations of each operating nuclear power plant and of the corporate support given to nuclear plant activities by the utility/owners. INPO also circulates information within the industry concerning (a) significant operating events or problems experienced at individual plants and (b) identifying good practices in effect at member power plants. It also

rates plants on the basis of performance factors such as availability, unplanned automatic scrams, radiation protection, and heat rate.

Utilities have started to complain that INPO's activities contribute to the increased O&M and capital additions expenditures. In fact, a utility has complained that:

> There are some .... who say INPO is another NRC. Every year we see more and more inspections.

Both the NRC and the nuclear industry's Institute for Nuclear Power Operations (INPO) have stated that they are only concerned with safety and, therefore, are not going to help utilities solve the problem of rising O&M costs. For example, an INPO representative told a 1990 conference of the American Nuclear Society that:

> Our mission is clear cut ..... When INPO was created in 1979 ... it was charged to promote the highest levels of safety and reliability - to promote excellence - in the operation of nuclear electric generating plants.
>
> Meeting minimal regulatory requirements is not acceptable, and cost control is management's responsibility.... Efforts to maintain and enhance reactor safety should not be debated from an economic standpoint... INPO was not created to be an economic advisor.
>
> .... INPO does not have the responsibility to assist utilities in achieving cost savings or for developing "good practices" aimed primarily at more economic operation and maintenance.[15]

[15] Power Engineering, March 1991, page 18.

James Taylor, then the NRC's Executive Director of Operations, told the same conference that the NRC has little interest in cost control. According to Mr. Taylor, "Nuclear safety is the only reason we're [i.e., the NRC] here."[16]

Furthermore, NRC Chairman Ivan Selin has been speaking lately about how important it is for the NRC, "in the name of safety," to expand its oversight by looking at nuclear utilities balance sheets. For example, Chairman Selin has noted that:

> He said, "I have reviewed the capital expenditure programs, the O&M budget allocations, and the financing options of the approximately 20 nuclear power plants I have visited," and added, "I have noticed that those utilities that are seen as good performers generally have a dedicated and planned program of capital investment for their plants. They recognize the value of their capital assets and actively work to ensure that those interests are protected and remain strong."
>
> "Many of the facilities considered to be the poorer performers seem to have more sporadic capital investment strategies. Graphs of their capital investment history resemble roller coasters-up and down, back and forth. The physical plant forces management into making decisions reactively instead of implementing a program to maintain the plant in an effective and efficient condition. While this does not, in and of itself, adversely affect the current safety status of a plant, it is a bad sign."[17]

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[16] Power Engineering, March 1991, page 18.

[17] Nucleonics Week, February 6, 1992, page 8.

Q. HAVE YOU SEEN ANY EVIDENCE THAT UTILITIES HAVE ACKNOWLEDGED THAT O&M COSTS AND CAPITAL ADDITIONS EXPENDITURES HAVE BEEN INCREASING AS NUCLEAR PLANTS AGE?

A. Yes. A number of utilities have acknowledged that it is reasonable to expect that as nuclear plants age, systems, structures and components will, at accelerating rates, fail and have to be replaced or will have to be repaired or replaced before they fail. In fact, a witness for Rochester Gas & Electric Corporation, the owner of the Ginna two-loop PWR, testified before the New York State Public Service Commission that as the Ginna plant got older:

> it seems reasonable to assume that maintenance costs will increase, plant availability will decrease and major capital replacements could greatly increase future depreciation expenses.[18]

The same point was made by an official at Carolina Power & Light Company who acknowledged in 1991 that the utility's older nuclear plants, Brunswick and Robinson, had cost more to run "because of their ages." This same official also noted that a recent outage of the twenty year old Robinson 2 PWR had been "a very costly outage as a result of the age of the plant."[19]

Similarly, a January 1988 study of the material condition of

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[18] Prepared testimony of Alan Larson filed in New York State Public Service Commission Case No. 28313, page 10.

[19] Nucleonics Week, August 15, 1991, pages 7 and 8.

the Oyster Creek Nuclear Plant noted that the overall condition of the plant had improved since an earlier 1982 study. However, the 1988 report also warned that:

> While these results suggest that the number of significant, immediate problems has been reduced, it must be recognized that after 18 years of operation, inevitable equipment degradation will require a continued and, likely, increasing level of preventive maintenance, monitoring and surveillance, and corrective actions. This is especially important in light of the long range goal of maximizing economic plant operating life. Incipient aging degradation which may not show up in present maintenance and inspection activities will play a larger role in establishing and extending the useful life of major components.[20]

Finally, Harold B. Ray, the Senior Vice President, Nuclear for Southern California Edison Company told the NRC's March 1992 Aging Research Information Conference that the reason that San Onofre Unit 1 was being prematurely retired was that the staff of the California Public Utilities Commission was convinced:

> that aging costs in the years beyond would exceed the benefits achievable by continued operation. Thus, they were unwilling to continue to provide the revenues to cover today's costs largely because the projected future costs resulting from plant aging.[21]

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[20] Volume I, page 3-1 of the "Oyster Creek Nuclear Generating Station Material Condition Study Phase II," dated January 1988.

[21] "Proceedings of the NRC Aging Research Information Conference," NUREG/CP-0122, September 1992, Vol. 2,

Q. WHAT O&M COSTS AND CAPITAL ADDITIONS EXPENDITURES SHOULD BE REFLECTED IN THE ECONOMIC ANALYSES IN THE FINAL EIS?

A. The economic analyses should assume real escalation of both O&M costs and capital additions expenditures of at least two to four percent above the overall rate of inflation to reflect the potential impact of plant aging and the other factors I have discussed in this section of my testimony.

Q. IS IT REASONABLE TO EXPECT, AS STAFF HAS ASSUMED, THAT O&M EXPENDITURES AT OPERATING NUCLEAR POWER PLANTS WILL DROP OFF DURING THE LAST FIVE YEARS OF OPERATION IN ANTICIPATION OF RETIREMENT?

A. No. It is reasonable to expect that O&M expenditures will not drop off during the last five years of operation. First, there is no reason to believe that the costs of operating the plant will drop off during the last five years before retirement. In particular, the same numbers of operations and support personnel will be required to operate the plant in a safe and reliable manner.

Nor is there any reason to believe that the costs of maintaining plant equipment so that it functions safely, reliably and when needed will drop off as the plant reaches the end of its

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page 444.

projected service life. Federal Regulations require that nuclear power plants be maintained in a safe condition and comply with all requirements necessary to ensure safe operation. The NRC has repeatedly cited utilities for failing to conduct needed preventive and/or corrective maintenance. Thus, it is not reasonable to expect that the NRC will allow a licensee to eliminate or skip any maintenance work on an older nuclear plant nearing retirement that could influence plant safety, either directly or indirectly.

However, I do agree that the capital additions expenditures will probably level off during the last five years of operation. Capital additions expenditures generally reflect more expensive and longer term projects than O&M expenditures. It is reasonable to expect that a utility might attempt to eliminate in anticipation of retirement some of these projects which are more concerned with improving long-term plant or equipment availability than with maintaining safety margins.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is David A. Schlissel. My business address is Schlissel Technical Consulting, Inc., 45 Horace Road, Belmont, Massachusetts 02178.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS PROCEEDING?

A. I am testifying on behalf of the Citizens Utility Board.

Q. HAVE YOU PREVIOUSLY FILED TESTIMONY IN THIS PROCEEDING?

A. Yes. I filed testimony in this proceeding on September 12, 1994.

Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?

A. The purpose of this rebuttal testimony is to respond to the testimony of Public Service Commission of Wisconsin witnesses Sarah Jenkins and Christopher P. Hagman and Wisconsin Electric Power Company witnesses James R. Keller and Martin K. Conry.

Q. DO YOU HAVE ANY GENERAL COMMENTS ON THE TESTIMONY OF STAFF WITNESS HAGMAN?

A. Yes. Mr. Hagman's testimony merely summarizes and presents corrections to the discussion of the Staff economic analyses contained in the Final Environmental Impact Statement. Consequently, the comments contained in my direct testimony in this proceeding concerning the Final EIS apply to Mr. Hagman's testimony as well.

Q. HAS STAFF MODIFIED ITS OPTION 3, THE SHUTDOWN, TO CORRECT FOR THE SERIOUS FLAW YOU IDENTIFIED IN THE COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FILED BY SCHLISSEL TECHNICAL CONSULTING, INC., LAST APRIL?

A. No. Staff has not modified its economic analyses in response to my explanation that Option 3 does not represent a realistic scenario for what would happen if the dry cask storage facility were built but the Unit 2 steam generators were not replaced or massively sleeved.[1] As I have explained in both my Comments on the Draft EIS and my direct testimony in this proceeding, Staff's Option 3 assumes that both Point Beach Units would be retired in 1998 despite the existence of the dry cask storage. This directly

[1] Comments on the Draft EIS submitted by Schlissel Technical Consulting, Inc., on behalf of the Citizens Utility Board, dated April 8, 1994, pages ....

contradicts Staff's own conclusion that if the dry cask storage facility were built, Point Beach Unit 1 could operate through the scheduled end of its service life in the year 2010 and Unit 2 could operate through the year 2000, even if that Unit's steam generators were not replaced or massively sleeved.[2] Consequently, the Staff economic analyses summarized by Mr. Hagman and presented in the Final EIS provide no insight as whether the massive sleeving or replacement of the Unit 2 steam generators are truly more economic for the Company and its ratepayers than early retirement of Unit 2 in the year 2000 and operation of Unit 1 through the remainder of its planned service life.

Q. IS THE OPTION 3 DISCUSSED BY COMPANY WITNESS KELLER SIMILARLY UNREALISTIC?

A. Yes. Like the Staff analysis in the Final EIS, Mr. Keller's Option 3 unrealistically assumes that both Point Beach Units would be shut down in 1998, despite the existence of the dry cask storage facility.[3]

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[2] See page ... of the Final EIS. Company witness Conry has also testified that the Company currently projects that the plugging limit for Unit 2 would be reached in the year 2000. Testimony of Martin K. Conry, page 11, lines 14-15.

[3] Testimony of James R. Keller, page 4, line 24, through page 5, line 5, and Exhibit JRK-1.

Q. DO YOU HAVE ANY GENERAL COMMENT ON THE ECONOMIC ANALYSES PRESENTED BY COMPANY WITNESS KELLER?

A. Yes. Mr. Keller's testimony appears to present the results of different economic analyses than were discussed in the Final EIS or in the testimony of Staff witness Hagman. Unfortunately, the extremely short period of time between the filling of direct and rebuttal testimony in this proceeding has prevented me from analyzing Mr. Keller's workpapers to determine the reasonableness of his economic analyses.

Q. DO YOU AGREE WITH MR. KELLER'S CLAIM THAT THE COMPANY USED CONSERVATIVE ASSUMPTIONS FOR FUTURE O&M AND CAPITAL ADDITIONS EXPENDITURES IN ITS ECONOMIC ANALYSES?

A. No. As I explained in my direct testimony, I believe that the assumption that Point Beach will continue to operate at very high capacity factors while experiencing only modest real growth in O&M expenditures and capital additions expenditures is very optimistic. A truly conservative scenario would assume some decrease in plant capacity factors and significant real increases in O&M and capital additions expenditures as the Units age.

reasonable and achievable given the Company's experience with the replacement of the Unit 1 steam generators and the nuclear industry's overall experience with steam generator replacements.

Q. DO YOU AGREE WITH PSCW WITNESS JENKINS' TESTIMONY THAT YOU HAVE PRESENTED WORST CASE SCENARIOS FOR FUTURE POINT BEACH OPERATING

Q. MR. KELLER STATED THAT THE ACTUAL 1993 POINT BEACH O&M EXPENDITURES WERE APPROXIMATELY $10 MILLION LOWER THAN WAS ANTICIPATED WHEN WEPCO AND PSCW STAFF BEGAN THEIR ECONOMIC ANALYSES.[4] DID THE SCHLISSEL/TELLUS ECONOMIC ANALYSES REFLECT THE ACTUAL 1993 POINT BEACH O&M EXPENDITURES?

A. Yes. On my recommendation, the economic analyses presented in the testimony of CUB witnesses Bruce Biewald and William Dougherty started with the actual 1993 Point Beach O&M expenditures of $78 million rather than the $88 million figure assumed by the Company and PSCW Staff.

Q. IS THERE ANYTHING IN THE TESTIMONY OF COMPANY WITNESS CONRY THAT CAUSES YOU TO CHANGE THE CONCLUSION IN YOUR DIRECT TESTIMONY CONCERNING THE REASONABLENESS OF THE COMPANY'S PROJECTED COST AND SCHEDULE FOR THE 1996 REPLACEMENT OF THE UNIT 2 STEAM GENERATORS?

A. No. Nothing in Mr. Conry's testimony has led me to change my conclusion that WEPCO's projected cost and schedule for the 1996 replacement of the Point Beach Unit 2 steam generators appear

[4] Testimony of James R. Keller, page 17, lines 1-8.

reasonable and achievable given the Company's experience with the replacement of the Unit 1 steam generators and the nuclear industry's overall experience with steam generator replacements.

Q. DO YOU AGREE WITH PSCW WITNESS JENKINS' TESTIMONY THAT YOU HAVE PRESENTED WORST CASE SCENARIOS FOR FUTURE POINT BEACH OPERATING COSTS?

A. No. At page 3 of her Exhibit SJ-2, Ms. Jenkins mentioned that Staff had incorporated Schlissel Technical Consulting's (STC) suggestion that the capital additions sensitivity assume a real increase of four percent per year. Although I am pleased that Staff adopted the STC conservative scenario for capital additions growth, Ms. Jenkins statement that this represented STC's "worst case scenario" was incorrect. The assumption that capital additions expenditures will grow at four percent above the overall rate of inflation is a conservative or a mildly pessimistic assumption but not a "worst case scenario." Indeed, it is possible to construct scenarios, however unlikely, in which Point Beach capital additions expenditures could experience substantially higher growth than the four percent real high end of my reasonable range. These would be "worst case scenarios."

Q. DOES THIS COMPLETE YOUR REBUTTAL TESTIMONY?

A. Yes.